

Burrunan dolphin (*Tursiops australis*) tourism in Port Phillip Bay, Australia: effects, implications and management

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Abstract

In Port Phillip Bay, Victoria, Australia, the endemic and vulnerable Burrunan dolphin (*Tursiops australis*) is the target species of a non-consumptive, economically important, dolphin-swim industry. This industry commenced in 1986, and southern Port Phillip Bay is now a key eco-tourism destination in Victoria, with 8 permitted trips daily targeting swimming with Burrunan dolphins. Although this industry has been in operation for 29 years, understanding of the occurrence, demographics, habitat use, behaviour and effects of tourism on Burrunan dolphins is limited. This lack of empirical data is of concern as it has impeded management of the Port Phillip Bay dolphin-swim industry. To ensure the sustainability of this industry, it is imperative that sound scientific data be provided so that management can make informed decisions. This study assessed the potential effects of the dolphin-swim industry on Burrunan dolphin behaviour whilst simultaneously assessing the efficacy of different management strategies.

The Wildlife (Marine Mammal) Regulations were developed by management (the Department of Environment, Land, Water and Planning) to mitigate adverse impacts of dolphin-swim tourism on dolphins in Victorian waters and provide for their long-term protection. This study investigated the efficiency of these regulations as a management tool by assessing dolphin-swim tour operators' compliance with these regulations. Data were collected in 282 surveys on-board permitted dolphin-swim vessels, between 1998 and 2013. Results revealed that tour operators are non-compliant, demonstrating satisfactory compliance for only two of the eight dolphin-swim regulations assessed.

The Wildlife (Marine Mammal) Regulations stipulate that tour operators must provide information to their customers on the biology and conservation status of dolphins and the threats they face. This is the first study to investigate whether dolphin-swim tours are successful in educating tourists about Burrunan dolphins and their environment, evaluating whether there are long-term increases in participants' biocentrism due to partaking in a dolphin-swim tour. Between 2011

and 2013 dolphin-swim tourists' demographics, motivation, biocentrism, knowledge and satisfaction levels were obtained from 511 questionnaires collected from dolphin-swim participants before, immediately after and 6 months post dolphin-swim tours. Over time, participants valued knowledgeable staff however tourists were only moderately satisfied with information regarding conservation of dolphins and their environment that they received during tours. Tourists were happy to comply with regulations as they do not want their actions to have a negative impact on the target species. Results revealed that dolphin-swim tours can be a useful vehicle for education, can promote pro-environmental beliefs, can raise participants' biocentric levels and make them more aware of the consequences of their actions.

One of the challenges facing management of the dolphin-swim industry is the lack of baseline data. Prior to evaluating the effects of tourism on this population this study examined the dolphins themselves. Data relating to the occurrence, demographics and behaviour of Burrunan dolphins in Port Phillip Bay were collected during 67 surveys conducted aboard the research vessel between December 2009 and May 2013. In total, 51 independent dolphin groups were encountered, resulting in 1,058, 3 min observations. Calves were present in almost half of observations (43.6%, $n = 461$). Dolphins were observed in small groups ranging from one to twenty-six individuals. The activity budget revealed that travelling and resting were the most and least frequently observed behaviours respectively, with foraging also accounting for a large proportion of the activity budget. Three important habitat areas that are hotspots for foraging Burrunan dolphins in southern Port Phillip Bay were identified. Dolphin behaviour varied significantly with season, year, diel, tide, sea surface temperature, distance from land, group size and group composition. Results indicate that southern Port Phillip Bay is important for foraging dolphins and nursing groups.

The effectiveness of Ticonderoga Bay Sanctuary Zone (the only protected area designated for dolphins within Port Phillip Bay) as a management strategy was investigated for the first time since its implementation by assessing whether the dolphins utilise this area for critical behaviours, e.g. foraging and resting.

Results revealed that Ticonderoga Bay Sanctuary Zone is of importance for foraging dolphins and should be maintained as a management tool as it provides an area where disruptions to dolphins whilst they are engaged in a biologically critical behaviour are minimised.

Responses of Burrunan dolphins to tour vessel approaches were assessed from permitted dolphin-swim vessel trips ($n = 306$) across two time periods: 1998 - 2000 and 2011 - 2013. Effect responses (avoidance and approach) of dolphins increased significantly over time as dolphins gained cumulative exposure to tour vessel approaches. These dolphins are forced to expend a greater level of time and energy avoiding or approaching tour boats. Approaches (i.e. Parallel) that did not contravene regulations elicited highest approach responses by dolphins towards tour vessels, whereas dolphins responded to illegal approaches (i.e. Direct or J) most frequently with avoidance. Initial dolphin behaviour had a strong effect on dolphins' responses to tour vessels, with resting groups the most likely to exhibit avoidance. Burrunan dolphins in Port Phillip Bay may have become habituated to tour vessels, as over time calves were significantly more likely to be present during dolphin-swims.

To determine the potential effects of tourism activities on the activity budget of Burrunan dolphins, focal-group follows ($n = 112$ hours) using a scan sample methodology were conducted from on-board the research vessel and from permitted dolphin-swim vessels. Data were analysed using Markov chain models, utilising 1,847 behavioural transitions collected over 149 sequences. The presence of dolphin-swim tour vessels affected the behavioural budget of Burrunan dolphins by changing transition probabilities, bout durations and the time taken to return to a behavioural state once disrupted. Foraging and socialising behaviours were the behaviours most significantly disrupted by tour boat interactions. The time Burrunan dolphins spent foraging during tour vessel interactions was significantly reduced. Foraging bout lengths decreased and dolphins took significantly longer to return to feeding in the presence of a tour boat. However, dolphin-swim tour vessels did not significantly affect the cumulative behavioural budget of Burrunan dolphins.

Data presented here reveal the nature and susceptibility of Burrunan dolphins to dolphin-swim tourism. Of concern, this study has highlighted a number of management strategies which are not currently performing their intended function of protecting this population of dolphins and therefore need revision. Alternative management strategies are identified and discussed, in the hopes that implementation will mitigate the adverse effects of tourism on this population of dolphins. On-going monitoring of this population is required, combined with an adaptive and holistic approach to management, to protect the dolphins and ensure the sustainability of the dolphin-swim industry.

Student Declaration

'I, Nicole Erin Filby, declare that the PhD Thesis by Publication entitled 'Burrunan dolphin (*Tursiops australis*) tourism in Port Phillip Bay, Australia: effects, implications and management' is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work'.

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Details of included papers

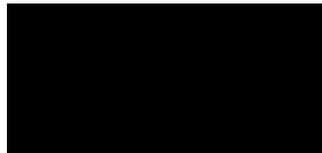
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Two	Social science as a vehicle to improve dolphin-swim tour operation compliance?	Published	<i>Marine Policy</i> , 51, 40-47 (2015) Impact factor = 2.948; Q1
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Nicole Erin Filby



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Chapter One

General Introduction



1.1 Cetacean tourism

Tourism is a substantial industry, with worldwide tourism exceeding \$900 billion USD in 2010 (UNWTO, 2011). One component of tourism, nature-based tourism, has grown at a faster rate than the overall industry, with cetacean-based tourism outpacing the growth of all other forms of wildlife tourism over recent decades (O'Connor et al., 2009). The cetacean tourism industry has grown rapidly primarily due to the charismatic appeal of megafauna such as marine mammals to people (Hoyt, 2012; Kellert, 1999). Cetacean-based tourism is defined here as any tourist activity with the primary purpose of watching or swimming-with cetacea (whales and dolphins) in their natural environment and does not include animals in captivity. The industry comes in several forms including land-based (e.g. vantage points or provisioning programs), vessel-based (e.g. watching or swimming programs) and aerial-based (e.g. helicopters or small planes). Globally, bottlenose dolphins (*Tursiops* spp.) are one of the most prominent species targeted by cetacean tourism industries, and this is largely due to their abundance in accessible coastal habitat (Bejder et al., 2006a; Christiansen et al., 2010; Hartel et al., 2014; Lusseau, 2003a; Mattos et al., 2007; Zeppel, 2009).

Commercial cetacean-based tourism began in 1955 in San Diego, California, USA and its popularity began to grow across the world in the late 1980s (Hoyt, 1995). Since its initiation in the 1950s, the industry has grown into a worldwide multimillion dollar phenomenon (Hoyt & Hvenegaard, 2002; Hrycik & Forestell, 2013). Cetacean-based tourism occurs in over 119 countries (Hoyt, 2001) with more than 13 million people participating every year, and participation is predicted to increase by 3 - 4% per annum (Christensen et al., 2009; Finkler & Higham, 2004; Hoyt, 2001). Currently, cetacean-based tourism is the largest economic activity dependent upon cetaceans (Parsons, 2012) with over USD\$2.1 billion generated in revenue worldwide in 2008 (O'Connor et al., 2009).

Cetacean-based tourism is recognised by the international community as having the potential to transition local economies from unsustainable

consumptive uses of cetaceans (e.g. whaling) to more sustainable non-consumptive uses (e.g. watching or swimming-with, Chen, 2011; Hoyt, 2001). In addition to being a more sustainable use of cetaceans, human interactions with free-ranging cetaceans are advantageous in that they:

- 1) Provide employment opportunities and generate substantial revenue for local communities (Cisneros-Montemayor et al., 2010; Mustika et al., 2012; Orams, 2013; Parsons et al., 2003a; Parsons, 2014);
- 2) Are an economically viable alternative to viewing cetaceans in captivity, with many tourists preferring to view marine mammals in the wild than in captivity (Draheim et al., 2010; Garrod & Wilson, 2003; Hoyt, 2001; Hughes, 2001; Jiang et al., 2008; Luksenburg & Parsons, 2014);
- 3) Can improve participant's well-being (Curtin, 2006; DeMares, 2000; Stewart, 2006; Webb, 2001); and
- 4) Provide local communities with an incentive to conserve ecosystems and their wildlife (Amir & Jiddawi, 2001; Goodwin, 1996; Gössling, 1999).

The coexistence of whaling and whale-watching has been described as incompatible (Hoyt & Hvenegaard, 2002) as whaling: 1) reduces the number of existing whales for whale-watching; 2) can cause avoidance responses by whales to boats (Baker et al., 1988; Bejder et al., 1999; Edds & MacFarlane, 1987; Janik & Thompson, 1996; Nowacek et al., 2001; Salvado et al., 1992); and 3) can create negative attitudes towards the destination by tourists. However, there are still a few countries (Japan, Norway and Iceland) where whaling and whale-watching co-exist, claiming both are financially viable concurrently (Parsons & Rawles, 2003).

Australia has one of the largest regional industries for cetacean-based tourism, being one of the six countries in the world with over 500,000 cetacean-watchers, representing 13% of the total global cetacean-watcher market, in 2008 (O'Connor et al., 2009). In Australia, income derived from cetacean-based tourism has risen substantially from AUD\$2.3 million in 1991 to AUD\$29 million in 2009 (IFAW, 2004; Jarvis & Ingleton, 2001; Valentine et al., 2004) with over 1.6 million people participating in whale-watching annually (O'Connor et al.,

2009). Australia is one of the few countries in the world that allow swimming-with free-ranging cetaceans (Carlson, 2008) and swims occur in the states of New South Wales (NSW), Queensland, South Australian (SA), Victoria and Western Australia (WA) (Appendix 1). Dolphin-swim tours have various modes of in-water encounters with cetaceans, including: free swim (e.g. Kangaroo Island, SA; Mandurah, WA); mermaid lines, whereby ropes are attached to the stern of a stationary vessel (e.g. Adelaide, SA; Bunbury, WA, Forster, NSW; Port Phillip Bay (PPB)); boom nets, whereby swimmers are attached to a harness that is lowered into a boom net at the bow of a moving vessel (e.g. Port Stephens, NSW); and the use of motorised water scooters to tow swimmers who are linked together (e.g. Rockingham, WA, Samuels et al., 2003; Zeppel, 2009). The main focal species for swimming with cetaceans in Australia are bottlenose dolphins (*Tursiops truncatus* and *Tursiops aduncus*), Burrunan dolphins (*Tursiops australis*) and common dolphins (*Delphinus delphis*, Mangott et al., 2011; Peters et al., 2013; Scarpaci, 2004; Steckenreuter et al., 2012).

1.1.1 Human dimensions of cetacean tourism

With millions of tourists participating each year, cetacean-based tourism provides an excellent opportunity for public education about dolphins and whales, their habitat and the need for conservation (Hoyt & Hvenegaard, 2002; Hrycik & Forestell, 2013; Stamation et al., 2007). Thus, in addition to the economic value of tourism, whale and dolphin watching tours have the potential to positively influence participant experiences and perceptions of the targeted species and their environment to facilitate responsible environmental behaviour (Christensen et al., 2007; Mayes, 2008; Orams, 1996; Weir et al., 1996). However, despite the economic importance of cetacean tourism, there has been only limited research which focuses on the human dimensions of cetacean-based tourism and whether cetacean tourism increases tourists' biocentric values and pro-conservation behaviours (Ballantyne et al., 2009; Christensen et al., 2007; Christensen et al., 2009; Finkler & Higham, 2004; Orams, 2000; Valentine et al., 2004; Zeppel & Muloin, 2009; Ziegler et al., 2012). Of the research that has been conducted, the majority focuses on whale-based tourism (Anderson & Miller, 2006; Christensen et al., 2007; Christensen et al.,

2009; Kessler et al., 2014; Stamation et al., 2007; Zeppel & Muloin, 2009). There is a paucity of data examining the human dimensions of dolphin tourism (Lück, 2003; Lück, 2015a; Mayes et al., 2004; Wiener, 2013). Currently, no studies are reported in the literature that evaluate whether participating in a dolphin-swim tour can lead to long-term, lasting increases in participants' biocentrism.

Research indicates that cetacean tourism interpretation that is carefully designed, managed and delivered, can effectively increase visitor knowledge, influence attitudes, encourage behaviour modification and contribute to a rewarding touristic experience (Anderson & Miller, 2006; Ballantyne et al., 2009; Lück, 2003; Orams, 1997; Orams, 1999; Smith et al., 2009; Tubb, 2003; Vining, 2003; Zeppel & Muloin, 2009). Interpretation is defined as an educational activity which aims to reveal meaning and relationships via the use of original objects, by first-hand experience and by illustrative media (e.g. videos; headphone guide tapes; pamphlets; and information boards) rather than simply communicating factual information (Lück, 2003). Interpretation is designed to increase patrons' biological knowledge of the targeted species, awareness of environmental problems, encourage interest and enthusiasm, provoke thinking and motivate participants to actively play a part in conservation (Ballantyne et al., 2009; Lück, 2003; Wiener et al., 2009; Zeppel & Muloin, 2009). Thus, the tourism experience must achieve more than simply providing tourists with a good time (Orams, 1999). Successful interpretation actively involves tourists by attempting to create questions in their minds, making them participants instead of observers, and assists the visitors to appreciate the area that they are visiting (Lück, 2003; Orams, 1996).

Interpretation not only helps protect the environment but can also increase visitor enjoyment and lead to longer term benefits in participants, such as greater environmental awareness and involvement in conservation organisations (Lück, 2003; Mayes et al., 2004; Orams, 1996; Zeppel & Muloin, 2009). Interpretation on-board cetacean-based tourism vessels has the potential to help protect cetaceans via changes in tourists' behaviour, and may be more important than regulations in ensuring long term environmentally

conscious and sustainable practices (Anderson & Miller, 2006; Hrycik & Forestell, 2013). Given that educating tourists can be a powerful tool for marine protection (Hrycik & Forestell, 2013; Lück, 2003), the lack of data available in the literature on the types of information desired by cetacean tourists is surprising (Lück, 2015b). Although most cetacean tourism operators offer some form of interpretation, few provide the type and depth of information that is required to educate patrons and/or cause them to change their lifestyle and adopt more pro-conservation behaviours (Christensen et al., 2007; Orams, 1997; Wiener et al., 2009). When compared against 87 nations that conduct cetacean tourism, Australia was judged as having very poor performance standards for interpretation (Hoyt, 2001). Without high quality interpretation as part of dolphin-swim tours, tourists' biocentric values and pro-conservation behaviours will not be enhanced, and thus management is deprived an important opportunity to enhance visitors' support for wildlife conservation issues.

Forestell and Kaufman (1991) proposed that interpretation programs on marine mammal tours should be structured so that they reflect the changes in tourists' mindsets as the tour progresses. A structured approach to interpretation is required so that their potential to increase tourists' pro-conservation attitudes, knowledge and satisfaction levels is maximised. Forestell and Kaufman (1991) further suggested that for whale-watching interpretation to be most effective, it should be delivered in three phases:

- 1) *Pre-contact phase*: the time between leaving the harbour and encountering the first whale. This is the best time to deliver information on safety, comfort and the itinerary;
- 2) *Contact phase*: the period of time during which whales are actively observed. This is the best time to deliver information regarding the biology and behaviour of the whales they are observing; and
- 3) *Post-contact phase*: the time between whale sightings, or the time between observing the last whale and returning to the harbour. This is the best time to deliver information on the conservation of cetaceans and their environment, and expand context from a local to a global scale.

Tourists are more likely to seek further information and reconsider global environment threats during this phase of the tour.

Enhanced models for delivery of effective interpretation programs have been developed (e.g. Orams, 1996; Orams, 1997) yet not all tours lend themselves to the standard pre-contact, contact and post-contact formats (Orams, 1996). During swim-with tours with cetaceans there is an inherent lack of opportunity for interpretation to be delivered during the contact phase, and therefore the content must be provided during other phases of those tours. However, although the time for when interpretation is best delivered during cetacean-watching tours is relatively well understood (Hrycik & Forestell, 2013), there is a lack of research that investigates interpretation during swim-with tours (Lück, 2015a).

It is important for management to have an understanding of tourists' motivations, views, backgrounds and concerns towards the dolphin-swim industry, the marine environment and conservation; as conservation management often requires the integration of social, economic and scientific aspects if sustainable management is to be achieved (Berrow, 2003; Birtles et al., 2002; Duffus & Dearden, 1990; Grumbine, 1994; Hoyt & Hvenegaard, 2002; Orams, 2000; Reynolds et al., 2009; Valentine & Birtles, 2004). Understanding what motivates tourists to spend considerable money and effort to experience dolphins in the wild may foster trip satisfaction and business success (Higham & Lusseau, 2007; Ziegler et al., 2012). Tourist motivation data is essential for developing effective management strategies that encourage pro-conservation attitudes in participants and support sustainable industry practice (environment and business, Anderson & Miller, 2006; Orams, 2000).

1.1.2 Short-term effects of cetacean tourism

Despite the potential benefits of cetacean-based tourism, the rapid expansion of this industry has raised concerns over potential effects on both the targeted species and the broader marine environment. This growing volume of peer-reviewed literature indicates that such tourism is not benign and that effects can

be wide ranging (Bejder et al., 2006a; Courbis & Timmel, 2009; Janik & Thompson, 1996; Nowacek et al., 2001; Parsons, 2012; Pirodda et al., 2015; Stockin et al., 2008). The impacts of tour vessels on cetaceans have been studied for more than 30 years, with the short-term responses of cetaceans to tourism well documented (as shown in Table 1.1). Behavioural studies indicate that interactions with tour vessels often results in decreased foraging, resting and/or socialising (e.g. Christiansen et al., 2010; Constantine et al., 2004; Dans et al., 2008; Lusseau, 2003a; Lusseau et al., 2009; Martinez et al., 2011; Meissner et al., 2015; Miller et al., 2008; Neumann & Orams, 2006; Stockin et al., 2008; Visser et al., 2011; Williams et al., 2006), with increased time spent travelling and/or milling (e.g. Arcangeli & Crosti, 2009; Lundquist et al., 2012; Miller et al., 2008; Peters et al., 2013; Stensland & Berggren, 2007) reported for numerous delphinid species (e.g. bottlenose dolphins, common dolphins, Hector's dolphins (*Cephalorhynchus hectori*) and killer whales (*Orcinus orca*)). These behavioural changes are often interpreted in terms of predicted or estimated energetic costs for animals, as reduced time spent foraging and/or resting is likely to increase an individual's energetic costs (Christiansen et al., 2010; Williams et al., 2006).

Many delphinids approach vessels in order to bow-ride (Filby et al., 2010; Shane et al., 1986; Williams et al., 1992), with the underlying assumption that if whales or dolphins choose to interact with tour vessels that there will be no detrimental effects. However, research indicates that even if cetaceans don't avoid tour vessels, they can be detrimentally affected by interactions with such vessels (Table 1.1). Thus, even seemingly positive encounters could have deleterious long-term effects on the population by detracting from biologically significant behaviours such as foraging, nursing and resting. Further, cetaceans that approach tour vessels are forced to expend greater levels of energy interacting with the vessels. Conversely, some species have been documented avoiding vessels (Au & Perryman, 1982; Constantine, 2001; Hewitt, 1985; Neumann & Orams, 2006; Stamation et al., 2010; Steckenreuter et al., 2012). For example, Seuront and Cribb (2011) reported Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in the Port Adelaide River, SA, responded to the presence of boats by increasing the complexity of their dive duration patterns (a

Table 1.1 Examples of short-term responses of cetaceans to tourism vessels and/or swimmers.

Response	References
<i>Behaviour</i>	Acevedo, 1991; Allen & Read, 2000; Arcangeli & Crosti, 2009; Bain et al., 2006; Barr & Slooten, 1999; Carrera et al., 2008; Christiansen et al., 2010; Christiansen et al., 2013; Constantine et al., 2004; Dans et al., 2008; Duprey et al., 2008; Janik & Thompson, 1996; Lemon et al., 2006; Lusseau, 2003a; Lusseau et al., 2009; Markowitz et al., 2009; Meissner et al., 2015; Noren et al., 2009; Peters et al., 2013; Ribeiro et al., 2005; Samuels & Bejder, 2004; Stamation et al., 2007; Steckenreuter et al., 2012; Stockin et al., 2008; Trites & Bain, 2000; Visser et al., 2011; Williams & Ashe, 2007; Williams et al., 2006; Würsig, 1996
<i>Swimming speed and direction</i>	Arnold & Birtles, 1998; Au & Perryman, 1982; Au & Green, 2000; Blane & Jaakson, 1994; Goodwin & Cotton, 2004; Janik & Thompson, 1996; Kruse, 1991; Lemon et al., 2006; Lundquist, 2007; Markowitz et al., 2009; Mattson et al., 2005; Nowacek et al., 2001; Scheidat et al., 2004; Stensland & Berggren, 2007; Timmel et al., 2008; Williams et al., 2002
<i>Respiration and dive characteristics</i>	Arnold & Birtles, 1998; Au & Green, 2000; Corbelli, 2006; Corkeron, 1995; Gordon et al., 1992; Heimlich-Boran et al., 1994; Jahoda et al., 2003; Janik & Thompson, 1996; Lusseau, 2003b; Miller et al., 2008; Ng & Leung, 2003; Nowacek et al., 2001; Stamation et al., 2010; Richter et al., 2006
<i>Group cohesion</i>	Barr & Slooten, 1999; Bejder et al., 1999; Blane & Jaakson, 1994; Green, 2003; Hastie et al., 2003; Heimlich-Boran et al., 1994; Markowitz et al., 2009; Miller et al., 2008; Nowacek et al., 2001; Ribeiro et al., 2005; Tosi & Ferreira, 2009
<i>Communication</i>	Buckstaff, 2004; Erbe, 2002; Guerra et al., 2014; Hawkins & Gartside, 2009; Luis et al., 2014; Pirota et al., 2015; Scarpaci et al., 2000a; Sousa-Lima & Clark, 2008; Van Parijs & Corkeron, 2001; Yin, 1999
<i>Habitat use</i>	Allen & Read, 2000; Bejder et al., 2006a; Briggs, 1991; Courbis & Timmel, 2009; Timmel et al., 2008

typical avoidance response), resulting in greater energy expenditure.

How cetacea respond to interactions with tour vessels varies with species, age class, gender and individuals (e.g. Cañadas & Hammond, 2008; Constantine, 2001; Constantine & Baker, 1997; Lusseau, 2003a; Richter et al., 2006; Symons et al., 2014). For instance, groups containing calves typically exhibit stronger responses than groups without calves (e.g. Cañadas & Hammond, 2008; Hastie et al., 2003; Lundquist et al., 2008; Stamation et al., 2010; Van Parijs & Corkeron, 2001). Responses of cetacea to dolphin-swim tour vessels are also linked to boat approach type, presence of swimmers, length of interaction, number and density of vessels, distance between boats and the animals, as well as vessel type (Bejder et al., 1999; Constantine, 2001; Markowitz et al., 2009; Martinez et al., 2011; Neumann & Orams, 2006; Nowacek et al., 2001; Orams, 2004; Steckenreuter et al., 2012; Stensland & Berggren, 2007; Timmel et al., 2008; Williams & Ashe, 2007; Williams et al., 2002; Williams et al., 2009). Given that responses vary greatly depending on the type of tourism undertaken, the species targeted and the location, and over time (Orams, 2004), the need for assessing and managing impacts of tourism on cetaceans on a case-by-case basis is highlighted.

