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# **Behaviour of dwarf minke whales (*Balaenoptera acutorostrata* subsp.) associated with a swim-with industry in the northern Great Barrier Reef**

Thesis submitted by

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in November 2010

for the degree of

Doctor of Philosophy

School of Earth and Environmental Sciences and Business

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## STATEMENT ON THE CONTRIBUTION OF OTHERS

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|---|---|---|
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| | - School of Business | $ 1,451 |
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- A/Prof Peter Valentine

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## Declaration on Ethics

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the N*ational Statement on Ethics Conduct in Research Involving Human* (1999), the *Joint NHMRC/AVCC Statement and Guidelines on Research Practice* (1997), the *James Cook University Policy on Experimentation Ethics*, *Standard Practices and Guidelines* (2001), and the *James Cook University Statement and Guidelines on Research Practice* (2001). The proposed research methodology received clearance from the James Cook University Experimentation Ethics Review Committee (approval numbers H2375 and A1111).

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# PUBLICATIONS ASSOCIATED WITH THIS THESIS

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**Mangott, A.,** Birtles A. & Marsh, H. (2011) Attraction of dwarf minke whales (*Balaenoptera acutorostrata* subsp.) to vessels and swimmers – management challenges for an inquisitive whale. *Journal of Ecotourism, xx, xxx-xxx*

From information in Chapters 3, and 6 following manuscripts are currently in preparation for submission.

**Mangott, A**., Birtles A., Marsh, H. & Valentine., P. (in prep.) Who is looking at whom? Exploratory behaviour of dwarf minke whales during swim-with interactions. *Wildlife Research* or the *Journal of Environmental Management*.

**Mangott, A.,** Birtles, A. and Marsh, H. (in prep.) Non-acoustical behaviour repertoire of interacting dwarf minke whales in the northern Great Barrier Reef. *Marine Mammal Science*

**Mangott, A.,** Birtles, A. and Marsh, H. (in prep.) Dwarf minke whale behaviours of concern during swim-with interactions – a risk assessment. *Environmental Conservation or Conservation Biology*

Related publication

Birtles, A., Arnold, P., Curnock, M., Salmon, S., **Mangott, A.**, Sobtzick, S., Valentine, P., Caillaud, A. & Rumney, J. (2008) Code of Practice for dwarf minke whale interactions in the Great Barrier Reef World Heritage Area. Great Barrier Reef Marine Park Authority, Townsville, Australia

# ABSTRACT

A diffuse aggregation of dwarf minke whales occurs in the northern Great Barrier Reef World Heritage Area during the austral winter months. This area coincides with a region heavily used by a large dive and snorkel tourism industry. Over the last two decades a small part of this industry has developed into a swim-with dwarf minke whale industry that has been limited via a permit scheme since 2003. Very little was understood about the whales' behaviour or the response of the whales to the vessels and swimmers. In order to address this knowledge gap, I designed this study with two major aims: (1) to provide detailed insights into the behaviour of dwarf minke whales around tourism vessels and swimmers, and (2) to establish recommendations for the tourism industry and management agencies to provide for discussions on future management and to contribute to the sustainability of this industry.

During my research (2006-2008), I described over 30 distinctive dwarf minke behaviours and provided evidence for the presence of behaviours with potential social and investigative functions. Behaviours with likely social attributes such as *belly presentations* and *bubble releases,* were significantly influenced by a large group size (>6 animals), while investigatory behaviours such as *close* and *very close approaches*, *motorboating*, and *headrises* were positively influenced by the presence of resighted animals. Dwarf minke whales are a predominantly solitary oceanic species. When they form social groups, behaviours which convey information among conspecifics via visual communication (e.g. presenting the white belly or releasing bubbles) may be particularly important. The presence of several investigative behaviours during interactions with vessels and swimmers highlights the inquisitive nature of these whales and suggests that such behaviours are an important part of their ecology (i.e. finding mates, food or avoiding predators).

I also investigated potential agonistic and disturbance displays of dwarf minke whales and provided an indication on the metabolic costs of interacting with humans. The scarcity of agonistic and disturbance responses and the absence of avoidance behaviours, all suggest that the vessels and swimmers have a relatively low impact on the whales. Nonetheless, several behaviours including *close (>1-3 metres)* and *very close (≤ 1 metre) approaches* to human observers and potential agonistic and disturbance behaviours (e.g. *gapes/gulps*, *jaw claps*) were identified as of potential harm to both the whales and the swimmers.

The investigative nature of dwarf minke whales was further explored by quantifying the distribution of interacting whales around vessels and swimmers and examining if their behaviour changes in interactions with humans over time. Dwarf minke whales voluntarily approached dive tourism vessels and maintained contact for prolonged periods ($X$ ± SE, 2006-2008 = 171 ± 11 minutes). These whales showed a highly clumped distribution around the vessel, surfacing more often within a 60 metres radius of the boat than expected and aggregating around swimmers. My results also suggest that dwarf minke whales change their behaviour over time in interactions with humans. Individual whales repeatedly passed very close to the swimmers ($X$=7.08 metres ± SE 0.09 metres; N=119 whales) and significantly decreased their passing distance over the course of an interaction. In both cases, closeness was significantly influenced by group size; the larger the group of whales, the closer individuals approached the observers. Individual dwarf minke whales significantly decreased their passing distance in subsequent interactions and resighted animals approached swimmers significantly closer than unknown individual whales.

The voluntary initiation of contact with humans, the whales' close and prolonged association with the vessel and swimmers, the closeness of their approaches and the increased familiarity to the stimuli, all suggest a strong exploratory drive of dwarf minke whales. Indeed, the inquisitive behaviour of dwarf minke whales contrasts with the behaviour of most free-ranging marine mammals interacting with humans. These behavioural attributes raise management issues and concerns about the safety of both the whales and the human participants.

I assessed the risk of harm associated with swimming with dwarf minke whales for both, the swimmers and the whales using both, my observational data and the perceptions of Key Informants (marine mammal experts, and members of management and non-governmental organisations). This assessment revealed that most dwarf minke whale behaviours displayed during interactions are of low risk of harm to the swimmers and the whales. Nevertheless, in a fifth of the total observed interactions (n=101) there was at least one whale behaviour present with potential to harm swimmers and/or whales. In addition, I identified 22 occasions from all interactions of the endorsed industry (N=467; 2006-2008) where whales made physical contact with objects (e.g. ropes, dinghy) or swimmers and five (22%) of those incidents were caused by only one individual resighted whale.

The Key Informants perceived the risk of harm to swimmers from the swim with industry as much greater than the risk of harm to the whales. Nonetheless they were concerned about the wellbeing of the whales in the medium to longer term, i.e. the potential of such industries to change the behaviour of the whales and impact on their behavioural budget and fitness. Most Key Informants evaluated the current swim-with dwarf minke whale industry positively; however, they considered that this industry needs continuous monitoring and future research in order to identify any long-term impacts and to address research gaps for adequate management.

I also evaluated the accuracy of data collected by crew on dwarf minke whale behaviours. The crew reported dwarf minke whale behaviours via the Whale Sighting Sheets. I compared these records (presence/absence of behaviour per encounter) with my data. The best fitting commonalities between my observations and data reported via the Whale Sighting Sheets were between *close (>1-3 metres)* and *very close approaches (≤ 1 metre)*, *headrises*, *motorboating* and *touching behaviour*. For crew to be able to identify these particular whale behaviours is important for both, cost-efficient longer-term monitoring and the risk management of interactions. I also used a passenger questionnaire (Interaction Behaviour Diary) to evaluate passengers' satisfaction with their whale swims, and to investigate their perceptions about potential harmful dwarf minke whale behaviours. Swimmers were more satisfied when dwarf minke whales approached very close (≤ 1 metre) to them and perceived such close encounters as harmless. Both these reactions pose challenges to the effective management of risks associated with interactions.

This study is the first comprehensive assessment of the behaviour of a baleen whale associated with a tourism industry. It provides a scientific basis for future studies on dwarf minke whales and will be useful for behavioural studies of other baleen whales associated with humans. This study provides specific recommendations to improve the future management of the swim-with dwarf minke whale industry and to ensure the protection of this species.

## Table of Contents


### CHAPTER 1

### GENERAL INTRODUCTION AND LITERATURE REVIEW.........1

1.1 WHALE WATCHING ......................................2
1.2 SWIM-WITH CETACEANS PROGRAMS ......................................3
1.3 EFFECTS OF WHALE WATCHING TOURISM ON CETACEANS ......................................4
*1.3.1 Short-term responses of cetaceans......................................4*
*1.3.2 Long-term responses......................................6*
1.4 LIFE HISTORY AND SOCIAL STRUCTURE OF ODONTOCETES AND MYSTICETES ...8
*1.4.1 Life history - reproduction, feeding and seasonal migration ......................................8*
*1.4.2 Social organisation in odontocetes......................................9*
*1.4.3 Social organisation in mysticetes......................................11*
*1.4.4 Challenges with extrapolating findings from odontocetes to mysticetes 12*
1.5 MEASURING BEHAVIOUR......................................13
*1.5.1 Research design ......................................13*
*1.5.2 Behavioural sampling techniques......................................15*
*1.5.3 Sampling methods......................................16*
1.6 THE SWIM-WITH DWARF MINKE WHALE INDUSTRY IN THE GREAT BARRIER REEF ......................................20
1.7 RESEARCH AIMS AND THESIS STRUCTURE ......................................23

### CHAPTER 2

### GENERAL MATERIAL AND METHODS ......................................27

2.1 STUDY AREA ......................................28
2.2 PLATFORMS OF OPPORTUNITY – THE SWIM-WITH DWARF MINKE WHALE INDUSTRY......................................29
2.3 LEGISLATIVE BACKGROUND......................................30
*2.3.1 National Guidelines for Whale and Dolphin Watching......................................32*
*2.3.2 Code of Practice for swimming with dwarf minke whales......................................33*
2.5 WHALE SIGHTING SHEET ......................................34
2.5 INTERACTION BEHAVIOUR DIARY......................................35
2.6 STUDY SPECIES – DWARF MINKE WHALES ......................................35
2.7 DESCRIPTION OF ENCOUNTERS/INTERACTIONS WITH DWARF MINKE WHALES ......................................37
2.8 GENERAL RESEARCH PROTOCOL (2006-2008)......................................38
2.9 DEFINITIONS ......................................40

### CHAPTER 3

### NON-ACOUSTIC BEHAVIOURAL REPERTOIRE OF DWARF MINKE WHALES INTERACTING WITH VESSELS AND SWIMMERS IN THE NORTHERN GREAT BARRIER REEF......41

3.1 INTRODUCTION ......................................42
3.2 METHODS......................................46
*3.2.1 Partial ethogram......................................46*
*3.2.3 Context of behavioural occurrences and associations of behaviours ....48*

3.2.4 *Limitations* ... 49
3.3 RESULTS ... 50
3.3.1 *General* ... 50
3.3.2 *Partial ethogram of interacting dwarf minke whales* ... 50
3.3.3 *Behavioural occurrences in in-water interactions / encounters* ... 63
3.3.4 *Potential factors influencing the occurrence of dwarf minke whale behaviour* ... 64
3.3.5 *Association of behavioural occurrences* ... 64
3.3.6 *Breathing intervals of individual dwarf minke whales* ... 65
3.4 DISCUSSION ... 66
3.4.1 *Potential functions of dwarf minke behaviours during interactions with humans* ... 67
3.4.2 *Potential agonistic, aggressive and disturbance behaviours of dwarf minke whales* ... 71
3.4.3 *Chapter summary* ... 75

**CHAPTER 4**

**WHO IS LOOKING AT WHOM? EXPLORATORY BEHAVIOUR OF DWARF MINKE WHALES DURING SWIM-WITH INTERACTIONS AND ASSOCIATED MANAGEMENT CHALLENGES ... 76**

4.1 INTRODUCTION ... 77
4.2 MATERIALS AND METHODS ... 80
4.2.1 *Whale Sighting Sheets 2006-2007* ... 80
4.2.2 *Ad libitum sampling protocol (2006)* ... 81
4.2.3 *Adaptive scan sampling protocol (2007)* ... 81
4.2.4 *Distance measurements of whale passes from the researcher (2008)* ... 82
4.2.5 *Data analyses* ... 83
4.3 RESULTS ... 86
4.3.1 *Distribution of dwarf minke whales around vessels and swimmers* ... 86
4.3.2 *Distance measurements of whale-swimmer passes (2008)* ... 88
4.4 DISCUSSION ... 92
4.4.1 *Initiation of interactions with vessels and swimmers* ... 94
4.4.2 *Approaching closer over time* ... 96
4.4.3 *Concerns arising from the attraction of dwarf minke whales to vessels and swimmers* ... 98
4.4.4 *Management challenges* ... 99
4.4.5 *Chapter summary* ... 100

**CHAPTER 5**

**DWARF MINKE WHALE BEHAVIOURS OF POTENTIAL RISK OF HARM TO SWIMMERS AND/OR WHALES ... 102**

5.1 INTRODUCTION ... 103
5.2 METHODOLOGY ... 106
5.2.1 *Dwarf minke whale behaviours which are of potential harm to swimmers and/or the whales* ... 107

5.2.2 *Factors contributing to the potential risk of harm* ... *107*
5.2.3 *Occurrence probability of dwarf minke whale behaviours in interactions/encounters* ... *108*
5.2.4 *Key Informant Survey* ... *108*
5.2.6 *Assessment of the risk of harm from dwarf minke whale behaviours* ... *112*
5.2.6 *Limitation to the study* ... *113*
5.3 RESULTS ... 113
5.3.1 *Key Informant Survey* ... *113*
5.3.2 *Occurrence probability of dwarf minke whale behaviours of potential harm to swimmers and/or the whales* ... *119*
5.3.3 *Risk of harm to swimmers or the whales from dwarf minke whale behaviours* ... *120*
5.3.4 *Interactions with dwarf minke whale behaviours of greater harm to swimmers and/or whales* ... *122*
5.3.5 *Dwarf minke whales making physical contact with objects and swimmers* ... *122*
5.4 DISCUSSION ... 124
5.4.1 *Direct risk of harm to swimmers from dwarf minke whales* ... *125*
5.4.2 *Risk of harm to swimmers associated with individual whales* ... *126*
5.4.3 *Risk of harm to swimmers from external factors* ... *129*
5.4.4 *Risk of harm to dwarf minke whales* ... *129*
5.4.5 *Indirect risk of harm to dwarf minke whales* ... *131*
5.4.6 *Risk of harm to the swim-with dwarf minke whale industry* ... *132*
5.4.7 *Chapter summary* ... *133*

**CHAPTER 6**

**MONITORING OF DWARF MINKE WHALE BEHAVIOURS AND INSIGHTS INTO PERCEPTIONS OF PASSENGERS REGARDING BEHAVIOURS OF POTENTIAL HARM ... 135**

6.1 INTRODUCTION ... 136
6.2 METHODS ... 139
6.2.1 *Occurrences of dwarf minke whale behaviours reported by the endorsed industry using the Whale Sighting Sheet* ... *139*
6.2.2 *Comparison of dwarf minke whale behaviour occurrences in interactions between the Whale Sighting Sheet and researcher observations (2006-2008)* ... *140*
6.2.3 *Association of investigatory behaviours with very close approaches (≤ 1 metre) of dwarf minke whales to swimmers and/or the vessel.* ... *141*
6.2.4 *Time to the first occurrence of a close approach (>1-3 metres) and very close approach (≤ 1 metre) by dwarf minke whales to swimmers and the vessel* ... *141*
6.2.5 *Passengers' satisfaction rates and perceptions of management of their in-water interactions* ... *142*
6.2.6 *Passengers' perceptions of dwarf minke whale behaviours and their concerns about swimming with these whales* ... *142*
6.3 RESULTS ... 143
6.3.1 *Behavioural occurrences in in-water interactions / encounters reported via the Whales Sighting Sheets* ... *143*

6.3.2 *Comparison of behavioural occurrences between the Whale Sighting Sheets and researcher observations* ........ 144
6.3.3 *Potential influencing behaviours on the occurrence of very close approaches (≤ 1 metre) of dwarf minke whales to swimmers and/or vessel* ........ 145
6.3.4 *Time to the first occurrence of a close approach (>1-3 metres) and very close approach (≤ 1 metre) of dwarf minke whales to swimmers and the vessel* ........ 145
6.3.5 *Passengers' satisfaction rates and perceived management of their in-water interactions* ........ 146
6.3.6 *Passengers' perceptions of dwarf minke whale behaviours which potentially put either swimmers or whales at risk* ........ 147
6.3.7 *Passenger concerns about swimming with dwarf minke whales* ........ 148
6.4 DISCUSSION ........ 150
6.4.1 *Chapter Summary* ........ 155

**CHAPTER 7**

**GENERAL DISCUSSION AND SYNTHESIS ........ 157**

7.1 INTRODUCTION ........ 158
7.2 MAJOR RESULTS OF THIS STUDY ........ 159
7.3 ADVANCES IN KNOWLEDGE ABOUT DWARF MINKE WHALES ........ 165
7.4 IMPLICATION FOR THE CONSERVATION AND MANAGEMENT OF DWARF MINKE WHALES ........ 166
7.5 OPTIONS FOR THE MANAGEMENT OF DWARF MINKE WHALES IN THE GREAT BARRIER REEF ........ 170
7.6 SPECIFIC RECOMMENDATIONS FROM MY PHD STUDY ........ 172
7.7 FUTURE RESEARCH ON THE BEHAVIOUR OF DWARF MINKE WHALES ........ 174
7.7.1 *Overall population size of dwarf minke whales in the Great Barrier Reef* ........ 175
7.7.2 *Satellite-linked telemetry; daily activity budget, area usage and migratory pathways and destination of dwarf minke whales* ........ 176
7.8 FINAL REMARKS ........ 177

**REFERENCES ........ 179**

## Appendices


**Appendix 1:** Whale Sighting Sheet 2009…………………………………….... 216

**Appendix 2:** Akaike Information Criterion (AIC) Index ranking the predictor variables which influence the occurrences of dwarf minke whale behaviours…………………………………………………….. 217

**Appendix 3:** Letter to the Key Informants outlining the aims and objectives and explaining the conduct, duration and time frame of the anticipated three surveys………………………………………………….. 219

**Appendix 4:** Meet the Minkes. Dwarf minke whale interpretive DVD, 2007… 220

**Appendix 5:** Key Informant Internet Survey questionnaire – Part 1………….. 221

**Appendix 6:** Key Informant Interview – Part 2……………………………….. 225

**Appendix 7:** Key Informant Survey – Part 3………………………………….. 229

**Appendix 8:** Key Informants' ratings of dwarf minke whale behaviours of potential harm to swimmers in the assigned distance categories (rating scale from 1 = no risk to 5 = very high risk)…………….. 233

**Appendix 9:** Key Informants' ratings of dwarf minke whale behaviours of potential harm to the whales in the assigned distance categories (rating scale from 1 = no risk to 5 = very high risk)…………….. 234

**Appendix 10:** Key Informants' field of expertise………………………………. 235

**Appendix 11:** Marine mammal species on which the Key Informants worked on……………………………………………………. 236

**Appendix 12:** Key Informants' view about commercial tourism operations offering swims with cetaceans…………..……………………. 237

**Appendix 13:** Key Informants' concerns for the targeted animals in swim-with cetacean industries……………………………………………. 238

**Appendix 14:** Key Informants responses to the question if they have any concerns for the participants (swimmers) in swim-with cetacean industries..........................................................................239

**Appendix 15:** Reasons why Key Informants perceived the rated behaviours of high or very high potential to harm swimmers………………….. 240

**Appendix 16:** Reasons why Key Informants perceived the rated behaviours of high or very high potential to harm whales……………………….241

**Appendix 17:** Interaction Behaviour Diary 2008……………………………...242

## List of Tables


Table 2.1 Descriptions of swim-with dwarf minke whale endorsed operations (2006-2008); day boat operations shaded……….……. 31

Table 3.1 Categorisation of the probability of the occurrence of dwarf minke whale behaviours…………………………………………..…… 47

Table 3.2 Dwarf minke whale encounters and in-water interactions observed during the research period (June/July) from 2006–2008……..…… 50

Table 3.3 Descriptions of dwarf minke whale behaviours observed during the research period in June/July 2006-2008…………………………… 51

Table 3.4 Occurrences of dwarf minke whale behaviours in in-water interactions during the research period in June/July 2006-2008…... 63

Table 3.5 Generalised linear model testing the likelihood of the occurrence of dwarf minke whale behaviours in in-water interactions……………64

Table 3.6 Results of a Generalised Linear Model showing the likelihood (Exp(B)) of the presence of behaviours in an in-water interaction if a particular behaviour occurred (** $\alpha$ level $\leq 0.01$; * $\alpha \leq 0.05$)…... 65

Table 4.1 Outcomes of a Repeated Measures ANOVA testing individual whale passing distance to the observer over time (Beginning, Middle and End Interaction) with the grouping predictor variables of whale group size (1-3, 4-6 and >6 animals), Boat status (Drifting, Stationary) and Wind status (15, 20 knots)……………... 89

Table 4.2 Outcomes of a Repeated Measures ANOVA comparing the passing distances of five individual whales from their first to their subsequent interaction……………………………………………91

Table 5.1 Risk assessment chart of dwarf minke whale behaviours according to the probability of occurrence and the Key Informants' perceived harm of dwarf minke whale behaviours to the swimmers and/or the whales …….…………………………………………………….. 112

Table 5.2: Key Informants' views about the swim-with dwarf minke whale industry in the northern Great Barrier Reef ……………………….. 116

Table 5.3: Occurrence probability of interactions featuring dwarf minke whale behaviours of potential harm to swimmers and/or the whales in the assigned distance categories……………………………..…… 119

Table 5.4 Individual dwarf minke whales exhibiting behaviours of greater risk to harm swimmers……………………………………..……...123

Table 5.5 Incidents of physical contact between dwarf minke whales and objects and swimmers…………………………….……..………..124

Table 6.1: Ranked occurrence probabilities of dwarf minke whale behaviours reported by crew via the Whale Sighting Sheets (2006-2008)…...  143

Table 6.2 Dwarf minke whale behaviours which significantly influence the occurrence of *very close approaches (≤ 1 metres)* of the whales to swimmers or vessel……………………………..……………. 145

Table 6.3 Passengers' perceptions why there were/weren't any dwarf minke whale behaviours that potentially put either swimmers or whales at risk of harm……………………………………………….…….. 149

Table 6.4: Passengers' concerns about swimming with dwarf minke whales… 150

## List of Figures


Figure 1.1 Diagram of thesis structure……………………………………..…….. 26

Figure 2.1 Map of the northern Great Barrier Reef showing the main locations (i.e. Agincourt Reefs, Ribbon Reefs, Cod Hole) where dwarf minke whales are encountered by the tourism industry in the austral winter months (May-August)………………………………………….…….28

Figures 2.2a Movement pattern (simplified) of dwarf minke whales around *Undersea Explorer* in drifting in-water interactions………………..38

Figures 2.2b Movement pattern (simplified) of dwarf minke whales around *Undersea Explorer* in stationary in-water interactions……………..38

Figure 3.1 Sequence showing a *belly presentation* by a dwarf minke whale…. 55

Figure 3.2 *Bubble releases* of dwarf minke whales……………………….……....56

Figure 3.3 *Headrises* of dwarf minke whales…………………………………..57

Figure 3.4 Sequence of a dwarf minke whale *pirouetting*…………………….. 58

Figure 3.5 *Breaching* dwarf minke whales…………………………………… 59

Figure 3.6 *Close (>1-3 metres) and very close approaches (≤1 metre)* by dwarf minke whales……………………………………………….. 60

Figure 3.7 *Lunging* dwarf minke whale……………………………………….. 61

Figure 3.8 *Gulping/gaping* dwarf minke whales………………………………62

Figure 3.9 Mean breathing intervals (sec ± SE) of twelve individual dwarf minke whales and three cow-calf pairs recorded over the three consecutive research periods (2006-2008)…………………………66

Figure 4.1 Assigned Areas (defined by distance to vessel) and sectors (based on an imaginary clock face) used for data collection on the distribution of interacting dwarf minke whales around the vessel and swimmers…………………………………………………… 82

Figure 4.2 Proportions of observed surfacing of whales from 20 in-water interactions in 2006 for 1-2 animals (n=170) and >2 animals (n=1656)……………………………………………..……….. 86

Figure 4.3 Observed versus expected frequencies of surfacing dwarf minke whales (per unit effort and unit area) in the three assigned areas (*Inner*, *Middle* and *Outer Area*) around the vessel from 18 in-water interactions in 2007……………………..………………...…...87

Figure 4.4. Observed versus expected frequencies of surfacing dwarf minke whales in the four assigned quarters (*Rope/Swimmer Quarter, Left Quarter*, *Right Quarter* and *Opposite Quarter*) in the area closest to the vessel (*Inner Area*) (n=18 in-water interactions)……………88

Figure 4.5 Whale group size dependent changes in mean (±SE) whale-swimmer passing distances (metres) of individual whales (*m* = 20) during the first 90 minutes of in-water interactions (time based categories: 'Beginning Interaction', 'Middle Interaction', 'End Interaction')….90

Figure 4.6 Changes in mean (±SE) passing distance (m; log10 transformed) of individual whales (n=5) from their first to their subsequent Interaction………………………………………………………. 91

Figure 4.7 Mean (±SE) passing distances (metres) of non-resighted and resighted whales to swimmers during the first hour of in-water interactions (n=9)……………………………………………….. 92

Figure 4.8a Process of habituation Type I (after Bejder et al., in press)……….. 98

Figure 4.8b Process of increased attraction (habituation Type II) as observed In dwarf minke whales………………………………………….. 98

Figure 5.1: Key Informants' mean rating of the potential of harm to swimmers (rating scale from 1 = no risk - 5 = very high risk) from individual dwarf minke whale behaviours in the four assigned distance categories……………………….……………………………. 118

Figure 5.2: Key Informants' mean rating of the potential of harm to whales (rating scale from 1= no risk - 5 = very high risk) from individual dwarf minke whale behaviours in the four assigned distance categories……………………………………………………….. 118

Figure 5.3 Risk of harm to swimmers from dwarf minke whale behaviours in the assigned distance categories (≤1 metre; >1-3 metres; >3-6 metres; >6 metre) with respect to the occurrence probability of the behaviour in interactions and the potential of harm (consequences) perceived by Key Informants……………………………....……………. 121

Figure 5.4 Risk of harm to dwarf minke whales from their behaviours in the assigned distance categories (≤1 metre; >1-3 metres; >3-6 metres; >6 metre), with respect to the occurrence probability of the behaviour in interactions and the potential of harm (consequences) perceived by Key Informants……........................……………………………. 121

Figure 6.1 Comparison of the occurrences of dwarf minke whale behaviours between my behavioural observations and the Whale Sighting Sheets over the research period of 2006-2008…………………….. 144

Figure 6.2: First occurrences of *close (>1-3 metres)* and *very close approaches (≤ 1 metre)* of dwarf minke whales to swimmers or the vessel in interactions (researcher observations)………………...…………… 146

Figure 6.3 Comparison of passengers' satisfaction between interactions where very close approaches of dwarf minke whales were present (n=215) or absent (n=216)……………………………………………….. 147

# CHAPTER 1

## GENERAL INTRODUCTION AND LITERATURE REVIEW

In this chapter I provide a general introduction to swim-with cetacean programs worldwide and in Australia and the effect of such industries on the behaviour of the targeted animals. I introduce the swim-with dwarf minke whale industry in the Great Barrier Reef and highlight the limited understanding about the behaviour of these whales in response to the tourism industry. Finally I outline the aims and the specific objectives of this study.

## 1.1 WHALE WATCHING

In the last 20 years, people all over the world have become increasingly fascinated with observing whales and dolphins in their natural environment. The International Whaling Commission (IWC), first considered whale-watching as a 'use' of whales in 1983 when a report on the non-consumptive utilisation of cetacean resources was tabled (Constantine, 1999). In 1993, only ten years later, the International Whaling Commission formally recognised whale watching as a legitimate tourism industry (IFAW, 1995). For conservation organisations whale watching generally is viewed as a viable, sustainable and more desirable 'use' of whales than harvesting them for products (IFAW, 1995).

Whale watching is a multi-billion dollar industry, providing an alternative means of making a living out of whales through offering non-consumptive opportunities to tourists (Carlson, 2004). Best estimates suggest that the industry grew from 5.4 million whale watchers in 1994 to nine million in 1998 (Hoyt, 2001) and to 13 million in 2008. In 1991, only 31 countries were involved but this number increased quickly to 87 countries in 1998 (Hoyt, 2001) and currently involves 119 countries. In 2008, whale-watch tourism generated US$ 870 million in ticket sales (direct expenditure) with subsequent indirect expenditure of US$ 1.2 billion resulting in a total whale watching expenditure of US$ 2.1 billion (O'Connor et al., 2009). The global whale watching industry involves more than 3,000 operations and employs an estimated 13,200 people (O'Connor et al., 2009).

In Australia, the whale watching industry has followed this global trend. Over the last decade the number of whale watchers more than doubled from 735,000 to 1.6 million representing an annual growth rate of 8.3%. Whale watching in Australia generates US$31 million in direct expenditure, up to US$172 million in total expenditure and supports over 600 jobs (IFAW, 2008). With regards to the revenue generated, Australia is currently placed second (after the U.S.A.) in the global rank of the top whale watching countries (O'Connor et al., 2009).

## 1.2 SWIM-WITH CETACEANS PROGRAMS

Swimming with wild cetaceans is a subset of whale watching that follows the same increasing trend in popularity as boat-based whale watching (Hoyt, 2001, 2004). Swim-with cetacean industries mainly target smaller cetaceans such as dolphins, but swimming with larger whales is becoming increasingly widespread (Rose et al., 2003; Rose et al., 2005). There is a fast growing list of swim-with operations but most are undocumented (Samuels et al., 2000; Samuels et al., 2003). Many swim-with cetacean industries are vessel-based (Constantine, 1999) and typically involve placing swimmers close to travelling or resting animals (Constantine and Baker, 1997; Samuels et al., 2003). For example most swims with humpback whales occur in their winter breeding grounds and typically swimmers are placed in the vicinity of resting juveniles and cow-calf pairs (Rose et al., 2005).

Many researchers are concerned about the potential impacts of whale watching tourism (including swims) on the targeted animals (Beach and Weinrich, 1989; Duffus and Dearden, 1993; Blane and Jaakson, 1994; Constantine and Baker, 1997), despite all the benefits from environmental tourism to regional economics, education and research. For the past 15 years, there has been increasing interest in studying the effects of tourism activities on marine mammals (Orams, 2004). The International Whaling Commission lists information on over 80 different research projects (Amaral and Carlson, 2005). Typically researchers look at vocal and non-vocal behaviours to evaluate the potential effects of nature-based tourism on cetaceans (Bejder and

Samuels, 2003). A growing number of studies demonstrate that cetacean-based tourism can and often does affect the behaviour of the animals targeted (Orams, 2000). Attributing these changes solely to the associated tourism industry however, often proves impossible (Corkeron, 2004). It is important to distinguish between short-term behavioural effects and long-term behavioural changes that are of biological significance. This distinction is imperative as it defies the common conclusion that any observed response by animals targeted by tourism activities is detrimental (Orams, 2004).

## 1.3 EFFECTS OF WHALE WATCHING TOURISM ON CETACEANS

### 1.3.1 Short-term responses of cetaceans

Most studies have focussed on behavioural changes of cetaceans associated with the presence and the frequency of tourist interactions (Corkeron, 1995). A useful measure of disturbance can be the dispersion or cohesion of cetacean groups, presuming that cetaceans will tighten their grouping in situations of surprise, threat or danger (Johnson and Norris, 1986). Various measures of group cohesiveness have been recorded and related to a potential source of impact (Blane and Jaakson, 1994; Bejder et al., 1999; Nowacek et al., 2001; Ribeiro et al., 2005).

Some cetacean species show signs of active avoidance of human presence, such as changes in movement patterns, swimming speed and direction and changes in surfacing, respiration and dive intervals. Cetaceans approached by tourist boats adopted a less predictable path and changed their swimming speed in an attempt to avoid the vessels (Kruse, 1991; Bejder et al., 1999; Nowacek et al., 2001; Williams et al., 2002b; Scheidat et al., 2004). Some of these studies have shown that the navigation and speed of the vessel interacting with the animals is a key parameter of the intrusiveness of an interaction (Nowacek et al., 2001; Williams et al., 2002a; Williams et al., 2002b).

Changes in surfacing, respiration and dive intervals are some of the most sensitive indicators of cetacean responses to vessels (Baker and Herman, 1989). These measures are readily quantifiable but only give meaningful and viable data when recorded for individual animals (Bejder and Samuels, 2003). Many studies have shown that tourism vessels alter the dive and breathing intervals of cetaceans (Stone et al., 1992; Blane and Jaakson, 1994; Janik, 1996; Nowacek et al., 2001; Lusseau, 2003b; Richter et al., 2006).

Other researchers highlight changes in cetacean vocalisation patterns in response to tourism vessels, including alterations in phonation rates, frequencies and call duration (Lesage et al., 1999; Scarpaci et al., 2000; Van Parijs and Corkeron, 2001; Buckstaff, 2004). Bottlenose dolphins (*Tursiops truncatus*) and Indo-Pacific humpback dolphins (*Sousa chinensis*) increased their whistling rates when tourism vessels approached or passed through the study area (Scarpaci et al., 2000; Van Parijs and Corkeron, 2001; Buckstaff, 2004).

Measuring changes in behavioural states is another common technique to investigate the impact of tourism on cetaceans. The five common behavioural states used for dolphins: resting, socialising, feeding, travelling and diving, and the transitions from one state to another give a useful indication of whether the targeted cetaceans change their behaviour in response to tourism vessels (e.g. Constantine and Baker, 1997; Lusseau, 2003a; Constantine et al., 2004). These studies revealed that cetaceans decreased resting and socialising and increased milling, travelling and diving when tourism boats were approaching or present. The exposure time of cetaceans to tourist boats (Constantine et al., 2003), the presence and density of vessels (Kruse, 1991) and the distance between boats and individuals within a pod (Corkeron, 1995; Coscarella et al., 2003) can also influence the occurrence and frequency of cetacean behaviour.

Short-term behavioural changes of cetaceans in reaction to tourism are potential indicators of long-term effects that may have biological relevance. Ideally, the goal of this kind of research is to link short-term reactions with long-term effects. In practice, however, only very few studies have demonstrated the biological significance of short-term behavioural changes in response to tourism activities (Bejder and Samuels, 2003; Lusseau and Higham, 2004).

### 1.3.2 Long-term responses

Long-term responses, if identified and isolated from a variety of other variables, are generally directly related to long-term impacts (IFAW, 1995). Long-term responses include impacts on: (a) the physical condition of the animals (e.g. from boat strikes), (b) cumulative or ongoing behavioural states (e.g. habituation, tolerance, sensitisation), (c) productivity and fitness (individual, group and population level), and (d) habitat use and distribution (beyond short term habitat avoidance) (IFAW, 1995). If one of these attributes is compromised, reduced, or altered, one can assume a negative impact on cetaceans (Frohoff, 2004).

Studies which explicitly set out to measure long-term effects are limited. Usually behavioural effects on cetaceans to impacts/disturbances are gradual, cumulative processes and therefore require a large amount of longitudinal data to detect demographic responses (Bejder and Samuels, 2003). Further complications result from the cetaceans' intra- and interspecific differences in susceptibility to such ongoing disturbances (Frohoff, 2004). In cases where long-term effects have been successfully investigated, studies took advantage of historical data or utilised longitudinal monitoring as an explicit part of the research design to investigate correlations between tourism and long-term changes in behaviour (Watkins, 1986; Constantine and Baker, 1997; Mann et al., 2000a; Constantine, 2001; Lusseau, 2004). Given the difficulties in accurately assessing the long-term implications of tourism impacts on cetaceans, it is important to apply the precautionary principle until the biological significance of such impacts is established scientifically (Lusseau and Higham, 2004).

Most behavioural impact studies have been conducted on odontocetes, but only little is known about the impacts of tourism industries on the behaviour and ecology of baleen whales. A particular knowledge gap exists for baleen whales associated with swim-with industries. The International Whaling Commission has recognised the potential of swim-with industries to impact whales through harassment and disturbance (International Whaling Commission, 2003). Following the precautionary principle, influential non-governmental organisations such as the Whale and Dolphin Conservation Society do not support swim-with activities with wild cetaceans, particularly larger whales (WDCS, 2004). The uncertainties about the impact of such operations on larger whales have influenced many countries to ban swim-with whale operations (e.g. Argentina, Canada, New Zealand, South Africa, U.K., and U.S.A.).

## 1.4 LIFE HISTORY AND SOCIAL STRUCTURE OF ODONTOCETES AND MYSTICETES

Taxonomically cetaceans are broadly divided into odontocetes and mysticetes. As their name indicates, odontocetes have teeth, and all the toothed whales such as sperm, pilot and killer whales together with all the dolphins and porpoises are included in this family. Mysticetes are also called 'baleen whales' as they have baleen plates. Baleen whales also have two external blowholes, while toothed whales have only one. Apart from these morphological differences, there are striking differences between those two Suborders in life history and social organisation.

### 1.4.1 Life history - reproduction, feeding and seasonal migration

One major difference between toothed and baleen whales is that almost all baleen whales (except Bryde's whale) follow a seasonal migration pattern (International Whaling Commission, 2004). Baleen whales exploit schooling plankton, crustaceans or small fish during the summer in polar waters and migrate to lower latitudes for breeding in winter. As they do not feed on their breeding grounds, they have to live off their energy reserves built up during summer (Tyack, 1986). Both the migration and the famine behaviour appear energetically costly. Indeed, migrating gray whales for example lose about one-third of their body weight by the time the whales return to their feeding grounds (Novak, 1991). However, while migrating to their breeding areas, net energy may actually be saved in the form of decreasing heat loss to the seawater at higher ambient temperature (Brodie, 1975). In baleen whales mating and calving are synchronised within the annual cycle and both occur during the months spent in warmer waters. Females of some species such as the Antarctic minke whales are capable of having one calf per year (Kato, 1995) but a two or three year breeding cycle is more common (Tyack, 1986). The period of lactation is relatively short and the calf is weaned within six to 12 months.

In contrast, few odontocetes are known to have long yearly migrations between separate feeding and breeding grounds. There are no known annual cycles of feast and famine, and compared to mysticetes, well defined annual peaks in their mating and calving strategies are missing. Most odontocetes also have gestation periods of well over one year and take longer to wean their calves. For example the period of pregnancy in sperm whales (*Physeter macrocephalus*) is about 14-16 months and the mean duration of suckling is two years (Best et al., 1984)

### 1.4.2 Social organisation in odontocetes

Social behaviour is highly developed in many species of odontocetes (Connor et al., 1998; Mann et al., 2000b). Social behaviour could have evolved either through kin selection (Brown, 1975) or through reciprocal altruism. Reciprocal altruism is an exchange of favours by two individuals in which one individual temporarily sacrifices potential fitness in expectation of a return. Both kin selection and reciprocal altruism favour the formation of groups travelling together and cooperating to find mates and food (Valsecchi et al., 2002).

Odontocetes seem to have very strong social bonds between females and their offspring (matrilineal groups), often forming groups which last several years. Such matrilineal groups are currently known from many odontocetes including sperm whales (e.g. Christal and Whitehead, 2001), dolphins (Connor et al., 2000; Wells, 2003) and killer whales (Baird, 2000). In sperm whales such groups are called ‘units’ and although there are occasional splits, mergers, and transfers between units, most members of a unit stay together for years (Christal and Whitehead, 2001). In bottlenose dolphins individuals live in structured communities with the merging of such communities building a population (Wells, 2003). Such dolphin communities are relatively stable over decades (Connor et al., 2000). The most stable social groupings among the odontocetes are found in killer whales (*Orcinus orca*) (Tyack, 1986). Two types of killer whales exist worldwide: the 'resident' and the 'transient' killer whales. The diet of 'residents' is predominantly fish; 'transients' actively hunt mammals. Both types are very similar in their social structure (Connor et al., 1998). 'Residents' travel with their mothers in stable matrilineal groups, averaging 3-4 individuals including up to four generations. These groups prefer to associate with one another in 'sub-pods', which in turn often travel together in 'pods' of 10-20 or more individuals (Connor et al., 1998). 'Transients' prefer to travel in smaller stable matrilineal groups (Baird and Dill, 1996). As both males and females stay within matrilineal groups, sexual dispersion occurs when mature males encounter similar groups with receptive females. Alternatively, males might leave their natal pod for periods in search of mates (Connor et al., 1998).

Odontocetes are also known to care for their offspring by forming nursery groups of various sizes. Caring for their young and rearing calves in larger, more stable groups significantly increases reproductive success (Wells, 2003). The improved protection from predators among nursery groups, the exposure to other individuals for socialising and learning and even allomaternal care of the offspring (caretaking by other females than the mother) may increase the changes of offspring reaching maturity (Mann and Smuts, 1999).

### 1.4.3 Social organisation in mysticetes

In baleen whales, social behaviour seems less well developed and the most stable bond which is between a female and her calf, lasts for less than a year (Tyack, 1986). Most species appear to be solitary but are found in groups while feeding or migrating (Valsecchi et al., 2002). Little is known about social organisation in baleen whales, as most of these whales are offshore in small groups and highly migratory, making research challenging and expensive or even currently impossible. The best understood and most studied baleen whales are coastal species such as the humpback whale (*Megaptera novaeangliae*) the gray whale (*Eschrichtius robustus*) and the right whale (*Eubalaena sp.*) (Tyack, 1986). Information on pelagic baleen whales including northern and southern hemisphere minke whales (*Balaenoptera acutorostrata* and *bonaerensis*) is growing; however studies on their social organisation are relatively rare. One additional challenge for studies on social structure in baleen whales is that most of these species are monomorphic (i.e. the morphology or physical appearance of males and females is similar) (Baker and Herman, 1984).

Long-term studies of baleen whales in feeding and breeding grounds suggest that social bonds are typically short-lived (e.g. Baker and Herman, 1984). Baleen whales aggregate in feeding areas, forming co-operative groups in order to maximise food consumption. Such aggregations have been described for most of the baleen whales including humpback whales (e.g. Whitehead, 1983), gray whales (e.g. Jones et al., 1984), and minke whales (e.g. Best, 1982; Macleod et al., 2004) However, these groups are rarely stable for more than a few hours and the size of such groups is mainly dependent on prey availability (Tyack, 1986).

Most baleen whale species whose breeding behaviour has been studied are polygamous, polygynous or promiscuous (Tyack, 1986; Mann et al., 2000b). Males have several strategies for gaining access to females on the breeding grounds. Males may join in large groups to fight for access to one central female (e.g. right whales; Kraus and Hatch, 2001), others may produce songs believed to serve as reproductive advertisements (e.g. humpback whales; Tyack, 1999) or to maintain spacing between males (i.e. dwarf minke whales; Gedamke, 2004).

Overall, baleen whales seem to possess less developed social structures compared with odontocetes. Mysticetes have very short association periods between mother and calf, an absence of matrilineal groups and no evidence of extended care taking and/or social learning. Although, mysticetes are often found in aggregations when feeding or in association with others when migrating, these co-operative behaviours are most likely to be based on reciprocal altruism (Valsecchi et al., 2002). This information is limited mainly to studies of the three most accessible coastal baleen whales, the humpback, the gray and the right whale. Thus, extrapolation to other much less studied species, such as blue, fin, sei, Bryde's and minke whales needs to be done with caution.

### 1.4.4 Challenges with extrapolating findings from odontocetes to mysticetes

As discussed in the previous sections (1.4.1 - 1.4.3), there are extensive differences between odontocetes and mysticetes in terms of their morphology, life history, ecology and social organisation (e.g. Tyack, 1986; Mann et al., 2000b). There are also big differences between odontocetes and mysticetes in terms of their accessibility for research (Mann et al., 2000b). While many odontocetes are encountered all year round in relatively accessible locations (i.e. close to the coast), mysticetes are typically more inconspicuous. Most mysticetes, with the exception of the coastal baleen whales (i.e.

humpback, gray and right whale), occur far from the coast and often can only be observed for very brief periods of the year. In addition, the behaviour of mysticetes is likely to be different at different times of the year and at different locations (i.e. feeding areas, migration routes, breeding areas). It is not surprising therefore that data are relatively rich for many odontocetes, but scarce and patchy for most baleen whales.

The lack of data on mysticetes and the vast differences between mysticetes and odontocetes make any comparisons and extrapolations challenging and often impossible. Nevertheless the current literature, management policies and public attitudes worldwide often fail to differentiate between odontocetes and mysticetes. Only by conducting species-specific research on the behaviour and social organisation of mysticetes species can appropriate protection, management and conservation take place. Until research provides more data on mysticetes, it is imperative to differentiate between these two cetacean suborders in terms of their behaviour, management and conservation. My study on dwarf minke whales addresses some of these limitations and provides new knowledge on the behaviour of a baleen whale while in contact with tourism vessels and their divers and swimmers.

## 1.5 MEASURING BEHAVIOUR

### 1.5.1 Research design

Cetacean ethologists are confronted with many unusual methodological challenges. Many cetaceans swim rapidly, range over long distances on a daily basis and have seasonal migrations of thousands of kilometres (Mann, 1999). At least some knowledge of the species to be studied is therefore necessary to choose the most appropriate research design (Martin and Bateson, 1993). Reconnaissance observations help in formulating questions and defining objectives, and in determining what aspects of behaviour can be measured, what manipulations are feasible, and the degree of variability that is to be expected (Lehner, 1996).

Two types of research approaches are used to study marine mammals: experimental and opportunistic. Experimental approaches minimise confounding influences of variables in a controlled environment, while opportunistic research records behaviour in natural conditions. It is unnecessary to draw a strict distinction between these two methods (Martin and Bateson, 1993). Descriptive research often generates hypotheses which lead to experimental research (Bakeman and Gottman, 1986) and experimental research is usually preceded by descriptions and definitions collected from opportunistic observations.

Both methods, when considered on their own, have limitations. Opportunistic observations have the potential for violating the fundamental assumption that nothing other than the factor of interest changes between control and experimental conditions. Although the experimental approach minimises confounding influences, it assumes that results would have been the same in natural conditions (Bejder and Samuels, 2003). Altman (1974) refers to this as the imbalance between external and internal validity, respectively, and states that both approaches are needed to correct the imbalance between them.

Opportunistic observations are the more frequently used method in field studies as this approach is logistically easier and requires less prior knowledge of dependent and independent variables (Bejder and Samuels, 2003). However, large sample sizes are needed to identify which variable is responsible for any observed effects. Irrespective of the chosen research design (experimental or opportunistic), research needs to utilise dedicated sampling techniques and methods to provide meaningful behavioural data.

## 1.5.2 Behavioural sampling techniques

### *1.5.2.1 The follow protocol*

Five different protocols are used to study marine mammal behaviour: (1) *survey*, (2) *group-follow*, (3) *individual-follow*, (4) *tracking* and (5) *anecdote*. These techniques are not mutually exclusive, and frequently more than one is used. Each of these methods has its strengths and limitations, depending on the situation and platform used.

