Marine and Tropical Sciences Research Facility

Understanding the social and economic values of key marine species in the Great Barrier Reef

MTSRF Project 4.8.6(a) Final Report, June 2010 with a section focusing on marine turtles

N. Stoeckl, A. Birtles, P. Valentine, M. Farr, M. Curnock, A. Mangott and S. Sobtzick

Australian Government
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JAMES COOK UNIVERSITY AUSTRALIA

Reef & Rainforest RESEARCH CENTRE

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Objective (a) Identify relative social and economic values of key marine species, particularly large fish around tourist facilities

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Reef & Rainforest RESEARCH CENTRE

June 2010

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Acronyms and Abbreviations

ABS..... Australian Bureau of Statistics
ANZSIC..... Australian and New Zealand Standard Industrial Classification
AUD..... Australian Dollar(s)
BES..... Business Expenditure Survey
CGE..... Computable general equilibrium
CPI ..... Consumer Price Index
CS ..... Consumer surplus
EMC ..... Environmental Management Charge
FNQ..... Far North Queensland
GBR ..... Great Barrier Reef
GBRMP..... Great Barrier Reef Marine Park
GBRMPA ..... Great Barrier Reef Marine Park Authority
GDP..... Gross Domestic Product
IO..... Input-output (model)
JCU ..... James Cook University
NOAA..... National Oceanic and Atmospheric Administration
Pax..... Passengers
QLD..... Queensland
SWW ..... Swim-with-whales
TEV ..... Total Economic Value
TNQ..... Tropical North Queensland
US ..... United States
WTP ..... Willingness to pay

1. Introduction

1.1 Objectives of project and focus of report

The research reported in this document was conducted by a group of researchers within the Marine and Tropical Sciences Research Facility (MTSRF) Program 8 (led by Dr Colin Simpfendorfer), under Project 4.8.6 (led by Professor Bruce Prideaux).

The specific task addressed by this group's activities relate to **Research Task 4.8.6 (a)**:

> *To identify relative social and economic values of key marine species, including large fish around tourist facilities.*

This report constitutes the Final Report of that research task, and also includes a section dedicated to the socio-economic values of marine turtles in relation to scuba diving tourism in the Far Northern Section of the Great Barrier Reef Marine Park (Section 6). The following sub-sections of this introduction provide a brief overview of the methodological approaches used to meet the goals of the project, with more specific details provided in the main body.

1.2 Relative social and economic values

The economic value of a good or service is notoriously difficult to estimate, particularly when dealing with non-priced goods such as environmental quality or, in this case, key marine species. This is because there are multiple 'values' associated with environmental 'goods' (or key marine species) – see Figure 1 – all of which need to be considered if attempting to estimate the total economic value of a species.

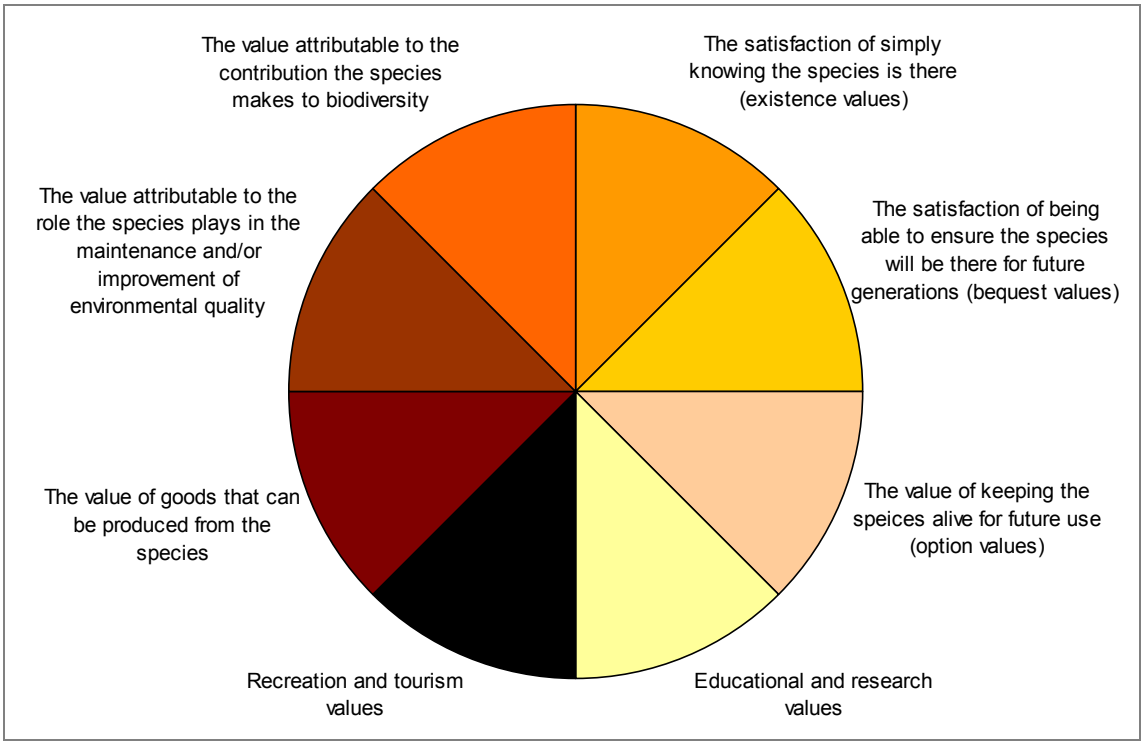

Figure 1: Total Economic Value (TEV). Note: segments are not drawn to scale.

Over the years, many different techniques – including, but not limited to, the travel cost method, hedonic pricing methods, replacement cost approaches, and choice modelling – have been developed and tested for their ability to quantify the values (or benefits) of different types of use and non-use values associated with environmental goods[1]. But the estimates generated in this report relate to just one part, of one 'segment' of the total economic value (TEV) pie in Figure 1 – the tourism values associated with key marine species. Our estimates are, therefore, an unambiguous underestimate of the TEV of these species.

1.3 Overview of methodological approach

Recognising that no single approach to estimating relative values is correct in all situations, this reports seeks to assess the relative tourism value of key species in several different ways:

a) It estimates the regional economic impact of boat-trips which facilitate interactions with key marine species[2];
b) It looks at the degree to which interactions with key species contribute to visitor 'satisfaction'; and
c) It investigates the willingness of people to pay for a 'guaranteed' chance of sighting key species while visiting the reef (*a marginal* value).

Researchers felt that it was important to generate these different types of estimates, because they each provide a different type of information that is useful in different contexts.

To be more specific, comparing the 'economic impact' of different types of boat-trips, or the 'satisfaction' that visitors derive from interactions with different species is akin to comparing the Gross Domestic Product (GDP) of countries. That is, knowing that one type of boat-trip has a larger economic impact than another or that visitors are gaining more satisfaction from their interactions with one type of species than another is akin to knowing that the US economy is larger than the Australian economy. This type of information tells us which types of trips (or species) are CURRENTLY of most 'value' (in terms of ability to satisfy tourists, and/or to generate incomes for local residents).

In contrast, willingness to pay (WTP) estimates provide information about future opportunities. Some species may not, for example, be seen frequently in the wild. Consequently, tourists do not have many opportunities to interact with them, so these species will almost certainly receive low overall satisfaction (and economic impact) 'scores'. But this does not mean that it is 'optimal' to ignore these species! Actions which preserve or help regenerate stocks of rare species ***could*** do more to improve visitor satisfaction, or to

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[1] Interested readers are directed to Garrod and Willis (1999), Bateman *et al.* (2002) and Willis *et al.* (1999) for a detailed review. The key point to note here, however, is that different methodological approaches, typically measure different types of economic value (e.g. use or non-use).

[2] When tourists spend money to come and view animals, they generate income and employment. So, marine species are of 'value' to local residents in that they create an economic 'impact'. But, the total tourism value of a species is not just equal to the amount actually paid (total expenditure). Rather it is the sum of the amount paid plus an undefined and often temporally variable 'consumer surplus', which is the additional amount that people are willing to pay over and above the asking price – sometimes estimated used approaches such as the travel cost method. This study looks at the economic 'impact' of marine tourism and thus generates an unambiguous underestimate of tourism values, since it neglects the values accruing to one part of the market (i.e. the consumer surplus). In other words, not only does the study focus on just one slice of the TEV pie (Figure 1), but it generates an unambiguous underestimate of the size of that 'slice'.

generate extra regional incomes than actions which protect the stocks of already abundant species. This is assuming, however, that visitors would like to have the opportunity to interact with those species. It is, therefore, important to collect information about visitor attitudes and preferences regarding future (potential) opportunities to interact with different species. Hence the importance of asking questions about visitor WTP for improved 'access'.

To meet the primary research objective, researchers therefore conducted a series of surveys – collecting data from both Reef visitors and from live-aboard and day-trip tourism operators visiting several areas of the Great Barrier Reef Marine Park (GBRMP) and Osprey Reef in the Coral Sea. Information about expenditure patterns, satisfaction with interactions and willingness to pay for 'guaranteed sightings' of key species (e.g. minke whales, sharks and rays, turtles and large fishes), was combined with information about the expenditure patterns of tourism operators has enabled an in-depth assessment of some of the relative social and economic values of these marine species and their impact on the local and regional economy. Moreover, the quantitative information gathered from these endeavours was supplemented with qualitative insights gleaned from Key Informant interviews and from a tourism operator workshop (reported separately by this research team for MTSRF Task 4.8.6(b)), to gain a good understanding of the relative social and economic values of key marine species that are frequently encountered by Reef tourists.

1.4 Structure of the report

Section 2 provides an overview of the region investigated, and of the surveys conducted. It describes the boat trips that were included in the study, the sampling methods, response rates and also presents some descriptive statistics relating to socio-demographic characteristics of respondents.

Section 3 focuses on the economic impact – describing the methodological approaches used, and presenting estimates of the regional economic impact of (a) dwarf minke whales (which aggregate in the northern Great Barrier Reef (GBR) each winter and are the focus of a swimming-with-whales tourism activity); and (b) multi-species boat trips that operate in several areas of the GBRMP, with some live-aboard vessels also visiting Osprey Reef in the Coral Sea.

Section 4 considers the issue of 'satisfaction'. It presents data on the 'satisfaction' scores attributed to different key species by visitors on different types of trips, and extrapolates those results to glean insights into the relative importance of key species to the population of tourists taking similar trips each year. It also compares the average satisfaction scores attributed to particular species and with the proportion of respondents who saw particular species, thus highlighting the important role that species 'accessibility' plays in contributing to visitor satisfaction.

Section 5 examines the issue of WTP – presenting data that allows one to compare (a) the amount which visitors are WTP for a 100% 'guaranteed' sighting key of different species, and (b) the (inferred) amount which visitors are WTP for a one percentage point improvement in the probability of sighting key species.

Section 6 focuses on marine turtles, providing a more in-depth analysis and discussion of the social and economic values of this important species.

The final Section (7) draws together key insights from the preceding discussions and offers concluding remarks.

2. The surveys

2.1 Operator expenditure surveys

2.1.1 Sampling

To estimate the regional economic 'impact' of (a) dwarf minke whales; and (b) multi-species Reef trips, a Business Expenditure Survey (BES) and Key Informant Interview[3] were designed by the research team and sampling began in mid-April 2007. A strict agreement about confidentiality of data from this survey was undertaken with each respondent, ensuring that no operators or individuals would be identifiable from the results. In cases where potential identification from figures might have been possible, the inclusion of such data in this report was done so with the explicit consent of the operator concerned.

In order to encourage participation by GBR tourism operators, a promotional 'Information Sheet' was developed and distributed to operators via email, accompanying requests for their participation[4].

It is important to note that prior to the commencement of this project, members of the research team (Birtles, Valentine, Curnock, Mangott and Sobtzick) had established a strong collaborative relationship with many of the Cairns and Port Douglas dive tourism operators included in the target sample, over a twelve-year period, via the Minke Whale Project (e.g. Birtles *et al.*, 2002; Valentine *et al.*, 2004). The confidence of the tourism industry in this research project and their trust of the research team have proven invaluable in achieving industry support and high levels of participation in our surveys. Due to the survey length and the detailed and sensitive nature of the financial data requested in the BES, the sampling approach taken by the research team was to allow operators to 'take their time' in providing their financial data. For many operators, in particular the smaller businesses, the limited staff and time available made it difficult for them to commit several hours of effort to the survey (e.g. working through company books on regional expenditures). The research team thus showed sensitivity toward operators regarding the completion of this survey and were very careful not to pressure or harass them. The tourism operators responded very positively and most were extremely helpful.

Respondents of the BES included four live-aboard dive operators from Cairns and Port Douglas, two day-trip Reef tour operators from Port Douglas a multi-vessel operation incorporating both day trips and live-aboard dive trips from Cairns and one operator that conducted day trips to the SS Yongala sunken shipwreck off Townsville (total n=8). The BES was circulated to eight additional GBR tourism operations in Port Douglas, Cairns and Townsville, however after corresponding with these operators over a >12 month period they were unable to complete and return the BES (several citing that they were just too busy and did not have the time available). The response rate for the BES is therefore calculated as 8/16 operations, or 50%.

2.1.2 Operator characteristics

All except one of the eight respondent organisations were locally owned and operated; six were formally registered companies, one was a partnership and one a sole proprietor/family businesses. With the average number of years in operation equal to 19 years, it is clear that

[3] Copies available on request.
[4] Copy available on request.

most respondents were 'long-term' operators. Indeed one respondent had been operating in the region for almost forty years, although there was one relative new-comer to the industry (four years in operation).

In total, the eight respondent organisations provided employment for 181 people during 2007/08; 46% of whom (84) were employed on a full-time basis. The average number of employees per firm was 22; and the average number of full-time employees was ten. No firm was owned or operated by an Aboriginal or Torres Strait Islander, and no firm employed any Aboriginal or Torres Strait Islanders.

2.2 Visitor surveys

2.2.1 Background

Visitor surveys (self-administered questionnaires completed by passengers/tourists on tourism vessels visiting the GBR) were collected between 2006 and 2009, with the primary aims of eliciting information about Reef tourists' experiences and perceptions of their interactions with marine wildlife, the extent to which key marine species contributed to their satisfaction, and details of their expenditure in the region during their visit to North Queensland. Due to the reliability of sightings of particular key marine species from live-aboard dive tourism operations travelling north from Cairns and Port Douglas (e.g. sharks, turtles, minke whales and large fishes), most of the sampling occurred on live-aboard vessels. These vessels were already accustomed to collecting passenger questionnaires for the Minke Whale Project (e.g. as reported in Valentine *et al.,* 2004) and were considered most likely to produce robust sample sizes and good response rates. In 2008 however efforts were made to increase the sampling from Reef day tours, assisted by a team of 18 volunteers (trained and managed by Birtles, Curnock, Mangott and Sobtzick for both this project and data collection for the Minke Whale Project), resulting in good data returns from six day-boats based in Port Douglas over the June-July minke whale season.

Overall, five distinct types of Reef trip were sampled, selected on the basis of their advertised high probability of encountering particular key marine wildlife species. The geographic areas/range of operations for these trip types are displayed in Figure 2. The trip types included:

1. **Far Northern GBR** – consisting of two live-aboard operators based in Cairns and Port Douglas that conducted a limited number of special and extended itineraries (ranging from eight to ten days duration) to the Far Northern Section of the GBRMP between the months of October and December. Among the range of Reef species encountered, a key feature of such trips included the opportunity to see and interact with large breeding aggregations of marine turtles in the vicinity of nesting islands/cays.
2. **GBR and Coral Sea** – consisting of five live-aboard dive tour operations based in Cairns and Port Douglas that conducted regular itineraries (ranging between three and six days duration) to the Ribbon Reefs and Osprey Reef in the Coral Sea. Several of these vessels conducted alternative itineraries at different times of the year (e.g. minke whale itineraries during June and July and Far Northern GBR itineraries between October and December). Among a range of Reef species encountered regularly, reliable sightings of potato cod occur at the Cod Hole and reliable sightings of white-tip reef and grey reef sharks occur at Osprey Reef in the Coral Sea (in association with feeding/attraction activities).

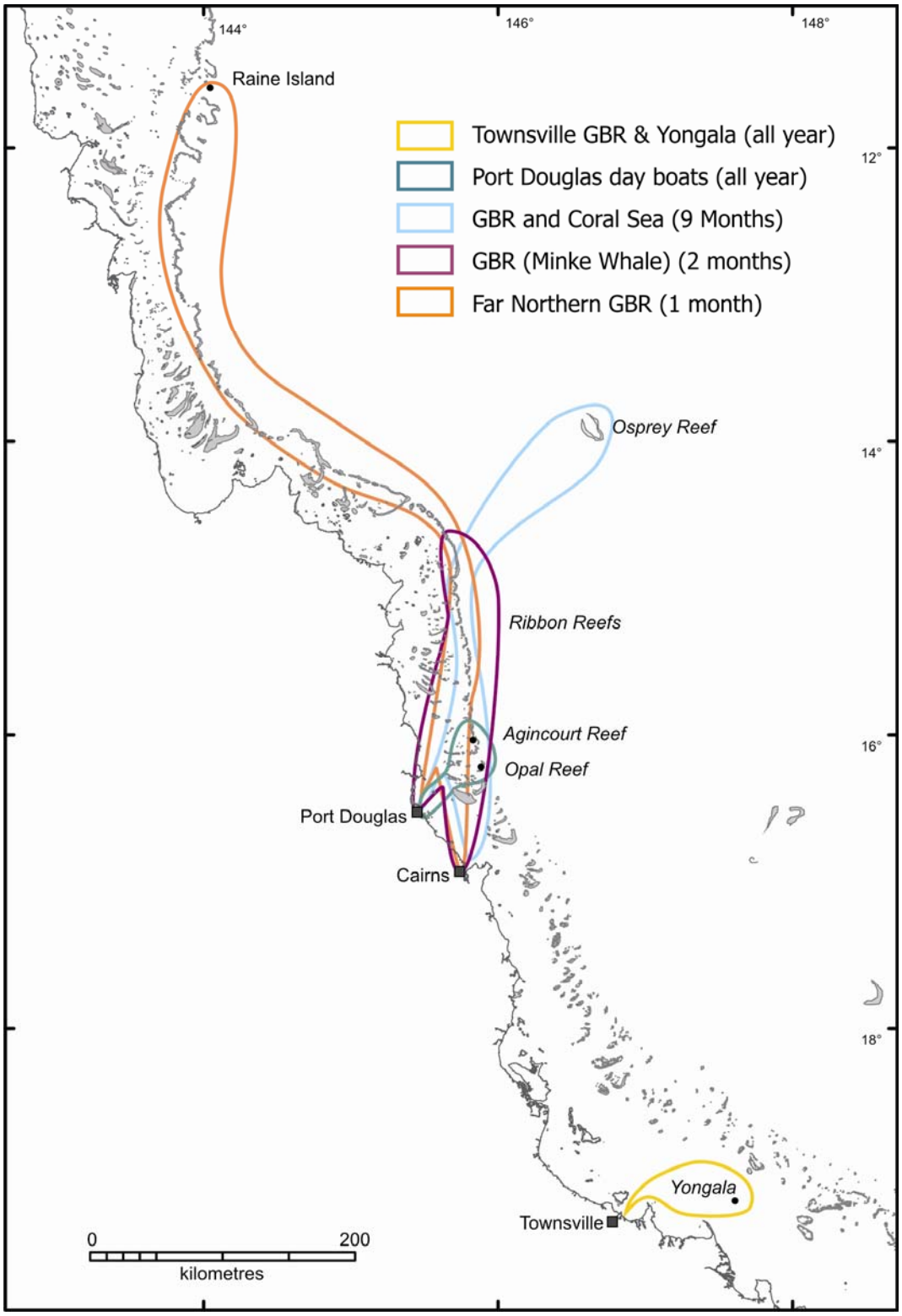

Figure 2: Reef trips included in visitor surveys.

3. **GBR (Minke Whale)** – consisting of up to six GBRMPA-permitted (swimming-with-whales endorsed) operators conducting live-aboard tours to the Ribbon Reefs during June and July when dwarf minke whale sightings are a key attraction. A further three day-boats based in Port Douglas have GBRMPA swimming-with-whales endorsements and occasionally interact with dwarf minke whales in the Offshore Port Douglas Sector (however such encounters are less reliable than for the live-aboard operators in the Ribbon Reefs Sector). Towards the latter half of July, these operators occasionally also encounter migrating humpback whales and participate in opportunistic vessel-based whale watching.
4. **Port Douglas day-boats** – consisting of three non-permitted (among numerous other) day-tour operations based in Port Douglas that conduct daily itineraries to the outer GBR, within the Offshore Port Douglas Sector of the GBRMP. A range of Reef species are encountered regularly however reliable sightings of some large resident fish (e.g. Maori wrasse, Malabar cod) and resident turtles are reported for some frequently visited sites. When operating during June/July these boats occasionally encounter dwarf minke whales – and the frequency of sightings on these vessels has been estimated to occur on between one in five and one in ten days (Mangott *et al.*, 2005).
5. **Townsville GBR and Yongala day-boats** – consisting of two dive tour operators based in Townsville and Ayr that regularly visit the wreck of the SS Yongala (located offshore from Townsville). The Yongala wreck provides reliable sightings of a range of key species that can be found on the wreck year-round. Such wildlife species include Queensland grouper, marine turtles, large schools of pelagic fish (e.g. trevally) and reef fish (e.g. small mouth nannygai, batfish), other large resident fishes (e.g. Maori wrasse, coral trout, cobia, mangrove jack), rays (e.g. resident marbled rays and occasional sightings of eagle and manta rays) and occasional sightings of bull sharks.

Plate 1: Live-aboard dive tourism vessels and marine wildlife interactions.

Four vessels from the live-aboard fleet visiting the Ribbon Reefs and Osprey Reef in the Coral Sea (2008).

Clockwise from top left: (i) diver and green turtle; (ii) feeding potato cod at the Cod Hole; (iii) shark feeding at Osprey Reef; (iv) swimming-with-dwarf minke whales in the Ribbon Reefs. Photos courtesy of Matt Curnock.

Plate 2: Reef day-trip vessels and marine wildlife interactions.

Port Douglas-based day-boats, and Reef day-trip tourists snorkelling and interacting with marine wildlife.

Clockwise from top left: (i) Yongala day-boat; (ii) schooling fish under bow of Yongala wreck; (iii) diver and Queensland grouper; (iv) scuba diver and large stingray. Photos courtesy of Matt Curnock.