1.1.3 Long-term effects of cetacean tourism

These short-term effects raise concerns relating to the sustainability of cetacean-based tourism as they may lead to long-term impacts. However, due to the difficult nature of ascertaining whether short-term behavioural responses result in long-term biological consequences, the long-term effects of boats on cetaceans remains poorly understood. Determining the long-term biological significance of short-term behavioural changes is critical for understanding population-level impacts, however it is a challenge facing tourism impact and management studies. Long-term studies on cetaceans are often difficult due to: the lack of baseline behavioural, abundance and distribution data for most cetacean populations (Bejder & Samuels, 2003); experimental controls not generally existing; challenging conditions at sea for observations; individuals often being difficult to identify; and the great difficulty in obtaining sufficient

funding for long-term studies. Despite such challenges, a number of longitudinal studies have emerged recently which provide useful information for management and conservation (Bain et al., 2014; Bejder et al., 2006a; Lusseau et al., 2006).

Long-term studies indicate that short-term behavioural changes including but not limited to avoidance tactics, can have long-term consequences. Repeated behavioural disruptions by vessels have been linked to: declining populations (e.g. bottlenose dolphins, Bejder et al., 2006a; Currey et al., 2009; Lusseau et al., 2006); decreased reproductive success (e.g. bottlenose dolphins, Bejder, 2005; Fortuna, 2007); increased mortality rates (e.g. dusky dolphins (*Lagenorhynchus obscurus*), Dans et al., 2008; spinner dolphins (*Stenella longirostris*), Courbis & Timmel, 2009); displacement from preferred habitats (e.g. bottlenose dolphins, Bejder et al., 2006a; Lusseau, 2005); area avoidance (e.g. humpback whales (*Megaptera novaeangliae*), Salden, 1988; bottlenose dolphins, Allen & Read, 2000; Wells, 1993); abandonment of breeding areas (e.g. grey whales (*Eschrichtius robustus*), Bryant et al., 1984; Reeves, 1977); and decreased energy intake (e.g. killer whales, Williams et al., 2006; minke whales (*Balaenoptera acutorostrata*), Christiansen et al., 2013). Hence the conservation status of a population targeted by tourism can be jeopardised if a large proportion of the population is repeatedly exposed to such impacts (Currey et al., 2009; Lusseau et al., 2006). These findings have led the whale-watching sub-committee of the Scientific Committee of the International Whaling Commission (IWC) to declare 'there is new compelling evidence that the fitness of individual odontocetes repeatedly exposed to cetacean watching vessel traffic can be compromised and that this can lead to population effects' (IWC, 2006) and that 'in the absence of data, it should be assumed that such effects are possible until indicated otherwise' (IWC, 2006). In most locations it remains unclear whether short-term behavioural responses will affect the population's long-term reproduction, fitness or survival. Therefore, understanding the links between short-term behavioural changes and long-term effects on individuals and their populations are required urgently in order to help manage the rapidly growing cetacean-based tourism industry.

1.2 Cetacean tourism management

The IWC (1998) listed research into the effectiveness of cetacean-based tourism management strategies as a research priority. However, limited research has been conducted in this area. Given the exponential increase in cetacean-based tourism, the call for research into effective management strategies is critical in order to ensure the sustainability of this industry. Sustainable management of cetacean-based tourism is required so that:

- 1) Activities do not cause the dolphin population to decline, or to become less viewable over time;
- 2) Customers safety is provided for;
- 3) Customers are satisfied with their experience;
- 4) Customers know that the activity is sustainable;
- 5) Operators make sufficient profits;
- 6) Local economics can maximise the industry's economic potential; and
- 7) Activities contribute positively to conservation and education of dolphins and their environment.

Implementing effective management strategies is a difficult task, given that management agencies are challenged with the need to manage animals targeted by tourism as well as the environment where they live whilst also maintaining the economic and educational benefits of this industry (Tosi & Ferreira, 2009).

1.2.1 Management strategies to improve the sustainability of the cetacean tourism industry

Given the difficulty of managing this industry, a number of management strategies have been developed to provide protection for the target species and their environment whilst simultaneously maintaining the economic viability of the industry (Lusseau, 2003a; Orams, 2001). These include both passive and active strategies. The term 'passive strategies' implies that no active response(s) will

be undertaken, accepting and allowing what happens or what others do without active response or resistance. Passive strategies include:

- Creation of regulations, codes of conduct, or guidelines (Allen et al., 2007; Gjerdalen & Williams, 2000; Reynolds & Braithwaite, 2001);
- Amending existing regulations, codes of conduct, or guidelines when necessary to promote compliance and increase protection for the targeted species (Scarpaci et al., 2004);
- Education aimed at increasing tourist and tour operator behaviour (Finkler & Higham, 2004; Orams, 1996; Roe et al., 1997; Sirakaya, 1997; Sorice et al., 2007; Valentine et al., 2004);
- Spatial management, i.e. creation of 'no go zones' and/or Marine Protected Areas (MPAs) (Agardy, 1994; Ashe et al., 2010; Hoyt, 2012; Tyne et al., 2014; Tyne et al., 2015; Williams et al., 2009). MPAs may use the implementation of speed restrictions, increased approaches distances and/or more stringent regulations for tour operators once inside the MPA (Higham & Lusseau, 2004; Hooker et al., 1999; Puglise & Kelly, 2007; Sorice et al., 2007);
- Creation of temporal closures to prohibit access to cetaceans during specific times that are critical to animals/populations (Constantine et al., 2004; Notarbartolo di Sciara et al., 2009);
- Issuing a moratorium on the number of permits issued (Scarpaci et al., 2004). This moratorium may be permanent;
- Stipulating that tour operators obtain specific qualifications in order to be eligible for permits (Hoyt, 2001);
- Frequent renewal of permits (where operators' conduct is assessed, including their compliance with regulations and well as the interpretation they provide to tourists); and
- Charging higher fees to reduce the number of people that participate (Zeppel, 2009).

Active strategies are characterised by actions or responses that carry consequences. Examples of active strategies include:

- Enforcement of regulations (with on-water presence by patrol boats and/or on-board enforcement officers or naturalists, Cunningham-Smith et al., 2006; Grozelany, 2001; Hoyt, 2001); and
- Prosecution of violators with implementation of fines and/or loss of permit, especially for repeat offenders (Whitt & Read, 2006).

Management agencies may use one or several of these strategies, and should engage with stakeholders and scientists when deciding on the best approach for management (Higham et al., 2009). These strategies are usually assumed to be effective however their effectiveness is often not determined (Morris et al., 2007). Indeed, frequently it falls upon independent researchers to identify whether such protection tools are in fact helping to sustainably manage the targeted species (Solice et al., 2007). Within the PPB dolphin-swim industry multiple strategies, both passive and active, have been implemented. These strategies include: permit capping; tour operator education; amendments to regulations based on independent research and the introduction of an MPA; Ticonderoga Bay Sanctuary Zone (TBSZ) in 1996.

1.2.2 Effectiveness of Regulations

Globally, management of cetacean-based tourism is diverse (see Carlson (2009) for a review) and includes:

- 1) Unmanaged and unregulated operations (Beasley et al., 2010; Mustika et al., 2013; Schaffar et al., 2010);
- 2) Codes of conduct (Allen et al., 2007; Parsons & Woods-Ballard, 2003);
- 3) Guidelines (Christiansen et al., 2010);
- 4) Permitting strategies (Bejder et al., 2006a; Lusseau et al., 2006; Notarbartolo di Sciara et al., 2009); and
- 5) Government legislation (hereafter, regulations, Scarpaci et al., 2003; Wiener et al., 2009).

Guidelines, voluntary codes of conduct and unregulated operations are managed by the industry and are not legally enforceable (e.g. Parsons & Woods-Ballard, 2003). In contrast, permitting strategies and regulations are managed by government agencies and are legally enforceable with fines, prohibition and/or imprisonment for breaches (Orams, 1999).

Regulations have been developed as a protection tool in order to reduce potential effects of tourism on cetaceans (Gjerdalen & Williams, 2000). Generally, the overarching aim of regulations is to mitigate effects of the cetacean tourism industry, so that targeted populations do not experience: increased mortality; reduced reproductive success; emigration from the area; displacement from or avoidance of important habitat areas (e.g. resting, feeding, breeding and calving areas) and/or increased avoidance of tourist boats. Furthermore, regulations are also in place to protect the industry, ensuring future sustainability and to provide for the safety of tourists.

Regulations define how tour operators must behave around dolphins and whales. Typical regulations often: limit the number of vessels; limit the number of swimmers; limit cumulative amount of time vessels spend with a group/population each day; establish operating procedures (e.g. do not approach animals from the rear or in their path); establish approach distances; prohibit approaching groups containing calves; allocate no-approach times (e.g. when animals are feeding and/or resting) and provide temporal or spatial exclusion zones (DEH, 2005; Hawkins, 2007).

There is an underlying assumption that tour operator compliance with regulations will reduce disturbance to the target species, thus ensuring a sustainable industry (Higginbottom, 2002; Lusseau, 2003a). If tour operators fail to comply with regulations then it is considered that management of the industry has failed (Scarpaci et al., 2003). In most instances, the primary mechanism used to govern dolphin-swim tour operators is by permit (Cunningham-Smith et al., 2006; Scarpaci et al., 2003). However, there is a real paucity of data that examines whether tour operators are complying with regulations and factors that motivate non-compliance. Given the lack of compliance-focused research,

it remains unknown whether regulations do in fact act as a protection tool for the targeted cetacean species. The few compliance studies that have been conducted (Table 1.2) indicate that cetacean tourism compliance is negligible globally, and that compliance cannot be assumed (Allen et al., 2007; Corbelli, 2006; Howes et al., 2012; Kessler & Harcourt, 2013; Meissner et al., 2015; Scarpaci et al., 2003; Scarpaci et al., 2004; Steckenreuter et al., 2012; Whitt & Read, 2006; Wiley et al., 2008). Even when compliance is satisfactory, it is essential to determine whether the regulations are effective in protecting the targeted species. To achieve this requires examining the behaviour and responses of the target population (as discussed in section 1.1.2) and compliance by tour operators to regulations simultaneously (Mann & Smuts, 1999; Scarpaci, 2004).

The compliance studies detailed in Table 1.2 used two different platforms for data collection: 1) land-based (e.g. Allen et al., 2007) and 2) licenced tour vessels (e.g. Kessler & Harcourt, 2013; Scarpaci et al., 2003). Both these data collection platforms have inherent benefits and biases. Data collected by a researcher on-board a licensed tour vessel may influence the behaviour of the operator, thus biasing results. However, observations from on-board tour vessels allow for closer observations of tour operator behaviour to regulations and further, allow the researcher to obtain observations in the entire vicinity of where the tour vessel operates. Observations from land-based platforms allow for zero-disturbance. That is, there is the benefit of no disturbance to the target species. Land-based observations can limit the researcher's capacity to accurately assess licenced tour vessels' compliance, given that some regulations can be difficult to assess across large expanses of water. In addition, in some locations land-based platforms can restrict obtaining complete observations of compliance if tour vessels operate in places not observable from land. Given this, observations from on-board licenced tour vessels are arguably the most accepted and utilised method for compliance data collection.

Table 1.2 Examples of compliance research for commercial cetacean watching and swimming tourism.

* *Satisfactory compliance is set at 80.0% or higher as per Allen et al., 2007; Scarpaci et al., 2003; Scarpaci et al., 2004.*

Compliance is deemed satisfactory if more than half of the regulations (where there is a range) have $\geq 80\%$ compliance levels.

Target species	Location	Compliance (%)	Satisfactory compliance*	Reference
Bottlenose dolphin (<i>Tursiops</i> sp.)	Port Phillip Bay, Victoria, Australia	Range: 38.3 - 69.4	NO	Scarpaci et al., 2003 Scarpaci et al., 2004
Humpback whale (<i>Megaptera novaeangliae</i>)	Newfoundland and Labrador, Canada	Range: 28.0 - 32.0	NO	Corbelli, 2006
Bottlenose dolphin (<i>Tursiops</i> sp.)	Clearwater, Florida, USA	Overall: 60.0	NO	Whitt & Read, 2006
Indo-Pacific bottlenose dolphin (<i>Tursiops aduncus</i>)	Port Stephens, NSW, Australia	Range: 71.0 - 99.0	YES	Allen et al., 2007
11 species of cetaceans	Stellwagen Bank, Massachusetts, USA	Overall: 22.0	NO	Wiley et al., 2008
Burrnanan dolphin (<i>Tursiops australis</i>)	Port Phillip Bay, Victoria, Australia	Range: 0.0 - 70.0	NO	Howes et al., 2012
Indo-Pacific bottlenose dolphin (<i>Tursiops aduncus</i>)	Port Stephens, NSW, Australia	Range: 10.0 - 86.5	NO	Steckenreuter et al., 2012
Humpback whale (<i>Megaptera novaeangliae</i>)	Sydney Harbour, NSW, Australia	Range: 26.4 - 96.7	NO	Kessler & Harcourt, 2013

Within cetacean-based tourism, a number of factors have been implicated in low compliance, including:

- Complexity of some regulations, for example, those that:
 - 1) Require simultaneous assessment of spatial and temporal factors (Scarpaci et al., 2004);
 - 2) Are difficult to initiate in the field (e.g. estimating distance across water, Baird & Burkhart, 2000; Scarpaci et al., 2003; Whitt & Read, 2006); and
 - 3) Require assessment of cetacean behaviour.

- Difficulty of enforcing and policing regulations (Cunningham-Smith et al., 2006; Samuels et al., 2003) due to:
 - 1) High costs (Wilson, 2003);
 - 2) In-field complications (Wilson, 2003);
 - 3) Regulations inadequately designed to assess enforcement (Scarpaci, 2004); and
 - 4) Interpretation issues resulting in difficulty in prosecution (Constantine & Barker, 1997).

- Pressure faced by tour operators to satisfy and meet customers' expectations (Whitt & Read, 2006).

One of the few cetacean tourism industries where tour operator compliance has been comprehensively studied is in PPB (Howes, 2008; Scarpaci et al., 2003; Scarpaci et al., 2004). Scarpaci et al., (2003) identified unsatisfactory compliance by dolphin-swim tour operators with a number of regulations. Following these findings, a 'Dolphin Sustainability Program' was implemented, using precautionary passive management strategies such as capping permits, distribution of educational material to tour operators and implementation of independent reviews (Hale, 2002). However, a follow up study conducted by Scarpaci et al., (2004) indicated that these strategies had failed as a

management tool, with no improvement in compliance levels detected. Based on this research, Scarpaci et al., (2004) subsequently recommended that management amend regulations so that they were simpler and easier to understand by tour operators, and thus more likely to be followed in the field. Unfortunately, research by Howes (2008) indicated that these regulatory amendments did not result in an improvement in compliance levels by PPB dolphin-swim tour operators. Given that the dolphin-swim industry in PPB exhibits a strong history of non-compliance with regulations, it was demonstrated that management was not effective and that alternative management strategies are required.

1.2.3 Marine protected areas (MPAs)

Management utilises MPAs in some industries as an alternative strategy to regulations for protecting marine mammals from tourism interactions (Agardy, 1994). The International Union for Conservation of Nature (IUCN) define MPAs as 'any area of intertidal or sub-tidal terrain, together with its overlying water and associated flora and fauna, which has been reserved by law or other effective means to protect part or all of the enclosed environment' (Kelleher, 1999). Marine parks, sanctuaries, reserves, refuge areas or closures are all different types of MPAs established for the long-term conservation of a species (Hoyt, 2012).

Protected areas for cetaceans are growing in number worldwide (Hoyt, 2012; Notarbartolo di Sciara et al., 2009; Tyne et al., 2015; Williams et al., 2009). However, a number of steps are required for successful implementation of an MPA, including:

- Consultation with tour operators, natural scientists and social science communities (Higham et al., 2014);
- Establishment of legislative framework by management agencies (which should be established prior to commencing commercial tour operations where possible (Higham et al., 2008)); and

- Identification of the size and location where the cetacean population is most vulnerable (via assessing the populations behaviour and habitat use, Higham et al., 2014).

However, MPAs are often established without the necessary empirical data, and there is minimal published data available that examines their efficacy (Gormley et al., 2012; Hartel et al., 2014). For example, TBSZ was implemented in southern PPB in 1996 to provide Burrnunan dolphins with a respite and refuge from anthropogenic stress, including commercial tourism, however almost 20 years on and it still has not had its effectiveness examined. It is likely that the difficulty in assessing the efficacy of MPAs is the main reason why it remains unknown as to whether many MPAs management objectives are being met (Berrow, 2003). Assessing the effectiveness of MPAs is considered a difficult task given the large home ranges of many species (Hyrenbach et al., 2000; Wilson et al., 2004) and the requirement of both qualitative and quantitative data (Hooker & Gerber, 2004; Hoyt, 2005). Evaluation of MPAs should focus on:

- 1) Whether the site design is effective (i.e. are critical biological behaviours exhibited relatively frequently within the MPA, and is the MPA in the appropriate location and of the correct size? Ashe et al., 2010; Hartel et al., 2014; Hyrenbach et al., 2000; Puglise & Kelly, 2007); and
- 2) Whether management agencies are providing effective management to ensure protection (i.e. are regulations being complied with at a satisfactory level, and is education for tourists, tour operators and the local community satisfactory? Hooker & Gerber, 2004; Howe, 2001; Kelleher, 1996; McCool & Stankely, 2001; Puglise & Kelly, 2007).

1.2.4 Management of cetacean tourism within Australia

Within Australian waters, cetacean-based tourism activities are managed by local, state and federal authorities. Each state is responsible for the protection of marine mammals and management of cetacean-based tourism interactions within state waters (i.e. up to 3 nautical miles offshore). With 45 species of

whales and dolphins that live in or migrate through Australian waters the *Australian National Guidelines for Whale and Dolphin Watching 2005* outline a national framework that allows people to observe and interact with cetaceans in a way that does not cause harm to the animals (DEH, 2005). These guidelines set a national policy for the management of whale and dolphin watching, aiming to minimise impacts on individuals and populations, and helping to ensure that people know how to act appropriately when they are around cetaceans (DEH, 2005). Relevant sections of the *Australian National Guidelines for Whale and Dolphin Watching 2005* are detailed in Appendix 2.

1.2.5 Management of cetacean tourism within Victoria – Wildlife (Whales) Regulations, 1998

In Victoria, Australia, the only place where swimming is legal with free-ranging cetaceans is in PPB (Appendix 1). The dolphin-swim industry in PPB first commenced in 1986 (Jarvis & Ingleton, 2001). A code of practice (COP) was established in 1995 by tour operators and the local government to provide guidelines for responsible behaviour of tour boats around dolphins in PPB (Samuels et al., 2003). The implementation of this COP to mitigate tourism impacts was in itself a conservation achievement, reflecting the first step in building a more sustainable tourism industry. This COP then formed the basis for the Wildlife (Whales) Regulations, 1998, which was incorporated into the Wildlife Act 1975.

The objectives of these regulations are to:

- a) *Provide for the long-term protection of marine mammals by:*
- 1) *Prohibiting or regulating activities connected with marine mammals;*
 - 2) *Prohibiting or regulating activities in the vicinity of marine mammals;*
 - 3) *Prescribing conditions for marine mammal watching and/or swim tour permits; and*
 - 4) *Prescribing minimum approach distances for marine mammals.*

b) Prescribe the fees payable for the issue of marine mammal watching and /or swim permits

These regulations stipulate a number of conditions that dolphin-swim tour operators must legally abide by in order to conduct swims with dolphins in Victoria. In order to improve operator compliance and overall protection of the targeted species (Hale, 2002), these regulations have been amended repeatedly over time and currently the dolphin-swim tour operators in PPB must abide by the Wildlife (Marine Mammals) Regulations, 2009 (Appendix 3 details relevant regulations). In order to ensure the sustainability of the dolphin-swim industry, tour operators need to adhere to these regulations. Within Victorian waters, the Department of Environment, Land, Water and Planning is currently the body responsible for enforcing regulations pertaining to dolphin-swimming.

Since the inception of the dolphin-swim industry, the number of tour operators has been variable (e.g. eight operators in 2000, Mayes, 2008), although presently there are three licenced tour operators (comprising four vessels) that operate dolphin-swims in PPB. In addition, there is a fourth company which is licenced for dolphin watching. One dolphin-swim company departs from Queenscliff on the western shore of the bay, whilst two tour operators depart from Sorrento on the eastern shore (Figure 1.1). Tours operate from October to May annually, running a maximum number of 2 trips per day per vessel. Tour vessels are generally on the water for 7 hours a day from 0830 to 1800. Weather conditions (e.g. cold water temperatures (~8 °C) and rough sea conditions (i.e. winds consistently greater than 20 knots)) prevent tours being run over the austral winter.

In addition to permitted operators, there are also a large number of other vessels which utilise the bay on a daily basis, which interact with dolphins opportunistically. Such vessels include container ships, ferries, commercial fishing boats, cruise ships, recreational boats, yachts, jet skis and kayaks. Over the weekends, particularly during the austral summer, there is a pronounced increase in the number of recreational vessels utilising PPB, with over 20 recreational vessels, in addition to commercial vessels, observed surrounding

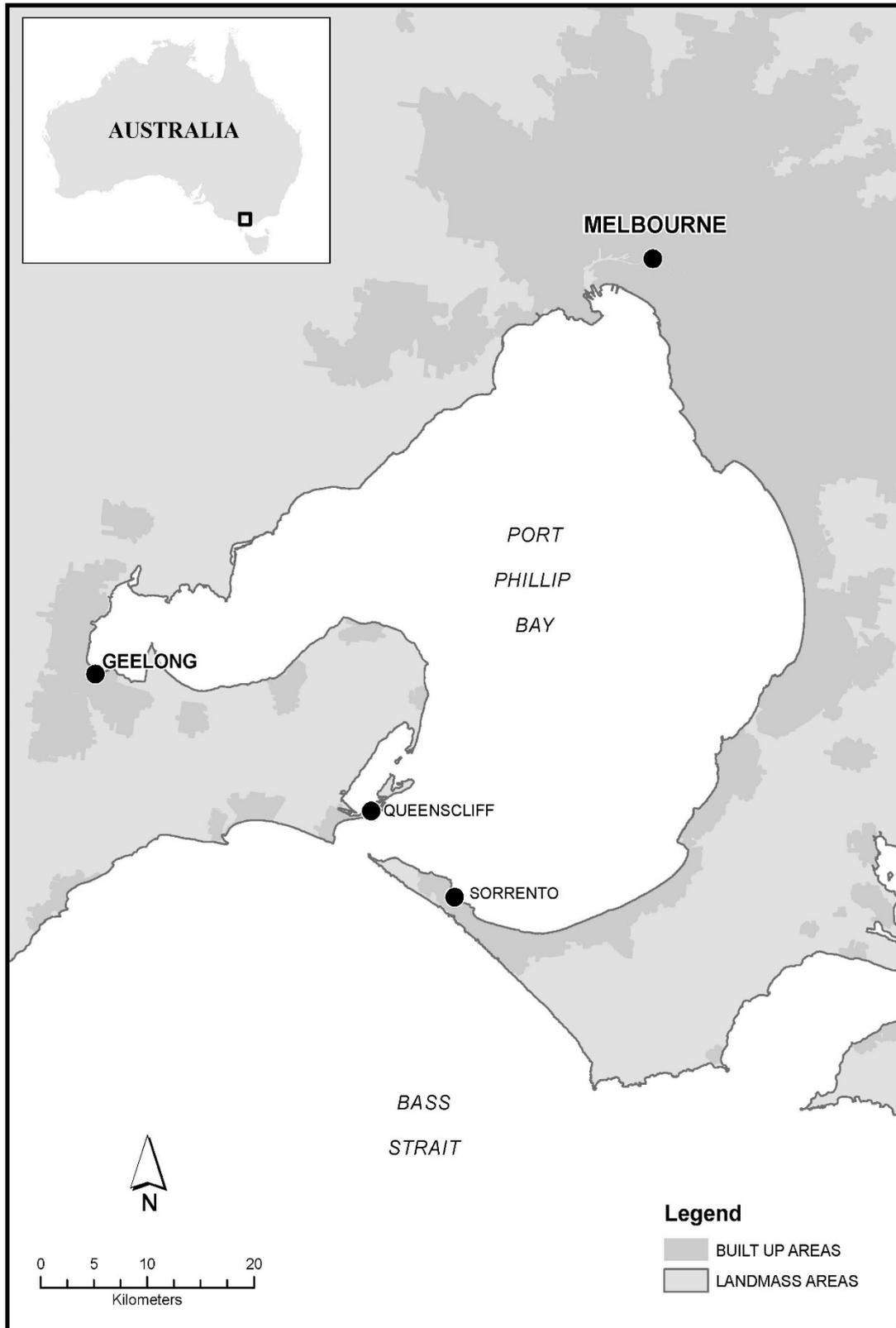


Figure 1.1 Location of Port Phillip Bay, Victoria, Australia, depicting Queenscliff and Sorrento where the dolphin-swim tour vessels depart. * *Built up areas represent areas with relatively high levels of infrastructure.*

dolphins during this time (Weir et al., 1996). These vessels have the potential to cause disturbance to marine mammals, with a growing number of cetaceans globally being involved in vessel strike (Dwyer et al., 2014; IWC, 2002; Laist et al., 2001; Martinez & Stockin, 2013; Reeves et al., 2003; Ritter, 2012; Silber et al., 2012; Wells & Scott, 1997). Collisions between vessels and cetaceans usually occur in coastal areas where cetaceans forage and breed (Laist et al., 2001) and can result in mortality or serious injury for delphinids (Camargo & Bellini, 2007; Dwyer et al., 2014; Martinez & Stockin, 2013; Stone & Yoshinaga, 2000).