**(1)** A *survey* encounters groups or individual animals for a limited time only. For example number of animals, identifications, location and behaviour are monitored in groups or individuals for 30 minutes or less (Mann, 1999). Only a snapshot of animal life can be gained with surveys, but these can be particularly valuable for addressing population-level questions such as demographics, density and distribution of animals (Mann, 1999).

**(2)** The *group-follow* protocol is widely used. By definition group follows are observations of a group of animals for longer than 30 minutes (Mann, 1999). Advantages of this protocol are that many animals can be surveyed and some questions on the temporal and spatial scale of social structure can be examined (Whitehead, 1995, 1997).

**(3)** With the *individual-follow* protocol, one individual (regardless of whether the animal is in a group or not) is the focus of observations during a particular sampling period (Lehner, 1996). The critical feature of this method is to focus on one animal and systematically record behaviours that are defined beforehand (Mann, 1999). The focus on individual animals provides the basis for quantitative measures of frequencies of behavioural events, duration of behavioural states and time budgets (Bejder and Samuels, 2003). In addition, observing behaviour of individuals in different contexts (e.g. who is with whom, when and where) is central to the understanding of the dynamics of social relationships (Mann, 1999). Events are behaviour patterns of relatively short durations, such as breaching, vocalisation or exhalation, which can be approximated as points in time. States are behaviour patterns of relatively long durations, such as feeding, or travelling. The salient features is their frequency and their duration, respectively (Martin and Bateson, 1993).

**(4)** *Tracking* refers to studies that electronically monitor individuals' locations or behaviour (Mann, 1999) using hydrophones (Sjare and Smith, 1986; Weilgart and Whitehead, 1990; Gillespie and Chappell, 1998), satellite tags (Watkins et al., 1996; Heide-Jørgensen et al., 2001; Laidre et al., 2004) or other tracking devices such as VHF tags (Folkow and Blix, 1993; Davis et al., 1996). These approaches can be expensive (Mann, 1999) and the attachment process or the device itself may affect behaviour (Watkins, 1981).

**(5)** A descriptive report of a single event or series of events is called an *anecdote* (Mann, 1999). Examples of anecdotes include descriptions of predation (Ford et al., 2005), copulation (Kraus and Hatch, 2001) and other events such as for example aerial behaviours (Waters and Whitehead, 1990).

### 1.5.3 Sampling methods

After choosing a protocol for following the animals of interest, a researcher has to decide what sampling methods to use. Sampling methods include: (1) *ad libitum*, (2) continuous, (3) one-zero, (4) point and scan and (5) sequence sampling. The success of each sampling method depends on the research question(s), the research design, the number and types of behavioural units selected to measure (states and/or events) the scale of measurement and practical considerations, such as observability, experience and availability of equipment (Lehner, 1996).

#### *1.5.3.1 Ad libitum sampling method*

The *ad libitum* sampling method implies that no systematic constraints are placed on what is recorded and when (Altmann, 1974; Martin and Bateson, 1993). In order to delineate and define behaviour and research questions researchers often involve some *ad libitum* sampling (Mann, 1999). *Ad libitum* sampling is useful for certain kinds of comparisons, but not for estimating rates of behaviour or for comparing behaviour patterns of different age or sex classes (Altmann, 1974). A limitation of the *ad libitum* sampling method is that observations will be biased towards those behaviour patterns and individuals that are most conspicuous (Martin and Bateson, 1993). Therefore *ad libitum* data are a valuable part of any field study but should not be represented as rates, proportions, frequencies, or other unbiased estimates of behaviour (Mann, 1999). However using this method can provide information about the feasibility of a planned study and facilitate the development of an ethogram. *Ad libitum* sampling may raise questions, ideas and hypotheses for future research and often records rare, but significant, behavioural events (Lehner, 1996).

#### *1.5.3.2 Continuous sampling*

Continuous sampling is a systematic record of frequencies or durations for a specified set of behaviours. For both behavioural events and states, continuous recording generally gives true frequencies, and true latencies and durations if an exact time base is used (Martin and Bateson, 1993). Measuring the exact times (and durations for behavioural states) of every occurrence of a behaviour is very demanding for the observer and the reliability of such data can be easily compromised (Mann, 1999). Such records are generally only possible if the observational conditions are excellent, the behaviours are sufficiently obvious, and that the behavioural events never occur too frequently to record (Altmann, 1974).

Continuous sampling is frequently used for marine mammals and can be implemented relatively simply for activities on the surface, including surfacing bout durations (Waters and Whitehead, 1990; Whitehead, 1999), breathing rates (Stern, 1992; Folkow and Blix, 1993), surface-display rates (Corkeron, 1995) and synchronous surfacing (Hastie et al., 2003). In addition, continuous data are the richest source of information on social behaviour and relationships, because such data include information on sequences, actors and recipients, rates and durations of behaviour for individual animals (Mann, 1999).

#### *1.5.3.3 One-zero sampling method*

With one-zero sampling, the observer scores whether a behaviour occurs (one), or not (zero), during a short interval of time (Lehner, 1996). One-zero sampling does not give true or unbiased estimates of durations or frequencies. The proportion of sample intervals in which the behaviour occurred to any extent cannot be equated either with the length of time spent performing the behaviour, or with the number of times the behaviour occurred (Martin and Bateson, 1993). In addition, one-zero sampling gives only a single dimensionless score for the whole recording session, therefore individual sample points within a recording session cannot be treated as statistically independent measurements.

#### *1.5.3.4 Point (instantaneous) sampling and scan sampling*

Point sampling is a technique in which the observer records an individual's current activity at a given time (e.g. every minute or every ten minutes). It is a sample of states rather than events (Altmann, 1974), since an event or a rare behaviour pattern is unlikely to occur at the instant of any one sample point and therefore will usually be missed (Martin and Bateson, 1993). The score obtained by point sampling is expressed as the proportion of all sample points on which the behaviour pattern was occurring. It does not give true frequencies or durations, however if the sample interval is short relative to the average duration of the behaviour pattern, then this method can produce a record that approximates to continuous sampling (Altmann, 1974; Lehner, 1996).

Scan sampling is simply a form of point sampling in which several individuals are observed at predetermined points in time and their behavioural states are scored (Lehner, 1996). Scans are conducted either at regular intervals (e.g. each animal is sampled at 10 sec intervals), or as quickly as possible (the next animal is observed as soon as the last was sampled) (Mann, 1999). Similar to point sampling, this technique is good for measuring states but brief events are likely to be missed. However if such sampling is done frequently, time distribution of behavioural states (in particular group synchrony) can be gained from the whole social group (Altmann, 1974).

Point and scan samples have successfully complemented each other in the research design of many cetacean behavioural studies. These techniques have most commonly been used in dolphin studies to quantify the five activity states, resting, milling, diving, socialising and travelling (Constantine and Baker, 1997; Constantine, 1999; Nowacek et al., 2001; Lusseau, 2003b, 2003a; Samuels and Bejder, 2004).

#### *1.5.3.5 Sequence sampling*

In sequence sampling, the observer focuses on a chain of behaviours or on particular interactions, rather than individuals, and records sequentially all relevant behaviours that occur during the event(s) (Lehner, 1996; Mann, 1999). The sample period ends when the observed sequence terminates or is interrupted. Determining when such a sequence starts and when it ends is crucial for this method (Altmann, 1974). Thus sequence sampling is recommended for easily observed behaviours (e.g. breaching). For example the onset for recording a sequence could be a breach of an animal and sequence sampling could be used to identify whether breaching animals attract or repel others (Mann, 1999). Sequence sampling is excellent for determining the conditional probabilities of behavioural sequences, but problems can arise in selecting sequences and identifying their beginning and end (Altmann, 1974).

In this study of the behavioural interactions between dwarf minke whales and tourist vessels and swimmers I used opportunistic observations and *ad libitum*, scan and sequence sampling methods within group and individual follow protocols as appropriate to address the research objectives described in Section 1.7. Information on the research design and methodologies of this study is detailed in the General Methods and within the individual Chapters.

## 1.6 THE SWIM-WITH DWARF MINKE WHALE INDUSTRY IN THE GREAT BARRIER REEF

In-water encounters with dwarf minke whales in the northern Great Barrier Reef were first reported in the early 1980s. Interactions with dwarf minke whales increased when the dive industry from Cairns and Port Douglas recognised the potential of the tendency of dwarf minke whales to voluntary approach divers and vessels (Arnold, 1997). Although the encounters were considered incidental to Reef diving experiences, operators increasingly began to direct their winter trips to destinations most likely to be visited by dwarf minke whales (Arnold and Birtles, 1999). The swim-with dwarf minke whale industry increased their effort with time and the season grew from two weeks in 1996 to six weeks in 2001-2002 (Valentine et al., 2004). Based on recommendations from research that has been ongoing since 1996, the Great Barrier Reef Marine Park Authority introduced a permit system for this industry in 2003. Nine permits were issued, including six live-aboard dive vessels and three day boat operators. The decision of the Great Barrier Reef Marine Park Authority to limit operations on swims with dwarf minke whales with a permit system made this industry one of the world's first fully endorsed swim-with whale tourism programs, along with Tonga and the Dominican Republic.

The current endorsed industry is part of a large dive and snorkel tourism industry departing from Cairns and Port Douglas in north eastern Australia. Tourism is the main industry in the Great Barrier Reef World Heritage Area, with approximately two million tourists visiting the Reef each year, generating over AU$ 5 billion per year in direct and indirect value (Access Economics, 2007). The region where dwarf minke whales are most commonly encountered is a heavily used marine tourism area, accounting for approximately a third of the annual tourism revenue of the Great Barrier Reef catchment (Access Economics, 2007). Although potential swims with dwarf minke whales are included in advertising for the endorsed industry, the main purpose of their trips is to dive and snorkel on the Great Barrier Reef. Schedules are very tight and most encounters with dwarf minke whales occur whilst vessels conduct leisure activities on one of a restricted number of dive sites (Valentine et al., 2004) (for more information on the operational conduct see Chapter 2 – General Methods).

The swim-with dwarf minke whale industry provides an excellent platform of opportunity to study the biology and behaviour of dwarf minke whales and to investigate interactions between these whales and the vessels and swimmers. Indeed, the Great Barrier Reef is the only place in the world where dwarf minke whales frequently approach vessels, and where extensive observations on these whales are possible from above and in-water. In the last decade, the research on these whales has focussed on: (1) the photo-identification and size estimation of individual whales, and (2) the social and managerial side of the endorsed industry. Before the commencement of my study, detailed knowledge about the behaviour of dwarf minke whales was limited. The most common behaviours had been described (Birtles et al., 2001b; Birtles and Arnold, 2002) but a detailed ethogram of their behaviour, allowing for a comparison with other cetaceans, was still missing. Prior to this study virtually nothing was known about whether or not dwarf minke whales change their behaviour in reaction to human presence. In this study, I attempted to address these knowledge gaps to establish an information baseline on the behaviour of these whales, to generate hypotheses for future research and to provide management recommendations to safeguard this species from deleterious human influences.

## 1.7 RESEARCH AIMS AND THESIS STRUCTURE

This PhD research had two major aims:

(1) to provide detailed insights into the behaviour of dwarf minke whales around tourism vessels and swimmers in the Great Barrier Reef and,

(2) to establish recommendations for the tourism industry and management agencies to provide for discussions on future management and to contribute to the sustainability of this industry.

In order to achieve these aims, my study had four distinct objectives, each related to a data chapter in my PhD study (Chapter 3-6; see Figure 1.1).

**Objective 1: To establish a detailed repertoire of the non-acoustic behaviour of dwarf minke whales around tourism vessels and their swimmers, and provide context and indications for potential functions of the observed behaviours (Study1; Chapter 3).**

In Chapter 3, I use observational data collected over three years of my research (2006-2008) including data collected by S. Sobtzick (u/water video footages) and Dr R.A. Birtles (u/water behaviour photos). The purpose of this Chapter is to provide an overview of the non-acoustic behavioural repertoire of dwarf minke whales encountered by and interacting with swim-with tourism dive vessels. I establish an index of the occurrence of a suite of dwarf minke whale behaviours (very rare – very frequent) and document the context in which they were seen. This Chapter forms the basis for all the following data Chapters, and in particular, gives context to the behaviours of potential risk of harm to the swimmers and the whales, examined in Chapter 5.

**Objective 2: Investigate the distribution of dwarf minke whales around vessels and swimmers and examine if these whales change their behaviour in interactions with humans over time (Studies 2 & 3; Chapter 4).**

Chapter 4, includes two studies. In 2007, I used an adaptive scan sampling protocol from the top deck of the vessel and analysed the data to determine the distribution of the whales around the vessel and their swimmers. In 2008, I conducted distance measurements of individual whale-researcher passes (individual follows protocol), to shed light on any changes in the behaviour of the whales while associated with humans. I also used this Chapter to examine the inquisitive nature of these whales in the context of other free-ranging wildlife, to generate hypotheses concurrent with behavioural theories of exploration and to address any management issues associated with the behaviour of dwarf minke whales.

**Objective 3: Determine the direct and indirect risks of harm associated with swimming with dwarf minke whales for the swimmers and the whales (Study 4; Chapter 5).**

In Chapter 5, I assess the potential risk of harm to the swimmers and the whales from the behaviour of dwarf minke whales around dive vessels. The risk of harm was established by examining: (1) the potential for harm (consequences) from dwarf minke whale behaviours for both the swimmers and the whales using the perceptions of experts in the field of marine mammal science, management and conservation, and (2) estimating the occurrence probability of the behaviours of concern in interactions. In this Chapter I build upon findings presented in Chapters 3 and 4.

**Objective 4: Evaluate the validity and effectiveness of dwarf minke whale behavioural records reported via the Whale Sighting Sheets and to provide details on the perceptions of passengers to help in effective risk management (Study 6; Chapter 6).**

In Chapter 6, I evaluate the validity of dwarf minke whale behavioural records by crew and assess the effectiveness of the Whale Sighting Sheets as a monitoring tool for particular whale behaviours. I compare my observational data on dwarf minke whale behaviour occurrences in interactions with the data reported by crew. I also provide details on the perceptions of passengers about swimming with dwarf minke whales using the Interaction Behaviour Diaries, to (1) help address the management issues established in Chapter 5 (i.e. termination of interactions due to presence of highly interactive whales), and (2) to improve the encounter management by the industry.

Finally in Chapter 7, I provide a summary of the major research findings of this study and discuss these in relation to their contribution to the conservation and management of dwarf minke whales in the Great Barrier Reef Marine Park. I also outline future research directions for dwarf minke whale conservation and management.

The aims and objectives of this study have been designed to establish new knowledge about the behaviour of a relatively unknown mysticete species. My study will also generate information and recommendations useful for management agencies to improve the management and conservation of dwarf minke whales in the Great Barrier Reef and beyond.

All data Chapters (Chapters 3-6) of this PhD study have been written in a format to facilitate publications in peer reviewed journals as recommended by the

James Cook University PhD Thesis Guide within the Handbook for Research Higher Degree Students 2005. I have attempted to minimise overlap between each of these Chapters.

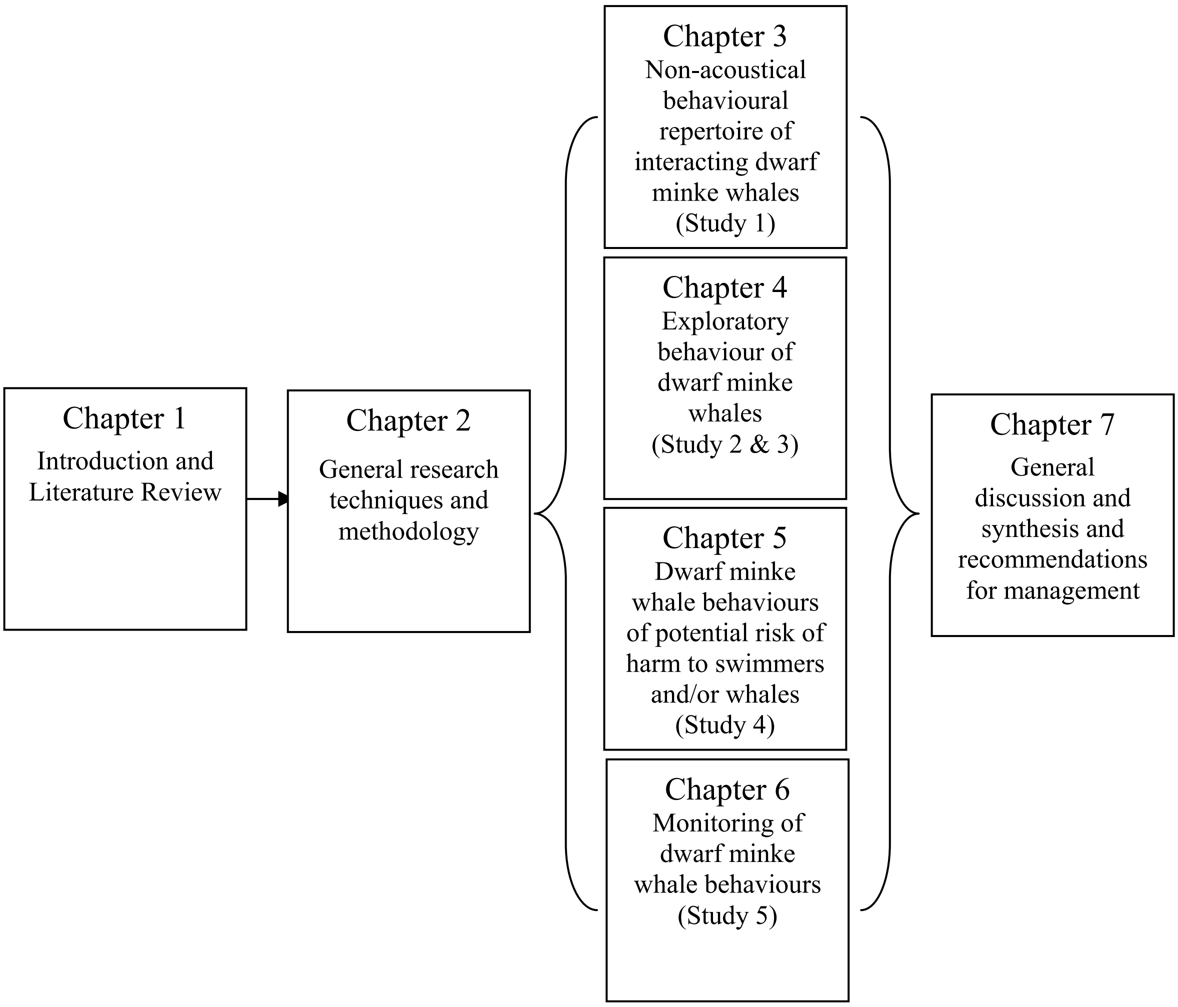



Figure 1.1 Diagram of thesis structure

# CHAPTER 2

## GENERAL MATERIAL AND METHODS

In this chapter I provide a general overview of my study, including a detailed description of the study area, the study species, the platform of opportunity (swim-with industry) of my research and the legislative background for swimming with dwarf minke whales in Australia. I also provide information on the general research protocols which I used during my studies.

## 2.1 STUDY AREA

The Great Barrier Reef Marine Park covers over 340,000ha in area and stretches from Cape York in the north to north of Bundaberg in the south along the east coast of Australia. Confirmed sightings of dwarf minke whales have been reported from the region north of Lizard Island (14°36'S) to the Swain Reefs (22°S) (Arnold, 1997). My study area was confined to the Cairns/Cooktown and Far Northern sections of the Great Barrier Reef Marine Park. In this region most sightings of dwarf minke whales occur in June and July along the Agincourt and Ribbon Reefs between Port Douglas and Lizard Island (Figure 2.1). Over half (53%) of all reported dwarf minke whale sightings occur behind the Ribbon Reefs 9 & 10 (Birtles et al., 2009) (Figure 2.1).

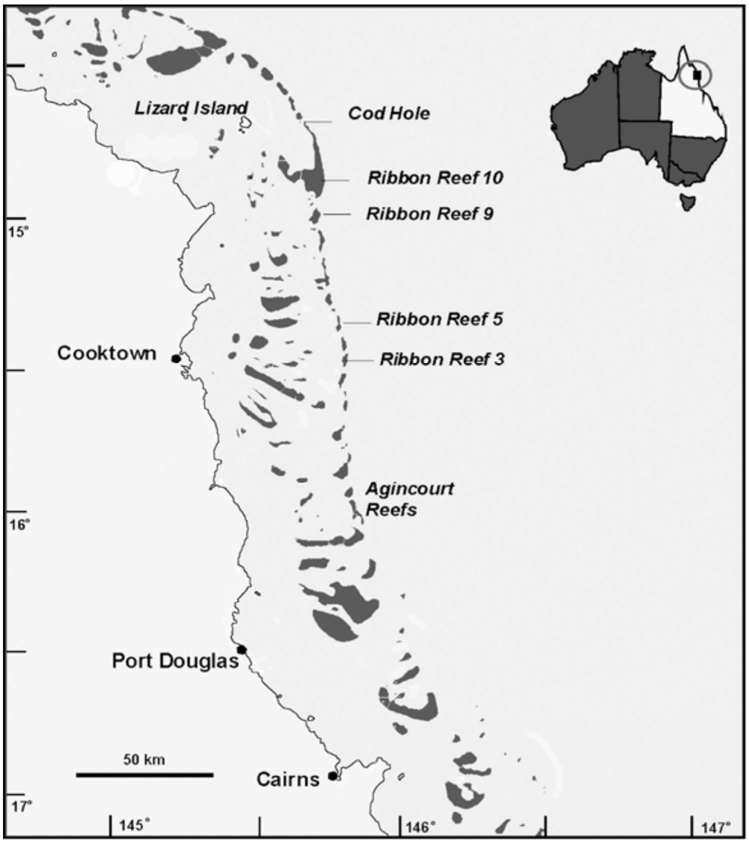



Figure 2.1 Map of the northern Great Barrier Reef showing the main locations (i.e. Agincourt Reefs, Ribbon Reefs, Cod Hole) where dwarf minke whales are encountered by the tourism industry in the austral winter months (May-August)

Most sightings are reported from the swim-with dwarf minke whale endorsed tourism industry, thus these records do not reflect the true distribution of the whales but are biased to the locations covered by the itineraries of the industry (see below for detailed itineraries of the endorsed industry). Recent efforts have been made to extend the dwarf minke whale 'sighting network'. Marine operators have been contacted in the southern regions of the Queensland and New South Wales coast and the west coast of Australia, to help by reporting dwarf minke whale sightings via the Whale Sighting Sheets. This extended sighting network will allow for a more complete picture of the distribution of dwarf minke whales.

## 2.2 PLATFORMS OF OPPORTUNITY – THE SWIM-WITH DWARF MINKE WHALE INDUSTRY

During the three years of my research, the endorsed industry consisted of three day boats and six live-aboard dive operations departing from Cairns and Port Douglas on the north-east coast of Australia. One of the six live-aboard operations was never operational and sold its permit to a charter operation in 2008 (see Table 2.1). The day boats conducted their operations in and around the Agincourt Reef complex while the live-aboard operations targeted more secluded locations along the Ribbon Reefs up to Ribbon Reef #10 (Figure 2.1). The itineraries of these operations varied considerably, ranging from four hours for the day boats, to three-four days and six days on the reef for the live-aboard vessels (Table 2.1). Although potential swims with dwarf minke whales were included in their advertising scheme, for all operators but one the main purpose of their trip was to dive and snorkel on the Great Barrier Reef. The operators' time schedules were very tight, thus encounters with dwarf minke whales usually occurred whilst conducting their leisure activities on one of their reef sites (Valentine et al., 2004). For the vessel most focussed on dwarf minke whale interactions, *Undersea Explorer*, diving and snorkelling was secondary and swims with the whales were conducted whenever possible. This vessel has been used as the main platform for my research and has been utilised by researchers of the James Cook University and the Museum of Tropical North Queensland (Minke Whale Project) studying dwarf minke whales from 1996 to 2009. During my research, most endorsed operations with regular schedules were committed to provide in-kind berth spaces to researchers throughout June and July (main season) facilitating cost-effective research. Depending on availability, operations provided space for one researcher as often as they could. *Undersea Explorer*, as the main research platform, guaranteed at least two but often facilitated three spaces free-of-charge per trip. There was a high commitment of the endorsed industry to research with a funding contribution of about $400,000 in the last six years (including in-kind berth spaces, voluntary passenger levies, passenger cash contributions and cash contributions from operators). Two of the live-aboard operations, *Explorer Ventures* and *Undersea Explorer* ceased operation due to financial hardship in 2008 and 2009, respectively (see Table 2.1). Their swim-with dwarf minke whale permit endorsements are currently for sale.

## 2.3 LEGISLATIVE BACKGROUND

All vessels encountering cetaceans in the Great Barrier Reef Marine Park are obliged to follow the Australian National Guidelines for Whale and Dolphin Watching (DEH, 2005). Swim-with dwarf minke whale endorsed operators additionally have to follow a Code of Practice, which was developed to manage the conduct of dive/snorkel tourism vessels encountering dwarf minke whales (Arnold and Birtles, 1999; Birtles et al., 2002c).

Table 2.1 Descriptions of swim-with dwarf minke whale endorsed operations (2006-2008); day boat operations shaded (after Birtles et al., 2009)

| **Permittee** | **Vessel name(s)** | **Length (m)** | **Cruising speed (knots)** | **Passenger capacity** | **Description of itinerary** |
|---|---|---|---|---|---|
| Poseidon Cruises Pty Ltd | *Poseidon III* | 24 | 25 | 90 | Day trips from Port Douglas to Agincourt Reefs. Departs Port Douglas at 8.30am and returns at 4.30pm. Total duration on the reef 4.5 hours |
| Chartercorp Reef Tours Pty Ltd | *Aristocat V* | 31 | 32 | 100 | Day trips from Port Douglas to Agincourt Reefs. Departs Port Douglas at 8.30am and returns at 4.30pm. Total duration on the reef 4.5 hours |
| Sable Lake Pty Ltd | *Silver Sonic* | 29 | 28 | 162 | Day trips from Port Douglas to Agincourt Reefs. Departs Port Douglas at 8.30am and returns at 4.30pm. Total duration on the reef 4.5 hours |
| Blue Oceanic Reef Pty Ltd | *Undersea Explorer* | 25 | 8 | 21 | Main research vessel. Six day trips to Ribbon Reefs. Departs Port Douglas on Saturday night, returning Friday night. Company ceased operation in 2009 |
| Mike Ball Dive Expeditions Pty Ltd | *Spoil Sport* | 29 | 12 | 31 | 3 day live-aboard trips to the Ribbon Reefs. (1) North-bound: departs Cairns Thursday 7pm; 3 day trip north along Ribbon Reefs. Passengers disembark Saturday 8.30am on Lizard Is. and fly back to Cairns. (2) Southbound: Passengers fly to Lizard Is. Saturday and embark vessel at 10am, 3 day trip south along Ribbon Reefs. Passengers disembark Thursday 8am in Cairns. |
| Explorer Ventures (Australia) Pty Ltd. | *Nimrod Explorer* | 21 | 9 | 18 | 3 day live-aboard trips to the Ribbon Reefs. Departs Cairns Tuesday 6pm, 3 days diving along Ribbon Reefs; Saturday morning passenger changeover in Cooktown – new passengers fly in from Cairns, completing guests fly back to Cairns; 3 days diving along Ribbon Reefs; Returns to Cairns early Tuesday morning. Company ceased operation at the end of 2008 |
| Floreat Reef Charters | *Floreat* | 15 | 12 | 11 | No set itineraries. Available for charter. |
| [1]Great Barrier Reef Cruises Pty Ltd | *N/A* | N/A | N/A | N/A | Company never operational. Permit sold to Eye to Eye Marine Encounters in 2008 |
| * Eye to Eye Marine Encounters | Permits shifted between various vessels including: (a) *Phoenix*, (b) *Sinbad*, (c) *Vivid* | a = 18<br>b = 38<br>c = no details | a = 9<br>b = 8<br>c = no details | a =12<br>b = 8<br>c = no details | No set itineraries. Various vessels available for charter. (see www.marineencounters.com.au) |
| [2]Reefcam Pty Ltd<br>*Ecrolight Pty Ltd (Deep Sea Divers Den) | *Taka* | 30m | 11 | 30 | Departs Cairns Friday 6pm, overnight steam north to Cod Hole, southbound trip along Ribbon Reefs and Agincourt Reef, Passengers disembark vessel Tuesday 3pm; new passengers arrive Tuesday 6pm, same trip up to Cod Hole and back along Ribbon and Agincourt Reefs, passengers disembark vessel Friday 3pm. Company changed ownership in 2008. |

[1] never operational; sold permit to Eye to Eye Marine Encounters in 2008
[2] operational until beginning of 2008, company bought and permit shifted to Ecrolight Pty Ltd
* Indicates new permit ownership in 2008

### 2.3.1 National Guidelines for Whale and Dolphin Watching

In 2005, the Commonwealth Department of Environment and Heritage updated the National Guidelines for Whale and Dolphin Watching, which apply to all recreational, commercial and incidental encounters with whales and dolphins. The Australian National Guidelines are a successor of the ANZECC guidelines of 2000 and are legally anchored in the Environmental Protection and Biodiversity Conservation Act of 2000 (Part 8 - Regulations; EPBC, 2000). The two-tiered policy of the Australian National Guidelines intend to protect and safeguard all cetacean species with two main aims: (1) "to minimise the impacts of whale and dolphin watching on individuals and populations of whales and dolphins" and (2) "to ensure that people know how to act appropriately when watching whales and dolphins" (DEH, 2005, p. 2).

Conducting deliberate swims or dives (incl. SCUBA) with whales and dolphins is prohibited under Tier 1 of the guidelines, unless under the authorisation of the relevant State, Territory or Commonwealth agency. This policy manages encounters with cetaceans by regulating operational conduct with approach distances (Tier 1). In particular, Tier 1 specifies two approach limits: (1) the 'caution zone' and (2) the 'exclusion zone'. Only three vessels are allowed at any time in the 'caution zone' (300-100 m from a whale, 150-50m from dolphins) and vessels must travel at no wake speed (≤ 6 knots) within this zone. No vessels are allowed to enter the 'exclusion zone' (< 100 m to a whale and <50 m to a dolphin) and no swimmers (including divers) are permitted to enter the water once a whale is closer than 100 m (50m for dolphins) from the vessel. Swimmers and/or divers are not contravening the guidelines if whales or dolphins decide to approach closer than the specified limits. In this situation, swimmers/divers are not allowed to approach the whale(s)/dolphin(s) closer than 30 m, are required to move slowly in the water and must not touch or attempt to touch the whale or dolphin (DEH, 2005).

Tier 2 of the guidelines provides options for alternative management for swimming and diving and some flexibility for species-specific management, including limits on the number of vessels/swimmers. Tier 2 management of dwarf minke whales has involved the use of permits with the aim of limiting and controlling dedicated interactions. Within this framework, endorsed operations are allowed to place swimmers in the water at the formerly allowed limit of no closer than 30 metres from a whale (ANZECC, 2000; EPBC, 2000).

### 2.3.2 Code of Practice for swimming with dwarf minke whales

The initial Code of Practice for swimming with dwarf minke whales was proposed in Arnold and Birtles (1999) and revised in Birtles et al. (2002c). The Code of Practice was voluntarily adopted and trialled by the Cod Hole and Ribbon Reef Operator Association (CHARROA) in 2002 before the Great Barrier Reef Marine Park Authority incorporated this Code as a permit condition in 2003. The Code of Practice provides information for any person likely to be involved in an encounter with a dwarf minke whale and seeks to both minimize the negative effects of interactions on cetaceans and allow humans to enjoy the experience in a sustainable way. Reviewed and updated in 2008, the Code of Practice is based on the current understanding of the biology and behaviour of dwarf minke whales and the advances of the research on the social aspect of the industry (Birtles et al., 2008). As an adaptive framework, the current Code of Practice will be further modified as researchers learn more about minke whales and the two-way interactions between the whales and humans.

The Code of Practice for swimming with dwarf minke whales reflects the current legislation and includes additional guidelines for operators and swimmers conduct. Swim-with dwarf minke whale endorsed operations must follow the Code of Practice as one of their two permit conditions. Additional measures for operational conduct include deployment of ropes for swimmers to hold onto, recommendations for rope management, voluntarily adopted protocols for cow and calf encounters and minimum vessel-vessel approach distances (1000m). Special considerations are given to the briefings, which are designed to relay information about the guidelines and vessel safety to the passengers. Briefings are an important tool to make visitors mindful, raise their awareness and guide visitors to do the right thing (Moscardo, 1998, 1999b). The other permit condition requires operators to fill in a Whale Sighting Sheet for every dwarf minke whale encounter as explained below.

## 2.5 WHALE SIGHTING SHEET

The Great Barrier Reef Marine Park Authority (GBRMPA) requires all endorsed operators to complete a Whale Sighting Sheet after each encounter with dwarf minke whales, as a permit condition. The Whale Sighting Sheet was developed in 1999 and is designed as a research and monitoring tool. Whale Sighting Sheets are distributed to the operators either by mail or can be downloaded from the internet (www.gbrmpa.gov.au/__data/assets/pdf_file/0019/7183/WSS2009_M_Read.pdf). Non-endorsed operators and private individuals sometimes use this monitoring tool to report their incidental encounters with dwarf minke and humpback whales. The Whale Sighting Sheet provides valuable information about the encounter including: (1) the date, (2) the time of the start and end of the encounter, (3) the location, (4) approximate numbers of whales present, (5) presence/absence of calves, (6) vessel status, (7) wind and sea conditions and (8) includes space for a brief description of the encounter. The Whale Sighting Sheets also aims to gather information about the behaviour of the whales, such as the closest approach distance of a whale to the vessel and the presence or absence and the approximate frequencies of the most common behaviours (see Appendix 1 for more detailed information).

## 2.5 INTERACTION BEHAVIOUR DIARY

The Interaction Behaviour Diary (see Appendix 17) is an on-site self-administered questionnaire for crew and passengers designed to capture: (1) the experience and satisfaction of passengers and crew of swimming with dwarf minke whales, and (2) to provide additional information on the behaviour of the whales. Passengers and crew were encouraged to complete one Interaction Behaviour Diary after each in-water interaction with dwarf minke whales. The Interaction Behaviour Diary was implemented as a research tool in 2006 and administered on board all endorsed operators during June and July of all three years of my PhD study (2006-2008). The Diary was modified from the 'Encounter Log Book' which was implemented by the Minke Whale Project in 2002.

## 2.6 STUDY SPECIES – DWARF MINKE WHALES

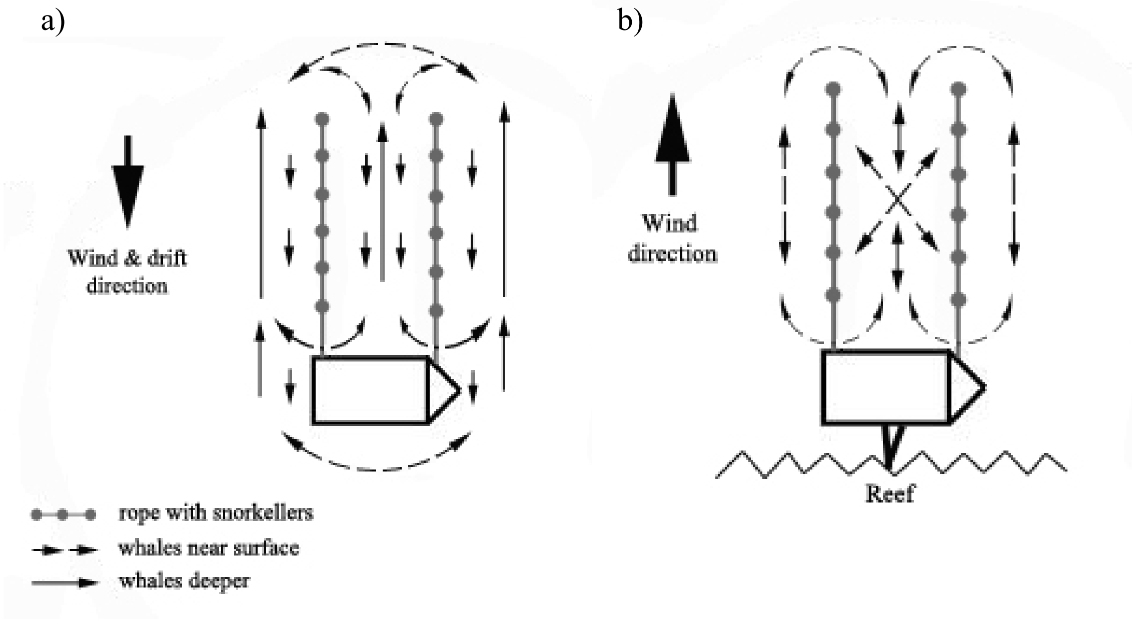
Minke whales are the second smallest of the baleen whales and were long thought to be a single species with a cosmopolitan distribution (Murphy, 1995). Differences in their phenotype and geographical distribution prompted genetic studies on the different types of minke whales which revealed two species: (1) the 'common' (*Balaenoptera* *acutorostrata*) or northern minke whale, and (2) the 'Antarctic' (*Balaenoptera bonaerensis*) or southern hemisphere minke whale (Rice, 1998). Best (1985) proposed another distinct form within the minke whales, the 'diminutive' form now commonly known as the dwarf minke whale, on the basis of their distinct colouration patterns and size differences (maximum recorded length just under 8m). This proposal was confirmed by Arnold et al. (1987) who reported sightings of dwarf minke whales from the east coast of Australia. Sighting records of dwarf minke whales show a seasonal distribution/migration (in austral winter months) along continental shelfs throughout the southern hemisphere including, South America, South Africa and Australia (Best, 1985). The Scientific Committee of the IWC (International Whaling Commission, 2001) officially recognised the southern and northern hemisphere minke whale species, but deferred a decision on the diminutive or dwarf form. However, the unique colouration pattern (Arnold et al., 2005) supports Rice's (1998) proposal of the dwarf minke whale being an as yet un-named subspecies of the 'common' minke whale, *Balaenoptera acutorostrata*.

Dwarf minke whales are regularly encountered on the north-eastern coast of Australia between May and September (Arnold, 1997), with most encounters occurring in June and July (Birtles et al., 2009). Dwarf minke whales in the Great Barrier Reef repeatedly approach vessels and maintain contact for prolonged periods (industry average 90 min; Birtles et al., 2009). The inquisitiveness of dwarf minke whales and their prolonged contact time with vessels, provide a good opportunity to study these whales' behaviour from above and in the water.

## 2.7 DESCRIPTION OF ENCOUNTERS/INTERACTIONS WITH DWARF MINKE WHALES

The crews of endorsed vessels are trained twice a year (usually May and November) during a one-day workshop to provide their passengers with the current information on the whales' biology and behaviour and to give detailed briefings prior to encountering whales. The biannual workshops with the endorsed industry are funded by the Great Barrier Reef Marine Park Authority and held by the Minke Whale Project (established in 1996 by researchers of James Cook University and the Museum of Tropical North Queensland).

Usually a vessel encounters whales either when it is moored on one of their reef dive/snorkel sites or while steaming, followed by drifting. The only operation regularly conducting drifts is the dive tourism vessel *Undersea Explorer*, on which most of my research was conducted. Passengers are informed about the possibility of encountering dwarf minke whales at the start of their trip and receive a general introduction on the Code of Practice of swimming with these whales. If dwarf minke whales are encountered, passengers receive a pre-swim-with whale briefing just prior to entering the water. The main messages of the Code of Practice are repeated, i.e. never swim towards a whale, never touch a whale, enter and exit the water quietly, avoid rapid movements in the water and hold onto the rope at all times. When a dwarf minke whale approaches a vessel, the crew deploy one or two ropes up to 50 m long from the starboard or port side of the vessel. Swimmers are asked to space themselves at regular intervals 3-4 m apart along the rope (with a maximum of six persons per rope recommended by the Code of Practice). In an interaction dwarf minke whales usually circle the boat and the swimmers in a loop, passing by regularly at distances well within the visual underwater range (approx. 30m) (personal observations; Fig. 2.1a & 2.1b). Swimmers may exit and reenter the water several times during an in-water interaction with the whales which may last for several hours.




Figures 2.2a & 2.2b Movement pattern (simplified) of dwarf minke whales around *Undersea Explorer* in (a) drifting and (b) stationary in-water interactions.

## 2.8 GENERAL RESEARCH PROTOCOL (2006-2008)

I conducted direct observations on the behaviour of dwarf minkes on swim-with whale permitted live-aboard tourism dive vessels from 2006 - 2008. As explained above, most of my data were collected on *Undersea Explorer* (main research platform; 96 days) however I utilised three other live-aboard dive vessels (*Nimrod Explorer* (13 days), *TAKA* (6 days), *Spoilsport* (3 days)). The general research protocol was adopted from Birtles et al. (2002a). A dedicated surface watch for dwarf minke whales was kept during daylight hours from 6.30am to 6.00pm. Observations were made on the top deck of the vessel at an eye height of approximately 7-10m depending on the vessel. This vantage point facilitated the observations in a 360º radius (180º radius if the vessel was moored at a reef). The number of observers varied, depending on how many researchers were on board and if the vessel was moored at a reef site or drifting in open water. On the main research platform (*Undersea Explorer*), there were generally three dedicated observers in open water and usually up to two at reef sites. Passengers and crew were encouraged to help but were not included in the research protocol. Committed searches for whales were only conducted on *Undersea Explorer*. The vessel would steam at a constant speed of five knots in anticipation of encountering whales. If a whale was sighted at a distance greater than 100 metres, the vessel maintained course until arriving at the approximate location where the whales had been seen. The engines were put in neutral and the vessel drifted with the wind. If a whale was seen within 100 metres, the vessel stopped immediately and commenced drifting. If the whale was not seen again within 15 minutes, the vessel resumed course. If the whale approached the vessel, two 50 metre ropes were deployed from the vessel. Two of my colleague researchers (R.A. Birtles (AB) and S. Sobtzick (SS)) were the first to take up positions on the end of each rope. Their main aim was to collect photo-ID (SS & AB) and length data (SS; using videogrammetry) on the individual whales, and over the course of an interaction to help document the underwater behaviour of the whales (AB). In the first two years of my PhD study (2006-2007), I observed and documented the behaviour of dwarf minke whales from the top deck of the vessel, using various protocols (e.g. *ad libitum*, adaptive scan sampling, individual follows; see individual Chapters for more detail). In 2008, I collected data on whale-swimmer passing distances from in-water using an individual follows protocol (see Chapter 4 for more detail). Topside information was recorded in a notebook and data were transcribed into a database at the end of each day. I measured the distances of surfacing whales from the vessel with a laser range finder (Leupold Wind

River RB800C) or estimated the distance to the nearest five metres. I regularly calibrated my accuracy in judging distances using the laser range finder. Reference points such as buoys and marks along the ropes helped to increase the accuracy of my estimates and reduce any distance estimation errors.

The end of an in-water interaction was declared when the duration to the last in-water sighting exceeded 20 minutes. Another reason for terminating an in-water interaction was when the vessel needed to move, either for safety reasons (e.g. drifting onto a reef; nightfall) or to follow their planned itinerary. In either case, at least one observer monitored the position of the whales, communicating closely with the skipper before the engines were put in gear. Initially the vessel was run at no wake speed, increasing in speed when whales were more than 100 metres away. Research on dwarf minke whales was conducted under the James Cook University Annual Animal Ethics Permit # A1111.

## 2.9 DEFINITIONS

An encounter was defined as any contact with dwarf minke whales from the first confirmed sighting to the end of the vessel's contact with the whales. Encounters included whales seen at a distance but only if they could be identified as a dwarf minke whale. If whales approached the vessel to within 30 metres of the vessel, it was called an interaction. A person in the water seeing a whale was defined as the beginning of an in-water interaction. All interactions were encounters but not all encounters led to an interaction (definitions modified from Birtles et al., 2002a).

# CHAPTER 3

## NON-ACOUSTIC BEHAVIOURAL REPERTOIRE OF DWARF MINKE WHALES INTERACTING WITH VESSELS AND SWIMMERS IN THE NORTHERN GREAT BARRIER REEF

The purpose of this chapter is to provide an overview of the non-acoustic behaviour repertoire of dwarf minke whales encountered by and interacting with swim-with tourism dive vessels. I establish the probability of occurrence of a suite of dwarf minke whale behaviours (ranging from very rare to very frequent) and present the context in which these behaviours were seen. This Chapter forms the basis for all following data Chapters, but in particular gives context to the behaviours which could be of potential risk of harm to the swimmers and/or the whales which are examined in Chapter 5. I collected most of the data for the partial ethogram, but I also accessed some data collected by S. Sobtzick (underwater video footages and photos) and my principal supervisor Dr R.A. Birtles (underwater photos of dwarf minke behaviours).

## 3.1 INTRODUCTION

The first step for studying the behaviour of any animal is to describe individual behaviours in the form of an ethogram. An ethogram is a collection of exact descriptions of basic behavioural patterns or events (Lehner, 1996). Behavioural events may later be integrated into units of greater complexity, i.e. behavioural states (Mann et al., 2000b). Ideally, an ethogram describes the entire behavioural inventory of a species (Immelmann, 1980). However partial ethograms are more frequent as researchers are often restricted in their observation of animal behaviours displayed at a particular time, location (e.g. wintering ground) or behavioural state (e.g. feeding). An ethogram (partial or complete) forms the basis for detailed studies on the behaviour of any animal and provides a useful tool to make comparisons with behaviours displayed by other species (Hinde, 1966; Lehner, 1996).

Studies of animal behaviour typically investigate the function, causation, development and evolutionary history of the displayed behaviour (Hinde, 1966). Determining the attributes (e.g. function) of behaviours is very challenging. Behaviours often occur in a variety of contexts and depending on factors such as the species, the animals' life-history, internal state and the environment, their meaning may deviate greatly. The majority of behaviours displayed are (direct or indirect) responses to their abiotic, biotic and social environment. In a social environment behaviours are believed to convey important information (Pryor, 1990), formed and shaped by the animals' shared phylogenetical and ontogenetical history (Tinbergen, 1959; Fehr and Exline, 1987). The exchange of information between animals is referred to as communication.

For animals in social aggregations, information exchange via communication is crucial (Altmann, 1967; Cullen, 1972; Smith, 1977). Indeed, a social system could not exist without a method to express information and subsequently convey its meaning reliably and consistently (Otte, 1974; Marler, 1977). Communication is defined as a process by which a sender and a receiver use signals in an attempt to create shared understanding (Tinbergen 1959; Marler 1965; Kimura 1993; Hauser 1996). Information exchange between animals within the social group is of great importance as it helps to achieve common goals including reproduction, defence against predators, foraging and group coordination (Vauclair, 1996).