2.2.2 Data collection and response rates

2.2.2.1 Boats travelling to the Far Northern GBR (the Far Northern live-aboard sample)

The Far Northern GBR provides outstanding scuba diving experiences with clear water, magnificent outer reef wall dives (often done as drifts) and high diversity and abundance of many coral reef species. These are remote sites (up to 1,000 km from Cairns and Port Douglas) and are only visited on specialised expeditions, usually run by just one or two vessels between October and December when the seas are calmest. This narrow window of opportunity falls between the south-easterly trade winds (which blow strongly in winter and early spring) and the summer monsoon season with its potential for cyclones.

Over 2006-2008, two live-aboard dive tourism vessels (*Undersea Explorer* and *Nimrod Explorer*) conducted specialised and extended live-aboard diving expeditions, between eight and ten days duration, to the Far Northern Section of the GBRMP for a period of about a month between October and December. Key features of these trips included sightings and interactions with large (breeding) aggregations of green turtles (*Chelonia mydas*) in the vicinity of remote and significant turtle nesting islands (e.g. Raine Island), as well as relatively high concentrations of sharks and pelagic fishes, encountered more opportunistically at a number of shelf edge sites. For one vessel a special research permit to conduct satellite tagging of tiger sharks (held by R. Fitzpatrick) provided an additional attraction for tourists to observe from on-board the vessel. The opportunity for tourists to watch sharks being tagged (from the safety of the vessel) was promoted as a highlight of the trip.

Over three seasons (2006-2008) a total of 217 passenger questionnaires were collected from both vessels conducting these special annual itineraries. Due to the low passenger numbers (with vessel passenger capacities of 18 and 21) and the limited number of expeditions to this region each year, the overall population to be sampled was relatively small in comparison to the other surveys reported in this study. A total of 16 trips (ten by *Undersea Explorer* and six by *Nimrod Explorer*) were sampled, on which a total of 255 passengers (122 in 2006, 91 in 2007 and 42 in 2008) were carried by the two vessels. The total sample achieved over the three seasons was n=217, thus the response rate is calculated as 217/255, or 85%. Sample sizes from each vessel per year are shown below in Table 1 (*NB. Results are de-identified in accordance with a confidentiality agreement with participating operators; passenger questionnaire results that follow are aggregated*).

Table 1: Passenger questionnaire sample sizes for two live-aboard dive vessels conducting special itineraries to the Far Northern Section of the GBRMP.

Vessel	No. of trips sampled (n)				Percentage of total sample per vessel
	2006	2007	2008	Total	
A	49 (4 trips)	72 (4 trips)	40 (2 trips)	161 (10 trips)	74%
B	38 (3 trips)	18 (3 trips)	-	56 (6 trips)	26%
Total n (No. of trips per year)	**87** (7 trips)	**90** (7 trips)	**40** (2 trips)	**217** (16 trips)	**100%**

NB: In the latter half of 2008, one of the operations unexpectedly ceased trading, resulting in only one remaining operator conducting itineraries to the Far Northern Section in 2008 that could be sampled (*NB. The second operator subsequently ceased trading in early 2009, the owner citing the Global Financial Crisis as the reason for their closure*). Thus only two trips on this vessel went to the Far Northern Section of the GBRMP in 2008, on which only 42 passengers in total were carried.

2.2.2.2 Live-aboard boats visiting the GBR Ribbon Reefs and Coral Sea (the Osprey live-aboard sample)

This questionnaire was distributed on five live-aboard dive vessels (*Undersea Explorer*, *TAKA*, *Spoilsport*, *Nimrod Explorer* and *Spirit of Freedom*) operating along the Ribbon Reefs with regular scheduled trips (weather dependent) to Osprey Reef in the Coral Sea. Highlights of the trips include the dive site 'Cod Hole' where several resident potato cod (*Epinephelus tukula*) are encountered with high predictability. Some of these operators also conduct a controlled feed of these fish in front of divers. Osprey Reef is renowned for its spectacular wall diving and regular and close encounters with several shark species (e.g. white-tip reef sharks, grey reef sharks, silver tip sharks and occasionally hammerheads and tiger sharks, etc.) as well as manta rays.

Questionnaires were collected on these trips between November 2007 and December 2008. Over this period a total of 93 trips were sampled, from which a total sample of 571 completed questionnaires was achieved. The actual total number of passengers carried on these trips could not be obtained from the operators, thus the response rate is estimated using the maximum passenger capacity of the vessels (ranging from n=18 to n=30; see Table 2 below). The maximum possible number of passengers that could have been carried over these 93 trips was 2349, thus the minimum response rate is calculated as 571/2349 or 24.3% (Table 2).

Table 2: Minimum response rates for the Osprey live-aboard sample.

Vessel/operation	Passenger capacity	No. of trips sampled	Maximum possible number of passengers carried on these trips (N)	Sample size (n)	Minimum response rate (n/N)
A	21	18	378	151	39.9%
B	30	33	990	143	14.4%
C	27	17	459	129	28.1%
D	18	16	288	118	41.0%
E	26	9	234	30	12.8%
Total	**122**	**93**	**2,349**	**571**	**24.3%**

2.2.2.3 Boats focusing on minke whales (the minke live-aboard and minke day-boat samples)

Note, these surveys were collected in collaboration with the PhD study by M. Curnock (submitted June 2010).

The minke live-aboard samples

These surveys were conducted during June and July over 2006 to 2008 on five swim-with dwarf minke whale endorsed live-aboard dive tourism vessels which operated regular itineraries of between three and six days duration trips over the dwarf minke whale season (June-July). These trips were advertised as providing dive opportunities along the Ribbon Reefs in the Cairns/Cooktown Section of the GBR and swims with dwarf minke whales (*Balaenoptera acutorostrata* subsp.), whenever possible. Several of these vessels also provided berth spaces for JCU researchers from the Minke Whale Project, who collected data on the biology and behaviour of the whales as well as on the management of swimming-with-whales interactions.

The minke day-boat samples

These surveys were conducted from three swimming-with-whales endorsed day snorkel and dive tourism vessels, based in Port Douglas, over the dwarf minke whale season (June-July) 2006-2008. These operations take passengers out to snorkel and dive on the outer Great Barrier Reef for a whole day. The daily itinerary involved visits to three different dive/snorkel sites where they conduct in-water activities (snorkelling and scuba diving). In the event of a dwarf minke whale encounter these operations may also provide the opportunity to swim with these whales.

Over three minke whale seasons (2006-2008) a total of 2,171 passenger questionnaires were collected from the above eight SWW-endorsed vessels (including both live-aboard and day-boats). Of these, 1,592 (73%) were from live-aboard vessels conducting the majority of their operations in the Ribbon Reefs Sector of the GBRMP, and the remaining 579 (27%) were from day-boats working solely in the Offshore Port Douglas Sector. Sample sizes from each vessel per year are shown below in Table 3 (*NB. Results are de-identified in accordance with a confidentiality agreement with participating operators; specific results of the passenger questionnaires will not be linked to any named vessel*.)

Table 3: Passenger questionnaire sample sizes for eight swim-with-whales (SWW) endorsed vessels.

Vessel	2006 (n)	2007 (n)	2008 (n)	Total (n)	Percentage of total sample
SWW-endorsed live-aboard vessels					
A	203	230	103	536	24.7
B	107	153	143	403	18.6
C	126	135	114	375	17.3
D	107	57	70	234	10.8
E	18	15	11	44	2.0
Total live-aboard	561	590	441	1592	73.3
SWW-endorsed day-trip vessels					
F	4	7	192	203	9.4
G	0	41	148	189	8.7
H	53	7	127	187	8.6
Total day-boat	57	55	467	579	26.7
Total	**618 (28%)**	**645 (30%)**	**908 (42%)**	**2,171**	**100**

While the live-aboard sample sizes are relatively similar across the three years, the samples for swim-with-whales endorsed day vessels were substantially larger in 2008 than for previous years. This is because the 2006 and 2007 samples included only passengers who had seen minke whales. The low respondent number was also because the busy day-boat crews were often not in a position to distribute our questionnaires. In 2008 an increase in the presence of researchers and volunteers (18 in total) on day trips enabled the team to distribute questionnaires to day-boat passengers on trips irrespective of whether or not they had seen minke whales.

The overall response rate for the passenger questionnaire over the three year period (2006-2008) was 44.9% (n=2171/N=4832). The number of passengers on each sampled trip for

live-aboard vessels A-D was provided by the respective operators for each year (2006-2008), allowing an exact response rate to be calculated for these four vessels (Table 4 below; *NB. all passengers on these trips were asked to complete a questionnaire towards the end their trip*). Total passenger numbers could not be obtained for vessel E for all years, nor for the day-trip vessels F, G and H for 2006 and 2007, and thus a *minimum* response rate for trips by these vessels was calculated using the vessel's passenger capacity as the maximum number of passengers that could have participated in the sampled trips.

On each trip that was sampled in 2008 the total number of passengers was also recorded to calculate an accurate response rate. The response rate varies considerably between vessels, in particular between the live-aboard (combined response rate = 64%) and day vessels (combined response rate = 25%). The higher numbers of passengers that are carried on the day trip vessels and the limited time available in their daily itineraries (in comparison to live-aboard vessels) are regarded as the greatest contributing factors to the lower survey responses achieved for these vessels.

Table 4: Passenger questionnaire response rates for swim-with-whales (SWW) endorsed vessels.

Vessel	2006 (No. of trips sampled and total passengers carried)	2007 (No. of trips sampled and total passengers carried)	2008 (No. of trips sampled and total passengers carried)	Total trips and passengers per vessel (N)	Response rate per vessel (n/N)
SWW- endorsed live-aboard vessels					
A	11 trips 269 pax	12 trips 318 pax	11 trips 300 pax	34 trips 887 pax	**60%** (536/887)
B	14 trips 289 pax	14 trips 273 pax	11 trips 253 pax	39 trips 815 pax	**49%** (403/815)
C	8 trips 138 pax	9 trips 149 pax	8 trips 128 pax	25 trips 415 pax	**90%** (375/415)
D	13 trips 151 pax	6 trips 84 pax	6 trips 95 pax	25 trips 330 pax	**71%** (234/330)
E	2 trips 22 pax*	2 trips 22 pax*	1 trip 11 pax	5 trips 55 pax*	**80%** (44/55)
SWW-endorsed day-trip vessels					
F	2 trips 184 pax*	1 trip 92 pax*	6 trips 463 pax	9 trips 739 pax*	**27%** (203/739)
G	0 trips 0 pax	3 trips 270 pax*	7 trips 493 pax	10 trips 763 pax*	**25%** (189/763)
H	4 trips 400 pax*	1 trip 100 pax*	6 trips 328 pax	11 trips 828 pax*	**23%** (187/828)
Response rate per year (n/N)	**43%** (618/1453)	**49%** (645/1308)	**44%** (908/2071)	158 trips sampled N = 4832 pax*	**Overall 44.9%** (2171/4832)

* Indicates maximum possible passengers (*abbreviated as 'pax'*) carried, based on vessel capacity where actual numbers of passengers on these trips is unknown. Response rates based on these figures are thus minimum estimates.

2.2.2.4 Port Douglas day-boats sample

In 2008, passenger surveys were also collected from three non-(minke) permitted Port-Douglas based Reef day-boats providing snorkelling and scuba diving activities in the Offshore Port Douglas Sector of the GBRMP. These vessels included: *Haba, Wavelength* and *Calypso* with passenger capacities ranging between 30 and 110 passengers. Surveys were collected during June and July 2008 over 14 trips in total, resulting in a sample of 386 completed questionnaires. Research team members (including trained volunteers) were responsible for distribution and collection of questionnaires, and recorded the total number of passengers carried per trip. The response rate is calculated as 386/789 passengers carried on all trips, or 48.9%. The response rates and sample sizes for each vessel are shown below in Table 5). (*NB. Results are de-identified in accordance with a confidentiality agreement with participating operators; specific results of the passenger questionnaires will not be attributable to any named vessel*.)

Table 5: Passenger questionnaire response rates for non-SWW-endorsed day-boats operating from Port Douglas.

Vessel/ operation	No. of trips sampled	No. of passengers carried on these trips (N)	Sample size (n)	Response rate (n/N)
A	3	78	50	64.1%
B	6	419	192	45.8%
C	5	292	144	49.3%
Total	**14**	**789**	**386**	**48.9%**

2.2.2.5 Day-boats visiting Yongala (the Yongala day-boat sample)

This questionnaire was distributed to the only two day-trip operations (*Pro Dive/Adrenalin Dive* in Townsville and *Yongala Dive* in Ayr) with regular scheduled trips to the SS Yongala wreck. Data collection commenced in June 2008 and finished in April 2009. Over this period a total of 28 trips were sampled, from which a total of 117 questionnaires were collected. As the actual number of passengers carried on these trips could not be obtained from the operators, the response rate is estimated using the maximum passenger capacity of the vessels (n=12 and n=20 respectively). The maximum possible number of passengers that could have been carried over these 28 trips was 440, thus the minimum response rate is calculated as 117/440 or 26.6% (Table 6 below; *NB. All results from this survey that follow are presented in aggregate form in accordance with JCU Human Ethics policy and a confidentiality agreement with the operators*). Due to the relatively low sample size and response rate in comparison to other samples within this study, caution is advised when interpreting results based on these data.

Table 6: Minimum response rates for the Yongala day-boat sample.

Vessel	Passenger capacity	No. of trips sampled	Maximum possible number of passengers carried on these trips (N)	Sample size (n)	Minimum response rate (n/N)
A	20	13	260	70	26.9 %
B	12	15	180	47	26.1 %
Total	**32**	**28**	**440**	**117**	**26.6 %**

2.2.3 Visitor characteristics

Before presenting data from these surveys, it is important to note that for the live-aboard, the minke whale (live-aboard and day-boats) and the Yongala trips, our samples sizes comprise a significant proportion of the entire 'population' of visitors taking 'similar' trips (see Section 3.3.1 for a complete discussion). Consequently, one can be reasonably confident that the sample data are representative of the broader population of similar Reef visitors. One should, however, be careful when interpreting data collected from the *Port Douglas* day-boat passengers. Specifically, our Port-Douglas day-boat sample (non-minke) was collected on just three boats, all of which are relatively small (when compared, for example, to some of the larger boats operating in the area which can carry up to 400 passengers), and none of which travel to the reef platforms frequented by the larger tour operators. Moreover, data were only collected during two, winter months. The Port-Douglas day-boat data cannot, therefore, be considered to be representative of the population of <u>all</u> 'Port Douglas day-boat visitors' because one cannot be sure that the visitors who travel on these boats during the winter months are 'typical' of those travelling on other day-boats and/or at other times of the year. Indeed, they may be quite 'atypical'.

Nevertheless, this does not mean that the contribution which the Port Douglas day-boat data makes is negligible. Quite to the contrary, by including this group alongside the other samples, we are able to compare and contrast expenditure patterns, satisfaction levels, and WTP across a variety of different types of visitors, thus highlighting some of the key similarities and differences between the visitor segments across a number of important variables that might otherwise be less apparent.

Amongst other things, respondents were asked to provide some general background information about themselves: their age; their gender; where they came from; how long they were staying in the region; and whether or not they had been to this part of the GBR before. As shown in Table 7, the total sample was fairly evenly divided by gender with 49% of all respondents female.

The average age of all respondents was 36 years and ranged between 9 and 87. Across all respondents, 37% were Australian residents and more than half were visiting the GBR for the first time – although the day-boats operating out of Port Douglas had a higher proportion of Australian residents (>= 50%) and the non-minke day-boats (i.e. those going to Yongala, and those operating out of Port Douglas) had a relatively high proportion of 'first-time' visitors.

The average length of time spent in and around Port Douglas and Cairns were three and five days respectively. For the Yongala day-boat sample, the average length of time spent in Ayr/Burdekin region was relatively short at just over one day - although the average respondent spent more than nine days in and around Townsville (Table 8). Day-boat visitors spent a longer period of time on-shore than did the live-aboard visitors.

Table 7: Selected characteristics – by sample.

Survey	Proportion female	Proportion Australian residents	Proportion first-time visitors to the GBR	Mean Age (years)
Far Northern live-aboards				
Far Northern live-aboard 2006	0.44 (n=87)	0.25 (n=87)	0.41 (n=85)	44.74 (n=84)
Far Northern live-aboard 2007	0.39 (n=90)	0.36 (n=90)	0.32 (n=90)	47.98 (n=90)
Far Northern live-aboard 2008	0.36 (n=39)	0.27 (n=40)	0.50 (n=40)	43.78 (n=37)
Ribbon and Osprey Reef live-aboards 2008	0.39 (n=635)	0.29 (n=637)	0.57 (n=638)	38.29 (n=627)
Minke live-aboards				
Minke live-aboard 2007	0.48 (n=588)	0.27 (n=586)	0.59 (n=589)	35.33 (n=576)
Minke live-aboard 2008	0.55 (n=440)	0.36 (n=440)	0.53 (n=438)	33.98 (n=428)
Minke day-boats				
Minke day-boats 2007	0.53 (n=55)	0.50 (n=54)	0.54 (n=54)	34.48 (n=54)
Minke day-boats 2008	0.50 (n=466)	0.50 (n=464)	0.48 (n=467)	35.04 (n=379)
Port Douglas (non-minke) day-boats 2008	0.60 (n=382)	0.57 (n=386)	0.64 (n=386)	35.68 (n=379)
Yongala day-boats 2008	0.47 (n=116)	0.37 (n=117)	0.84 (n=117)	31.15 (n=115)
All Respondents	**0.49 (n=2,898)**	**0.37 (n=2,901)**	**0.59 (n=2,904)**	**36.38 (n=2,847)**

Table 8: Mean number of days spent onshore before and after the boat trip – by sample.

Survey	Port Douglas	Cairns	Ayr/ Burdekin	Townsville
Far Northern live-aboards				
Far Northern live-aboard 2006	2.15 (n=80)	5.03 (n=80)		
Far Northern live-aboard 2007	1.22 (n=80)	3.72 (n=80)		
Far Northern live-aboard 2008	1.91 (n=35)	3.74 (n=35)		
Minke live-aboards				
Minke live-aboard 2007	1.75 (n=490)	6.93 (n=490)		
Minke live-aboard 2008	2.40 (n=359)	5.78 (n=359)		
Ribbon and Osprey Reef live-aboard 2008	1.56 (n=546)	4.44 (n=546)		
Minke day-boats				
Minke day-boats 2007	5.68 (n=44)	4.75 (n=44)		
Minke day-boats 2008	4.81 (n=417)	4.86 (n=417)		
Port Douglas (non-minke) day-boats 2008	6.75 (n=347)	3.16 (347)		
Yongala day-boats 2008			1.23 (n=79)	9.45 (n=79)
All Respondents	**3.13 (n=2398)**	**5.03 (n=2,398)**	**1.23 (n=79)**	**9.45 (n=79)**

3. Economic impact

Whilst there are numerous examples of studies which have attempted to quantify the economic value of a species in terms of 'willingness to pay' for its conservation (a type of bequest value), there is '… another sense in which wildlife may be 'valued'; this is in terms of the benefits that the presence of wildlife … may confer on the economy of the surrounding area' (Crabtree *et al.*, 1994, p 61). It is on this type of value that this section focuses – namely, on the money that tourists spend within local communities when coming to view, and interact with key marine species.

As noted in Smith *et al.* (2006), 'wildlife tourism' – the viewing and visiting of wild animals for recreational purposes or as a tourist attraction – is a relatively recent phenomenon, but this type of tourism has grown rapidly in recent years (Orams, 1996; Roe *et al.*, 1997; Hoyt, 2001; Wilson and Tisdell, 2001; Mvula, 2001). In Australia, there are many destinations where tourists 'expect' to view particular types of wildlife, e.g. crocodiles in the Northern Territory (Ryan, 1998; Tremblay, 2002); little penguins at Phillip Island (Head, 2000; Phillip Island Nature Park, 2005); dingoes on Fraser Island (Lawrance and Higginbottom, 2002); dolphins at Monkey Mia (CALM, 1993); and whales at Hervey Bay (Corkeron, 1995). The story is no different in the GBR: visitors travelling to the reef expect to have the opportunity to view and interact with a range of different marine species. These marine species are of clear value to the tourism operators and to the communities which rely upon such 'marine wildlife tourism' for incomes and/or employment.

The key problem here, however, is that one cannot simply add up all the money that 'marine wildlife tourists' spend when in a region, and attribute it to a particular marine species. This is because one cannot validly claim that it is a specific marine species which attracts all visitors to the region. Indeed, one cannot even claim that it is the GBR which attracts all Reef-going visitors to Queensland. Some people, for example, come to the region to visit friends and relatives, some come on business trips, and some travel to the region primarily to see the Wet Tropics rainforest, rather then the GBR (Tourism Queensland 2003; Tourism Queensland, 2006a; 2006b; 2007). So for these people, their visit to the Reef may be considered as all but incidental to their trip to the region. Consequently, only part of the *total expenditure* of some visitors to a particular region can be validly attributed to the GBR, to boat trips and/or to the key marine species viewed whilst on those trips.

Operationally, this means that if one wishes to estimate the regional economic impact of any particular species, one must be able to access information describing first, how much regional tourist expenditure is directly attributable to that particular species (termed *substitution* by Jones and Wood, 2008), and second, how much of the money spent by those tourists is channelled either directly or indirectly into the regional economy. Yet it is not always possible to take the first step, so it is not always possible to estimate the economic impact of a single, marine species. This is because many Reef trips are inherently multi-species in nature. Birtles *et al.* (2001) reviewed over 70 species of free-ranging marine wildlife targeted by tourism operations around Australia and discussed the management of 25 of the more important taxa including whales, dolphins, sharks, rays, big fish, turtles and dugongs. They showed that multi-species trips were a common phenomenon along our coast.

In this section of the GBR some species are only available to tourists at certain times of year and/or at certain locations and most reef-based boat trips target more than one particular species on any individual trip. Indeed most of the advertising material associated with boat-trips visiting the GBR clearly notes that visitors will have the opportunity to interact with, and enjoy a wide variety of marine species.

However, central data collecting agencies such as the Australian Bureau of Statistics, and the Tourism Research Authority do not generally ask questions that are specific enough to allow one to determine how to attribute total visitor expenditure across activities, or specific marine species. So information of this nature is generally not publically available. Researchers involved in this project thus chose to follow the lead of others (such as Crabtree *et al.*, 1994; Utech, 2000; Parsons *et al.*, 2003; Stoeckl *et al.*, 2005 and SQW, 2006) – including questions within a visitor survey that allowed one to draw inferences about the proportion of visitor expenditure that could be attributed to a number of particular marine wildlife taxa.