1.3 Subject species

In this thesis, the dolphins referred to are Burrunan dolphins (*Tursiops australis*), as they are the species that inhabit the study area within PPB. Further, they are the only cetacean species targeted by the dolphin-swim industry within the bay. Being a newly described species, there is a paucity of data on Burrunan dolphins (Charlton-Robb et al., 2011). Hence, where information on Burrunan dolphins has not yet been described, this review will cover what is known about bottlenose dolphins (*Tursiops* spp.), as they are the species most closely related to Burrunan dolphins and the species most commonly targeted by cetacean-based tourism operations (Bejder et al., 2006a; Christiansen et al., 2010; Hartel et al., 2014; Hastie et al., 2003; Hawkins, 2007; Lusseau, 2003a; Mattos et al., 2007; Steckenreuter et al., 2012; Stensland & Berggren, 2007). Based on morphological and mitochondrial DNA data there are now three recognised species of *Tursiops* within Australian waters: the 'common' bottlenose dolphin (*Tursiops truncatus*, Wang et al., 1999; Wang et al., 2000a); the indo-pacific bottlenose dolphin (*Tursiops aduncus*, LeDuc et al., 1999; Wang et al., 1999; Wang et al., 2000a; Wang et al., 2000b); and the recently discovered Burrunan dolphin (*Tursiops australis*, Charlton-Robb et al., 2011; Charlton-Robb et al., 2015).

Although there remains controversy surrounding the validity of Burrunan dolphins as a separate species (Committee on Taxonomy, 2012; Perrin et al., 2013), multiple lines of genetic and morphological evidence (Charlton-Robb et

al., 2011; Charlton-Robb et al., 2015; Möller et al., 2008), phylogenetic analyses using whole mitochondrial genome sequencing (Moura et al., 2013) and stable isotope analysis of dolphins teeth (Owen et al., 2011) form the basis for the Burrunan dolphin being described as a separate species.

Burrunan dolphins are endemic to southern Australian coastal regions and have so far been found in the inshore waters of Victoria, Tasmania, SA and potentially southern WA (Bilgmann et al., 2007; Charlton et al., 2006; Charlton-Robb et al., 2011; Charlton-Robb et al., 2015; Möller et al., 2008; Owen et al., 2011; Peters et al., 2013). Only two resident populations of Burrunan dolphins have so far been identified, both within Victoria, and within semi-enclosed bodies of water: PPB (estimated resident population: 80 to 100 animals); and the Gippsland Lakes (estimated resident population: 50 animals, Charlton et al., 2006; Charlton-Robb et al., 2011; Dunn et al., 2001; Hale, 2002; Scarpaci, 2004, Figure 1.2).

Within PPB, Burrunan dolphins display high site fidelity, using the southern coastal waters of the bay all year round, bringing them into frequent contact with humans and dolphin-swim tour operators (Scarpaci et al., 2000a; Scarpaci et al., 2003). Although Burrunan dolphins have occasionally been observed further north in the bay, they appear to spend the majority of the time in southern PPB waters, close to the mouth of the bay (Mason, 2007; Scarpaci, 2004). It is possible that they spend the majority of their time in this area in order to exploit foraging opportunities, as numerous migratory species which these dolphins are known to consume (e.g. squid (*Sepioteuthis australis*) and barracouta (*Thyrsites atun*)), move in and out of PPB's narrow mouth (Hale, 2002; Owen et al., 2011).

Burrunan dolphins are listed as 'threatened' under the Victorian Flora and Fauna Guarantee Act 1988, because they are considered vulnerable to extinction due to their small population size, genetic distinctiveness (Charlton-Robb et al., 2011; Charlton-Robb et al., 2015; Warren-Smith & Dunn, 2006), restricted home range (which is in close proximity to a major urban centre, making them susceptible to numerous anthropogenic threats, Hale, 2002), exposure to anthropogenic pollution (e.g. they are highly contaminated with

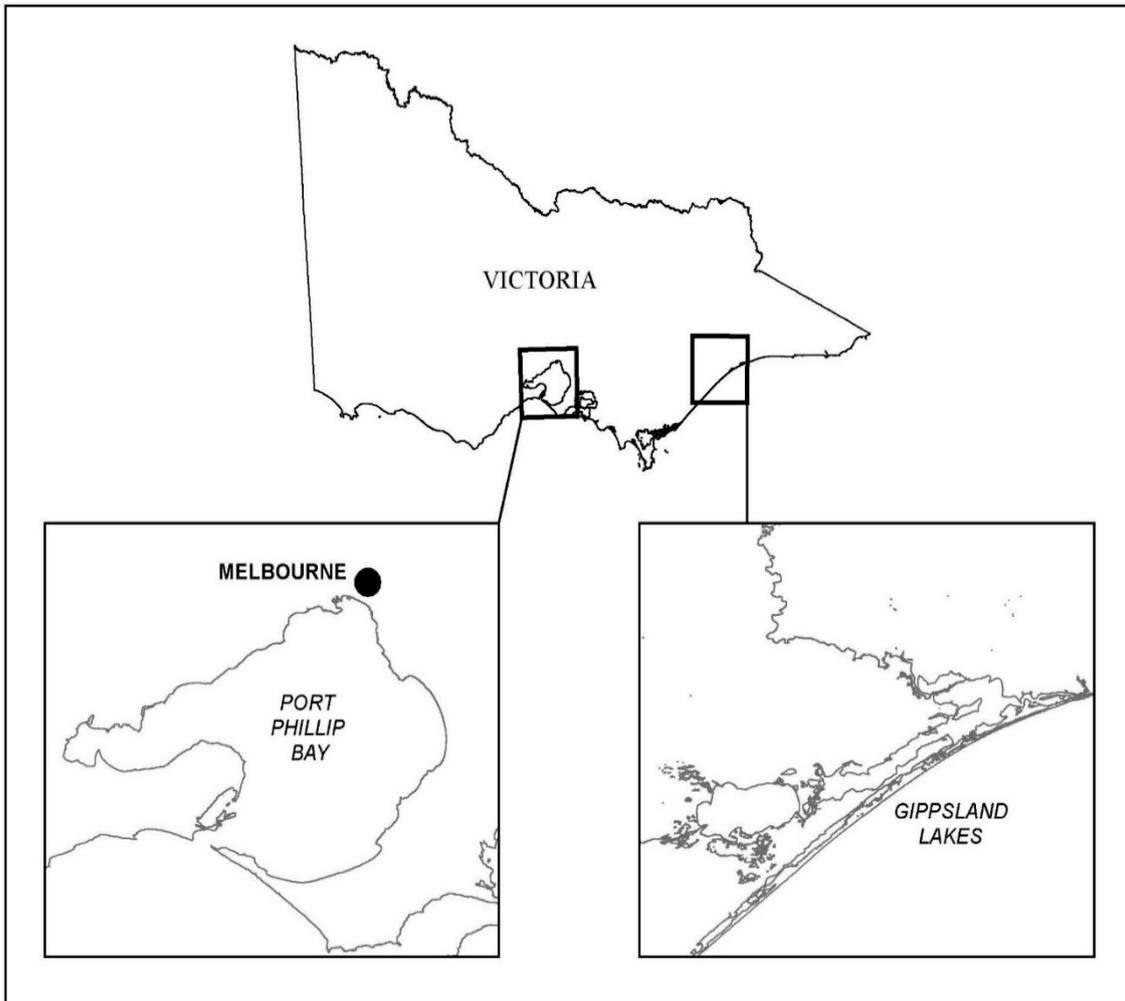


Figure 1.2 Locations of known resident populations of Burruran dolphins (*Tursiops australis*) in Victoria, Australia: Port Phillip Bay and Gippsland Lakes.

mercury, Monk et al., 2014) and female natal philopatry (i.e. their tendency to remain in a specific area in order to feed or breed, Hale, 2002; Kruetzen et al., 2004; Möller & Beheregaray, 2004). Further, this population is at risk due to their coastal distribution (Charlton-Robb et al., 2011) which exposures them to a historically non-compliant commercial dolphin-swim industry (Scarpaci et al., 2004) and vessel strike (Dunn et al., 2001) within the bay. Adverse impacts from vessel activity could lead to a reduction in recruitment of females into the breeding population, which may lead to the possible expiration of this small population (Hale, 2002). Thus, effective management of this population and the threats it faces is vital to ensure their longevity.

1.3.1 Behavioural ecology

Bottlenose dolphins are exceptionally social animals, exhibiting high behavioural flexibility and cognitive ability (Connor et al., 2000; Herman, 2006). They live in fluid fission-fusion societies (Aureli et al., 2008), where group composition can change daily (Connor et al., 2000) and yet long-term associations can be maintained between individuals (Möller et al., 2001; Smolker et al., 1992; Wells et al., 1987; Würsig & Würsig, 1977). By adopting distinct fission-fusion strategies, individuals adjust their grouping patterns according to the shifting balance of costs (e.g. within-group food competition) and benefits (e.g. enhanced predator detection and avoidance through increased vigilance) associated with grouping (Connor et al., 2000; Oudejans et al., 2015; Tsai & Mann, 2013). Within fission-fusion societies, the composition of groups may change within an hour or over a number of days (Connor et al., 2000).

In order to establish effective management for the protection of a population and their environment, it is imperative that the behavioural ecology of individual populations is understood (Ashe et al., 2010; Hooker et al., 2011; Hyrenbach et al., 2000; Lusseau & Higham, 2004; Wilson et al., 2004). Previous research indicates that behavioural observations are required to determine how a population utilises different areas of their habitat, and that this information is critical for effective animal conservation (Tyne et al., 2015). Behavioural

observations allow for the identification of areas that are regularly used by a population for feeding, breeding and resting, which are essential for survival and maintaining healthy population growth (Ashe et al., 2010; Hoyt, 2012; Hyrenbach et al., 2000). In the absence of this behavioural budget information for populations, management cannot prioritise which areas, if any, need to be protected (Hooker et al., 2011; Lusseau & Higham, 2004).

When conducting behavioural studies, behaviours are usually classified as either 'states' (behaviours that are prolonged over considerable durations, i.e. several minutes or hours) or 'events' (behaviours that are of short duration and may be instantaneous or last for a few seconds) (Altmann, 1974). In broad terms, dolphin researchers generally recognise five behavioural 'states' for dolphins that make up their behavioural budget: travel; mill; social; rest; and forage (definitions of behavioural 'states' that were used to determine the behavioural budget of Burrunan dolphins during field work in this study are located in Appendix 4). Numerous behavioural 'events' have been described for delphinids and include: bubble-blow; head-flop; side-flop; headbutt; pounce; leaping; tail slapping; snuggle; surfing and porpoising, amongst others (Acevedo-Gutiérrez, 1999; Herzing, 2000; Lusseau, 2006; Mann, 2000; Slooten, 1994).

Due to the inherent difficulties of studying delphinids at sea, knowledge on the behaviour of many dolphin species is not as advanced as that of terrestrial mammals (Mann et al., 2000). However, it has been recognised that behavioural budgets of dolphins are influenced by a number of environmental factors including: prey availability; time of day; season; water depth; water temperature; bottom topography; and tidal movement (Bearzi et al., 1999; Cockcroft & Peddemors, 1990; Filby et al., 2013; Hansen, 1990; Hanson & Defran, 1993; Lusseau et al., 2003a; Neumann, 2001; O'Donoghue et al., 2010; Scott et al., 1990; Shane, 1990; Shane et al., 1986). Of these, research indicates that the most important factor in determining an animal's behavioural budget is food availability (Bertolino et al., 2004; Hanya, 2004; Powers & McKee, 1994).

Common sampling methods for direct observations of cetacean behaviour include: *Ad libitum*; continuous; one-zero; incident; point; sequence; or scan sampling (see Altmann (1974) and Mann, (1999) for reviews). Observations (also referred to as 'follows') can either be made at the group or individual level (Mann, 1999). Individual follows are usually only feasible for solitary animals (e.g. Minke whales at their feeding grounds in Faxafloi Bay, Iceland, Christiansen et al., 2013). For species that live in larger groups (like most delphinids), individual follows are not appropriate given the inherent difficulty of identifying individuals in the field and the increased probability of disturbing the group when attempting to track one animal. Thus, an alternative method for documenting cetacean behaviour is to conduct group follows. When conducting focal group follows, the predominant behaviour is usually determined as the behavioural state in which more than 50% of the animals are involved (Stockin et al., 2008; Stockin et al., 2009). The majority of behavioural studies conducted on delphinids utilise focal group scan sampling methodologies (whereby the observer records a group of animals' predominate behaviour at preselected moments in time). Time between sample periods varies across locations and species studied (e.g. Christiansen et al., 2010; Dans et al., 2012; Lundquist et al., 2012; Meissner et al., 2015; Tyne et al., 2015).

Although numerous behavioural studies exist that detail bottlenose dolphins' behaviour (Bearzi, 2005; Hanson & Defran, 1993; Shane, 1990), there is a paucity of studies in the literature that examine the behaviour of Burrunan dolphins. The little that is known about the behaviour of Burrunan dolphins in the absence of vessels originates from land-based surveys conducted in a restricted, inshore area of the populations range within PPB (Scarpaci et al., 2010a). This study only documented travel, forage and social behaviours (Scarpaci et al., 2010a) and thus did not examine the entire behavioural repertoire of this species.

In 2010, Peters et al., (2013) conducted three months of field work to assess whether tour vessel approaches and the presence of swimmers in the water affected the behaviour, response and cohesiveness of dolphin groups in Gulf St. Vincent, SA. Results indicated that interactions with tour vessels and

swimmers altered dolphin behaviour. However, a major limitation of this study was that data were collected only from on-board the tour vessel. Hence no true indication of what the dolphins' behaviour was prior or post tour vessel interaction could be collected, and thus the full effect of the presence of tour vessels and swimmers on the behaviour of Burrunan dolphins remains unknown.

1.4 Thesis outline and significance

Assessing the potential effects of dolphin-swim tourism on Burrunan dolphins within PPB, and devising and assessing appropriate management strategies, is critical and urgent given that:

- 1) The dolphin-swim tourism industry in PPB is historically non-compliant;
- 2) The population targeted by dolphin-swim tourism is the endemic Burrunan dolphin that is listed as threatened;
- 3) Population numbers for Burrunan dolphins remain uncertain, but are low;
- 4) Baseline behavioural data for Burrunan dolphins is lacking, with a paucity of data on the behaviour of this population of dolphins in the absence of vessel activity;
- 5) There are limited data on the effects of dolphin-swim tourism on this population, although previous research detected short-term effects (Scarpaci et al., 2010a); and
- 6) There are no data available on the potential long-term effects of dolphin-swim tourism on this population.

This thesis evaluates the efficacy of implemented management strategies in the PPB dolphin-swim industry. Previously, most research investigating cetacean-based tourism examine each aspect of management in isolation, e.g. compliance (Kessler & Harcourt, 2013; Scarpaci et al., 2004; Whitt & Read, 2006), social science (Christensen et al., 2007; Valentine et al., 2004; Wiener, 2013), MPAs (Ashe et al., 2010; Gormley et al., 2012; Hartel et al., 2014), or the behaviour of the target species (Bejder et al., 2006a; Christiansen et al., 2010; Stockin et al., 2008). This segregated approach impedes effective management

as individual management strategies are unlikely to equate to adequate protection for the target species from tourism-related disturbance (e.g. Allen et al., 2007). Therefore, this study simultaneously assesses dolphin-swim tour operators' compliance with regulations, the human dimensions of cetacean tourism, Burrunan dolphins' behaviour and the effectiveness of TBSZ. Assessing these different management tools concurrently is necessary to obtain a holistic assessment of the effectiveness of management of the PPB dolphin-swim industry and to facilitate adaptive management practices (Higham et al., 2008), as managing cetacean tourism industries requires a multi-disciplinary approach.

It is necessary that dolphin-swim tour operators' compliance with regulations is assessed, so that it can be determined whether the current management regime is acting as a protection tool for the Burrunan dolphin population. Compliance of tour operators indicates their ability and willingness to interpret and observe limitations to their behaviour during interactions with dolphins.

It is imperative to assess dolphin-swim participants' motivators, knowledge, satisfaction, topics of interest and conservation and biocentric levels before and after participating in a tour as this will provide important information for designing and implementing management strategies. Information from social science research can be used to assess whether the provision of educational material increases participant's biocentric values, and thus whether it is an effective management strategy. If management agencies are informed about the type of information that is desired by dolphin-swim tourists, then informed interpretative material can be developed which has the power to increase the sustainably potential of dolphin-swim interactions. Further, if tour operators are informed about what their patrons want, and this is aligned with sustainable practice, then there is the potential for tourists to be used as a force to drive tour operator compliance, encouraging them to adopt environmentally-responsible behaviours, as an alternative management strategy for this industry.

Effective conservation management also requires an understanding of the species behaviour and habitat use, as well as identifying potential

anthropogenic threats that may cause the population to decline. Given that recent research has linked short-term effects of cetacean tourism with long-term biological consequences for the viability and fitness of targeted populations (Bejder et al., 2006a; Lusseau et al., 2006; Williams et al., 2006), it appears that even low-level tourism may not be as benign as once thought (Bejder et al., 2006a; Stockin et al., 2008). Thus there is a need for baseline data on population behaviour and habitat use, so that management can be informed as to whether hotspots for critical behaviours (i.e. resting and feeding) exist. This information can be used to inform management on where MPAs for this population of Burrunan dolphins would be most useful, and whether the existing MPA (TBSZ) is an effective management strategy, as its efficacy has been assumed since its implementation. Further, assessing the potential effects of dolphin-swim tourism on the behavioural budget of Burrunan dolphins is essential because if the population is significantly impacted by dolphin-swim interactions then management strategies need to be revised. Behavioural information on the target species is required to inform management what level of protection is required for the target species and the level of urgency for actions.

Given the relative paucity of long-term studies that examine the effects of cetacean-based tourism, this thesis provides a unique opportunity to examine how responses of dolphins to tour vessels change over time. By accessing data from previous studies (Scarpaci, 2004; Scarpaci et al., 2003; Scarpaci et al., 2004) this thesis examines how dolphin responses to swim-with-dolphin tourism have changed over a 15 year period, from the late 1990s when the dolphin-swim industry in PPB was in its early stages, through to 2013, when different regulatory amendments were in place.

This thesis provides advice on the future management of the dolphin-swim industry in PPB based on assessments of impacts of the industry on the behaviour and responses of the target species, and also on assessment of efficacy of current management strategies. It is hoped that the information provided herein will be used to inform management and stakeholders of the suitability of current management strategies and provide information that can be

utilised to improve the sustainability of the PPB dolphin-swim industry. Further, this research will contribute to global understanding of cetacean-based tourism management, which is vital for mitigating the potential short and long-term effects of tourism on cetaceans.

1.5 Thesis structure and aims

This thesis comprises four research chapters (Chapters Two to Five) with an introductory (Chapter One) and concluding (Chapter Six) chapter. Each chapter has been written in publication format and represents a manuscript that is either *published, in press or in review*. The publication status and journal authorship are detailed under 'Details of included papers' on page *vii*. Further, authors' contributions to manuscripts are detailed at the beginning of each chapter under 'Declaration of co-authorship and co-contribution: papers incorporated in thesis by publication'. This 'Thesis by Publication' format has resulted in some unavoidable repetition, particularly in relation to methods and materials. However, every effort has been made to limit duplication where appropriate, with all references combined at the end of the thesis.

The specific aims of this research were to:

- 1) Quantify dolphin-swim participants' demographics, motivation, biocentrism, knowledge, topics of interest and satisfaction levels before, after, and six months post, a dolphin-swim tour in PPB, and determine whether participation in a dolphin-swim tour can lead to long-term increases in participants' biocentrism;
- 2) Determine the efficacy of the Wildlife (Marine Mammal) Regulations, 2009, in acting as a protection tool for Burrunan dolphins by assessing dolphin-swim tour operator compliance with regulations over time (1998 – 2013);
- 3) Provide the first comprehensive activity budget for Burrunan dolphins in the absence of vessels;

- 4) Determine the effectiveness of TBSZ as a management strategy, by assessing whether Burrunan dolphins exhibit biologically critical behaviours (i.e. foraging and resting) in this MPA;
- 5) Examine Burrunan dolphins' long-term responses (i.e. approach, neutral or avoid) to dolphin-swim tour vessels, in relation to legality of approach type, group dynamics and behaviour; and
- 6) Investigate the potential effects of dolphin-swim tourism on Burrunan dolphins in PPB by comparing their behaviour in the presence and absence of tour vessels.

Chapter Two

Social science as a vehicle to improve dolphin-swim tour operation compliance?



This chapter is a reformatted version of the published manuscript:

Filby et al. (2015) Social science as a vehicle to improve dolphin-swim tour operation compliance? *Marine Policy*, 51: 40-47. (Appendix 5)

Declaration of co-authorship and co-contribution: papers incorporated in thesis by publication

Declaration by: Nicole Erin Filby

Signature:



Date: 26th of October 2015

Paper Title: Social science as a vehicle to improve dolphin-swim tour operation compliance?

In the case of the above publication, the following authors contributed to the work as follows:

Name	Contribution %	Nature of Contribution
Nicole Filby	75	Study concept, experimental design, fieldwork, data collection, statistical analysis and interpretation, manuscript writing, manuscript editing
Carol Scarpaci	20	Study concept, experimental design, data collection, manuscript editing
Karen Stockin	5	Manuscript editing

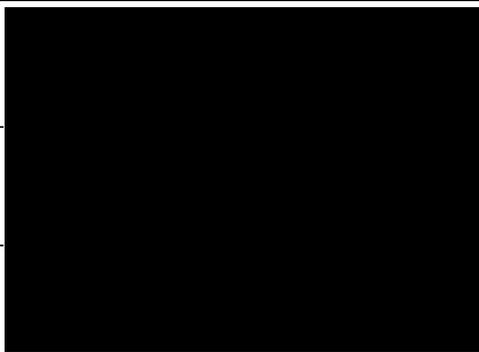
Declaration by co-authors

The undersigned certify that:

1. They meet criteria for authorship in that they have participated in the conception, execution or interpretation of at least that part of the publication in their field of expertise;
2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. There are no other authors of the publication according to these criteria;
4. Potential conflicts of interest have been disclosed to **a)** granting bodies, **b)** the editor or publisher of journals or other publications, and **c)** the head of the responsible academic unit; and
5. The original data is stored at the following location(s):

Location(s): College of Engineering and Science, Victoria University, Melbourne, Victoria, Australia

and will be held for at least five years from the date indicated below:

		Date
Nicole Filby		11 th of September 2015
Carol Scarpaci		2 nd of September 2015
Karen Stockin		11 th of September 2015

2.1 Abstract

This study investigates whether tourists can be a force to evoke compliance, via conducting social science and compliance studies simultaneously. Tourist demographics, motivation, biocentrism, knowledge and satisfaction levels were obtained from 511 questionnaires collected from dolphin-swim tourists between 2011 and 2013. Simultaneously dolphin-swim tour operators' compliance to regulations was assessed via 282 surveys collected from 1998 to 2013. Of the 8 dolphin-swim regulations assessed, tour operators demonstrated satisfactory compliance to 2 of the regulations. Conversely, tourists were happy to comply with regulations as they don't want to have a negative impact on the targeted species. The importance of understanding the human dimensions of dolphin tourism for the successful management of the industry is highlighted, as it enables interpretation to be developed that increases tourists' education and biocentric levels. Tourists can be used as a vehicle for increasing tour operator compliance, enabling the industry to become more sustainable, whilst simultaneously encouraging economic growth.

2.2 Introduction

Cetacean-based tourism is defined as any activity with the primary purpose of watching or swimming-with cetacea (whales and dolphins) and is one of the fastest growing industries in the world (Zeppel & Muloin, 2009). Cetacean-based tourism generated over USD\$2.1 billion in revenue worldwide in 2008 (O'Connor et al., 2009), making it the largest current economic activity dependent upon cetaceans (Parsons, 2012). In Australia, income derived from cetacean-based tourism has risen substantially, with a growth of 8.3% in the last decade (Jarvis & Ingleton, 2001; O'Connor et al., 2009). In 2008, more than 1.6 million tourists participated in cetacean-based tourism in Australia, and the industry is now worth over \$29 million to the Australian economy (O'Connor et al., 2009; Valentine et al., 2004). However, the rapid expansion of this industry has raised concerns over the impacts these operations have on the targeted species, the marine environment and the sustainability of this tourism industry (Ziegler et al., 2012). Long-term studies indicate that short-term behavioural

changes and avoidance tactics may have long-term consequences (e.g. decreased reproductive success (Bejder et al., 2006a) and increased mortality rates (Courbis & Timmel, 2009; Dans et al., 2008)) for individuals and their populations (Lusseau & Bejder, 2007).