Animals convey information through several channels and the most commonly used are: (1) mechanoreception (contactual and acoustic), (2) photoreception (visual) and (3) chemoreception (taste and olfactory senses). All of these sensory channels may be used to convey information in cetaceans (Herman and Tavolga, 1980; Pryor, 1990). The type of channels used depends on the animals' sensory abilities and is greatly influenced by contextual factors (King and Shanker, 2003). The predominant and indeed the best studied channel for information exchange between cetaceans is the acoustic communication channel (Caldwell and Caldwell, 1977; Clark, 1990; Pryor, 1990; Gedamke, 2004).

Non-vocal signals are also of great importance for communication between cetaceans (Herman 1980; Pryor 1990; Dudzinski 1998; Reynolds and Rommel 1999; Dudzinski et al. 2002). Vocal and non-vocal signals are often used in combination to enhance or maximise a message (Dudzinski, 1998). Non-vocal information exchanges in cetaceans may take several forms. Exchanges can be visual (displays, postures), contactual (rubbing, touching, biting), and/or auditory-behavioural (Caldwell and Caldwell 1977; Pryor 1990; Norris et al. 1994). Auditory-behavioural displays include rapidly shutting the jaws together (*jaw claps*), leaping out of the water (*breaches*), expelling bubbles from the blowholes, or slapping the pectoral fins or flukes onto the water surface (*pectoral* or *tail slaps*). Auditory-behavioural signals are often associated with aggressive, annoyance or disturbance displays in cetaceans (McBride and Hebb 1948; Caldwell and Caldwell 1977; Shane et al. 1986; Dudzinski et al. 2002) but are also used to signal group affiliation (Norris and Dohl, 1980) or are associated with excitement or investigation (Madsen and Herman, 1980).

Many cetaceans convey messages via their visual senses but the nature of such exchanges varies greatly between species (Nachtagall 1986; Herman 1990; Mass 1990). The environment influences the animals' visual development and visual appearance and determines the extent to which visual communication is used (Herman and Tavolga, 1980; Würsig et al., 1990). For instance, conveying messages via visual signals is very limited for dolphins living in turbid waters such as the Ganges and Indus river dolphins. River dolphins hence have uniform coloration and poor eyesight (Würsig et al., 1990). In contrast, the coloration pattern is often accentuated in oceanic species living in clear waters (e.g. striped and spotted dolphins, fin whales, minke whales) and vision is highly developed in such species (Madsen and Herman, 1980; Würsig et al., 1990; Arnold et al., 2005).

Visual cues can be transmitted by cetaceans through the water column using signals which are: (1) under their muscular control (active signals), or (2) via the morphology of the animals (passive signals) (Caldwell and Caldwell, 1977). Active signals are displays such as *gapes* in dolphins (Caldwell and Caldwell, 1967a; Overstrom, 1983; Östman, 1991) or *gulps* in baleen whales (Baker and Herman, 1984; Silber, 1986; Tyack and Whitehead, 1983). Active signals may include more complex sequences of behaviours which facilitate movement coordination or convey information about reproductive motivation such as *belly presentations* or *courtship* displays (Dudzinski, 1998; Herman and Tavolga, 1980; Pryor, 1990; Würsig et al., 1990). Passive signals are messages expressed by body coloration, shapes and sizes as well as scarring patterns (Perrin 1970; Madsen and Herman 1980; Felleman et al. 1990). Passive signals have the potential to provide information about age, gender, status and species (Pryor, 1990; Pryor and Kang-Shallenberger, 1991).

For many cetaceans, vision also plays an important role in gathering information and reacting to stimuli from their abiotic environment (Madsen and Herman, 1980). For instance, using behaviours such as spyhopping (raising their heads until their eyes are above the water surface) allows the animals to position themselves relative to the land (e.g. migrating whales; Cummings et al., 1971; Herman and Forestell, 1977; Pike, 1962) or to inspect the water surface features (e.g. ice floats) for prey (e.g. orcas; Norman and Fraser, 1949). Vision is also used by cetaceans to investigate unfamiliar objects such as vessels and swimmers (e.g. Gray, humpback, minke whales; Madsen and Herman 1980; Dahlheim et al. 1981; Jones et al. 1984; Roden and Mullin 2000). Both odontocetes (e.g. dolphins, pilot whales) and baleen whales (e.g. humpbacks) have been observed looking directly at swimmers or divers. The eyes of the animal fixate on the human as the animal glides by (Madsen and Herman, 1980; Pryor, 1990; Scheer et al., 2004).

Frequent close and prolonged interactions with dive tourism vessels and their swimmers have been reported for dwarf minke whales, during their annual winter aggregation in the northern Great Barrier Reef (Arnold 1997; Birtles et al. 2002). This region is believed to serve as breeding ground for this species (Birtles et al., 2002a). Dwarf minke whales are a predominantly solitary and oceanic species (Connor, 2000), hence communicative mechanisms may be crucial to coordinate and facilitate aggregations. Among the baleen whales, dwarf minkes have the most complex coloration pattern (Arnold et al., 2005). Accentuated coloration patterns and living in clear oceanic waters are correlated with excellent visual capabilities in cetaceans

(Würsig et al., 1990). Visual communication may therefore be a key pathway to convey information between dwarf minke whales.

The prolonged and close interactions between dwarf minke whales and tourist vessels and swimmers provide a great opportunity to gain a better understanding of the whales' behaviours in this context. These extended temporal observations may also offer detailed information about their social life and potentially enable the identification of any adverse behaviour by the whales in response to humans. The main objective of this study was to establish a detailed repertoire of the non-acoustic behaviours of dwarf minke whales around tourism vessels and their swimmers, as a basis for further studies of their behaviour.

## 3.2 METHODS

### 3.2.1 Partial ethogram

The partial ethogram was developed using three independent but complementary methodologies: (1) analysis of video sequences, (2) direct observations (detailed in Chapter 2), and (3) using existing behavioural descriptions (Birtles et al., 2001b; Birtles and Arnold, 2002). The video sequences from 2003 - 2008 were made available by a colleague (S. Sobtzick) who filmed dwarf minke whales, primarily for identification purposes and videogrammetry. These video sequences were scanned for behavioural sequences later in the laboratory. To follow the correct procedure for establishing an ethogram, I used behavioural events as the method of data collection (Hinde, 1966; Lehner, 1996; Mann et al., 2000b). Occurrence of dwarf minke whale behaviours Data on the occurrences of dwarf minke behaviours were collected using an *ad libitum* sampling protocol (Altmann, 1974). With this sampling protocol (i.e. *ad libitum* –

recording everything) there is a potential for false negatives, as the observations are limited to the field of view of the researcher and the attention (of the observer) may be drawn to the most obvious behaviour displays, missing more inconspicuous behaviours and resulting in inaccurate true frequencies. I therefore conducted the analysis on the level of encounters, i.e. presence/absence of the behaviours in an encounter. Frequencies were established for 13 dwarf minke whale behaviours (see Table 3.4). The selection was based on my ability to observe and identify the behaviour from the top deck of the vessels. A few selected underwater behaviours were included (*belly presentation, bubble release)* as well as some that occurred both on the surface and/or underwater (*close approach (>1-3m), very close approach (≤ 1m), gape/gulp*, *tactile behaviour*). The presence of underwater behaviours was established or confirmed by debriefing my colleagues (R.A. Birtles & S. Sobtzick) after each in-water interaction, or later from the video analyses. All but two behaviours (*breach*, *lunge*) were recorded from whales directly associated with the vessel and swimmers. *Breaching* and *lunging* whales are visually obvious from a distance of up to a nautical mile (1.8km).

The selected behaviours were classified and ranked according to their probability of occurrence in interactions or encounters (number of interactions / encounters with behaviour present divided by the total number of interactions / encounters (2006-2008)) (Table 3.1).

Table 3.1 Categorisation of the probability of the occurrence of dwarf minke whale behaviours

| [1]Occurrence probability (%) | 0 – 10 | >10 – 20 | >20 - 40 | >40 |
|---|---|---|---|---|
| Category | Rare | Occasional | Frequent | Very frequent |

[1] presence/absence per encounter

The location of the vessel, wind speed (knots), sea state (Beaufort) and boat status (stationary, drifting) were recorded every hour. The total number of whales in an in-water interaction and the presence of resighted whales (whales in subsequent interactions) was established and confirmed in collaboration with S. Sobtzick and R.A. Birtles who were conducting a parallel photo ID study on the whales.

### 3.2.3 Context of behavioural occurrences and associations of behaviours

A Generalised Linear Model (binomial distribution, logit function) was used to investigate potential factors (predictors) influencing the occurrence of dwarf minke whale behaviours (response). To ensure an adequate sample, only behaviours with an occurrence probability of >20% (occasional and above) were included in the analysis (see Table 3). Potential influencing factors were: (1) 'Boat status' (drifting, stationary), (2) 'Resights' (presence, absence), (3) Whale group size (1-3, 4-6, >6 animals), (4) Weather conditions (calm = 0-10 knots, medium = 11-20 knots, rough = >20 knots of wind) and (5) Time in season (beginning, middle, end). 'Dummy variables' (k-1) were constructed for ordinal variables with more than two levels (see: Agresti, 1990; Zar, 1999). These variables were coded as: 'Animal group size A' (4-6 & others), 'Animal group size B' (>6 & others), 'Weather A' (calm & others), 'Weather B' (medium & others) and 'Time in Season A' (beginning & others) and 'Time in Season B' (middle & others). The predictor variables with the highest AIC score (see Appendix 2) were used to build the Generalized Linear Model. The analysis was conducted at a significance level of $\alpha \leq 0.05$.

The occurrences of each of the five behaviours (responses) were tested against each other using a Generalized Linear Model, to establish if the occurrence of one behaviour influenced the occurrence of another ($\alpha$-level $P = 0.01$; Bonferroni adjustment). Both models were checked for data over-dispersion with four Goodness-of-Fit tests (Deviance, Scaled deviance, Pearson $Chi^2$, Scaled Pearson $Chi^2$). All analyses were conducted using the statistical program STATISTICA 8.0.

### 3.2.4 Limitations

There are two limitations to this study: (1) the established ethogram of dwarf minke whales represents only behaviours from whales interacting with tourism vessels in the northern Great Barrier Reef. These whales may display modified behaviour due to vessel and swimmer presence, which may differ from their natural behaviour. There are no records of the behaviour of dwarf minke whales when they are not interacting with vessels, thus this repertoire represents a partial ethogram only. (2) Data on the occurrences of dwarf minke behaviours were collected using an *ad libitum* sampling method (Altmann, 1974). With this sampling method (i.e. *ad libitum* – recording everything) there is a potential for false negatives, as the observations are limited to the field of view of the researcher and the attention (of the observer) may be drawn to the most obvious behaviour displays, missing more inconspicuous behaviours and resulting in inaccurate true frequencies. (3) Some behaviours (e.g. belly presentation) may be directed to conspecifics, an object or a swimmer on the rope. Establishing the relative frequency with which any of these behaviours were directed to any specific category is extremely difficult to determine without an experiment in a controlled environment. Thus in this field based study, there have been no attempts made to distinguish between these specific categories.

## 3.3 RESULTS

### 3.3.1 General

I spent a total of 118 days at sea during the three research periods (June/July 2006-2008). Dwarf minke whales were encountered on 209 occasions and 101 of these encounters became in-water interactions (Table 3.2). Behavioural observations were made during 280 hours of in-water interactions. Whales most often approached vessels when they were stationary, moored at a reef (n=72). On 29 occasions whales also approached while vessels were steaming and the boats subsequently drifted with the whales. The mean ($X$ ± SE) overall interaction was 171.1 ± 11.43 minutes time (n=101; 2006-2008) with an average ($X$ ± SE) of 6.4 ± 0.48 whales (see Table 3.2). The extended contact with dwarf minke whales facilitated the observations of their behaviour among conspecifics and around swimmers.

Table 3.2 Dwarf minke whale encounters and in-water interactions observed during the research period (June/July) from 2006 – 2008

| Year | Days at sea | Total encounters | # In-water interactions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | N | Length (minutes) | | # Whales | | Boat status | |
| | | | | Mean | SE* | Mean | SE* | S[1] | D[2] |
| 2006 | 40 | 68 | 29 | 160.8 | 18.48 | 6.1 | 0.89 | 24 | 5 |
| 2007 | 39 | 68 | 36 | 160.1 | 19.03 | 6.4 | 0.82 | 26 | 10 |
| 2008 | 39 | 73 | 36 | 190.3 | 21.18 | 6.5 | 0.82 | 22 | 14 |
| **TOTAL** | **118** | **209** | **101** | **171.1** | **11.43** | **6.4** | **0.48** | **72** | **29** |

[1] S = Stationary; [2] D = Drifting; * Standard Error

### 3.3.2 Partial ethogram of interacting dwarf minke whales

A total of 35 distinctive behaviours were identified during the research period. The partial ethogram consists of 12 surface behaviours (S), 18 underwater behaviours (UW) and five behaviours which can occur at the surface and underwater. Among the behaviours documented several have been classified as agonistic and/or aggressive (*) or indicative of disturbance (**) in other cetaceans (see Table 3.3).

Table 3.3 Descriptions of dwarf minke whale behaviours observed during the research period in June/July 2006-2008 (*S = surface behaviour, UW = underwater behaviour; * = behaviours documented in other cetacean species as agonistic displays or aggressive, ** = behaviours potentially indicating disturbance*)

| **Behaviour** | **Description** |
|---|---|
| **Respiration and behaviours associated with breathing** | |
| *Breathing* (S) | Surface exhalation; exhalation may be audible depending on the distance and/or visible with a small (approx. one metre high) cone of mist, if the whale exhales rapidly. Rapid exhalations occur more often in rough sea conditions |
| *Subsurface exhalation* (UW) | The exhalation of air immediately followed (within two seconds) by the whale breaking the surface to breathe. The released air may form a stream or a cloud of bubbles, depending how fast the whale travels and how rapidly the air is released. |
| *Slow roll* (S) | Whale breaks the surface at a shallow angle (<45°) with a low arched body. Whale sequentially exposes the upper parts of its rostrum, the blowholes and its dorsal fin in a slow rolling motion. Tail stalk and fluke stay submerged. |
| *High arch* (S) | Whale breaks the surface at a >45° angle in a slow to moderately fast forward movement with a high arched body. Whale sequentially exposes its snout, rostral saddle, blowholes, dorsal fin and tail stalk. Fluke stays submerged. Behaviour occurs more often in moderate to rough seas. |
| **Locomotion / swims** | |
| *Glide* (UW) | Whale gives a few strokes of the tail stalk (low amplitude), then glides until the next ‘startup’ position. |
| *Pass* (UW) | Whale glides through water column passing other whale(s), swimmers, the boat or other objects (e.g. dinghy, buoys) at different speeds. |

| | |
|---|---|
| *Motorboating* (S) | A near horizontal whale breaks the water surface maintaining snout and the upper part of the head just above the water surface while the whale slowly moves forward. The head may bob up and down a little due to the slow propulsion. The whale usually takes a breath just before submerging. |
| *Surf* (UW, S) | Whale uses the swell as a means of locomotion, arching its back to utilise the energy of the wave/swell. |
| *Zoom* (UW) | A surfing whale which rapidly accelerates moving underneath the surface at high speed. |
| **Lateral Rolls and Loops** | |
| *Belly presentation* (UW) | A moving whale turns onto its side presenting its bright white belly to an object, swimmer or another whale. This lateral position is often maintained for some seconds and the behaviour is often repeated. |
| *Lateral roll 180* (UW) | Whale turns laterally onto its back (belly up) while moving forward, then turns back in opposite direction. |
| *Lateral roll 360* (UW) | Whale revolves its body laterally 360° while swimming forward. Similar to corkscrew in some cetaceans. |
| *Loop* (UW) | Whale swims a full backwards or forwards loop. |
| **Vertical or near vertical behaviour** | |
| *Head rise* (S) | Whale ascends vertically or near vertically breaking the water surface with its snout. Eyes stay submerged. |
| *Spyhop* (S) | Whale ascends vertically or near vertically breaking the water surface with its snout, raising its eyes above the water surface. |
| *Loll* (S) | Whale in a vertical or near vertical position with its snout elevated above the surface (*headrise / spyhop*), falls slightly to the side then brings itself back into a vertical position. |

| | |
|---|---|
| *Submerged tail stand* (UW) | Whale almost stationary (may be slowly ascending or descending) in a vertical or near vertical submerged position. The whale may fight its negative buoyancy by slowly kicking its tail. Pectoral fins are used to stabilise body in a vertical position. |
| *Pirouette* (UW) | Whale remains vertical or near vertical (usually submerged) in the water and starts to revolve on the spot. The rotation is aided by slowly kicking its tail together with wiggling movements of its body. The pectoral fins are used to stabilise its body in the vertical position. |
| ***Bubble releases** | |
| *Bubble trickle* (UW) | Whale releases trickles of bubbles from its blowholes. |
| **Bubble trail* (UW) | Whale releases a trail of bubbles while moving forward. Bubbles look like a screen or a curtain when passing upwards through the water column. |
| **Bubble blast* (UW) | Whale (>1m from the surface) abruptly releases a large amount of air forming a cloud of bubbles. Whale stays submerged and the behaviour is not immediately (within two seconds) followed by breathing. |
| **Aerial behaviour** | |
| **Breach* (S) | Whale propels its body rapidly out of the water often creating a large splash when it falls back onto the water surface. The tail usually remains in the water and the whale often lands on its back. Visible from distances of 1-2 km. May be a single *breach* or multiple *breaches*. One or (rarely) more whales may be involved. |
| *Half breach* (S) | Whale propels half or less than half its body out of the water creating a splash when it falls back onto the water surface. |
| *Lunge* (S) | Whale travels at high speed porpoising (one or more times) out of the water. Anecdotal reports of the industry indicate a speed of over 20 knots (36 km/h). One or more whales may be involved. |

| | |
|---|---|
| *Aerial lunge* (S) | Whale jumps out of the water with its whole body and re-enters the water snout first. The trajectory forms a parabolic curve. |
| ****Abrupt change of speed** | |
| ***Sudden speed up* (UW) | Whale suddenly accelerates by kicking its tail, leaving the immediate area at increased speed. Most often observed in response to conspecifics or other animals (e.g. sea snakes) |
| ***Sharp veer* (UW) | Whale in forward motion suddenly changes direction or angle of travel, sharply turning away (in a lateral position) from something. |
| ***Sudden deep dive* (UW) | Whale suddenly descends. |
| **Gapes, Gulps and Jaw claps** | |
| **Gape* (S, UW) | Whale opens its jaws exposing its baleen plates and oral cavity. This behaviour can be displayed on the surface (e.g in combination with a *spyhop/headrise*) or underwater and can range from the whale flashing its baleen to fully opening its mouth. |
| **Gulp* (UW) | Whale opens jaws and partly or fully inflates its throat pouch. The whale appears in total control of how much water is entering its oral cavity and to what degree the throat pouch is extended. |
| **Jaw clap* (S) | Whale opens its mouth above the surface and its jaws are brought together with a loud crack. |
| **Approach behaviour** | |
| *Close approach (>1- 3m )* (S, UW) | Any approach by a dwarf minke between one and three metres to either a swimmer or an object (e.g. boat, buoy). |
| *Very close approach (≤ 1m)* (S, UW) | Any approach by a whale equal to or less than one metre to either a swimmer or an object (i.e. boat, dinghy, buoy). |
| **Physical contact** | |
| *Touch* (S, UW) | Whale deliberately or accidentally touches an object with a body part |

Figure 3.1: Sequence showing a *belly presentation* by a dwarf minke whale

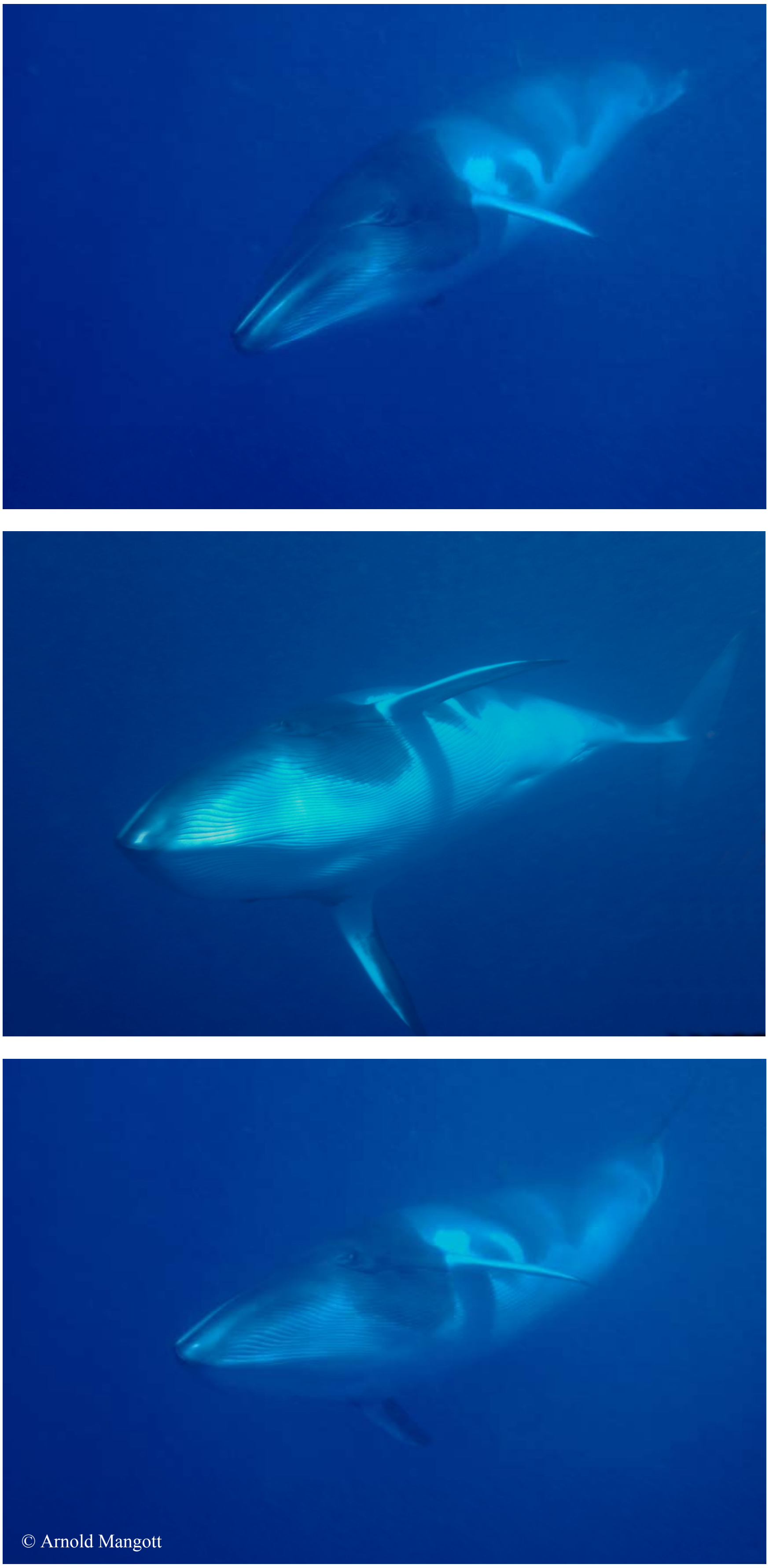


Figure 3.2: *Bubble releases* of dwarf minke whales

a) *bubble trail*



b) *bubble blast*

Figure 3.3: *Headrises* of dwarf minke whales

Figure 3.4: Sequence of a dwarf minke whale *pirouetting*

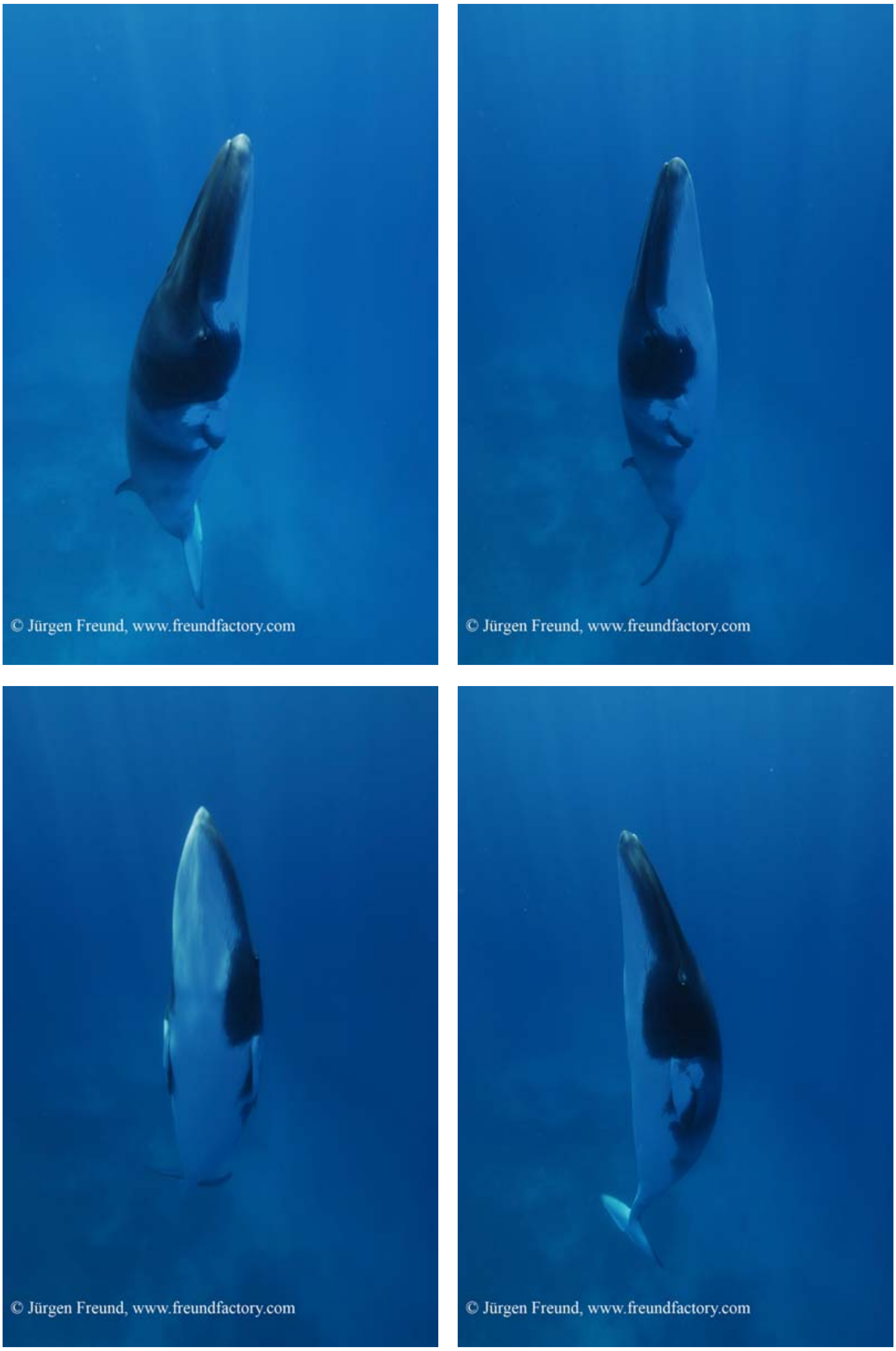


Figure 3.5: *Breaching* dwarf minke whales

Figure 3.6: *Close (>1-3m) and very close approaches (≤1m)* by dwarf minke whales



Figure 3.7: *Lunging* dwarf minke whale *(note the different positioning of the whale, i.e. dorso-ventral orientation (first picture) which is usually observed versus the lateral orientation (last picture) which is a rarely observed variation*

Figure 3.8: *Gulping/gaping* dwarf minke whales

a) gape on the surface


b) gulp

### 3.3.3 Behavioural occurrences in in-water interactions / encounters

I established probabilities of occurrence of 13 dwarf minke whale behaviours (presence – absence in in-water interactions / encounters). *Belly presentations* were of very frequent occurrence. Behaviours such as a c*lose approaches (>1-3m), headrises*, *motorboating* and *bubble releases* were frequent. *Breaches, very close approaches (≤1m)* and *physical contact* were classified as seen occasionally. Behaviours such as *gapes/gulps*, *lolls*, *spyhops*, *pirouettes*, and *lunges* were observed only rarely over the research period (Table 3.4).

Table 3.4 Occurrences of dwarf minke whale behaviours in in-water interactions during the research period in June/July 2006-2008

| Behaviour | Total observed in-water interactions | Interactions with behaviour | | |
|---|---|---|---|---|
| | | n | [1]Occurrence probability | Occurrence category |
| *Belly presentation* | 101 | 46 | 0.46 | very frequent |
| *Close approach (>1-3m)* | | 39 | 0.39 | frequent |
| *Headrise* | | 32 | 0.32 | |
| *Motorboating* | | 25 | 0.25 | |
| *Bubble releases* | | 22 | 0.22 | |
| [2]*Breach* | 209 | 42 | 0.20 | occasional |
| *Very close approach (≤1m)* | 101 | 20 | 0.20 | |
| *Physical contact* | | 18 | 0.18 | |
| *Gape / Gulp* | | 10 | 0.10 | rare |
| *Loll* | | 6 | 0.06 | |
| *Spyhop* | | 6 | 0.06 | |
| *Pirouette* | | 5 | 0.05 | |
| [2]*Lunge* | 209 | 4 | 0.02 | |

[1] Occurrence probability = Interactions where behaviour was present divided by total observed interactions;

[2] the occurrence probability of these behaviours is calculated using the total number of encounters (n=209) as whales displaying these behaviours were not necessarily associated with vessels and swimmers)

### 3.3.4 Potential factors influencing the occurrence of dwarf minke whale behaviour

Several factors influenced the occurrence of dwarf minke behaviours. *Bubble releases*, *close approaches* and *belly presentations* were influenced by whale group size, i.e. the larger the group the more likely the behaviour occurred. *Motorboating, close approaches* and *headrise* were influenced by the presence of resighted whales. The chances of seeing *close approaches* and *bubble releases* were significantly increased when the vessel was drifting (Table 3.5). Weather conditions and time in the season did not influence any of the five behaviours.

Table 3.5 Generalised linear model testing the likelihood of the occurrence of dwarf minke whale behaviours in in-water interactions.

| Behaviour | Effect | df | B | Exp (B) | SE | Wald Stat. | p |
|---|---|---|---|---|---|---|---|
| *Bubble release* | Whale group size (>6) | 1 | 2.699 | **14.865** | 0.655 | 16.999 | **<0.001** |
| | Boat status (drifting) | 1 | 1.023 | **2.782** | 0.323 | 10.045 | **0.002** |
| *Belly presentation* | Whale group size (>6) | 1 | 1.403 | **4.067** | 0.505 | 7.707 | **0.005** |
| *Close approach (>1-3m)* | Whale group size (>6) | 1 | 1.756 | **5.789** | 0.335 | 12.408 | **<0.001** |
| | Boat status (drifting) | 1 | 0.690 | **1.994** | 0.286 | 5.807 | **0.016** |
| | Resights (yes) | 1 | 0.754 | **2.125** | 0.281 | 7.173 | **0.007** |
| *Motorboating* | Resights (yes) | 1 | 0.975 | **2.651** | 0.292 | 11.196 | **0.001** |
| *Headrise* | Resight (yes) | 1 | 0.677 | **1.968** | 0.228 | 8.804 | **0.003** |

df = degrees of freedom; B = regression coefficient; Exp(B) = likelihood of occurrence; SE = Standard Error;

Wald Stat. = Statistic of test

### 3.3.5 Association of behavioural occurrences

The Generalised Linear Model (binomial distribution, logit function) indicated that some behaviours are associated with each other, i.e. are more likely to occur if another behaviour occurred (Table 3.6). The strongest associations were between: *bubble* *release* and *belly presentation, belly presentation* and *headrise;* and between *headrise* and *motorboating* and *motorboating* and *close approach (>1-3m).*

Table 3.6 Results of a Generalised Linear Model showing the likelihood (Exp(B)) of the presence of behaviours in an in-water interaction if a particular behaviour occurred (** $\alpha$ level ≤ 0.01; * $\alpha$ ≤ 0.05)

| | *Belly presentation* | *Close approach (>1-3m)* | *Headrise* | *Bubble release* | *Motorboating* |
|---|---|---|---|---|---|
| *Belly presentation* | | 1.07 | 4.84** | 8.60** | 2.31 |
| *Close approach (>1-3m)* | 1.07 | | 1.44 | 3.07* | 6.54** |
| *Headrise* | 4.84** | 1.44 | | 2.29 | 4.53** |
| *Bubble release* | 8.60** | 3.07* | 2.29 | | 0.26 |
| *Motorboating* | 2.31 | 6.54** | 4.53** | 0.26 | |

### 3.3.6 Breathing intervals of individual dwarf minke whales

I was able to conduct an individual focal follow protocol for a total of 12 individual whales and three cow-calf pairs during the three consecutive research periods. There was a high variation in Breathing Intervals within and between individuals with the mean ($X$ ± SE) ranging from 96 ± 24 to 264 ± 48s. Breathing Intervals of individual whales ranged from 10s to 748s. I observed a more stable Breathing Interval for the three cows and calves with a mean ($X$ ± SE) ranging from 132 ± 18 to 156 ± 30s for the cows and 24 ± 1.2 to 36 ± 3.6s for the calves (Figure 3.1).

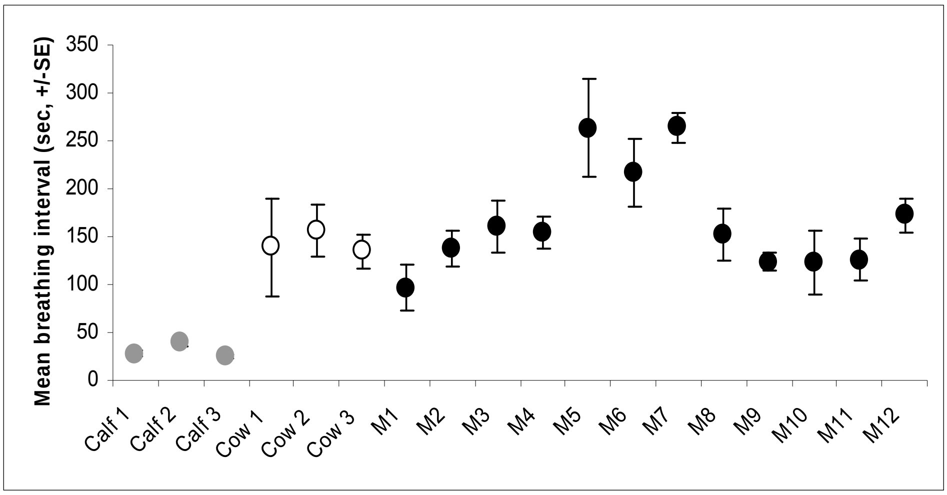



Figure 1.9 Mean breathing intervals (sec ± SE) of twelve individual dwarf minke whales and three cow-calf pairs recorded over the three consecutive research periods (2006-2008). (M = individual minke whale; gender unknown)

## 3.4 DISCUSSION

Dwarf minke whales associated with vessels and swimmers in the northern Great Barrier Reef display a wide variety of behaviours. The repertoire recorded consisted of 35 behaviours including 12 distinct surface behaviours, 18 underwater behaviours and five behaviours which may occur on the surface or underwater. The dwarf minke partial ethogram reported here, built upon previous work of Arnold and Birtles (Birtles et al., 2001b) and is the first of its kind for oceanic rorqual whales. The nature of interacting dwarf minkes, i.e. approaching vessels voluntarily and maintaining contact with them for prolonged periods (mean 2.8 hours), facilitated detailed observations and provided a unique opportunity to identify the potential functions of some behaviours.

### 3.4.1 Potential functions of dwarf minke behaviours during interactions with humans

The probability of a dwarf minke whale presenting its belly, releasing bubbles and/or approaching close (>1-3 metres) to a swimmer or another object (e.g. boat), was significantly increased in a dwarf minke whale social setting, i.e. if more than six whales were present in an in-water interaction. Potential social functions are attributed to *belly presentations* and *bubble releases* in other cetaceans (Otte, 1974; Caldwell and Caldwell, 1977; Madsen and Herman, 1980; Mobley and Helweg, 1990; Tyack, 2000) while *close approaches* are described to have investigative functions (Madsen and Herman, 1980).

#### *3.4.1.1 Belly presentations and bubble releases*

Both *belly presentations* and *bubble releases* have a distinct visual component with possible communicative functions (Madsen and Herman, 1980). *Belly presentations* by interacting dwarf minke whales occur frequently, and are often directed to conspecifics but also to the vessel and swimmers. A cetacean flashing its bright white belly may signal its position (Norris and Dohl, 1980) and/or indicate its movement intentions (Herman and Tavolga, 1980). Both signals may help to coordinate group movements (Norris and Dohl, 1980). Like many other baleen whales dwarf minke whales are predominantly solitary (Connor, 2000), thus movement coordination in aggregations may be of particular importance. *Belly presentations* are also interpreted as acts of courtship or sexual solicitation (Caldwell and Caldwell, 1977; Tyack, 2000) as the display of the ventral field reveals the configuration and positioning of the genitals in males and females (Madsen and Herman, 1980). As the northern Great Barrier Reef is thought to be a breeding ground for dwarf minke whales (Birtles et al., 2002a) it is possible that a *belly presentation* to conspecifics signals sexual intent.

It is unclear why dwarf minke whales present their belly to swimmers and/or vessels. One potential explanation is that the lateral positioning of the whale provides an additional form of binocularity. Several cetacean species are believed to use binocular vision (Caldwell and Caldwell, 1972b) predominantly for gazes in the forward and downward direction (Dral, 1972). Binocular vision is facilitated by a protractor-retractor muscle in the cetacean eye which can extend the field of view of both eyes (Yablokov et al., 1972). Binocularity enhances depth acuity (Fox, 1978) and improves accuracy for localising objects (Dawson, 1980). When dwarf minkes present their belly to swimmers, both eyes are often apparent and obviously protruded. The eyes appear to focus on the observer. Their accuracy of approaches to humans and movements among conspecifics and in close proximity to swimmers suggests that dwarf minke whales use binocular vision. Thus a *belly presentation* may also facilitate investigation in dwarf minke whales.

Another type of visual signalling used by cetaceans in a social setting is the release of bubbles (Madsen and Herman, 1980). Several potential functions have been suggested for bubble releases, ranging from inquisitiveness and surprise in bottlenose dolphins (Caldwell and Caldwell, 1977), displacement reactions in harbour porpoises (Amundin and Amundin, 1973) to male aggressive displays in spotted dolphins (Pryor and Kang-Shallenberger, 1991). In humpback whales, bubble releases indicate a whale's physical condition to its conspecifics and are used as a threat display or to screen challenging males from a female (Tyack and Whitehead, 1983; Baker and Herman, 1984; Clapham et al., 1992). Some cetaceans also use bubbles for play (Delfour and Aulagnier, 1997; McCowen et al., 2000) or as part of their feeding strategy

(Hain et al., 1982; Visser, 1999). In dwarf minke whales, the potential function of *bubble releases* is unclear, as this behaviour has been observed in many different contexts, including around the vessel and swimmers and with or without other whales in the vicinity. In none of these cases, has there been any sign of threat, fear or aggression and in no instances was there evidence of prey in the area.

#### *3.4.1.2 Close approaches (>1-3m)*

Close approaches by animals may be attributed to inquisitiveness and investigation (Berlyne, 1966; Hinde, 1966). The likelihood of a *close approach (>1-3m)* to a swimmer or an object, such as the boat by a dwarf minke was increased by two factors: (1) a large whale group size and (2) the presence of whales familiar with the vessel (resights). The positive influence of both factors on close approaches to observers is well supported in the literature. Safety in numbers is a common principle in the animal kingdom (Alexander, 1974; Wrangham, 1980; Van Schaik, 1983; Norris and Schilt, 1988; Connor, 2000). Forming groups has several benefits including better protection from predators through increased group alertness (Alexander, 1974) as well as the dilution effect, i.e. the decreased likelihood of any one individual being taken (Connor, 2000). Feeling safer in a group may also enhance the confidence of individuals towards a foreign stimulus, as observed in great apes including bonobos and chimpanzees (Van Krunkelsven et al., 1999b; Morgan and Sanz, 2003) and cetaceans such as common dolphins (Neumann and Orams, 2005). Dwarf minkes in a larger group therefore may be less threatened by the presence of a vessel and their swimmers and elicit close approaches.

Increased inquisitiveness (approaching closer) has also been recognised in animals which became familiar with a foreign stimulus (Berlyne, 1966). Well described examples come from gorillas and chimpanzees where animals gradually habituate to human observers and change their initial responses from flight to tolerance and even investigation (Van Krunkelsven et al., 1999b; Werdenich et al., 2003; Blom et al., 2004). The increased confidence of habituated animals also seems to influence their conspecifics. Wild chimpanzees for example approach observers more often and closer when habituated animals are present (Bertolani and Boesch, 2008). Feeling safer among a larger group and more confident around vessels and swimmers may facilitate *close approaches (>1-3m)* by dwarf minke whales.

#### *3.4.1.3 Motorboating and headrise*

The presence of resighted dwarf minkes also significantly increased the likelihood of *motorboating* and *headrises*. Both behaviours are probably investigative in function as they have been observed in close proximity to vessels and swimmers. In addition, my findings indicate that *motorboating* and *headrises* tend to co-occur, suggesting that both behaviours may have a similar function. Indeed, *motorboating* often occurs after a *headrise*. The whale first rises nearly vertically into a *headrise* then proceeds into a horizontal position on the surface (*motorboating*). In both behaviours the eyes of the whale can be seen moving in the socket supporting the investigative function of the behaviours.

Neither *motorboating* nor *headrises* are well described in the cetacean literature; *spyhops* however seem to occur frequently. A *spyhop* is similar in its movement to a *headrise*; however the eyes of the whale are above water rather than submerged. *Spyhops* have been observed in many cetaceans including Gray whales (Pike, 1962; Jones et al., 1984), southern right whales (Cummings et al., 1971), humpback whales (Herman and Forestell, 1977), pilot whales (Hofmann et al., 2004; Scheer et al., 2004), sperm whales (Norris, 1974) and orcas (MacAskie, 1966). In all cases, *spyhops* were thought to be associated with visual investigation and/or orientation. Interacting dwarf minke whales display *headrises* more frequently than *spyhops*. This difference is not surprising. The objects being investigated by dwarf minkes are mainly in the water (snorkellers/swimmers) not above. *Headrises* may also function as a display in a social setting (Madsen and Herman, 1980). *Headrises* by dwarf minke whales tend to be associated with potential social behaviours such as *belly presentations* (directly) and *bubble releases* (indirectly).

### 3.4.2 Potential agonistic, aggressive and disturbance behaviours of dwarf minke whales

Six of the 35 described behaviours exhibited by interacting dwarf minke whales, are considered agonistic, aggressive or indicative of disturbance in other cetaceans. Potential agonistic or aggressive displays included: (1) *gape/gulps*, (2) *jaw claps*, (3) *bubble releases* and disturbance behaviours included: (1*) sudden speed up*, (2) *sharp veer aways* and (3) *sudden deep dives*.

#### *3.4.2.1 Potential agonistic and/or aggressive displays*

In cetaceans aggressive visual signals follow patterns that are common among other mammals, including opening the mouth or making threats that resemble biting actions (Overstrom, 1983; Samuels and Gifford, 1997). Open mouth threats (*gapes*) and *jaw claps* are displayed commonly in bottlenose dolphins (Caldwell and Caldwell, 1967b; Overstrom, 1983; Herzing, 1988; Östman, 1991), Atlantic spotted dolphins (Wood, 1953; Herzing, 1996) and pantropical spotted dolphins (Pryor and Kang-Shallenberger, 1991). Apart from the *head lunge,* the most frequently observed agonistic behaviour in humpback whales is the *gulp* (Baker and Herman, 1984). The inflation of the ventral pouch (*gulp*) serves to create the impression of larger size which may intimidate challenging conspecific competitors (Tyack and Whitehead, 1983; Silber, 1986).

Dwarf minke whales were observed to display four potentially agonistic behaviours, *bubble releases, gapes*, *gulps,* and *jaw claps* in interactions with humans. Apart from *bubble releases* (frequent), these behaviours were rare (see Table 3.4). Moreover, if these behaviours occurred they were displayed only once and none were followed by any increased level of aggression, either between conspecific whales or towards swimmers. The rare occurrence of potential agonistic behaviours in interacting dwarf minke whales may be explained by the theory that threat/dominance displays and defence actions are unlikely to occur in a fission-fusion society, with a lack of home range and with a large number of conspecifics, which associate in an unpredictable manner (Whitehead, 2003). Nevertheless, in other baleen whales (e.g. humpback whales, southern right whales; Tyack and Whitehead, 1983; Silber, 1986; Baker and Hermann, 1984) aggressive and competitive interactions are common, thus it may be that agonistic displays in dwarf minke whales are either very subtle and therefore not recognised, or such displays have not been shown in the vicinity of the observer.

#### *3.4.2.2 Avoidance and disturbance behaviours*

Several cetacean species often exhibit avoidance and disturbance behaviours, especially odontocetes associated with human activity such as vessel based or in-water cetacean viewing (Kruse, 1991; Stone et al., 1992; Blane and Jaakson, 1994; Janik, 1996; Bejder et al., 1999; Nowacek et al., 2001; Williams et al., 2002b; Lusseau, 2003a; Richter et al., 2003; Scheidat et al., 2004; Ribeiro et al., 2005; Lemon et al., 2006). Nonetheless, the interactions of dwarf minkes with tourism vessels and swimmers are different from the interactions reported in these studies, for three reasons: (1) dwarf minke whales approach vessels voluntarily and there is no need for operators to pursue the whales, (2) the interactions do not pose any movement restrictions on the whales (most encounters occur when the vessels are moored on a reef with deep water accessible at least for 180º), (3) operators are obliged to follow a Code of Practice including the use of ropes for swimmers to hold onto, which limits swimmers from moving towards an individual whale. Also, active avoidance of vessels by dwarf minke whales (e.g. altered path or speed of travel, increased breathing interval) as reported for other cetaceans is not apparent.

Dwarf minke whales also exhibited behaviours indicative of disturbance including *sudden speed ups*, *sharp veers* and *sudden deep dives.* Nonetheless, these behaviours were rarely seen as a reaction to swimmers or the vessel supporting previous observations of Birtles and Arnold (2001b). *Speed ups*, *veers* and *deep dives* were most often observed in response to conspecifics or other animals, such as sea snakes. In all instances, the disturbance reactions were short-lived (e.g. startle response followed by gliding) and the whales stayed in the close vicinity of the vessel. Avoidance and disturbance behaviours in response to human contact are documented to negatively influence the energy budget of cetaceans (e.g. Kruse, 1991; Scheidat et al., 2004). The fact that dwarf minke whales interact with vessels and swimmers for nearly three hours on average suggests that there is at least some additional energetic demand for the whales involved.