This could not, however, be done for all key wildlife in the GBR ecosystem. Many of the boat trips included in this study are inherently multi-species and indeed there is only one marine species (the dwarf minke whale) that is specifically targeted by some live-aboard boat operators[5] seasonally as the primary focus of their trip. So this research project only generates a direct estimate of the economic impact of one species: dwarf minke whales. When considering other species, it generates an estimate of the economic impact of (multi-species) boat-trips, and then uses information about visitor satisfaction with interactions with different key species, to draw inferences about the relative contribution (or 'value') of those different species to the overall trip. Figure 3 provides a schematic overview of the procedures used, clearly highlighting that the approaches are similar, but NOT identical. Further details are provided in the following sub-sections, the structure of which follows that of the schematic.

3.1 Step 1: Estimating per-person expenditure

As highlighted in Figure 3, there are a series of steps which must be taken to estimate the economic impact of (a) a species (in this case, dwarf minke whales), or (b) different types of boat trips. In both cases, the first step requires one to estimate the total regional expenditure of tourists on relevant boat trips.

This was done by:

a) using survey responses to estimate the average daily expenditure of visitors to the region when on land (i.e. in Cairns and Port Douglas);

b) multiplying these daily expenditures by the number of days spent in the region before and after the boat-trip, to generate an estimate of the total (non-boat) expenditures; and

c) adding that to the cost of the boat trip and to reported expenditures while on the boat trip, to determine the total regional expenditure of respondents.

Further details are provided below.

[5] Although the minke-permitted operators stress the fact that passengers will have ample opportunity to view and enjoy other wildlife as they are generally on dive trips which also include 2-4 dives a day and which all include the Cod Hole at the top of Ribbon Reef #10.

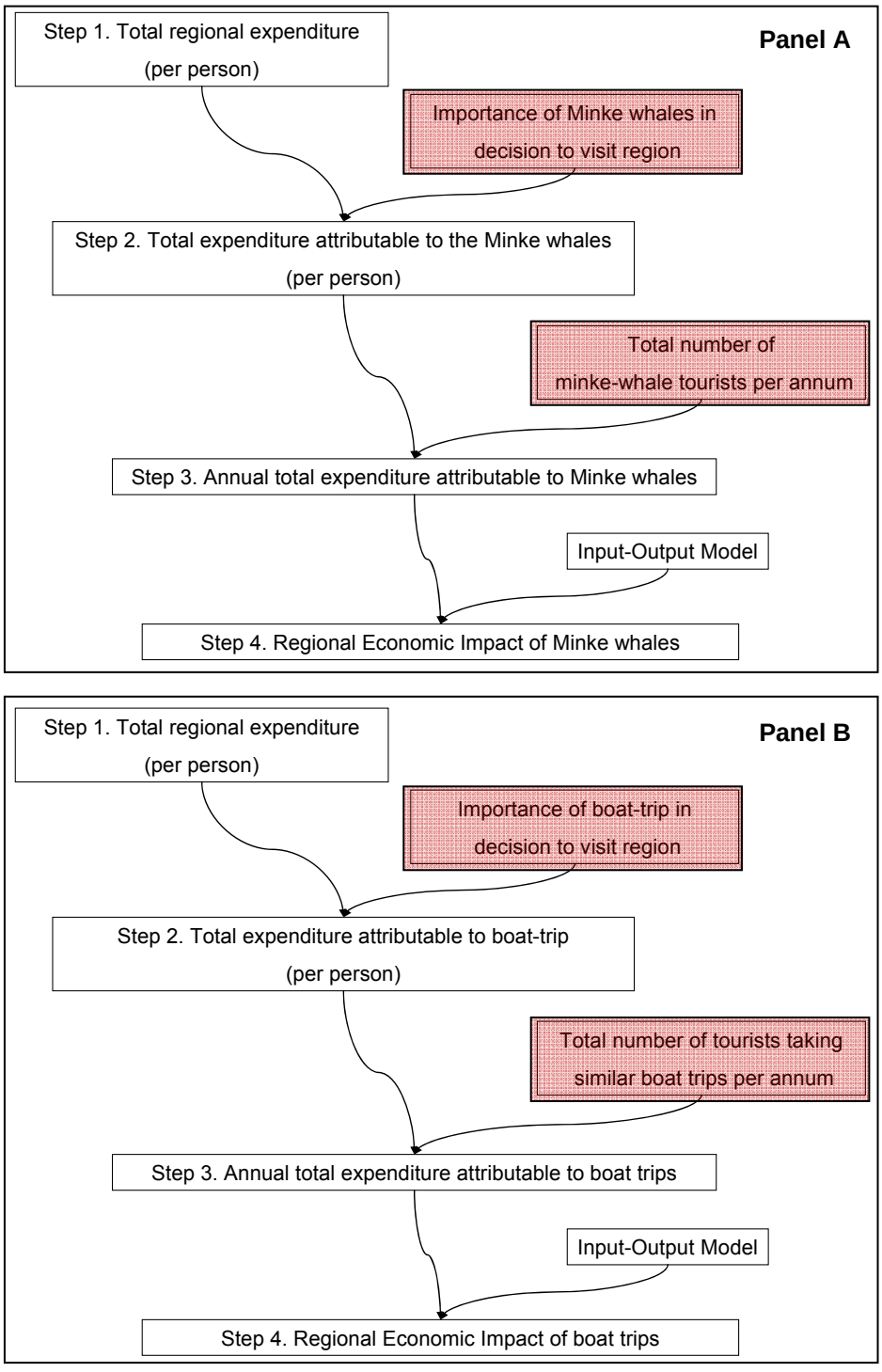

Figure 3: Estimating the economic impact of minke whales (panel A) and of multi-species boat trips (panel B).

Daily (non-boat) expenditure per person

Respondents were asked to indicate the approximate amount that they had spent per day on different categories of goods. This was done by asking them to tick an appropriate expenditure category, as per the questionnaire excerpt below:

Item – Cost PER DAY	$0	$1-20	$21-50	$51-100	$101-150	$151-200	$201-300	>$300
Food or drinks from a takeaway	☐	☐	☐	☐	☐	☐	☐	☐
Meals in a café or restaurant	☐	☐	☐	☐	☐	☐	☐	☐
Groceries	☐	☐	☐	☐	☐	☐	☐	☐
Accommodation	☐	☐	☐	☐	☐	☐	☐	☐
Other (please specify):	☐	☐	☐	☐	☐	☐	☐	☐

Researchers used the mid-point of each category to estimate daily expenditure on any particular type of good (e.g. $35 for the range $21-$50; $75 for the range $51-100, etc.), although the lowest amount (e.g. $300) was used for the top category, giving an unambiguous downward bias to final estimates. These mid-points were then added together to arrive at an estimate of daily regional expenditures across all items (excluding money spent on the boat). Table 9 shows estimates of both the mean and the median daily non-boat regional expenditures of our respondents, by sample.

First, there is evidence that expenditures have increased over time: for any particular type of trip expenditures are always highest in 2008. This is largely to be expected, given the rising cost of living, but some of this may also reflect changed visitor expenditure patterns. The average daily (non-boat) expenditure is lowest for the day-boat visitors travelling to Yongala – less than half of that associated with the other day-boat samples – whilst the average daily (non-boat) visitor expenditure is highest for the day-boats that operate from Port Douglas. This is at least partially a reflection of the fact that accommodation costs are generally higher in Port Douglas *(NB. one live-aboard boat departed from Port Douglas)* than in Cairns or Townsville.

Table 9: Daily non-boat regional expenditure ($AUD, per respondent) – by sample.

Survey	Mean	Median
Far Northern live-aboards		
Far Northern live-aboard 2006 (n=66)	$344.13	$275.00
Far Northern live-aboard 2007 (n=68)	$354.55	$298.50
Far Northern live-aboard 2008 (n=23)	$453.80	$447.00
Ribbon and Osprey Reef live-aboard 2008 (n=517)	$342.13	$268.00
Minke live-aboards		
Minke live-aboard 2007 (n=472)	$306.88	$250.00
Minke live-aboard 2008 (n=310)	$313.10	$250.75
Minke day-boats		
Minke day-boats 2007 (n=37)	$362.43	$343.00
Minke day-boats 2008 (n=381)	$483.73	$408.50
Port-Douglas day-boats 2008 (n=324)	$537.49	$447.75
Yongala day-boats 2008 (n=88)	$196.91	$140.25

Total (non-boat) expenditure per person

As noted above, visitors were also asked to indicate the total number of days they spent in the local region (Cairns/Port Douglas, or Ayr/Townsville depending upon sample) before and after the boat trip. Daily expenditure estimates were then multiplied by the total number of days spent in the region (Table 8), to generate an estimate of total regional non-boat spending (see Table 10). Following the lead of SQW (2006), residents, and pseudo-residents (those staying in the region for more than 30 days) were excluded from this expenditure analysis.

Table 10: Total non-boat regional expenditure ($AUD, per respondent) – by sample.

Survey	Mean	Median
Far Northern live-aboard		
Far Northern live-aboard 2006 (n=66)	$1,488.99	$1,112.50
Far Northern live-aboard 2007 (n=65)	$1,731.71	$1,174.00
Far Northern live-aboard 2008 (n=23)	$2,551.65	$1,640.00
Ribbon and Osprey Reef live-aboard 2008 (n=438)	$2,103.68	$1,115.75
Minke live-aboards		
Minke live-aboard 2007 (n=419)	$1,922.18	$1,188.00
Minke live-aboard 2008 (n=287)	$2,034.74	$1,039.50
Minke day-boats		
Minke day-boats 2007 (n=36)	$2,682.26	$2,717.00
Minke day-boats 2008 (n=370)	$4,196.63	$2,773.50
Port Douglas day-boats 2008 (n=315)	$4,713.37	$3,380.00
Yongala day-boats 2008 (n=72)	$1,138.73	$584.00

Total (boat and non-boat) expenditure per person

Estimates of the *total* regional per-visitor expenditure (including dive boat expenditures) were then generated by adding the estimates of total (non-boat) regional expenditure to:

- The publically advertised price of the boat trip; and
- (Self-reported) extra expenditures incurred by the respondents while on the boat trip.

Table 11 shows mean and median total boat and non-boat expenditure for each sample, while Figure 4 differentiates between boat and non-boat expenditures for each broad 'type' of trip (e.g. Far Northern live-aboard; Minke live-aboard; Minke day-boat).

Total expenditure for the Far Northern live-aboard trips is considerably higher than that of other trips, and this is mainly because the boat trips are relatively expensive (total non-boat regional expenditures for this group are similar to the Minke live-aboard and the Ribbon and Osprey Reefs trips (referred to above as 'Osprey live-aboard' – see Table 10). Non-boat expenditure is higher for Minke day-boat trips than it is for other trips. This is partially because the people taking these trips spend more time on-shore in the region before and after the boat trip than do the live-aboard visitors, but it is also because the Minke day-boat visitors spend more per day than do other visitors, as discussed above.

Table 11: Total boat and non-boat regional expenditure ($AUD, per respondent) – by sample.

Survey	Mean	Median
Far Northern live-aboard		
Far Northern live-aboard 2006 (n=66)	$5,008.13	$4,364.62
Far Northern live-aboard 2007 (n=65)	$5,097.70	$4,684.00
Far Northern live-aboard 2008 (n=23)	$6,284.26	$5,327.00
Ribbon and Osprey Reef live-aboard 2008 (n=438)	$3,785.49	$2,881.00
Minke live-aboards		
Minke live-aboard 2007 (n=419)	$3,643.93	$3,035.00
Minke live-aboard 2008 (n=287)	$3,830.33	$2,899.00
Minke day-boats		
Minke day-boats 2007 (n=36)	$2,895.84	$2,910.50
Minke day-boats 2008 (n=370)	$4,396.32	$2,,948.25
Port Douglas day-boats 2008 (n=315)	$4,912.73	$3,620.00
Yongala day-boats 2008 (n=72)	$1,358.98	$801.50

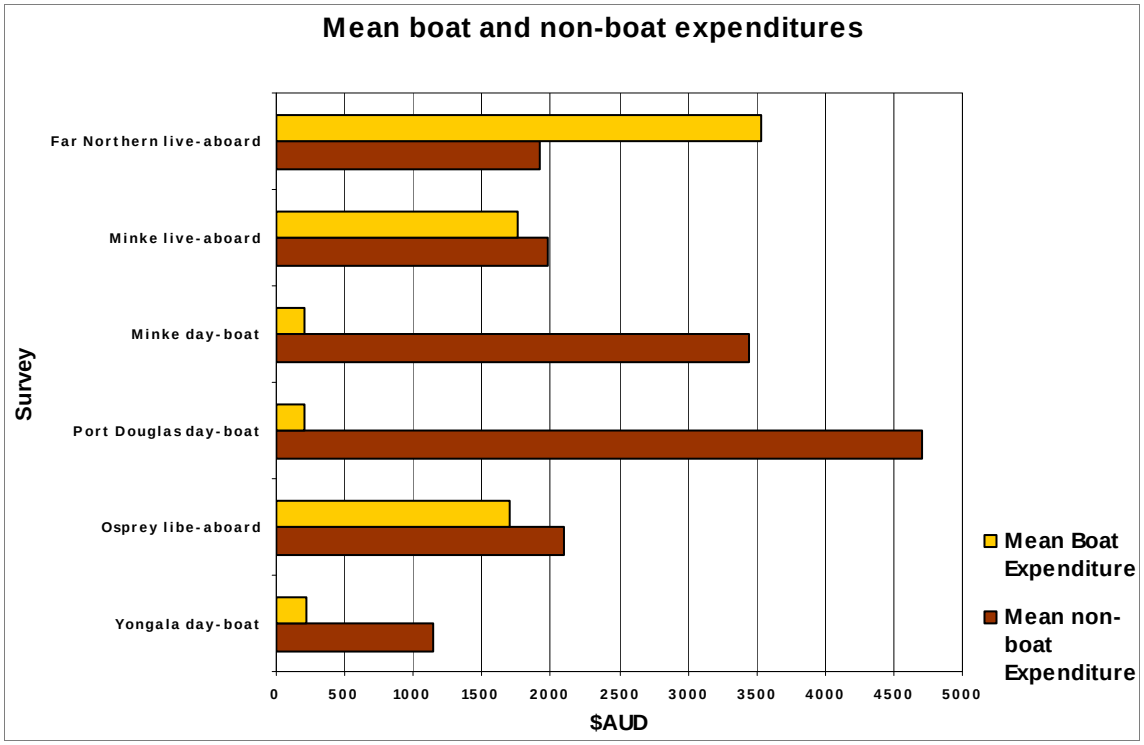

Figure 4: Total boat and non-boat regional expenditures ($AUD, per respondent) – by trip type.

Interestingly, it is only the Yongala day-boat visitors whose total expenditure is less than Tourism Queensland's estimates of the average expenditure per international visitor – close to $2,000 (Tourism Queensland, 2010). Moreover, our estimates of average daily expenditure exceed those reported in Access Economics (2007, p 69)[6] – approximately $171

[6] These estimates were also generated by Tourism Queensland.

per day during 2005 – although the Access Economics daily expenditure estimates are remarkably close to our daily expenditure estimates from the Yongala day boat sample if one accounts for inflation. Nevertheless, our samples are dominated by live-aboard dive-boat visitors, and by visitors staying in Port Douglas, a destination that is, arguably, close to the 'top end' of the market, even within Tropical North Queensland. Furthermore, at seven nights, the average length of stay of visitors to Tropical North Queensland during 2008 was less than that of our visitors (Tourism Queensland, 2008). Consequently, it is neither surprising nor worrying to see that our estimates of total expenditures exceed that of the 'average' visitor to Queensland[7].

3.2 Step 2: Estimating per-person expenditure attributable to minke whales and to boat trips

As noted at the beginning of Section 3, one cannot validly claim that all of the money a visitor spends while in the Cairns/Port Douglas region is directly attributable to a particular boat trip or to a particular species (in this case, minke whales). So, researchers used responses to specific questions included in the survey (see below), to determine the proportion of total regional expenditure that could be directly attributed to (a) minke whales – hereafter termed *MinkeAttribution*; and (b) the boat trip – termed *BoatAttribution*.

What was your primary reason for coming to this region? .....

If you had not been able to go on this boat trip, would you have still taken this trip to the Cairns/Port Douglas region?
(*Please mark* [✓] *the appropriate box for the scenario that best fits your travel choices*)

☐ Yes, and I would have spent the same amount of time in the Cairns/Port Douglas region
(*If so, please choose from box below*):

☐ **But** I would have gone on a different Reef/boat trip instead
- What type of dive/boat trip would you have taken instead? .....

☐ **But** I would have done something else in the Cairns/Port Douglas region instead
- What type of activity would you have done instead? .....

☐ Yes, but I would have spent less time/fewer days in the Cairns/Port Douglas region:
- *If so*, how much? I would have spent ..... fewer days in this region.

☐ No, I would have travelled elsewhere.

☐ No, I would not have taken the trip away from home at all.

☐ I don't know.

Responses to the first question were used as follows:

- If a respondent indicated that their primary reason for coming to the region was to see/swim with Minke whales, then *MinkeAttribution* was set to one.
- If a respondent indicated that their primary reason for coming to the region was to go on the boat-trip then *BoatAttribution* was set to one.

Responses to the second question were used as detailed below:

- If the respondent indicated that they would still have come to region even if they could not have taken the boat trip and spent the same amount of time – and

[7] The Queensland 'averages' will be dominated by non-dive boat visitors, and the Tropical North Queensland Data will be dominated by visitors who are based in Cairns, as opposed to Port Douglas.

- they would have gone on a different Reef/boat trip instead, then *BoatAttribution* was set to one.
  - If the particular boat-trip specified was one of the SWW-endorsed vessels, then *MinkeAttribution* was set to one.
  - If the specified boat trip was NOT a permitted boat, or was a generic trip (e.g. any trip to the Reef), then *MinkeAttribution* was set to zero.
- they would have done something else instead – then *BoatAttribution* and *MinkeAttribution* were set to zero.

- If the respondent would have still come to region but would have spent less time then *BoatAttribution* and *MinkeAttribution* were set to: the reduction in time that would have occurred divided by the total time actually spent in the region.
- If the respondent would not have come to the region (i.e. travelled elsewhere or not taken the trip away from home), then *BoatAttribution* and *MinkeAttribution* were set to one.

As shown in Table 12, a large proportion of non-boat visitor expenditure is attributable to the boats; not surprisingly, the figure is much smaller for the day-boats, and *MinkeAttribution* is, in all cases, less than *BoatAttribution*, reflecting the fact that at least part of boat expenditure is not directly associated with the species (i.e. other species and/or other aspects of the trip are likely to be important to the passengers).

Table 12: Mean proportion of expenditure attributable to boat trip[8] – by sample.

Survey	Proportion of non-boat regional expenditure attributable to minke whales[9]	Proportion of non-boat regional expenditure attributable by boat trip
Far Northern live-aboard		
Far Northern live-aboard 2006		0.90 (n=68)
Far Northern live-aboard 2007		0.94 (n=71)
Far Northern live-aboard 2008		0.90 (n=30)
Ribbon and Osprey Reef live-aboard 2008		0.86 (n=484)
Minke live-aboard		
Minke live-aboard 2007	0.73 (n = 470)	0.90 (n=504)
Minke live-aboard 2008	0.69 (n=354)	0.90 (n=388)
Minke day-boats		
Minke day-boats 2007	0.32 (n=43)	0.55 (n=45)
Minke day-boats 2008	0.31 (n=269)	0.72 (n=384)
Port Douglas day-boats 2008		0.80 (n=326)
Yongala day-boat 2008		0.73 (n=63)

[8] The relatively small 'n's' in this table (compared to the total sample size) reflect the fact that many respondents did not provide enough detail within this particular question for us to determine the value of either *MinkeAttribution* or *BoatAttribution.*

[9] The estimates of expenditure attributable to minke whales in the 2009 Preliminary Report, were higher than those reported here. This is because we have revised previous estimates downwards by setting *minke attribution to zero* for cases where respondents said they would have gone on a different boat trip if they could not have gone on this one, but did not provide enough information for us to determine whether that other boat trip would have been a minke boat trip or a generic boat trip. In the 2009 Report, these responses were left blank hence those 'average' figures were higher.

The total regional expenditure that was attributable to (a) minke whales; and (b) boat-trips was subsequently calculated as:

Mean expenditure attributable to minkes =
mean(MinkeAttribution) x mean(Total regional expenditure)

Mean expenditure attributable to boat-trips =
mean (Boatattribution) x mean(Total regional expenditure)

These estimates (see Table 13) are, by design, underestimates of the total expenditure attributable to minkes and/or to the boat trips since they attribute both boat and non-boat expenditures.

Table 13: Total boat and non-boat regional expenditure attributable to minke whales and to boat trips ($AUD, per person) – by sample.

Survey	Expenditure attributable to minke whales		Expenditure attributable to boat-trip	
	Using means	Using medians	Using means	Using medians
Far Northern live-aboard				
Far Northern live-aboard 2006			$4,507.32	$3,928.16
Far Northern live-aboard 2007			$4,791.84	$4,402.96
Far Northern live-aboard 2008			$5,655.83	$4,794.30
Ribbon and Osprey live-aboard 2008			$3,255.52	$2,477.66
Minke live-aboards				
Minke live-aboard 2007	$2,660.07	$2,215.55	$3,279.54	$2,731.50
Minke live-aboard 2008	$2,434.38	$2,000.31	$3,447.30	$2,609.10
Minke day-boats				
Minke day-boats 2007	$926.67	$931.36	$1,592.71	$1,600.78
Minke day-boats 2008	$1,362.86	$913.96	$3,165.35	$2,122.74
Port Douglas day-boats 2008			$3,930.18	$2,896.00
Yongala day-boat 2008			$992.06	$585.10

3.3 Step 3: Estimating annual tourism expenditure attributable to minke whales and to boat trips

3.3.1 Estimating the total number of tourists taking 'similar' trips per annum

As shown in Figure 3, if one wishes to estimate the regional economic 'impact' of a species, or a boat trip, one needs information about the total number of visitors per annum taking similar boat trips (be they minke whale trips or other, multi-species trips). So our 'impact' estimates are based on the five trip types for the calendar year 2008, for which we have sufficiently robust samples (with data on tourists' regional expenditure patterns) and information to generate 'population' estimates. These are:

1. Far Northern live-aboard trips;
2. Ribbon and Osprey Reef live-aboard trips (abbreviated to 'Osprey' trips in figures below);
3. Minke live-aboard trips;
4. Minke day-boat trips; and
5. Port Douglas day-boat trips.

Estimates of the total number of passengers taking similar trips in 2008 (shown in Table 14) were calculated based on known passenger numbers (where available, e.g. from Curnock, in prep.) and conservative occupancy rate estimates derived from other recent studies (e.g. Miller, 2005), although it is important to note that both tourism expenditures and tourism numbers vary annually, and that a decline in tourism visitation to the Cairns region has been observed in 2009 and 2010 (e.g. Dalton, 2010).