In order to counteract the negative impacts of cetacean-based tourism, tours have the potential to positively influence participant's experiences and perceptions of the targeted species and their environment to facilitate responsible environmental behaviour amongst participants (Christensen et al., 2007; Mayes, 2008; Orams, 1996). Research indicates that cetacean tourism interpretation that is carefully designed and delivered, can effectively increase visitor knowledge, influence attitudes, encourage behaviour modification and contribute to a rewarding touristic experience (Anderson & Miller, 2006; Ballantyne et al., 2009; Orams, 1997; Smith et al., 2009; Zeppel & Muloin, 2009). However, limited research focuses on the human dimensions of dolphin tourism and its potential to increase tourists' biocentric values and pro-conservation behaviours (Lück, 2003; Mayes et al., 2004; Wiener, 2013). Indeed, this is the first study to evaluate whether there are long-term increases in participant's biocentrism due to participating in a dolphin-swim tour. This study also evaluates factors that can promote education and what type of information is desired by tourists.

Interpretation not only helps protect the environment but can also increase visitor enjoyment and lead to longer-term benefits in participants, such as greater environmental awareness and involvement in conservation organisations (e.g. Lück, 2003; Mayes et al., 2004; Orams, 1996; Zeppel & Muloin, 2009). It has been suggested that interpretation on-board vessels has the potential to help protect cetaceans via changes in tourists' behaviour, and may be more important than regulations in ensuring long-term environmentally conscious and sustainable practices (Anderson & Miller, 2006; Hrycik & Forestell, 2013; Jacobs & Harms, 2014). Dolphin-swim tourism compliance is negligible globally (Allen et al., 2007; Whitt & Read, 2006; Wiley et al., 2008), with the industry in Port Phillip Bay (PPB) historically non-compliant due to failed management (Scarpaci et al., 2003; Scarpaci et al., 2004). Non-

compliance is driven by the pressure faced by tour operators to satisfy customers and meet expectations (Whitt & Read, 2006) and facilitated via a lack of enforcement (Scarpaci et al., 2004). In the absence of government enforcement, the question remains: how can tour operators be encouraged to comply to regulations so that the industry remains sustainable? If tour operators are informed about what their patrons want, and this is aligned with sustainable practice, then there is the potential for tourists to be used as a force to drive tour operator compliance. Irrespective that the dolphin-swim industry can be governed by regulations, levels of compliance can be low. Therefore, alternative strategies are required to improve compliance and mitigate impacts that dolphin-swim industries may pose to target species. In other sectors, social science questionnaires have determined that individuals are willing to pay more for environmentally friendly products, and that good eco-performance generates competitive advantages, such as increased word of mouth for their business (Baker, 2003; Han et al., 2009; Laroche et al., 2001).

This study explores whether tourists themselves can evoke compliance, via conducting social science and compliance studies simultaneously. The objectives of this study were to investigate whether social sciences (specifically customer questionnaires) can provide the opportunity to encourage tour operator compliance. Specifically, this study aimed to evaluate dolphin-swim participant's demographics, motivation, biocentrism, knowledge and satisfaction levels before, after and 6 months post a dolphin-swim tour. Finally, this study aimed to compare compliance across two time frames to determine whether stricter and simpler amendments in the regulatory requirements motivated tour operations to improve compliance levels.

2.3 Materials and methods

2.3.1 Study site

Port Phillip Bay is home to approximately 80 – 100 individual dolphins, recently identified as a genetically and morphologically isolated species of bottlenose dolphin; the Burrunan dolphin (*Tursiops australis*, Charlton-Robb et al., 2011;

Hale, 2002). To interact with Burrunan dolphins, tourists' on-board dolphin-swim tour vessels engage in a 3.5 hour tour of the southern end of PPB (38°05'S, 144°50'E), on the south-eastern coast of Victoria, Australia.

2.3.2 Questionnaire design

Questionnaires were designed around six core components:

- 1) Factors that motivate tourists to participate in a dolphin-swim tour;
- 2) Participant's biocentric values;
- 3) Participant's level of conservation activity;
- 4) Participant's perceived knowledge about dolphins;
- 5) Participant's interest levels on topics about dolphins and their environment; and
- 6) Participant's satisfaction with the dolphin-swim tour.

Questionnaires were voluntary and only distributed to participants over the age of 18. The experimental design employed a number of scaled items (previously tested in other marine wildlife encounter programs, e.g. Anderson & Miller, 2006; Christensen et al., 2009; Finkler & Higham, 2004; Orams, 2000; Valentine et al., 2004). Closed-response questions were rated using 5-point Likert-type scales (Finkler & Higham, 2004), which enabled participants to respond to a range of variables related to their experience, biocentric values, and their knowledge about dolphins and their environment. A 75% questionnaire completion rate was required to be included within the study.

Questionnaires were distributed to dolphin-swim tourists: pre dolphin-swim (PRE) (completed one week or less prior to dolphin-swim tour); post dolphin-swim (POST) (completed within a day of participation); and 6 months post dolphin-swim (6MP) (completed 6 months or more after the dolphin-swim tour). Questionnaires were accessible online, via the survey monkey website: www.surveymonkey.com (examples of each Questionnaire can be seen in Appendix 6.1 – 6.3). PRE and POST questionnaires were distributed to dolphin-swim tourists via a link embedded into an email from the dolphin-swim companies, and accompanied by an 'Information for participants involved in

research' document (Appendix 7). The 6MP questionnaires were distributed via email to tourists who had participated in either of the first two questionnaires, and attached a 'Research opportunity for dolphin-swim participants and letter of gratitude' document (Appendix 8) to this email. The author (NF) was on-board dolphin-swim tours to encourage participation and answer any questions.

2.3.3 Compliance data collection

Observations of tour operator compliance to regulations were conducted on-board dolphin-swim tour vessels in PPB across two time frames (period 1: 2007 – 2008 (utilising Scarpaci's unpublished data); and period 2: 2011 – 2013 (utilising data collected in this study)). Data from these two time frames were collected independently as different management regulations were in place. However, data collection methods for periods 1 and 2 were consistent. Data were recorded for distance between tour vessels, repositioning of tour vessels during a dolphin-swim, interactions with dolphin groups within Ticonderoga Bay Sanctuary Zone (TBSZ) and number of swimmers, using 1 min scan samples (Altmann, 1974).

Ticonderoga Bay Sanctuary Zone is a small (approx. 2000 m²) sanctuary zone inside PPB (Howes et al., 2012), extending 250 m offshore from Point Nepean (38°17'56.9"S, 144°38'54.8"E; 38°18'5"S, 144°38'54.8"E) to Police Point (38°18'46.8"S, 144°42'19.6"E; 38°18'56.6"S, 144°42'19.6"E) (Wildlife (Marine Mammal) Regulations, 2009). Continuous observations were used to record approach type (Table 2.2), number of approaches and whether education was provided. An encounter was defined as the period during which a dolphin-swim vessel was engaged in interaction with a dolphin group (within 300 m), as described in Scarpaci et al., (2003). Distance was determined using a Yardage Pro 500 range finder. As stated in the Wildlife (Marine Mammal) Regulations, 2009, a calf was defined as any individual that was less than half the length of an adult female. Tour operator compliance to the Wildlife (Marine Mammal) Regulations, 2009, was assessed for the conditions listed in Table 2.1, with compliance deemed satisfactory if 80% or higher (Allen et al., 2007; Scarpaci et al., 2003; Scarpaci et al., 2004). Compliance to the regulation 'tour operators

Table 2.1 Definitions of conditions stipulated in the Wildlife (Marine Mammal) Regulations, 2009, that were assessed during the present study.

Condition	Regulations	How compliance was assessed
1. Do not approach a dolphin head-on, or cut in front of a dolphin's path	Part 3, 9(1a, b, c)	When a tour vessel was within 100 m of a dolphin group and moved in a steady direction towards the group it was deemed an approach. Three approach types were observed (Table 2.2)
2. Tour vessel must not approach a dolphin group closer than 100 m more than 5 times each tour	Part 5, 17(5)	Number of approaches tour vessels undertook per trip recorded
3. Must ensure that a tour vessel does not approach within 300 m of another tour vessel when they are within 100 m of a dolphin group	Part 3, 9(4)	Distance between tour vessels assessed when vessels were within 100 m of a dolphin group and another tour vessel was within 300 m
4. Must not swim with a calf	Part 5, 17(15)	Observer considered staff had opportunity to observe presence of a calf prior to a swim (i.e. calf was clearly visible to observers unaided eye, or staff indicated to customers that a calf was present)

Table 2.1 Continued. Definitions of conditions stipulated in the Wildlife (Marine Mammal) Regulations, 2009, that were assessed during the present study.

Condition	Regulations	How compliance was assessed
5. Tour operators must not approach a dolphin within 200 m whilst in TBSZ	Part 5, 16(12)	Distance between tour vessels and dolphins recorded when tour vessels within TBSZ
6. Must not reposition a tour vessel during a dolphin-swim	Part 5, 17(11)	Recorded any manoeuvring of tour vessel during a dolphin-swim that was not motivated by safety concerns
7. Must ensure that no more than 10 people participate in a dolphin-swim	Part 5, 17(14)	Number of swimmers (within 300 m of dolphins) recorded every minute until conclusion of dolphin-swim
8. Tour operators must provide information on the biology and conservation status of and threats facing dolphins	Part 5, 16(2)	Recorded whether staff provided information on dolphins during tour. If staff provided information on species name, home range and threats facing the dolphins in PPB they were deemed to be compliant to this condition

Table 2.2 Definitions of approach types utilised by tour operators in Port Phillip Bay, Victoria, Australia (modified from Scarpaci et al., 2003).

Approach Type	Definition	Legality
Parallel Approach	Tour vessel positioned to either side of a group of dolphins	Legal
Direct Approach	Tour vessel positioned directly into the middle of a group of dolphins	Illegal
J Approach	Tour vessel initially travelled parallel to a dolphin group, but then moved directly in front of the group	Illegal

must provide information on the biology and conservation status of and threats facing dolphins' was only assessed in period 2, as this was not part of the regulations during period 1.

2.3.4 Data analysis

Participant's biocentrism, satisfaction, interest and motivation were based on an indicator value, calculated as the mean response to statements on the Likert-type questions. Scores of 1 - 2.9 were considered non-biocentric, 3 - 3.9 represented a neutral attitude and scores of 4 - 5 were deemed biocentric (Christensen et al., 2007). Scores from PRE, POST and 6MP questionnaires were compared using Mann Whitney U tests or Kruskal–Wallis tests to determine if biocentrism, satisfaction, interest and motivation varied between time frames (Pallant, 2001). Results were considered significant at $p \leq 0.05$.

A modified four-item New Environmental Paradigm (NEP) scale was utilised, as designed by Luzar et al., (1998). The NEP was used to assess participant's biocentric values regarding conservation of the marine environment, and

participant's biocentric values in terms of motivation and intent to become involved in marine conservation. Each answer received a value from 1 to 5, and participants with scores of 3 - 3.9 were deemed to have neutral biocentric values, scores of less than 2.9 represented negative biocentric values, and scores of 4 - 5 represented positive biocentric values.

2.4 Results

Questionnaires were conducted from February 2011 - October 2013. The response rate was 5.7% ($n = 511$), accounting for 40.1% ($n = 205$), 41.1% ($n = 210$) and 18.8% ($n = 96$) for PRE, POST and 6MP, respectively. Participants were most likely to complete POST and 6MP questionnaires (11.7%, $n = 49$) followed by PRE and 6MP questionnaires (7.6%, $n = 32$) and PRE and POST questionnaires (2.6%, $n = 11$). Less than 1% (0.7%, $n = 3$) of participants completed all 3 questionnaires.

2.4.1 Demographics

Respondents were primarily from Victoria, Australia (85.0 %, $n = 182$), followed by international travellers (8.9%, $n = 19$) and travellers from other states of Australia (6.1%; $n = 13$). The international composition of travellers varied (Europe = 3.4%; UK = 2.8%; USA/Canada = 1.9% and Asia = 0.9%). Majority of respondents were female (69.3%, $n = 142$), while males accounted for 30.7% ($n = 63$). Age of respondents ranged from 18 to 71 years old (mean = 39, SE = 0.89). Respondents were generally well educated with 75.7% ($n = 155$) of participants post-secondary qualified and of these, 62.5% ($n = 128$) qualified to tertiary standards. The intent of participants was to swim with free-ranging dolphins (94.7%, $n = 195$). Respondents independently organised and travelled to the dolphin-swim tour site. The majority (73.2%, $n = 150$) of respondents had not previously fed, swam with or interacted with dolphins in other locations. For the majority of patrons, this was their first encounter with dolphins in PPB (89.8%; $n = 184$). Almost all participants felt that swimming with dolphins was beneficial to themselves and posed no impact on the dolphins (Figure 2.1). The potential impact of swimming with, and observing dolphins from boats, was

further disregarded by participants over time, although this was not significant, $H(2) = 3.11, p = 0.212$ and $H(2) = 0.05, p = 0.974$, respectively.

The majority of participants did not frequently engage in environmental activities, with almost half (49.7%, $n = 94$) of participants having never participated in conservation activities and 43.9% ($n = 83$) having never made a monetary donation to an environmental cause. Most participants had visited an aquarium or zoo at least once (41.7%, $n = 79$ and 45.0%, $n = 85$ respectively) and approximately 80% of participants had watched a marine documentary on dolphins.

2.4.2 Visitor motivation factors

Prior to the dolphin-swim trip, factors that motivated tourists to select a tour boat company were: activities offered (75.6%, $n = 155$); environmental beliefs and company awards (61.5%, $n = 126$); and cost (60.5%, $n = 124$). Participants were not motivated to select a tour boat company based on: dolphin sighting guarantee (26.3%, $n = 54$); size of boat (24.4%, $n = 50$); or number of people (44.9%, $n = 92$). There was a significant difference ($t(4) = 4.168, p = 0.014$) between factors that participants ranked as important and those not considered as important.

Irrespective of the time frame, factors important to participants did not change (i.e. POST and 6MP tour the most important factors when participating in a dolphin-swim were still: seeing dolphins in their natural environment; knowledgeable staff; and opportunities to see dolphins, Table 2.3). Getting close to dolphins was not of high importance when participating in a dolphin-swim, and significantly declined in importance by a third from PRE (mean = 3.92, SD = 0.89) to 6MP (mean = 3.49, SD = 0.89, $U = 6602, p = 0.000$). Observing large numbers of dolphins was also not an important factor to patrons when deciding to participate in a dolphin-swim tour, with the level of importance decreasing significantly by a half from PRE (mean = 3.45, SD = 1.05) to 6MP (mean = 3.00, SD = 0.86, $U = 6735, p = 0.000$).

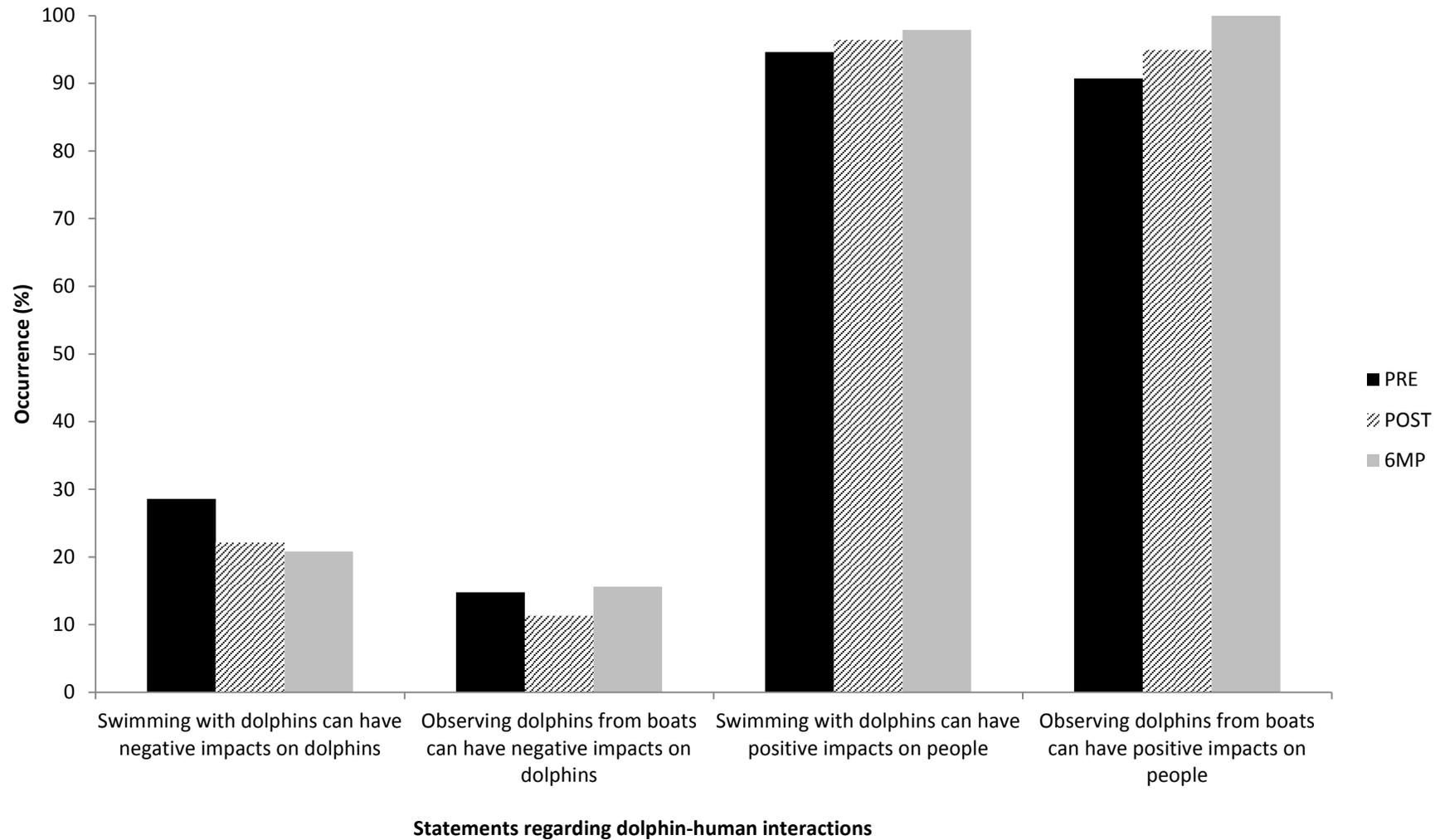


Figure 2.1 Participant's views on dolphin-swimming (agree and strongly agree).

Table 2.3 Factors of very-high importance to patrons when participating in a dolphin-swim (PRE, POST and 6MP).

	Category	PRE (%)	PRE (n)	POST (%)	POST (n)	6MP (%)	6MP (n)
Large numbers of dolphins to see	Dolphin experience	45.5	86	30.9	65	20.0	19
Getting close to dolphins	Dolphin experience	68.2	129	63.3	133	44.2	42
Opportunity to see dolphins	Dolphin experience	92.6	175	87.7	184	89.5	85
Seeing dolphins in their natural environment	Dolphin experience	94.7	179	93.3	196	92.7	88
Interesting information about dolphins	Knowledge	80.4	152	75.2	158	87.3	83
Knowledgeable staff	Knowledge	94.2	178	89.5	188	94.7	90

Table 2.4 Mean NEP values for biocentric values – Marine conservation.

Biocentric Values – Marine Conservation	
PRE	4.59
POST	4.66
6MP	4.54

Table 2.5 Mean NEP values for biocentric values – Intention.

	Overall Biocentric Values – Intention	Minimal Effort	Time and Money Output
PRE	3.11	3.66	2.56
POST	3.34	3.89	2.79
6MP	3.26	3.83	2.68

Table 2.6 Participants' current state of conservation activity.

	PRE (%)	PRE (n)	6MP (%)	6MP (n)
I am already involved in conservation activities	40.3	52	50.0	36
I will get involved in conservation activities	3.9	5	2.7	2
I have been thinking about participating in conservation activities for less than six months	14.7	19	4.2	3
I have been thinking about participating in conservation activities for more than six months	34.1	44	41.7	30
I do not ever intend in participating in conservation activities	7.0	9	1.4	1

Table 2.7 Participants' level of interest (very-highly interested) for topics about dolphins (PRE, POST and 6MP tour).

* *Statistically significantly different at $p < 0.05$.*

	Category	PRE (%)	PRE-POST	POST (%)	POST-6MP	6MP (%)	PRE-6MP
Daily activities of dolphins	General	48.4	↑*	63.1	↓*	52.1	↑
Details about individual dolphins	General	50.0	↑*	59.9	↓	52.2	0
Dolphins intelligence & strange characteristics	General	73.1	↑	79.7	↓	71.3	0
Breeding/rearing of young dolphins	General	50.0	↑*	63.1	↓	56.4	↑
Dolphin distribution and populations numbers	General	46.7	↑*	66.3	↓	57.5	↑
Dolphins diet	General	36.6	↑*	50.3	↓	47.8	↑
Dolphin social habits	General	66.7	↑	74.9	0	73.4	↑
Dolphins relationships with other species	General	66.1	↑	74.3	↓	70.2	↑
Dolphins importance in the ecosystem	General	62.3	↑	74.8	↓	65.9	↑
Marine environment conservation	Conservation	63.5	↑	70.6	0	71.3	↑

Table 2.7 Continued. Participants' level of interest (very-highly interested) for topics about dolphins (PRE, POST and 6MP tour). * *Statistically significantly different at $p < 0.05$.*

	Category	PRE (%)	PRE-POST	POST (%)	POST-6MP	6MP (%)	PRE-6MP
Dolphin conservation	Conservation	62.9	↑*	74.4	↓	69.1	↑
Dolphin stranding's & rescues	Conservation	49.5	↑*	62.6	↓	58.5	↑
Dolphin features that are similar to humans	Humanisation	52.7	↑	65.2	↓	50.0	0
Dolphin interactions with aboriginals	Indigenous	39.3	↑	47.5	↓	43.6	↑

Table 2.8 Participants' biocentric values (or levels of knowledge) (agree-strongly agree) regarding dolphins (PRE, POST and 6MP tour). * *Statistically significantly different at $p < 0.05$.*

		PRE (%)	PRE-POST	POST (%)	POST-6MP	6MP (%)	PRE-6MP
It's ok to keep dolphins in captivity	Utilisation for people	14.5	↓*	13	0	11.7	↓
It's ok to feed dolphins	Utilisation	19.3	↓*	9.2	0	9.5	↓*
It's ok to swim with dolphins	Utilisation	76.4	↑	79.5	0	79.8	↑
Dolphins are an important resource to Australia	Utilisation	83.9	↑	89.7	0	89.4	↑
Dolphins are more special than other wild animals	Humanisation	18.3	0	18.4	↑	22.3	↑
Dolphins have feelings	Humanisation	84.9	↑	89.7	0	90.4	↑
Dolphins have thoughts	Humanisation	85.4	↑	87.6	↑	92.6	↑
Dolphins are intelligent	Humanisation	97.9	0	97.3	0	98.9	0
Harming dolphins should be punishable as an offence	Protection	89.3	0	88.7	↑	92.5	↑

Table 2.8 Continued. Participants' biocentric values (or levels of knowledge) (agree-strongly agree) regarding dolphins (PRE, POST and 6MP tour). * *Statistically significantly different at $p < 0.05$.*

	Category	PRE (%)	PRE-POST	POST (%)	POST-6MP	6MP (%)	PRE-6MP
My daily actions affect dolphins	Ownership	45.7	↑	51.9	↑	64.9	↑*
My daily actions affect the marine environment	Ownership	67.6	↓	65.4	↑*	73.4	↑*
Dolphins are affected by events that occur in land environments	Conservation	91.4	↑	94.6	0	95.8	↑
It's important to protect dolphins	Conservation	95.2	↑*	97.8	0	96.8	0
It's important to protect the marine environment	Conservation	96.7	↑	99.5	0	99.0	↑

Table 2.9 Participants' level of satisfaction (very-highly satisfied) with various aspects of their dolphin-swim (POST and 6MP tour).

	Category	POST (%)	POST- 6MP	6MP (%)
Number of dolphins I saw	Dolphin	66.5	↓	63.1
How close I could get to dolphins	Dolphin	63.8	0	63.1
Health of dolphins	Dolphin	73.8	↑	76.9
Natural behaviour of dolphins	Dolphin	72.3	↓	70.5
Amount of time I spent watching dolphins	Dolphin-time	57.6	0	58.9
Amount of time I swam with dolphins	Dolphin-time	44.0	↓	40.0
How closely you observed the dolphins	Dolphin-proximity	63.3	0	64.2
Amount of watercraft in area	Experience	63.9	↓	61.0
Number of people in the water	Experience	71.2	↓	66.4
Space available on boat for visitors	Experience	76.9	↑	81.1

Table 2.9 Continued. Participants' level of satisfaction (very-highly satisfied) with various aspects of their dolphin-swim (POST and 6MP tour).