#### *3.4.2.3 Potential additional energetic demands on dwarf minke whales*

As for other baleen whales, unexpected energy demands such as the prolonged interactions with vessels and swimmers may have detrimental effects on the fitness of dwarf minke whales. Baleen whales, with the exception of Bryde's whales do not usually feed in their wintering grounds relying on stored energy reserves throughout this period (Corkeron and Connor, 1999; Clapham, 2000). The most sensitive indicator of increased energy consumption is a change in the respiration rate of an animal (Baker and Herman, 1989).

The mean breathing intervals of interacting dwarf minkes were highly variable, both within and between individuals. The mean breathing interval of dwarf minkes was much longer than that reported from common minke whales (on average 60% longer).

Common minke whales off Central California are reported to breathe every 1.5 minutes while travelling at 4.5 knots (Stern, 1992). Minkes off Norway breathe every 1.2, 1.4 and 1.7 minutes while feeding, travelling or sleeping, respectively (Folkow and Blix, 1992; Blix and Folkow, 1995). The differences between the respiration rates of dwarf minke and common minke whales are most likely explained by the different behavioural states (interacting with humans vs. feeding). The temperature of the water may also influence the different breathing rates between common and dwarf minke whales. For whales, respiration increases with decreasing water temperature as more energy is needed to maintain homeostasis. Thus, a direct comparison between dwarf minkes in the Great Barrier Reef (water temperature 24 C) and common minke whales (water temperature 5-12 C) may not be valid. Nonetheless, the longer breathing intervals of dwarf minkes compared to even sleeping common minke whales suggest that these whales are not overly stressed when interacting with vessels and swimmers. Baseline data on the energetics of dwarf minkes however are non-existent. More data are needed to substantiate assumptions whether or not interactions with tourism vessels draw on the energy budget of dwarf minkes.

### 3.4.3 Chapter summary

- Dwarf minke whales in the northern Great Barrier Reef demonstrate a variety of non-acoustic behaviours during interactions.
- This classification of the non-acoustic behaviours of dwarf minkes is the first of its kind for oceanic rorqual whales.
- Potential social functions were attributed for *belly presentations* and *bubble releases*
- Likely investigative functions were attributed for *close* and *very close approaches*, *motorboating*, and *headrises.*
- Exploratory behaviours were positively influenced by the presence of whales familiar with vessels (resighted whales).

# CHAPTER 4

## WHO IS LOOKING AT WHOM? EXPLORATORY BEHAVIOUR OF DWARF MINKE WHALES DURING SWIM-WITH INTERACTIONS AND ASSOCIATED MANAGEMENT CHALLENGES

This Chapter investigates the behaviour of dwarf minke whales interacting with the Northern Great Barrier Reef swim-with whale tourism industry. I integrate two studies to: (1) provide information on the distribution of the whales around the vessel and the swimmers (2006-2007) and (2) quantify changes in the behaviour of the whales while associated with humans (2008). I collected most of the data for this Chapter, but I accessed and included data collected by Dr R.A. Birtles (some whale-swimmer distance measurements) to supplement and strengthen the analyses.

## 4.1 INTRODUCTION

The nature of human-wildlife encounters differs according to the behavioural responses of the targeted animal. The most common responses are to avoid, tolerate or approach unfamiliar stimuli such as human observers (Whittaker and Knight, 1998). Some species, such as the tiger (*Panthera tigris*), the leopard (*Panthera pardus*) and the lynx (*Lynx lynx*), are very shy and generally avoid human contact (Sunde et al., 1998; Mohd and Dionysus, 2003; Ngoprasert et al., 2007). Other species tolerate human observers up to a threshold distance, after which a behavioural response is triggered. This response typically involves either fleeing the area, (e.g. masked boobies (*Sula dactylatra*), royal penguins (*Eudyptes schlegeli*), harp seals (*Phoca groenlandica*) and Asian rhinos (*Rhinoceros unicornis*)) (Kovacs and Innes, 1990; Burger and Gochfeld, 1993; Lott and McCoy, 1995; Holmes et al., 2005) or defensive, antagonistic behaviour (e.g. African elephants (*Loxodonta africana*) and elephant seals (*Mirounga angustirostris*)) (LeBoef and Panken, 1977; Burke, 2004). Occasionally, however, wildlife is attracted to observers (Knight and Temple, 1995), a behavioural response that is usually termed exploratory behaviour or curiosity.

Curiosity has been defined as a desire to know, to see or to experience something that leads to the acquisition of new information (Berlyne, 1966; Loewenstein, 1994; Collins et al., 2004; Litman and Jimerson, 2004). Like other desires (e.g. desire for food), curiosity is associated with approaching a stimulus and an experience of reward (Berlyne, 1966; Loewenstein, 1994). Exploratory behaviour, or curiosity has been described in animals as taxonomically diverse as bees (Lindauer, 1952), cephalopods (Hochner et al., 2006), fish (Compagno et al., 2005), birds (Hinde, 1954), rodents (Hill, 1958), primates (Morgan and Sanz, 2003) and cetaceans (Bejder and Dawson, 1998; Dahlheim et al., 1981; Herzing, 1999; Ritter, 2003).

The reasons why some species of wildlife interact with humans more than others may be a reflection and/or combination of several factors including social structure (Van Schaik, 1983; Norris and Schilt, 1988), behavioural state (Berlyne, 1960), life-history stage (Mason, 1971; Fairbanks, 1993) and previous experience with stimuli (Curry et al., 2001; Blom et al., 2004). These factors are likely to determine the nature of the interaction, including who is initiating the contact (humans or animals), how long an interaction lasts and how close humans can get to the targeted animal.

Most interactions between humans and free-ranging wildlife are initiated by humans. Repeated approaches are usually necessary to maintain contact with cetaceans (Barr and Slooten 1998; Bejder et al. 1999; Constantine 1999, 2001; Coscarella et al. 2003; Neumann and Orams 2005). Viewing duration varies between species and the nature of the interaction (swims or viewing from a vessel). Nonetheless encounters are generally short. Most swim-with cetacean experiences last for 3 - 14 minutes (Constantine and Baker, 1997; Constantine, 1999; Herzing, 1999; Constantine, 2001; Scheer et al., 2004; Neumann and Orams, 2005; Lundquist, 2007; Würsig et al., 2007). The mean interaction times of vessel-based viewing operations are typically longer, ranging from 33-71 minutes (Constantine and Baker, 1997; Bejder et al., 1999; Felix and Haase, 2001; Finkler and Higham, 2004).

When smaller cetaceans (e.g. delphinids) choose to approach vessels, they often do so in the form of bowriding (Norris and Prescott, 1961; Shane and Schmidly, 1978; Shane et al., 1982; Constantine and Baker, 1997; Ritter, 2003; Neumann and Orams, 2005). Generally such encounters are short (several minutes) and the animals quickly lose interest. For some (smaller) cetaceans approaching and initiating interactions with humans is not limited to riding the bow wave of a vessel but occasionally approach for a closer inspection when the boat is stationary (e.g. dolphins in the Bahamas & Azores;

Herzing, 1999; Ritter, 2003). Baleen whales including humpback whales (*Megaptera novaeangliae*) (Watkins, 1981), Bryde's whales (*Balaenoptera edeni*) (Donovan, 1982) and Gray whales (*Eschrichtius robustus*) (Jones et al., 1984) have been reported to approach vessels. In particular Gray whales in their breeding grounds (mainly mothers with their calf) are described as highly curious towards vessels (Dahlheim et al., 1981).

Wild animals frequently change their behaviour in response to continued human interactions. The extent of such behavioural change may depend on previous experiences and/or represent a gradual increase in familiarity with the stimulus, resulting in habituation (Hinde, 1966). Habituation is defined as the persistent waning of a response as a result of repeated stimulation that is not followed by any kind of reinforcement (Thorpe, 1963; Nisbet, 2000). Asian rhinoceros (*Rhinoceros unicornis*) in the Chitwan National Park, for example, express different threshold distances depending on their degree of habituation to human observers (Lott and McCoy, 1995; Curry et al., 2001). On average, non-habituated rhinos depart once humans come closer than 50 m, while habituated rhinos tolerate approaches half that distance (Curry et al., 2001). Habituation in response to humans is often seen as a negative outcome for wildlife. The reduction of their natural fear towards human activity can increase animals' vulnerability to disease transmission (Woodford et al., 2002), hunting (Aveling and Aveling, 1989; McNeilage, 1996), vandalism (Samuels and Bejder, 2004), entanglement and ship strikes (Stone and Yoshinaga, 2000; Spradlin et al., 2001).

As explained in Chapter 2, a small, vessel-based tourism industry conducting swims with dwarf minke whales has developed in the Great Barrier Reef World Heritage Area (GBRWHA) over the past 15 years. The whales make repeated approaches to vessels and humans in the water (including divers operating hundreds of metres from the nearest vessel; personal observation) and maintain contact for up to nine hours (2.8 hours on average; see Table 3.2). The behaviour of dwarf minke whales when they are interacting with tourism vessels is not understood in any detail. Very little is known about how close dwarf minke whales remain to vessels and their swimmers in interactions. It is also unclear if the behaviour of individual dwarf minke whales changes in response to repeated exposure to humans. Virtually nothing is known about how within-species factors, such as whale group size influence individual whale behaviour during encounters with humans. Such knowledge would provide valuable insight into behavioural processes of these whales and would facilitate the successful management of the swim-with whale tourism industry.

The aims of this chapter are: (1) to better understand the distribution of dwarf minkes around vessels and swimmers, (2) to investigate if dwarf minke whales change their behaviour in interactions with humans over time, (3) to identify factors which influence the behavioural changes, (4) to examine how much familiarity with the stimulus contribute to those changes, and (5) to identify any management issues associated with the behaviour of dwarf minke whales.

## 4.2 MATERIALS AND METHODS

### 4.2.1 Whale Sighting Sheets 2006-2007

I used the Whale Sighting Sheets (see Chapter 2 for more details) from 2006 and 2007 to gain an overview of: (1) the total number of dwarf minke whale encounters of the endorsed industry, (2) how many interactions the industry had with dwarf minke whales, and (3) whether the interactions occurred when the vessel was stationary or drifting (boat status).

### 4.2.2 Ad libitum sampling protocol (2006)

I used an *ad libitum* sampling protocol (Altmann, 1974) to document dwarf minke whale behaviour during all in-water interactions in 2006. I recorded the time, distance from the vessel and the sector (based on an imaginary clock face, Figure 4.1) every time the whale(s) broke the surface. Distances of surfacing whales from the vessel were measured with a laser range finder (Leupold Wind River RB800C) or estimated to the nearest five metres.

### 4.2.3 Adaptive scan sampling protocol (2007)

After reviewing my data for 2006, I used an adaptive scan sampling protocol in 2007 to reduce the risk of collecting spatially biased data. Three observation areas defined by distance from the vessel were assigned: (1) '*Inner Area*' (0–60 metres), (2) '*Middle Area*' (61-120 metres) and (3) '*Outer Area*' (121–180 metres). Each area was divided in half (i.e. Areas A & B; see Figure 4.1) for observational purposes. The six sub-areas (e.g. *Inner Area A*, *Outer Area B*) were sampled in a random sequence for set periods of time (five minutes for *Inner Areas* and 1 minutes for each of the *Middle* and *Outer Areas*) followed by a one minute break. For each observation of a whale in the assigned sub-area, I recorded the time, the distance to the vessel and the location (sector) every time a whale broke the water surface. The location (sector) of the ropes was recorded at the start of each area observation. I followed this protocol for the duration of each in-water interaction.

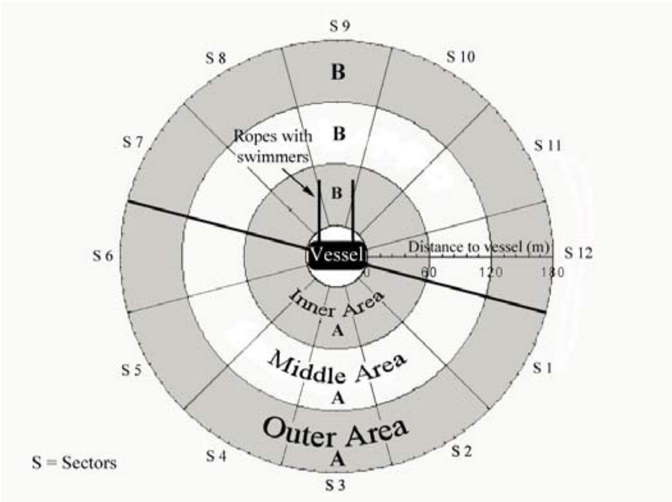



Figure 4.1 Assigned areas (defined by distance from vessel: *Inner Area A & B* (0-60 metres); *Middle Area A & B* (61-120 metres) and *Outer Area A & B* (121-180 metres)) and sectors (based on an imaginary clock face) used for data collection on the distribution of interacting dwarf minke whales around the vessel and swimmers.

### 4.2.4 Distance measurements of whale passes from the researcher (2008)

Data from 2006 and 2007 showed that most whales surfaced close to the vessel and in particular aggregated around the rope with swimmers. To investigate this pattern further I changed my sampling protocol from the previous two years to establish: (1) the actual passing distances of individual whales to swimmers, and (2) if individual whale passing distances to swimmers changed over time. I measured the distance of each passing whale from my position at the end of one of two 50 metres ropes that were deployed from the vessel. Swimmers hold onto these ropes to control their interactions with the whales as required by the Code of Practice (Birtles et al., 2008). I measured distance (metres) with a hand held sonar (Hondex, PS-7 (200 KHz), LCD digital sounder) and photographed both the whale and its passing distance (LCD reading) using a Canon G7 with underwater housing or recorded the distance on an underwater slate. Whales could approach from any direction in the three dimensional environment. To accommodate for individual differences in their approach paths, I changed my direction of observation every ten minutes. Because of the difficulties of both: (1) identifying individual whales and (2) getting a reading on the sonar at greater distances, I measured and photographed only whales which came within a visual range of approximately 20 metres. I identified all whales for which passing distances were obtained by their individual coloration patterns (Arnold et al., 2005). These identifications were confirmed with help from a parallel photo-ID PhD study conducted by Susan Sobtzick (Sobtzick, in prep). To strengthen the analysis I accessed and included whale-swimmer distances collected by Dr R.A. Birtles.

### 4.2.5 Data analyses

#### *4.2.5.1 Distribution of dwarf minke whales around vessels and swimmers*

I analysed the data from the 2007 adaptive scan sampling protocol as follows: (1) I conducted a Chi-square test of independence ($\alpha = p \leq 0.05$) to test if: (a) boat status (drifting or stationary) and (b) weather conditions influenced the distribution of dwarf minke whales around the vessel. To investigate the effect of weather conditions, I pooled data from interactions as follows: (a) '0-10 knots', (b) '11-20 knots' and (c) '>20 knots' of wind. Wind speed was estimated to the nearest five knots and regularly confirmed with experienced crew members on board. (2) I conducted Chi-square goodness-of-fit tests ($\alpha = p \leq 0.05$) to determine if the observed frequencies in the assigned areas deviated from the expected frequencies. Expected frequencies were standardised per unit effort and per unit area.

I examined data from the area closest to the vessel (*Inner Area*) further. The position of the rope varied according to currents and wind direction, thus I standardised the data to the location of the rope and then pooled the data into four quarters: (1) ‘*Rope/Swimmer Quarter*’, (2) ‘*Left Quarter*’, (3) ‘*Right Quarter*’ and (4) ‘*Opposite Quarter*’. I used a Chi-square goodness-of-fit test to investigate if the observed frequencies deviated from expected frequencies assuming equal use of the four quarters. Test assumptions followed Roscoe and Byars (1971) and Zar (1999).

#### *4.2.5.3 Whale-researcher passing distances within interactions*

I examined whether individual whales came closer to me as the in-water interaction progressed and whether passing distance was affected by whale group size, boat status and/or weather conditions using a Repeated Measures ANOVA. I examined the passing distances of 20 identified whales (response; $n$ = 420 passes; 7 passes x 3 time intervals for each of 20 whales) in the first 90 minutes of each interaction, at three discrete time intervals: (1) ‘Beginning Interaction’ (0-30 minutes), (2) ‘Middle Interaction’ (31-60 minutes) and (3) ‘End Interaction’ (61-90 minutes). I randomly selected seven passing distances of each individual whale in each of the three time intervals (i.e. Beginning, Middle and End Interaction), to maintain a balanced design. The other independent variables (grouping predictor variables) were fixed factors: (a) whale group size (1-3, 4-6 and >6 whales), (b) boat status (drifting, stationary) and (c) wind speed (15, 20 knots; only these two wind speeds were recorded over the study period in 2008). I analysed differences in passing distance in response to the grouping predictor variables and behavioural-interaction time. I tested the assumption of compound symmetry using the Mauchley’s test of sphericity (Zar, 1999). The ANOVA design is summarised in Table 4.1

#### *4.2.5.4 Passing distance of individual dwarf minke whales in subsequent interactions*

I used a second Repeated Measures ANOVA to compare the passing distances of five individual whales involved in more than one interaction involving >6 animals (group size significantly influenced passing distance of individual whales). The 10 closest passing distances recorded in each individual whales' first interaction were compared to the 10 closest passing distances in their second interaction (Repeated Measure Factors). The data were taken from the first 60 minutes of the interactions ($n$ = 10). As whale group size influenced whale approach distance to swimmers, I included only data from interactions with more than six whales. I explored parametric assumptions using residual analysis, and I transformed the data (log10) to reduce heteroscedasticity (Zar, 1999).

#### *4.2.5.5 Passing distance of resighted dwarf minke whales*

I used a paired sign test to investigate if a resighted whale approaches closer than a randomly chosen unknown whale in the same interaction. As whale group size influenced whale approach distance to swimmers, I used only data from interactions with more than six whales ($n$ = 9). Within each of the nine encounters I took the mean of the ten closest passing distances of a resighted whale and compared it to the mean of the ten closest passing distances of an unknown individual whale.

#### *4.2.5.6 Limitations*

This study only investigated within interaction and within season behavioural changes of identified dwarf minke whales. No attempt was made to distinguish between whales resighted within the season and whales resighted between years.

## 4.3 Results

### 4.3.1 Distribution of dwarf minke whales around vessels and swimmers

#### *4.3.1.1 Ad libitum observations (20 interactions in 2006)*

Most whales surfaced in the '*Inner Area'* (82%), followed by the '*Middle Area'* (15%) and the '*Outer Area*' (3%). To test whether this pattern was an artefact of the heterogeneous sighting probability of individual whales, the data were subdivided into: (1) in-water interactions with 1-2 animals and (2) in-water interactions with >2 animals (mean ± SE = 8.3 ± 1.3 animals; Figure 4.2). No significant difference in the relative frequency of observations in the various areas between the two categories was detected ($\chi^2$ = 1.655; df = 2, $P$ = 0.437), indicating that the sighting probability was not significantly heterogeneous.

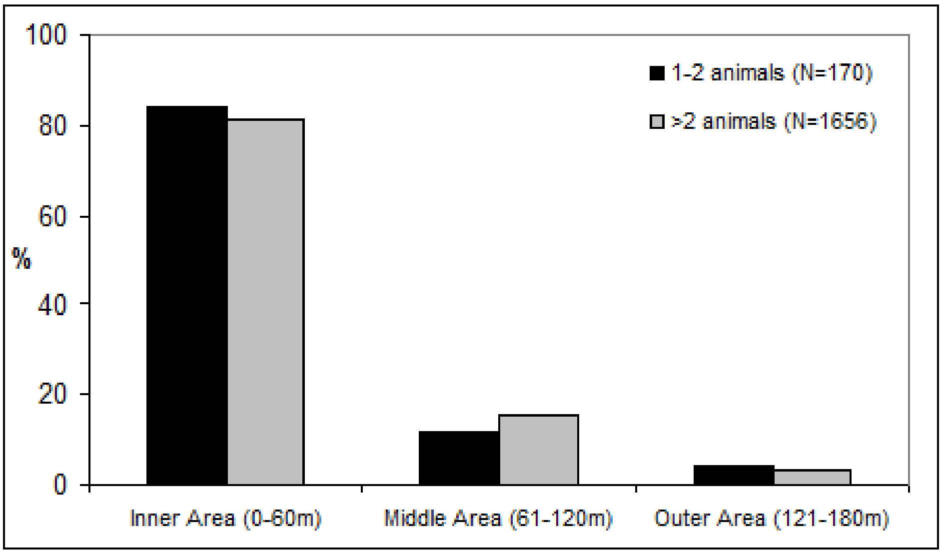



Figure 4.2 Proportions of observed surfacing of whales from 20 in-water interactions in 2006 for 1-2 animals (n=170) and >2 animals (n=1656 sufacings).

#### 4.3.1.2 *Adaptive scan sampling (2007)*

The spatial surfacing pattern of the whales was independent of (1) boat status ($\chi^2 = 2.529$, df = 2, $P = 0.282$) and (2) weather conditions ($\chi^2 = 7.704$, df = 4, $P = 0.133$) justifying the use of data from all in-water interactions in subsequent analyses. The whales surfaced significantly more often than expected in the '*Inner Area*' and significantly less often in the '*Middle Area*' and the '*Outer Area'* ($\chi^2 = 729.374$, df = 2, $P = < 0.001$) (Figure 4.3).

Within the area closest to the vessel ('*Inner Area*'), the whales surfaced significantly more often than expected in the '*Rope/Swimmer Quarter*' and significantly less often in the '*Left Quarter*' and the '*Opposite Quarter*' ($\chi^2 = 48.325$, df = 3, I < 0.001; Figure 4.4). No difference was found in the '*Right Quarter*'. The outcomes indicate that dwarf minke whales interacting with vessels and their swimmers not only clump around the vessel (<60 metres) but aggregate especially around the swimmers.

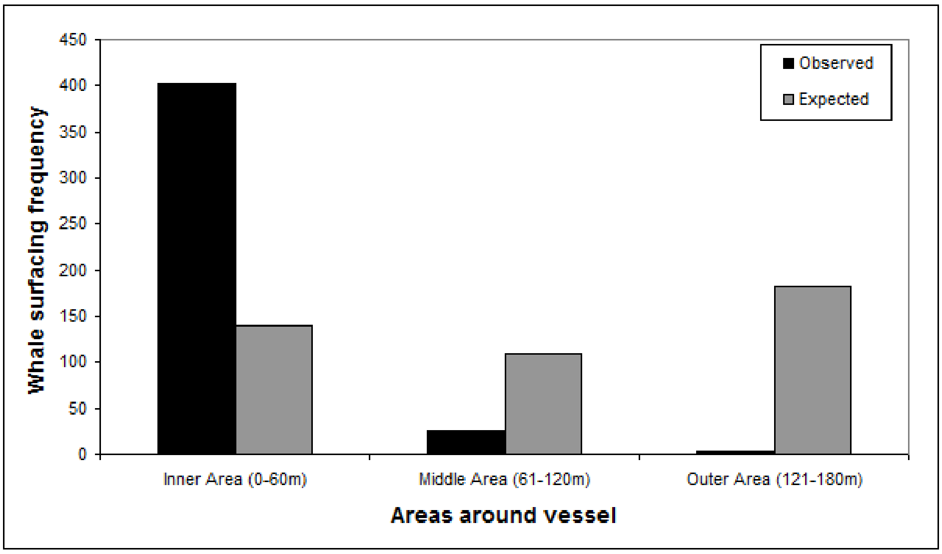



Figure 4.3 Observed versus expected frequencies of surfacing dwarf minke whales (per unit effort and unit area) in the three assigned areas (*Inner*, *Middle* and *Outer Area*) around the vessel from 18 in-water interactions in 2007 (see Figure 3a for Areas).

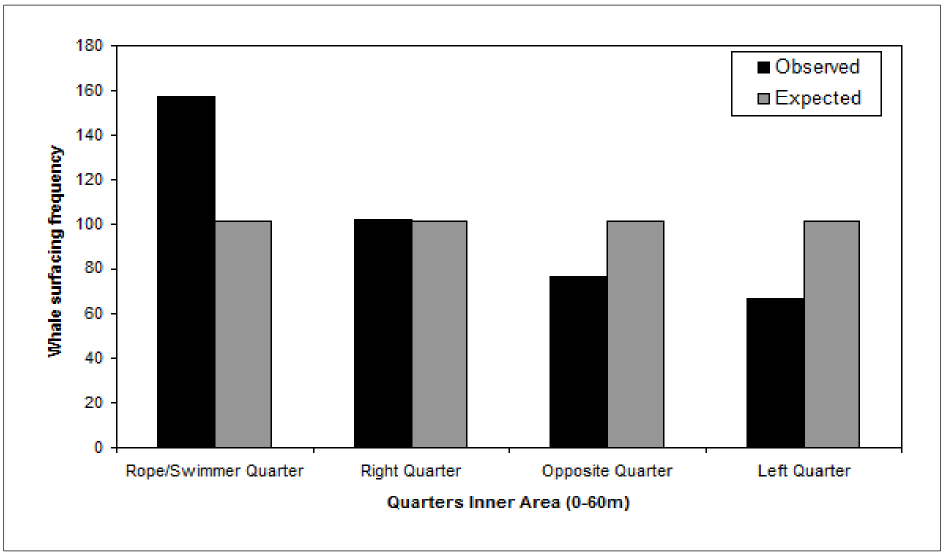



Figure 4.4. Observed versus expected frequencies of surfacing dwarf minke whales in the four assigned quarters (*Rope/Swimmer Quarter, Left Quarter*, *Right Quarter* and *Opposite Quarter*) in the area closest to the vessel (*Inner Area*) (n=18 in-water interactions).

### 4.3.2 Distance measurements of whale-swimmer passes (2008)

#### *4.3.2.1 Whale passing distances to researcher*

Distance measurements were recorded during 28 in-water interactions. The number of measurements taken of individual whales was variable with a median of six measurements per whale (range 1 – 56). The mean passing distance ($n$ = 119 whales) to the researcher was ($X$+SE) 7.08 ± 0.09 metres. Resighted individuals ($n$=24) were skewed towards the end of the season ('Beginning Season' = 4; 'Middle Season' = 4; 'End Season' = 16 resighted whales).

#### *4.3.2.3 Whale passing distances within interactions*

During an in-water interaction, individual whales came significantly closer to swimmers through time (Repeated Measures ANOVA, within subject effect: $F_{2, 270}$= 11.839; $P$ =

<0.001). This behavioural response was significantly more pronounced in whales belonging to a large group, compared to whales belonging to a smaller group (Repeated Measures ANOVA, between subject effect: $F_{2, 135} = 14.208$; $P = < 0.001$). A Tukey's HSD post-hoc test revealed that individual whales significantly decreased their passing distance to swimmers by a mean of 1.4 metres (from 7.1±0.24 metres to 5.7±0.22 metres) between the categories 'Beginning Interaction' and 'End Interaction' ($P = < 0.001$), and individual whales among the largest group size category '>6 whales' came significantly closer than whales in the smallest group size class '1-3 animals' ($P = < 0.001$; Figure 4.5). Boat status and Wind speed did not significantly influence passing distance (Table 4.1)

Table 4.1 Outcomes of a Repeated Measures ANOVA testing individual whale passing distance to the observer over time (Beginning, Middle and End Interaction) with the grouping predictor variables of whale group size (1-3, 4-6 and >6 animals), Boat status (Drifting, Stationary) and Wind status (15, 20 knots)

| **Source** | **df** | **Mean Square** | **F** | ***P*** |
|---|---|---|---|---|
| **Within-Subjects Effects** | | | | |
| Time in interaction (Beginning, Middle, End Interaction) | 2 | 58.01 | 11.839 | <0.001 |
| Error (Time in interaction) | 270 | 4.90 | | |
| **Between-Subjects Effects** | | | | |
| Boat status (Drifting, Stationary) | 1 | 9.77 | 0.775 | 0.380 |
| Wind speed (15, 20 knots) | 1 | 0.61 | 0.124 | 0.982 |
| Whale group size (1-3, 4-6 and >6 animals) | 2 | 150.26 | 14.208 | <0.001 |
| Error | 135 | 10.58 | | |

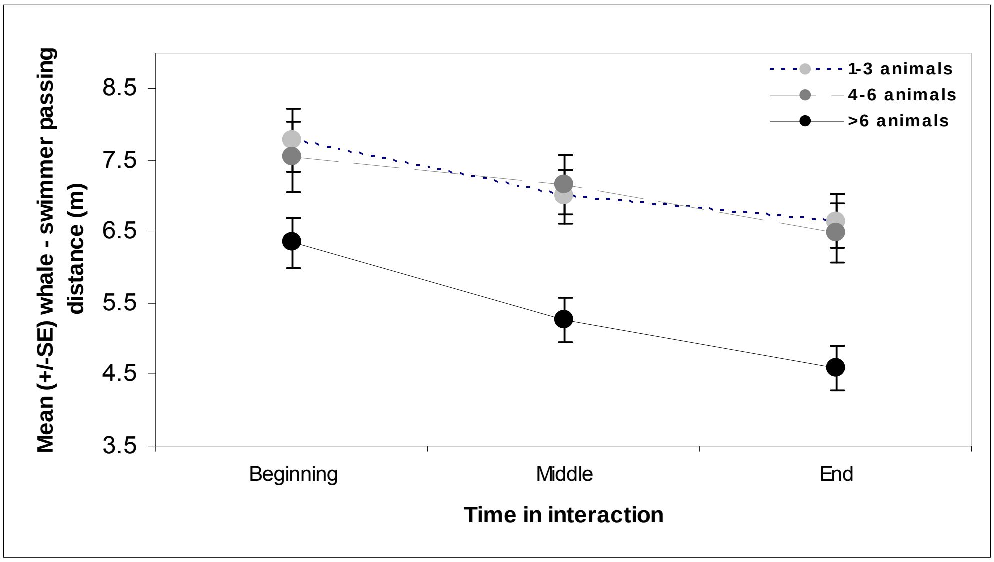



Figure 4.5 Whale group size dependent changes in mean (±SE) whale-swimmer passing distances (m) of individual whales (*n* = 20) during the first 90 minutes of in-water interactions (time based categories: 'Beginning Interaction', 'Middle Interaction', and 'End Interaction')

#### *4.3.2.4 Change in behaviour between interactions of resighted whales*

The passing distances of individual whales in a subsequent independent interaction (resighted) were significantly closer by a mean of 1.5 metres than those recorded in their penultimate known interaction (Repeated Measures ANOVA, between subject effect: $F_{1, 45} = 34.164$; $P = < 0.001$; Figure 4.6). There was a significant difference between individual resighted whales (Repeated Measures ANOVA, within subject effect: $F_{1, 45} = 34.164$; $P = < 0.001$), however all whales came closer in the subsequent interaction (no interaction effect, Table 4.2).

**Table 4.2** Outcomes of a Repeated Measures ANOVA comparing the passing distances of five individual whales from their first to their subsequent interaction.

| Source | df | Mean Square | F | *P* |
|---|---|---|---|---|
| **Within-Subjects Effects** | | | | |
| Whale ID (1-5) | 1 | 0.241 | 14.251 | <0.001 |
| Error | 45 | 0.016 | | |
| **Between-Subjects Effects** | | | | |
| Interactions (First & Subsequent) | 1 | 0.410 | 34.164 | <0.001 |
| Interactions*Whale ID (1-5) | 4 | 0.023 | 1.978 | 0.114 |
| Error | 45 | 0.012 | | |

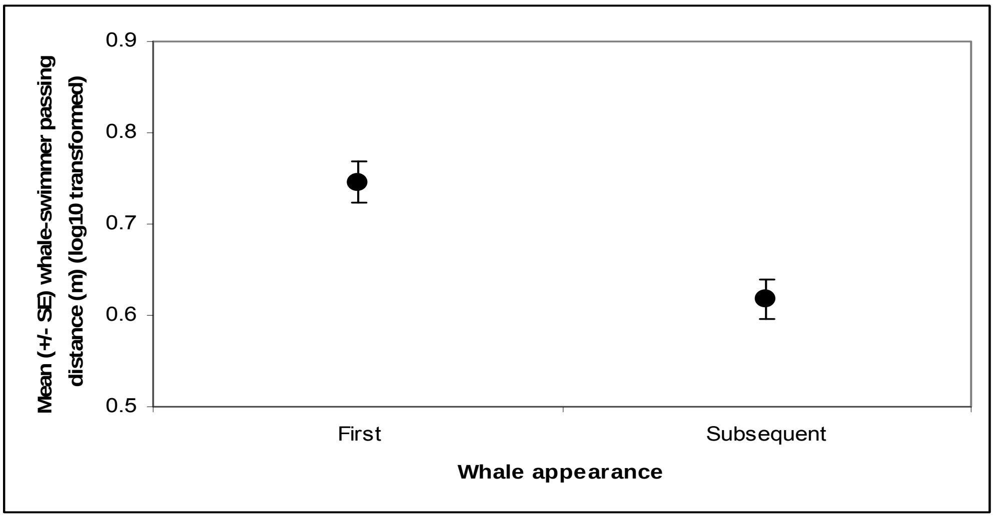



Figure 4.6 Changes in mean (±SE) passing distance (m; log10 transformed) of individual whales (n=5) from their first to their subsequent interaction

Resighted whales came significantly closer than unknown individuals by a mean distance of 2.5 metres (Paired Sign test: $Z_{1,8} = 2.667$, $P = 0.008$; Figure 4.7). This trend was consistent between all nine encounters.

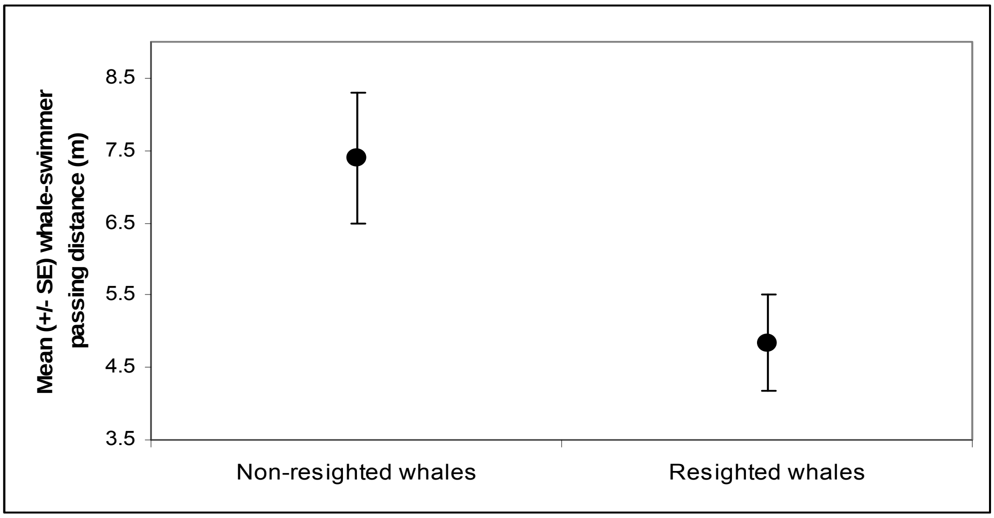



Figure 4.7 Mean (±SE) passing distances (m) of non-resighted and resighted whales to swimmers during the first hour of in-water interactions (n=9)

## 4.4 DISCUSSION

Dwarf minke whales in the Great Barrier Reef repeatedly approach dive tourism vessels, maintain close contact with the vessel (<60m) for prolonged periods (ranging from 0.2-9.3 hours; mean ± SE = 2.8 ± 0.2 hours; see Table 3.2 in Chapter 3) and aggregate around swimmers. Moreover, the whales approached closer over the time of an interaction. Group size affected the way individual dwarf minke whales interact with human swimmers (the larger the group size the closer individual whales approached) and familiarity through repeated exposure (i.e. resighted individuals) to the vessel and swimmers influenced behaviour.

The behaviour of dwarf minke whales differs from that of most free ranging wildlife encountered by humans. Most marine and terrestrial wildlife either avoid or tolerate (to various degrees) human observers, and the initiation of contact is most often made by humans rather than the animals (e.g. Holmes et al., 2005; Lott and McCoy, 1995; Sandbrook and Semple, 2006; Scarpaci et al., 2005). Although voluntary approaches are observed in some cetaceans (e.g. Caldwell and Caldwell, 1972a; Dahlheim et al., 1981; Herzing, 1999; Roden and Mullin, 2000), most interactions between people and cetaceans (generally odontocetes) are short or infrequent. Common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*) in the Bahamas for example, initiate interactions, but maintain contact for only 11 minutes on average (Herzing, 1999). Similarly pilot whales (*Globicephala melas*) in the Canary Islands stay with swimmers on average 12-14 minutes (Scheer et al., 2004). Occasional interactions of up to an hour occur between dolphins and swimmers in the Azores (Ritter, 2003).

The limited information available suggests that, especially on their wintering grounds mysticetes may initiate contact with humans more than odontocetes do. The Gray whale displays behaviour similar to that of the dwarf minke whale (Jones et al., 1984; for comparison see Birtles et al. 2002a). Gray whales initiate contact with humans; actively seeking out slow moving vessels and maintaining contact for up to three hours in their wintering grounds (Dahlheim et al., 1981; Jones et al., 1984). Most interacting Gray whales are mothers and calves, with calves being more investigative than their mothers (Jones et al., 1984). There are also anecdotal reports of prolonged and inquisitive encounters between humans and humpback whales in the Silver Banks and Tonga. As for Gray whales, most interacting humpbacks are mothers and calves (Rose et al., 2005). The current understanding of the age composition of interacting dwarf minkes shows that all age classes are present but suggests that the interacting population is skewed towards adolescent whales (Dunstan et al., 2007), and only very few mother and calf pairs are seen every season (Birtles et al., 2002a).

Encounters with minke whales exhibiting exploratory behaviour have been described previously. Leatherwood et al., (1982) conducted an experiment as part of a census, investigating responses of Antarctic minke whales (*Balaenoptera bonaerensis*) to an ice breaker and found that whales frequently approached the stationary vessel. In the Caribbean, three common minke whales (*Balaenoptera acutorostrata*) maintained close contact with a vessel for a period of two hours (Roden and Mullin, 2000).

Compared with other cetaceans, particularly odontocetes, my findings indicate that encounters between dwarf minke whales and humans are unusual: (1) the whales initiate the interactions with vessels and swimmers, (2) the whales maintain close contact with humans for prolonged periods, and (3) the whales pass very close to the swimmers and decrease this distance over time. Why dwarf minke whales show such behaviour is puzzling and may be best explained by the animal behaviour motivation theory of exploration (e.g. increase in exploratory behaviour due to deprivation of stimulation, animal age or behavioural state; Fowler, 1965; Berlyne, 1966; Hinde, 1966; Loewenstein, 1994), as discussed in detail below.

### 4.4.1 Initiation of interactions with vessels and swimmers

The probability that a given stimulus will elicit exploratory rather than fear responses depends on various factors including the age of the animal (Hinde, 1966). Responsiveness to novel objects increases progressively from juveniles to adults, and wanes after that (Mason, 1971, 1973). This developmental pattern occurs frequently throughout the animal kingdom in species as divergent as primates (Fairbanks, 1993; Mayeaux and Mason, 1998), bovines (Murphey et al., 1981), felines (Glickman and Van Laer, 1964), and cetaceans (Constantine, 2001). Most (60%) interacting dwarf minkes are adolescents (Dunstan et al., 2007) providing some explanation for their inquisitive behaviour. Adolescence is often described as a time of enhanced receptivity for learning (Poirier et al., 1978). Juvenile curiosity and willingness to take risks in unfamiliar situations may provide immediate benefits; including opportunities for learning that will enhance fitness later in life (e.g. Martin and Caro, 1985; Fairbanks, 1993).

Social interactions provide another opportunity for animals to learn from conspecifics (Norris and Schilt, 1988). Approaching relatively fixed and acoustically easily detectable objects such as vessels may facilitate socialising and may be a reason why dwarf minkes initiate and maintain contact with boats. Numbers of dwarf minke whales build up over the course of an interaction (Birtles et al., 2002a) and social behavioural displays (e.g. belly presentations) are seen frequently among larger groups (see Chapter 3).

Berlyne (1966) reported that animals are most likely to explore and play when they have no emergencies to deal with. Unlike adult baleen whales in their wintering grounds, juveniles or adolescents are not yet fully engaged with mating processes and therefore may have time and energy to spare for exploration. Migrating baleen whales (including dwarf minkes) feed little if at all in their wintering grounds (Corkeron and Connor, 1999; Birtles et al., 2002a) providing them with additional time for investigation. Dwarf minke whales have never been observed feeding in the Great Barrier Reef and only two defecations have been recorded in the 14 years of research (Birtles et al., 2002a). Despite the fact that the whales involved with swim –with tourism in the Great Barrier Reef are fasting and presumably increasingly hungry as the season progresses, I consider it unlikely that they are attracted to tourist vessels as a result of prior experience feeding on discards or escaped fish from fishing vessels. I reject this hypothesis for two reasons: (1) the whales stay around the tourist vessels for hours despite never being fed; (2) the whales approach divers up to several hundred metres away from a vessel and remain with them for extended periods (up to an entire length of a dive (approximately 45 minutes), personal observation).

Responsiveness of animals to novel stimuli changes with behaviour state (Hinde 1966; Coscarella et al. 2003; Ritter 2003). For instance, several species of cetaceans including Atlantic spotted dolphins (*Stenella frontalis*), bottlenose dolphins and pilot whales have been reported to interact with vessels in some behavioural states (e.g. socialising) but avoid the vessel in others (e.g. feeding) (Ritter, 2003). Similarly Gray whales are highly inquisitive while in their breeding grounds but avoid contact when migrating (Ollervides, 2001; Moore and Clarke, 2002). Observations of the exploratory behaviour of dwarf minke whales were limited to their wintering grounds. There is very limited information on where these whales go after spending time in the Great Barrier Reef. Therefore it is difficult to predict if the behavioural response of dwarf minkes changes with a different behavioural state, as observed in some other whales.

### 4.4.2 Approaching closer over time

The passing distance of dwarf minkes to swimmers decreased during an interaction, with whales in a larger group approaching closer than whales among a smaller group. An increase in the level of exploratory behaviour of individual animals when among a larger group has been reported previously in cetaceans (e.g. common dolphins; Neumann and Orams, 2005) and apes (e.g. chimpanzees and bonobos; Van Krunkelsven et al., 1999a; Morgan and Sanz, 2003). Safety in numbers is a common strategy in animals (e.g. Alexander, 1974; Van Schaik, 1983; Norris and Schilt, 1988). Forming groups is viewed primarily as an antipredator strategy, but provides additional benefits including increased confidence, learning opportunities and socialising (Norris and Schilt, 1988; Neumann and Orams, 2005). Thus, dwarf minkes in a larger group may be more confident, less disturbed by and potentially even attracted to an unfamiliar object, such as a vessel.

An exploratory rather than fear response typically depends on the animals' previous experience with a stimuli (Berlyne, 1966). The approach distance in dwarf minke whales was influenced by different levels of familiarity to the vessels and swimmers. Individual whales decreased their passing distance from one to the subsequent interaction and resighted individual whales approached much closer to swimmers than unknown whales (by a mean of 2.5 metres). Behavioural changes as a result of familiarity with a stimulus have been described in many taxa including rhinoceros (Lott and McCoy, 1995), elephants (Burke, 2004), penguins (Ratz and Thompson, 1999) and pinnipeds (Kovacs and Innes, 1990). In great apes, groups gradually change their initial response to human observers from flight to tolerance and even investigation (Van Krunkelsven et al., 1999b; Werdenich et al., 2003; Blom et al., 2004). The increased confidence of resighted dwarf minkes may stimulate other individuals to approach vessels and swimmers without fear. Wild chimpanzees approach observers more often when animals familiar with the stimulus are present (Bertolani and Boesch, 2008). The change in an animals' tolerance levels towards observers, from low to high is commonly referred to as habituation (Thorpe, 1963). As dwarf minke whales initiate the interaction, i.e. voluntarily approach vessels and swimmers rather than being approached (see Bejder et al., 2009), I do not consider that their behaviour can be classified as habituation using the standard definition of the term. However, the behaviour has some elements in common with habituation because the whales decrease their distance from humans over time. Consequently, I refer to the more usual form of habituation as habituation Type I and to the behavioural process observed in dwarf minke whales as habituation Type II or increased attraction (Figure 4.8a & b).

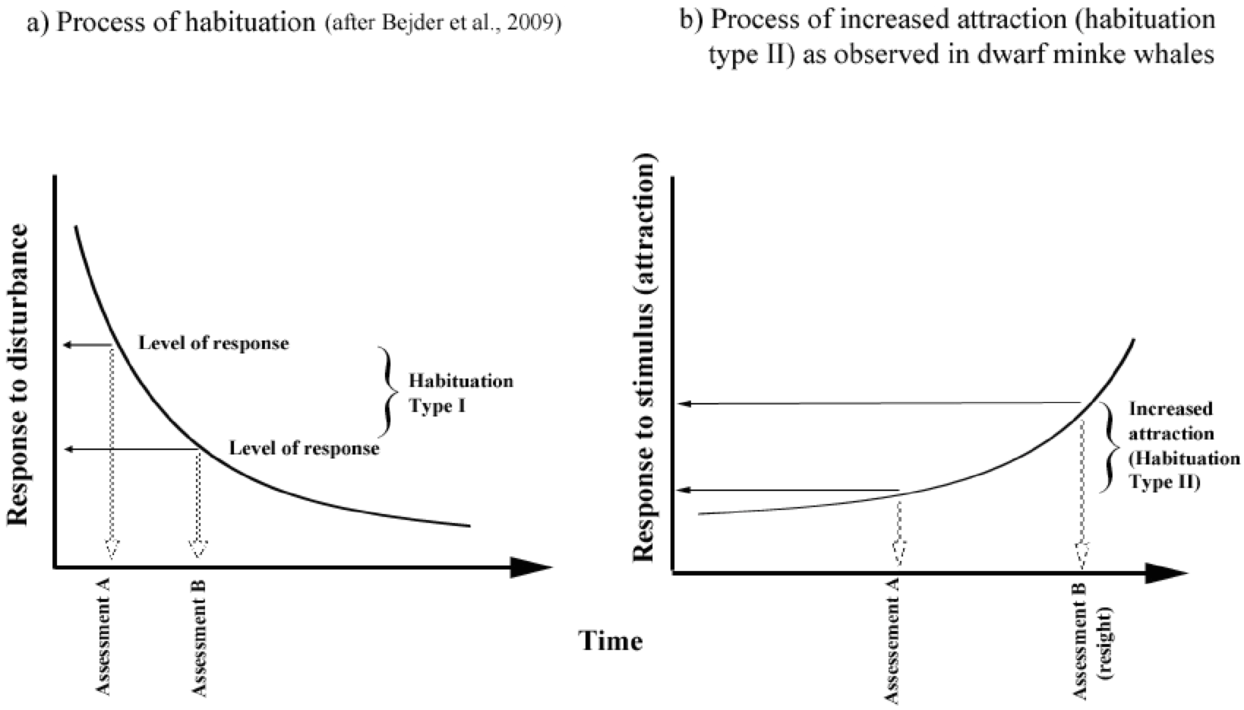



Figure 4.8a & b Comparison between the process of habituation Type I (Bejder et al., in press) and the process of increased attraction (habituation Type II)

### 4.4.3 Concerns arising from the attraction of dwarf minke whales to vessels and swimmers

The attraction of dwarf minke whales towards humans generates concern for the whales and especially for swimming participants (see Chapter 5). This behaviour (attraction) can lead to an increased vulnerability of dwarf minke whales increasing the probability of boat strikes or entanglement in fishing gear, as reported for other cetaceans (Stone and Yoshinaga, 2000; Spradlin et al., 2001; Frohoff, 2004). Also, the prolonged interactions between dwarf minke whales and humans may impact negatively on the whales' overall daily activity budget and therefore in the longer term may influence fitness. Adolescent cetaceans are of particular concern as frequent interactions with humans may alter their normal course of behavioural development, potentially resulting in altered patterns of social behaviour (Samuels et al., 2003).