1. Far Northern live-aboard trips

For the 2008 Far Northern trips, only 42 passengers were carried to this region by the sole operator conducting these itineraries.

2. Ribbon and Osprey live-aboard trips

For the Ribbon Reef and Coral Sea sample (n=5 boats), we generated an estimate of the total number of passengers for 2008 by multiplying the passenger capacity of each vessel (ranging between 18 and 30 passengers) by the total number of trips taken for the calendar year, excluding those within June and July as well as the Far Northern GBR itineraries (taken as 371 trips in total), taken at a conservative occupancy estimated rate of 70% (based on Miller, 2005) and resulting in an estimated 'population' of 6,542 passengers.

3. Minke live-aboard trips

For the Minke live-aboard itineraries (conducted by five permitted vessels during June and July only), precise passenger numbers were available for these operations (via Curnock, in prep.). A total of 1,053 passengers were carried.

4. Minke day-boat trips

For the Port Douglas SWW-endorsed day-boats (n=3 vessels), we generated an estimate of the total number of passengers by multiplying the passenger capacity of each vessel (ranging between 80 and 100 passengers) by the total number of trips taken during June and July 2008 (known to be 178 vessel days; as reported by Curnock, in prep.) by a

conservative occupancy rate of 60%[10] (resulting in an estimated 'population' of 9972 passengers for the June-July period).

5. Port-Douglas day-boat trips

When attempting to estimate the total 'population' of (non-minke whale) day- passengers relevant to our study, we first contacted the GBRMPA to determine the total number of full-day visitors to the Offshore Port Douglas Sector during 2008, as recorded in the Environmental Management Charge (EMC) database: a total of 238,482. From that number, we subtracted:

a) Our estimate of the total number of minke day-boat passengers (from above, 9,972): and

b) Our estimates of the total numbers of Far Northern, Ribbon and Osprey Reef and Minke live-aboard passengers (*NB. This was a very conservative approach as only one live-aboard vessel was known to spend one day per week in this sector*).

This generated an estimate of the total number of (non-minke) day-boat passengers travelling to our study area during 2008 of 221,968. Our conservative estimate of the 'population' used in subsequent analyses, is therefore, 220,000.

Table 14: Estimated total visitor numbers compared to number of respondents, 2008 – by trip type.

Sample	Estimated total passengers taking similar trips during 2008 (the 'population')
Far Northern live-aboard	42
Ribbon and Osprey live-aboard	6,542
Minke live-aboard	1,053
Minke day-boats	9,972
Port Douglas day-boats	220,000

3.3.2 Scaling per-respondent estimates upwards to estimate annual total visitor expenditure

Estimates of the per-person expenditures attributable to minke whales and to boat trips (from Table 11) were then categorised according to the ANZSIC sector in which spending occurred, so that it could be used within an appropriate IO table. These estimates were then multiplied by our estimates of the total number of people travelling on each type of boat trip during 2008 (see Table 14) to generate an estimate of the total annual tourism expenditure that is attributable to (a) minke whales and to (b) boat trips that visit the highlighted sections Figure 1 (specifically those going to the *Off-shore Port Douglas*, the *Ribbon Reef* and the *Far Northern Sector* of the GBR). There was, however, one, important exception to this generic methodological approach; one that applied to the Port Douglas day-boat sample.

[10] This is considerably lower than the actual occupancy rates measured during our survey periods (96.5, 89.2 and 91.1 for each participating boat), but these measured occupancy rates were during school holidays – just one-half of the main minke season *(NB. 90% of encounters with dwarf minke whales occur during the months of June and July*; Birtles *et al.*, 2009). Hence the importance of using lower occupancy rates. That point aside, because our occupancy rate is conservative, our estimate of the total day-boat passengers – just under 10,000 – is also likely to be conservative.

To be more specific, we are reasonably confident that the expenditure estimates associated with the first four samples reflect those of their associated 'populations', primarily because we were able to collect data from a relatively large proportion of the total 'population'. However, the expenditure estimates associated with the Port Douglas day-boats are much more tenuous. As noted earlier, our sample is only a small proportion of the total population of day boat visitors. Consequently, the average expenditure patterns of our sample may not adequately reflect those of the population as a whole. Indeed, at $537 our estimates of average daily non-boat expenditure from our Port Douglas day-boat sample are significantly higher than the daily expenditure estimates of visitors in Tropical North Queensland during 2005-06 (Access Economics, 2007, p 69). Rather than treating the sample data as if it were representative of the 'population' of all day boat visitors in the *Offshore Port Douglas Sector* of the GBRMP, we therefore used data from both Access Economics and from Tourism Queensland to generate more representative estimates of the expenditure associated with these boats.

First, we used Tourism Queensland's estimates of the average expenditure per night of international and domestic overnight visitors to Tropical North Queensland ($154 and $170 per night respectively)[11] in conjunction with the ABS CPI index for Brisbane (ABS, 2008) to generate estimates of the average expenditure per night of international and domestic visitors during 2008: $170 and $188 respectively[12]. We then multiplied these nightly expenditure estimates by Tourism Queensland's 2008 estimates of the total number of domestic (intra and interstate) and international visitor nights to TNQ to determine an estimate of the total 2008 visitor spend in that region ($2.465b)[13]. Dividing that total amount by the total number of visitors[14] allowed us to generate an estimate of the total spend per visit of tourists in this region during 2008. At $1,086, this equates to approximately 22% of our estimates of the expenditure per Port Douglas day-boat visitor, clearly indicating that our sample data is not – as suspected – representative of the population at large. Consequently, we used these lower expenditure estimates (of $1,086 per visit) in subsequent calculations. Following the lead of Oxford Economics (2009), we have also chosen to attribute just 50% of all expenditure to the boat trips (rather than the 80% associated with our sample). The estimates associated with our Port Douglas sample are thus likely to be underestimates of the true population measures, primarily because we have used conservative estimates for each part of the calculation process.

The final estimates are presented in Table 15, clearly highlighting the fact that it is not just the boating (or, more precisely the 'transport') sector that benefits from this type of tourism. Many other sectors, particularly Accommodation earn money that is directly attributable to the presence of key marine species and to the existence of boat-operators that help visitors interact with those species. Indeed, the money that flows into the accommodation and retail sectors is greater than that which flows into the transport sector – and this is true, even excluding the Port Douglas day-boat estimates.

[11] Reported in Access Economics (2007, p 69).
[12] The CPI index was 164.1 in June 2008 and 149 in June 2005. So the 2005 daily expenditure estimates were each multiplied by 164.1 / 149.
[13] Calculated by multiplying domestic per-night spend ($170) by the sum of (domestic) intra and interstate visitor nights (3,724,000 and 3,702,000 respectively) and international per night spend ($188) by international visitors nights (6,402,000) and adding together.
[14] A total of 2,269,000 altogether, comprising 495,000, 1,017,000 and 757,000 interstate, intrastate and international respectively.

Table 15: Regional expenditure attributable to minke whales and to boat trips ($AUD, 2008 only) – by type of boat trip and sector in which spending occurs[15].

Survey	Expenditure					Total
	Retail trade	Accommodation	Transport (inc. trip price and expenditure on boats)	Communication	Recreational	
Estimated Total Regional expenditures during 2008 = Mean expenditure per person x N						
Far Northern live-aboards	24,864	70,466	161,225	2,137	5,230	263,922
Ribbon and Osprey live-aboards	3,159,786	6,634,217	12,143,110	284,828	1,488,401	23,710,342
Minke live-aboards	526,500	1,000,052	2,107,862	52,727	267,690	3,954,830
Minke day-boats	8,506,116	22,812,095	6,932,615	610,024	4,979,026	43,839,877
Port Douglas day-boats	43,560,000	124,032,222	35,723,272	2,424,763	32,019,135	237,759,392
Total for boat trips	55,777,266	154,549,052	57,068,084	3,374,479	38,759,482	309,528,363
Mean Expenditures attributable to minke whales = Mean attributable expenditure per person x N						
Minke live-aboard	363,285	690,036	1,454,425	36,381	184,706	2,728,833
Minke day-boats	2,636,896	7,071,750	2,149,111	189,107	1,543,498	13,590,362
Total for Minkes	3,000,181	7,761,785	3,603,536	225,489	1,728,204	16,319,195
Expenditures attributable to boat trips = Mean attributable expenditure per person x N						
Far Northern live-aboards	22,378	63,419	145,103	1,923	4,707	237,529
Ribbon and Osprey live-aboards	2,717,416	5,705,426	10,443,075	244,952	1,280,025	20,390,894
Minke live-aboards	473,850	900,046	1,897,076	47,454	240,921	3,559,347
Minke day-boats	6,124,404	16,424,709	4,991,483	439,217	3,584,899	31,564,711
Port Douglas day-boats	21,780,000	62,016,111	17,861,636	1,212,382	16,009,568	118,879,696
Total for boat trips	31,118,048	85,109,711	35,338,373	1,945,928	21,120,120	174,632,177

[15]Rounding errors imply that total expenditure numbers will not be exactly equal to mean expenditure x N.

3.4 Step 4: Estimating the regional economic impact of minke whales and boat trips

The regional economic 'stimulus' which expenditure generates is often greater than the initial amount of expenditure. The process by which this happens can best be explained by use of an example. Let us suppose that a visitor to a regional town spends $100, which had been earned outside the region, at a local grocery store. The owner of the store may put aside some money for savings/profit (say $10) and for taxation (say $20). He/she may also spend money importing stock from overseas (say $30), and may spend the rest on wages, or on fresh produce from the local gardener (say $40).

Figure 5 depicts the process diagrammatically, clearly showing that the total regional stimulus of the $100 of tourist expenditure is greater than $100: it is equal to the $100 earned by the grocer, plus the $40 earned by the gardener. Indeed the final regional stimulus may even be higher than $140, depending upon how much money the gardener spends within the local economy.

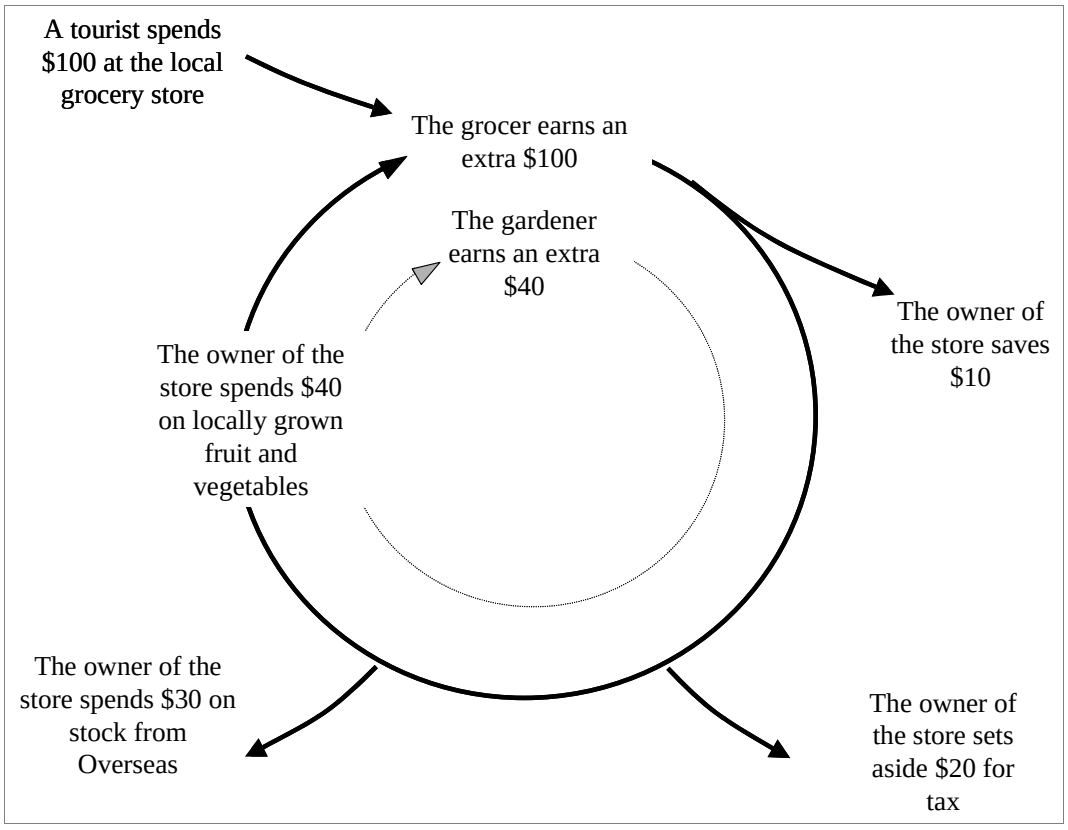

Figure 5: The circular flow of extra tourist dollars in a regional economy.

The advantage of looking at the process conceptually, as in Figure 5, is that it is easy to see that the final size of the economic stimulus of a tourist dollar depends upon the expenditure patterns of local firms and households. The larger the proportion of any 'extra' income re-spent within the local region, the greater the overall regional benefits of that initial tourist expenditure (or, in economic terminology, the greater the regional *multiplier*).

The 'theoretically correct' way to estimate the regional economic impact of visitor expenditure (be it that which is attributable to minke whales, boat trips, or something else) is to build a

computable general equilibrium (CGE) model that allows one to trace through all the complicated financial links within a region (characterised in Figure 5), thus working out how the visitor expenditure that is attributable to the multi-species boat trips (or to the minkes) affects all other parts of the economy. But these models are notoriously expensive to build, and none were available for the regions under investigation in this project. So researchers used the Far Northern Input-output (IO) table produced by the (Queensland) Office of the Government Statistician (2004)[16].

Further details concerning IO models are provided in Appendix 1, but suffice to say here, IO models are basically simplified CGEs. They use historical data about the way in which different types of businesses (or sectors) have previously spent money to make predictions about what might happen across an entire region if there were an increase or decrease in economic activity. An IO model that contained data like that in Figure 5 would, for example, predict that an increase of $100 in tourist expenditure would generate an increase in regional incomes of at least $140 (more, if the local gardener spends some of his/her money locally). If the $100 of expenditure is entirely attributable to minke whales, then this model would estimate the regional economic 'impact' of the minke whales to be at least $140.

In this study, the Office of the Government Statistician's 34-sector IO table of the Far Northern Economy was aggregated into a 15 sector table – with sectors corresponding to the sectors used in this study. This smaller, IO table was then used to estimate a matrix of technical coefficients used in the subsequent calculations. Data from Section 3.3 were used to estimate the change in final demand (*f)* that would occur if the minke whale industry or if all of these Reef-based boat trips were to 'disappear' – although estimates associated with the Transport sector were pre-multiplied by 0.83 before use, since the operator survey (see Appendix 2) indicated that only 83% of revenues collected by tourism operators is spent within the local community.

Estimates of the direct and indirect impact of (a) minke whales; and (b) the multiple species boat-trips are presented in Table 16. These were calculated using mean expenditure figures (rather than medians, which would generate lower estimates) and indicate that:

a) Minke whales contributed approximately $20 million to the FNQ economy during 2008; and that
b) The combined impact of all the boats operating in and around the *Off-shore Port Douglas Sector* of the GBR could be as high as $236m. That said, for the reasons discussed above, the estimates associated with the first four types of trips can be considered to be reasonably accurate; those associated with the Port Douglas day-boats, and thus, by extension, the aggregate estimate, should be considered as indicative only, and must be treated with caution, unless, or until, more regionally specific data can be collected.

[16]Consequently, the estimates presented here are subject to the normal assumptions attending traditional IO analysis, namely one must be prepared to assume that: all firms within an industry use the same technology regardless of their scale and location; that technology would not change if the industry were to disappear; that all inputs are used in fixed proportions; that the industries exhibit constant returns to scale; that all prices are constant; and that there are no input constraints (i.e. all firms within all industries are able to access required inputs).

Table 16: Direct and indirect impact of (a) minke whales and (b) boat trips – by sector in which spending occurs ($AUD, 2008).

Sector	Regional Economic Impact of Minke whales	Regional Economic Impact of Boat trips					
		Far Northern live-aboards	Ribbon and Osprey live-aboards	Minke live-aboards	Minke day-boats	Port Douglas day-boats	TOTAL
Agriculture	$91,192	$783	$91,900	$16,626	$182,195	$778,372	$1,069,876
Mining	$26,300	$290	$28,548	$5,046	$52,099	$214,203	$300,186
Manufacturing	$296,964	$4,641	$398,942	$70,455	$564,267	$2,236,193	$3,274,498
Electricity supply, gas and water	$210,810	$2,486	$220,580	$37,708	$422,477	$1,639,919	$2,323,170
Construction	$108,065	$1,500	$121,946	$20,649	$214,221	$824,495	$1,182,811
Retail and Wholesale Trade	$3,757,783	$30,460	$3,492,179	$607,659	$7,645,730	$27,601,166	$39,377,194
Accommodation, cafes and restaurants	$7,930,344	$65,636	$5,899,012	$933,513	$16,756,607	$63,305,443	$86,960,211
Transport	$3,502,486	$127,108	$9,259,785	$1,677,345	$5,148,050	$21,738,047	$37,950,335
Communication services	$501,869	$6,067	$598,848	$109,405	$970,819	$3,301,493	$4,986,632
Finance, property and business services	$2,834,282	$31,726	$2,800,287	$472,455	$5,741,573	$22,175,126	$31,221,167
Government admin. and defence	$283,395	$8,248	$617,875	$111,085	$460,405	$1,872,832	$3,070,445
Education	$20,723	$279	$23,471	$4,018	$40,976	$158,340	$227,084
Health and community services	$54,992	$688	$60,917	$10,511	$109,007	$426,803	$607,926
Cultural and recreational services	$1,897,188	$6,009	$1,438,647	$269,427	$3,926,619	$17,456,549	$23,097,251
Personal and other services	$27,568	$368	$31,723	$5,476	$54,278	$212,030	$303,875
TOTAL	$21,543,962	$286,288	$25,084,660	$4,351,378	$42,289,325	$163,941,011	$235,952,662

4. Visitor satisfaction with marine species interactions

To identify how much different species of marine wildlife contribute to the satisfaction of passengers on their trip, respondents were asked, 'How much did your interactions with each of the following types of marine wildlife contribute to your overall satisfaction with your trip?' Respondents were asked to rate their satisfaction on a ten-point semantic differential scale (1 = 'Didn't contribute at all to my satisfaction', to 10 = 'Contributed a great deal to my satisfaction') for the identified or nominated key marine wildlife groups. They were also asked to list 'any species in particular' for each group, and were provided the option to tick a box if they did not see these wildlife.

The key marine wildlife groups that were listed in each questionnaire varied slightly between surveys. For example, as dwarf minke whales show only a limited presence over the year (with >90% of sightings occurring in June and July, Birtles *et al.*, 2009) they were only listed in the minke whale surveys. And in those surveys the Sea Birds category was excluded from some surveys due to limited space and the listing of other key wildlife groups with a high sighting probability. In addition, the question about 'seeing many different types of wildlife' was incorporated after June 2007, hence only some of the surveys could be used for this particular rating.

Across all surveys, respondents' mean satisfaction was high to very high for all wildlife categories, except Sea Birds (Figure 6). This indicates that sea birds may not be as attractive to some types of passengers as under water marine species. Having the opportunity to interact with a wide variety of species scored highest overall (8.56), although interactions with both marine turtles, and with sharks and rays during the 2008 Far Northern live-aboard trips had the highest ratings for any particular survey (9.31), closely followed by the ratings associated with minke whales during the 2007 live-aboard survey (9.28) – see Table 17.

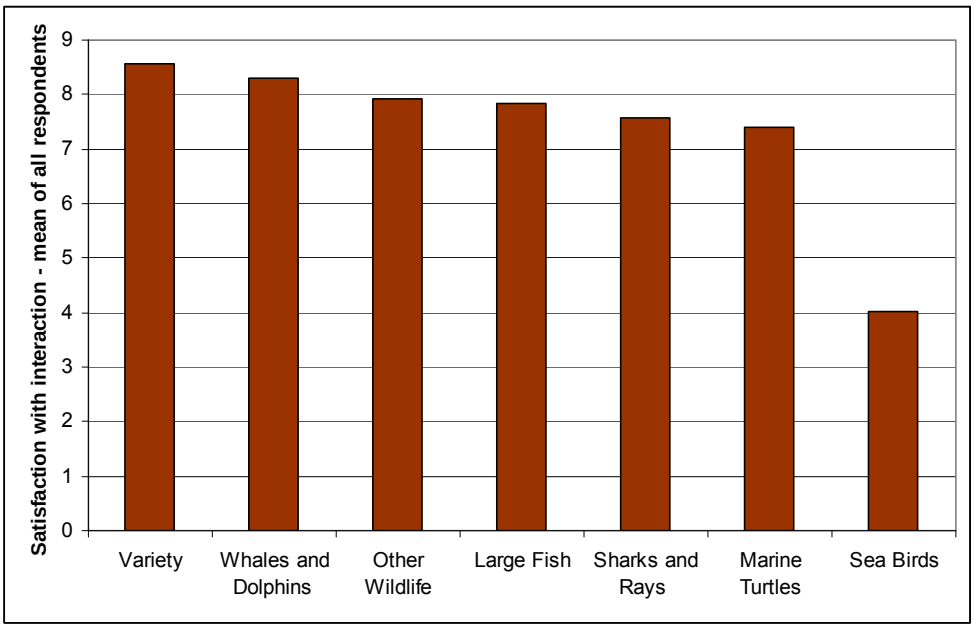

Figure 6: Visitor satisfaction with interaction (mean) – by wildlife group, all respondents.

Table 17: Visitor satisfaction with interaction (mean) – by wildlife group and sample.