	Category	POST (%)	POST- 6MP	6MP (%)
Sea conditions during tour	Experience	82.2	↑	85.3
Dolphin-swim rules I had to follow	Rules	80.6	↑	83.2
Interest of information given	Knowledge	80.1	↑	85.2
Information on how to help conserve dolphins	Knowledge	46.6	↑	60.0
Information on how to help conserve dolphins environment	Knowledge	46.6	↑	61.0
Overall satisfaction	General	83.8	0	83.1

2.4.3 Visitor biocentric attitudes and values towards dolphins and their environments

The modified NEP scale (Table 2.4) includes declarations about conservation, and is modelled to reveal negative and positive values amongst participants regarding conservation of the marine environment, assisting with marine conservation programs, conservation of dolphins and marine wildlife. Results revealed that participant's biocentric values concerning marine conservation were positive and relatively high, and that this increased significantly over time from PRE (mean = 4.59, SD = 0.63) to POST (mean = 4.66, SD = 0.61, $U = 315470$, $p = 0.008$).

Participants NEP values were neutral regarding their intent to: become more involved in marine conservation issues; make donations to environmental organisations; join wildlife/dolphin preservation organisations; donate time assisting with wildlife conservation; remove litter that could harm marine wildlife; decrease their personal water pollution levels; assist in protection of dolphins where possible and tell others about the need to conserve our oceans (Table 2.5). However, respondents were most likely to engage in minimal effort/low commitment conservation activities (e.g. pick up rubbish (mean = 77.4%) or tell others about the need to care for our oceans (mean = 65.6%)) than activities that require ongoing commitment and monetary donations (e.g. join a wildlife or dolphin preservation organisation (mean = 16.5%)). Participants biocentric intent to be involved in conservation activities increased significantly over time from PRE (mean = 3.11, SD = 1.28) to POST (mean = 3.33, SD = 1.28, $U = 1101277$, $p = 0.000$) and from PRE to 6MP (mean = 3.26, SD = 1.20, $U = 543733$, $p = 0.011$).

2.4.4 Visitor motivation to adopt pro-active conservation initiatives

The majority of PRE participants (59.7%) had never participated in conservation activities. After the dolphin-swim tour, participants levels of conservation activity increased by 9.7%, with half of participants now involved in conservation activities (Table 2.6). Level of responses for 'I do not ever intend in participating

in conservation activities' PRE was 7.0% but declined to 1.4% of participants 6MP (Table 2.6). After the dolphin-swim tour, the number of participants who have never participated in conservation activities declined by 8.3% from 32.5% ($n = 62$) (PRE) to 24.2% ($n = 23$) (6MP).

2.4.5 Visitor knowledge and interest in dolphins

Visitors perceived their knowledge levels about dolphins had increased POST. The majority of PRE respondents had a perceived slight level of knowledge about dolphins (48.2%, $n = 91$) and this shifted to a perceived moderate level of knowledge POST (59.3%, $n = 115$) and 6MP (68.4%, $n = 65$).

Results reveal that the time participants are most interested in topics about dolphins is post dolphin-swim (Table 2.7), with interest levels increasing for all factors from PRE responses, and declining for all 6MP responses for majority of topics. The most popular learning category POST was dolphin's intelligence and strange characteristics (79.7%). Participant's level of interest increased significantly from PRE to POST for topics regarding: daily activities of dolphins; details about individual dolphins; breeding and rearing of young dolphins; dolphin distribution and population numbers; dolphin's diet; dolphin conservation; and dolphin stranding's and rescues (Table 2.7). Across the three sampling periods (PRE, POST and 6MP), conservation topics held the highest levels of interest to customers, whilst humanisation and indigenous topics held the lowest level of interest (Table 2.7). As seen in Table 2.7, there was no significant difference in participant's interest levels from PRE to 6MP.

The majority of respondents indicated that harming dolphins should be punishable as an offence and believed that it is not ok to feed dolphins (Table 2.8). Temporally, participants were in highest agreement with statements that were conservation based, and patrons' conservation levels regarding the importance of protecting dolphins increased significantly over time from PRE to 6MP (Table 2.8), indicating that participants have high biocentric values. Participants' environmental ownership (i.e. that their daily actions could affect

dolphins and the marine environment) increased significantly over time from PRE to POST (Table 2.8).

2.4.6 Visitor satisfaction with dolphin-swim tour

Participants were highly satisfied with how close they got to dolphins, the dolphin-swim rules they had to follow, the sea conditions and interest of information given (Table 2.9). Participants were not satisfied with information on how to help conserve dolphins and their environment, or the amount of time they swam with dolphins (Table 2.9).

2.4.7 Compliance

During period 1, there were 104 surveys conducted on-board tour vessels, resulting in 59 independent dolphin sightings. Mean tour duration was 3 hours and 17 mins (SE = 4.41). During period 2, 178 surveys were conducted, resulting in 104 dolphin sightings. Mean tour duration was 3 hours and 22 mins (SE = 1.61). Sighting success rate was 58.0% and 46.6%, respectively for periods 1 and 2. During period 1, the total time dolphins were within 300 m of tour vessels was 25 hours and 38 mins (mean = 22 min 8 sec) compared to 46 hours and 6 mins (mean = 26 min 35 sec) for period 2. Of the 8 conditions assessed across 1998 - 2013, tour operators demonstrated satisfactory compliance to only 2 of the conditions (number of swimmers and education, Figure 2.2).

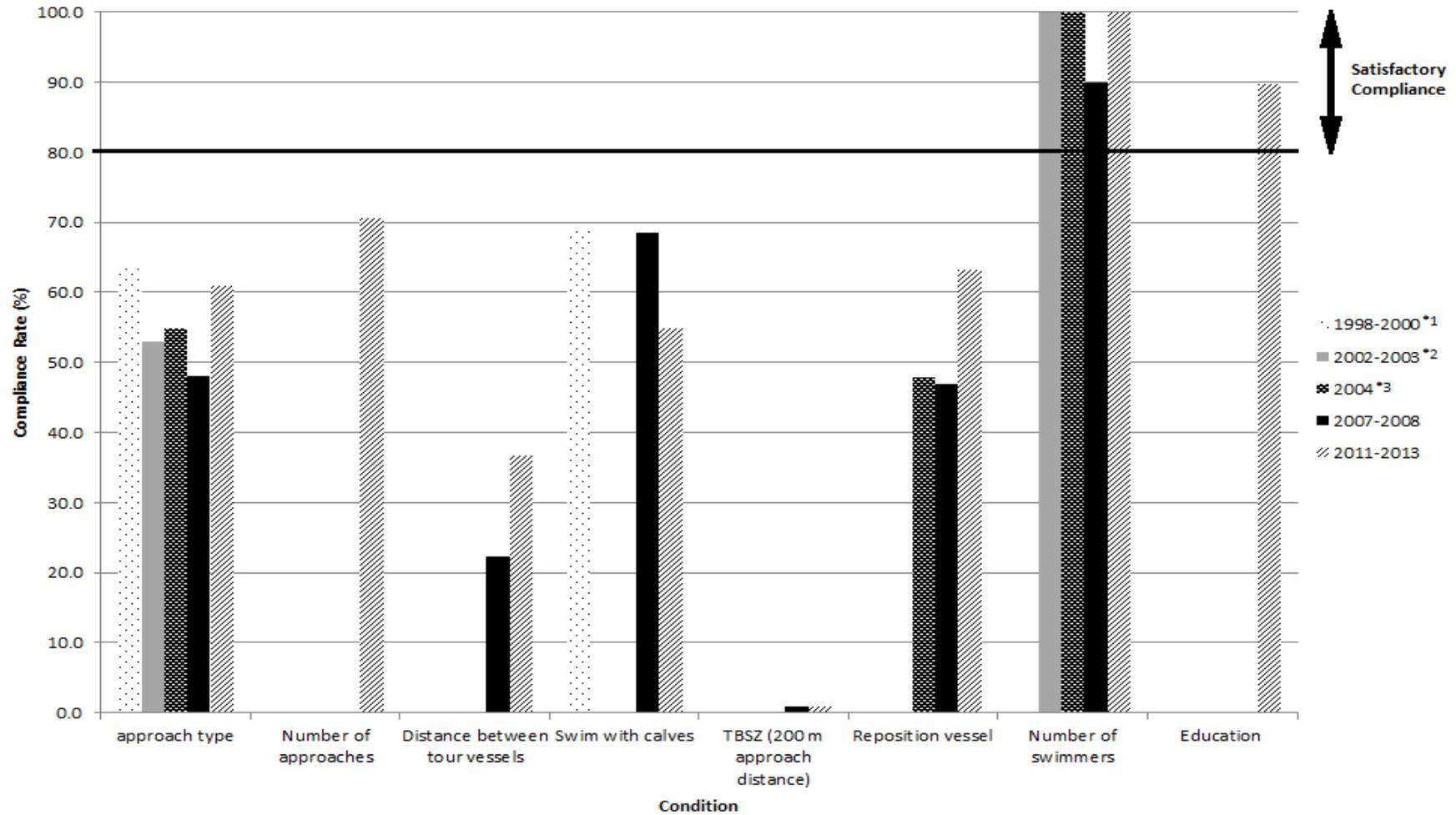


Figure 2.2 Compliance rates to conditions stipulated in the Wildlife (Marine Mammal) Regulations, 2009, for dolphin-swims in Port Phillip Bay Victoria, across 436 surveys, 1998 – 2013. *1 Scarpaci et al., 2003 *2 Scarpaci et al., 2004 *3 Scarpaci, unpublished data.

2.5 Discussion

A non-compliant dolphin-swim industry that does not satisfy the tourist expectation could deteriorate the experience, impact future sustainability and decrease future business potential. In PPB, the top three motivators to participate in a dolphin-swim tour for tourists were observing dolphins in their natural environment, opportunity to see dolphins and knowledgeable staff. Observing large numbers of dolphins and getting close to dolphins ranked the lowest motivator for participants to commit to a dolphin-swim tour. Furthermore, participants continued to assign decreasing value to these two factors over time, indicating that they are not important features in a tour from the perception of the participants. Indeed, over time, the majority of participants were highly satisfied with the proximity of the tour vessel to dolphins during the tour, reinforcing the fact that geographical proximity of dolphins to tourists is not important for participant's satisfaction, and that non-compliance by tour operators to this condition is not constructive for business.

Development of simpler regulations and stricter conditions did not motivate tour operators to improve compliance. However, participants were satisfied with the dolphin-swim rules they had to follow. Previous research indicates that participants want guidance and are likely to comply with rules and regulations once explained. Tourists do not want their actions to impose disturbance on targeted wildlife (Curtain, 2010; Wiener et al., 2009). For example, Ballantyne et al., (2009) found that when whale-watching participants were aware that they had to abide by regulations in order to minimise impacts on the whales, the experience was made even more special for tourists. The Wildlife (Marine Mammal) Regulations, 2009, restricts approach type, the number of swims a tour operator can attempt per trip and does not permit tourists to swim with calves. However, tour operators fail to comply with these conditions and consequently, from 1998 - 2013 there has been an increase in dolphins' avoidance to tour vessels (Chapter Four; Filby et al., 2014). This could result in a decrease in the amount of time tourists observe dolphins under the water, ensuing in decreased customer satisfaction. Presently, less than 50% of

participants were satisfied with the amount of time they swam with dolphins, however, customers indicated that they were happy to follow dolphin-swim rules. Thus, it is recommended that tour guides explain why regulations are in place in order to increase customer satisfaction and encourage business growth. To facilitate compliance (e.g. do not swim with a calf; only 5 approaches per dolphin group per tour) tourists should be advised that the intent of the regulations is to reduce disturbance to the dolphins. By explaining regulations to customers prior to the dolphin-swim, participant's expectations will be managed, reducing disappointment and increasing customer satisfaction. Furthermore, this will remove pressure from tour operators to breach regulations.

The small population size of the dolphins in PPB, increased number of tourists in the peak summer season, co-operative sighting strategies amongst tour operators, tour vessels alternating swimmers to interact with a single dolphin group and the lack of enforcement in southern PPB, has meant that frequently there are high concentrations (up to 10 vessels per group of dolphins) of traffic (tour and recreational vessels) around dolphin groups. This crowding creates a competitive scenario amongst tour operators for access to dolphins, triggering non-compliance to the prescribed minimum distances between tour vessels. The results presented indicate low customer satisfaction to number of boats around dolphins and implied participants experienced perceived crowding. Bell (2010) reported that number of boats had a significant impact on the quality of visitor experience for visitors to Molokini Shoal Marine Life Conservation District, Hawaii, with two-thirds of respondents feeling crowded and 80% supporting management interventions that would limit the number of boats in the area. Therefore, satisfactory compliance is not only important to mitigate the effects of tourism on the targeted species but can also improve customer satisfaction that in turn, could provide economic growth via repeat business, word of mouth recommendations and positive reviews through marketing websites (e.g. trip advisor).

Over time, participants valued knowledgeable staff and this remained a consistently important feature to patrons when deciding on participating in a tour. These results reinforce that education is wanted by participants, that they

expect interpretation as part of their tour, and indicates that tour leaders are central to the experience. However, tourists were only moderately satisfied with information they received on conserving dolphins and their environment. Importantly, for management, what tourists want (education) is not going to be an expensive outlay for tour operators and could be used as a vehicle to trigger positive action by tourists (e.g. join a dolphin/conservation group, or a dolphin stranding/rescue group) post dolphin-swim trip to encourage pro-conservative behaviours. This study also identified that the optimal time to conduct educational activities is after the dolphin-swim, as participants are most interested in different topics about dolphins and their environment at this time. These results concur with Ballantyne et al., (2009), Hrycik & Forestell (2013) and Lück (2003) who found that during the 'post-contact' phase, whale-watching participants were most receptive to information on biology and conservation of cetaceans, were more likely seek further information and reconsider global environmental threats.

The lack of information provided to dolphin-swim participants affects the conservation potential of this industry (Ziegler et al., 2012). The majority of PRE respondents had a slight perceived level of knowledge about dolphins and this increased to a moderate level for the majority of POST and 6MP participants. This indicates that participants' perceived increase in knowledge levels lasts over time and is not superficial. Participants felt that they gained knowledge on-board the dolphin-swim tours, indicating that tours can be an effective way to educate people and raise their biocentric levels; although there is the potential for further increase here. Dolphin-swim tours can be an effective vehicle for education, as demonstrated by the significant decrease over time in participants' level of agreement to the statement 'it is OK to feed dolphins'. However, despite being ranked (PRE) as the second (knowledgeable staff) and fourth (interesting information), most important aspects of the tour service, a number of POST participants were dissatisfied with information provided on dolphin-swim tours in PPB. Although participants in this study were educated (over 60% tertiary qualified), their initial level of knowledge about dolphins was low (50% = none or slight), indicating that in order for interpretation to be successful in promoting marine conservation ideals, tour operators in PPB need

to provide basic information on the fundamentals of dolphin ecology and their marine habitat issues.

There was a 20% increase in the number of participants from PRE to POST and 6MP who realised that their daily activities can affect dolphins, indicating that tour participation has made them more aware of the consequences of their actions. Furthermore, participant's biocentric values concerning marine conservation are positive and increase significantly over time. Therefore, it can be suggested that tours can be a vector for promoting pro-environmental beliefs. However, although the majority of participants had biocentric values, they were not members of environmental organisations and failed to demonstrate pro-conservative actions, revealing that positive biocentric values do not necessarily transcend to actions. For example, dolphin-swim participants were unwilling to outlay time, high levels of effort or finances to help conserve dolphins and their environment. However, participants were more likely to take conservation actions that require minimal amounts of time or effort (i.e. remove litter that could harm wildlife). When participants perceive that their actions could have a direct impact on the environment, they have a higher intent to take action to help. Participant's commitment to biocentric action is dependent on the level of investment required, with minimal effort activities (e.g. communicate to others about the need to conserve the marine environment) being the most likely actions to occur.

A limitation of this study was that less than 1% of participants completed all three questionnaires. Furthermore, the response rate was exceptionally low (< 6%), indicating a positively biased data set, as people who are already biocentric are more likely to participate. Previous research examining the human dimensions of marine wildlife tourism via questionnaires received response rates in the range of 54% - 76% (Christensen et al., 2007; Lück, 2003; Orams, 2000; Parsons et al., 2003b; Smith et al., 2009). The aforementioned studies all distributed their questionnaires in person, and therefore the lower response rate received herein is likely due to the fact questionnaires were distributed online, whereby participants have no personal contact with the researcher and therefore, may feel less obliged to participate. Thus, it is

recommended that future social science research, that collects data via questionnaires, be distributed in person to achieve a higher response rate and less biased sample. Alternatively, to increase participation rates, incentives such as price reductions on tour bookings, partial refunds or discounts on future tours could be offered.

Other recommendations to increase participants' biocentric and satisfaction levels, improve the sustainability of the dolphin-swim industry in PPB and increase economic growth include: 1) tour operators incorporate topics of interest to participants (as detailed in results, section 2.4.5) into the on-board interpretation; 2) tour operators target activities in their interpretation that participants have shown interest and intent in doing (detailed in results, section 2.4.3); 3) interpretative material to be scheduled at specific times of the tour, (e.g. explain regulations prior to the dolphin-swim and deliver conservation information after dolphin encounters); and 4) initiate compulsory annual training programs, that are delivered by the managing body to staff of tour companies. Training should aim to raise staffs' awareness of all regulations and what interpretation needs to be provided on the tour. Training should incorporate information on the biology and conservation of the targeted species, and actions that participants can take to become involved in conservation activities (e.g. brochures and websites participants could visit). By developing a structured, comprehensive interpretation program, with input from researchers, stakeholders and the governing body for the industry, tour operators have the opportunity to increase customer satisfaction levels by meeting their need and expectation for knowledge during dolphin-swim tours. Results presented herein suggest that the opportunity to learn about conservation is likely to enhance, rather than detract from the experience. Economically, this will benefit the industry as satisfied customers are more likely to bring repeat business. However, on-going monitoring is vital to determine if training programs are effective over time, and to determine if there is an increase in tour operators' compliance corresponding with an increase in tourists' increased knowledge.

2.6 Conclusions

With a history of non-compliance, and a lack of government enforcement, there needs to be a shift from ownership falling solely on tour operators to ownership being shared between tour operators and patrons. It appears as though tourists, if properly educated, can be used as a means to increase tour operator compliance, as tourists are happy to comply with regulations and do not want to have a negative impact of the targeted species. This study demonstrates how human dimensions of dolphin tourism are important for the successful management of the industry. By giving tourists what they actually want, commercial operators are empowered to conserve the sustainability of the industry while possibly increasing profit margins.

Chapter Three

Activity budget of Burrunan dolphins (*Tursiops australis*) used to assess effectiveness of a sanctuary zone



This chapter is a reformatted version of the manuscript:

Filby et al. (in review) Can Marine Protected Areas be developed effectively without baseline data? Activity budget of Burrunan dolphins (*Tursiops australis*) used to assess effectiveness of a sanctuary zone. *Marine Policy*.

Declaration of co-authorship and co-contribution: papers incorporated in thesis by publication

Declaration by: Nicole Erin Filby

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Paper title: Can Marine Protected Areas be developed effectively without baseline data? Activity budget of Burrunan dolphins (*Tursiops australis*) used to assess effectiveness of a sanctuary zone

In the case of the above publication, the following authors contributed to the work as follows:

Name	Contribution %	Nature of Contribution
Nicole Filby	85	Study concept, experimental design, fieldwork, data collection, statistical analysis and interpretation, manuscript writing, manuscript editing
Carol Scarpaci	10	Study concept, experimental design, manuscript editing
Karen Stockin	5	Manuscript editing

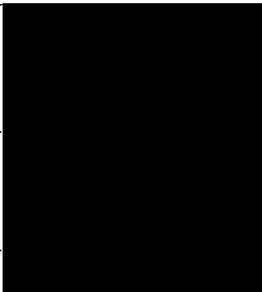
Declaration by co-authors

The undersigned certify that:

1. They meet criteria for authorship in that they have participated in the conception, execution or interpretation of at least that part of the publication in their field of expertise;
2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. There are no other authors of the publication according to these criteria;
4. Potential conflicts of interest have been disclosed to **a)** granting bodies, **b)** the editor or publisher of journals or other publications, and **c)** the head of the responsible academic unit; and
5. The original data is stored at the following location(s):

Location(s): College of Engineering and Science, Victoria University, Melbourne, Victoria, Australia

and will be held for at least five years from the date indicated below:

		Date
Nicole Filby		11 th of September 2015
Carol Scarpaci		2 nd September 2015
Karen Stockin		11 th September 2015

3.1 Abstract

Marine Protected Areas are increasingly used to protect marine mammals from anthropogenic threats despite limited studies that assess their efficacy. The small population of Burrunan dolphins (*Tursiops australis*) that inhabit Port Phillip Bay, Australia, are genetically isolated, listed as threatened and are exposed to dolphin-swim tourism. This study aimed to identify areas within Port Phillip Bay where dolphins are most likely to rest and forage, and whether these behaviours occur frequently within Ticonderoga Bay Sanctuary Zone, the only protected area designated for dolphins within Port Phillip Bay. To that end, a comprehensive activity budget for Burrunan dolphins was established and critical habitat identified. Behavioural data were collected from 51 independent dolphin groups during 67 boat-based surveys conducted in southern Port Phillip Bay between December 2009 and May 2013. Travel (63.9%) and rest (1.8%) were the most and least frequently observed behaviours, respectively. Foraging (16.4%), mill (10.8%) and social (7.2%) accounted for the remainder of the activity budget. Results indicate that Port Phillip Bay is important for foraging dolphins and nursing groups, with Ticonderoga Bay Sanctuary Zone of proven importance for foraging dolphins. Three candidate Marine Protected Areas were objectively identified in areas that are hotspots for foraging Burrunan dolphins in southern Port Phillip Bay. The findings of this study will be used to inform current conservation management strategies. If implemented, the aim of the proposed Marine Protected Areas will be to reduce impacts from anthropogenic disturbance, namely dolphin-swim tour vessels.

3.2 Introduction

Coastal cetaceans are exposed to a variety of anthropogenic threats, such as competition with fisheries (e.g. Bearzi et al., 2008; Hamer et al., 2008), exposure to tourism (e.g. Higham et al., 2014; Peters et al., 2013), marine pollution (e.g. Gui et al., 2014; Law et al., 2012) and vessel strike (e.g. Dwyer et al., 2014; Laist et al., 2001), making them vulnerable to population declines (Higham et al., 2008; Lusseau & Bejder, 2007). Marine protected areas (MPAs), defined by the International Union for Conservation of Nature as 'any area of

intertidal or sub-tidal terrain, together with its overlying water and associated flora and fauna, which has been reserved by law or other effective means to protect part or all of the enclosed environment' (Kelleher, 1999), have been developed as a tool to help protect species from these anthropogenic risks (Agardy, 1994). MPAs may also be referred to as marine parks, sanctuaries, reserves or closures, and are established for the long-term conservation of a species (Hoyt, 2012). However, designation of MPAs for marine mammals can present particular difficulties given the large home ranges of many species (Hyrenbach et al., 2000; Wilson et al., 2004). Previous research indicates that behavioural observations are required to determine the full extent of the importance of an area to a population, and whether it is indeed an area that requires protection (Lusseau & Higham, 2004).

Critical habitat has been identified as those parts of a species range that are essential for survival and maintaining a healthy population growth, and includes areas that are regularly used for feeding, breeding and resting (Hoyt, 2012). Understanding behavioural patterns and a population's use of different areas is key to effective animal conservation (Tyne et al., 2015). In the absence of this information, habitats can be under or over protected, as areas of high animal abundance does not necessarily constitute critical habitat (Hooker et al., 2011). Therefore, identification of critical areas for core biological activities (e.g. resting, nursing and/or feeding) of a population are essential when implementing MPAs and monitoring their efficiency as a management tool (Ashe et al., 2010; Hyrenbach et al., 2000). However, MPAs are often established without the necessary empirical data, with minimal published data available to examine their efficacy (Gormley et al., 2012; Hartel et al., 2014).

The sensitivity of dolphins to specific impacts (i.e. commercial dolphin-swim tourism) is known to be dependent upon behaviour (Lusseau, 2003a; Meissner et al., 2015). A long-term study undertaken across 15 years in Port Phillip Bay (PPB) revealed that Burrunan dolphins (*Tursiops australis*) responses to tour vessels was highly dependent upon their initial behavioural state, with groups being more sensitive to interactions when resting (Chapter Four; Filby et al., 2014). Further, research examining the effects of tourism on PPB Burrunan

dolphins revealed that for foraging groups, the duration of bouts, recovery time and the total amount of time spent foraging, substantially decreased when tour vessels were present (Chapter Five). These results suggest that minimising tour vessel interactions with Burrunan dolphins during these two behavioural states may be an important aspect in managing this population. The aim of the present chapter was to identify areas within PPB where dolphins are most likely to rest and forage, and to establish the appropriateness of the location of Ticonderoga Bay Sanctuary Zone (TBSZ). That is, was the implementation of TBSZ a correct management decision and does it currently provide a sanctuary area where dolphins frequently exhibit critical behaviours such as resting and foraging?