The elevated attraction of dwarf minke whales to the stimulus caused by increasing familiarity with vessels and swimmers also generates public safety concerns (Birtles et al., 2002a). In this study, resighted individual whales came on average 2.5 metres closer than unknown minkes. Given their size, weight and agility, the close proximity of dwarf minkes to human observers increases the likelihood of accidents (Birtles et al., 2002a). Whales making physical contact with a dinghy, the rope and passengers were very rarely observed (see Chapter 5). Injuries to swimmers from baleen whales have been reported in various species including Gray whales, southern right whales (*Eubalaena australis*) and humpback whales (Hall, 2000; Rose et al., 2007). Accidental and intentional injuries to swimmers from baleen whales will be discussed at length in the next Chapter.

### 4.4.4 Management challenges

The IWC (2000) stated that "swim-with programs vary among species and there is the need to assess such operations on a case by case basis". The Australian National Guidelines are suitable for most cetaceans found around Australia as the animals are either very large and thus easily detected (e.g. humpback whales), do not approach vessels on a regular basis (e.g. right whales, sperm whales) or spend only a minimal time (several minutes) with boats (e.g. dolphins). However, this policy does not take into account the behaviour of dwarf minke whales, which voluntarily interact with tourism boats on a regular basis and maintain close contact for several hours.

The inquisitive behaviour of dwarf minke whales provides challenges for non-endorsed vessels to conduct their leisure activities (in particular over June and July) without breaching the whale watching guidelines. The guidelines specify that if a dwarf minke whale approaches closer than 100 metres, humans are not allowed to enter the water. People already in the water will encounter the whales incidentally and are not in breach of the law. Passengers still on the boat would be obliged to remain there, sacrificing their leisure activities and creating inevitable dissatisfaction, and potentially jeopardising the success of businesses dependent on customer satisfaction. Thus, there is a clear trade-off between business success and compliance (Scarpaci et al., 2003; Whitt and Read, 2006). Regulating dwarf minke whale interactions and enforcing compliance is challenging for the Great Barrier Reef Marine Park Authority as the area where the whales are encountered is very remote and large (i.e. outer Great Barrier Reef in the Cairns/Cooktown Section; see Figure 2.1).

The extent of incidental interactions between non-endorsed vessels (their swimmers) and dwarf minke whales in the Great Barrier Reef Marine Park has not been documented. Anecdotal information indicates that incidental interactions occur frequently. It is therefore currently impossible to gauge the cumulative effects of swim-with whales tourism on the animals. A comprehensive overview would require all commercial and recreational vessels operating within the Great Barrier Reef Marine Park to record and report every encounter with dwarf minke whales. This requirement however would be very difficult to enforce.

### 4.4.5 Chapter summary

- Dwarf minke whales in the northern Great Barrier Reef are attracted to vessels and swimmers, initiating interactions and maintaining close contact for prolonged periods. These behaviour attributes contrast with most other wildlife-human interactions.

- Interacting dwarf minke whales showed a clumped distribution around the vessel (<60 metres), and actually aggregated around the swimmers.
- Interacting dwarf minke whales changed their behaviour over time.
- These whales show a strong and increasing attraction to the stimulus (vessel and swimmers) which may act as an easily located socialising device for dwarf minkes.
- The more familiar the whales were with the stimulus (i.e. resighted individuals) the more inquisitive and confident the whales became, i.e. the closer they approached.
- The whale group size significantly influenced the approach distance to humans, i.e. the larger the whale group the closer individuals approached, suggesting an increased confidence arising from the safety in numbers.
- Attraction to human activity is likely to increase the risk of harm to both humans and dwarf minke whales.

# CHAPTER 5

## DWARF MINKE WHALE BEHAVIOURS OF POTENTIAL RISK OF HARM TO SWIMMERS AND/OR WHALES

The purpose of this chapter is to assess the risk of harm to the swimmers and to the whales from the behaviour of dwarf minke whales around dive vessels. The risk of harm was established by assessing: (1) the potential of harm (consequences) to both the swimmers and the whales from whale behaviours using experts in the field of marine mammal science, management and conservation, and (2) estimating the probability of the occurrence of an interaction in which the behaviours of concern occurred over a season. To establish the risk of harm, I built upon findings presented in Chapters 3 & 4.

## 5.1 INTRODUCTION

Swimming with wild marine mammals is an increasingly popular form of wildlife tourism involving a wide variety of species (Bejder et al., 1999; Rose et al., 2003; Frohoff, 2004; Hoyt, 2004; Rose et al., 2005). Humans clearly enjoy interacting with animals in a natural setting (Hughes and Carlsen, 2008), and the opportunities to do so are amplified by a flood of advertisements and images of close interactions between humans and wildlife (Spradlin et al., 2001).

Currently, swim-with opportunities are provided with many marine mammals including manatees (Seideman, 1997; Sorice, 2001; Bonde et al., 2004), Australian sea lions and fur seals (CALM, 1992; Boren et al., 2002; Martinez, 2003; Scarpaci et al., 2005), dusky, common, bottlenose, spinner, Hector's and Atlantic spotted dolphins (Barr and Slooten, 1998; Dudzinski, 1998; Bejder et al., 1999; Herzing, 1999; Samuels et al., 2003; Constantine et al., 2004; Danil et al., 2005; Delfour, 2007). Although most interactive programs involve small odontocetes, commercial programs providing interactions with larger toothed and baleen whales are becoming increasingly widespread (Frohoff, 2004; Rose et al., 2005). Such programs include dense beaked whales and pilot whales (Ritter, 2003; Hofmann et al., 2004; Scheer et al., 2004; Barradell and Ritter, 2008), humpback whales (Rose et al., 2005), southern right whales (Lundquist, 2007) and dwarf minke whales (Birtles et al., 2002a).

The associated cost and benefits of such interactions to the animals are the subject of considerable discussion and opinions diverge extensively among wildlife managers, members of Non Governmental Organisations and the research community (Samuels and Bejder, 2004). Advocates argue that the benefits outweigh the costs as swim-with programs enhance environmental tourism, regional economics, public education and ultimately foster conservation (Orams, 1996; Hoyt, 2001; O'Regan, 2001;

Higham and Carr, 2002). Supporters also allege that in situations involving free ranging wildlife, the animals have the choice as to whether or not they will interact with humans (e.g. Dudzinski, 1998) and this has become a fundamental criteria for allowing such activities in the Australian Commonwealth Guidelines (DEH, 2005).

The assessment that tourism enhances the conservation of the targeted animals is based upon the best case scenario; currently this is more the exception than the rule (Higham, 2007). Several authors highlighted the complexity of interactions between humans and free ranging wildlife (Beale and Monahan, 2004; Bejder et al; 2006; Corkeron, 2004). Swim-with situations vary widely in their conduct, location, and species targeted (Samuels et al., 2003). Species react differently to external pressures (e.g. tourism) and even the reactions and resilience of individual animals to such pressures may be different (Frohoff, 2004). Thus, the cost and benefits to the animals need to be considered in detail on a case by case basis.

Despite the potential benefits of such programs there are considerable concerns about the safety and wellbeing of the targeted animals (e.g. Spradlin et al., 2001; Samuels and Bejder, 2004). Indeed, a large number of publications provide information that suggests that marine mammals are at risk of being disturbed, harassed, stressed and/or injured by such close interactions (e.g. Seideman, 1997; Boren et al., 2002; Samuels and Bejder, 2004). There are reports highlighting vessel strikes (Wells and Scott, 1997; Laist et al., 2001), disturbance of behavioural states (Lusseau, 2003a; Constantine et al., 2004), increased energetic demand (Kruse, 1991; Williams et al., 2002b), and temporary displacement (Lusseau and Higham, 2004) of cetaceans targeted by tourism. Depending on the magnitude and duration of such disturbances to the animals, long-lasting effects (e.g. habitat abandonment, negative physiological effects, habituation) may emerge with the potential to alter the fitness of the population (Knight and Cole, 1995; Richardson et al., 1995; Mann et al., 2000a; Frohoff, 2004; Bejder et al., 2006; Lusseau and Bejder, 2008).

Close and repeated interactions with marine mammals also pose substantial public safety concerns (Seideman, 1997; Spradlin et al., 2001; Samuels and Bejder, 2004). Situations where humans were threatened, injured and even killed while in close contact with marine mammals have been documented on numerous occasions (e.g. Shane et al., 1993; Santos, 1997; Kirkwood et al., 2003). Samuels and Bejder (2004) in a study on human-dolphin interactions in Florida estimated that humans were at risk of being injured once every half an hour. Humans have been seriously wounded by Australian sea lions while swimming in close proximity to a colony (Kirkwood et al., 2003). There have also been incidents involving baleen whales. For example just recently two swimmers were seriously injured by a humpback whale cow which turned aggressive when her calf was approached too closely (Rose et al., 2007).

In most cases, the aggressive act by the animal was triggered by inappropriate human behaviour such as harassing, touching or feeding. Such behaviour may arise from the urge of humans to connect with individual animals to satisfy feelings such as the need to nurture or foster friendship (Hughes and Carlsen, 2008). The public perception that cetaceans are friendly and gentle creatures is widespread (Orams, 1997). Such misconceptions have been promoted by mainstream media displaying the animals as smart, cheerful and harmless (Seideman, 1997; Spradlin et al., 2001). Many participants are unaware of the potential dangers involved in swimming with marine mammals, because participants are lacking sufficient knowledge about the animals' behaviour and they have a preconceived opinions and high expectations about a friendly and life-changing encounter (Seideman, 1997).

Irrespective of the management and mitigation scheme in place, close contact with wild and powerful animals will always involve some risk for the animals and the participants. Complete avoidance of risk is impossible in real life situations, and one can only choose between levels of risk (Kaplan and Garrick, 1981). To manage uncertainties and guarantee rational decision making, a clear and quantitative way of articulating risk is required (Kaplan and Garrick, 1981). Risk assessments are seen as an integral part of quality assurance (Beer and Ziolkowski, 1995). Human-wildlife interactions have rarely been subjected to formal risk assessments. Most studies of interactions between humans and marine mammals have reported on the potential danger rather than formally assessing the risk (Samuels and Bejder, 2004; Scarpaci et al., 2005).

The aims of this study were to assess the direct and indirect risks of harm associated with swimming with dwarf minke whales, for: (1) the swimmers, and (2) the whales involved and to provide risk mitigation strategies for the sustainable management of this industry.

## 5.2 METHODOLOGY

The evaluation of risk of harm to swimmers and/or the whales from dwarf minke whale behaviours was conducted in five steps: (1) identification of dwarf minke behaviours of potential risk of harm; (2) identification of factors contributing to the risk of harm (e.g. closeness); (3) establishment of the probability of occurrence of the behaviours; (4) evaluation of the perceptions of harm (consequences) to swimmers and whales; and (5) establishment of the risk of harm. The first three steps were conducted using observational data that I collected between 2006 and 2008, the perceptions of harm were evaluated with a Key Informant Survey, and the risk of harm was established using a risk assessment matrix, modified from Australian Workplace Health and Safety (Comecare, 1997).

### 5.2.1 Dwarf minke whale behaviours which are of potential harm to swimmers and/or the whales

Over my three year research period (2006-2008) I identified eleven dwarf minke whale behaviours which are of potential harm to swimmers and/or the whales. These behaviours were: (1) *slow swim past*; (2) *high speed pass*; (3) *belly presentation*; (4) *bubble release*; (5) *headrise/spyhop*; (6) *pirouette*; (7) *motorboating*; (8) *gape/gulp*; (9) *breach*; (10) *sudden speed up* and (11) *sharp veer*. This selection was based upon behaviours that occurred (at least once) within close range (<6 metres or within a whale body length) of the swimmers and/or the vessel. I also included behaviours (e.g. *gape/gulp*, *bubble releases*) that have been interpreted in the literature as aggressive and/or agonistic in other species of cetaceans.

### 5.2.2 Factors contributing to the potential risk of harm

I examined two factors contributing to the risk of harm to swimmers and/or the whales: (1) the closeness of the whale behaviour to swimmers and/or the vessel, and (2) the occurrence probability of the behaviour in an interaction/encounter. I calculated occurrence probabilities for behaviours in four whale-swimmer/vessel distance categories: (a) within swimmer touching distance (≤ 1 metre); (b) up to half a whale body length (>1-3 metres); (c) up to one whale body length (>3-6 metres) and (d) over one whale body length (>6 metres). The average whale body length of approximately

6m was based upon Dunstan et al., (2007). An assumption was made that the closer the behaviour was to the swimmer and/or the vessel the higher the risk of harm.

### 5.2.3 Occurrence probability of dwarf minke whale behaviours in interactions/encounters

I used an *ad libitum* sampling protocol (2006-2008), a scan sampling protocol (2007) and an individual follows protocol (2008) to collect data on the occurrence of dwarf minke whale behaviours. The detailed methodologies of each of the protocols and data collection are outlined in Chapter 2 – General Methods and in the Chapters 3 and 4. I calculated and categorised the occurrence probabilities of the identified dwarf minke behaviours as in Chapter 3. Here, I calculated the occurrence probability in more detail, according to the assigned distance categories:

$$P[x_1 \ldots x_4] = \frac{n![x_1 \ldots x_4]}{N_{\text{int}}}$$

where,

| | | |
|---|---|---|
| P | = | probability of behaviour occurring in an interaction/encounter |
| $x_1 \ldots x_4$ | = | distance categories |
| n! | = | interactions/encounters in which behaviour occurred |
| $N_{int}$ | = | total number of interactions/encounters |

### 5.2.4 Key Informant Survey

I identified Key Informants on the basis of their high levels of experience in research, management and/or conservation of marine mammals. Potential participants were stratified across the international cetacean research community, management organisations and members of Non-Governmental Organisations.

I contacted over 30 potential Key Informants via email with an introductory letter outlining the aims and objectives of the study, explaining the conduct, duration and time frame of the planned three surveys (see Appendix 3). Key Informants who indicated they were willing to participate (n=24) were sent a follow-up letter, to provide them with additional details of the study and to thank them in advance for their participation and time commitment. The study included three components. Two parts were conducted using an online web based tool to create and publish custom surveys, named 'Survey Monkey' (www.surveymonkey.com), and one part was carried out as an interview. The sequence of the three surveys was as follows:

#### *5.2.4.1 Key Informant Survey - Part 1 (ca. 30 minutes)*

I designed the first part of the survey to record background information about the Key Informants and to assess some broad issues in relation to swim-with cetacean industries (see Appendix 5). This survey was a structured online questionnaire including both closed and open ended questions. Access to the survey was given via a link, sent over email. The Key Informants also received a copy of the questionnaire (Word document).

#### *5.2.4.2 Key Informant Interview - Part 2 (ca. 40 minutes)*

After completion of Part 1 of the survey by the Key Informants, I sent them a hardcopy of the interview (see Appendix 6). The interview required some knowledge of dwarf minke whale behaviours. Therefore, I asked the Key Informants to watch a 15 minute interpretational DVD (Mangott et al., 2007; Appendix 4) to familiarise them with the behaviour of these whales prior to the interview. This DVD provides a detailed explanation of dwarf minke whale behaviours and was developed as an interpretive tool to educate passengers and crew prior to and after their swim-with experiences. I provided two options for the Key Informants to access this information: (1) via a streaming video which was uploaded onto the internet (www.myspace.com/arnoldmangott), or (2) posting the DVD to them. Once the Key Informants had familiarised themselves with the behaviours of dwarf minkes (I contacted the Key Informants after about two weeks) I scheduled the interview with them.

I designed the Key Informant interview to elicit potential meanings and context of dwarf minke whale behaviours which are potentially of harm to swimmers and/or the whales, and to identify any behavioural analogies with other cetaceans. The interview also included questions on management strategies regarding the interactions of these whales with vessels and swimmers. I conducted two interviews in person and 16 interviews over a phone link. I chose to interview the two Key Informants in person as both were situated in Townsville (Great Barrier Reef Marine Park Authority). The interview consisted of an orally administered and digitally recorded semi-structured questionnaire (see Appendix 6). Most of the questions were open-ended. Open ended questions allow for discussion and provide a better flow in the interview and therefore the opportunity to gather more quality information. I recorded the interview using a Sony IC –SX46 digital recorder and later transcribed it into written format. After completion of the interview, I sent the Key Informants the link to the third and final part of the survey via email.

#### *5.2.4.4 Key Informant Survey - Part 3 (ca. 45 minutes)*

My main aim of this survey was to assess the Key Informants' perceptions of particular dwarf minke whale behaviours that are potentially of harm to swimmers and/or the whales. This survey also provided for the identification of management strategies best suited for the behaviour of this species. This survey was a structured online questionnaire including closed-ended, open-ended and rating scale questions (Appendix 7). I asked the Key Informants to rate their perceptions of harm to: (a) the swimmers, and (b) the whales, considering particular dwarf minke behaviours occurring in the assigned distance categories (see 5.2.2). The rating scale was from 1 = no risk to 5 = very high risk. I empirically selected the mean as the best measure of central tendency of the Key Informants' rating of harm (for individual ratings of the Key Informants see Appendix 8 and 9). I analysed the closed-ended questions, frequencies and/or ratings from all three surveys using descriptive statistics (e.g. mean ± SE) and analysed the open-ended questions using content analyses.

All three surveys followed the JCU Human Ethics Guidelines and I asked all participants to sign a letter of consent before commencement of each survey. This letter of consent informed the Key Informants about the nature and confidentiality of the surveys and sought agreement for their voluntary participation. I sent reminder emails to participants in regular intervals throughout the survey period, to assure the highest possible response rate.

#### *5.2.4.4 Content Analysis*

Content analysis is used to both quantitatively and qualitatively express the information and ideas in written or spoken text of individuals and involves the coding of the text in search of common themes (Krippendorff, 1980; Neuendorf, 2002). There are two approaches to coding data: (1) emergent coding, and (2) a priori coding. I used emergent coding which establishes categories following some preliminary examination of the data (after Haney et al., 1998). *A priori* coding refers to categories which are established prior to the analysis and these categories are based upon some theory. Most importantly and irrespective of the coding scheme (emergent or *a priori*), the coding needs to be: (1) stable or intra-coder reliable (i.e. the coder gets always the same results), and (2) reproducible or inter-coder reliable (i.e. different coder come to the same coding scheme) (Weber, 1990; Denzin and Lincoln, 1994). It is important to mention that respondents often express more than one theme in their answer, thus the number of responses/themes does not necessarily coincide with the number of respondents.

### 5.2.6 Assessment of the risk of harm from dwarf minke whale behaviours

To evaluate the risk of harm to swimmers and/or the whales from dwarf minke behaviours, I overlayed the occurrences probability of the behaviours together with the Key Informants' perceptions of harm (consequence) with a risk assessment chart (Table 5.1). The risk assessment chart is suggested by the Australian Workplace Health and Safety Regulations for self assessment of the risk at a workplace (Comecare, 1997).

Table 5.1 Risk assessment chart of dwarf minke whale behaviours according to the probability of occurrence and the Key Informants' perceived harm of dwarf minke whale behaviours to the swimmers and/or the whales (after the Australian Workplace Health and Safety Regulations; Comecare, 1997)

**Occurrence probability of dwarf minke behaviour**

| **Potential of harm** | Very rare | Rare | Occasional | Frequent | Very frequent |
|---|---|---|---|---|---|
| Very high | Medium | High | High | High | High |
| High | Medium | Medium | Medium | High | High |
| Medium | Low | Medium | Medium | Medium | High |
| Low | Low | Low | Low | Medium | Medium |
| Very low | Low | Low | Low | Low | Low |

### 5.2.6 Limitation to the study

Two different interview techniques (i.e. face to face (n=2) and telephone interview (n=16)) were used with the Key Informants to elicit potential meanings and context of dwarf minke whale behaviours. The two different techniques may have influenced my data collected and may have had some implications for the outcomes of this study.

## 5.3 RESULTS

### 5.3.1 Key Informant Survey

#### *5.3.1.1 Background of Key Informants*

Of the 24 Key Informants who agreed to participate, 21 completed the first survey. The survey participants were stratified over a wide range of organisations. Respondents were either affiliated with an 'Independent research organisation' (42.9%) or a 'University' (38.1%), or associated with a 'Governmental management organisation' (33.3 %), 'Non-governmental organisation' (19%) or a 'Governmental research organisation' (9.5%). Key Informants were highly qualified, with a mean (± SE) of 17.2 ± 1.9 yrs work experience in the marine mammal field. Their field of expertise was extensive, ranging from veterinary anatomy, marine mammal biology, ecology and behaviour, marine mammal medicine and pathology to conservation, management, policy and planning and sustainable wildlife tourism (see Appendix 10).

The Key Informants had worked with a total of 36 species of marine mammals including odontocetes (n=18), mysticetes (n=9), pinnipeds (n=6), sirenians (n=2) and polar bears (see Appendix 11). Most had studied the biology or behaviour of more than two species (n=15) and/or were involved in conservation and management (n=15).

#### *5.3.1.2 Key Informants' perception of swim-with cetacean operations*

About two-thirds of the respondents (62%) had first-hand experience with commercial operations offering swims with cetaceans. These cetacean swims were conducted either with dwarf minke whales in the Great Barrier Reef (n=4), dolphins in Australia or New Zealand (n=8) or humpback whales in Tonga (n=2).

Key Informants were asked: "What do you think about commercial tourism operations offering swims with cetaceans? About half of the respondents (n=10) were generally supportive, eight opposed such practices and three of the Key Informants were undecided. Some supportive respondents (n=3) highlighted the educational factor involved in such operations and its potential to benefit cetacean conservation. Most of the Key Informants (n=7) supported swim-with industries as long as these operations were well managed and controlled, underpinned by good science, and ecologically sustainable. Those respondents opposing swim-with operations were most concerned about the short and potential long term behavioural changes of the whales (for detailed responses see Appendix 12).

#### *5.3.1.3 Key Informants' concerns for the targeted animals*

Key Informants were asked: "Do you have any concerns for the targeted animals in swim-with cetacean industries?" All Key Informants but one (n=20) expressed concerns for the targeted animals in swim-with industries. The most common concerns were that such operations have the potential to harm or harass the target animals (n=6), disrupt critical behavioural states (n=5), negatively influence the time-activity budget (n=4) and cause disturbance, stress and induce aggression (n=4) (for detailed responses see Appendix 13).

##### *5.3.1.4 Key Informants' concerns for the participants*

Key Informants were asked: "Do you have any concerns for participants (swimmers) in swim-with cetacean industries?" Most Key Informants (90%) expressed concerns for the swimmers and were mostly worried about the direct harm from cetaceans (n=35) due to for example, potential aggression (n=9), increased risk of accidents because of close contact (n=6) with large and powerful animals (n=5), inappropriate perception of wild animals (n=4) and limited understanding of the animals' behaviour (n=3). Some of the responses (n=5) expressed concerns about participants being harmed indirectly by the animals (disease transmission) or that they are at risk from external factors such as 'lack of swimming skills' (n=3), 'underestimating the environment' (n=2) and 'shark attacks' (n=2). The two Key Informants who did not express any concerns thought that there is no more risk involved when swimming with cetaceans than with water sports (for detailed responses see Attachment 14).

##### *5.3.1.5 Key Informants' view about the swim-with dwarf minke whale industry in the Great Barrier Reef*

All of the respondents (n=21) were aware that dwarf minke whales visit the northern Great Barrier Reef each austral winter. Most respondents (60%) had encountered dwarf minkes at least once in their life time, either in the Great Barrier Reef or off the coast of New South Wales or Western Australia. The view of most of the Key Informants (n=15) about the swim-with dwarf minke whale industry in the Great Barrier Reef was positive; only two respondents were sceptical and four felt they did not know enough about it. Positive responses included the good management measures (e.g. Code of Practice, permits, monitoring) in place (n=8), the significant research and conservation benefits (n=5) and several highlighted the strong association of this industry with research and management (n=4). Nonetheless, respondents thought that the swim-with dwarf minke whale industry needs continuous monitoring and ongoing research in order to identify any long-term impacts and to address research gaps for adequate management. Key Informants also expressed concerns about the possibility of the industry expanding and about the discontinuation of funding for research (Table 5.2).

Table 5.2: Key Informants' views about the swim-with dwarf minke whale industry in the northern Great Barrier Reef

| Key Informant responses | # Responses |
|---|---|
| **Positive (n=15)** | 1 |
| **because the industry:** | |
| • is well managed (Code of Practice, permits, monitoring, use of ropes etc.) | 8 |
| • has significant research and conservation benefits | 5 |
| • associates strongly with research and management | 4 |
| • is world's best practice | 3 |
| • is managed much better than other swim-with programs | 2 |
| • is based on whale-initiated encounters - reducing risks for negative effects | 2 |
| • has the potential to be sustainable | 2 |
| • is not solely focussed on swims | 1 |
| • is the exception to the feeling that such programs should be avoided | 1 |
| • targets whales and whales are not highly philopatric | 1 |
| • does not run throughout the year | 1 |
| **Total positive because** | **31** |
| **But:** | |
| • the industry definitely needs monitoring | 1 |
| • only time will tell if any long-term impacts are occurring | 1 |
| • there are still a lot of research gaps, so difficult to form an opinion | 1 |
| • there are concerns about the industry expanding | 1 |
| • there are concerns about potential discontinuation of funding for research | 1 |
| • not certain to what degree regulations are appropriate | 1 |
| • difficult for those without permits not to have interactions | 1 |
| **Total positive but** | **7** |
| **as long as:** | |
| • the whales are not harassed | 1 |
| • permits remain restricted | 1 |
| **Total positive as long as** | **2** |
| **TOTAL POSITIVE** | **40** |
| **Sceptical (n=2)** | |
| • industry is too late to stop even if there are impacts on the whales | 1 |
| • most of the time such programs are money driven | 1 |
| **TOTAL SCEPTICAL** | **2** |
| **No opinion (n=4)** | |
| • don't know enough about it | 2 |
| **TOTAL NO OPINION** | **2** |

#### *5.3.1.6 Key Informants' perceptions of harm (consequences) to the swimmers and/or whales from individual dwarf minke whale behaviours*

The Key Informants perceived the potential of harm (consequences) to swimmers and whales to be greatest when the behaviour occurred close to the swimmers or the vessel. The potential of harm to swimmers from dwarf minke whale behaviours was perceived much higher (consistently one rating step higher) than the potential of harm to the whales (Figure 5.1 & 5.2). Four behaviours were perceived as having a high or very high potential to harm swimmers in at least one distance category. These behaviours were *breaching* within a body length of a whale (<6 metres) from swimmers and *sudden speed up*, *sharp veer away* and *high speed pass* within touching distance of a swimmer (0-1m). The reasons why Key Informants thought that these behaviours had a high or very high potential to harm swimmers included: ‘potential miscalculation of distance by the whale may cause collision with the swimmer’; ‘high speed, high energy behaviour is not easily controlled by an animal’; ‘any situation close to swimmer could be disastrous because of their body size’ and ‘any high speed behaviour at close range has the potential for harm (for detailed responses see Appendix 15). All other behaviours were rated as of medium, low or very low potential of harm, regardless of the distance they occurred to swimmers.

For the whales, only *breaching* within touching distance to the swimmer or vessel (0-1m) was perceived as having a high potential to harm the animals (Figure 5.2), because of the increased likelihood of collision with the vessel or entanglement in the rope (for detailed responses see Appendix 16).

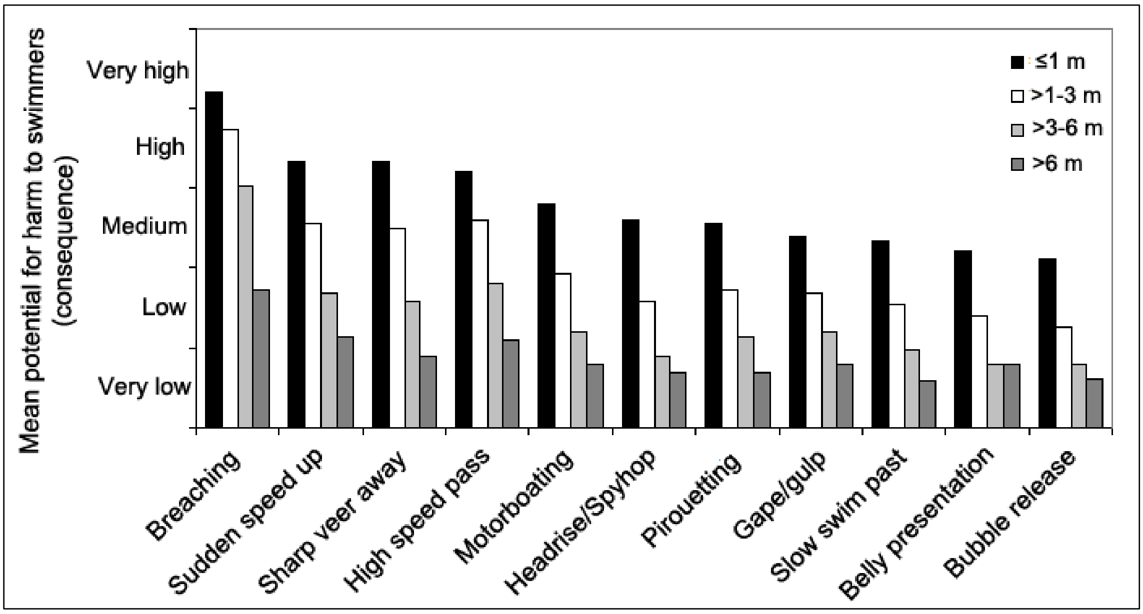



Figure 5.1: Key Informants' mean rating of the potential for harm to swimmers (rating scale from 1 = no risk - 5 = very high risk) from individual dwarf minke whale behaviours in the four assigned distance categories

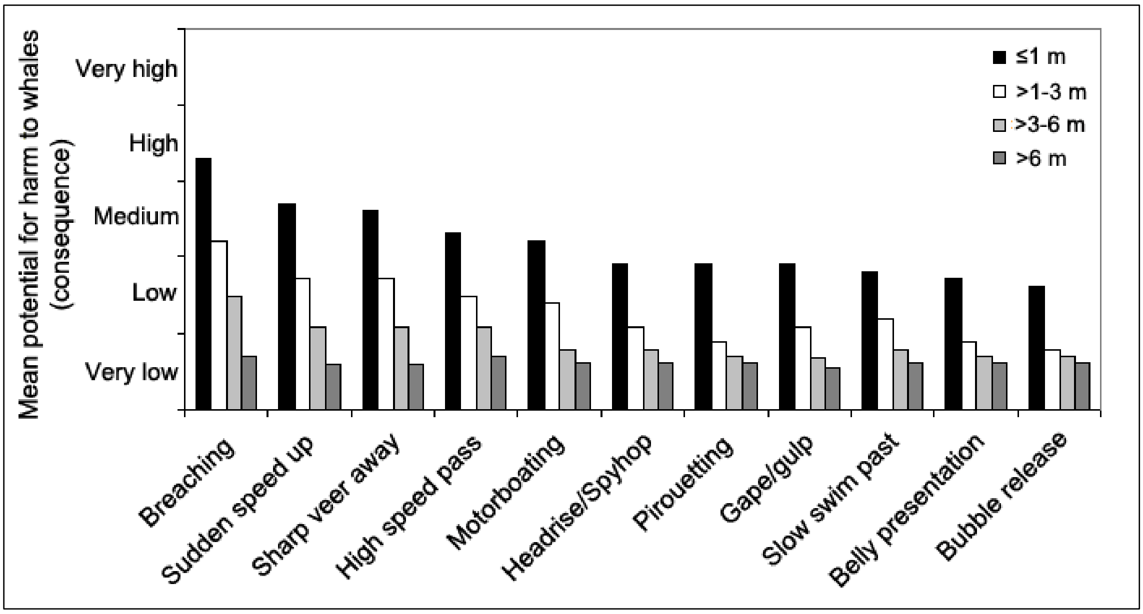



Figure 5.2: Key Informants' mean rating of the potential for harm to whales (rating scale from 1= no risk - 5 = very high risk) from individual dwarf minke whale behaviours in the four assigned distance categories

### 5.3.2 Occurrence probability of dwarf minke whale behaviours of potential harm to swimmers and/or the whales

I used empirical data to estimate the probability of an interaction featuring dwarf minke behaviours (n=9) in various distance categories. *Sharp veer aways* and *sudden speed ups* were excluded due to the unreliability of consistently observing these two underwater behaviours from the top deck of the vessel, from where most of my observations were made (2006-07). Most interactions with a behaviour closer than a whale body length to swimmers (<6 metres) occurred either occasionally (>0.1-0.2) or rarely (0-0.1). Interactions with a b*elly presentation*, *headrise/spyhop* and *bubble release* over one whale body length (>6m) away occurred frequently (>0.2-0.4). The most frequent behaviour in interactions was *slow swim past* with an occasional, frequent and very frequent occurrence (>0.6) in the distance categories ≤1m, >1-3m and >3m, respectively (Table 5.3). Most breaches are not associated with dwarf minke whales interacting with the vessel and swimmers and indeed occur on average at a distance of 920 metres from the vessel.

Table 5.3: Occurrence probability of interactions featuring dwarf minke whale behaviours of potential harm to swimmers and/or the whales in the assigned distance categories

| Behaviour | Total observed interactions (N) | Occurrences of interactions/encounters with dwarf minke whale behaviours in the assigned distance categories | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ≤1 metre | | >1-3 metres | | >3-6 metres | | >6 metres | |
| | | n | Probability | n | Probability | n | Probability | n | Probability |
| *Slow swim past* | 101 | 17 | 0.17 | 35 | 0.35 | 74 | 0.73 | 101 | 1 |
| *Belly presentation* | | 1 | 0.01 | 1 | 0.01 | 17 | 0.17 | 40 | 0.40 |
| *Headrise/Spyhop* | | 5 | 0.05 | 5 | 0.05 | 7 | 0.07 | 26 | 0.26 |
| *Motorboating* | | 5 | 0.05 | 5 | 0.05 | 10 | 0.10 | 17 | 0.17 |
| *Bubble release* | | 0 | 0 | 0 | 0 | 3 | 0.03 | 22 | 0.22 |
| *High speed pass* | | 0 | 0 | 0 | 0 | 7 | 0.07 | 14 | 0.14 |
| *Gape/Gulp* | | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0.10 |
| *Pirouette* | | 1 | 0.01 | 0 | 0 | 1 | 0.01 | 3 | 0.03 |
| *Breach* | 209 | 0 | 0 | 0 | 0 | 2 | 0.01 | 40 | 0.19 |

### 5.3.3 Risk of harm to swimmers or the whales from dwarf minke whale behaviours

#### *5.3.3.1 Risk of harm to swimmers*

By combining the Key Informants' perceptions of harm to swimmers with the estimated probability of occurrence, the majority of dwarf minke whale behaviours were rated as of low risk of harm to the swimmers. *Breaching* (≤ 6 metres) and *high speed pass* (≤ 1 metre) were perceived to be of high and very high risk of harm respectively, but due to their rare occurrence in interactions, these two behaviours were regarded as only of medium risk of harm to swimmers. No behaviour was therefore regarded as of high risk of harm to the swimmers (Figure 5.3).

#### *5.3.3.2 Risk of harm to dwarf minke whales*

The risk of harm from all except one dwarf minke whale behaviour to the whales themselves was regarded as low. Only *breaching* within touching distance to swimmers or the vessel was regarded as of medium risk of harm to the whales due to the perceived high potential of harm to the animals. No behaviour was regarded as of high risk of harm to the whales (Figure 5.4)

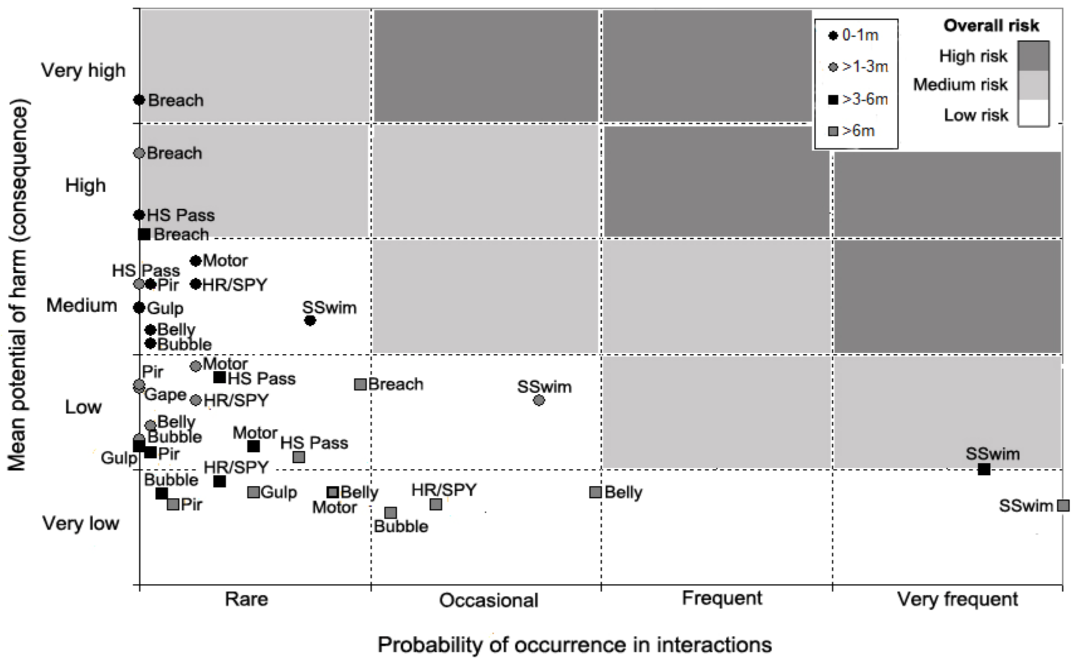
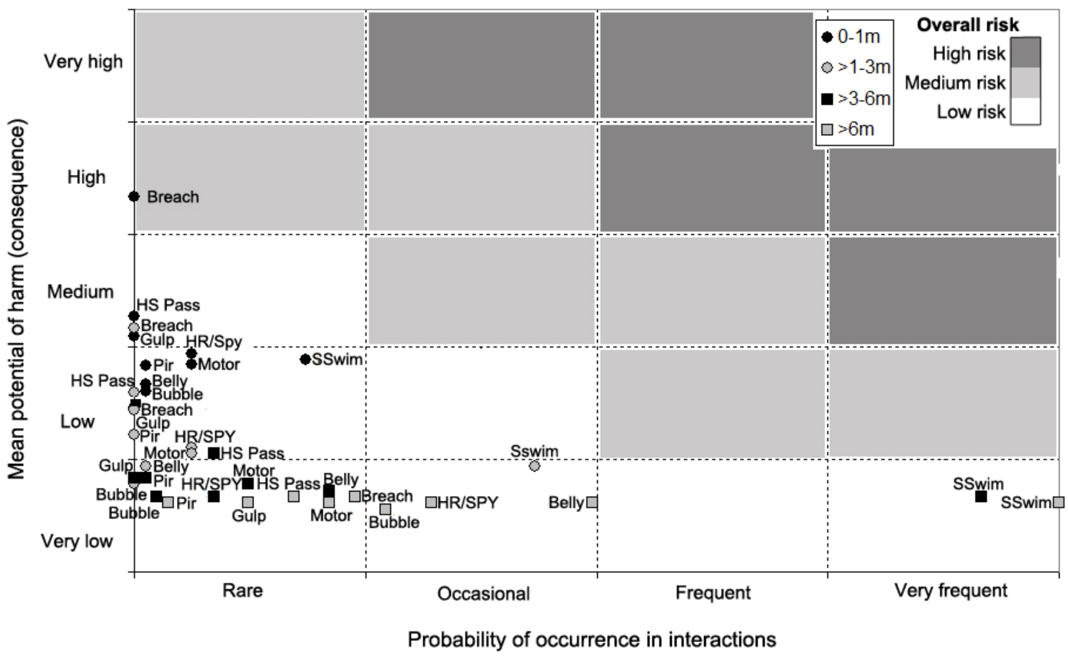



Figure 5.3 Risk of harm to swimmers from dwarf minke whale behaviours in the assigned distance categories (≤1 metre; >1-3 metres; >3-6 metres; >6 metres) with respect to the occurrence probability of the behaviour in interactions and the potential for harm (consequences) perceived by Key Informants




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Abbrev: | Belly | = | Belly presentation | HR/SPY | = | Headrise/Spyhop | Pir | = | Pirouetting |
| | Bubble | = | Bubble blast | HS Pass | = | High speed pass | SSwim | = | Slow swim past |
| | Gulp | = | Gape/Gulp | Motor | = | Motorboating | | | |

Figure 5.4 Risk of harm to dwarf minke whales from their behaviours in the assigned distance categories (≤1 metre; >1-3 metres; >3-6 metres; >6 metres), with respect to the occurrence probability of the behaviour in interactions and the potential for harm (consequences) perceived by Key Informants

### 5.3.4 Interactions with dwarf minke whale behaviours of greater harm to swimmers and/or whales

Dwarf minke whale behaviours perceived of having a medium or higher potential to harm swimmers occurred in 20 interactions (19.8%) over the researcher period (2006-2008). These behaviours were *headrise*, *pirouetting*, *motorboating*, *belly presentation*, *slow swim past* within touching distance (≤ 1 metre) and *breach* between half and one whale body length (>3-6 metres) of a swimmer. Apart from *breaching,* all behaviours are considered to have an investigative function (see Chapter 3). Most of those behaviours were displayed by only four individual whales. All of these were whales which had been seen more than once, i.e. resighted whales. These four individuals accounted for 92% of *headrises*, 69% of *motorboating*, 59% of *slow swim pasts* and all *headrises* and *pirouettes*, and were present in only four of the 101 interactions. The only behaviour perceived of having a high potential to harm swimmers was close *breaching* which occurred twice, displayed both times by a calf (Table 5.4)

### 5.3.5 Dwarf minke whales making physical contact with objects and swimmers

Individual dwarf minke whales made physical contact with objects (e.g. ropes, dinghy) or swimmers on 22 occasions during my three year research period (Table 5.5).
In 2007, an unidentified whale became entangled in the rope which passengers hold onto. At this time five whales were present but only one swimmer (volunteer researcher) was in the water holding the rope with a buoy attached to the end. Observations and photos suggest that the whale was *headrising* in close vicinity to the rope and fell backwards onto it with its dorsal side. While turning over, the whale

managed to get a loop of the rope around its body. The whale was startled and swam vigorously forward dragging the rope, attached buoy and the volunteer researcher through the water with great force. The volunteer researcher let go of the rope which became submerged together with the surface buoy. The buoy bobbed to the surface some seconds later with a broken piece of rope attached. Inspection after the incident revealed that the main (thicker) rope was intact. However, the thinner rope holding the buoy at the end of the line had been broken. All whales involved in the encounter disappeared instantly.

Table 5.4 Individual dwarf minke whales exhibiting behaviours of greater risk to harm swimmers

| Whale ID (Catalogue #) | Behaviour | N interactions | Frequency of behaviour per interactions | [2] % of total frequency of behaviour | Distance category | [1] Perceived risk of harm |
|---|---|---|---|---|---|---|
| 'Pavlova' (0048) | *Headrise* | 1 | 27 | 67.5 | ≤ 1 m | Medium (S) Low (W) |
| | *Slow swim past* | | 10 | 19.2 | | |
| | *Pirouetting* | | 7 | 100 | | |
| | *Motorboating* | | 4 | 45 | | |
| | *Belly presentation* | | 1 | 100 | | |
| 'Male Whale' (0109) | *Headrise* | 1 | 6 | 15 | | |
| | *Slow swim past* | | 5 | 9.6 | | |
| | *Motorboating* | | 1 | 11 | | |
| 'Shirley Shark Bite' | *Headrise* | 1 | 5 | 12.5 | | |
| | *Slow swim past* | | 13 | 25 | | |
| | *Motorboating* | | 1 | 11 | | |
| 'Tail Specks' (0004) | *Slow swim past* | 1 | 3 | 5.8 | | |
| | *Motorboating* | | 1 | 11 | | |
| [3] ? | *Motorboating* | 1 | 2 | 22 | | |
| ? | *Headrise* | 1 | 1 | 2.5 | | |
| ? | *Slow swim past* | 13 | [*]21 | 40.4 | | |
| ? | *Headrise* | 1 | 1 | 2.5 | | |
| Calf (0217) | *Breach* | | 1 | 50 | >3-6 m | High (S) Low (W) |
| Calf ? | | 1 | 1 | 50 | | |

[1] S = to swimmer; W = to whales
[2] overall interactions
[3] ? = unidentified whale
[*] ranging from 1-3 / interaction

Table 5.5 Incidents of physical contact between dwarf minke whales and objects and swimmers (total interactions reported via the WSS in 2006 = 129; 2007 = 154, and 2008 = 154)

| Date | Whale ID | Data source | Description | # |
|---|---|---|---|---|
| **2006** | | | | |
| 14.06 | ? | IBD | Whale nudged dinghy | 1 |
| 19.06 | ? | RO's | Whale touched mooring rope during a headrise | 1 |
| 30.06 | ? | IBD | Whale touched rope with its fluke | 1 |
| | | | **TOTAL 2006** | **3** |
| **2007** | | | | |
| 30.06 | Pavlova | Video | Whale touched rope with snout | 1 |
| 30.06 | | Video | Whale touched rope with fluke | 1 |
| 02.07 | | Video | Whale touched rope with snout | 2 |
| 02.07 | | Video | Whale pushed rope aside during a headrise | 1 |
| 11.07 | | RO's | Whale touched researcher's slate with fluke | 1 |
| 05.07 | ? | RO's | [1]Whale entangled in rope | 1 |
| 29.06 | ? | WSS | Whale touched rope | 1 |
| 03.07 | ? | WSS | Whale touched anchor chain | 1 |
| 15.07 | ? | WSS | Whale touched a crew member | 1 |
| 02.07 | ? | WSS | Whale touched passengers flipper with its fluke | 1 |
| | | | **TOTAL 2007** | **11** |
| **2008** | | | | |
| 18.06 | ? | WSS | Whale tail hit passengers flipper | 1 |
| 26.06 | ? | WSS | Whale touched rope | 1 |
| 01.07 | ? | WSS | Whale swam over rope after a headrise | 1 |
| 03.07 | ? | WSS | Whale touched diver with pectoral fin | 1 |
| 05.07 | ? | WSS | Whale touched rope | 1 |
| 07.07 | ? | WSS | Whale swam over rope | 1 |
| 16.07 | ? | WSS | Whale pulled float on mermaid line underwater | 1 |
| 20.07 | ? | WSS | Whale touched passengers flipper | 1 |
| 26.07 | ? | WSS | Whale touched rope | 1 |
| | | | **TOTAL 2008** | **9** |

[1] Whale entanglement incident as described above (see 5.3.5)

Abbreviations:
RO's = Researcher (volunteer) observations
IBD = Interaction Behaviour Diary; passenger questionnaire
Video = Video sequences from crew and passengers donated to the photo ID project
WSS = Whale Sighting Sheets

## 5.4 DISCUSSION

Most dwarf minke whale behaviours were of low risk of harm to the swimmers and the whales irrespective of distance. The low risk of harm to swimmers and the whales was due to the fact that the closer the behaviours to swimmers or vessel (distance categories with higher risk rating), the lower the probability of occurrence. Nevertheless, 20

(19.6%) of the observed interactions involved at least one whale behaviour which was perceived as of elevated (medium/high) harm. There is considerable evidence that most of these behaviours were of investigative nature, displayed by only few individual resighted whales. The Key Informants perceived the potential of harm to swimmers to be much higher than the potential of harm to the whales themselves. The Key Informants were more concerned about the wellbeing of the whales in the medium to longer term, i.e. the potential of such industries to change the behaviour of the whales in the longer term and impact on their behavioural budget and fitness.