Survey	Marine Turtles	Sharks and Rays	Large Fish	Whales and Dolphins	Sea Birds	Other Wildlife	Variety
Far Northern live-aboard							
Far Northern live-aboard 2006 (N=85)	8.82 (n=85)	8.37 (n=84)	8.48 (n=83)		4.69 (n=81)	6.72 (n=64)	
Far Northern live-aboard 2007 (N=90)	6.01 (n=86)	8.03 (n=90)	8.35 (n=88)		5.32 (n=84)	7.13 (n=54)	8.73 (n=82)
Far Northern live-aboard 2008 (N=39)	9.31 (n=39)	9.31 (n=39)	8.26 (n=39)		5.24 (n=33)	5.85 (n=27)	8.91 (n=35)
Ribbon and Osprey live-aboard 2008 (N=628)	7.41 (n=503)	8.30 (n=619)	8.09 (n=625)		3.53 (n=387)		8.52 (n=610)
Minke live-aboard							
Minke live-aboard 2007 (N=563)	7.34 (n=507)	7.30 (n=515)	7.46 (n=540)	9.28 (n=563)		8.42 (n=471)	
Minke live-aboard 2008 (N=433)	7.91 (n=387)	7.46 (n=375)	7.54 (n=423)	8.76 (n=430)	4.02 (263)	7.48 (n=266)	8.87 (n=404)
Minke day-boats							
Minke day-boats 2007 (N=51)	6.09 (n=11)	6.71 (n=28)	6.73 (n=44)	8.82 (n=51)	3.00 (n=13)	6.92 (n=26)	
Minke day-boats 2008 (N=443)	5.46 (n=158)	6.52 (n=232)	7.67 (n=396)	6.37 (n=225)		7.83 (n=304)	8.33 (n=390)
Port Douglas day-boats (N=367)	7.01 (n=124)	6.24 (n=131)	8.07 (n=317)	5.81 (n=126)		8.09 (n=247)	8.32 (n=328)
Yongala day-boats 2008 (N=116)	8.36 (n=105)	7.93 (n=45)	8.61 (n=114)	7.37 (n=51)		8.38 (n=100)	8.90 (n=113)
Total (N=2815)	**7.39 (n=2005)**	**7.58 (n=2158)**	**7.84 (n=2669)**	**8.29 (n=1446)**	**4.02 (n=861)**	**7.91 (1559)**	**8.56 (n=1962)**

Importantly, low satisfaction ratings may be associated with either low-quality interactions, or a low number of interactions (or both). The top number within each cell of Table 7 shows the mean satisfaction scores for any particular wildlife group on any particular trip type. The number below it indicates the number of respondents who rated the wildlife group. If respondents did not see a particular animal, they did not 'rate' it. So by comparing the number of respondents rating a particular animal (small 'n'), with the number of passengers answering *any* of the satisfaction questions (the large 'N' in the left hand column), one can determine the proportion of passengers on any particular trip type who did (or did not) see a particular species type. If one examines these figures, it becomes evident that low satisfaction ratings are associated with a low number of interactions, as evidenced by the following:

i. For most trips, the species receiving the lowest satisfaction scores are those with the lowest proportion of respondents who saw a particular species (calculated as 'n'/'N').

ii. Far Northern trips focus upon marine turtles, and in both 2006 and 2008, visitors reported very high levels of satisfaction with their interactions with these animals. However, satisfaction scores for this group of marine animals were generally low in 2007 – a year

during which turtle sightings were particularly low. Indeed, over October-December 2007, reports from the dive operators indicated an unusually low number of turtles nesting at Raine Island over the summer nesting season, resulting in survey respondents not encountering the density of green turtles that had been seen in previous seasons. So despite the fact that 86 of the 90 persons surveyed on this trip during 2007 saw at least one turtle, these respondents did not see as many as their counterparts in other years, and this has clearly affected passengers' satisfaction with their wildlife experiences. Section 6 analyses and discusses this issue in greater detail.

iii. Satisfaction ratings for interactions with minke whales during the 2007 minke day-boat trips were significantly higher than those during the 2008 sample. But during 2007, the research group only surveyed passengers who had seen minke whales. Consequently, one expects their satisfaction ratings to be high, and this is detected in responses to the survey question.

iv. Visitors on the minke whale trips reported lower levels of satisfaction with marine turtles, sharks and rays and large fish interactions than did the other groups of respondents – and a much lower proportion of minke respondents saw these species than did others. There is a much greater focus on encountering sharks and rays and large fish on the Ribbon and Osprey Reef trips than on those which are primarily dedicated to minke whales, and this is clearly reflected in the satisfaction scores.

Figure 7 plots the average satisfaction score against the proportion of respondents who did not see a particular animal (calculated as 1 – n/N) for all 2008 respondents. Not only does it show the strong relationship between the proportion of respondents who did not see a particular wildlife group and the satisfaction derived from that interaction, but it allows one to identify animals where (a) there are few opportunities for visitors to interact with them, and where (b) this is impacting upon satisfaction levels. This is particularly evident for marine turtles, whales and dolphins, and sharks and rays.

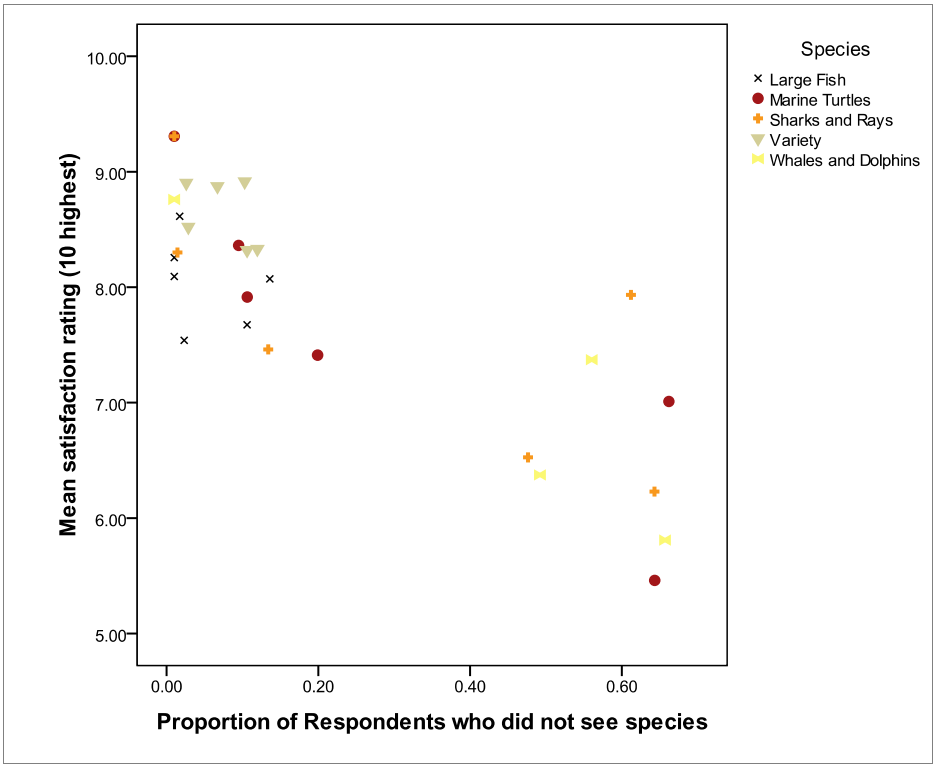

Figure 7: Visitor satisfaction with interaction versus proportion of respondents who did not see particular animals – by wildlife group, 2008 samples.

Recognising that some respondents are more (or less) naturally exuberant than others, and may, therefore, record high (or low) satisfaction levels for all interactions, researchers normalised responses, calculating a 'satisfaction index' for each of the wildlife groups identified above. This was done by dividing the single satisfaction score which each respondent attributed to a particular animal (group) by the sum of all of their satisfaction scores. When respondents indicated that they did not see a particular animal, the satisfaction index was set to zero. Similarly, if respondents answered at least one of the 'satisfaction' questions about one animal, but did not respond to other satisfaction scores, researchers replaced the 'missing' value with zero (assuming, in this case, that non-response indicated either no, or very low, levels of satisfaction).

Figure 8 shows the indices in pie charts for all day-boat samples, while Figure 9 shows the indices in pie charts for all live-aboard samples. These clearly highlight the fact that with the exception of the 2007 minke day-boats (where only passengers who had seen minkes were asked to complete a questionnaire), large fish and variety are vitally important to satisfaction on day-boats. This is in contrast to the live-aboard samples. Large fish are still important to these groups, but whales and dolphins, sharks and rays, and marine turtles, are of greater relative importance than they are to day-boat visitors.

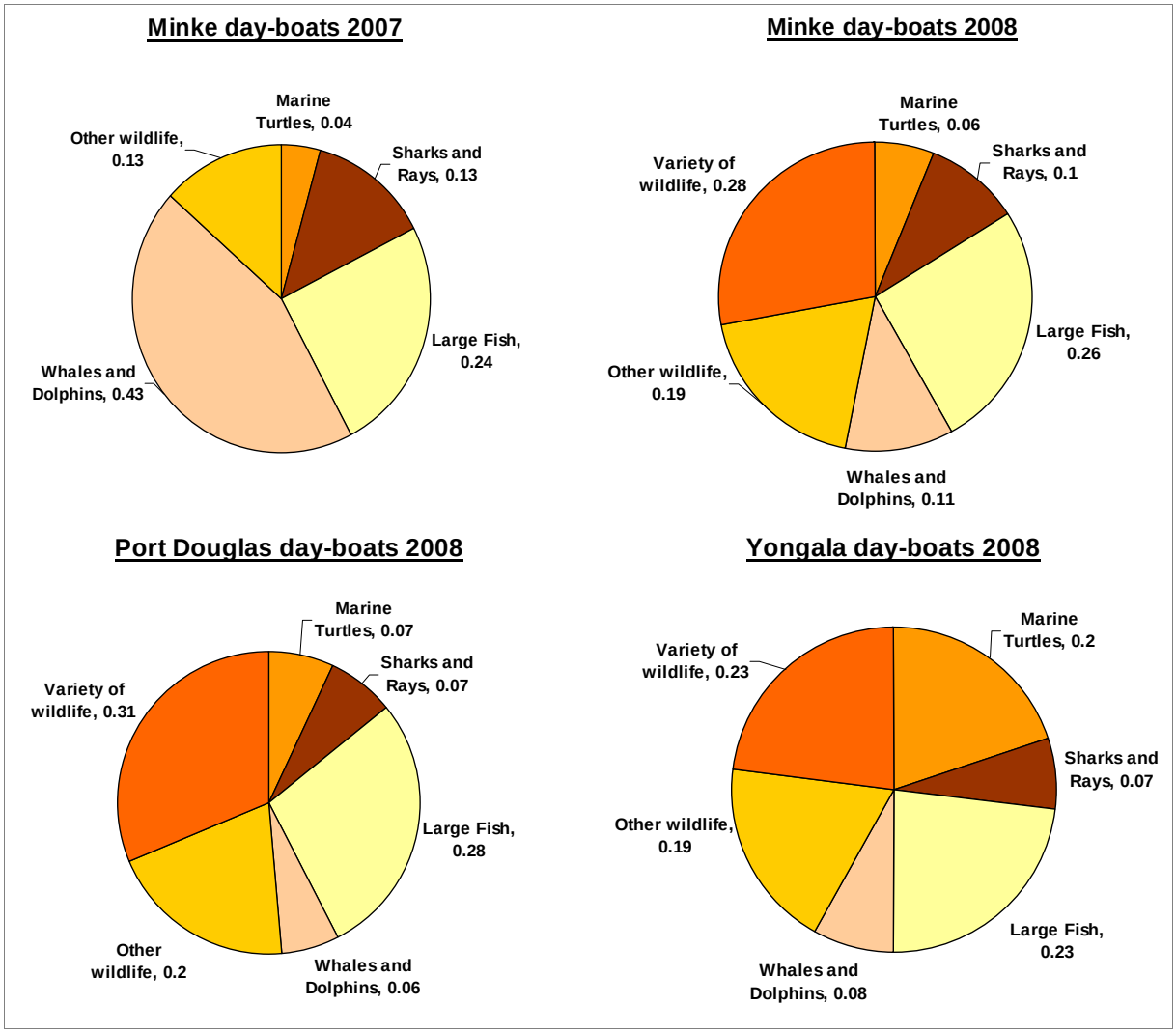

Figure 8: Index of visitor satisfaction (mean) – by wildlife group, sample and year; day-boat respondents.

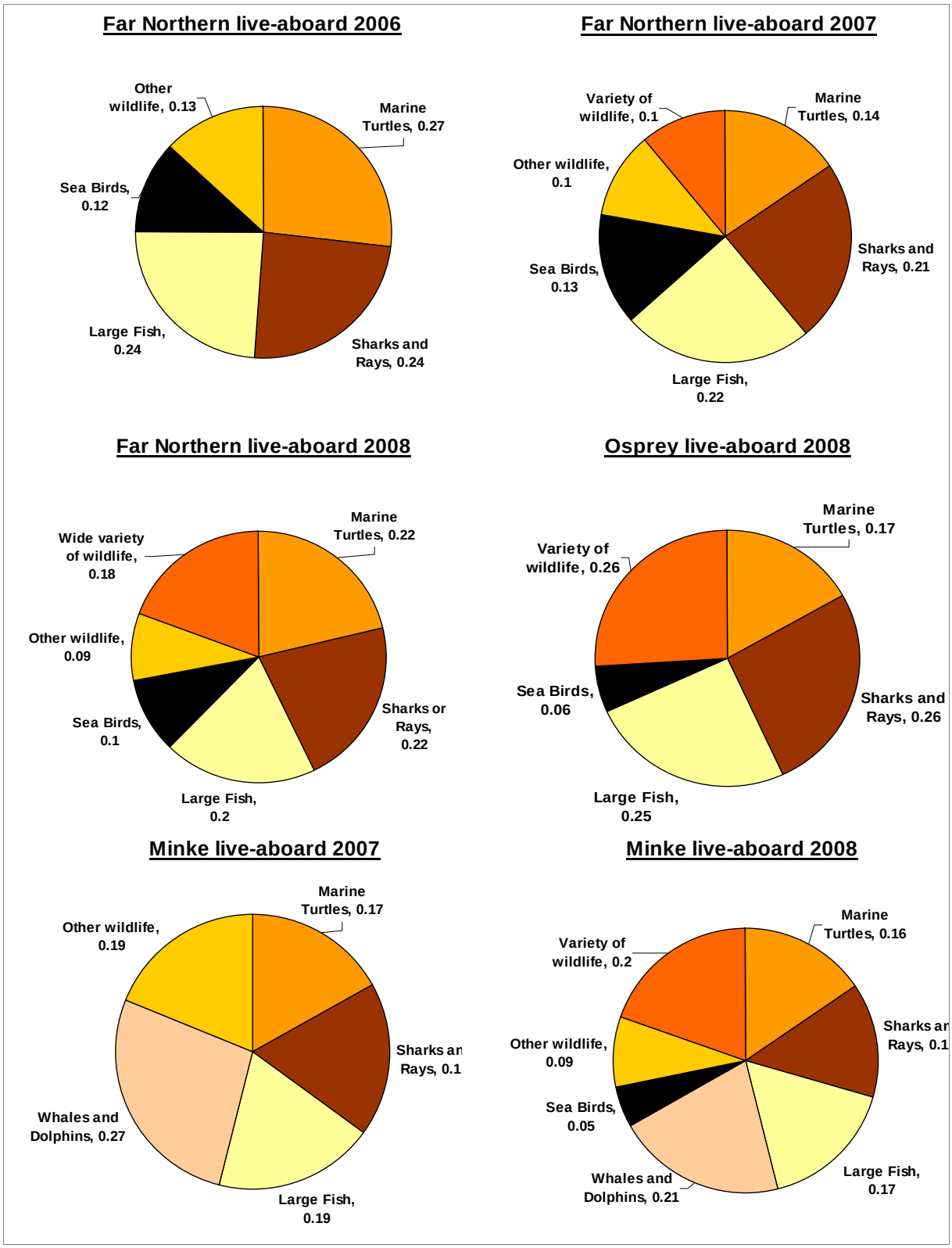

Figure 9: Index of visitor satisfaction (mean) –
by wildlife group, sample and year; live-aboard respondents.

Figure 10 shows the average index for each species across all respondent groups, while Table 18 presents these indices for each survey batch in numerical form. Although the conversion of raw numbers into normalised indices makes a few changes with respect to the top ranked species within any individual survey batch, the overall observation that 'variety' and large fish make significant contributions to satisfaction (across all reef trips combined) is robust across methodological approaches.

Table 18: Index of visitor satisfaction (mean) – by wildlife group and sample.

Survey	Marine Turtles	Sharks and Rays	Large Fish	Whales and Dolphins	Sea Birds	Other Wildlife	Variety
Far Northern live-aboard							
Far Northern live-aboard 2006	0.2672 (n=85)	0.2398 (n=85)	0.2397 (n=85)		0.1210 (n=85)	0.1323 (n=85)	
Far Northern live-aboard 2007	0.1442 (n=90)	0.2122 (n=90)	0.2181 (n=90)		0.1262 (n=90)	0.0972 (n=90)	
Far Northern live-aboard 2008	0.2202 (n=39)	0.2208 (n=39)	0.1956 (n=39)		0.0962 (n=39)	0.0855 (n=39)	0.2024 (n=35)
Ribbon and Osprey live-aboard 2008	0.1708 (n=628)	0.2562 (n=628)	0.2540 (n=628)		0.0608 (n=628)		0.2582 (n=628)
Minke live-aboard							
Minke live-aboard 2007	0.1748 (n=563)	0.1755 (n=563)	0.1946 (n=563)	0.2695 (n=563)		0.1852 (n=563)	
Minke live-aboard 2008	0.1551 (n=433)	0.1405 (n=433)	0.1676 (n=433)	0.2072 (n=433)		0.0927 (n=433)	0.2003 (n=404)
Minke day-boats							
Minke day-boats 2007	0.0450 (n=51)	0.1307 (n=51)	0.2363 (n=51)	0.4321 (n=51)		0.1323 (n=51)	
Minke day-boats 2008	0.0564 (n=443)	0.1045 (n=443)	0.2592 (n=443)	0.1116 (n=443)		0.1894 (n=443)	0.2790 (n=443)
Port Douglas day-boats 2008	0.0749 (n=367)	0.0698 (n=367)	0.2758 (n=367)	0.0628 (n=367)		0.2029 (n=367)	0.3138 (n=367)
Yongala day-boats 2008	0.2000 (n=116)	0.0706 (n=116)	0.2304 (n=116)	0.0786 (n=116)		0.1864 (n=116)	0.2340 (n=116)
Total	**0.1403 (n=2815)**	**0.1618 (n=2815)**	**0.2288 (n=2815)**	**0.1749 (n=1973)**	**0.0755 (n=842)**	**0.1259 (n=2815)**	**0.2589 (n=1993)**

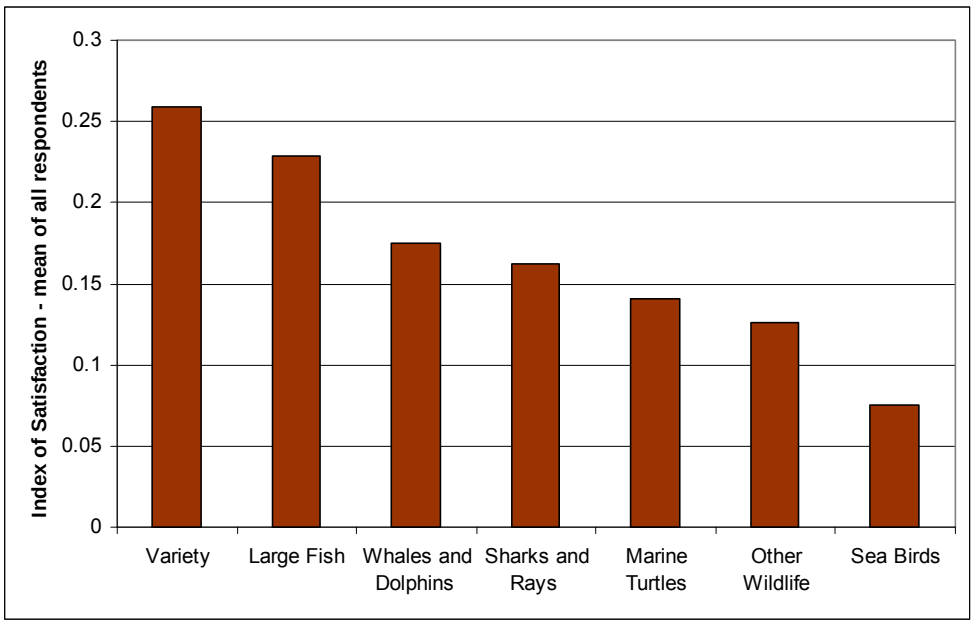

Figure 10: Index of visitor satisfaction (mean) – by wildlife group, all respondents.

The key problem with calculating an average satisfaction score (or satisfaction indices) across all respondents, however, is that it gives greater weight to the opinions of visitors who participate in trips that are over-represented by the sampling method. For example, we collected data from almost 90% of visitors travelling to the Far Northern Section, and from almost 50% of Minke live-aboard passengers. But the sample included just 10% of minke day-boat passengers, fewer still of those going to the Ribbon Reefs and Osprey Reef, and less than 0.2% of the entire (estimated) population of Port Douglas day-boat visitors. So the Far Northern live-aboard, and Minke live-aboard visitors are given more 'voice' than is merited if wishing to extrapolate findings to the population as a whole.

Researchers therefore constructed an alternative measure of overall visitor satisfaction with different marine wildlife. Here, the average, 2008, index of satisfaction for each wildlife group for each type of trip (e.g. Far Northern live-aboard, Minke live-aboard, Minke day-boat, Ribbon and Osprey live-aboard, and Yongala day-boats) was multiplied by an estimate of the total number of people taking those trips (see Table 14), and then divided through by the total number of passengers taking all similar trips. This approach thus generates a weighted average – with the weights reflecting visitor numbers (see Figure 11).

Importantly, the weighting process does not alter the relative importance of variety and large fish – the indices associated with these are still markedly higher than those associated with other wildlife. This again, seems to highlight the importance of wildlife accessibility: visitors clearly enjoy interacting with minke whales, dolphins, marine turtles, sharks and rays – as evidenced by the very high satisfaction ratings associated with these groups among those visitors who have the opportunity to see these animals. But relatively few visitors (particularly day visitors) are able to interact with these animals, be it because of issues associated with general or temporal scarcity. Hence the reduced satisfaction 'ratings' for these wildlife groups.