Ticonderoga Bay Sanctuary Zone was established in 1996 and aims to provide an area of 'respite' and 'refuge' from anthropogenic stress, including commercial dolphin-swim tourism, for Burrunan dolphins resident within PPB (Hale, 2002; personal communication, Dolphin Research Institute (DRI); Wildlife (Marine Mammal) Regulations, 2009). TBSZ is a small (~ 2000 m²) sanctuary zone that expands 250 m offshore from Point Nepean to Police Point (Figure 3.1). However, implementation of TBSZ was not based on scientific data on how the dolphins utilise this area, but instead proposed by a non-government organization (DRI) based on the high frequency of anecdotal dolphin observations in this area. Unfortunately, such information alone does not reveal whether TBSZ is of critical importance to this population, in terms of usefulness for core biological activities and whether this site warrants protection over other sites in PPB.

In order to assess the effectiveness of TBSZ as a management tool for this population of dolphins, an activity budget for this species in this region is required. However, given that the Burrunan dolphin is a newly described species, there is a paucity of behavioural data available for it (e.g. Chapter Four; Filby et al., 2014; Scarpaci et al., 2010a). The little that is known originates from land-based surveys conducted in a restricted, inshore area of the populations range within PPB, which examined only travel, forage and social behaviours (Scarpaci et al., 2010a). Burrunan dolphins are endemic to Australia and are recognised as threatened under the Victorian Flora and Fauna

Guarantee Act, 1988. Currently, only two resident populations have been identified: one in PPB, Victoria and the other in Gippsland Lakes, Victoria (Charlton-Robb et al., 2015). The PPB population is considered vulnerable to extinction due to its small size (approximately 80 - 100 individuals, Charlton-Robb et al., 2015; Hale, 2002; Warren-Smith & Dunn, 2006), genetic distinctiveness (Charlton-Robb et al., 2011; Charlton-Robb et al., 2015), restricted home range (Hale, 2002), exposure to anthropogenic pollution (Monk et al., 2014) and female natal philopatry (Hale, 2002). Burrunan dolphins within PPB display high site fidelity, using the southern coastal waters all year round (Scarpaci et al., 2000b; Scarpaci et al., 2003). Their coastal distribution (Charlton-Robb et al., 2011; Peters et al., 2013) increases their risk of exposure to a number of threats, including exposure to a non-compliant commercial dolphin-swim industry (Chapter Two; Filby et al., 2015; Scarpaci et al., 2004) and vessel strike (Dunn et al., 2001).

Herein, a comprehensive activity budget for Burrunan dolphins in PPB is described for the first time, giving an understanding of the potential importance of PPB waters for this genetically isolated and threatened population. The behaviour of Burrunan dolphins was assessed in relation to diel, season, year, water depth, sea surface temperature (SST), tide, group size and group composition. The proportion of time dolphins spent devoted to key activity states (forage, travel, social, mill, rest) was examined. Using data obtained from the activity budget, this study assessed locations within southern PPB where Burrunan dolphins are more likely to rest and forage in order to provide critical insights into the effectiveness of TBSZ and how the dolphins utilise PPB.

3.3 Materials and methods

3.3.1 Study site

The study area consisted of an approximately 270 km² region in the southern end of PPB (144 50' 00.0 E, 38 05' 00.0 S), on the south-eastern coast of Victoria, Australia (Figure 3.1). For the purpose of this study, behavioural surveys focused on the southern section of PPB, due to the known distribution

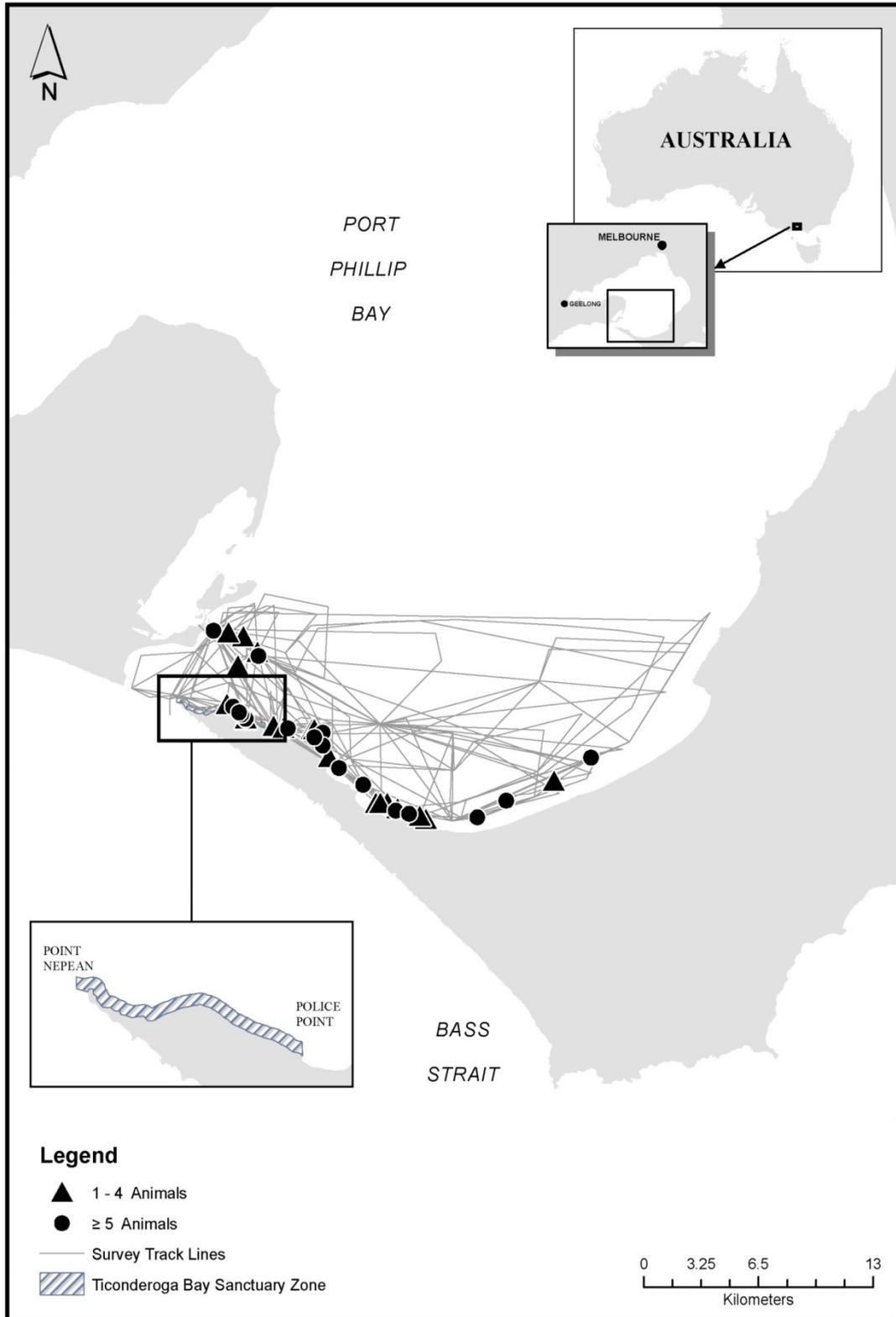


Figure 3.1 Location of study area within southern Port Phillip Bay, Victoria, Australia, with vessel tracks and locations where Burruran dolphin (*Tursiops australis*) groups were initially sighted.

of this species (Scarpaci et al., 2003; Scarpaci et al., 2004; Scarpaci et al., 2010a). PPB is a 1,940 km² shallow water (mean depth = 13.6 m) marine embayment, opening into Bass Strait at its southern end. The bay has a gentle bathymetric slope, except along the south-east coast where the gradient is steeper (CSIRO, 1996). Within the bay there are extensive shallow seabed banks (< 4.0 m depth) which are surrounded by deeper waters (6.0 - 20.0 m).

3.3.2 Data collection

Behavioural observations of dolphins in PPB were conducted between December 2009 and May 2013 from on-board the research vessel, *Pelagia*, a 6.5 m platform, powered by two 100-horsepower, four-stroke Yamaha engines. Survey effort was biased to within 1.5 km from land (never extending beyond 13 km) in order to maximise the potential for encountering dolphins (Scarpaci, 2000). During each individual survey, effort was made to traverse the width of southern PPB in order to cover both eastern and western regions homogeneously. In over 90% of surveys, the 250 m width of TBSZ was fully traversed. Dolphins were easily observed if present within this region.

While the focus of this study was not to determine dolphin distribution, a concerted effort was made to ensure that surveys were conducted in all austral seasons and diel categories, and that the full range of water depths and distances from land were surveyed, in order to exclude any spatial or temporal variation affecting interpretation of habitat use. Only surveys conducted in sea states of Beaufort 3 or less were used in the analysis.

Whilst searching for dolphins the research vessel travelled at a speed of ~ 10 knots. Observations with the naked eye were conducted by a minimum of two experienced observers who continuously scanned 180° of the sea surface in front of the research vessel in search of dolphins (Frantzis & Herzing, 2002; Mann, 1999). Observations of seabirds were used in addition to surface activity of dolphins (e.g. aerial displays, tail slaps and spy hops) to locate dolphin groups (Filby et al., 2010). Once dolphins were detected, the research vessel

slowed to an approach speed (~ 2 – 4 knots) and time, GPS coordinates, behavioural data, group size and composition and vessels present were recorded. Prey species taken by dolphins was noted opportunistically when observed during surveys. Environmental parameters (i.e. water depth, SST, sea state and tide) were also noted. GPS co-ordinates of dolphin groups were recorded using a Raymarine SL72 tracker. Distance from land for each observation was calculated using the Near Tool in ArcGIS software (V10.2. ESRI). Water depth (m) and SST (°C) was recorded using a Lowrance HDS5x Depth Sounder.

During behavioural sampling, focal group follows were conducted, with behaviour assessed via 3 min instantaneous scan sampling and continuous observations of the group's predominant behaviour (Altmann, 1974; Mann, 1999). The predominant behaviour was determined as the behavioural state in which more than 50% of the animals were involved (Stockin et al., 2008; Stockin et al., 2009). Five behavioural states were identified (Table 3.1), modified from the definitions used by Filby et al., (2013) and Scarpaci et al., (2010). These behavioural states were mutually exclusive and, collectively, effectively described the entire behavioural repertoire of the dolphins observed.

A group was defined as any number of animals observed within 5 body lengths of any other dolphin, moving in the same direction and engaged in the same activity (Shane, 1990). The perimeter of the group was established via the use of a 10 m-chain rule between members (Smolker et al., 1992). A group could consist of one or more different age classes including: 1) adult (i.e. apparently fully grown individuals; > 2 m); 2) juvenile (i.e. approximately two-thirds the length of an adult and not travelling in the echelon position alongside an adult); 3) calf (i.e. approximately half the length of an adult, and still travelling in the echelon position alongside an adult, presumed to be its mother, Figure 3.2) and 4) neonate (i.e. young calves still displaying foetal folds, a flaccid dorsal fin and extreme buoyancy when surfacing, Figure 3.3) (Charlton-Robb et al., 2011).

Table 3.1 Behavioural states recorded between 2009 and 2013 for Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Victoria, Australia (modified from Filby et al., 2013 and Scarpaci et al., 2010a).

<i>State</i>	<i>Definition</i>
Travel	Dolphins engaged in consistent, directional movement, making noticeable headway along a specific compass bearing, with regular dive intervals
Forage	Dolphins involved in any effort to pursue, capture and/or consume prey, as defined by observations of two or more of the following: fish chasing; erratic movements at the surface; multi-directional diving; coordinated deep diving and rapid circle swimming. Prey often observed at the surface
Mill	Dolphins exhibited non-directional movement. Frequent changes in bearing prevented dolphins from making headway in any specific direction
Rest	Dolphins observed in a tight group (< 1 body length between individuals), engaged in slow manoeuvres (slower than the idle speed of the observing boat) with little evidence of forward propulsion. Surfacing slow and more predictable than observed in other behavioural states
Social	Dolphins observed chasing, copulating and/or engaged in any other physical contact with other group members, such as rubbing and touching. Aerial behaviours such as breaching frequently observed



Figure 3.2 Burrunan dolphin (*Tursiops australis*) calf travelling in the echelon position alongside its presumed mother in Port Phillip Bay, Australia. Photo: Author



Figure 3.3 Burrunan dolphin (*Tursiops australis*) neonate alongside its presumed mother in Port Phillip Bay, Australia. Note: pale foetal fold lines evident along the thorax of the neonate, indicated by arrows. Photo: Author

The research vessel remained with the larger group when a fission event occurred, as larger groups were easier to follow. Focal follows ended when animals were lost (10 min elapsed without a sighting), when sea conditions deteriorated or when daylight hours ended and thus the end of a follow was not dependent upon the behaviour of the focal group (Ingram & Rogan, 2002). An interaction with a dolphin group was defined as an encounter, the period during which the research vessel was within 300 m of the group (Ingram & Rogan, 2002). Each 3 min scan was defined as an observation.

The research vessel remained with the focal group and was manoeuvred in a consistent manner to minimise the potential impacts associated with the boat, following dolphins at a distance of approximately 100 m (Degradi et al., 2008). All behavioural data was collected by the author (NF) so that observations between focal groups were standardised. When more than one independent focal group was encountered during a survey, focal groups were considered independent only if separated spatially to a degree that would prevent individuals becoming resampled during a second focal follow (> 5 km) and when subsequent photo identification analysis revealed no matches between the respective focal group members.

3.3.3 Data analysis

Observations when other vessels (e.g. tour, recreation, commercial) were within 300 m of the focal group were discarded from the analyses. Hence, only observations that occurred in the presence of the research vessel were used. Following this, diurnal and seasonal patterns in activity budget and relationships with environmental variables (i.e. water depth, SST, distance from land, sea state and tide) were investigated. Finally, relationships between behaviour and group size and composition were examined.

Diurnal patterns were segregated into three categories: morning (08.00 - 10.59); midday (11.00 - 13.59); and afternoon (14.00 - 16.59). Data collected from different years were classified as: 2011; 2012; and 2013. Tidal state was investigated by assigning each observation to one of three categories: flood (in-

coming time); slack (15 – 20 min of slack water between high and low tides); or ebb (out-going tide). To analyse seasonal affects, groups were classified as having occurred during the austral seasons: spring (September – November); summer (December – February); autumn (March – May) and winter (June – August). Group composition was categorised as either calves absent (i.e. only adults and/or juveniles present) or calves present (i.e. adults and/or juveniles and calves and/or neonates, present). Water depth, SST, distance from land and group size were analysed as continuous raw data.

Statistical analysis was conducted using SPSS 20. The distributions of continuous variables (water depth, distance from land, SST and group size) were tested for normality and homogeneity (Zar, 1996). Distribution of data was non-normal; hence the non-parametric Kruskal–Wallis test was applied to the dataset, to examine whether behaviour was influenced by: water depth; SST; distance from land or group size. Kruskal–Wallis analyses were also used to assess whether group size, water depth or distance from land varied with season. A series of *post hoc* (Bonferroni correction for multiple comparisons) was run when applicable, with adjusted alpha levels of 0.005. Mann Whitney *U* tests were applied to compare group size and group composition. The relationship between group size and water depth was investigated using Spearman’s Rank Order correlation coefficient. Pearson’s chi-squared tests were used to assess relationships between behaviour and: diel; season; year; tide and group composition. Results were considered statistically significant at the $p \leq 0.05$ level.

3.3.4 Spatial analysis of behaviour

To determine ‘critical’ and ‘important’ regions within PPB for resting and foraging groups, GPS co-ordinates, date, time and behavioural state for each 3 min observation were entered into a Geographic Information System (GIS) using ArcGIS. These observations were subsequently plotted. Using the Grid Index Features Tool within ArcGIS, the PPB study area was divided into 1887 grid cells (500 m x 500 m) and each observation was assigned to the corresponding grid cell. Relative to the small size of TBSZ (250 m wide), a 500

m² grid cell was selected. The size of grid cells was determined so that the number of sightings in each cell was maximised, as was the number of cells that contained sightings, whilst still enabling a detailed partitioning of PPB to be provided.

Following Lusseau and Higham (2004), the number of observations in which dolphins were resting or foraging in each grid cell was standardised by the total number of sightings in each cell. Thus, the percentage of time that dolphins spent resting and foraging in each cell was calculated in order to give an understanding of the areas in which these two behaviours most frequently occurred, and whether these areas were within TBSZ. Cells were defined as either 'no resting/foraging observed', 'resting/foraging observed', 'important for resting/foraging' or 'critical' for resting/foraging'. The population's overall activity budget was used to set the percentage levels for how 'important' and 'critical' were defined for biologically important processes, i.e. resting and foraging (Lusseau & Higham, 2004). Based on Lusseau and Higham (2004), the activity budget of Burrunan dolphins (detailed below in section '3.4.2 Activity budget') was used to set the percentage levels for how 'important' and 'critical' were defined for resting and foraging dolphins. Thus, if more than 1.8% of observations in a grid cell were of resting dolphins, then the cell was deemed as 'important' for resting dolphins. If 3.6% or more of observations in a grid cell were of resting dolphins, the cell was defined as 'critical' for resting dolphins. For foraging, if greater than 16.4% of sightings in a cell were of foraging dolphins, the cell was defined as 'important' for foraging dolphins. If 32.8% or more of observations in a grid cell were of foraging dolphins, the cell was defined as 'critical' for foraging dolphins. These 'important' and 'critical' values are biologically significant because they are based upon the activity budget of this population of dolphins.

3.4 Results

3.4.1 Field effort

Between December 2009 and May 2013, 388 hours and 45 mins of survey effort were conducted during 67 independent boat-based surveys. Dolphins were encountered on 49.3% ($n = 33$) of trips, with behaviour recorded for 51 independent Burrunan dolphin group encounters over 66 hours and 38 mins. This resulted in 1,058, 3 min scan samples (hereafter referred to as observations) (Figure 3.4). Due to weather constraints, greatest effort occurred during summer (34.3%, $n = 23$), spring (31.3%, $n = 21$) and autumn (26.9%, $n = 18$), with low effort over winter (7.5%, $n = 5$). The majority of observations occurred during sea states of \leq Beaufort 1 (73.1%, $n = 774$).

3.4.2 Activity budget

Travel (63.9%; $n = 676$) was the most frequently recorded behavioural state, followed by forage (16.4%; $n = 173$). Mill behaviour was documented for 10.8% ($n = 114$) of observations. Rest (1.8%; $n = 19$) and social (7.2%; $n = 76$) were the behaviours least observed. During surveys, Burrunan dolphins were observed eating garfish (*Hyporhamphus melanochir*), squid (*Sepioteuthis australis*), snapper (*Pagrus auratus*) and barracouta (*Thyrsites atun*) (personal observation).

3.4.3 Temporal variation

Diurnal differences in dolphin behaviour were detected in 2011 ($\chi^2(8) = 25.45$, $p = 0.001$), 2012 ($\chi^2(8) = 27.96$, $p < 0.001$) and 2013 ($\chi^2(8) = 26.58$, $p = 0.001$). Travel was the behaviour observed most frequently in all diel categories except for 2013 during the morning, when milling was the behaviour most observed (Figure 3.5). During each year, groups milled infrequently during the afternoons (Figure 3.5). In all years, the majority of observations occurred at midday (2011: 64.7%, $n = 323$; 2012: 72.7%, $n = 229$; 2013: 78.6%, $n = 165$) with the lowest number of observations recorded during afternoons (2011: 14.4%, $n = 72$; 2012: 11.1%, $n = 35$; 2013: 6.7%, $n = 14$).

Winter scans were discounted from analyses examining behavioural variation across seasons due to small sample size. Subsequent analyses revealed that seasonal variation in behaviour was evident ($\chi^2(8) = 50.55, p < 0.001$), with foraging most prevalent during summer (40.2%, $n = 47$, Figure 3.6). Socialising groups were observed 43.4% ($n = 33$) of the time in spring and remained prevalent in summer/autumn, accounting for 56.6% ($n = 43$) of observations.

Data from 2009 and 2010 were excluded from analyses determining behavioural variation across years, due to the small sample size violating assumptions. Subsequent analyses revealed Burrunan dolphins' behaviour varied significantly from 2011 to 2013 ($\chi^2(8) = 164.98, p < 0.001$). Within behaviours, there was a decrease in the frequency of observed travelling, foraging and socialising groups from 2011 (46.5%, $n = 301$, 74.0%, $n = 128$ and 55.4%, $n = 41$, respectively) to 2013 (17.9%, $n = 116$, 2.9%, $n = 5$ and 28.4%, $n = 21$, respectively). Conversely, there was an increase in the amount of milling documented from 2011 (25.5%, $n = 28$) to 2013 (55.5%, $n = 61$). Due to the difference detected in behaviour across years, further analyses were conducted independently for the 2011, 2012 and 2013 datasets.

3.4.4 Environmental variation

Dolphin behaviour varied significantly with tidal state in 2011 and 2012 (Table 3.2), with the proportion of milling (2011: 7.1%, $n = 22$; 2012: 11.0%, $n = 19$; 2013: 30.7%, $n = 59$) and resting groups (2012: 5.2%, $n = 9$; 2013: 10.9%, $n = 21$) greatest during ebb tides. During each year, the majority of observations occurred during ebb tides (2011: 62.3%, $n = 311$; 2012: 54.9%, $n = 173$; 2013: 91.4%, $n = 192$). Dolphin groups were observed in water depths ranging from 1.9 – 19.6 m (mean = 9.64, SD = 3.99) however dolphin behavioural state was not influenced by water depth during any year (Table 3.2). Dolphins were observed in SST ranging from 8.8 to 22.3°C (mean = 17.22, SD = 2.87).

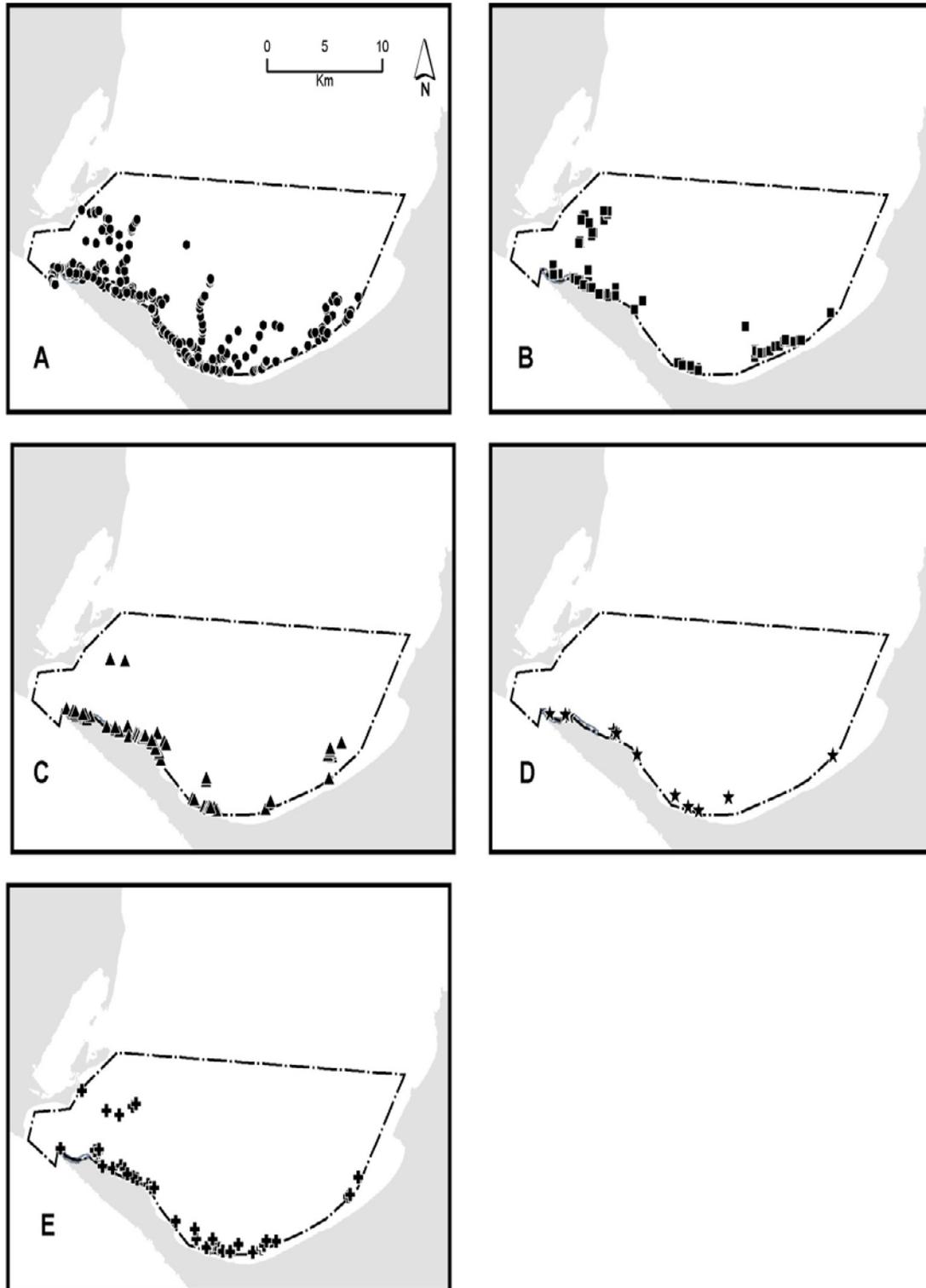


Figure 3.4 Behavioural observations of Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Australia, between 2009 and 2013 ($n = 1058$): A) Travel; B) Forage; C) Mill; D) Rest; and E) Social. Dashed line denotes study area, with scale and orientation same as depicted in A) for all figures.