### 5.4.1 Direct risk of harm to swimmers from dwarf minke whales

Despite of their very rare occurrences in interactions, two behaviours, *breaching* (<6 metres) and *high speed passes* (<1 metre) were regarded as of medium risk of harm to swimmers. Key Informants thought that these two behaviours had a high and very high potential to harm swimmers due to the close proximity and the associated potential detrimental impact of an accidental whale-swimmer collision. I never observed *high speed passes* within touching distance of a swimmer during my research period, thus the medium risk of harm to swimmers from this behaviour may not be of great concern. I observed a *breach* twice within a whale body length (<6 metres) of a swimmer. Both *breaches* were displayed by a calf.

Calves are regarded as particularly playful and inquisitive (Lien, 2001) and are unpredictable in their behaviour and movement. The presence of a calf may potentially alter the behaviour of its mother and also of other whales. Two people have been seriously injured in a swim attempt with a humpback whale mother and calf in the Dominican Republic (Rose et al., 2007) and one person was charged by a southern right whale mother (Venter, 2008). In both cases, the mother reacted violently to the close proximity of swimmers to its calf. Only a few cow-calf encounters are recorded each season for dwarf minke whales in the northern Great Barrier Reef (Birtles et al., 2002a). It is against Australian law to allow people into the water when a cow-calf pair is present (DEH, 2005). Nonetheless, people already in the water can remain there if approached by a cow and calf. Considering the risk involved in swimming with calves and the unpredictability of the behaviour of the whales, I recommend that such in-water interactions are terminated immediately by the operator and passengers urged to enjoy the encounter from the deck of the vessel.

### 5.4.2 Risk of harm to swimmers associated with individual whales

Investigative behaviours such as *headrise*, *pirouetting*, *motorboating*, *belly presentation* and *slow swim past* within a close range (≤ 1 metre) of the observers were perceived to have an elevated potential to harm swimmers. These behaviours, occurred in 20% of all the interactions observed but were displayed by only a few very inquisitive whales. Indeed, four known individual whales accounted for most of the perceived harmful behaviours in only four interactions. Investigative behaviours were associated with the presence of resighted whales (see Chapter 3). Dwarf minke whales show a strong attraction to vessels and swimmers and the more familiar the whales are with the stimulus (i.e. resighted whales) the more confident and curious they become (see Chapter 4).

Also, the presence of familiar whales may increase the confidence and/or levels of excitement of other individuals, as reported in other animals (see Chapter 4). The stimulated confidence of other individual dwarf minke whales may add to the concern for the wellbeing of the swimmers.

Eliminating the exposure of swimmers to such highly inquisitive whales would therefore almost remove the risk of harm to the swimmers from such behaviours. If highly interactive and curious whales are present I recommend that staff monitor the interaction with particular vigilance and terminate the experience and retract all ropes from the water if an individual whale shows behaviours such as *pirouettes*, *headrises, motorboating, belly presentations* and/or *slow swim pasts* within touching distance of a swimmer.

Terminating an interaction with a highly interactive whale may result in passenger dissatisfaction. It has been shown that the closer dwarf minke whales approached the swimmers, the higher the satisfaction of the observers (Valentine et al., 2004).

To prevent potential disappointment, passengers need to be made aware of the risk involved when swimming with wild cetaceans. This information should be included in the briefings at the start of their trip. Management measures including the termination of an encounter in a situation when a highly inquisitive individual whale or a calf is present need to be made explicit. A consent form at the start of the trip may help with enforcing this risk mitigation strategy.

The potential for intended or accidental injury to swimmers in close contact with a large and powerful animal such as a whale cannot be eliminated. Many studies on marine mammal-human interactions (in particular swims) express concerns about the safety of the public involved (e.g. Samuels et al., 2003; Scarpaci et al., 2005). As outlined in the introduction, there have been numerous incidents where people have been injured while in close contact with wild marine mammals such as pinnipeds (Christie, 1998; Kirkwood et al., 2003), odontocetes (Orams et al., 1996; Samuels et al., 2000; Santos, 1997; Shane et al., 1993; Wilson, 1994) and baleen whales (Hall, 2000;

Rose et al., 2007). Most of these studies report on human injuries or fatalities resulting from antagonistic behaviours of the animals which were either provisioned with food and/or harassed by humans prior to the incidents.

Dwarf minke whales rarely exhibited behaviours which are regarded as aggressive or agonistic in other cetaceans (see Chapter 3). Aggressive behaviours may be naturally reduced in these whales due to their life history (e.g. absence of hierarchical structures Norris, 1967; Whitehead, 2003). Current knowledge of the behaviour of dwarf minke whales however is limited to the behaviour displayed in interactions with a tourism based industry in the Great Barrier Reef. Without detailed knowledge about the baseline behaviour and social structure of dwarf minke whales, it is challenging to determine the intent of a behaviour, i.e. whether or not it is aggressive.

Preventive measures are in place to minimise harassment of whales. Operations and their swimmers must adhere to the Code of Practice (Birtles et al., 2008) which includes the Australian National Guidelines for swimming with cetaceans (DEH, 2005). The Code of Practice includes the use of ropes, for swimmers to hold onto while swimming with the whales. The rope not only provides a floatation device for swimmers and stops them drifting away from the vessel, but more importantly can help prevent swimmers from moving towards the whales. In order to avoid startle reactions from whales, swimming towards a whale, making physical contact with a whale and moving rapidly in the water are against Australian law. Swimmers are usually briefed on the guidelines prior to entering the water and crew are required to enforce the Code of Practice throughout an interaction.

### 5.4.3 Risk of harm to swimmers from external factors

Key Informants identified risks of harm from the external environment as additional potential concerns to swimmers. Conditions are often unpredictable and underestimated (e.g. currents, wave action) and potential hazards include fatigue, hypothermia and ultimately drowning (Wilks and Davis, 2000). The sea is often rough (Beaufort ≥ 4) during dwarf minke swims in the austral winter months (Birtles et al., 2002a). Management measures, such as holding onto ropes while in the water and permanent supervision of swimmers from the top deck of the vessel by crew help to limit the risk.

Another, unpredictable risk of harm to swimmers in open seas is from sharks, in particular when swimming near or with animals which are potential prey. Shark attacks have been reported from swims around seal colonies (Kirkwood et al., 2003) and a Tongan guide has been attacked while swimming with humpback whales (Stanley, 2005). Sharks such as, silvertips (*Carcharhinus albimarginatus*), grey whalers (*Carcharhinus amblyrhynchos*) and bull sharks (*Carcharhinus leucas*) were sighted every season during dwarf minke whale swims (pers. obs.). Encounters with these predators are rare (personal observation).

### 5.4.4 Risk of harm to dwarf minke whales

All dwarf minke whale behaviours, except *breaching* within touching distance of swimmers/vessel, were regarded as of low risk of harm to the whales regardless of the distance. Very close *breaching* was regarded as of medium risk to the whales, due to the perceived high potential of harming the whales.

Irrespective of the perceived low potential of harm to the whales, their curious nature generates concerns for their safety. Safety concerns are greatest for whales familiar with the stimulus (resights) and in particular for whales which make (or have repeatedly made) physical contact with objects such as the dinghy, swimmers and the rope (see Chapter 4). These concerns were substantiated in 2007 when an unidentified whale got entangled in the rope which swimmers hold onto while in the water. Fortunately the one person in the water was unharmed during this very vigorous episode and the whale freed itself by breaking the thinner line to which a buoy was attached at the end of the rope.

Many instances of entanglement of marine mammals in ropes and fishing gear have been documented (Kraus, 1990; Lien, 1994; Knowlton and Kraus, 2001; Knowlton et al., 2005). One study on scarring of humpback whales in Alaska revealed that a significant proportion of the population is affected by entanglement (Neilson, 2006). Numerous probable entanglement scars have been observed on dwarf minke whales by members of the research team however the actual proportion of such damaged whales is yet to be established. The high level of curiosity of dwarf minke whales and their evident increased attraction (habituation Type II) to vessels and human presence (see Chapter 4) may increase their vulnerability to accidental entanglement in fishing gear or marine debris in particular if this behaviour is maintained outside the study area and in these different contexts. Currently there is very limited information on the migratory path of these whales or where they go when leaving the well protected waters of the Great Barrier Reef. Such information is crucial to assess and manage potential threats to dwarf minke whales from existing or future planned anthropogenic developments. To limit the risk of a dwarf minke becoming entangled during swim-with interactions, I recommend terminating interactions and retracting the rope from the water if highly interactive and curious whales are present.

### 5.4.5 Indirect risk of harm to dwarf minke whales

Key Informants were particularly concerned about the behavioural consequences (e.g. disruption of critical behavioural states, adverse effects on the time-activity budget) which may result from interactions with humans. These concerns are substantiated by the literature reporting on negative impacts on the animals from whale watching including swims (Kruse, 1991; Blane and Jaakson, 1994; Williams et al., 2002b; Lusseau, 2003a; Buckstaff, 2004; Constantine et al., 2004; Lemon et al., 2006; Stockin et al., 2008). Most of these studies concerned odontocetes and not much is known about such impacts on baleen whales. Also only a few studies were able to link short-term behavioural responses to changes affecting the fitness of the targeted population in the longer term (Lusseau, 2004; Stockin et al., 2008).

This research into dwarf minke whales biology and behaviour is limited to: (1) the interacting population, i.e. whales which approach vessels, and (2) the endorsed swim-with whale industry. There are indications that the interacting population is smaller than previously thought (Sobtzick, in prep). The overall population size of dwarf minke whales in the Great Barrier Reef however is unknown and it is unclear what proportion of the population is interacting with vessels and their swimmers. In addition, nothing is known about the baseline behaviour of these whales and what they are doing when they are not interacting with humans.

Currently only the endorsed industry is obliged to report encounters with dwarf minke whales. There is only very limited knowledge about how many boats and swimmers (commercial and private) are interacting with these whales. The endorsed industry forms only a small part of the vessels operating in the Great Barrier Reef Marine Park. The exploratory behaviour of dwarf minke whales and the high numbers of vessels in the Marine Park, indicates that encounters/interactions with dwarf minke whales could be very frequent (see Chapter 4). Without a monitoring scheme which includes all vessels operating in the Great Barrier Reef it is therefore difficult to determine if and to what degree the swim-with industry will affect the overall behaviour budget of these whales.

Addressing these research gaps is vital to determining the overall sustainability of the dwarf minke whale swim-with industry in the Great Barrier Reef.

Knowing that dwarf minke whales are strongly attracted to vessels and swimmers and decrease their approach distances over time, there is the potential that the risk for both the swimmers and the whales may change over time. The continuation of the present monitoring program is therefore strongly recommended.

### 5.4.6 Risk of harm to the swim-with dwarf minke whale industry

The major risk for the swim-with dwarf minke whale industry is an incident/fatality involving a swimmer or a whale during an interaction. A (fatal) incident will trigger a legal investigation process which may, depending on the circumstances, incur financial hardship and/or legal prosecution to the involved industry party. An incident will also entail negative publicity from media reports, which ultimately will lead to a loss of reputation. Negative media reports will also inflame public discussion on whether or not such practices should be allowed. Australia is one of few countries in the world allowing swim-with whale operations. The likely negative public perceptions following an incident could even cause the Great Barrier Reef Marine Park Authority to reconsider the endorsement of such practices.

My results clearly indicate that there are potential risks involved in swimming with dwarf minke whales. It is therefore essential for the industry to stay well within the legal requirements (i.e. following the Code of Practice and the Australian National

Guidelines), to incorporate the recommendations stated in this risk assessment in their operation (i.e. briefing passengers on the risks involved and terminating interactions with a calf and/or highly interactive whales). The industry may even consider additional legal precautions such as a liability waiver which each passenger signs before swimming with the whales.

The risk of harm not only to the whales but for the industry itself may increase if new and inexperienced operators become endorsed. Two swim-with dwarf minke whales operators ceased business in 2008 and their permit endorsements are up for sale. To ensure the integrity of the industry and the safety of the whales and passengers, it is essential that: (1) new operators undergo quality training before endorsed swim-with operations commence, and (2) potential purchasers of permits are very carefully scrutinised on their past performance and standards.

### 5.4.7 Chapter summary

- The risk of harm to the whales and swimmers from swimming with dwarf minke whales is relatively low.
- Dwarf minke whale behaviours, perceived of having a medium or higher potential to harm swimmers occurred in 20 interactions (19.8%) over the research period (2006-2008). These behaviours were *headrise*, *pirouetting*, *motorboating*, *belly presentation* and *slow swim past* within touching distance (≤ 1 metre) and *breach* between half and one whale body length (>3-6 metres) of a swimmer.

- Most observed dwarf minke whale behaviours with an elevated potential to harm swimmers were exploratory behaviours associated with individual whales familiar with the stimulus (i.e. resighted whales).
- Key Informants identified risks to swimmers' safety from the external environment (i.e. weather and water conditions & presence of sharks) which need to be assessed by crew on a case by case basis.
- Very interactive whales are at a higher risk of entangling in the rope (which swimmers hold onto). The observed high level of curiosity of dwarf minke whales and their evident attraction to vessels and human presence increases their vulnerability to accidental entanglement in fishing gear or marine debris.
- The full consequences of this industry to the whales' wellbeing are still unknown (e.g. potential for behavioural changes, disruption of important behavioural states, higher probability of entanglement in fishing gear, etc.) and need to be addressed in future research.

# CHAPTER 6

## MONITORING OF DWARF MINKE WHALE BEHAVIOURS AND INSIGHTS INTO PERCEPTIONS OF PASSENGERS REGARDING BEHAVIOURS OF POTENTIAL HARM

This chapter evaluates the validity and effectiveness of dwarf minke whale behaviour records by crew, reported via the Whale Sighting Sheets. Completing a Whale Sighting Sheet after each encounter with dwarf minke whales is a permit condition used to gain information on the encounter details (e.g. location, duration, number of whales present and behaviours displayed by the whales). I also provide details on the perceptions of passengers about swimming with dwarf minke whales which highlight knowledge gaps on the risk associated with such practices. Addressing these key parameters in future briefings and interpretive material will help to improve effective encounter management.

## 6.1 INTRODUCTION

In a conservation framework monitoring is a process of continuous and repetitive observation of elements of the environment (Selman, 1992). In the last decades, environmental monitoring has concentrated either on the ecosystem (e.g. condition of the environment, biodiversity) or on the resilience of species (e.g. population dynamics and abundance) (Lancia et al., 1994; Allen et al., 1996; Pollock et al., 2002). Practices to monitor behavioural changes in wildlife associated with human industries such as tourism is only commencing (Borrie et al., 1998; Green and Giese, 2004; Higginbottom, 2004). Changes in behaviour of animals associated with anthropogenic activities are seen as the first warning sign of a negative impact on the animals (Frohoff, 2004). Some impacts on the natural environment are very obvious e.g. habitat loss, however detecting changes in wildlife behaviour is challenging, as the effects are cumulative rather than catastrophic (Bejder and Samuels, 2003). Cumulative effects on wildlife are particularly difficult to reverse unless detected early (Higginbottom and Buckley, 2003). Also, impacts of human recreation on wildlife can occur at all levels, from individuals through communities and populations (Knight and Cole, 1995). Implementing systems for early detection of changes in the behaviour of wildlife in response to tourism is therefore particularly important, to ensure ecological sustainability of such industries (Green and Giese, 2004).

Monitoring is most effective over a long period, providing extensive reporting, rather than short term, intensive studies (Berrow, 2003), as it allows a change to be detected above and beyond the natural temporal fluctuations in the system in question (Field et al., 2007). To achieve successful monitoring several principles need to be adhered to: (1) the objectives of the monitoring scheme should be clear and achievable and the data collected needs to be viable, (2) a monitoring scheme should measure parameters sensitive enough to detect change at the appropriate scale and with sufficient statistical power and (3) monitoring needs to be financially sustainable and the results analysed in regular intervals to determine if standards are being met (Yoccoz et al., 2001; Vaske et al., 2002; Whittaker et al., 2002; Berrow, 2003; Higginbottom et al., 2003; Green and Giese, 2004; Higginbottom, 2004; Field et al., 2007). Prompt analyses of the data is critical as the findings may provide an early warning that something is changing, which should trigger a dedicated study (Berrow, 2003). Also if results point to deficiencies, it can be used to refine the monitoring program (Field et al., 2007).

Unfortunately these requirements are often not met, particularly in relation to wildlife tourism (Higginbottom et al., 2003). The difficulties of meeting these criteria include financial constraints, limited access to the animals, high level of variability of wildlife responses and lack of scientific knowledge about the biology, ecology and behaviour of the species (Higginbottom et al., 2003; Green and Giese, 2004). Under tight financial constraints, deficiencies commonly occur in both the statistical power for a given survey effort and the skills to draw firm conclusions from the monitoring data (Field et al., 2005). The need to optimise survey designs by maximising statistical power and minimising financial costs is therefore paramount.

The issue of power to detect real changes early enough to manage tourism-wildlife interactions effectively is critical (Higginbottom, 2004). Although rigorous statistical analysis should be used to validate monitoring data, excessive dependence on such tests may obscure biological patterns (Karr and Chu, 1997). Dependence on narrow statistical approaches overlooks the fact that a statistically significant result may not equate with an effect of biological importance (Stewart-Oaten et al., 1986; Yoccoz, 1991; Stewart-Oaten, 1996). Management objectives, rather than arbitrary statistical conventions, should determine conclusions drawn from data and actions thus triggered

(Field et al., 2005; Field et al., 2007). Also, there is a need for greater collaboration between managers, scientists, and in the case of wildlife tourism, tourism operators to implement valid and realistic monitoring protocols (Birtles et al., 2001a; Higginbottom et al., 2003).

Utilising tourism industries for wildlife monitoring purposes can prove useful, as long as standardised, appropriate sampling methods are used, and the precautionary principle is adopted in the face of uncertainty (Hare et al., 1990; Birtles et al., 1996; Valentine et al., 2004). There is some literature emerging that there is great value in the information gathered by those working in the tourism industry, conservation agencies or by amateur naturalists (e.g. Gregr and Trites, 2001; Dalebout et al., 2003; Hauser et al., 2006; Sobtzick, in prep). Operators become increasingly aware of the necessity to adopt good practices and ensure that impacts on wildlife they depend on is minimised (Green and Giese, 2004; Higginbottom, 2004). Monitoring changes in wildlife behaviour is essential for any wildlife tourism operation to continue without causing undue disturbance (Berrow, 2003). Such information may even prove highly valuable as a research tool if avenues are provided to develop robust protocols and share results (Berrow, 2003).

In order to effectively manage both visitors and operators, management agencies need to consider: (1) the magnitude of acceptable change, (2) the potential to achieve the objectives, (3) the expertise and labour required, and (4) the costs involved (Vaske et al., 1995; Vaske et al., 2002; Whittaker et al., 2002; Higginbottom et al., 2003). Effective management in this context depends on a range of factors including accessibility of scientific knowledge and levels of visitor understanding and their concern about impacts and/or risks (Whittaker et al., 2002). It is desirable therefore to also monitor the characteristics and perceptions of visitors (Higginbottom, 2004).

For the swim-with dwarf minke whale industry in the Great Barrier Reef, several monitoring tools have been established: (1) to provide information on encounters with the whales, (2) to evaluate encounter management performance over time, and (3) to gain knowledge about passengers. These instruments have been implemented in collaboration with all stakeholders, i.e. the tourism industry, management agencies and researchers (Birtles et al., 2002a; Birtles et al., 2002b; Valentine et al., 2004; Birtles et al., 2009). Nevertheless, there is currently insufficient knowledge about the validity of some data collected by the industry, e.g. data on the behaviour of the whales, this deficiency urgently needs to be addressed.

The aims of this chapter were: (1) to test the validity of data on whale behaviours collected by the industry, and (2) to establish the perceptions of passenger regarding the risk involved in swimming with these whales. Both are essential for the management of human-dwarf minke whale interactions and for effective risk management.

## 6.2 METHODS

### 6.2.1 Occurrences of dwarf minke whale behaviours reported by the endorsed industry using the Whale Sighting Sheet

Completing a Whale Sighting Sheet after each dwarf minke whale encounter is a permit condition (see Chapter 2 – General Methods). I used the data collected in the whale behaviour box of all completed Whale Sighting Sheets from 2006-2008 (see Appendix 1; Question 27) to establish an index of occurrences of dwarf minke whales behaviours from all reported encounters/interactions of the endorsed industry. Apart from the encounter details (e.g. length of interaction, number of whales, location, boat status, etc.) it provides information on the occurrence of dwarf minke whale behaviours observed by crew. These behaviours were: (1) *belly presentation*, (2) *close approach (>1-3 metres)*, (3) *headrise*, (4) *bubble release*, (5) *gape/gulp* and (6) *breach* (2006 onwards); *motorboating*, *very close approach (≤ 1 metre)* and *pirouette* (2007 onwards). *Physical contact* by dwarf minke whales was integrated into the Whale Sighting Sheets in 2008. As in Chapter 3 of my PhD study, the occurrences are based on the presence – absence of dwarf minke whale behaviours in interactions/encounters, providing a more robust indication of how often these whale behaviours occur.

### 6.2.2 Comparison of dwarf minke whale behaviour occurrences in interactions between the Whale Sighting Sheet and researcher observations (2006-2008)

In order to evaluate whether or not it is possible for the industry to collect valid behavioural data, I compared the Whale Sighting Sheet data to my observational data presented in Chapter 3. Due to the difficulties and bias involved in observing behaviour without a determined sampling protocol, my data and the Whale Sighting Sheet data were compared at the level of presence-absence of the behaviours in interactions or encounters. I analysed the data comparison with a Chi-square test of independence ($\alpha$-level 0.05) (Zar, 1999).

### 6.2.3 Association of investigatory behaviours with very close approaches (≤ 1 metre) of dwarf minke whales to swimmers and/or the vessel.

I used a Generalized Linear Model (binomial distribution, logit function) to test which of the identified investigatory behaviours reported via the Whale Sighting Sheets (i.e. *close approach (>1-3 metres)*, *pirouetting*, *motorboating*, *headrise;* see Chapter 3) significantly influenced the occurrence of *very close approaches (≤ 1 metre)* which were perceived as having an elevated potential to harm swimmers (see Chapter 5). The model was checked for data over-dispersion with four Goodness-of-Fit tests (Deviance, Scaled deviance, Pearson $Chi^2$, Scaled Pearson $Chi^2$). The analysis was conducted using the statistical program STATISTICA 8.0.

### 6.2.4 Time to the first occurrence of a *close approach (>1-3 metres)* and *very close approach (≤ 1 metre)* by dwarf minke whales to swimmers and the vessel

I analysed my observational data (2006-2008) to determine when in swim-with interactions behaviours of elevated potential of harm to swimmers (i.e. *close (>1-3 metres)* and *very close approaches (≤ 1 metre)* of whales to swimmers/vessel) occurred. I established three time-based categories: (1) 1-60 minutes, (2) 61-120 minutes, and (3) >120 minutes in an interaction, and analysed the data with a Chi-square goodness-of-fit test ($\alpha = 0.05$).

### 6.2.5 Passengers' satisfaction rates and perceptions of management of their in-water interactions

I used the Interaction Behaviour Diaries (2006-2008; see Chapter 2 and Appendix 17) to determine the passenger satisfaction about their in-water interactions. Passengers were asked to rate the satisfaction of their interactions on a rating scale from 1 = very poor to 10 = excellent (see Appendix 17, question 15). I used a Mann-Whitney-U test ($\alpha$ = 0.05) to investigate whether the satisfaction of passengers was different in interactions where *very close approaches (≤ 1m)* were present from these in which such behaviour was not observed. Passengers were also asked to rate their satisfaction with the management of their interactions on a rating scale from 1 = very poor to 10 = excellent (see Appendix 17, question 16). Data on passengers' satisfaction and of the management of their interactions are reported using descriptive statistics (i.e. mean, standard error).

### 6.2.6 Passengers' perceptions of dwarf minke whale behaviours and their concerns about swimming with these whales

Passengers were asked if they felt there were any whale behaviours which could potentially put either swimmers or whales at risk in the Interaction Behaviour Diaries (2007-2008; Appendix 17, question 20). In a follow-up open ended question passengers were asked to provide the reasons why they felt this way.

Passengers were also asked whether or not they had any concerns before they swam with dwarf minke whales for the first time. If they did have any concerns, passengers were asked to provide the reasons why they felt this way (see Appendix 17, question 29). Data from the closed-ended questions were analysed with descriptive statistics and I analysed the open-ended questions with a Content Analysis (see Chapter 5).

## 6.3 RESULTS

### 6.3.1 Behavioural occurrences in in-water interactions / encounters reported via the Whales Sighting Sheets

Frequency of occurrence was established for ten dwarf minke whale behaviours reported by the endorsed industry via the Whales Sighting Sheets (presence-absence in in-water interactions / encounters). The most frequently reported behaviours were *close approach (>1-3m)* and belly *presentation*. Behaviours such as *headrise*, *very close approach (≤ 1m)* and *motorboating* were seen *occasionally*. *Bubble releases*, *breaches*, *pirouettes*, *physical contact* and *gapes/gulps* were only rarely seen (Table 6.1).

Table 6.1: Ranked occurrence probabilities of dwarf minke whale behaviours reported by crew via the Whale Sighting Sheets (2006-2008)

| **Behaviour** | **Total reported interactions** | **Interactions with behaviour** | | |
|---|---|---|---|---|
| | | n | [1]Occurrence probability | Occurrence category |
| *Close approach (>1-3m)* | 437 | 193 | 0.44 | very frequent |
| *Belly presentation* | | 168 | 0.38 | frequent |
| *Headrise* | | 121 | 0.28 | occasional |
| [2]*Very close approach (≤1m)* | 308 | 72 | 0.23 | |
| [2]*Motorboating* | 308 | 65 | 0.21 | |
| *Bubble releases* | 437 | 55 | 0.13 | rare |
| [4]*Breach* | 721 | 95 | 0.13 | |
| [2]*Pirouette* | 308 | 27 | 0.09 | |
| [3]*Physical contact* | 154 | 12 | 0.08 | |
| *Gape / Gulp* | 437 | 17 | 0.04 | |

[1] Occurrence probability = Interactions where behaviour was present divided by total reported interactions
[2] Behaviours reported from 2007 onwards
[3] Behaviour reported only in 2008
[4] Occurrence of *breaching* calculated using the total number of encounters as the whale showing the behaviour is not necessarily associated with the vessel and swimmers

### 6.3.2 Comparison of behavioural occurrences between the Whale Sighting Sheets and researcher observations

There was no significant difference in the proportions of the behaviour occurrences between my behavioural observations and the observations of crew reported in the Whale Sighting Sheets ($\chi 2 = 8.48$; df = 9; $P = 0.486$; see Figure 6.1).

Very conspicuous behavioural displays such as *headrise*, *motorboating*, *close (>1-3 metres)* and *very close approach (≤ 1 metre)* and *physical contact* provided for commonalities with the best fit. The behaviours occurring underwater (e.g. *belly presentation*, *bubble releases*, *gape/gulps*) and *breaching* which occurs most often in a distance of the vessel, diverged most from my data. Overall this result indicates that at the level of presence/absence of dwarf minke whale behaviours the crew were able to identify dwarf minke whale behaviours in encounters/ interactions. It also highlights that the Whale Sighting Sheet is a useful tool to monitor the presence of behaviours in interactions.

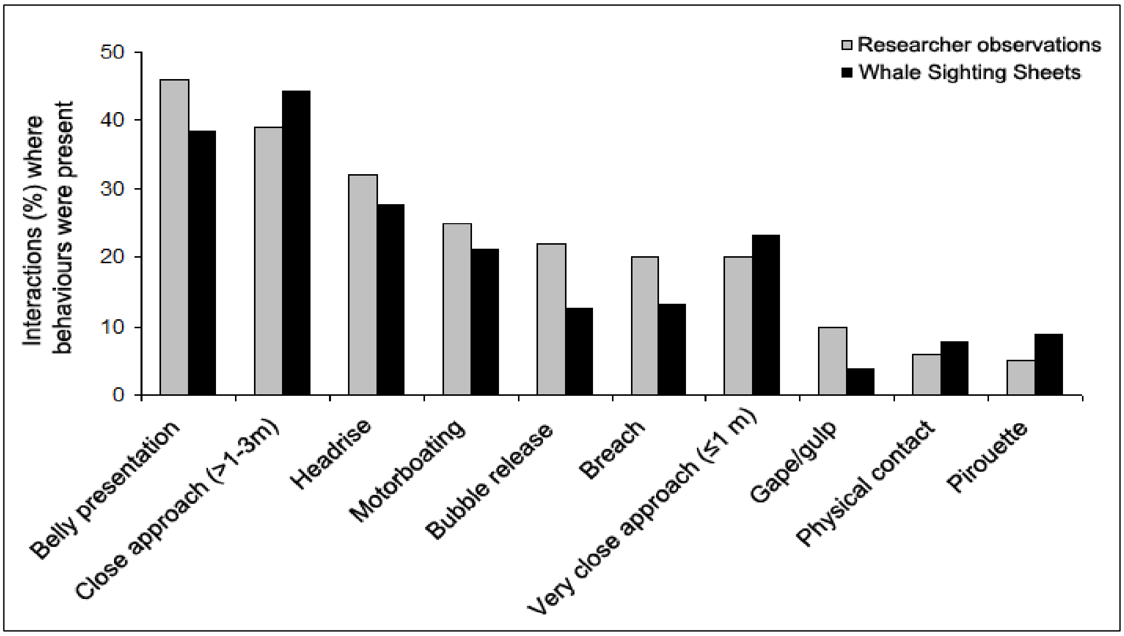



Figure 6.1 Comparison of the occurrences of dwarf minke whale behaviours between my behavioural observations and the Whale Sighting Sheets over the research period of 2006-2008

### 6.3.3 Potential influencing behaviours on the occurrence of *very close approaches* (≤ 1 metre) of dwarf minke whales to swimmers and/or vessel

All four investigatory behaviours were significantly associated with the occurrence of *very close approaches*. The likelihood of a *very close approach (≤ 1 metre)* was increased by more than five-fold if a *close approach* occurred; nearly four times with *pirouetting* and almost three times if *motorboating* and *headrises* were present in an interaction (Table 6.2). The significant association among investigatory behaviours confirms my findings presented in Chapter 3.

Table 6.2 Dwarf minke whale behaviours which significantly influence the occurrence of *very close approaches (≤ 1 metre)* of the whales to swimmers or vessel

| Behaviour | Effect | [1]B | [2]Exp (B) | Standard error | Wald statistic | P value |
|---|---|---|---|---|---|---|
| *Close approach (>1-3m)* | *Very close approach (≤ 1m)* | 1.67 | 5.31 | 0.24 | 47.61 | <0.001 |
| *Pirouetting* | | 1.35 | 3.84 | 0.25 | 30.14 | <0.001 |
| *Motorboating* | | 1.09 | 2.97 | 0.16 | 46.56 | <0.001 |
| *Headrise* | | 1.07 | 2.91 | 0.15 | 50.34 | <0.001 |

[1] Regression coefficient
[2] Likelihood (inverted normal log of regression coefficient)

### 6.3.4 Time to the first occurrence of a *close approach (>1-3 metres)* and *very close approach (≤ 1 metre)* of dwarf minke whales to swimmers and the vessel

According to my observations (2006-2008) *close approaches (>1-3 metres)* of dwarf minke whales to swimmers occurred significantly more often than expected within the first hour of an in-water interaction ($\chi^2$ = 10.37, df = 2, P = 0.006) compared with the second hour or longer. There was no significant pattern for *very close approaches (≤*

*1m)* which may occur anytime in an interaction ($\chi^2 = 1.14$, df = 2, $P = 0.565$; Figure 6.2). The diffuse pattern gives some indication that in particular *very close approaches (≤ 1 metre)* are characteristic of individual whales familiar with the stimulus (see Chapter 4). It also shows that such potential harmful behaviours can occur anytime in an interaction and crew therefore need to monitor each swim from the start to the end with a high degree of vigilance.

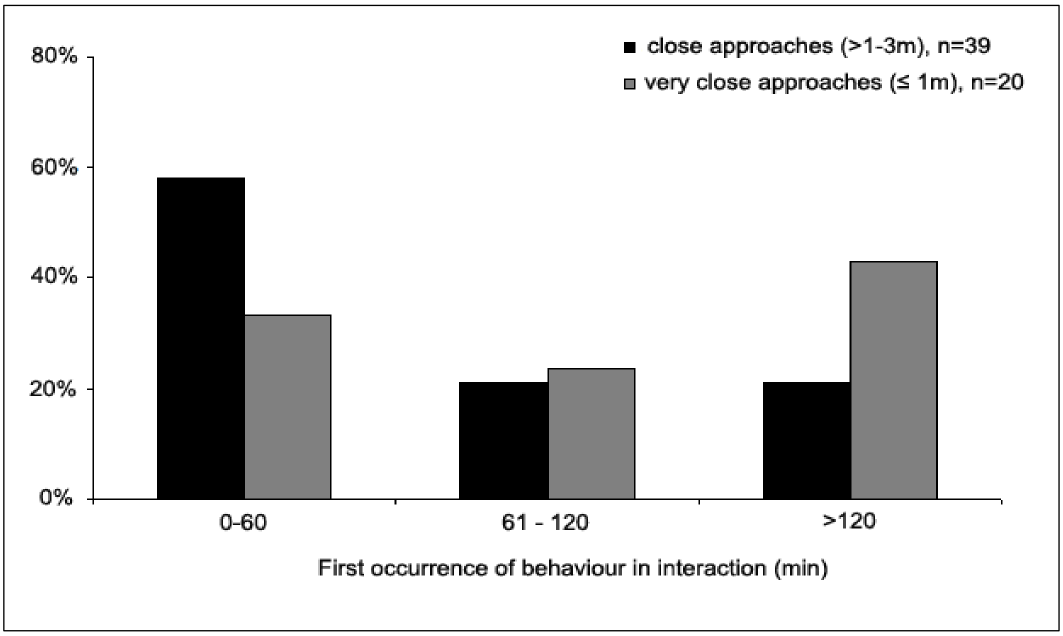



Figure 6.2: First occurrences of *close (>1-3 metres)* and *very close approaches (≤ 1 metre)* of dwarf minke whales to swimmers or the vessel in interactions (researcher observations)

### 6.3.5 Passengers' satisfaction rates and perceived management of their in-water interactions

After their in-water interactions passengers were asked to score the satisfaction of their experience on a rating scale from 1 = very poor to 10 = excellent. Most passengers (n=621) were highly satisfied with their interaction with a mean ($X \pm$ SE) satisfaction rate of $9.25 \pm 0.52$. The satisfaction level of passengers in in-water interactions where *very close approaches* of dwarf minke whales occurred was significantly higher than in interactions where the whales did not approach as close (*Mann-Whitney U*: $Z_{1, 218}$ = -3.595; *P* = <0.001; Figure 6.3).

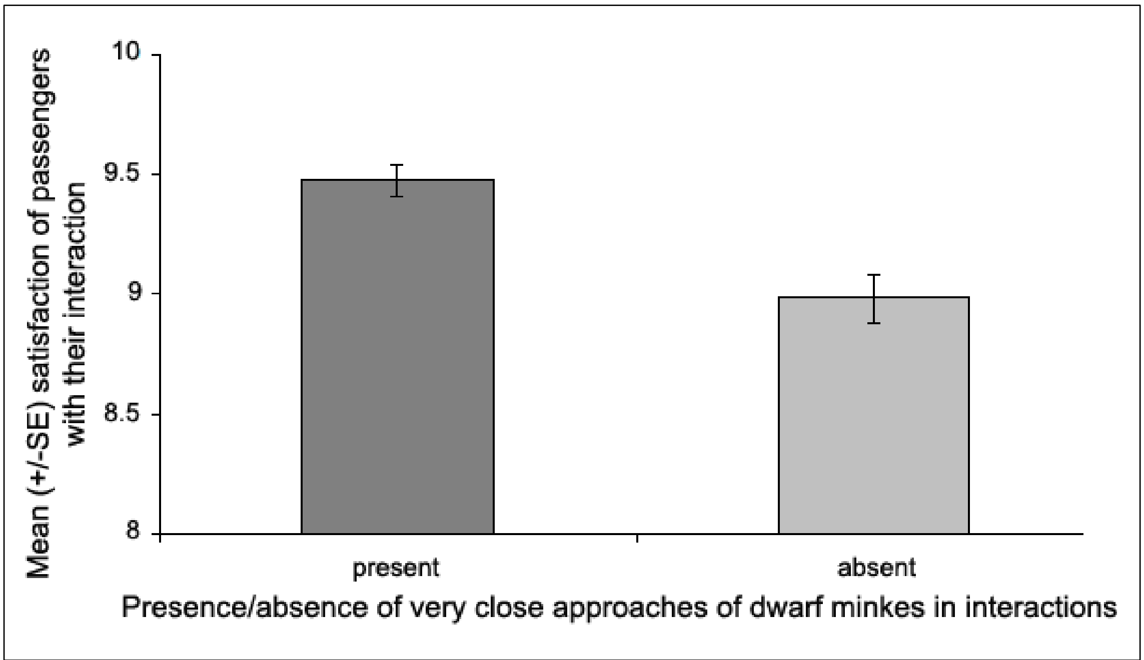



Figure 6.3 Comparison of passengers' satisfaction between interactions where very close approaches of dwarf minke whales were present (n=215) or absent (n=216)

### 6.3.6 Passengers' perceptions of dwarf minke whale behaviours which potentially put either swimmers or whales at risk

After an interaction passengers were asked if they felt there were any whale behaviours which could potentially put either swimmers or whales at risk. I analysed data for interactions in which *very close approaches* of dwarf minke whales to swimmers occurred. Most passengers (95.6%; N=204) felt there were no dwarf minke whale behaviours which potentially put either swimmers or whales at risk present in their in-water interaction. There was no significant difference between passengers' perceptions of in-water interactions with (N=204) and without (N=187) *very close approaches* of dwarf minke whales (*Mann-Whitney U*: $Z_{1,391}$ = -0.235; $P$ = 0.814). The reasons why most passengers felt there were no harmful dwarf minke whale behaviours were because: (1) the whales seemed very docile, calm and gentle, (2) the whales showed no sign of aggression, (3) swimmers were careful and followed the instructions of crew, (4) whales were very controlled and careful in their movement, and (5) the whales were in control of the interaction. The nine passengers who felt there were harmful dwarf minke whale behaviours thought that: (1) whales approach so close that accidents could easily happen, (2) human contact can have detrimental effects to the whales and (3) the whales are used to human contact (for detailed responses see Table 6.3).

### 6.3.7 Passenger concerns about swimming with dwarf minke whales

Passengers were asked if they were concerned before they swam with dwarf minke whales for the first time. Most passengers reported that they did not have any concerns (88.8%; n=410) prior to swimming with dwarf minke whales. Passengers who were concerned about swimming with dwarf minke whales were mostly concerned about: (1) the whales being large, powerful and wild animals, (2) any impact on the whales, (3) the unpredictability of wildlife, and (4) getting hit by a whale. Two concerned passengers trusted in the experience of crew when reassured that these whales are gentle creatures (see Table 6.4 for detailed responses).

Table 6.3 Passengers' perceptions of why there were/weren't any dwarf minke whale behaviours that potentially put either swimmers or whales at risk of harm

| **Passenger responses** | **# responses** |
|---|---|
| **No behaviours of potential risk of harm present** | |
| **Because:** | |
| whales seemed very docile, calm and gentle | 17 |
| whales showed no sign of aggression | 16 |
| swimmers were careful and followed the instructions | 13 |
| whales were very controlled and careful in their movements | 12 |
| whales were in control of the interaction | 11 |
| whales kept a safe distance | 8 |
| it felt safe | 6 |
| whales did not touch anyone/anything | 5 |
| whales were very friendly | 5 |
| whales appeared inquisitive themselves | 4 |
| whales seemed to be happy around the vessel | 4 |
| the encounter was managed | 4 |
| there was no negative impact on the whales | 2 |
| the whole interaction process seemed benign | 2 |
| whales are smart animals | 1 |
| it is impossible to feel anything but love and respect for them | 1 |
| **TOTAL BECAUSE** | **111** |
| **As long as:** | |
| we don't harm them | 2 |
| swimmers don't try to chase them | 1 |
| nobody tries to touch or feed them | 1 |
| swimmers are properly prepared for the interaction | 1 |
| **TOTAL AS LONG AS** | **5** |
| **But:** | |
| accidents can happen | 1 |
| that may change in the long term | 1 |
| if a swimmer is scared then there is a risk of harm | 1 |
| it is a bit scary when they get close | 1 |
| a whale may get tangled in the swimmers rope | 1 |
| **TOTAL BUT** | **5** |
| **TOTAL NO** | **121** |
| **Yes behaviours of potential risk of harm present** | |
| **Because:** | |
| whales approach so close that accidents can easily happen | 2 |
| human contact can have unforseen detrimental effects on the whales | 2 |
| whales are used to human contact | 1 |
| the more comfortable whales are with humans the higher potential for accidents | 1 |
| if there is an accident then the whales will be blamed | 1 |
| any encounter with a wild animal can be dangerous | 1 |
| people do not add anything positive for the whales | 1 |
| **TOTAL YES** | **9** |

Table 6.4: Passengers' concerns about swimming with dwarf minke whales

| Passenger responses | # responses |
|---|---|
| **Concerned:** | |
| because the whales being large, powerful, wild animals | 27 |
| about any impact on the whales | 8 |
| because wildlife can be unpredictable | 7 |
| about getting hit by a whale | 7 |
| about the whales being aggressive | 1 |
| because the open sea can always be dangerous (e.g. sharks) | 4 |
| because I did not know what to expect | 2 |
| about the sheer closeness to these whales | 2 |
| | **58** |
| **Concerned but:** | |
| I was told beforehand how gentle these creatures are | 1 |
| Crew are experienced and know what they doing | 1 |
| | |
| **TOTAL CONCERNED** | **60** |

## 6.4 DISCUSSION

Monitoring dwarf minke whale behaviours using observations of crew reported via the Whale Sighting Sheets proved effective at least on the level of occurrences, i.e. presence/absence of whale behaviours in interactions/encounters. The best fitting commonalities between my behavioural observations and the data from the Whale Sighting Sheets completed by crew were between *close (>1-3 metres)* and *very close approach (≤ 1 metre)*, *headrise*, *motorboating* and *touching behaviour*. These very conspicuous behavioural displays were classified as being of investigative nature (see Chapter 3 & 4) and were identified as of potential harm to both the swimmers and the whales (see Chapter 5). For crew to be able to identify these behaviours is important for both, cost-efficient longer-term monitoring and management of interactions.

In the past, data reported by lay people proved to be useful to assess the abundance and distribution of cetaceans via strandings, whale catches and sighting information (Jaquet et al., 1996; Gregr and Trites, 2001; Dalebout et al., 2003; Clapham et al., 2004; Maldini et al., 2005; Hauser et al., 2006). In general, behavioural data collected by non-trained and non-dedicated observers are seen to be detrimentally biased, inadequate and inappropriate for rigorous research (e.g. Altmann, 1974; Mann, 1999; Samuels et al., 2000; Bejder and Samuels, 2003). However, depending on the objectives, the use of such data and the level on which the data are analysed (e.g. presence/absence), observations from lay people may still provide useful information for a monitoring scheme.

Three factors may have enabled crew to accurately record dwarf minke whale behaviours: (1) education, (2) dedicated observations of interactions, and (3) conspicuousness of the whale behaviours in question. Crew from the swim-with endorsed operations were regularly familiarised with dwarf minke whale behaviours at biannual workshops before and after each swim-with season. In 2007, my colleagues (Alastair Birtles, Susan Sobtzick and Matthew Curnock) and I developed an interpretive DVD to inform and educate both crew and passengers on the most common dwarf minke whale behaviours. This DVD was screened on most trips of the endorsed vessels during the peak season of June and July from 2007 onwards. Swim-with dwarf minke whale endorsed operators are required to assign a dedicated observer for the entire period of an interaction with these whales (Birtles et al., 2008). In addition, dwarf minke whale behaviour events such as *headrises*, *motorboating* and *touching* as well as behaviours based on distance (e.g. *close* and *very close approaches*) are easy to distinguish and identify (even for lay observers) and often occur right in the area of observation, i.e. in proximity to swimmers and the ropes (see Chapter 4).

Future monitoring of the behaviour of dwarf minke whales is crucial. Investigatory behaviours of these whales are likely to change in time (see Chapter 4) and are intrinsically linked with an elevated risk to both swimmers and the whales (see

Chapter 5). My data show that the established monitoring scheme via the Whale Sighting Sheets is viable. Being able to use industry-wide data on the behaviour of theses whales (i.e. Whale Sighting Sheets) may prove very useful for the effective management and the sustainability of the industry.

Identifying dwarf minke whale behaviours is important for crew to closely manage interactions and to safeguard the participants (swimmers and whales). The potential of harm to swimmers and whales increases the closer the whales display the behaviour to observers or objects (see Chapter 5). All four investigatory behaviours (*close approach*, *headrise*, *motorboating*, *pirouetting*) were strongly associated with the occurrence of *very close approaches*. The occurrences of these behaviours may therefore be used as an indicator of the presence of a highly interactive whale. My findings suggest that *close approaches* of whales to swimmers or objects are more likely to occur in the first hour of interactions. However a highly interactive whale (whale approaching to touching distance) may join the interaction at any time, highlighting the importance of monitoring an interaction during the whole swim-with period.