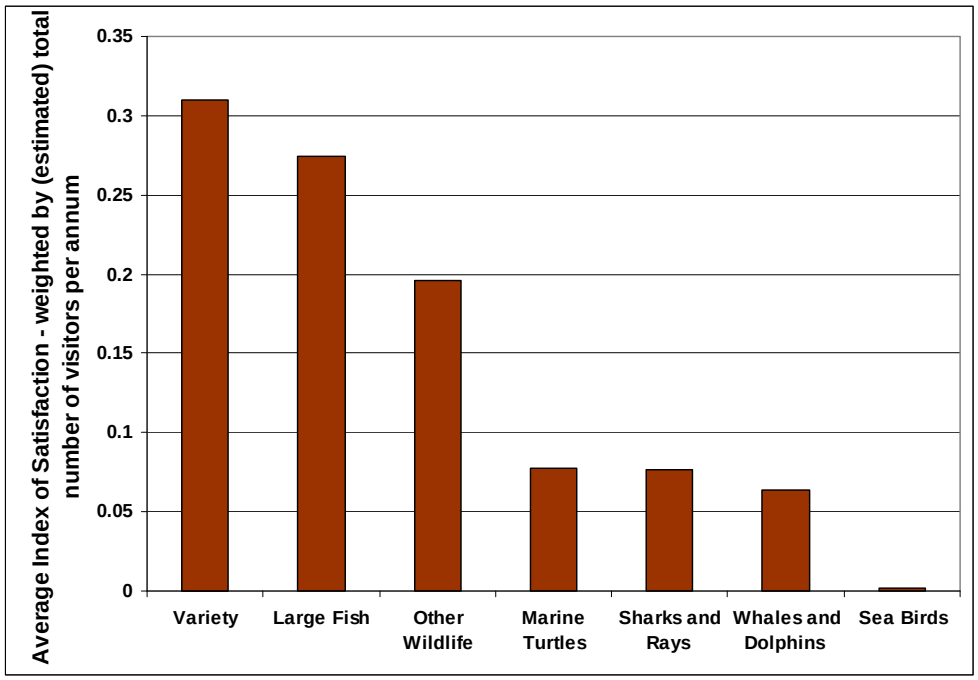

Figure 11: Visitor satisfaction index – by wildlife group, mean weighted to reflect the 'population' of visitors[17].

[17] It was not possible to estimate the total number of visitors going to Yongala during 2008, so this graph omits data from Yongala respondents.

5. Willingness to pay for increased chance of sighting key species

As noted in Section 1, estimates of economic impact and visitor satisfaction only provide information about the current state of affairs – they do not provide information about what *could* (or should) be occurring. To make those types of assessments, one needs information about the marginal value of wildlife species (i.e. about how people would respond to changes that impact upon those wildlife) rather than information that simply describes what is occurring (as per the values presented thus far). So from 2008 onwards, monetary estimates of the relative 'value' of different animals encountered by visitors whilst on the boat-trips were derived by comparing visitor responses to a hypothetical question about their willingness to pay (WTP) for a 100% 'guarantee' of seeing a range of different types of marine wildlife. A copy of the pertinent question appears below[18]:

For this question, please IMAGINE that it is possible for boat operators to provide a 100% GUARANTEE of seeing different types of wildlife. If they could do that, how much EXTRA (above what you have already paid for this trip) would you be prepared to pay for a 100% guarantee to see each of the following? *(Please tick one box for each wildlife category)*

(Categories represent Australian Dollars)

Wildlife	$0	$1-20	$21-50	$51-100	$101-150	$151-200	$201-300	More than $300
Sharks:	☐	☐	☐	☐	☐	☐	☐	☐ Please specify how much: .....
Large Fish:	☐	☐	☐	☐	☐	☐	☐	☐ Please specify how much: .....
Marine Turtles:	☐	☐	☐	☐	☐	☐	☐	☐ Please specify how much: .....
Seeing many different types of marine wildlife:	☐	☐	☐	☐	☐	☐	☐	☐ Please specify how much: .....

In an attempt to minimise both starting-point and interval bias, four different questionnaires were produced – using two different ranges of values ($0-150; $0-300), with associated differences in intervals; and using two different starting values (one version had '$0' in the first column adjacent to the wildlife group name; the other version had the highest range – $150 or $300 – adjacent to the group name). The mean 'willingness to pay' for each wildlife group was then calculated using the mid-point of each interval. In all cases, researchers interpreted non-response for any individual wildlife group as being equal to zero if the respondent indicated a positive WTP for at least one group.

[18] Although the National Oceanic and Atmospheric Administration (NOAA) panel on contingent valuation studies (Arrow *et al.*, 1993) recommends that valuation studies should be based on the single bounded dichotomous choice technique, this study used the payment card technique. There are at least two good reasons for this. First, as noted by Welsh and Poe (1998): the dichotomous choice technique can, in some instances, overestimate mean WTP. But what is, in this instance, more problematic, is that if one wishes to use this technique to estimate the value of one 'item' (X), then one would need to produce several different survey questionnaires, each with a different dichotomous choice (e.g. are you WTP $50 for X; are you WTP $100 for X), and then analyse the data using an appropriate statistical technique. By extension, if one wished to use the technique to generate several different 'values' of several different 'items' (X, Y and Z), then one would need to produce a multiplicity of questionnaires, each with a different (randomised) set of dichotomous choices. And this would require a very large sample to ensure an adequate number of responses to each dichotomous choice. Consequently, this research used the payment-card approach.

Figure 12 shows the WTP for each wildlife group (averaged across all respondents) while Table 19 presents the descriptive statistics associated with these responses for each individual survey group. Across all surveys, respondents' mean WTP was highest for 'Whales and Dolphins' and 'Sharks and Rays', and 'Sharks and Rays' had either the highest or second highest WTP for every survey group; Marine Turtles also featured in the Far Northern live-aboard Survey; and Variety in Osprey live-aboard. Not surprisingly, WTP for Minke Whales was highest for the minke-specialist trips.

Table 19: Willingness to pay for a '100% guaranteed' sighting ($AUD, per respondent) – by wildlife group and sample.

Survey		Sharks and Rays	Whales and Dolphins	Large Fish	Marine Turtles	Variety
Far Northern live-aboard survey 2008	Mean	83.91	-	35.13	38.75	33.09
	Median	75.50	-	.00	.00	.00
	Valid N	29	0	32	30	28
Ribbon and Osprey live-aboard	Mean	68.76	-	30.38	35.96	42.80
	Median	35.50	-	10.50	5.50	5.50
	Valid N	511	0	511	499	490
Minke live-aboard 2008	Mean	50.20	57.63	19.74	36.02	40.57
	Median	35.50	35.50	5.50	10.50	15.50
	Valid N	330	324	325	321	314
Minke day-boat 2008	Mean	40.28	47.30	23.11	37.56	36.91
	Median	15.50	35.50	5.50	15.50	15.50
	Valid N	390	409	375	399	357
Port Douglas day-boat 2008	Mean	43.71	54.02	24.06	41.92	36.16
	Median	35.50	35.50	10.50	35.50	10.50
	Valid N	321	332	291	320	277
Yongala day-boats 2008	Mean	75.56	96.47	42.32	52.36	73.18
	Median	63.50	82.00	15.50	35.50	63.50
	Valid N	108	108	104	104	102
Total	Mean	54.49	56.58	26.33	38.56	41.64
	Median	35.50	35.50	10.50	15.50	10.50
	Valid N	1,689	1,173	1,638	1,673	1,568

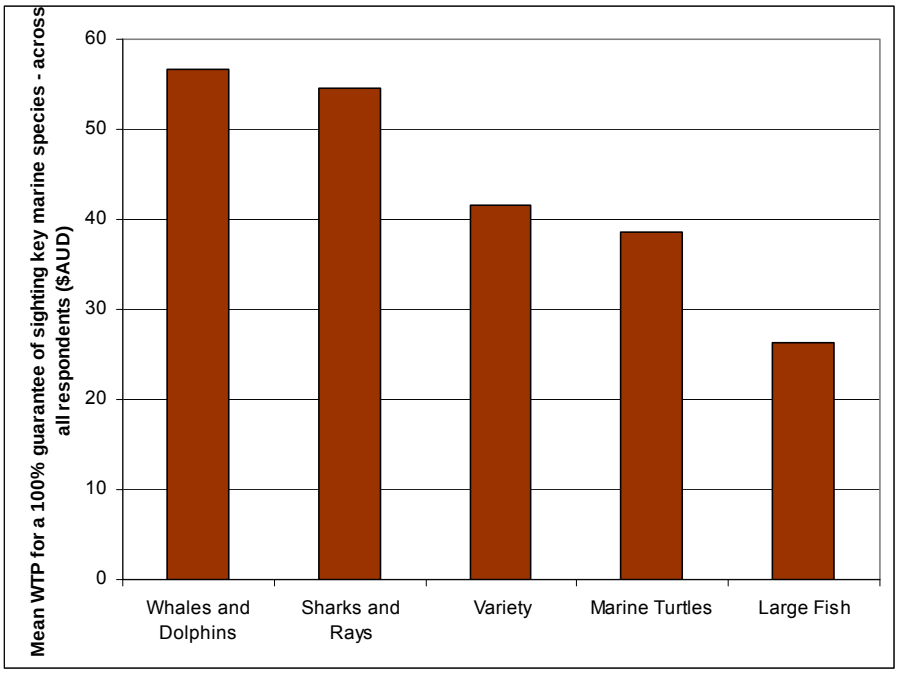

Figure 12: Willingness to pay for a '100% guarantee' sighting ($AUD, per respondent) – by wildlife group.

Again recognising that averages which have been calculated across all respondents give a disproportionate number of 'votes' to groups that are over-represented in the survey, researchers calculated a weighted average of WTP. Specifically, they multiplied mean WTP for each wildlife group, for each survey group (using 2008 figures only) by estimates of the total number of visitors taking similar trips[19](see Figure 13).

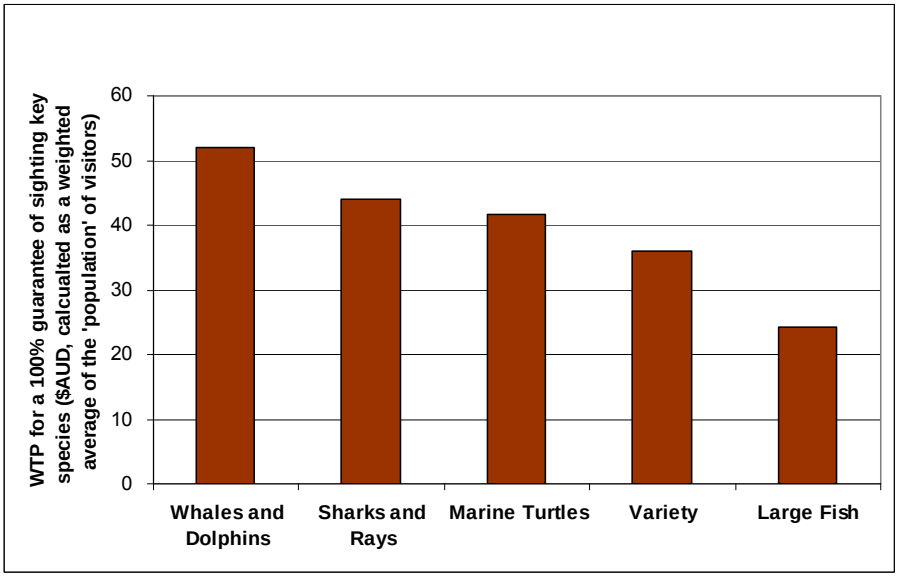

Figure 13: Willingness to pay for a '100% guarantee' sighting ($AUD, per person) – by wildlife group, mean weighted to reflect the 'population' of visitors[20].

[19]The 2008 Far Northern respondents and Live-aboard Ribbon and Osprey respondents were not asked about their WTP for a 100% guarantee of seeing Whales and Dolphins. In these two cases, the mean WTP of 2007 Far Northern respondents ($19.90) was used instead.

[20]It was not possible to estimate the total number of visitors going to the Yongala during 2008, so this graph omits data from Yongala respondents.

As in the previous section that considered satisfaction, this transformation – from a perspective that considers only respondents, to one that considers the entire population of visitors – does little to alter our measures of the relative importance of key marine wildlife groups. Whales and Dolphins, and Sharks and Rays still feature prominently (which is not surprising given that the Ribbon and Osprey live-aboard visitors are both numerous, and WTP large sums to see these wildlife) – although Marine Turtle feature more prominently in the second approach than in the first.

Economic theory suggests that one should not be surprised by this, *ceteris paribus*¸ people should be willing to pay more for something that is relatively rare, than for something that is abundant. Given this background, one therefore expects to observe a higher WTP for a 100% guarantee of sighting species which a relatively low proportion of respondents report having sighted than those which most people have sighted – see Figure 14. However, the relationship between the proportion of respondents who did not see a particular animal and WTP is not as strong as that which exists with satisfaction: there are clearly some confounding factors – one of which seems to depend upon whether the respondent is on a day-boat or live-aboard vessel. This is illustrated in Figure 15, which shows that there is a stronger relationship between the proportion of respondents who did not see a particular animal and WTP for visitors on day-trips than for visitors on the longer, live-aboard trips. This makes intuitive sense, given that those taking longer trips are also more likely to have the opportunity to interact with a greater variety of wildlife species – it is those with limited time, who are WTP most for an increased chance of interacting with particular animals.

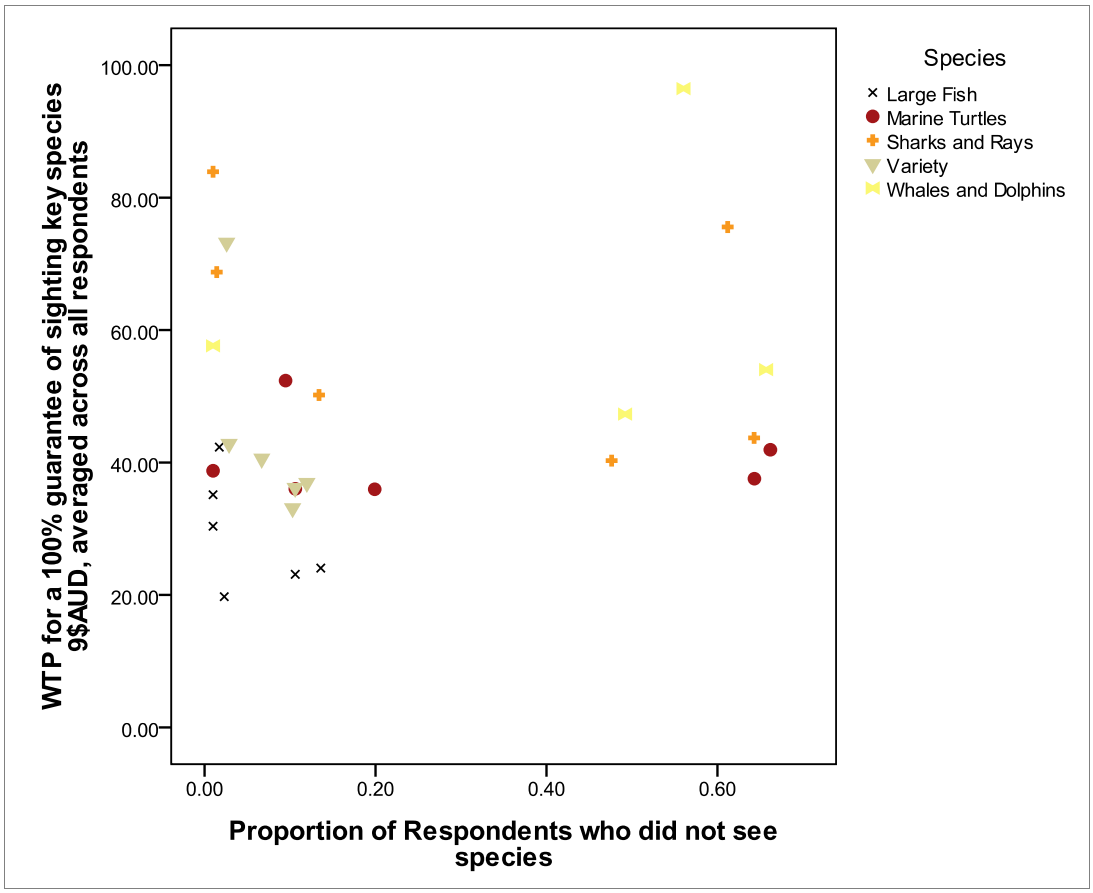

Figure 14: Willingness to pay for a '100% guaranteed' sighting vs. proportion of respondents who did not see particular animals ($AUD) – by wildlife group, 2008 respondents.

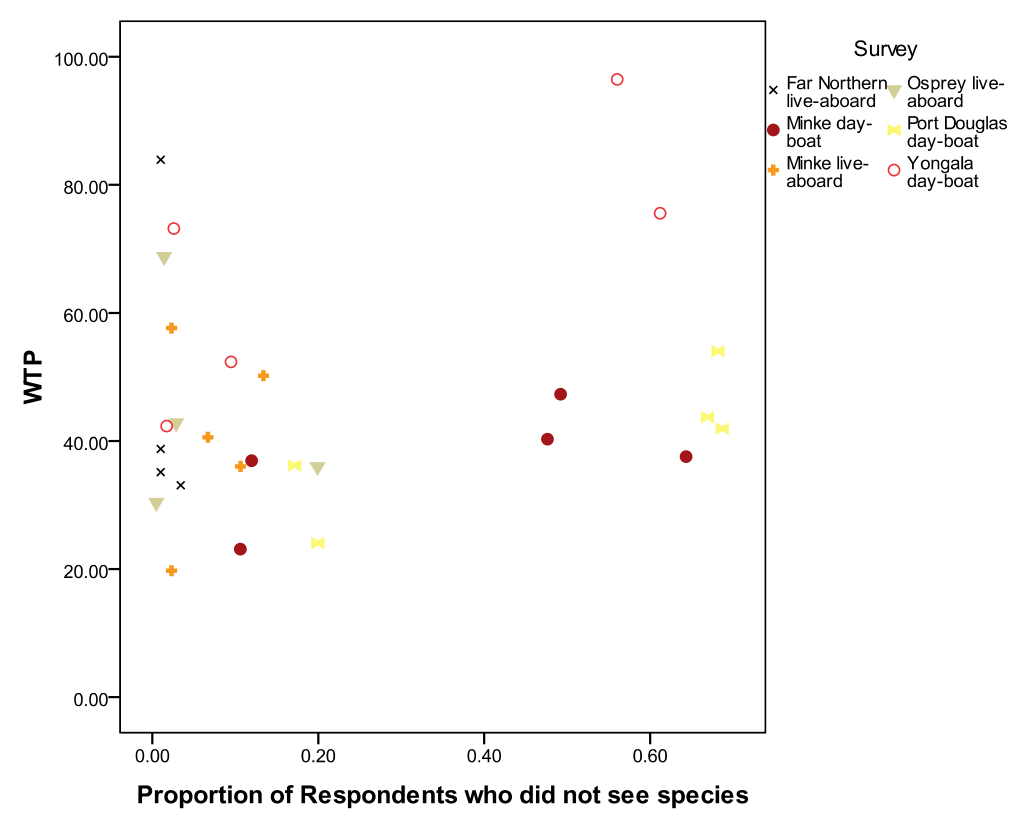

Figure 15: Willingness to pay for a '100% guaranteed' sighting vs. proportion of respondents who did not see particular animals – by trip type, 2008 respondents.

It is also interesting to note that Yongala day-boat respondents are, on average willing to pay more for a 100% 'guaranteed' sighting of any species than the other day-boat respondents. This highlights the importance of using caution when extrapolating results from one group of visitors to another: there are differences between different types of live-aboard visitors, between live-aboard and day-boat visitors, and between different types of day-boat visitors.

Nevertheless, it is clear that the probability of sighting key species affects both satisfaction and WTP. Further evidence of the fact that visitors are willing to pay more for a 'guaranteed' sighting of rare species than for relatively common ones can be found by more closely examining comments associated with the WTP question. Specifically, when respondents were asked to specify their WTP for a 100% 'guarantee' of sighting particular wildlife groups, they were given the opportunity to list particular species of interest (see Appendix 3 for a complete listing). This information provides some interesting insights not readily apparent from the 'aggregate' data presented thus far.

For example, visitors travelling to the Ribbons and Osprey Reef were willing to pay more for a guaranteed sighting of sharks and rays than for other wildlife group and the most commonly mentioned sharks were: hammerheads (33% of responses), whale sharks (17%) and tiger sharks (15%) – see Figure 16. Miller (2005) found that the probability of sighting sharks and rays (excluding reef sharks) at all five dive sites that are regularly visited by the Ribbon and Osprey Reef boat operators (including Steve's Bommie, Pixie Pinnacle, and Cod Hole at Ribbon Reef; and Admiralty Anchor and North Horn at Osprey Reef) is low – varying between 0 and 20% depending on the particular location. It is therefore not surprising to find that just 6% of these respondents mentioned the oft-sighted 'reef shark' when asked WHICH type of shark they were WTP for.

Similar observations can also be made with respect to other trip types: passengers travelling on the Minke live-aboard trips during 2008 visited five dive-sites most of which coincide with those of the Ribbon and Osprey Reef trips mentioned above (Steve's Bommie, Pixie Pinnacle, and Cod Hole (Ribbon Reefs) and they were most interested in seeing sharks and rays which are encountered less frequently at these sites (see Figure 17).

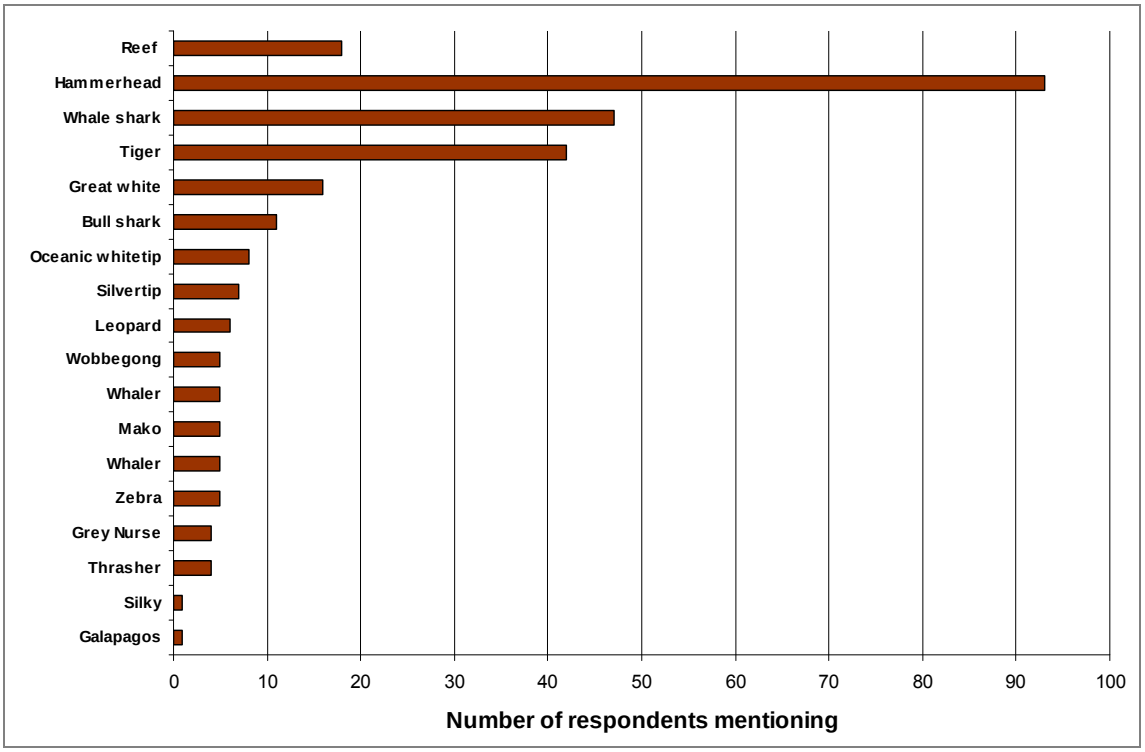

Figure 16: Number of respondents who identified particular types of sharks in response to the Willingness-to-Pay survey question (2008 Ribbon and Osprey Reef live-aboard respondents).