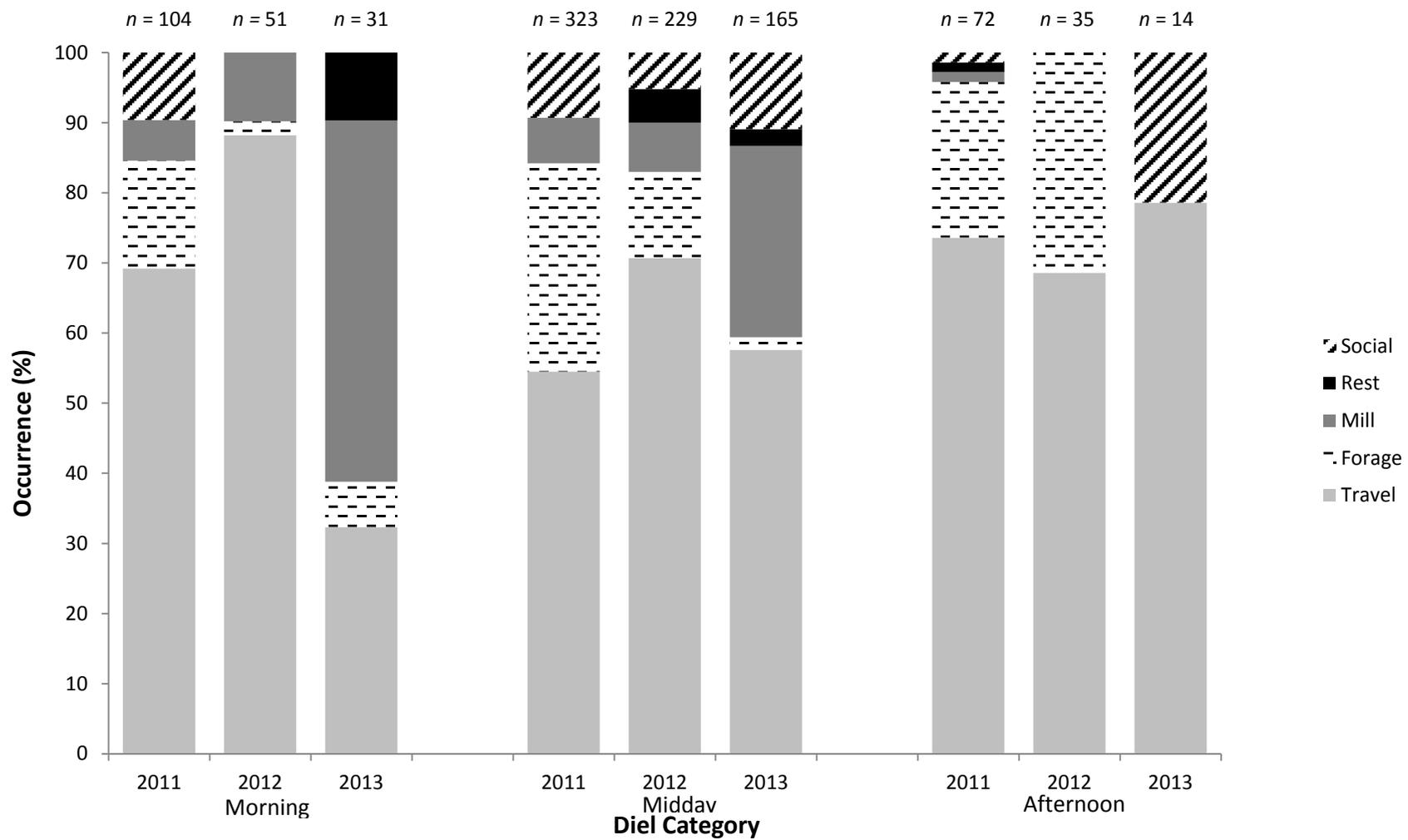


Figure 3.5 Activity budget by diel category for Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Australia for 2011, 2012 and 2013.

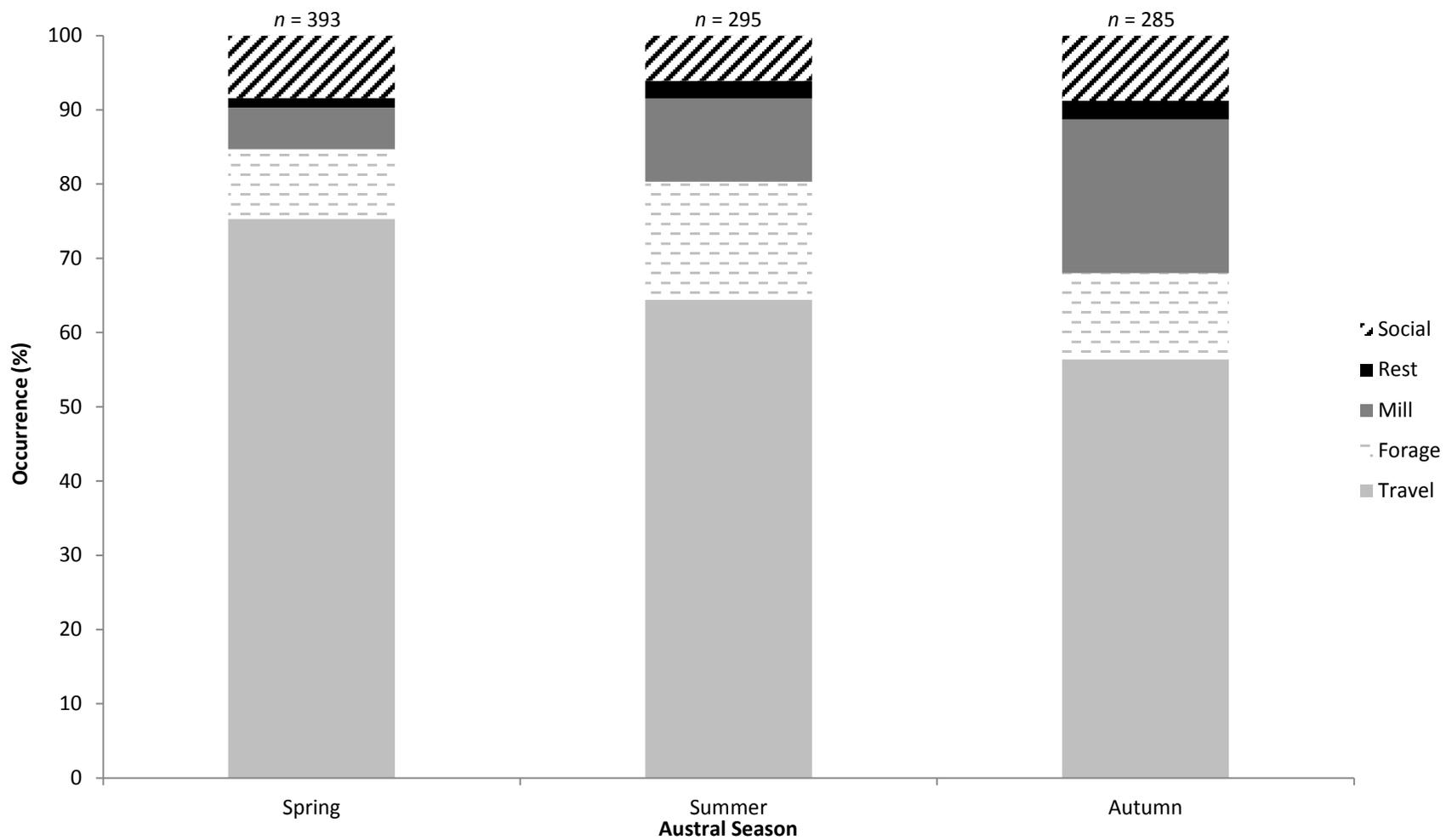


Figure 3.6 Seasonal activity budget for Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Australia, between 2009 and 2013.

Travelling and foraging groups were observed in the most diverse ranges of SST (8.8 to 22.3°C and 8.8 to 21.3°C, respectively). Dolphins' behaviour significantly varied with SST during 2011, 2012 and 2013 (Table 3.2). However, *post hoc* analyses revealed no trends that were significant across all years (Tables 3.3 and 3.4).

Burrunan dolphins were sighted at distances from land within PPB ranging from 0.03 to 5.50 km (mean = 1.06, SD = 0.97). On average, resting groups were observed closest to shore (mean = 0.62, SD = 0.38) and foraging groups furthest from shore (1.38, SD = 1.03). In all years, dolphin behaviour varied significantly as distance from land changed (Table 3.2). In 2011 and 2012, foraging groups were recorded significantly further from shore than milling groups (Tables 3.5 and 3.6). Further, foraging groups were observed significantly further from shore than travelling or resting groups in 2012 (Tables 3.5 and 3.6). In 2012, resting groups were found significantly closer to shore than socialising groups (Tables 3.5 and 3.6). Across all years, the distance from land where dolphins were observed significantly fluctuated across seasons ($H(3) = 97.36, p < 0.001$). Observations of dolphins closest to shore occurred in autumn (mean = 0.80, SD = 0.90), while dolphins were sighted in distances furthest from land during the winter months (mean = 1.36, SD = 0.60)

3.4.5 Group size and composition

Burrunan dolphins were observed in small groups ranging from 1 - 26 individuals (median = 5, SD = 4.59, \pm SE = 0.14), with most groups (52.9%, $n = 560$) encountered containing ≤ 5 animals (Figure 3.7). Calves were absent during 56.4% of observations ($n = 597$). In all years, dolphin behaviour varied significantly with group size (2011: $H(4) = 15.64, p = 0.004$; 2012: $H(4) = 16.13, p = 0.003$; 2013: $H(4) = 42.37, p < 0.001$). In 2011, socialising groups were significantly larger than travelling groups (Tables 3.7 and 3.8). In 2012, foraging groups were significantly larger than travelling groups (Tables 3.7 and 3.8). In 2013 resting dolphins were observed in significantly smaller groups than travelling or socialising groups (Tables 3.7 and 3.8). Further, in 2013 milling

groups were reported in significantly smaller groups than travelling or socialising groups (Tables 3.7 and 3.8).

Across all years, there was a small negative correlation between group size and water depth ($r_s(1058) = -0.18, p < 0.001$), with larger groups associated with shallower waters, and smaller groups associated with deeper waters. Across all years, group size varied significantly by season, $H(3) = 129.41, p < 0.001$, with largest dolphin groups observed in autumn (mean = 8.78, SD = 5.81) and spring (mean = 7.67, SD = 3.92).

Group size (comparing only the number of adults within groups) was significantly higher ($U = 78407.00, p < 0.001$), in groups containing calves and/or neonates (mean group size = 6.11, SD = 3.29, $n = 461$) than groups without calves and/or neonates (mean group size = 3.80, SD = 2.16, $n = 597$). Thus, groups with calves and/or neonates were, on average, twice the size of groups with only adults or adults and juveniles present. Dolphin behaviour varied significantly with group composition in 2011, 2012 and 2013 ($\chi^2(4) = 13.99, p = 0.007, \chi^2(4) = 28.41, p < 0.001, \chi^2(4) = 22.02, p < 0.001$, respectively). Across all years, the proportion of foraging groups was greatest when calves were present (2011: 28.7%, $n = 81$; 2012: 26.7%, $n = 23$; and 2013: 4.3%, $n = 3$).

Table 3.2 Summary of analyses between dolphin behaviour and environmental variables (tide, water depth, sea surface temperature and distance from land). * Indicates significance at $p < 0.05$.

	2011	2012	2013
Tide	$\chi^2(8) = 104.77^*$	$\chi^2(8) = 40.82^*$	$\chi^2(8) = 9.33$
Water Depth	$H(4) = 3.09$	$H(4) = 6.13$	$H(4) = 5.90$
SST	$H(4) = 46.40^*$	$H(4) = 26.19^*$	$H(4) = 24.21^*$
Distance from Land	$H(4) = 15.33^*$	$H(4) = 30.62^*$	$H(4) = 41.52^*$

Table 3.3 Mean sea surface temperature (°C) and standard deviations for behaviours across 2011, 2012 and 2013 for dolphin sightings in Port Phillip Bay, Australia.

	2011		2012		2013	
	Mean	SD	Mean	SD	Mean	SD
Travel	17.25	2.96	16.59	1.97	19.14	2.32
Forage	14.93	4.32	18.28	1.72	17.18	0.99
Mill	18.09	1.53	16.68	1.07	17.98	1.91
Rest	19.80	0.01	17.47	1.64	16.61	0.88
Social	18.77	1.38	18.43	3.28	18.36	2.35

Table 3.4 *Post hoc* comparisons for behaviour and sea surface temperature (°C) for dolphin sightings between 2011 and 2013 in Port Phillip Bay, Australia. Kruskal-Wallis *H* value shown. * *Indicates significance at p < 0.005.*

		2011	2012	2013
Travel	vs Forage	23.443*	19.162*	4.222
	vs Mill	1.175	0.066	14.245*
	vs Rest	1.427	3.128	9.993*
	vs Social	15.221*	5.973	1.728
Forage	vs Mill	12.861*	10.071*	0.576
	vs Rest	1.282	1.743	1.087
	vs Social	27.578*	2.171	0.995
Mill	vs Rest	1.466	1.485	3.973
	vs Social	5.787	3.212	0.940
Rest	vs Social	0.777	1.133	5.446

Table 3.5 Mean distance from land (km) and standard deviations for behaviours across 2011, 2012 and 2013 for dolphin sightings in Port Phillip Bay, Australia.

	2011		2012		2013	
	Mean	SD	Mean	SD	Mean	SD
Travel	0.97	0.86	1.13	1.02	1.48	1.18
Forage	1.22	0.92	2.05	1.12	0.33	0.17
Mill	0.69	0.74	0.90	0.61	0.63	0.60
Rest	1.79	0.01	0.57	0.34	0.53	0.01
Social	0.75	0.52	1.51	0.76	0.87	1.05

Table 3.6 *Post hoc* comparisons for behaviour and distance from land (km) for dolphin sightings between 2011 and 2013 in Port Phillip Bay, Australia. Kruskal-Wallis *H* value shown. * *Indicates significance at $p < 0.005$.*

		2011	2012	2013
Travel	vs Forage	6.456	18.215*	7.341
	vs Mill	4.598	0.761	33.357*
	vs Rest	1.419	5.774	1.253
	vs Social	0.102	4.226	7.756
Forage	vs Mill	8.588*	11.687*	2.015
	vs Rest	0.884	15.498*	5.852
	vs Social	6.964	3.128	1.618
Mill	vs Rest	2.068	4.772	4.723
	vs Social	2.846	5.065	1.724
Rest	vs Social	2.590	8.301*	2.812

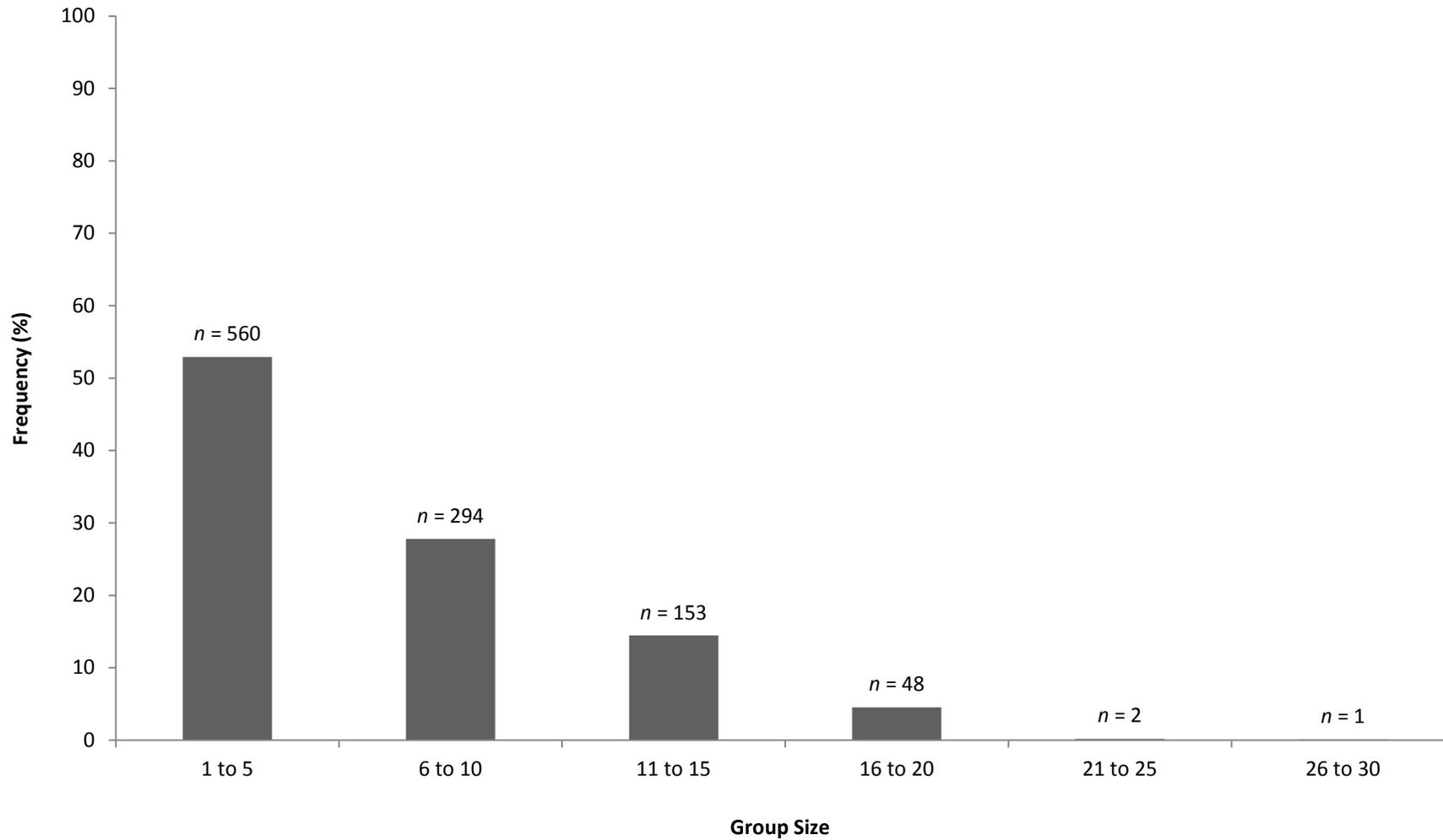


Figure 3.7 Group size of Burrunan dolphins (*Tursiops australis*) from 2011 – 2013 in Port Phillip Bay, Australia.

Table 3.7 Mean dolphin group size and standard deviations for behaviours across 2011, 2012 and 2013 in Port Phillip Bay, Australia.

	2011		2012		2013	
	Mean	SD	Mean	SD	Mean	SD
Travel	5.91	4.12	6.53	3.63	8.22	6.23
Forage	7.21	5.30	10.08	5.46	11.20	6.57
Mill	6.21	3.25	7.71	4.51	4.28	1.25
Rest	10.00	0.01	8.18	4.24	3.29	0.95
Social	7.76	3.27	7.00	2.22	10.24	5.85

Table 3.8 *Post hoc* comparisons for behaviour and dolphin group size between 2011 and 2013 in Port Phillip Bay, Australia. Kruskal-Wallis *H* value shown.

* Indicates significance at $p < 0.005$.

		2011	2012	2013
Travel	vs Forage	2.615	13.734*	0.408
	vs Mill	0.575	1.314	20.881*
	vs Rest	1.526	1.392	9.677*
	vs Social	15.819*	0.842	4.963
Forage	vs Mill	0.130	4.621	5.467
	vs Rest	0.308	2.586	5.588
	vs Social	1.834	2.693	0.000
Mill	vs Rest	1.481	0.032	4.125
	vs Social	6.663	0.385	28.964*
Rest	vs Social	1.032	0.616	13.231*

3.4.6 Spatial analysis of behaviour

Of the 1058 observations, resting and foraging accounted for 1.8% ($n = 19$) and 16.4% ($n = 173$), respectively. Ten grid cells could be classified as 'critical' for resting (Figure 3.8), although in the majority ($n = 7$) of these cells only one observation was recorded. One cell had 5 or more observations of resting dolphins and this was within TBSZ (denoted with a ☆, Figure 3.8). Twenty percent of 'critical' cells for resting dolphins ($n = 2$) occurred within TBSZ. For foraging dolphins, 22 grid cells were deemed 'critical', while 9 cells were found to be 'important' for foraging (Figure 3.9). Of these cells deemed 'critical' for foraging dolphins, 4.5% ($n = 1$) occurred within TBSZ, whereas almost half (44.4%, $n = 4$) of cells that were defined as 'important' for foraging dolphins occurred within TBSZ. Six of the 22 (27.3%) 'critical' grid cells, and 1 of the 9 (11.1%) 'important' cells for foraging had 5 or more observations (denoted with a ☆, Figure 3.9). Of these, 7 foraging 'critical' and 'important' cells with greater than 5 observations, 28.6% ($n = 2$) fell within TBSZ. Only one grid cell was 'important'/'critical' for resting and foraging and this is represented with a † in Figures 3.8 and 3.9.

3.5 Discussion

3.5.1 Activity Budget

Effective conservation of a population requires understanding spatial and temporal fluctuations in behaviour as this provides insight into how the population uses its environment (Ashe et al., 2010; Burlakova et al., 2011; Tyne et al., 2015). The activity budget presented here provides current data to support long-term effective management of TBSZ and other MPAs in PPB for the Burrunan dolphin conservation.