For safety reasons, one of my recommendations is to terminate interactions with a highly interactive whale (see Chapter 5). Such a management measure is likely to be challenging to implement and to enforce, as I have found that the satisfaction of passengers is significantly increased if a *very close approach* occurred in the interactions. This increase in satisfaction was expected as experiencing a close encounter with wildlife evokes strong and positive emotional reactions in observers (Muloin, 1998). It has been shown on several occasions that the closeness of animals to human observers contributes to the enjoyment of passengers in wildlife interactions (Pearce and Wilson, 1995; Muloin, 1998; Schanzel and McIntosh, 2000; Valentine et al., 2004). Swim-with dwarf minke whale participants therefore are likely to be less satisfied if they are required to exit the water when they otherwise could witness a close experience. In perspective however, the satisfaction ratings of swimmers who did not experience a *very close approach* by dwarf minke whales were still very high with a mean of 9 out of 10, a score that exceeds that of most other wildlife experiences (e.g. Orams, 2000; Schanzel and McIntosh, 2000; Moscardo, 2001; Akama and Kieti, 2003).

Some passengers may be more disturbed by such a decision than others. For example, professional wildlife photographers are often present on dwarf minke whale trips (pers. obs.). The closer to the animal they get, the better the chance of getting a unique and lucrative photo (Bentrupperbäumer, 2005). Photographers are well known to ignore rules and disregard danger to achieve their goals (Klein, 1993; Kellert, 1996; Sinha, 2001). Being upfront and explicit with potential management interventions is therefore imperative. Also the suggested consent form for passengers at the start of the trip (see Chapter 5) may prove helpful to achieve compliance in the case of a termination of an interaction.

To provide and sustain customer satisfaction, it is critical to ensure realistic expectations (Orams, 1996; Moscardo, 1999a; Birtles et al., 2001a; Raynolds and Braithwaite, 2001; Valentine et al., 2004). Expectations of tourists are formed by several factors, including previous experiences, their motives, attitudes and values and are heavily influenced by advertising and media (Gnoth, 1997; Higginbottom, 2002). Passenger expectations about dwarf minke whales and the encounters tend to be low before their trip (Valentine et al., 2004). The expectations of swim-with whale participants are therefore mainly shaped by the information they receive on board the vessels, highlighting the importance of providing accurate information in interpretive material and briefings. Implementing key messages about the risk involved in swimming with dwarf minke whales and providing sound interpretation for associated management measures (i.e. intent to terminate certain interactions), may therefore prove effective to gain passengers' acceptance of the need to terminate certain interactions.

Most passengers were unaware to the potential dangers involved in swimming with dwarf minke whales. Passengers' perspectives of their interactions were largely emotionally driven as they perceived the whales to be very docile, calm and gentle and very controlled and careful in their movements. The public perception that cetaceans are friendly and gentle creatures is widespread (Orams, 1997) and this belief has been promoted by mainstream media conveying the animals as smart, cheerful and harmless (Seideman, 1997; Spradlin et al., 2001). Participants may lack knowledge about the animals' behaviour and their preconceived opinions about cetaceans results in a lack of consciousness to potentially harmful situations (Seideman, 1997).

The public's perception that cetaceans are friendly creates difficulties in managing tourism that incorporates an aspect of risk, i.e. swim-with whale interactions. Most passengers felt there was no risk involved with swimming with dwarf minke whales, highlighting the need to create a more realistic picture about the whales in briefings or interpretive talks. The risks involved in swimming with dwarf minke whales, and in particular being in the water with highly interactive whales must be made more explicit. It is worth mentioning that nothing has happened in terms of injury to people in the last 14 years. Nevertheless there is evidence of people being touched and even bumped by whales (see Chapter 5), thus an accident could happen at any time. If people are mindful of the issues, they are easier to manage (Moscardo, 1999b; Taylor and Knight, 2003) and are more likely to understand that in certain circumstances it is safer to watch the whales from the vessel. Creating a more realistic picture about the whales and stressing the risk of swimming with these whales to the passengers is also in the best interest of the swim-with operations, as an incident/fatality involving a swimmer or a whale during an interaction will have consequences for the industry (e.g. loss of reputation, potential prosecution etc, see Chapter 5).

### 6.4.1 Chapter Summary

- The Whale Sighting Sheet proved effective in monitoring dwarf minke whale behaviours, at least on the level of occurrences, i.e. presence/absence of whale behaviours in interactions.
- The best fitting commonalities between my observations and the data collected by crew were between *close (>1-3 metres)* and *very close approach (≤ 1 metre)*, *headrise*, *motorboating* and *touching behaviour*. These behaviours were classified as of investigative nature and of potential harm to swimmers and the whales and are most likely to be associated with individual resighted whales (see Chapter 4 and 5).
- The occurrences of *very close approaches (≤ 1 metre)* were strongly associated with *close approaches (>1-3 metres) headrises*, *motorboating* and *touching behaviour*. These behaviours therefore can be used as indicators of the presence of (a) very interactive whale(s).
- *Very close approaches (≤ 1 metre)* of dwarf minke whales can occur at any time within an interaction, thus monitoring of the entire swim-with period is critical.
- The satisfaction of passengers who were in the water with whales approaching very close was significantly higher than that of passengers who did not have such close experiences. Nevertheless, the satisfaction rating of the latter still exceeds most human-wildlife experiences.

- Most passengers were not afraid of going into the water for their first time with dwarf minke whales; neither did most passengers feel that there was any risk involved while swimming with these whales. This highlights that crew need to generate a more realistic picture of these whales, as an accident could happen at any time.
- Understanding the perceptions of passengers is important, as messages can be built into briefings and interpretive talks which help to make the passengers more mindful and easier to manage in interactions.

# CHAPTER 7

## GENERAL DISCUSSION AND SYNTHESIS

In this chapter, I provide a summary of the major results of this study and discuss the results in the relation to their contribution towards the conservation and management of dwarf minke whales. In addition, I discuss how my results contribute to the understanding of the behaviour of dwarf minke whales and highlight future research directions.

## 7.1 INTRODUCTION

As highlighted in Chapter 1 of this PhD study, swim-with cetacean industries are globally increasing at a fast rate (Hoyt, 2001, 2004; O'Connor et al., 2009). The main target of swim-with cetacean industries are smaller cetaceans such as dolphins, but swimming with larger whales is becoming more wide spread (Rose et al., 2003; Rose et al., 2005). Assessing the scope of swim-with cetacean operations worldwide is difficult, as most are undocumented (Samuels et al., 2000; Samuels et al., 2003). There is considerable evidence that cetacean-based tourism can and often does affect the behaviour of the targeted animals, at least in the short term (e.g. Constantine et al., 2004; Scheidat et al., 2004; Ribeiro et al., 2005; Stockin et al., 2008). Most studies report on changes in behaviour of odontocetes, very few studies have explored the impacts of swim-with industries on the behaviour and ecology of whales. The combination of: (1) the lack of knowledge about their biology and ecology, and (2) the uncertainties about the impact of swim-with operations on whales have influenced many countries to ban swim-with whale operations (e.g. Argentina, Canada, New Zealand, South Africa, U.K., U.S.A.).

Prior to this study, very little was known about the behaviour of dwarf minke whales around tourism vessels and their swimmers, despite the International Whaling Commission’s call for research into the behaviour of baleen whales to facilitate the assessment of potential impacts of whale watching (including swims) on the targeted animals (International Whaling Commission, 2004). My study has also contributed to the general understanding of the behaviour of oceanic rorqual whales. My detailed descriptions and analysis of the nature and context of the behaviours of dwarf minke whales facilitates behavioural comparisons with other cetaceans and provide further insight into potential functions of cetacean behaviours.

This study has greatly contributed to our knowledge about the behaviour of dwarf minke whales associated with a tourism industry. Outcomes of this study highlight the unusual behavioural attributes of dwarf minke whales and the behaviour of individual whales while in contact with humans. My findings should inform management and serve as a basis for future research. My study has also improved our knowledge about the risk of harm associated with swimming with dwarf minke whales. Understanding and effectively managing the risks involved is crucial to the sustainability of this industry and the wellbeing of the whales and swimmers.

My contribution to the knowledge of the behaviour of this species is summarised and synthesised below. First, I summarise the major results obtained under each of the objectives specified in the introduction of this thesis. Second, I highlight my results in the broader theorem of the ecology of this species. Third, I discuss the implications of my results for the management of the swim-with dwarf minke whales industry and the protection of this species within the waters of the Great Barrier Reef Marine Park. Finally, I outline directions for future research that would enhance the current understanding of dwarf minke whale ecology, and contribute to a more complete management framework for this species.

## 7.2 MAJOR RESULTS OF THIS STUDY

**Objective 1: To establish a detailed repertoire (ethogram) of the non-acoustic behaviour of dwarf minke whales around tourism vessels and their swimmers, and provide context and indications for potential functions of the observed behaviours (Study1; Chapter 3).**

I developed the first detailed ethogram of the non-acoustic behaviours of dwarf minke whales around tourism vessels and their swimmers as a basis for understanding their frequency during interactions/encounters. The partial ethogram consists of 35 discrete dwarf minke whale behaviours including 12 surface behaviours, 18 underwater behaviours and five behaviours which may occur on the surface or underwater. This partial ethogram represents the first of its kind for oceanic rorqual whales. I studied the relative frequency of 13 behaviours, five were of rare occurrence and three were seen occasionally in in-water interactions. *Bubble releases*, *motorboating*, *headrises* and *close approaches (>1-3 metres from swimmers)* occurred frequently and *belly presentations* were seen very frequently in encounters. The analysis of the circumstances under which the behaviours occurred revealed potential social functions for *belly presentations* and *bubble releases* and suggested investigative functions for *motorboating*, *headrises* and *close approaches*.

I observed six dwarf minke whale behaviours described from other cetaceans as agonistic or disturbance behaviours. Potential aggressive behaviours included: (1) *gape/gulps*, (2) *jaw claps*, (3) *bubble releases*. Disturbance behaviours were identified as: (1) *sudden speed up*, (2) *sharp veer aways* and (3) *sudden deep dives*. Apart from *bubble releases*, most potentially aggressive displays occurred very rarely. None of these behaviours were followed by an apparent increased level of aggression, neither between conspecific whales nor towards swimmers. I rarely observed potential disturbance behaviours of dwarf minkes in reaction to swimmers or the vessel. Disturbance behaviours were most often in response to conspecifics or other animals, such as sea snakes. In all instances, the disturbance reactions were short-lived (e.g. startle response followed by gliding) and the whales stayed in the close vicinity of the vessel. The fact that dwarf minke whales interact with vessels and swimmers for nearly three hours on average suggests that there is at least some additional energetic demand for the whales involved. Baseline data on the energetics of dwarf minkes however are non-existent. More data are needed to substantiate assumptions whether or not interactions with tourism vessels draw on the energy budget of dwarf minkes.

**Objective 2: To investigate the distribution of dwarf minke whales around vessels and swimmers and examine if these whales change their behaviour in interactions with humans over time (Studies 2 & 3; Chapter 4).**

My results revealed that dwarf minke whales in the Great Barrier Reef are strongly attracted to vessels and swimmers. These whales repeatedly approach dive tourism vessels, maintain close contact with the vessel (<60 metres) for prolonged periods (mean ± SE = 2.8 ± 0.2 hours) and aggregate around swimmers. The behaviour of dwarf minke whales changed over time. Dwarf minke whales significantly decreased their passing distance to swimmers over the time of an interaction.

Whale group size affected the way an individual whale interacts with human swimmers. Individual whales approached swimmers significantly closer when they were part of a larger group, suggesting increased confidence due to safety in numbers. Finally, I found substantial evidence that familiarity through repeated exposure to a stimulus (i.e. vessel and swimmers) influenced the behaviour of dwarf minke whales. Individual whales approached human observers significantly closer in subsequent interactions and familiar (resighted) whales came significantly closer to swimmers than unknown whales.

The behavioural attributes of dwarf minke whales (i.e. long and close association with vessels and swimmers, increasing attraction (habituation Type II) of these whales over time) are unusual and differ from that of most cetaceans encountered by humans. These attributes pose several challenges to the effective management of these whales and provide grounds for concern about the wellbeing of both the swimmers and the whales.

**Objective 3: To determine the direct and indirect risks of harm associated with swimming with dwarf minke whales for the swimmers and the whales (Study 4; Chapter 5).**

Using a risk assessment approach, I established that most dwarf minke whale behaviours during interactions are of low risk of harm to the swimmers and the whales. Nevertheless, in 20% of the total interactions (2006-2008) at least one dwarf minke whale behaviour was present with an increased potential to harm swimmers and/or whales. These behaviours included *headrises*, *pirouettes*, *motorboating*, *belly presentations* and *slow swim pasts* within a close range (≤ 1 metre) and two *breaches* between half and one whale body length from a swimmer. Apart from the two *breaches*, all of these potential harmful behaviours were of investigative nature and were displayed by only few individual resighted whales. The two *breaches* at close range to swimmers were both displayed by a calf.

The Key Informants perceived the risk of harm to swimmers from dwarf minke whale behaviours to be much higher than the risk of harm to the whales; they were more concerned about the wellbeing of the whales in the medium to longer term, i.e. the potential of such an industry to change the behaviour of the whales and impact on their behavioural budget and fitness. Only very close *breaching* was regarded as of medium risk to the whales. Irrespective of the perceived low potential of harm to the whales, their curious nature generates concerns for their safety. Safety concerns are greatest for whales familiar with the stimulus (resights) and particularly whales which have made physical contact with objects such as the dinghy, swimmers and the rope. I identified 23 occasions from all the interactions of the endorsed industry (N=437; 2006-2008) where whales made physical contact with objects (e.g. ropes, dinghy) or swimmers, five (22%) of those incidents were caused by a single individual resighted whale.

Most Key Informants felt positive and optimistic about the current swim-with dwarf minke whale industry, because of: (1) good management measures in place, (2) the significant research and conservation benefits, and (3) the strong association of this industry with research and management. Nevertheless, many Key Informants thought that the swim-with dwarf minke whale industry needs continuous monitoring and future research in order to identify any long-term impacts and to address research gaps for adequate management. Key Informants also expressed concerns about the possibility of the industry expanding and about the discontinuation of funding for research.

**Objective 4: To assess the accuracy of collection of whale behavioural data by the industry for monitoring purposes, and to establish the perceptions of passengers regarding the risk involved in swimming with dwarf minke whales. (Study 5; Chapter 6).**

I assessed the accuracy of data on dwarf minke whale behaviours reported via the Whale Sighting Sheets. Monitoring dwarf minke whale behaviours via the Whale Sighting Sheets proved effective. The best fitting commonalities with my observational data were between *close (>1-3 metres)* and *very close approaches (≤ 1 metre)*, *headrises*, *motorboating* and *physical contact*. These very conspicuous behavioural displays were likely to be investigative in nature and have been identified as of potential harm to both the swimmers and the whales. For crew to be able to identify these particular whale behaviours is important for both cost-efficient longer-term monitoring and the risk management of interactions.

The potential for harm to both the swimmers and the whales increases the closer whale behaviours occur to swimmers or other objects. I found that all four investigatory behaviours (*close approach*, *headrise*, *motorboating*, *pirouetting*) were strongly associated with the occurrence of *very close approaches*, which confirmed my earlier findings. Displaying very close behaviours to swimmers and/or objects is most likely an attribute of whales familiar with the stimulus (i.e. resights) and only very few highly interactive whales appear to have adequate confidence to approach very close to the stimulus. These four investigatory behaviours therefore suggest the presence of (a) highly interactive whale(s), and should be taken (by crew monitoring the interaction) as an early warning signal of increased risk to both swimmers and whales.

I anticipated that a termination of an interaction, because of the behaviour of dwarf minke whales could have the potential to cause a decrease in satisfaction felt by passengers. My data from the Interaction Behaviour Diaries (2006-2008) revealed a significantly higher passenger satisfaction in interactions with *very close approaches* by dwarf minke whales, compared to interactions where passengers did not experience a *very close approach*. Nevertheless, passenger satisfaction was still very high (with a mean of 9 out of 10) even in the absence of a *very close approach* by a whale. I also established that most passengers are not apprehensive about swimming with dwarf minke whales and are unaware of the risks involved in such a practice. To manage swimmers effectively in interactions with the whales and to provide for an understanding of potential management measures (e.g. termination of an interaction), passengers need to be made aware that swimming with these whales can pose a safety risk for them and for the whales, in particular if highly interactive whales are present.

Although no injury to passengers have been reported in the last 14 years, an accident could happen at any time. Indeed, from my observations and those of others (e.g. fellow researchers, crew and passengers) there is evidence of swimmers being touched and even bumped by whales. If passengers know the likely management responses from the start and are mindful of the issue, they are more likely to understand that in certain cases it is safer to watch the whales from the vessel. Creating a more realistic picture about the whales and stressing the risk of swimming with these cetaceans to the passengers is also in the best interest of the swim-with operations, as an incident/fatality involving a swimmer or a whale during an interaction will have consequences for the industry (e.g. loss of reputation, potential prosecution)

## 7.3 ADVANCES IN KNOWLEDGE ABOUT DWARF MINKE WHALES

One of the major aims of this study was to provide detailed insight into the behaviour of dwarf minke whales around tourism vessels and swimmers in the Great Barrier Reef. A major theme throughout my PhD study was the exploratory behaviour of dwarf minke whales. The strong attraction to vessels and their swimmers and the observed exploratory behaviour of dwarf minke whales are remarkable and I suggest that these behavioural traits differ from that of most cetaceans encountered by humans. Curiosity or exploration is a common behavioural theme for many animals (e.g. insects, fish, birds, rodents, primates, cetaceans: Lindauer, 1952; Hinde, 1954; Hill, 1958; Dahlheim et al., 1981; Herzing, 1999; Morgan and Sanz, 2003; Compagno et al., 2005) and is particularly important for them in an ecological and evolutionary sense. A natural exploratory drive enables animals to learn from and respond to their environment, facilitates finding food or potential mates, and helps them to avoid predators (Berlyne, 1966; Mason, 1971, 1973; Norris and Schilt, 1988; Fairbanks, 1993). These are all factors which are crucial for the survival of the species.

The presence of behavioural displays with social context during interactions (e.g. *belly presentations*, *courtship*, *bubble releases*) suggests that dwarf minke whales use such aggregations to socialise. The relevance of this region to dwarf minke whales is still unclear. The fact that individual whales return to the Great Barrier Reef each austral winter (Arnold, 1997; Birtles and Arnold, 2002; Sobtzick, in prep), the presence of all age classes (Dunstan et al., 2007), including cow-calf pairs (Birtles et al., 2002a) and the apparent social aggregations, all indicate that this region is important to this species.

## 7.4 IMPLICATION FOR THE CONSERVATION AND MANAGEMENT OF DWARF MINKE WHALES

Behavioural studies serve as the foundation for present-day management of cetacean focused tourism (Bejder and Samuels, 2003). Whale watching guidelines, regulations and codes of conduct have been created in many locations around the world (Carlson, 2004). However, regulations have often been based on insufficient knowledge about the species and are typically umbrella policies not specific to species, demographics, or behaviour of the targeted animals (Bejder and Samuels, 2003).

The Australian National Guidelines for cetacean watching are an example of such an umbrella policy. They are suitable for most cetaceans (e.g. dolphins, humpback whales, bryde's whales) but some of them are inappropriate for dwarf minke whales. It is clear from this study and others (e.g. Birtles et al., 2002a) that dwarf minke whales voluntarily approach vessels in the Great Barrier Reef on a regular basis and maintain close contact (mostly within 60m radius of the vessel) for several hours. Regulating encounters with such inquisitive whales with minimum approach distances, i.e. 100m exclusion zone for vessels and swimmers, creates challenges for compliance with the policy in place. Non-endorsed swim-with dwarf minke whale vessels in the Great Barrier Reef are not allowed to place swimmers in the water when a whale is within 100m of the boat (DEH, 2005). The swim-with endorsed industry is exempt from this rule and swimmers may enter the water providing any dwarf minke whales are at least 30 metres away. In the case of a dwarf minke whale approaching a non-endorsed vessel, such operations would be faced with the choice of putting their regular leisure activities on hold, most likely for an extended time. Such a measure potentially creates dissatisfaction and jeopardises the success of businesses dependent on customer satisfaction. I therefore suggest that there is a clear trade-off between business success and compliance as reported from industries elsewhere (Scarpaci et al., 2003; Whitt and Read, 2006). Considering that only a small proportion of the vessel based industry in the Great Barrier Reef are endorsed for swimming with dwarf minke whales (N=8), this issue encompasses most of the vessels operating in this area.

The International Whaling Commission noted that research on evaluating the effect of whale watching on cetaceans may be the most important contribution to future discussions (International Whaling Commission, 2004), in particular biological and behavioural research (Amaral and Carlson, 2005). My study illustrates that dwarf minke whales changed their behaviour in response to human activity. The whales' attraction to the stimulus (vessels and swimmers) increased. Attraction in animals is defined as the strengthening of a positive association with a repeated stimulus and manifests behaviourally as an increase in an animal's positive attention to that stimulus over time

(Knight and Cole, 1995; Knight and Temple, 1995; Frohoff, 2004). Increased attraction of wildlife to human activity often proves harmful to both wildlife and humans (Knight and Temple, 1995). Cetaceans which lose their natural wariness to human activity are potentially more prone to harassment (Samuels and Bejder, 2004), boat strikes (Stone and Yoshinaga, 2000; Spradlin et al., 2001; Bejder and Samuels, 2003), and entanglement in fishing gear or marine debris (Lien, 1994; Knowlton and Kraus, 2001; Knowlton et al., 2005). Such concerns were substantiated when a dwarf minke whale got entangled in the rope used for swimmers to hold onto while in the water. Given the increased attraction to vessels it is plausible that dwarf minkes could become an easy target for the whaling industry in the southern ocean (potential feeding grounds). However their migration path(s) is still unknown and there is no evidence that this exceptional curiosity is maintained post their Great Barrier Reef sojourn.

Any change in behaviour due to habituation, desensitisation or in the case of dwarf minke whales increased attraction (habituation Type II), has the potential to negatively affect the population (e.g. Mann et al., 2000a; Frohoff, 2004). Such impacts may be hard to detect as they are likely to be cumulative rather than catastrophic (Bejder et al., 1999). Prolonged interactions between dwarf minke whales and humans could impact negatively on their overall daily activity budget. Depending on the magnitude of such interactions (e.g. duration, frequency) and the importance of the displaced behaviour to the animals (e.g. resting, courtship, socialising) long-lasting effects may emerge with the potential to alter the fitness of the population (e.g. Mann et al., 2000a; Frohoff, 2004). Most interacting dwarf minke whales are adolescent animals (Dunstan et al., 2007). Immature animals are of particular concern, as the documented increased familiarity with human activity may alter their normal course of behavioural development, potentially resulting in altered patterns of social behaviour (Samuels et al., 2003). Monitoring the behaviour of dwarf minke whales in the longer term is critical. The Whale Sighting Sheets proved to be a valid tool for this task. The education of crew on the behaviours of the whales however was a key factor for the successful monitoring of dwarf minke whale behaviours. Without regular workshops or educational sessions with the industry provided by the Great Barrier Reef Marine Park Authority, the validity and accuracy of the data could be jeopardised. I therefore recommend the continuation of both, the current monitoring scheme via the Whale Sighting Sheets and the education of the industry at regular intervals.

Swim-with cetacean interactions pose substantial public safety concerns (Seideman, 1997; Spradlin et al., 2001). The risk of harm to swimmers is increased in situations where animals are habituated, desensitised or attracted to the stimulus (Knight and Temple, 1995; Frohoff, 2004). My assessment of risk confirmed these concerns and provided strong evidence that increased attraction of individual whales is of particular concern to the wellbeing of swimmers. On average the risk of harm for swimmers was low; however there were several situations where dwarf minke whales displayed potentially harmful behaviours in close vicinity of swimmers. Two harmful situations were caused by calves, *breaching* in close vicinity to swimmers. Immature animals are particularly investigative in new situations or when presented with a novel stimulus (Mason, 1971, 1973; Fairbanks, 1993; Mayeaux and Mason, 1998) and are unpredictable in their behaviour and movement. All other potentially harmful situations for swimmers were caused by whales familiar with the stimulus displaying behaviours classified as investigative. As reported from other animals (e.g. Morgan and Sanz, 2003; Werdenich et al., 2003; Blom et al., 2004) and suggested in this thesis, increased familiarity with a stimulus may promote the confidence and/or excitation levels of individual whales. Thus, the management response needs to be specific to individual animals and carefully assessed on a case by case basis. Providing such a management strategy will help to safeguard the swimmers' and the whales' wellbeing and help prevent a 'low probability, high consequence event', which would impact detrimentally on the industry.

## 7.5 OPTIONS FOR THE MANAGEMENT OF DWARF MINKE WHALES IN THE GREAT BARRIER REEF

As a result of the unusual behaviour of dwarf minke whales in the Great Barrier Reef, the management of these whales is difficult. Three main management options have been applied elsewhere to safeguard cetaceans targeted by swim-with operations: (1) bans, (2) space-time closures to tourism operations and (3) regulation and education. The most common approach has been to ban such operations and this has been adopted by many countries around the world, and is supported by Non-Governmental Organisations such as the Whale and Dolphin Conservation Society. The findings of my study demonstrate that a ban on such operations for dwarf minke whales in the northern Great Barrier Reef would be ineffective (i.e. whales approach vessels, etc.).

Spatial or temporal closures to tourism operations can be an effective way of protecting marine mammals (Dawson and Slooten, 1993; Williams et al., 2002b; Lusseau and Higham, 2004). Spatial closures typically protect areas of critical ecological importance e.g. areas for feeding, resting and breeding (Lusseau and Higham, 2004). Similarly temporal closures can encompass critical habitats and provide protection for a particular time period, i.e. areas used for calving and breeding in migratory cetaceans. Such areas have been successfully implemented in many migratory species, for example the Stellwagen Bank Sanctuary and Hawaiian Islands Humpback

Whale Sanctuary, both for humpback whales (Lusseau and Higham, 2004). More extensive studies on dwarf minke whale distribution, resident times, behaviour, and abundance in the context of the spatial patterns of industry effort are needed to evaluate the appropriateness of such an approach. Closing an area would also need to take into consideration the full range of uses of the area (e.g. recreational, commercial, charter, commercial fishing) and the impact of such a closure on existing operations. A decision tree for delineation and management of critical habitats could be used to optimise the design of such an area (see Lusseau and Higham, 2004).

The Great Barrier Reef Marine Park Authority currently uses a two tier management approach that involves: (1) enforcing the 'generic policy' (Tier 1) for all vessels in the marine park encountering cetaceans, and (2) providing options for species specific management (Tier 2). Tier 2 management of dwarf minke whales has involved the use of permits with the aim of limiting and controlling dedicated interactions. My and findings from others (Arnold and Birtles, 1999) suggest that the 'generic policy' (Tier 1) is often inappropriate and insufficient for managing encounters between vessels, divers and dwarf minke whales. I therefore suggest that all boats with the potential to encounter dwarf minke whales in the northern Great Barrier Reef region should be made aware of the current legislation and Best Practice Guidelines included in this Code of Practice. Educational sessions in the lead-up to the dwarf minke whale season (April/May) currently provide endorsed operators with the knowledge about how to manage their encounters in such a way as to minimise their impacts on the whales (Arnold and Birtles, 1999; Valentine et al., 2004). The audience for such workshops needs to be extended to all operators in the area.

The appropriateness of the current management approach will be reviewed by the Great Barrier Reef Marine Park Authority in 2010. Depending on the findings of ongoing research, other more stringent measures of protection (e.g. maximum interaction time, maximum cumulative interaction time, temporal or spatial exclusion zones), as provided for in the Tier 2 of the National Guidelines, may need to be considered. One option would be for the Great Barrier Reef Marine Park Authority to declare a Special Management Area in the northern Great Barrier Reef (area with the highest encounter likelihood) as this is an existing management provision that could be used to manage encounters with seasonal spatial controls. The continuation of research to assess and monitor the impact of this industry on the whales' behaviour over time is critical for future management and to detect cumulative impacts.

## 7.6 SPECIFIC RECOMMENDATIONS FROM MY PHD STUDY

To provide a better management of dwarf minke whales and the vessels and swimmers interacting with them, I recommend:

- that all boats with the potential to encounter dwarf minke whales in the northern Great Barrier Reef region should be made aware of the current legislation and Best Practice Guidelines included in the Code of Practice for swimming with dwarf minke whales (Birtles et al., 2008).

- that biannual educational sessions (e.g. workshops) provided for endorsed operators from 2003-2008 should be continued and extended to all operators in the area where dwarf minke whales are likely to occur. The resulting detailed knowledge (e.g. of encounter management, behaviour of the whales, passenger attitudes and likely behaviours) would drastically minimise potential impacts on the whales and maintain the high standard necessary to monitor dwarf minke whale behaviour.

- that a broader dwarf minke whale sightings network should be established to assess the cumulative effects of swim-with dwarf minke whales tourism on the whales and to get an indication of the distribution of these whales.

- that the current monitoring scheme via the Whale Sighting Sheets should be continued and assessed regularly (i.e. once a year) to track the exploratory behaviour of dwarf minke whales in time and to detect any longer term behavioural changes of the whales from the tourism industry.

- that levels of acceptable change and the associated management responses need to be established, to provide for the long-term sustainability of the industry and to safeguard dwarf minke whales in the future.

To reduce the risk to swimmers and whales I recommend that:

- interactions involving a calf or a highly interactive whale (i.e. displaying behaviours within touching distance) should be terminated and all ropes should be retracted from the water to decrease the risk to both swimmers and whales.

- the established passenger briefings at the start of the trip should incorporate messages about the risks involved in swimming with dwarf minke whales, and in particular passengers should be made aware about the need to terminate potentially dangerous interactions. Passengers mindful of the risks are easier to manage and more receptive to potential management interventions (e.g. termination of interactions)

- the risk involved in swimming with dwarf minke whales should be re-assessed on a regular basis, as the behaviour of the whales is likely to change in time (in particular the investigatory behaviours).

- levels of acceptable risk for swimming with dwarf minke whales need to be established and discussed with all stakeholders, i.e. operators, management agencies and researchers. The resulting management responses need to be incorporated in future management of the industry.

- new operators or potential purchasers of permits are very carefully scrutinised on their past performance and standards and undergo quality training before endorsed swim-with operations commence and

## 7.7 FUTURE RESEARCH ON THE BEHAVIOUR OF DWARF MINKE WHALES

This study has greatly improved our knowledge about the behaviour of dwarf minke whales associated with a swim-with whale tourism industry in the Great Barrier Reef. Despite these advances, our knowledge about the whales' ecology and behaviour is still very limited. The main constraint of my study was that it only examined the behaviour of dwarf minke whales during interactions with vessels and swimmers, thus its applicability to the overall conservation of this species is limited. To provide for a broader management and conservation framework for these whales, future behavioural research on dwarf minke whales needs to go beyond the association with the tourism industry.

### 7.7.1 Overall population size of dwarf minke whales in the Great Barrier Reef

It is crucial to establish the proportion of the dwarf minke whale population in the Great Barrier Reef that is associated with the tourism industry, as this will put my own and all other findings to date (e.g. Arnold and Birtles, 1999; Birtles et al., 2001b; Birtles et al., 2002a; Sobtzick, in prep) into context. If the population size is small and most whales are interacting with the tourism industry, a behavioural change is more likely to be detrimental, while if the opposite is true (large population size with only few whales interacting) it may be of much lower consequence.

Providing an accurate overall population size of dwarf minke whales in the Great Barrier Reef may prove difficult. Most population estimations of cetaceans are derived from vessel based line-transects or mark-recapture (e.g. Matsuoka et al., 2003; Calambokidis and Barlow, 2004; Branch, 2005). Line-transects would inherit a significant bias for dwarf minke whales, as these whales are attracted to vessels, a problem encountered by surveys on Antarctic minke whales in the southern ocean (Leatherwood et al., 1982).

Another method used for cetaceans to provide for an estimate of population size is via aerial surveys and these have been used successfully for several species of cetaceans (e.g. minke, bowhead, southern right, fin and gray whales) at several locations including Alaska, Antarctic, Canada and the U.S. (Kinglsey and Reeves, 1998; Keller et al., 2006; Hedley et al., 2007; Kelly et al., 2008). Dwarf minke whales aggregate in the Great Barrier Reef in the winter months (Arnold and Birtles, 1999), when strong south-easterly winds are prevailing and calm days are infrequent (Birtles et al., 2002a). Relatively calm weather and fairly smooth sea conditions are essential to detect small cetaceans such as dwarf minke whales from the air, thus aerial surveys on dwarf minke whales may prove time consuming and costly. New technology (e.g. infrared cameras), such as used in the southern ocean (e.g. Kelly et al., 2009) may facilitate such surveys and may extend the ability to detect dwarf minke whales to moderate sea conditions.

### 7.7.2 Satellite-linked telemetry; daily activity budget, area usage and migratory pathways and destination of dwarf minke whales

Satellite telemetry has been successfully used for several cetacean species including narwhales, minke whales, humpback whales, southern right whales, orcas and several species of dolphins (Mate et al., 1994; Mate et al., 1995; Davis et al., 1996; Heide-Jørgensen et al., 2001; Laidre et al., 2004; Wade et al., 2006; Zerbini et al., 2006; Best and Mate, 2007). Using satellite tags is the most systematic approach for collecting viable data on animal movements and spatial use patterns across small and large areas and over different temporal scales (Koenig et al., 1996). A great advantage of satellite telemetry is that different data loggers (e.g. depth recorder) can be incorporated into these tags to provide information other than location (Cooke et al., 2004).

Currently nothing is known about dwarf minke whale behaviour when they are not with the dive tourism vessels. Knowledge about their daily activity budget is crucial to determine what impact the tourism industry has on the whales. Depending on the magnitude of such interactions and the importance of the displaced behaviour to the animals (e.g. resting, courtship, socialising) long-lasting effects may emerge with the potential to alter the fitness of the population (e.g. Mann et al., 2000a; Frohoff, 2004).

Very little is known about how these whales are distributed in space and time while they are in the Great Barrier Reef and there is no information available where these whales are going after their Great Barrier Reef sojourn. Establishing the area use within the Great Barrier Reef is important and such knowledge may prove essential if the current management scheme is insufficient and more stringent measures of protection are needed (e.g. spatial and temporal closures, special management areas). Equally important is to determine the migration pathways of dwarf minke whales. Outside the well protected Great Barrier Reef Marine Park, dwarf minke whales may be faced with increased risk of entanglement in fishing gear, injury from noise pollution (sonar, oil exploration) and ship strikes, in particular if their exceptional exploratory drive is maintained beyond their wintering grounds. These whales may even become an easy target for the whaling industry if they migrate to the southern ocean.

The use of satellite telemetry would therefore greatly enhance our understanding of the natural behaviour patterns of dwarf minke whales, their use of space and their movement and migration patterns. Although there are concerns about the health of the animals involved in tagging procedures, there have been increased efforts over the last decade to develop deployment methods from a safe distance (Stone et al., 1994; Hanson and Baird, 1998), ensure safer capture procedures (Norman et al., 2004), and smaller and more efficient tags.

## 7.8 FINAL REMARKS

Effective management of wildlife focussed tourism requires a comprehensive understanding of the ecology and behaviour of the targeted animals. Understanding the behaviour of wildlife associated with tourism is imperative, as behavioural changes often act as an early warning sign of disturbance (Frohoff, 2004). Recent research efforts have improved our understanding of the behaviour of odontocetes targeted by tourism; knowledge about the influence of such industries on the behaviour of baleen whales however is still very limited.

This study is the first comprehensive investigation on the behaviour of a baleen whale (dwarf minke whales) in association with a swim-with tourism industry. My findings highlighted several management challenges directly associated with the behaviour of the whales, and provide preliminary scientific evidence that effective management may only be achieved on a species specific level. My study should inspire others to formulate new and interesting questions about the behaviour of dwarf minke whales, and serve as a motivation for future research. Addressing the research gaps highlighted in my thesis (e.g. migration pathways and destinations, behaviour budgets, population size) is critical to provide the understanding necessary to implement a sustainable management and conservation framework for dwarf minke whales. Answering some questions will be challenging and will require coordinated approaches, across research groups, disciplines and geographic regions.

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## **Appendix 1:** Whale Sighting Sheet 2009

**MINKE WHALE PROJECT** **WHALE SIGHTING SHEET 2009**

We are interested in all of your whale sightings, but are particularly keen on hearing about minkes (dwarf minke whale pictured above left). Please fill out this sheet as best you can to help our sightings records.

### Part A: Fill in immediately when whales are seen:

**1.** Time of **initial sighting**:……………………………………. **2.** Date: _______ / _______ / 2009
**3.** Location: **Coordinates at start:** Lat:…………………………...**(S)** Long:…………..………..……….**(E)**
**4.** Approx. **distance from vessel** when first sighted: ……… **5.** Time of first approach (to within 30m) ….…

### Part B: Fill in immediately after end of encounter:

**6.** Time of last sighting:……………. **7. Vessel:**……………………… **8.** Your name: …………..….……
**9. Coordinates at end *(if drifting/steaming)*:** Lat:………..………. **(S)** Long:………….…………….(E)
10. How did the encounter end? (please tick one) ☐ Whale(s) left the boat ☐ Boat left the whale(s)

### Part C: Fill in at end of encounter:

**11. Type of whale: *(please circle one)*** **Minke / Humpback / Other**:…………………………….………..
**12.** Number of whales: ……………………..……… Approx / Certain
**13.** Estimated size(s): (No. of whales): more than 6m: #____; 4m-6m: #_____; less than 4m: #______
**14.** Any calves? (2009 calf will be < ½ size of mother, in close proximity to her & breathing more often): # _______________
- If a cow & calf were seen; how long did they stay in the area? (give times) From:___ To: ____

**15.** Vessel status when whale(s) first sighted: *(please circle one)* Anchored / Moored / Steaming / Drifting
**16.** Did the vessel status change during the encounter? *(Please explain and give times; e.g."dropped mooring to drift 15:35")*
…………………………………………………………………………………………...…………
**17.** Distance drifted during encounter: ……… *naut. miles* **18.** Average wind speed: …… *knots*
**19.** Average wave height: ………………… *metres* **20.** Underwater visibility ……… *metres*
**21.** Name of nearest reef or dive site:…………...………… **22.** Distance to that reef/site:……….. ____
**23.** Closest approach distance by whale(s) (metres from boat): … **24.** Rope used?: Y / N *(please circle one)*
**25.** Maximum number of divers in at one time: Using snorkel: ……… Using SCUBA: …………….
**26.** Brief description of encounter *(e.g. movement of whales, swimmers, etc; use back of page if necessary):*
…………………………………………………………………………………………...…………
…………………………………………………………………………………………...…………

**27.** Were any of the following behaviours observed? (Tick where appropriate and **write number of times** observed)
*(For descriptions of behaviours see the CRC Reef brochure, the Interaction Behaviour Diary or the Minke Whale Project Interpretive DVD 2007)*
□ Breaching? # times:_____ □ Headrise/Spyhop? # ____ □ Bubble blast? #_____ □ Gulping? #:_____
□ Sudden speed up? # ____ □ Sharp veer away? #_____ □ Sudden deep dive? #: _____
□ Jaw clap? # _______ □ Belly presentation? #_____ □ Close approach (<3m)? #:_____________
□ Motorboating? #:______ □ Pirouetting? #:_________ □ Very close approach (<1m)? # __________
□ Vocalisation(s)? (please describe): ……………..……□ Physical contact (please describe)……………………
□ Other (please specify)…………………………………………………...…………………….

28. Description of any significant markings/ scars on the whales (use back of page if necessary):
…………………………………………………………………………………………...…………

31. Your contact details / vessel stamp:
Address & Telephone:…………………….….………..Email:………………………………………………….

Please return completed forms and copies of any photos/video to the Minke Whale Project:

c/- Dr Alastair Birtles (Minke Whale Project Leader), Tourism Program, Western Campus, James Cook University, Townsville QLD 4811.
Ph: (07) 4781 4736 Fax: (07) 4725 1116 Email: Alastair.Birtles@jcu.edu.au

The Minke Whale Project will forward copies of all completed Whale Sighting Sheets to the Great Barrier Reef Marine Park Authority. The Minke Whale Project is partially funded by the Great Barrier Reef Marine Park Authority: "Dwarf Minke Whale Tourism Research and Monitoring Program." Summaries of the season's data will be provided to operators. Thank you for your help with this research.

**Appendix 2:** Akaike Information Criterion (AIC) Index ranking the predictor variables which influence the occurrences of dwarf minke whale behaviours

| # | Variable 1 | Variable 2 | Variable 3 | Variable 4 | Variable 5 | Variable 6 | Variable 7 | [1]DF | [2]AIC | [3]L. ratio $Chi^2$ | P - value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belly presentation:** | | | | | | | | | | | |
| 1 | Weather B (1=11-20 knots) | Group size A (4-6 animals) | Group size B (>6 animals) | | | | | 3 | 136.57 | 10.96 | 0.012 |
| 2 | Weather B (1=11-20 knots) | Group size A (4-6 animals) | Group size B (>6 animals) | Resights (present/absent) | | | | 4 | 136.90 | 12.63 | 0.013 |
| 3 | Group size A (4-6 animals) | Group size B (>6 animals) | | | | | | 2 | 136.92 | 8.62 | 0.014 |
| 4 | Group size A (4-6 animals) | Group size B (>6 animals) | Boat status (drifting/stationary) | | | | | 3 | 137.44 | 10.09 | 0.018 |
| **Bubble release** | | | | | | | | | | | |
| 1 | Group size B (1=>6 animals) | Time in Season A (1=middle) | Boat status (drifting/stationary) | Boat status * resights (present/absent) | | | | 4 | 89.41 | 33.63 | <0.001 |
| 2 | Group size B (>6 animals) | Time in Season A (1=middle) | Boat status (drifting/stationary) | | | | | 3 | 90.19 | 30.85 | <0.001 |
| 3 | Group size A (4-6 animals) | Group size B (>6 animals) | Time in Season A (1=middle) | Boat status (drifting/stationary) | Boat status * resights | | | 5 | 90.52 | 34.52 | <0.001 |
| 4 | Group size B (>6 animals) | Time in Season B (1=beginning) | Boat status (drifting/stationary) | | | | | 3 | 90.53 | 30.51 | <0.001 |
| **Close approach (>1-3m)** | | | | | | | | | | | |
| 1 | Group size A (4-6 animals) | Group size B (>6 animals) | Boat status | Resights (present/absent) | Boat status * resights | | | 5 | 112.88 | 32.88 | <0.001 |
| 2 | Group size A (4-6 animals) | Group size B (>6 animals) | Time in Season A (1=middle) | Boat status | Resights (present/absent) | Boat status * resights | | 6 | 113.03 | 34.74 | <0.001 |
| 3 | Weather A (1=calm) | Weather B (1=medium) | Group size A (4-6 animals) | Group size B (>6 animals) | Time in Season A (1=middle) | Boat status (drifting/stationary) | Resights (present/absent) | 7 | 113.12 | 38.64 | <0.001 |
| 4 | Weather A (1=calm) | Weather B (1=medium) | # Group size A (4-6 animals) | Group size B (>6 animals) | Boat status (drifting/ stationary) | Resights (present/absent) | Boat status * resights (present/absent) | 7 | 113.48 | 36.28 | <0.001 |

[1] DF = degrees of freedom
[2] AIC = Akaike Information Criterion
[3] L. ratio = Likelihood Ratio

**Appendix 2 continued:** Akaike Information Criterion (AIC) Index ranking the predictor variables which influence the occurrences of dwarf minke whale behaviours

| # | Variable 1 | Variable 2 | Variable 3 | Variable 4 | Variable 5 | Variable 6 | [1]DF | [2]AIC | [3]L. ratio Chi[2] | P - value |
|---|---|---|---|---|---|---|---|---|---|---|
| **Headrise:** | | | | | | | | | | |
| 1 | Resights (present/absent) | | | | | | 1 | 120.72 | 9.43 | 0.002 |
| 2 | Boat status (drifting/stationary) | Resights (present/absent) | | | | | 2 | 121.46 | 10.68 | 0.005 |
| 3 | Group size B (>6 animals) | Resights (present/absent) | | | | | 2 | 121.91 | 10.23 | 0.006 |
| 4 | Group size B (>6 animals) | Resights (present/absent) | | | | | 2 | 121.98 | 10.17 | 0.006 |
| **Motorboating:** | | | | | | | | | | |
| 1 | Weather B (1=medium) | Time in Season B (1=beginning) | Resights (present/absent) | | | | 3 | 99.99 | 21.04 | <0.001 |
| 2 | Weather B (1=medium) | Resights (present/absent) | | | | | 2 | 100.85 | 18.19 | <0.001 |
| 3 | Weather B (1=medium) | Time in Season B (1=beginning) | Boat status (drifting/stationary) | Resights (present/absent) | | | 4 | 101.52 | 21.52 | <0.001 |
| 4 | Weather A (1=calm) | Time in Season B (1=beginning) | Resights (present/absent) | | | | 3 | 101.78 | 19.26 | <0.001 |

[1] DF = degrees of freedom
[2] AIC = Akaike Information Criterion
[3] L. ratio = Likelihood Ratio

**Appendix 3:** Letter to the Key Informants outlining the aims and objectives and explaining the conduct, duration and time frame of the anticipated three surveys

Dear …

My name is Arnold Mangott. I am currently undertaking a PhD on the behaviour of dwarf minke whales (*Balaenoptera acutorostrata* subsp.) associated with the swim-with tourism industry in the Great Barrier Reef, Australia. I am supervised by Dr Alastair Birtles, Prof Helene Marsh and A/Prof Peter Valentine. The findings of my PhD will form part of a comprehensive sustainability assessment, advising the Great Barrier Reef Marine Park Authority on the future management of the swim-with dwarf minke whale industry, to be reassessed in 2009.

As a part of my study, I am seeking feedback from experienced scientists, managers and members of conservation agencies on particular dwarf minke whale behaviours. The aim of this assessment is to establish your perceptions and expert opinions on particular dwarf minke behaviours, identify any inter-specific behaviour analogies, and most importantly to acquire your ideas about any dwarf minke behaviours which you think are of potential risk to either the whales and/or the swimmers.

Your expert opinions and perceptions are of critical importance to the evaluation of the risk involved with particular behaviours of dwarf minke whales when interacting with humans. I realise that you are a very busy person, however I hope that you will appreciate the value of this research project and are willing to contribute your valuable time to participate in this study.

This assessment will be done in three parts, an internet based survey (approx. 10-15 min), an interview (via phone/Skype, approx 20-30 min) and an internet based risk assessment (approx. 40 min). To allow for flexibility these three parts can be done over a period of several weeks.

I thank you very much in advance for your support. If you would like to be involved in this assessment, please contact me via the above email address.
Many thanks for your time

Kind regards

**Appendix 4:** Meet the Minkes. Dwarf minke whale interpretive DVD, 2007

## **Appendix 5:** Key Informant Internet Survey questionnaire – Part 1

Dear…..