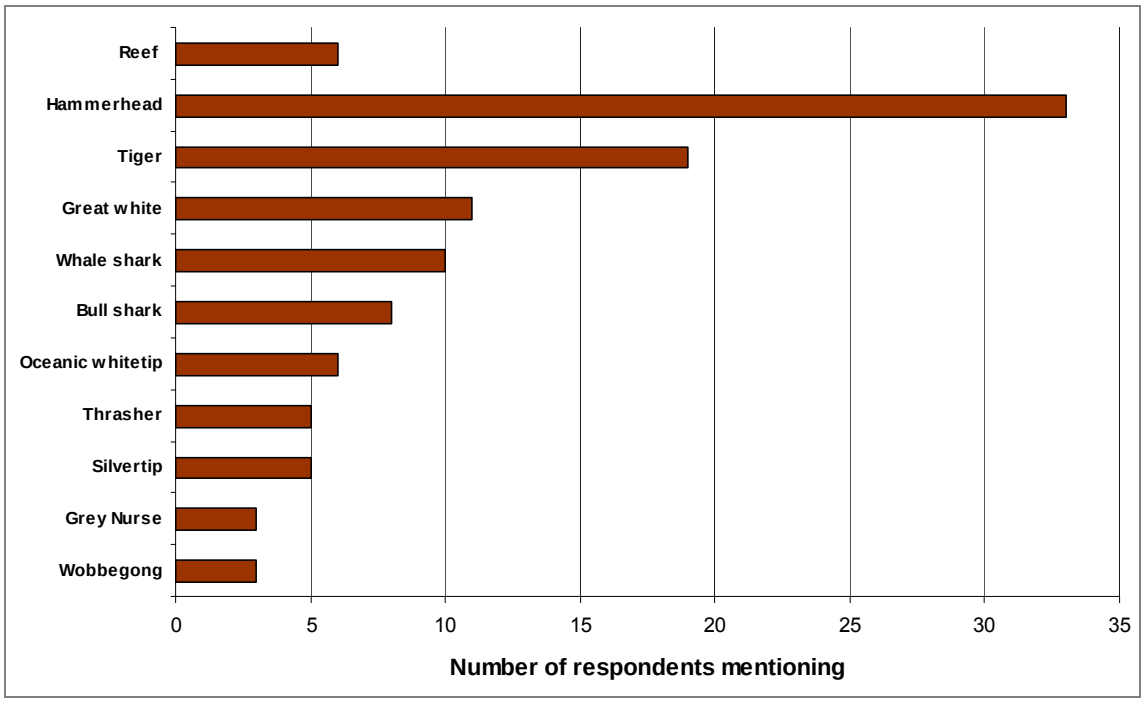

Figure 17: Number of respondents who identified particular types of sharks in response to the Willingness-to-Pay survey question (2008 Minke live-aboard respondents).

This highlights the fact that it is not strictly valid to compare 'raw' responses to the WTP survey question across species. There are some species which are relatively common. So visitors have, say, a 99% chance of seeing them on any particular trip. Consequently, when the survey asked about their WTP for a 100% chance of seeing that particular species, responses related to a one percentage point improvement in the probability of seeing that animal. In contrast, if considering a species that is relatively rare (say one with a 60% chance of being sighted), then the WTP question will elicit responses that relate to a forty percentage point improvement in the probability of sighting it. It is clearly erroneous to compare responses without allowing for these differences.

Researchers therefore used data on the proportion of respondents who saw a particular species (n/N from Table 17) to generate an estimate of the current probability, expressed as a percent, of sighting a particular species on a particular type of trip (p). They then worked out the implied improvement in the probability of sighting a particular species (Δp) that would occur, if one were able to 'guarantee' a sighting. For example, if 25% of visitors on one particular type of trip had seen a species, then the probability of seeing that particular species on that type of trip was estimated at 25%. By extension, a 100% 'guarantee' of seeing that species, was assumed to imply a 75 percentage point improvement in the probability of sighting that species. On those trips, each respondent's WTP for a 100% 'guaranteed' sighting was subsequently divided by the implied improvement, to generate an estimate of people's WTP for a one percentage point improvement in the probability of sighting a particular species[21]. As done previously, final estimates have been averaged across the entire respondent group (Table 20) and have also been weighted to reflect the entire 'population' of visitors (Figure 18).

At a disaggregated level (see Table 20), the highest single WTP for a one percentage point increase in the probability of sighting a wildlife group is for sharks on the Far Northern live-aboard trips ($83.91). This is followed by a $57.63 'bid' for a one percent improvement in the probability of seeing whales and dolphins on the Minke live-aboard sample, a $47.98 bid for a one percent improvement in the probability of sighting sharks are the Ribbon and Osprey trips, and a $38.75 bid for marine turtles in the Far Northern section of the GBR.

Across all respondents, the highest average WTP for a one percent improvement in the probability of sighting key species is associated with sharks and rays ($17.09) – although that is not much higher than the amount which respondents are, on average, willing to pay for improvements in the chance of seeing whales and dolphins, or large fish. When final estimates are weighted to account for the entire population of visitors, large fish and whales and dolphins 'win out' over sharks. This is largely because the respondents who expressed the highest WTP for improvements in the probability of sighting sharks are those from the Far Northern live-aboard sample – a relatively small group of people when compared to the overall population of visitors to this part of the Reef.

[21] If p = 100, 100-p was approximated as 1.

Table 20: Willingness-to-pay for a one percentage point increase in the probability of sighting key wildlife – by wildlife group and sample.

Survey		Marine Turtles	Sharks and Rays	Large Fish	Whales and Dolphins	Variety
Far Northern live-aboard 2008	Δp	1	1	1		10.3
	WTP	38.75	83.91	35.13		3.21
Ribbon and Osprey live-aboard 2008	Δp WTP	19.9 1.81	1.4 47.98	1 30.38		2.9 14.93
Minke live-aboard 2008	Δp	10.6	13.4	2.3	1	6.7
	WTP	3.39	3.75	8.55	57.63	6.06
Minke day-boats 2008	Δp	64.3	47.63	10.6	49.21	12.0
	WTP	0.58	0.85	2.18	0.65	3.09
Port Douglas day-boats	Δp	66.2	64.3	13.6	65.7	10.6
	WTP - 1	0.63	0.68	1.77	0.82	3.41
Yongala day-boats	Δp	9.5	61.2	1.7	56.0	2.6
	WTP - 1	5.52	1.23	24.55	1.72	28.30
Total	**Δp**	**35.5**	**29.3**	**5.8**	**39.3**	**7.3**
	WTP - 1	**2.49**	**17.09**	**14.23**	**16.65**	**9.08**

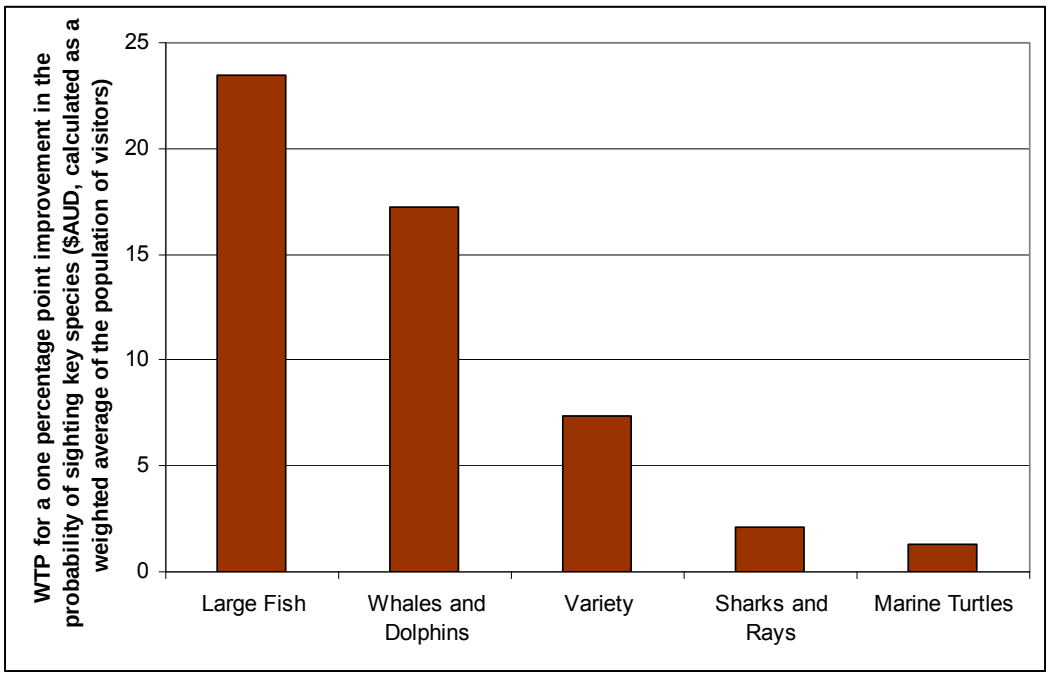

Figure 18: Willingness-to-pay for a one percent improvement in the probability of sighting key wildlife groups ($AUD) – by wildlife group, mean weighted to reflect the 'population' of visitors[22].

[22] It was not possible to estimate the total number of visitors going to Yongala during 2008, so this graph omits data from Yongala respondents.

6. Socio-economic values of marine turtles

As noted in Section 1, this report aims to provide information about the relative socio-economic values of several different marine wildlife groups (as discussed in the preceding sections). But it also aims to provide a more complete picture of the socio-economic values of marine turtles. Most evident from the foregoing analysis is the fact that marine turtles are of particular 'value' to visitors on the Far Northern live-aboard trips; turtles are sighted with lower frequency and in much lower abundance on other trips. It is, therefore, appropriate, for this marine turtle section, to focus upon the Far Northern sample.

Section 2.2.2.1 provided a generic overview of these trips, of the three-years of sampling undertaken in this region and of the visitor response rates. Overall, the sample represents 85% of the entire 'population' of passengers who took these trips over that three year period. Consequently, we are confident that the data collected by our survey is representative of the relevant population.

Over the three seasons of sampling, two significant events occurred which affected the data returns and the results. These have already been noted in previous sections of the report, but it is appropriate to reiterate here:

(i) Over October-December 2007, reports from the dive operators indicated an unusually low number of turtles nesting at Raine Island over the summer nesting season, resulting in survey respondents not encountering the density of green turtles that had been seen in previous seasons. This affected survey responses (as shown in the results below), in particular the extent to which interactions with marine turtles contributed to passengers' satisfaction with their wildlife experiences.

(ii) In the latter half of 2008, one of the operations unexpectedly ceased trading, resulting in only one remaining operator conducting itineraries to the Far Northern Section in 2008 that could be sampled (*NB. the second operator subsequently ceased trading in early 2009, the owner citing the Global Financial Crisis as the cause for their closure*). Thus only two trips on this vessel went to the Far Northern Section of the GBRMP in 2008, on which only 42 passengers in total were carried.

Sample description

As briefly summarised in Table 7, for the total sample (n=217, across all three years) the mean age of respondents was 46 (range 20 to 71). Sixty percent of the sample was male. Respondents came from 22 different countries, with the largest proportions originating from Australia (30.4%), the USA (26.3%), the UK (10.1%) and Germany (7.4%). Respondents from other European countries made up a further 16.6% of the sample (see Figure 19).

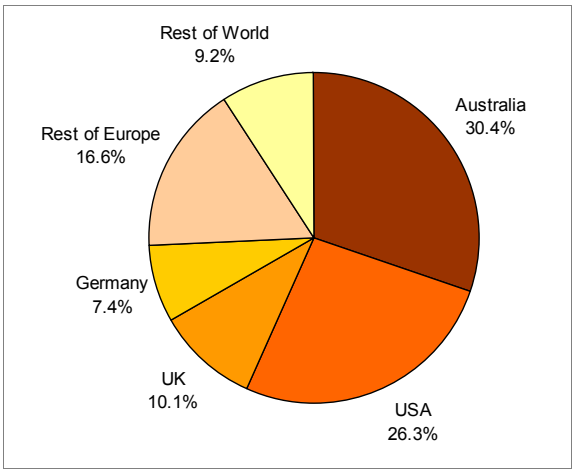

Figure 19: Country/region of origin – Far Northern live-aboard respondents.

Purpose of visit to Far North Queensland

For 60.8% of respondents (n=127), their dive trip to the Far Northern GBR was the main purpose for their trip away from home. For a further 36.8% of respondents (n=77), the dive trip was one of several activities and/or destinations planned during their visit.

Previous visits to the GBR and previous scuba diving experience

Fifty-three percent of the sample (n=115) were repeat visitors to the GBR. Among these respondents, the median number of previous visits was four (ranging from 1 previous to an estimated 5000 visits for one Australian respondent; presumed to be a Reef tour operator employee on holidays). In addition, 18.6% of respondents were repeat visitors to the Far Northern Section of the GBR.

Overall, the survey respondents were highly experienced scuba divers, with 86.6% (n=188) holding an Advanced Open Water certification or above (including 35.5% holding a Dive Master or Instructor-level/equivalent certification; n=77). The median number of years previous scuba diving experience was 13 (range 1-55 years), and the median number of dives performed previously was 295 (range 9-8000 dives). Only two respondents were not certified scuba divers.

A comparison of the dive history and experience of this group with those from other sampled live-aboard itineraries (including the Minke, and Ribbon and Osprey live-aboard trips and involving the same two operators plus three additional live-aboard operations) reveals that the Far Northern sample represented a group of highly experienced scuba divers, with a greater proportion of respondents holding scuba certification at or above Dive Master level (35.5%), a higher median number of years scuba diving experience (13 years) and a higher median number of dives performed in their lifetime (295 dives; see Table 21 below). Such levels of experience are characteristic of advanced recreational specialists (as outlined in Miller, 2005) that participate in such extended live-aboard itineraries to the remote Far Northern GBR for the opportunity to encounter rare and unusual wildlife phenomenon (e.g. large aggregations of breeding green turtles).

Table 21: Summary of dive history and experience of passengers on different live-aboard itineraries in the Great Barrier Reef Marine Park and Coral Sea (2006-2009).

	Far Northern live-aboard	**Ribbon and Osprey live-aboard**	**Minke live-aboard**
Proportion of survey sample that were repeat visitors to the GBR	53%	42%	57%
Proportion of survey sample holding Dive Master or Instructor level scuba dive certification	**35.5%**	17.3%	12.6%
Median (and range) years previous scuba diving experience	**13 years** (range = 1-55)	7 years (range <1-51 years)	5 years (range <1-41 years)
Median (and range) total number of dives performed in total diving experience	**295 dives** (range = 9-8000)	89 dives (range = 1-7000)	54 dives (range = 1-24,000)

Passengers' experiences in the Far Northern GBR

Respondents were asked (in an open-ended format) to list their three best experiences on their dive trip to the Far Northern GBR. From the total sample, 204 respondents provided short answers, which were coded via a grounded approach (content analysis), resulting in 696 coded elements that contributed to the respondents' best experiences. A summary of these results are shown below (Table 22).

Table 22: Summary of elements contributing to passengers' three best experiences on their dive trip to the Far Northern GBR.

Contributing element	n	Contributing element	n
MARINE LIFE: SHARKS		**OTHER MARINE LIFE (Cont'd)**	
Sharks (in general)	48	Flashlight fish	1
Tiger shark(s)	23	Blenny	1
Tiger shark tagging	17	Sea fans	1
Silvertip whaler shark	7	Soft corals	1
Shark abundance	3	Coral spawning	1
Variety of shark species	3	Bumphead parrotfish	1
Hammerhead shark	2	Surgeon fish	1
Zebra / leopard shark	2	Octopus	1
Tawny nurse shark	2	Bioluminescent algae	1
Grey reef shark	1	Potato Cod	1
Wobbegong shark	1	*Marine life total (incl. sharks and turtles)*	*326*
Sub-total for sharks	*109*	**LOCATIONS / DIVE SITES**	
MARINE LIFE: TURTLES		Raine Island	69
Turtles	58	Sand Bank #7	17
Seeing nesting/laying turtles	23	Remote Far North	9
Seeing many turtles	6	Other specific locations / sites	51
Seeing turtles mating	2	*Total for locations*	*146*
Seeing turtle hatchlings	1	**VESSEL/OPERATIONAL ASPECTS**	
Sub-total for turtles	*90*	Good/professional/friendly crew	27
OTHER MARINE LIFE		Involvement in research	23
Marine life in general	16	Social aspects	18
Healthy coral/reefs	12	Good food	17
Coral	9	Educational aspects (e.g. bio talks)	15
Scorpion fish	9	Good boat	6
Fish (non-specific)	9	Safety	1
Manta ray	8	Flight over reef	1
Dolphins	7	*Total for vessel/operations*	*108*
Fish diversity and abundance	6	**DIVING ASPECTS**	
Pelagic fish (trevally, barracuda)	6	Diving in general	48
Seeing animal behaviours	6	Wreck (archaeological) dive	19
Nudibranch(s)	5	Wall dive	8

Contributing element	n	Contributing element	n
Cuttlefish	5	Night diving	8
Dugong	4	Drift dive	5
Nautilus	3	Pinnacle dive	5
Birds	2	Good visibility	3
Rays	2	Good photography	2
Frog fish	2	Underwater colours	2
Diversity of marine life	2	*Total for diving aspects*	*100*
Queensland grouper	2	**Good weather**	**5**
Flame file shell	1	**Other comments (combined)**	**11**
Coral diversity	1	**TOTAL CODED ELEMENTS**	**696**

As highlighted in Table 22, the most outstanding features of these trips to the Far Northern GBR are sightings and interactions with sharks and marine turtles. The remoteness of the area and visitation to turtle nesting cays (e.g. Sand Bank No.7) as well diving in the vicinity of Raine Island were also clear highlights. Many of the responses to this question provided insights into the special nature of the region and the wildlife interactions it provides. Example responses are shown below:

> 'Seeing a dugong on 'the gut' reef – very special. Diving with hundreds of turtles – Raine Island. Sand Cay No. 7 – Sitting on beach surrounded by turtles coming and going, stars, then seeing turtle lay eggs. Fourth would be seeing tiger shark being tagged.'
>
> '1. Sand Cay # 7 – Watching nesting turtles. 2. Raine Island – Watching turtles leave the beach in the morning. 3. Observing first hand, research on tiger sharks.'
>
> '1. Diving with sharks on Raine Island. 2. Seeing turtles laying on Sand Cay # 7. 3. Sharks at Silver City.'

Satisfaction and expectations

In addition to questions about overall satisfaction with interactions with particular species (discussed in Section 4), respondents were also asked to rate their overall satisfaction with their diving trip (on a rating scale from 1 = very poor to 10 = excellent). The mean rating was 8.72 ($\pm$SE=0.093; median = 9) which is considered to be very high among tourism satisfaction studies (Pearce, 2006). Respondents were then asked to rate (on an equivalent scale) their satisfaction with their wildlife experiences on their trip; the mean rating for which was slightly lower at 8.50 ($\pm$SE=0.101; median = 9). When asked to rate how well their Far Northern GBR diving trip met their expectations (on a scale of 1 = 'well below my expectations' to 3 = 'met my expectations' to 5 = 'well above my expectations') the mean rating was 3.53 ($\pm$SE=0.070; median = 3), indicating that for the majority of participants their expectations of the trip were met or exceeded.

In light of the rich open-ended descriptions provided for respondents' best experiences, a closer examination was made of the lower mean rating score for passengers' satisfaction with their wildlife experience(s). A comparison of the above rating scores between years revealed a significant difference in passengers' ratings of their satisfaction with their wildlife experience(s) (Kruskal Wallis test: $\chi^2_{1,216} = 18.707$; $p<0.001$). In this case the rating scores were clearly lower in 2007 (median = 8, compared with a median of 9 for both 2006 and 2008; see Table 23 below).

Table 23: Between-year comparison (2006-2008) of Far Northern GBR passengers' ratings of (i) their overall satisfaction with their dive trip, (ii) their satisfaction with their wildlife experience(s), and (iii) the extent to which their expectations of the trip were met.

	2006 (n=87)		2007 (n=90)		2008 (n=40)	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
Overall satisfaction with dive trip *(rating scale 1-10)*	8.62	9	8.71	9	8.97	9
*Satisfaction with wildlife experience(s) *(rating scale 1-10)*	8.76	9	7.98	8	9.08	9
Extent to which expectations with trip were met *(rating scale 1-5)*	3.58	3	3.46	3	3.60	3.5

* A significant difference was found between years for this variable; p<0.001

Based on feedback from the operators that a lower number of turtles were encountered in 2007, the possibility that this occurrence influenced respondents' ratings of satisfaction with their wildlife experience(s) was examined more closely. The questionnaire asked respondents to indicate the extent to which interactions with different marine wildlife groups contributed to their overall satisfaction with their trip (on a rating scale from 1 = 'didn't contribute at all to my satisfaction' to 10 = 'contributed a great deal to my satisfaction'). Marine turtles, sharks and fishes were included among the wildlife categories. Significant differences were found between years for respondents ratings for Marine Turtles (Kruskal Wallis: $\chi^2_{1,216}$ = 68.998; p<0.001) and for sharks (Kruskal Wallis: $\chi^2_{1,216}$ = 18.304; p<0.001). As shown below in Table 24, the mean and median ratings for turtles were substantially lower in 2007 (median = 6.5, compared with median ratings of 9 in 2006 and 10 in 2008), while the median ratings for sharks varied between 8.5 in 2006 to 8.0 in 2007 and 10 in 2008. No significant differences were found between years for these ratings for other wildlife taxa (Table 24).

Table 24: Between year comparison of Far Northern GBR passengers' ratings of the extent to which different marine wildlife groups contributed to their satisfaction with their dive trip.

	2006 (n=87)		2007 (n=90)		2008 (n=40)	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
***Turtles**	8.82	**9**	6.01	**6.5**	9.31	**10**
Fishes	8.48	9	8.35	9	8.51	9
***Sharks**	8.37	**8.5**	8.02	**8**	9.31	**10**
Other wildlife	6.72	7	7.13	8	5.85	7

* Significant difference found between years for these variables; p<0.001.

The opportunity to see and interact with large breeding aggregations of green turtles was advertised as a key feature of the Far Northern GBR itineraries. While all but four respondents in 2007 indicated that they saw turtles, it is clear that the lower numbers observed did not contribute as strongly to passengers' satisfaction as the large aggregations seen in the seasons before and after (in which the ratings for turtles achieved the highest mean and median scores among the listed wildlife categories).

Negative aspects

Passengers were asked (in open-ended format) if there were any things that stood out as having reduced (i.e. negatively impacted on) their enjoyment of their wildlife experience(s). Of the 142 respondents that answered this question, 50 indicated that nothing had reduced their enjoyment. Among the responses from those that listed detracting elements, the key themes that emerged were perceived impacts on the Reef and/or marine wildlife, the weather and sea conditions, and a lack of sightings of particular marine wildlife (as shown in Table 25 below). Six respondents noted that a lack of turtles had reduced their satisfaction and all six of these respondents were on trips in 2007.

Table 25: Summary of coded elements from passengers' statements about things that lessened their enjoyment of their wildlife experience on their Far Northern GBR dive trip.

Detracting element (description)	**n**
Nothing / no detractions from wildlife experience(s)	50
PERCEIVED IMPACTS	
Dead coral / damaged reef	15
Divers' damaging coral	6
Fish feeding at Cod Hole	2
Finding fishing line in a Marine Park Green Zone	1
Divers chasing marine wildlife	1
Flash photos taken of nesting turtles	1
Generally concerned about impacts and Reef conservation	1
Sub-total: Perceived impacts	*27*
WEATHER AND SEA CONDITIONS RELATED	
Rough seas/bad weather	9
Poor visibility	8
Strong current(s)	4
Seasickness	2
Sub-total: Weather & sea conditions related	*23*
LACK OF MARINE WILDLIFE	
Lack of sharks	8
Lack of turtles	6
Lack of wildlife in general	3
Lack of manta rays	1
Lack of pelagic fishes	1
Sub-total: Lack of marine wildlife	*19*
OTHER ISSUES/PROBLEMS	
Vessel / operation / itinerary related	10
Personal / equipment problems	9
Inability to land on Raine Island	5
Too many divers in the water	2
Too many passengers on the boat	1
Social problem with other passengers	1
Sub-total: Other issues/problems	*28*
TOTAL CODED ELEMENTS	**147**
Left question blank	*75*

7. Summary and concluding remarks

Approximately 90% of respondents on the live-aboard dive-boat trips, and at least 50% of day-boat respondents, reported that they would not have come to Northern Queensland (and hence spent money there) if they had not had the opportunity to go on those trips. Evidently, marine wildlife tourism is an important contributor to regional economies, and our calculations (which, unlike previous studies, differentiates between visitor spending *per se*, and visitor spending that can be directly attributed to this type of tourism) indicates that it makes a substantial and important contribution to incomes in FNQ. Moreover:

- It is not just the transport (boating) sector that benefits: the accommodation, transport, retail and the finance, property and business service sectors are significant beneficiaries of the incomes generated by marine wildlife tourism in this region;
- These general observations, if not the specific estimates, are likely to apply to the GBR as a whole. Of the 1.8 million people who visited the GBRMP during 2008, approximately 80% visited just seven percent of the Marine Park, and approximately 44% of all full-day visits took place in the Offshore Cairns/Port Douglas region (GBRMPA, 2009).

The key point to be made here, therefore, is that it is not just important to preserve and protect marine wildlife for their intrinsic and ecological values. These wildlife are clearly an important source of income for those living alongside the GBR. Those wishing to maintain these income flows therefore need to maintain the flow of tourists to this region. Hence the importance of exploring some of the 'values' or 'preferences' of these tourists and asking questions such as: are some marine species more important, or of higher 'value' than others?

As is evident from the preceding discussions, there are multiple different measures of 'value' that provide different types of information. It is therefore instructive to look at some of these 'values' simultaneously, as has been done in Table 26 – which uses results from Sections 3 and 4, to 'rank' key marine wildlife groups. In this table, 1 indicates that the particular group rated highest on that particular measure.

Far Northern live-aboard passengers consistently rate Sharks and Rays and Marine Turtles as being of greatest 'value' – irrespective of the measure used. Ribbon and Osprey Reef live-aboard passengers consistently rate Sharks and Rays as being of particularly high value – although for this group of passengers, variety and large fish are also important. Not surprisingly, Minke live-aboard passengers, rate Whales and Dolphins highest on all measures. Evidently, these wildlife groups and species are particularly important to the live-aboard market (arguably, the 'high', or expensive, end of the market. And interestingly, it is these animals which tourism operators rate as contributing most to passenger satisfaction (as reported in our concurrent MTSRF report for Task 4.8.6(b)).

The story is, however, quite different for day-boat respondents (both Minke day-boats and Yongala day-boats), where it seems that Large Fish and Variety are the 'bread and butter' of these operations: they rate highly on three of the four measures of 'value', although all day-boat respondents would be WTP relatively large amounts for a 100% guaranteed sighting of Sharks and Rays or Whales and Dolphins.

Table 26: The relative 'value' of key marine wildlife groups – by sample and measure of 'value'.

	Ranked 'values' using raw satisfaction scores	Ranked 'values' using Index of satisfaction	Ranked Values using WTP for a one percentage point increase in the probability of sighting	Ranked Values using WTP for a 100% 'guarantee' of sighting
Far Northern live-aboard 2008				
Sharks and Rays	**1**	**1**	**1**	**1**
Whales and Dolphins		*Not asked about Whales and Dolphins*		
Large Fish	3	4	3	3
Marine Turtles	**1**	**2**	**2**	**2**
Variety	**2**	3	4	4
Osprey live-aboard 2008				
Sharks and Rays	**2**	**2**	**1**	**1**
Whales and Dolphins		*Not asked about Whales and Dolphins*		
Large Fish	3	3	**2**	4
Marine Turtles	4	4	4	3
Variety	**1**	**1**	3	**2**
Minke live-aboard 2008				
Sharks and Rays	5	5	4	**2**
Whales and Dolphins	**2**	**1**	**1**	**1**
Large Fish	4	3	**2**	5
Marine Turtles	3	4	5	4
Variety	**1**	**2**	3	3
Minke day-boats 2008				
Sharks and Rays	3	4	3	**2**
Whales and Dolphins	4	3	4	**1**
Large Fish	**2**	**2**	**2**	5
Marine Turtles	5	5	5	3
Variety	**1**	**1**	**1**	4
Port Douglas day-boats 2008				
Sharks and Rays	4	4	4	**2**
Whales and Dolphins	5	5	3	**1**
Large Fish	**2**	**2**	**2**	5
Marine Turtles	3	3	5	3
Variety	**1**	**1**	**1**	4
Yongala day-boats 2008				
Sharks and Rays	4	5	5	**2**
Whales and Dolphins	5	4	4	**1**
Large Fish	**2**	**2**	**2**	5
Marine Turtles	3	3	3	4
Variety	**1**	**1**	**1**	3

It is therefore not surprising to find that at an aggregate level (i.e. when one weights measures to reflect the entire 'population' of visitors), Large Fish and Variety perform well across most measures of value that describe the current state of affairs (see Table 27) – it is the rarer animals that come to the fore, when looking at the values expressed for enhanced opportunities for tourism interactions with such animals.

Table 27: The relative 'value' of marine wildlife groups across the 'population' of visitors – by measure of value.

	Ranked 'values' using raw satisfaction scores – weighted by the population of visitors	Ranked 'values' using Index of satisfaction – weighted by the population of visitors	Ranked values using WTP for a one percentage point improvement in the probability of sighting – weighted by the population of visitors	Ranked Values using WTP for a 100% 'guarantee' of sighting – weighted by the population of visitors
Sharks and Rays	4	4	3	**2**
Whales and Dolphins	5	5	4	**1**
Large Fish	**2**	**2**	**2**	5
Marine Turtles	3	3	5	3
Variety	**1**	**1**	**1**	4

The main 'take-home' messages of this analysis are therefore that:

- Large Fish and Variety are the most important, current, contributors to visitor satisfaction. This seems to reflect the fact these are the wildlife groups that are frequently encountered by the current body of visitors. Consequently, it is from these animals that visitors gain most satisfaction. Those wishing to maintain the observed, high levels of visitors' satisfaction thus need to continue to work to ensure that visitors have access to these animals, and that their interactions with them are managed in a way that is sustainable – for both the animals and the tourists.

- Visitors who have the opportunity to interact with rarer animals – be they marine turtles, sharks and rays, or whales and dolphins, report very high levels of satisfaction. Indeed, the satisfaction ratings associated with these groups are the highest recorded in this, substantial survey of almost 3,000 individual visitors to the northern parts of the GBR. Moreover, visitors are WTP more for a 100% 'guaranteed' sighting of rarer species – particularly sharks and rays – than they are for other, more commonly sighted species. Those wishing to improve current satisfaction levels (or to make the GBR relatively more attractive than other reef-destinations, and/or to increase the incomes of those who rely upon marine wildlife tourism) thus need to work together to determine how best to raise the probability that visitors will have the opportunity to interact with these key species; again, in a positive way.

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Appendix 1 Theoretical background: the basic IO model

IO models are based on Transactions Tables which describe the economic structure of an economy. Set out in matrix format, the columns of the table show how a particular industry spends its money, whilst the rows tell where an industry sells its output. If, for example, one had a simple economy, without a government (hence no taxes and/or government expenditure) and which comprised two industries (agriculture and manufacturing), then one could compile an IO table that describes the financial flows within that region – as shown in the table below.

	Agriculture	**Manufacturing**	**Final (Consumption) Demand**	**Total Sales**
Agriculture	100 (x_{11})	200 (x_{12})	700 (F_1)	1000 (X_1)
Manufacturing	400 (x_{21})	x_{22}	F_2	X_2
Households	500 (x_{31})	x_{32}	F_3	X_3
Total expenditure	1000 (X_1)	X_2		

If one were interested in determining how the Agricultural sector spends its money, then one would look down the column – ascertaining that the sector spends $100 purchasing goods from within the agricultural sector; $400 on manufactured goods; and $500 on householders (e.g. wages). If one is interested in determining where the agricultural sector earns its money, one would look across the row – ascertaining that it earns $100 from selling products to itself (e.g. manure sales to fruit growers); $200 from the manufacturing sector; and $700 from consumers.

While this information allows one to DESCRIBE an economy, it does not allow one to make predictions about the way in which that economy is likely to change in response to, for example, an increase in demand for agricultural exports. To do this, one must first convert the 'transactions table' into a 'table of technical coefficients' (A). A table of technical coefficients reports the amount that each industry spends in other parts of its economy as a proportion of total expenditure. Continuing on from the example above, the (shaded) transaction table for this economy would be[23]:

	Agriculture	**Manufacturing**
Agriculture	0.10 $a_{11} = x_{11} / X_1$	a_{12}
Manufacturing	0.20 $a_{21} = x_{21} / X_1$	a_{22}

When using this 'model' to make predictions about the likely, economy-wide effects of an increase in demand for Agricultural products, one assumes that (a) there is an increase in final demand for that sector's output (ΔF), and that (b) the sector spends that extra money as it has in the past. Hence when there is an increase in final demand (ΔF), there is an initial increase in regional income (X) that is equal to the ΔF, but there are also some flow-on increases in regional income that occur because at least some of X will be spent within other

[23] There is no need to include a row for Households, since by definition, $a_{31} = 1 - (a_{11} + a_{21})$, and $a_{32} = 1 - (a_{12} + a_{22})$.

local businesses[24] – and the extra money earned by these other local businesses, themselves, generate subsequent rounds of 'induced' extra expenditure.

Importantly, one can use this information to calculate the total change in final demand that will occur in response to that initial change (i.e. the initial change, plus those induced by extra rounds of expenditure). One can do this by recognising that each column of the table of technical coefficients shows the inputs required by that particular industry, to produce just one unit of output. So, by definition:

$$a_{11}{}^{*}x_{11} + a_{12}{}^{*}x_{12} + F_1 = X_1$$

$$a_{21}{}^{*}x_{21} + a_{22}{}^{*}x_{22} + F_2 = X_2$$

In matrix algebra this can be re-written as:

$$(Ax) + (f) = (x)$$

Equation 1

Where: A is a block matrix of direct input coefficients
F is a vector of final demands
X is a vector of sectoral outputs

Which implies that final demand (F) is equal to:

$$(f) = (x) - (Ax) = (I - A)(x)$$

Equation 2

Hence, the total change in final demands that is generated by a change in demand for the final output of just one sector is:

$$\Delta(f) = (1 - A)\Delta(x)$$

Equation 3

Which means that the total regional change in output (ΔX) that occurs as a result of the change in final demand (ΔF) will equal:

$$\Delta(x) = (1 - A)^{-1}\Delta(f)$$

Equation 4

Where:

$(1\text{-}A)^{-1}$ is often referred to as the Leontief (inverse) matrix

It is this, general approach which is used in input-output studies, and which was used here.

[24] Specifically, 0.1*ΔF (a_{11}*ΔF= $a_{11}X_1$) is spent in the agricultural sector; and 0.2*ΔF (a_{21}*ΔF= a_{21} X_2) is spent on manufactured goods.

Appendix 2 Analysis of operator expenditure patterns

Amongst other things, operators were asked to provide us with information about their expenditure patterns, specifically telling us about the types of things on which they spend their money. Researchers categorised these expenses into broad groups that (approximately) coincide with the Australia and New Zealand Standard Industry Classification (ANZSIC). They then calculated the (weighted) average percentage of all revenues spent within each industry[25].

Across all respondents, the highest average percentage of revenues went towards wages and salaries (nearly 37%). Respondent organisations also spent a relatively large share of total revenues on the maintenance of boats, vehicles and gear (approximately 13% of total expenditure); provisions, stevedores and other on-board supplies – classified here as 'wholesalers' (12.5%); fuel (10%); and commissions (9%). Expenditure in other sectors was generally quite small – mostly less than 5% of total expenses.

Respondents were also asked to indicate how much of the organisation's expenditure on each type of good or service, went to locally based businesses – where a purchase was deemed to have been made 'locally', if it occurred within the town in which the business was operating (specifically, Cairns, Port Douglas, or Ayr). This information was combined with information about the amount that is spent on different types of goods and services (above), to get a true picture of the importance of organisational expenditure within a region. To explain that in an example, our data shows that almost 12.5% of business expenses are attributable to wholesalers (ship's chandler, etc.). And respondents have indicated that approximately 70.4% of all 'wholesale'- type expenditures, are spent in the town in which the organisation is operating. Consequently, we are able to say that approximately 8.8% of the expenditures of boat operators (70.4% x 12.5%) go to the 'local' wholesale industry.

This expenditure information is summarised in Figure 20 which clearly highlights the fact that a significant proportion of operator expenditures go to 'local' organisations. Almost 30% of wholesale products are purchased outside the local region, some maintenance is done in other areas, and commissions are clearly paid to organisations throughout the world, but overall, almost 83% of all business expenses are paid to 'local' businesses (when purchasing supplies) and householders (in the form of wages).

[25]These averages, are weighted averages – calculated by multiplying the average reported expenditure within any given sector by the number of organisations who reported having made that type of expenditure and then dividing by the total number of organisations responding to the expenditure question (in this case 7; one respondent did not provide sufficient expenditure data to be included in this analysis). They may not, therefore, sum to 100.

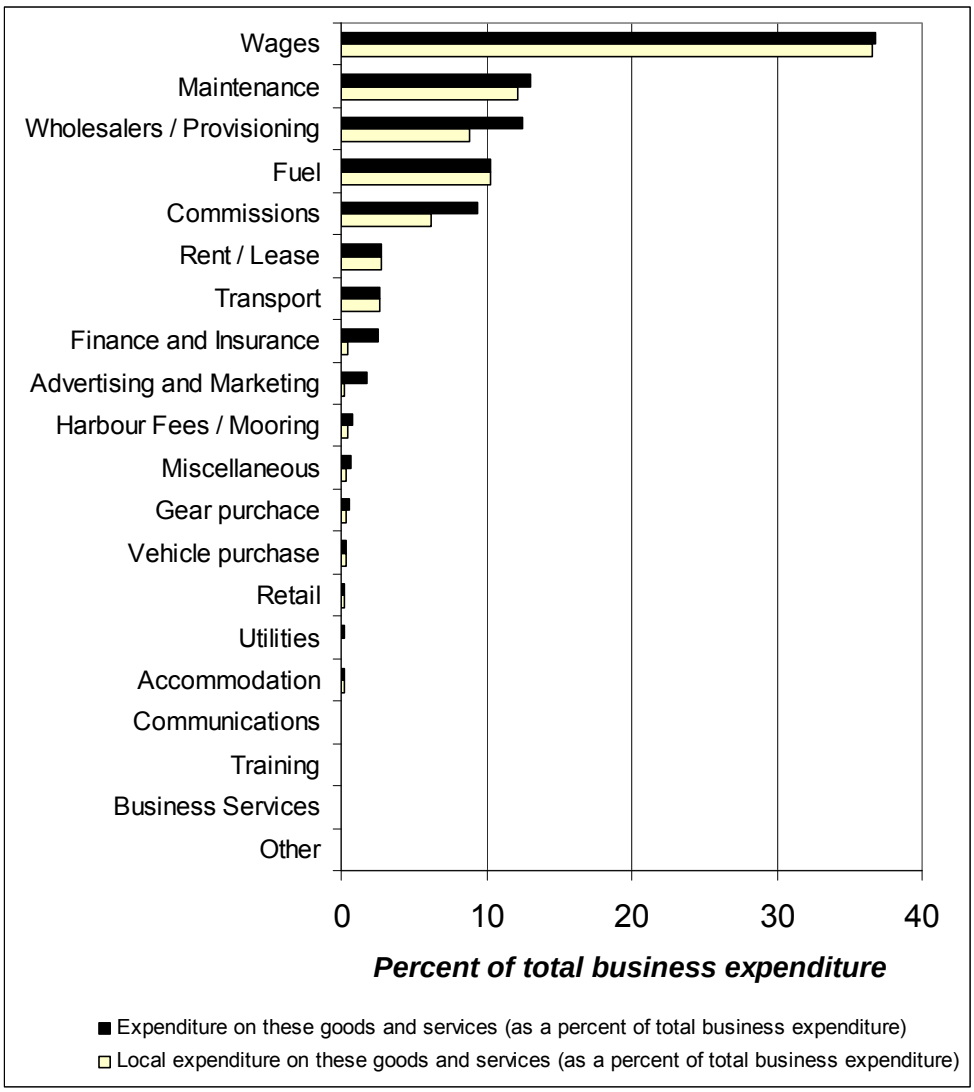

Figure 20: Percent of total business expenditures on different types of goods and services

Appendix 3 Particular types of species identified by 2008 respondents in the WTP survey question

Survey	Sharks	Rays	Whales and Dolphins	Turtles	Large Fish	Other wildlife/ variety of wildlife
Far Northern live-aboard 2008	Great White Hammerhead Silvertip shark Tiger shark Whale shark	Devil ray Manta ray Sting ray	Whales		Tuna	Bottom dwellers Nudibranch
Minke live-aboard 2008	Bull shark Great White Grey Nurse Grey Reef shark Hammerhead Large sharks Oceanic white tip Pelagic Reef sharks Silvertip shark Thresher shark Tiger shark Whale shark White tip Wobbegong	Blue spotted ray Devil ray Eagle ray Manta ray Sting ray	Blue whale Bottlenose Dolphins Humpbacks Orca Sperm whale Spinner dolphin	Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle	Barracuda Black Marlin Maori Wrasse Sailfish Sunfish Sweetlip Emperor Swordfish Titan Triggerfish	Anemonefish Boxer Shrimp Butterflyfish Clams Coral spawning Crabs Crustaceans Cuttlefish Dugong Flatworms Frogfish Garden eels Giant clam Hairy Ghost Pipefish Jellyfish Lionfish Mangrove Jacks Mantis Shrimp Moorish Idol Moray Eels Nudibranch Octopus Olive snake Pigmy seahorses Pipefish Puffer fish File shells Rockfish Sailfish Scorpion fish Sea Cucumber Sea snakes Seahorses Shrimp Squid

Survey	Sharks	Rays	Whales and Dolphins	Turtles	Large Fish	Other wildlife/ variety of wildlife
						Starfish Stonefish Sunfish Trevally Triggerfish
Osprey live-aboard 2008	Blacktip shark Bull shark Galapagos shark Great White Grey Nurse Grey Reef shark Hammerhead Leopard shark Reef sharks Silky shark Silvertip shark Tiger shark Whale shark White tip Wobbegong	Manta ray Sting ray Eagle ray	Whales Minke whales Humpbacks	Flatback turtle Green turtle Leatherback turtle Loggerhead turtle	Barracuda Barramundi Black Marlin Mackerel Napoleon Queensland grouper Tuna	Anemonefish Cuttlefish Frogfish Leafy Scorpion Lionfish Moorish Idol Moray Eel Nautilus Nudibranch Octopus Olive snake Parrot fish Puffer fish Scorpion fish Seahorses Sea snakes Solefish Stonefish Swordfish
Minke and Port-Douglas day-boats 2008	Blacktip shark Bull shark Great White Grey Nurse Grey Reef shark Hammerhead Reef sharks Tiger shark Whale shark White tip	Eagle ray Manta ray Rays Sting rays	Blue whale Dolphins Humpbacks Minke whales Orca Sperm whale	Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Long Neck turtle	Barracuda Cod Coral Trout Giant Moray Groupers Maori Wrasse Black Marlin Potato Cod Red bass Sunfish Tuna	Anemonefish Blue starfish Christmas tree worms Clams Crayfish Dugongs Eels Flatworm Flying fish Giant clams Green algae Jellyfish Leafy Sea Dragons Lionfish Moorish Idol Nautilus Nudibranch Parrot fish Puffer fish Rainbow fish Salt water crocodile Scorpion fish

Survey	Sharks	Rays	Whales and Dolphins	Turtles	Large Fish	Other wildlife/ variety of wildlife
						Sea cucumbers Squid Starfish Trumpetfish
Yongala day-boats 2008	Blacktip shark Bull shark Great White Hammerhead Tiger shark Whale shark	Eagle ray Manta ray Marble ray Sting ray	Dolphins Humpbacks Minke whale	Green turtle Leatherback turtle	Mackerel Groupers Tuna	Anemonefish Cuttlefish Giant squid Moray Eel Nudibranch Octopus Olive snake Parrot fish Sea snakes