I am doing a PhD on the behaviour of dwarf minke whales associated with a swim-with tourism industry on the northern Great Barrier Reef region in Australia. Currently I am seeking feedback from knowledgeable members of the marine mammal science community, conservation organisations and managers on their perceptions and expert opinions about particular behaviours displayed by dwarf minke whales while interacting with swimmers and vessels. With your experience in the field of cetacean research (biology, behaviour etc.), management and/or conservation I hope to better understand these particular behaviours in the light of their potential meaning, context and the risk involved for both the animals and the swimming participants.

Information concerning individuals is strictly confidential, and will not be published or released. As you are aware, your participation is entirely voluntary. This survey is designed to capture your background as well as your opinions on broader issues associated with swim with cetacean programs and will take approximately 10-15 minutes of your time. Your opinions on the following questions are highly valued. Your support of this research is also greatly appreciated and I hope that the outcomes of the study will lead to ecologically sustainable interactions with dwarf minke whales.

*Respondent is to read, understand and agree with the following statement:*

☐ **I have been informed about the nature of this survey, its confidentiality and I agree to participate. I am aware that my participation is entirely voluntary.**

--------------------------------------------

Name of participant

1) **With which organisation are you affiliated?**

☐ Non-governmental organisation
☐ University
☐ Governmental management organisation
☐ Governmental research organisation
☐ Independent
☐ Other (please specify) ________________________

2) **What is your position/role in this organisation?**

3) **How long have you been working with this organisation?**

4) **What is/are your field(s) of expertise (specialisation)?**

5) **How long have you been working with marine mammals or have been involved in work associated with marine mammals?**

6) **What species of marine mammals have you been working with / does your work encompass?**

7) **What aspects (e.g. behaviour, photo ID, management, conservation etc.) of marine mammals does/did your work include?**

*Many studies on cetaceans associated with swim-with industries (the majority are on dolphins) have shown that such operations have the potential to change the behaviour of the targeted animals. Research has mainly identified short-term behavioural changes of cetaceans including prolonged dive durations, changes in direction and speed of travel and increased avoidance behaviour in reaction to tourism boats and swimmers. There are major difficulties in confirming if short-term behavioural changes affect the animals in the longer term leading to (for example) lower reproductive success or habitat displacement.*

8) **How long have you been aware of commercial tourism operations offering swims with cetaceans anywhere in the world?**

9) **Have you ever been on a commercial tourism operation offering swims with cetaceans?**

☐ Yes
(if yes, please explain where, how often and with what species)

☐ No

**10) What do you think about commercial tourism operations offering swims with cetaceans?**

**11) Do you have any concerns for the targeted animals in swim-with cetacean industries?**

☐ Yes

☐ No

Please explain why

**12) Do you have any concerns for participants (swimmers) in swim-with cetacean industries?**

☐ Yes

☐ No

Please explain why

**13) Do you feel any differences (for the animals and/or the participants) between operations offering swims with dolphins and operations offering swims with whales?**

☐ Yes

☐ No

Please explain

**14) What do you think forms the basis of many countries worldwide tolerating swim with dolphin operations but banning practices to swim with whales?**

*A swim-with industry targeting dwarf minke whales has developed in the Great Barrier Reef World Heritage Area (GBRWHA) over the past 15 years. To minimise the impact on the whales a Code of Practice was developed in 1999 by Dr Alastair Birtles and Dr Peter Arnold, to manage the conduct of dive/snorkel tourism vessels encountering dwarf minke whales. This Code of Practice became a permit condition in 2003 when the Great Barrier Reef Marine Park Authority (GBRMPA) issued swim-with whales permits. This decision made this industry the first swim-with whale fully-permitted program in the world. Nine permits were issued to six live-aboard vessels and three day boat operators for a 'trial' period of six years (2003-2009). After this period the Great Barrier Reef Marine Park Authority will decide on the future management of this industry based partly on the research findings of an overall sustainability assessment by the Minke Whale Project.*

**15) Are you aware of dwarf minke whales visiting the Great Barrier Reef each austral winter months?**

☐ Yes

(*if yes*) When was the first time you heard about them?

☐ No

**16) Have you ever encountered dwarf minke whales?**

☐ Yes

a) Where did you encounter them?
b) Approximately how often have you seen dwarf minkes in your life?
c) Tell me a little about this/these experience(s)

☐ No

**17) What is your current view about the swim-with dwarf minke whale industry in the Great Barrier Reef?**

**18) Do you have any other comments/suggestions regarding this survey?**

## Appendix 6: Key Informant Interview – Part 2

Name: ________________________ Date & Time: __________________

Nature & Location of interview: _______________________________________

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*The following introduction is to be read to the interviewee prior to the interview:*

I am doing a PhD on the behaviour of dwarf minke whales associated with a swim-with tourism industry on the northern Great Barrier Reef. Currently I am seeking feedback from knowledgeable members of the marine mammal science community, conservation organisations and managers on their perceptions and expert opinions about particular behaviours displayed by dwarf minke whales while interacting with swimmers and vessels. Many of these behaviours occur in other cetaceans, however due to differences in life history and context these behaviours may not be analogous. With your experience in the field of cetacean research (biology, behaviour etc.), management and/or conservation it is hoped to better understand these particular behaviours in the light of their potential meaning, context and the risk involved for both the animals and the swimming participants.

Information concerning individuals is strictly confidential, and will not be published or released. With your permission, this interview will be recorded and later transcribed into a written format. As you are aware, your participation is entirely voluntary. This interview will take approximately 30-40 minutes of your time and your opinions on the following dwarf minke whale behaviours are highly valued. Your support of this research is also greatly appreciated and I hope that the outcomes of the study will lead to ecologically sustainable interactions with dwarf minke whales.

---

*Interviewee is to read, understand, agree with and sign the following statement:*

**I have been informed about the nature of this interview, its confidentiality and I agree to participate. I also agree to this interview being recorded.**

**Signature: _____________________ Date: ________________________**

**Name: ________________________**

***Begin recording, quote: time, date & location of interview, and the name of the interviewee.***

***Before we start this interview I would like to ask you if there is anything you would like clarified resulting from watching the behaviour section of the 'Meet the Minkes interpretive DVD, 2007?***

1) **Was there anything you would like to have clarified from the behaviour section of the 'Meet the Minkes interpretive DVD, 2007'?**

   ☐ Yes ☐ No

*To facilitate the interview I would also like to ask you to have the 'Dwarf Minke Whale Behaviour Definition Sheet' easily accessible.*

*While they are in the Great Barrier Reef, dwarf minke whales show a very unusual behaviour. These whales approach vessels voluntarily. About 80% of all interactions occur when the boat is stationary at a reef site. If the whales decide to interact, they stay in close proximity to the vessel (the majority within a 60 metre radius of the vessel), aggregating around swimmers for prolonged periods of time (mean interaction time 2003-2007 = 90 minutes). This behaviour raises several potential issues including habituation and/or de-sensitisation to vessels and swimmers and difficulties of compliance with the Australian National Whale Watching Guidelines, particularly for the non swim with whales permitted operations in this area.*

3) **What would be your perception about why these animals are voluntarily interacting with vessels and humans?**

4) **Are you aware of any other animal(s) showing similar behaviour (i.e. voluntarily interacting, staying in close proximity for prolonged periods of time)?**

   ☐ *Yes* ☐ *No*

   *(if yes) What animal(s) show such behaviour?*

The next part of the interview is designed to evaluate potential meaning and context of particular dwarf minke behaviours. Would you please tell me…

- a) if you have ever observed this behaviour yourself (in (i) dwarf minke whales or (ii) any other cetaceans or marine mammals)?

  …if you have observed this behaviour,

  - in what context it occurred?
  - how you would interpret this behaviour?

- b) if you have ever recognised anything which could have stimulated this behaviour?
  - if you have ever seen this behaviour (in dwarf minkes or any other cetaceans) to be clearly directed towards c) a vessel, d) swimmers/snorkellers; e) SCUBA divers; f) another animal of the same species

**Question 5 – 15; Dwarf minke whale behaviours**

| Behaviour | a) Have you ever observed this behaviour in (i) dwarf minkes or (ii) any other cetaceans or marine mammals in the wild? | | | | b) Have you ever recognised anything which you thought could have stimulated this behaviour? | | | c-g) Have you ever seen that this behaviour was clearly directed towards... (if yes please explain) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (*if yes*) | | | | | c) a vessel | | d) swimmers/ snorkellers | | e) SCUBA divers | | f) another animal of the same species | | g) anything else | |
| | Yes | No | In what context did this behaviour occur? | How would you interpret this behaviour? | Yes | No | (*if yes*) Please explain | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| 5) Breaching | | | | | | | | | | | | | | | | | |
| 6) Belly presentation | | | | | | | | | | | | | | | | | |
| 7) Headrise | | | | | | | | | | | | | | | | | |
| 8) Spyhop | | | | | | | | | | | | | | | | | |
| 9) Pirouetting | | | | | | | | | | | | | | | | | |
| 10) Bubble release | | | | | | | | | | | | | | | | | |
| 11) Motorboating | | | | | | | | | | | | | | | | | |
| 12) Gaping/gulping | | | | | | | | | | | | | | | | | |
| 13) Sudden speed up | | | | | | | | | | | | | | | | | |
| 14) Sharp veer away | | | | | | | | | | | | | | | | | |
| 15) Close approaches (<3m) | | | | | | | | | | | | | | | | | |
| 16) Very close approaches (<1m) | | | | | | | | | | | | | | | | | |

**17) What do you think would be the best management strategy to protect these animals knowing that they are interacting voluntarily with tourism vessels and their swimmers?**

**18) Do you have any other comments/suggestions regarding this interview?**

Thank you very much for your time and your support. Again, all the information from this interview will be strictly confidential and information regarding individuals will be de-identified.

**Appendix 7:** Key Informant Survey – Part 3

This survey is about your perceptions of particular dwarf minke whale behaviours which potentially put swimmers and/or the animal at risk of harm. All of the following behaviours have been outlined in the 'Meet the Minkes interpretive DVD – 2007'. Information concerning individuals is strictly confidential, and will not be published or released. As you are aware, your participation is entirely voluntary. This survey will take approximately 30-40 minutes of your time to complete. Your expert opinions and perceptions are of critical importance to the evaluation of the risk involved with particular behaviours of dwarf minke whales when interacting with humans.

*Respondent is to read, understand and agree with the following statement:*

☐ **I have been informed about the nature of this survey, its confidentiality and I agree to participate. I am aware that my participation is entirely voluntary.**

--------------------------------------------

Name of participant

I would like your perception of risk about the following dwarf minke whale behaviours. Would you please

- rate what risk of harm (from 1-5; 1 = no risk to 5 = very high risk) to
  a) swimmers and b) the whales you would associate with these individual behaviours when a whale shows these behaviours
    - greater than a typical dwarf minke body length (>6m)
    - between one and half a dwarf minke body length (>3-6m)
    - within half a dwarf minke body length (>1-3m)
    - within a very close range/swimmer's touching distance (≤1m)

  from swimmers, the rope or the vessel.

after each rating of high (4) or very high risk (5) please explain why you think so

**Question 1 – 9; Dwarf minke whale behaviour - assessment of risk to swimmers and the whales**

| Behaviour | How would you rate the risk of harm to (i) swimmers and (ii) the whale, if a dwarf minke shows the following behaviour at the specified distance from swimmers, the rope or the vessel | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Please rate using the following scale**<br>**1------------------2------------------3------------------4------------------5**<br>no risk, low, medium, high, very high risk<br>and after each rating of high (4) or very high risk (5) please explain why you think so | | | | | | | |
| | a) greater than a dwarf minke body length (>6m) | | b) between half and one dwarf minke body length (>3-6 m) | | c) within half a dwarf minke body length (>1–3 m) | | d) within a very close range (swimmer's touching distance) (≤1m) | |
| | i) swimmers | ii) the whales | i) swimmers | ii) the whales | i) swimmers | ii) the whales | i) swimmers | ii) the whales |
| 1) Slow swim past | | | | | | | | |
| 2) High speed pass | | | | | | | | |
| 3) Breaching | | | | | | | | |
| 4) Belly presentation | | | | | | | | |
| 5) Headrise/Spyhop | | | | | | | | |
| 6) Pirouetting | | | | | | | | |
| 7) Bubble release | | | | | | | | |
| 8) Motorboating | | | | | | | | |
| 9) Gaping/gulping | | | | | | | | |
| 10) Sudden speed up | | | | | | | | |
| 11) Sharp veer away | | | | | | | | |

# Definitions of dwarf minke whale behaviours:

***Breaching:*** A dwarf minke propels its body rapidly out of the water often creating a large splash when it falls back onto the water surface. It usually leaves its tail in the water and often lands on its back. This can be seen at a distance of a kilometre or two. There may just be a single breach or multiple breaches. One or (rarely) more animals may be involved.

***Belly presentation:*** A belly presentation is when a moving minke turns onto its side presenting its bright white belly to an object, swimmer or another whale. This lateral position is often maintained for some seconds and the behaviour is often repeated.

***Headrise/Spyhop:*** A headrise / spyhop is when an animal ascends vertically or near vertically breaking the water surface with its snout. The difference between a headrise and a spyhop relates to how far the animal raises its snout or head from the water. We call it a headrise when the eyes of the animal stay submerged and a spyhop when the animal actually raises its eyes above the water surface.

***Pirouetting:*** Animal in a vertical or near vertical submerged position revolves its body. It may do this on the spot or may drift slowly sideways. The rotation is aided by slowly beating its tail together with wiggling movements of its body. The pectoral fins are used to stabilise its body in the vertical position.

***Bubble release:*** There are quite a variety of bubble releases, ranging from a massive bubble blast through a bubble trail to a bubble trickle. These can be either a surface bubble release (which we define as ≤ 1m from the surface and followed rapidly by a breath) or a deep bubble release (>1m from the surface and animal stays submerged).

***Motorboating:*** A near horizontal whale breaks the water surface and its snout and the upper part of the head is maintained just above the water surface while slowly moving forward.

***Gaping/gulping:*** A gape is when a minke opens its jaws exposing its baleen plates and oral cavity. If the throat pouch is partly or fully inflated we refer to it as a gulp.

***Sudden speed up:*** A sudden speed up is when an animal suddenly accelerates by kicking its tail and it may leave the immediate area at high speed. This behaviour is likely to be a fright or startle response to some sort of a disturbance to the animal. The cause of the disturbance is sometimes observable but may not always be so. It can be an auditory disturbance.

***Sharp veer away:*** A sharp veer away is when a swimming animal suddenly changes its direction or angle of travel, sharply turning away from a snorkeller, another whale or an object.

***Close approach (<3 m) & very close approach (<1m)*** We define any approach closer than three metres to either a swimmer or an object such as the boat as a close approach, no matter what behaviour the animal is displaying. Any approach closer than one metre is defined as a very close approach.

**12) Have you ever experienced any situation with dwarf minkes where you thought that their behaviour could potentially lead to a risk of harm to**

a) swimmers/snorkellers? b) the whales?

☐ Yes ☐ No ☐ Yes ☐ No

(*if yes*) please explain (*if yes*) please explain

**13) Have you ever experienced any situation with any other cetaceans where you thought that their behaviour could potentially lead to a risk of harm to**

a) swimmers/snorkellers? b) the whales?

☐ Yes ☐ No ☐ Yes ☐ No

(*if yes*) please explain (*if yes*) please explain

**14) What dwarf minke whale behaviour(s) in regards to distance do you feel is/are of the greatest risk to**

a) the animal?

b) the swimmers/snorkellers?

**15) Is there anything else which concerns you about the swim with dwarf minke whale industry?**

**16) Are you aware of any incidents in commercial swim-with whale programs which resulted in any injuries to the animals and/or the swimmers** (this can include shark attacks, etc.)**?**

☐ Yes ☐ No

(if yes) please list incidents you are aware of

**17) Evidence in the literature suggest that there is the potential for disease transmission (from marine mammal to humans and vice versa) if humans come in close contact with marine mammals. How do you feel about this risk during interactions with dwarf minke whales?**

**18) Do you have any other comments/suggestions regarding this survey?**

**Appendix 8:** Key Informants' ratings of dwarf minke whale behaviours of potential harm to swimmers in the assigned distance categories (rating scale from 1 = no risk to 5 = very high risk)

| Behaviours | Distance categories (m) | No risk | Low risk | Medium risk | High risk | Very high risk | Total |
|---|---|---|---|---|---|---|---|
| Breaching | >6 | 4 | 6 | 8 | 0 | 0 | 18 |
| | >3-6 | 0 | 2 | 8 | 5 | 3 | |
| | >1-3 | 0 | 0 | 3 | 8 | 7 | |
| | ≤ 1 | 0 | 0 | 1 | 4 | 13 | |
| High speed pass | >6 | 9 | 7 | 2 | 0 | 0 | 18 |
| | >3-6 | 4 | 6 | 6 | 2 | 0 | |
| | >1-3 | 2 | 2 | 8 | 5 | 1 | |
| | ≤ 1 | 0 | 3 | 4 | 6 | 5 | |
| Sudden speed up | >6 | 11 | 4 | 3 | 0 | 0 | 18 |
| | >3-6 | 7 | 4 | 4 | 2 | 1 | |
| | >1-3 | 2 | 4 | 5 | 5 | 2 | |
| | ≤ 1 | 0 | 3 | 3 | 6 | 6 | |
| Sharp veer away | >6 | 11 | 6 | 1 | 0 | 0 | 18 |
| | >3-6 | 7 | 5 | 4 | 1 | 1 | |
| | >1-3 | 2 | 4 | 6 | 4 | 2 | |
| | ≤ 1 | 0 | 3 | 3 | 6 | 6 | |
| Motorboating | >6 | 12 | 6 | 0 | 0 | 0 | 18 |
| | >3-6 | 9 | 6 | 2 | 1 | 0 | |
| | >1-3 | 5 | 5 | 5 | 2 | 1 | |
| | ≤ 1 | 0 | 5 | 5 | 6 | 2 | |
| Belly presentation | >6 | 13 | 5 | 0 | 0 | 0 | 18 |
| | >3-6 | 13 | 5 | 0 | 0 | 0 | |
| | >1-3 | 6 | 6 | 4 | 1 | 0 | |
| | ≤ 1 | 2 | 5 | 8 | 2 | 1 | |
| Gaping/gulping | >6 | 14 | 3 | 1 | 0 | 0 | 18 |
| | >3-6 | 8 | 8 | 2 | 0 | 0 | |
| | >1-3 | 5 | 5 | 7 | 1 | 0 | |
| | ≤ 1 | 0 | 7 | 6 | 4 | 1 | |
| Headrise/Spyhop | >6 | 14 | 4 | 0 | 0 | 0 | 18 |
| | >3-6 | 11 | 6 | 1 | 0 | 0 | |
| | >1-3 | 6 | 6 | 5 | 1 | 0 | |
| | ≤ 1 | 0 | 6 | 6 | 5 | 1 | |
| Pirouetting | >6 | 14 | 4 | 0 | 0 | 0 | 18 |
| | >3-6 | 9 | 8 | 1 | 0 | 0 | |
| | >1-3 | 5 | 7 | 3 | 3 | 0 | |
| | ≤ 1 | 0 | 5 | 9 | 2 | 2 | |
| Bubble release | >6 | 16 | 2 | 0 | 0 | 0 | 18 |
| | >3-6 | 13 | 4 | 1 | 0 | 0 | |
| | >1-3 | 10 | 3 | 4 | 1 | 0 | |
| | ≤ 1 | 3 | 5 | 8 | 1 | 1 | |
| Slow swim past | >6 | 16 | 2 | 0 | 0 | 0 | 18 |
| | >3-6 | 10 | 7 | 1 | 0 | 0 | |
| | >1-3 | 6 | 6 | 5 | 1 | 0 | |
| | ≤ 1 | 1 | 7 | 7 | 1 | 2 | |

**Appendix 9:** Key Informants' ratings of dwarf minke whale behaviours of potential harm to the whales in the assigned distance categories (rating scale from 1 = no risk to 5 = very high risk)

| Behaviours | Distance categories (m) | No risk | Low risk | Medium risk | High risk | Very high risk | Total |
|---|---|---|---|---|---|---|---|
| Breaching | >6 | 16 | 1 | 1 | 0 | 0 | 18 |
| | >3-6 | 9 | 3 | 3 | 3 | 0 | |
| | >1-3 | 5 | 3 | 4 | 5 | 1 | |
| | ≤ 1 | 1 | 1 | 4 | 6 | 6 | |
| High speed pass | >6 | 16 | 1 | 1 | 0 | 0 | 18 |
| | >3-6 | 12 | 2 | 4 | 0 | 0 | |
| | >1-3 | 8 | 4 | 4 | 2 | 0 | |
| | ≤ 1 | 3 | 7 | 1 | 5 | 2 | |
| Sudden speed up | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 12 | 2 | 3 | 1 | 0 | |
| | >1-3 | 7 | 4 | 4 | 3 | 0 | |
| | ≤ 1 | 2 | 6 | 2 | 4 | 4 | |
| Sharp veer away | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 12 | 2 | 3 | 1 | 0 | |
| | >1-3 | 7 | 4 | 4 | 3 | 0 | |
| | ≤ 1 | 2 | 6 | 1 | 5 | 4 | |
| Motorboating | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 14 | 3 | 1 | 0 | 0 | |
| | >1-3 | 11 | 4 | 3 | 0 | 0 | |
| | ≤ 1 | 5 | 5 | 3 | 5 | 0 | |
| Belly presentation | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 15 | 2 | 1 | 0 | 0 | |
| | >1-3 | 12 | 4 | 2 | 0 | 0 | |
| | ≤ 1 | 6 | 6 | 3 | 3 | 0 | |
| Gaping/gulping | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 13 | 4 | 1 | 0 | 0 | |
| | >1-3 | 10 | 2 | 3 | 3 | 0 | |
| | ≤ 1 | 4 | 5 | 3 | 5 | 1 | |
| Headrise/Spyhop | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 16 | 1 | 1 | 0 | 0 | |
| | >1-3 | 10 | 5 | 3 | 0 | 0 | |
| | ≤ 1 | 5 | 4 | 5 | 4 | 0 | |
| Pirouetting | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 13 | 4 | 1 | 0 | 0 | |
| | >1-3 | 10 | 3 | 5 | 0 | 0 | |
| | ≤ 1 | 6 | 4 | 4 | 4 | 0 | |
| Bubble release | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 16 | 1 | 1 | 0 | 0 | |
| | >1-3 | 13 | 4 | 1 | 0 | 0 | |
| | ≤ 1 | 6 | 6 | 4 | 2 | 0 | |
| Slow swim past | >6 | 17 | 0 | 1 | 0 | 0 | 18 |
| | >3-6 | 16 | 1 | 1 | 0 | 0 | |
| | >1-3 | 12 | 4 | 2 | 0 | 0 | |
| | ≤ 1 | 4 | 6 | 5 | 3 | 0 | |

## **Appendix 10:** Key Informants' field of expertise

| Key Informants' field of expertise | # Responses |
|---|---|
| **Anatomy** | |
| Veterinary anatomy | 1 |
| | |
| **Biology** | |
| Cetacean biology | 3 |
| Marine mammal biology | 2 |
| Conservation biology | 1 |
| | |
| **Ecology** | |
| Cetacean ecology | 4 |
| Behavioural ecology | 3 |
| Marine ecology | 2 |
| Marine Mammal ecology | 1 |
| Population ecology | 1 |
| | |
| **Behaviour** | |
| Marine Mammal behaviour | 3 |
| Bioacoustics | 3 |
| Animal behaviour | 1 |
| Cetacean behaviour | 1 |
| | |
| **Medicine and Pathology** | |
| Marine Mammal medicine and pathology | 1 |
| | |
| **Tourism** | |
| Marine Ecotourism | 2 |
| Tourism interactions with cetaceans | 1 |
| Sustainable wildlife tourism | 1 |
| | |
| **Conservation and management** | |
| Species conservation and management | 3 |
| Marine Mammal conservation | 2 |
| Cetacean conservation and management | 2 |
| Marine Environmental conservation and management | 2 |
| Wildlife tourism management | 2 |
| Marine Park management | 1 |
| | |
| **Policy and Planning** | |
| Marine Policy and Planning | 4 |
| Marine Conservation Policy | 1 |
| Cetacean policy | 1 |

## **Appendix 11:** Marine mammal species on which the Key Informants worked

| Marine mammal species | # Responses |
|---|---|
| **Odontocetes** | |
| Bottlenose dolphins | 10 |
| Orcas | 3 |
| Common dolphins | 2 |
| Harbour porpoises | 2 |
| Sperm whales | 2 |
| Indo pacific humpback dolphins | 2 |
| Australian snubfin | 2 |
| Dusky dolphins | 1 |
| Inshore dolphins | 1 |
| Beluga whales | 1 |
| Amazon river dolphins | 1 |
| Commerson dolphins | 1 |
| Long-finned pilot whales | 1 |
| Striped dolphins | 1 |
| Short beaked dolphin | 1 |
| Finless porpoise | 1 |
| Spinner dolphins | 1 |
| Risso's dolphins | 1 |
| **TOTAL odontocetes** | **34** |
| **Mysticetes** | |
| Humpback whales | 9 |
| Dwarf minke whales | 4 |
| Blue whales | 3 |
| Southern right whales | 3 |
| Antarctic minke whales | 2 |
| Northern hemisphere minke whales | 2 |
| Bryde's whales | 1 |
| Pygmy blue whales | 1 |
| Fin whales | 1 |
| **TOTAL mysticetes** | **26** |
| **TOTAL CETACEANS** | **60** |
| **Pinnipeds** | |
| Sea otters | 2 |
| Sea lions | 2 |
| Elephant seals | 2 |
| Ice seals | 1 |
| Leopard seals | 1 |
| Ross seals | 1 |
| **TOTAL pinnipeds** | **9** |
| **Sirenians** | |
| Dugongs | 6 |
| Antillan manatee | 1 |
| **TOTAL sirenians** | **7** |
| **Other marine mammals** | |
| Polar bears | 1 |
| **TOTAL other marine mammals** | **1** |
| **GRAND TOTAL MARINE MAMMALS** | **77** |

**Appendix 12:** Key Informants' view about commercial tourism operations offering swims with cetaceans

| Key Informant Responses | # Resp. |
|---|---|
| **Supportive** | |
| generally supportive | 1 |
| | |
| **because:** | |
| potential to educate general public about cetaceans, their environment and conservation | 3 |
| potential benefits to cetacean conservation | 3 |
| | |
| **as long as:** | |
| the activity is well controlled and managed | 4 |
| activity is underpinned by good science | 4 |
| activity is ecologically sustainable | 2 |
| there is no dangers to the people involved | 1 |
| operators understand and follow the rules | 2 |
| | |
| **but:** | |
| it requires regulation to ensure long-term sustainability and wellbeing of animals | 1 |
| operations have the potential for negative effects on individuals and populations | 1 |
| **TOTAL SUPPORTIVE** | **22** |
| **Oppose** | |
| **if:** | |
| animals are chased or harassed by operators | 1 |
| | |
| **because:** | |
| potential to cause both short and longer term impacts on the animals (e.g. behavioural changes) | 9 |
| potential for impacts on animals greater than boat based tourism | 2 |
| often experience does not promote conservation | 1 |
| typically there is lack of management | 1 |
| very difficult to run successfully for both animals and swimmers | 1 |
| cumulative and long-term impacts of this type of tourism is often ignored | 1 |
| often animals are targeted in sensitive behavioural states (e.g. feeding, resting) | 1 |
| prefer there be no swim with programs | 1 |
| do not believe any new swim-with programs should be introduced | 1 |
| advantage of winning over people to the cause of whale and dolphin conservation can be gained by means other than people entering the water. | 1 |
| oppose captive attractions outright | 1 |
| **TOTAL OPPOSED** | **21** |
| **Undecided** | |
| **Depends on:** | |
| education and potential disturbance | 1 |
| experience of staff | 1 |
| attitude of the company | 1 |
| who is initiating the interactions (animals or humans); if whales initiating less likely | 2 |
| | |
| negative effect | |
| | |
| **TOTAL UNDECIDED** | **5** |

**Appendix 13:** Key Informants' concerns for the targeted animals in swim-with cetacean industries

| **Key Informant Responses** | **# Resp.** |
|---|---|
| | |
| **Concerned because industries:** | |
| have potential to intentionally harm or harass animals | 6 |
| have potential to disrupt critical behavioural states (e.g. resting, nursing) | 5 |
| have potential to negatively influence behavioural/time-activity budget | 4 |
| have potential to disturb, stress and induce aggression | 4 |
| have potential to cause short and long term behavioural changes to animals | 3 |
| have potential transmit diseases | 2 |
| increase chances of physical harm to animals (e.g. collision and noise) | 2 |
| not enough science or monitoring to determine negative impacts | 2 |
| scientific evidence of negative effects to animals do not transfer into management | 1 |
| most existing operators do not run responsible swim with programs | 1 |
| pressure to satisfy passengers leads to misconduct | 1 |
| | |
| **if:** | |
| activity is unregulated | 2 |
| | |
| **but:** | |
| depends who is initiating the interaction (human or cetaceans) | 2 |
| **TOTAL Concerned** | **35** |
| **Not concerned because:** | |
| | |
| Generally, cetaceans can avoid swimmers and vessels | 1 |
| **TOTAL Not concerned** | **1** |

**Appendix 14:** Key Informants responses to the question if they have any concerns for the participants (swimmers) in swim-with cetacean industries

| Key Informant Responses | # Resp. |
|---|---|
| **Direct harm to swimmers from cetaceans because:** | |
| • of potential aggression from the animals (intended injury) | 9 |
| • the close contact increases the risk of accidents (unintended injury) | 6 |
| • large and powerful animals can lead to accidents | 5 |
| • operators/swimmers have inappropriate perceptions of wild animals | 4 |
| • swimmers are poorly informed | 4 |
| • there is limited (scientific) understanding of animals' behaviour | 3 |
| • people do stupid things that put themselves at risk | 2 |
| • cetaceans may be habituated | 1 |
| • you cannot predict what is going to happen | 1 |
| **Total of direct harm from cetacean** | **35** |
| | |
| **Indirect harm to swimmers from cetacean because:** | |
| • of the potential disease transmission | 5 |
| **Total indirect harm from cetacean** | **5** |
| | |
| **Harm to swimmers from external factors** | |
| • swimmers underestimate environment (rough, cold, open ocean conditions) | 2 |
| • lack of swimming skills | 3 |
| • getting on/off vessels | 1 |
| • shark attacks | 2 |
| • boat collisions | |
| **Total of harm from external factors** | **8** |
| **TOTAL HARM FOR SWIMMERS** | **48** |
| | |
| **Swimmers are not of harm from cetaceans because:** | |
| • there is only minimal risk, not more risk involved than in water sports | 2 |
| • there are no agonistic behaviour from animals | 1 |
| **TOTAL NO HARM** | **3** |

**Appendix 15:** Reasons why Key Informants perceived the rated behaviours of high or very high potential to harm swimmers

| Behaviour | Responses | # Resp. |
|---|---|---|
| Breaching | Potential that whale miscalculates trajectory and lands on swimmer | 11 |
| | High speed, high energy behaviour which is not easily controllable | 3 |
| | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Sound and pressure waves could be harming swimmers | 1 |
| | Aggressive activity has potential to harm swimmer | 1 |
| Sudden speed up | Potential collision through miscalculation of distance | 6 |
| | Whale likely to pay less attention when startled for some reason | 2 |
| | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Too little time for swimmer to react and get out of way | 1 |
| | Any high speed behaviour has the potential for harm | 1 |
| | Any aggressive behaviour close to swimmer potential for harm | 1 |
| Sharp veer away | Potential collision through miscalculation of distance | 6 |
| | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Whale likely to pay less attention suddenly moving away from something | 1 |
| | Any high speed behaviour at close range has the potential for harm | 1 |
| | May indicate nervousness and hence is unpredictable | 1 |
| | Any aggressive behaviour close to swimmers has potential for harm | 1 |
| High speed pass | Potential collision through miscalculation of distance | 4 |
| | Any high speed behaviour at close range has the potential for harm | 3 |
| | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Any aggressive behaviour close to swimmers has potential for harm | 1 |
| Motorboating | Potential collision through miscalculation of distance | 3 |
| | Because of their body size any situation close to swimmer can be disastrous | 3 |
| | Less controlled behaviour has potential for injury | 1 |
| | At close range animal can be easily startled and injure swimmers | 1 |
| | Any aggressive behaviour close to swimmers has potential for harm | 1 |
| Headrise | Potential collision through miscalculation of distance | 3 |
| | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Whale might not be able to see the swimmer in this position | 1 |
| | At close range animal can be easily startled and injure swimmers | 1 |
| Pirouetting | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Less controlled behaviour has potential for injury | 1 |
| | Potential collision through miscalculation of distance | 1 |
| Gape/gulp | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | Potential collision through miscalculation of distance | 1 |
| | Swimmers may panic and cause startle reaction in whale | 1 |
| | May be a threat/agonistic display of whale | 1 |
| Slow swim past | Because of their body size any situation close to swimmer can be disastrous | 2 |
| Belly presentation | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | May be a threat/agonistic display of whale | 1 |
| Bubble release | Because of their body size any situation close to swimmer can be disastrous | 2 |
| | May be a threat/agonistic display of whale | 1 |

**Appendix 16:** Reasons why Key Informants perceived the rated behaviours of high or very high potential to harm whales

| Behaviour | Responses | # Resp. |
|---|---|---|
| Breaching | Potential that whale miscalculates trajectory and lands on swimmer, rope or vessel | 9 |
| | Potential entanglement in rope | 5 |
| | High speed, high energy behaviour which is not easily controllable | 3 |
| Sudden speed up | Potential for collision with vessel/swimmer | 7 |
| | Potential for entanglement in rope | 4 |
| | Short distance and speed - the whale has no margin for error in its movements | 3 |
| | Potential of whale being harassed, touched, hit by swimmers | 1 |
| | Whale likely to pay less attention when startled for some reason | 1 |
| | Potential for disease transfer | 1 |
| Sharp veer away | Potential for collision with vessel/swimmer | 4 |
| | Potential for entanglement in rope | 4 |
| | Short distance and speed - the whale has no margin for error in its movements | 2 |
| | Potential of whale being harassed, touched, hit by swimmers | 1 |
| | Whale likely to pay less attention when startled for some reason | 1 |
| | Potential for disease transfer | 1 |
| High speed pass | Potential for collision with vessel/swimmer | 5 |
| | Potential for entanglement in rope | 4 |
| | Short distance and speed - the whale has no margin for error in its movements | 2 |
| | Potential of whale being harassed, touched, hit by swimmers | 1 |
| | Potential for disease transfer | 1 |
| Motorboating | Potential of whale being harassed, touched, hit by swimmers | 3 |
| | Potential for collision with vessel/swimmer | 2 |
| | Potential for entanglement in rope | 1 |
| | Short distance and speed, the whale has no margin for error in its movements | 1 |
| | Potential for disease transfer | 1 |
| Headrise | Potential of whale being harassed, touched, hit by swimmers | 3 |
| | Potential for disease transfer | 1 |
| Pirouetting | Potential of whale being harassed, touched, hit by swimmers | 2 |
| | Potential for entanglement in rope | 1 |
| | Potential for disease transfer | 1 |
| Gape/gulp | Potential of whale being harassed, touched, hit by swimmers | 3 |
| | Potential for entanglement in rope | 2 |
| | Swimmer may panic and potentially startle the whale | 1 |
| | Potential for disease transfer | 1 |
| Slow swim past | Potential of whale being harassed, touched, hit by swimmers | 3 |
| | Potential for disease transfer | 1 |
| Belly presentation | Potential of whale being harassed, touched, hit by swimmers | 1 |
| | Potential for disease transfer | 1 |
| Bubble release | Potential of whale being harassed, touched, hit by swimmers | 1 |
| | Potential for disease transfer | 1 |

# MINKE WHALE PROJECT

Dwarf minke whale
Balaenoptera acutorostrata subspecies

# Interaction Behaviour Diary

# 2008

JAMES COOK UNIVERSITY

SUSTAINABLE TOURISM CRC

**CHARROA**
Cod Hole and Ribbon Reef
Operators Association

museum of tropical queensland
queensland museum

## A study of the interactions between swimmers and dwarf minke whales

***For the past twelve years, scientists from James Cook University (JCU) and the Museum of Tropical Queensland have been studying the biology & behaviour of the Great Barrier Reef's dwarf minke whales. They have been able to do this thanks to the help of the live-aboard dive boats, their crews and the passengers themselves. The aim of this Diary is to collect data on the occurrence of specific dwarf minke behaviours (see descriptions below), the contexts in which these behaviours took place and your experiences when interacting with these whales. By recording your observations in this Diary you can help improve our understanding of these behaviours. You will also contribute to a PhD study by Arnold Mangott (JCU).***

***If you would like to help us collect behavioural information, please complete one of these four page Diaries after any of your minke whale encounters that you found particularly interesting or exciting. Your participation is entirely voluntary and one Diary will take approximately 10 minutes to complete. All passengers and crew are encouraged to fill in a Diary, and more than one account of a single encounter is welcome (in separate Diaries please). Please use one Diary per encounter per person. Your observations are very valuable for this study.***

***Thank you for your help with this research***

**Which behaviours are we looking for?** *(see the CRC Reef Current State of Knowledge Information Brochure 2002 or the 'Dwarf minke whale behaviour' section of the "Meet the Minkes: Minke Whale Project Interpretive DVD 2007" for more detailed descriptions of dwarf minke whale behaviours)*

***Breach:*** Seen occasionally. A minke propels its body rapidly out of the water often creating a large splash when it falls back onto the water surface. It usually leaves its tail in the water and often lands on its back. This can be seen at a distance of a kilometre or two. There may just be a single *breach* or multiple *breaches*. One or (rarely) more animals may be involved.

***Headrise & spyhop:*** A minke ascends vertically or near vertically breaking the water surface with its snout. A *headrise* (seen occasionally) is when the eyes of the animal stay submerged and a *spyhop* (rare) is when the animal actually raises its eyes above the water surface.

***Submerged tail stand & pirouette:*** a *submerged tail stand* (rare) is when a minke is almost stationary in a vertical or near vertical submerged position. If it starts to revolve its body we refer to it as a *pirouette* (very rare). The rotation is aided by slowly kicking its tail together with wiggling movements of its body.

***Bubble release:*** Rare. There are quite a variety of bubble releases, ranging from a *bubble trickle* through a *bubble trail* to a massive *bubble blast*. These can be a *surface bubble release* (≤ 1m from the surface followed rapidly by a breath) or a *deep bubble release* (>1m from the surface and animal stays submerged).

***Belly presentation:*** Seen occasionally. A moving minke turns onto its side presenting its bright white belly to an object, swimmer or another whale. This lateral position is often maintained for some seconds and the behaviour is often repeated. It provides a good opportunity to see the genital area of the whale and hence determine its gender.

***Motorboating:*** Rare. A near horizontal whale breaks the water surface and its snout and the upper part of its head is maintained just above the water surface while slowly moving forward.

***Gape & gulp:*** Very rare. A g*ape* is when a minke opens its jaws exposing its baleen plates and oral cavity. If the throat pouch is partly or fully inflated we refer to it as a *gulp*.

***Jaw clap:*** Very rare. The jaws are brought together with a loud crack at or above the surface.

***Close approach (>1-3m ):*** Seen occasionally. Any approach by a dwarf minke closer than three metres to either a swimmer or an object such as the boat.

***Very close approach (<1m):*** Rare. If the whale approaches to within one metre we define it as a *very close approach*.

***Sudden speed up:***
***Sharp veer away:***
***Sudden deep dive:***
} Rare. These abrupt changes in speed, direction or depth result in the whale moving away from other whales, swimmers, the vessel or occasionally from some unseen stimulus.

***Physical contact:*** Very rare. Any *physical contact* by a dwarf minke whale (i.e. contact with rope, anchor chain, dinghy, swimmer, vessel etc.)

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**1) Name of boat:** …………………………………………………………………………

**2) Date of encounter:**…….. **Encounter number for that day** (e.g. 1st, 2nd, etc)**:**………

**3) How many whales did you see in this encounter?** ……Approx./Certain *(please circle one)*

**4) Estimated size(s):** (no. of whales): more than 6m: #....., 4m-6m: #…., less than 4m: #…

**5) Did you see any calves?** ☐ Yes ☐ No

(a calf is referred to as <1/2 size of the mother, in close proximity to her and breathing more often)

(if yes) approximately how long did it stay in the area? …………(min)

**6) What was the closest distance to which you were approached by a whale in this encounter?** ………metres or ………feet

**7) Did you swim with minke whale(s) on SCUBA during this encounter?** ☐ Yes ☐ No

**8) Did you swim with minke whale(s) on snorkel during this encounter?** ☐ Yes ☐ No

**9) If you were in the water, were you holding onto**

☐ a rope ☐ a bar ☐ nothing ☐ other:…………………………

**10) How many ropes were deployed?** ……

- where were they deployed from? ☐ Stern ☐ Bow ☐ Stern & Bow ☐ Side

**11) If you were on a rope how many people (max.) were on the rope with you?** …...

**12) How did you feel about this number of people on the rope?** *(please tick one box)*

☐ Too many ☐ OK ☐ Not enough

- Why did you feel this way? …………………………………………………..

…………………………………………………………………………………………

**13) How many people (maximum) would you suggest on one rope?** …………………

**14) How useful do you think the rope is for managing encounters?** **(please circle one number)**

Totally useless **1-------2-------3-------4-------5-------6-------7-------8-------**9-------10 Very useful

- Why do you feel this way? ……………………………………………….

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**15) How would you rate your overall satisfaction with <u>this</u> minke whale encounter?**

Very poor **1-------2-------3-------4-------5-------6-------7-------8-------9-------10** Excellent

- Please explain why? ……………………………………………………………...

…......…………………………………………………………...……………………

**16) How well do you feel <u>this</u> minke whale encounter was managed by the boat crew?**

Very poorly managed **1-------2-------3-------4-------5-------6-------7-------8-------9-------10** Extremely well managed

- Please explain why? ……………………………………………………………...

…………………………………………………………………………………………

**17) What dwarf minke behaviour did you see in this encounter?**

| Behaviour/Vocalisation | Did you observe/hear this behaviour? (please tick) | | How often did you see/hear this behaviour? | What was the closest distance (in metres) of this behaviour | | Comments |
|---|---|---|---|---|---|---|
| | Yes | No | | to you | to the boat | |
| *Breach* (propels its body rapidly out of the water) | | | | | | |
| *Headrise* (eyes submerged) | | | | | | |
| *Spyhop* (eyes above water) | | | | | | |
| *Submerged tail stand* | | | | | | |
| *Pirouetting* | | | | | | |
| *Surface bubble release* | | | | | | |
| *Deep bubble release* | | | | | | |
| *Belly presentation* | | | | | | |
| *Motorboating* | | | | | | |
| *Gape* | | | | | | |
| *Gulp* | | | | | | |
| *Jaw clap* | | | | | | |
| *Close approach* (<3m) | | | | | | |
| *Very close approach* (<1m) | | | | | | |
| *Sudden speed up* | | | | | | |
| *Sharp veer away* | | | | | | |
| *Sudden deep dive* | | | | | | |
| *Physical contact* | | | | | | |
| *Star Wars vocalisation(s)* | | | | | | |
| *Social vocalisation(s),* e.g. Grunts | | | | | | |
| Other: | | | | | | |
| | | | | | | |

**18) Did you feel that any of the behaviours were directed at**

**(a) the vessel?** ☐ Yes ☐ No
**(b) the swimmers?** ☐ Yes ☐ No

If so please describe:…………….……………………………...……..….………………

…..…………………………………………..…………………………….………

**19) Did you notice a difference in the whales' behaviour towards SCUBA divers compared to snorkellers?**

Please explain……………………………..……………………………………

……………………………………………………………………….…………

**20) Do you feel any of the behaviours you saw could potentially pose a risk to the safety of the whales and/or the swimmers?**

☐ Yes ☐ No

Why do you feel this way? ……………………………………..………………….

……………………………………………………………………..…….…………

**21) Description of the Encounter*:*** Please give as much detail as possible, including the number of whales that you saw, any interesting and unusual behaviours displayed by the whales, any changes in the whales' behavioural patterns during the encounter, whether these behaviours occurred in any specific context, e.g. change in the number of swimmers, new or more whales arriving, swimmers moving towards the whales, etc. and which marking(s) (if any) allowed you to recognise an individual whale.

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**22) Have you seen the 'Dwarf minke whale behaviour' section of the "Meet the Minkes" DVD before this encounter?** ☐ Yes ☐ No

**23) What other information about dwarf minke behaviours have you received?**

☐ CRC Reef Current State of Knowledge 2002 ☐ Interaction Behaviour Diary Cover Sheet

☐ Biology Talk ☐ Informal discussions (with staff or other passengers)

☐ Reference books about whales provided on boat ☐ Presentation / talks by guest whale researcher(s)

**You are welcome to complete as many of the preceding Behavioural Diaries as you like but please fill in the following section only once and after you have seen the 'Dwarf minke whale behaviour' section of the "Meet the Minkes: Minke Whale Project Interpretive DVD 2007"**

- **If you completed the following section previously, please proceed to the bottom of the next page and give your contact details if you like. Thank you very much for your great input into this research!**

**24) How confident do you feel about being able to identify and distinguish between the featured behaviours after seeing the 'Dwarf minke whale behaviour' section of the DVD?**

☐ not confident ☐ confident ☐ very confident

Please explain why? ……………………………………………..…………….
……………………………………………………………………………..………

**25) Did this interpretive DVD contribute to your overall satisfaction about swimming with these whales?**

☐ Yes ☐ No

please explain: …………………………………………………..…..…………..
…………………………………………………………..…………………..…

**26) Is there anything you would suggest to improve the DVD?**

☐ Yes ☐ No

please explain: …………………………………………..………..…………..
…………………………………………………………………..…….…………

**27) Did you know much about dwarf minke whale behaviour before this trip?**

Please explain a little: ………………………………….……………………..
…………………………………………………………………...…………

**28) Had you ever swum with dwarf minke whales before this trip?** ☐ Yes ☐ No

*(if yes)*

a) Approximately how often did you swim with minkes before this trip? …..time(s)

b) When was the first time you swam with minke whales? ……year?

**29) Before you swam with dwarf minkes for your first time, were you concerned about being in the water with these whales?** ☐ Yes ☐ No

*(if yes)*

a) what were you concerned about?.......................................................................
……………………………………………………………………………………

b) do you still have any concerns? ☐ Yes ☐ No

*(if yes)* Why? ..........................................................................................................
…………………………………………………………….……………………
*(if no)* What do you think has changed? ……………….………………………

Your contact details (optional): Name: …………………………………………………
Email address:…………………………………………...…………………………...

Would you like us to email you a copy of this Diary as a lasting record of your experience? ☐ Yes ☐ No

**THANK YOU VERY MUCH FOR YOUR HELP WITH THIS RESEARCH**