Behavioural data presented here reveal that travel and forage are the most prevalent behavioural states, accounting for 63.9% and 16.4% of the activity budget for PPB Burrunan dolphins, respectively. Scarpaci et al., (2010) documented feeding occurring in 32% of behavioural observations for the same population. Simply, it could be concluded that the proportion of time this

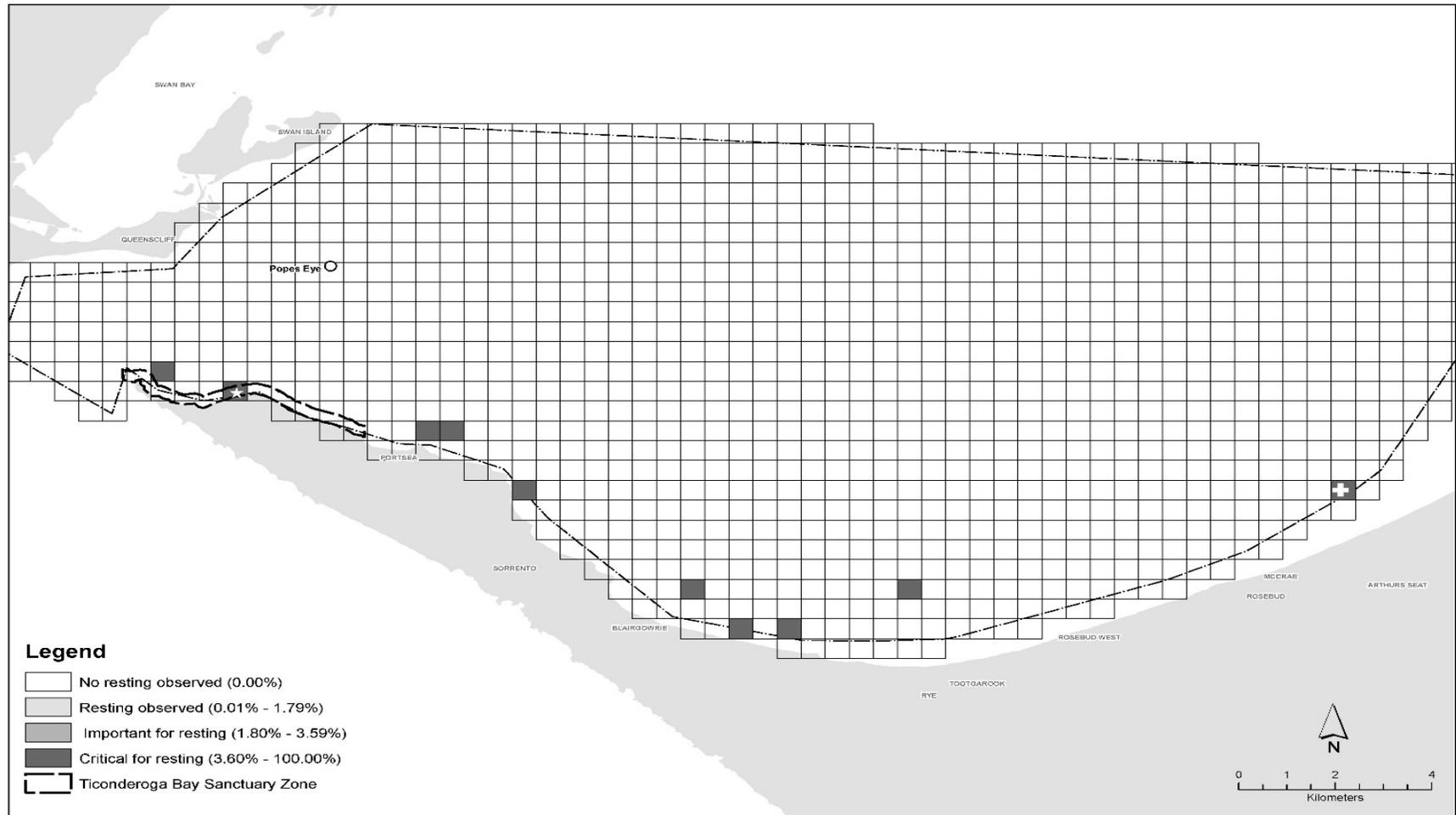


Figure 3.8 Study area with 500 m² grid cells overlaid, with observations of Burrunan dolphins (*Tursiops australis*) resting (☆ = grid cell had ≥ 5 observations of resting dolphins. ⊕ represents grid cell 'important'/'critical' for resting and foraging)

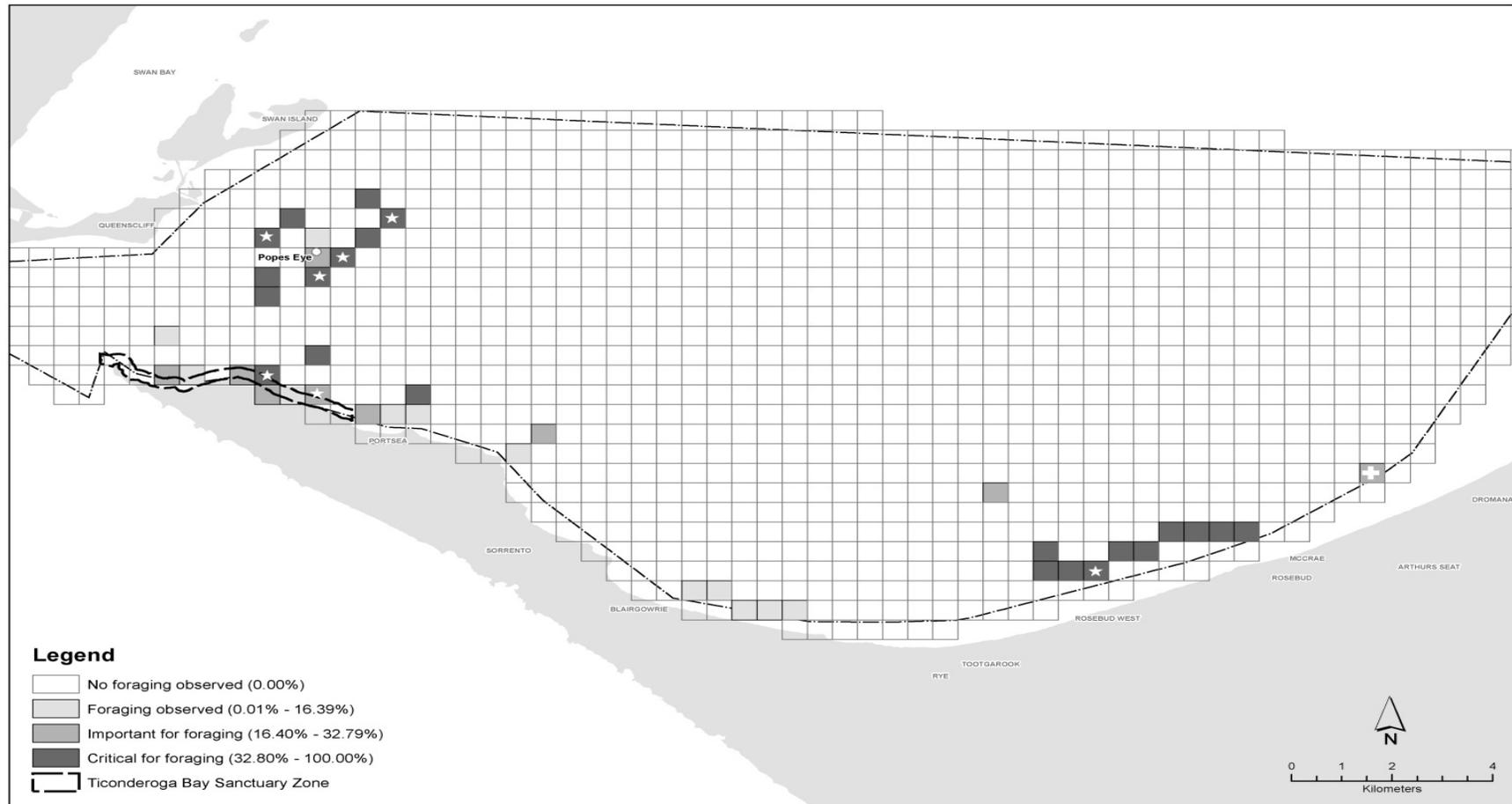


Figure 3.9 Study area with 500 m² grid cells overlaid, with observations of Burruran dolphins (*Tursiops australis*) foraging (☆ = grid cell had ≥ 5 observations of foraging dolphins. ⊕ represents grid cell 'important'/'critical' for resting and foraging).

population spends foraging has decreased over time. However caution needs to be exercised when inferring biological significance, as research methodology must be accounted for. Time dolphins spent foraging in the present study falls within the range found for other *Tursiops* spp., with most reports stating that the proportion of time engaged in foraging ranges from 13 – 28% (Arcangeli & Crosti, 2009; Bearzi, 2005; Chilvers, 2001; Hanson & Defran, 1993; Jones & Sayigh, 2002; Lusseau, 2003a; Peters et al., 2013; Shane, 1990; Steckenreuter et al., 2012). The amount of foraging documented in this study is potentially an under-estimate, as Burrunan dolphins may be engaging in nocturnal foraging bouts, as has been reported occurring for numerous delphinid species (e.g. Díaz López & Bernal Shirai, 2006; Elwen et al., 2009; Miller et al., 2010; Soldevilla et al., 2010). Further, the high proportion of time that dolphins spent travelling could be in search of scattered prey patches (Ashe et al., 2010; Dans et al., 2012; Neumann, 2001). Information regarding the diet of Burrunan dolphins is limited, although Burrunan dolphins were observed to feed on garfish, squid, snapper and barracouta during this study. Further, stomach contents of stranded dolphins in PPB suggest Australian salmon (*Arripis truttaceus*) and King George whiting (*Sillaginodes punctatus*) occur within the diet (Mason, 2007).

In PPB, resting accounted for only 1.8% of the activity budget, which is low compared to the 30% and 11% reported for resting bottlenose dolphins (*Tursiops* sp.) by Arcangeli and Crosti (2009) and Lusseau and Higham (2004), respectively. However, the proportion of resting documented in this study is comparable to the 4% and 3% reported for resting bottlenose dolphins in Port Stephens, Australia (Steckenreuter et al., 2012) and Moreton Bay, Australia (Chilvers, 2001), respectively. Given that this is the first study to document the activity budget of Burrunan dolphins, the activity budget detailed herein cannot be compared to activity budgets for other populations of this species, and thus provides baseline data only. The low number of observations of resting dolphins could be attributed to 1) an under-representation given the inconspicuous surface activity of resting dolphins and/or the inability to conduct nocturnal observations, or 2) heavy commercial and recreational traffic rendering PPB not so suited for resting dolphins.

Seasonal variation in behaviour was evident, with foraging most prevalent during summer. From an ecological perspective, seasonal shifts in foraging are likely due to changes in prey availability and distribution, which is likely to be strongly correlated with water temperature itself subject to seasonal fluctuations (Cockcroft & Peddemors, 1990; Lusseau et al., 2003; Neumann, 2001; O'Donoghue et al., 2010). Australian salmon and snapper migrate into PPB seasonally, entering the bay during late spring and summer when the temperature inside PPB is warmer than the temperature outside in Bass Strait (Coutin et al., 2003; Kuitert, 1993; Mason, 2007). Fish movement into the bay during spring and summer may explain the high percentage of dolphins foraging in the southern end of PPB during summer relative to the rest of the year. However, foraging bout lengths decreased significantly in summer when dolphin-swim tourism interactions were at their peak (Chapter Five) and thus dolphin's energy intake may be reduced (New et al., 2013; Pirodda et al., 2015). Of relevance, the amount of time dolphins spent foraging and socialising decreased from 2011 to 2013 by 71% and 27%, respectively. These results could be attributed to 1) potential changes in prey abundance, and/or 2) lost foraging opportunities due to reduction in time spent foraging when dolphins interact with non-compliant tour vessels (Chapter Two; Filby et al., 2015; Chapter Five), and/or 3) a reduction in energy availability equates to dolphins socialising less in the absence of tour vessels. This reduction in critical behaviours vital to the survival of the population could lead to long-term population level consequences (Bejder et al., 2006a; Higham et al., 2008; Lusseau & Bejder, 2007; Steckenreuter et al., 2012).

This study, which involved much greater effort in the offshore waters of southern PPB, confirms the primarily coastal distribution of this population. The affinity of Burrunan dolphins for inshore, coastal waters, in a highly populated area makes them susceptible to human impacts. Resting groups of dolphins were observed closest to land compared to other behavioural states, which could be a predator-avoidance mechanism, as deep water shark species cannot attack from below in the shallows, nor from the flanking coastline. Similar theories have been proposed for spinner dolphins (*Stenella longirostris*) in

northwestern Hawaii (Cribb et al., 2012), for dusky dolphins (*Lagenorhynchus obscurus*) in Argentina (Würsig & Pearson, 2014) and for Heaviside's dolphins (*Cephalorhynchus heavisidii*) in southern Africa (Elwen et al., 2006).

Group sizes in PPB were small, although consistent with those reported by Scarpaci et al., (2010) for Burrunan dolphins in PPB. Similar median group sizes have also been reported for other *Tursiops* spp. inhabiting inshore coastal waters (e.g. Baird et al., 2001 (range = 1 - 16, median = 6); Constantine et al., 2004 (range = 2 - 50, median = 8); Hubard et al., 2004 (range = 1 - 50, median = 4)). Given that small groups (1 - 9 animals) in PPB responded more negatively to tour vessels than large groups (≥ 10 animals) (Chapter Four; Filby et al., 2014), this population could be at increased risk to disturbance from tour vessels. Larger groups were associated with shallower waters more frequently than small groups, with groups containing calves being larger and containing more adults than groups without calves. These larger groups containing calves are likely formed as nursery groups, with the demonstrated preference for shallow habitats by these groups associated with predator avoidance (Mann et al., 2000; Weir et al., 2008).

Scarpaci et al., (2000b) theorised that southern PPB is an important region for nursery groups, as it provides shelter from the open ocean and has high productivity. The present study concurs as calves were present in almost half of observations, and 3 or more neonates were observed each field season. Calves and neonates were observed most frequently in summer and autumn, coinciding with observations in the field of birthing (personal observation). Largest group sizes in autumn could be attributed to an influx of adult males into PPB during the breeding season, as Smith et al., (2013) hypothesised was occurring for Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Bunbury, Western Australia. This is consistent with the observed peak in calving in PPB during summer (unpublished data) and a gestation period for bottlenose dolphins that is approximately twelve months (Connor et al., 1996). Groups foraged more frequently when calves were present which can be attributed to nursery groups having high energetic requirements (Filby et al., 2013). If PPB is an important area for Burrunan dolphin nursery groups, this is of concern given

the high level of boat traffic in the region and the vulnerability of calves to vessel collision (Dwyer et al., 2014; Martinez & Stockin, 2013) and the potential for their nursing behaviours to be interrupted (Wells et al., 2008).

Although this study has contributed greatly to our understanding of the behavioural ecology of Burrunan dolphins, it is acknowledged that a limitation of this study is that no *true* control exists, in which no boats were close to dolphins. This was because the only practical way to study the behaviour of the dolphins was to use a research boat. It was not possible to conduct land-based theodolite surveys due to the large study area, distribution of dolphins was wide and the fact that dolphin occurrence close to shore was not predictable. Since boat-based surveys were necessary, protocols proven to minimise the potential impact of the research vessel were utilized. With new technology and rapidly dropping costs, drones or unmanned aircraft systems could be utilised in future studies to provide *true* controls.

3.5.2 Priority habitat for protection

The implementation of TBSZ, which was founded on the pre-cautionary principle (i.e. that absence of information is insufficient reason to delay undertaking conservation measures, Hooker et al., 2011), was a correct management decision, and should remain as the *status quo*. Burrunan dolphins used TBSZ as an important foraging site, with almost half of 'important' foraging cells and 4.5% of 'critical' foraging cells occurring within the sanctuary zone. Of these cells, a third had 5 or more observations of foraging dolphins, with the steeply sloping benthic topography in this area potentially providing high concentrations of fish or assisting dolphins during foraging (Ingram & Rogan, 2002). However, Howes et al., (2012) reported that tour operators did not exercise any additional caution during dolphin encounters within TBSZ and exhibited unsatisfactory compliance with regulations within the sanctuary zone. Thus, unsatisfactory compliance by tour operators, and lack of enforcement by management, is currently limiting the efficiency of TBSZ.

Using data obtained in the activity budget, spatial analyses of behaviour revealed two other locations as 'critical' for foraging Burrunan dolphins within PPB. Thus, to effectively manage this population, a multi-site management plan for this complex social species is recommended. The primary foraging area, or 'hotspot', for dolphins within southern PPB was Popes Eye (PE), with secondary foraging sites at Rosebud west to McCrae (RW-MC) and TBSZ. Waters along the RW-MC coastline are outside the main tidal flow, meaning that dolphins may need to expend less energy swimming against the tide and that fish may be more easily herded and caught near the shore (Hale, 2002). The importance of PE as a 'critical' foraging spot for dolphins provides additional rationale for the establishment of PE as a Marine National Park in 2002. It is possible that: 1) PE has always served a foraging purpose for Burrunan dolphins; and/or 2) the implementation of a marine national park has provided opportunity for fish populations to increase, providing either an enhanced or new opportunity for dolphins to forage. Furthermore, the proximity of PE to the open ocean might explain why there are high levels of foraging in this area, with tidal inflow bringing potential prey into PPB from Bass Strait, and the man-made fort providing structural opportunity to support a kelp ecosystem.

It cannot be concluded whether TBSZ is an important resting area for this population due to the low sample size for resting dolphins obtained in this study. Caution must be applied in interpreting results until a larger sample size is obtained. Thus, it is suggested that TBSZ is maintained until further research determines if any other areas are 'critical' or 'important' to resting dolphins within PPB.

3.5.3 Management recommendations

For management to offer optimal protection to Burrunan dolphins in the areas identified herein as their core foraging habitat (Figure 3.9), it is recommended that the following management actions be implemented:

- 1) PE Marine National Park's boundary is extended from its current radius of 100 m from its centre to 1000 m, so that it incorporates a higher percentage of critical foraging cells.

- 2) Formation of a new MPA between RW-MC (1: 144 51' 16.19 E, 38 20' 15.05 S; 2: 144 51' 12.08 E, 38 22' 5.85 S; 3: 144 55' 0.62 E, 38 21' 2.74 S; 4: 144 55' 1.05 'E, 38 20' 18.83 S) with speed restricted to 5 knots (no wake) up to 1500 m offshore so that critical foraging areas are encompassed (Figure 3.9). Seasonal closures should be implemented in this proposed MPA over summer during the peak calving period when recreational vessel traffic is greatest.

This study has identified three important habitat areas for Burrunan dolphins within PPB that management can now prioritise as needing protection. Implementation of the proposed MPAs, which protects critical foraging and resting areas for Burrunan dolphins, is the key to the long-term conservation of this species. For small populations, like Burrunan dolphins, the conservation stakes are particularly high, and thus the need for immediate management action is required. The results described herein have implications for the conservation of other dolphin-swim and dolphin-watching industries where management may be able to use similar strategies when deciding where to implement MPAs.

Chapter Four

Long-term responses of Burrunan dolphins (*Tursiops australis*) to swim-with dolphin tourism in Port Phillip Bay, Victoria, Australia: a population at risk



This chapter is a reformatted version of the published manuscript:

Filby et al. (2014) Long-term responses of Burrunan dolphins (*Tursiops australis*) to swim-with dolphin tourism in Port Phillip Bay, Victoria, Australia: A population at risk. *Global Ecology and Conservation*, 2: 62-71. (Appendix 9)

Declaration of co-authorship and co-contribution: papers incorporated in thesis by publication

Declaration by: Nicole Erin Filby

Signature:



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Paper Title: Long-term responses of Burrunan dolphins (*Tursiops australis*) to swim-with dolphin tourism in Port Phillip Bay, Victoria, Australia: A population at risk

In the case of the above publication, the following authors contributed to the work as follows:

Name	Contribution %	Nature of Contribution
Nicole Filby	75	Study concept, experimental design, fieldwork, data collection, statistical analysis and interpretation, manuscript writing, manuscript editing
Carol Scarpaci	20	Study concept, experimental design, data collection, manuscript editing
Karen Stockin	5	Manuscript editing

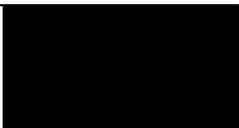
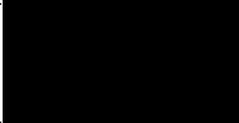
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4.1 Abstract

This study investigated Burrunan dolphin (*Tursiops australis*) responses to dolphin-swim tour vessels across two time periods: 1998 - 2000; and 2011 - 2013. A total of 211 dolphin sightings were documented across 306 surveys. Sighting success rate and mean encounter time with dolphins decreased significantly by 12.8% and 8.2 min, respectively, between periods. Approaches that did not contravene regulations elicited highest approach responses by dolphins towards tour vessels, whereas dolphins' responded to illegal approaches most frequently with avoidance. Small groups responded to tour vessels with avoidance significantly more than large groups. Initial dolphin behaviour had a strong effect on dolphins' responses to tour vessels, with resting groups the most likely to exhibit avoidance. Calves were significantly more likely to be present during swims in 2011 - 2013. Dolphins' responses to tour vessels changed over time, with effect responses (avoidance and approach) increasing significantly as dolphins gained cumulative experience. Burrunan dolphins are forced to expend a greater level of time and energy avoiding or approaching boats, shifting from a non-effect response to an effect response. Consequences of this include possible decrease in biological fitness by detracting from core biological activities such as foraging and resting. Combined with a decrease in sighting success between periods, the results imply that this population of dolphins, which is endemic to Australia and listed as threatened under the Victorian Flora and Fauna Guarantee Act, 1988, may not be well suited to the dolphin-swim industry. The management implications of these results warrant a shift from passive to active management in Port Phillip Bay. The importance of long-term research is highlighted, given behavioural responses detected herein would be undetected in short-term studies.

4.2 Introduction

Human interactions with free-ranging dolphins have the power to improve well-being (Curtin, 2006), enhance participant's values for the targeted species (Orams, 1997) and increase their knowledge levels and pro-conservation actions (Chapter Two; Filby et al., 2015). Cetacean-based tourism is one of the

fastest growing industries worldwide, generating over USD\$2.1 billion in revenue in 2008 (O'Connor et al., 2009). In Australia more than 1.6 million tourists participate each year, generating over \$29 million to the Australian economy, with a high growth rate of 8.3% per annum between 1998 and 2008 (O'Connor et al., 2009).

There is an underlying assumption that if dolphins choose to interact with tour vessels that there will be no detrimental effects. However, dolphin interactions with tour vessels can generate changes in dolphin: respiration patterns (Nowacek et al., 2001); swimming direction (Lemon et al., 2006); swimming speed (Timmel et al., 2008); diving times (Lusseau, 2003b); phonation rates (Sousa-Lima & Clark, 2008); behaviour (Peters et al., 2013); and synchrony (Tosi & Ferreira, 2009). How dolphins respond to interactions with tour vessels will depend partly on age class, with calves being more inquisitive and less cautious of vessels, making them more susceptible to impacts (Constantine, 2001; Martinez & Stockin, 2013). Further, research indicates that dolphin responses to dolphin-swim tour vessels are linked to boat approach type and presence of swimmers and vessels (Bejder et al., 1999; Constantine, 2001; Martinez et al., 2011; Neumann & Orams, 2006; Steckenreuter et al., 2012), with responses varying greatly between the type of tourism undertaken, targeted species and the location (Orams, 2004). These impacts raise concerns relating to the sustainability of this industry (Ziegler et al., 2012). Indeed, a limited number of long-term studies indicate short-term behavioural changes can have long-term consequences (e.g. decreased reproductive success (Bejder et al., 2006a) and increased mortality rates (Dans et al., 2008) for individuals and their populations (Lusseau & Bejder, 2007)).

Whilst the long-term effects of increasing levels of swim-with dolphin tourism on free-ranging dolphins remains unknown, research suggests that habituation (i.e. a reduction in a behavioural response occurring when a stimulus is frequently repeated with no apparent punishment or reward, Allaby, 1994) often transpires (Constantine, 2001). Tolerance (i.e. no apparent response to a stimulus) is another frequently reported response by animals to human presence (Constantine, 2001), while displacement away from critical habitat has been

reported for sensitive individuals (Bejder et al., 2006a). Sensitisation may also occur, whereby there is a response increase as the animal learns that the stimulus does have significant consequences (Peters et al., 2013).

The population of dolphins in Port Phillip Bay (PPB) have recently been identified as a genetically and morphologically isolated species of bottlenose dolphin; the Burrunan dolphin (*Tursiops australis*, Charlton-Robb et al., 2011). Burrunan dolphins are endemic to Australia, with only two resident populations identified: one in PPB; and the other in Gippsland Lakes, Victoria. Burrunan dolphins in PPB display high site fidelity, using the southern coastal waters all year round, bringing them into frequent contact with humans (Scarpaci et al., 2000b; Scarpaci et al., 2003). Under the Victorian Flora and Fauna Guarantee Act, 1988, this population is listed as threatened, and is considered vulnerable to extinction due to its small size (approximately 80 - 100 individuals, Hale, 2002), genetic distinctiveness (Charlton-Robb et al., 2011), restricted home range (which is in close proximity to a major urban centre, making them susceptible to numerous anthropogenic threats, Hale, 2002) and female natal philopatry (Hale, 2002). Further, this population is at risk due to the considerable volume of vessel activity in the area (commercial and recreational vessels, Dunn et al., 2001) and exposure to a non-compliant commercial dolphin-swim industry (Chapter Two; Filby et al., 2015; Scarpaci et al., 2004).

The dolphin-swim industry in PPB began in 1986 (Jarvis & Ingleton, 2001). In 1995, a code of practice was established by tour operators and the Department of Conservation and Natural Resources to provide guidelines for responsible behaviour of tour boats around dolphins in PPB. This code of practice then formed the basis for the Wildlife (Whales) Regulations, 1998, with regulations specific to the dolphin-swim tour industry. In order to increase tour operator compliance and improve overall protection of the targeted species (Hale, 2002), these regulations have been amended repeatedly over time to ensure industry sustainability (Scarpaci et al., 2004) and currently tour operators must abide by the Wildlife (Marine Mammal) Regulations, 2009. In PPB there are currently 3 swim-with dolphin licenced tour operators, entailing 4 vessels, which run a maximum number of 2 trips per day per vessel.

Whilst numerous studies have examined and detected short-term behavioural changes of dolphins in response to tourism activities, few have utilised long-term methodologies to assess potential changes over extended time periods. Given the longevity of marine mammals, and the changes that occur within the management of the dolphin-swim tourism industry over time, long-term studies are imperative. This is especially so when dealing with endemic, threatened species upon which an entire commercial industry is based. In this chapter, a novel long-term assessment approach was applied to assess changes in dolphin behaviour over a 15 year period. The aim of this study was to investigate Burrunan dolphins' responses to dolphin-swim tour vessels in PPB over time, in an attempt to detect temporal changes in dolphins' responses to tour vessels and determine how those changes may influence the population's reproduction, survival or population growth in the long-term. In particular, this study assesses whether the population shows any signs of habituation, sensitisation or tolerance to the dolphin-swim tour vessels with cumulative experience. Furthermore, boat approach type was examined to determine if dolphins' responded differently depending on legality of approach, to determine the effectiveness of the regulations that dictate how tour vessels approach dolphins. Lastly, this study examines if there is a relationship between dolphins' responses to tour vessels based on their age class or their initial behavioural state.

4.3 Materials and methods

4.3.1 Data collection

This study was conducted on the population of free-ranging Burrunan dolphins that inhabit PPB (38°05'S, 144°50'E). Observations of dolphins' responses to tour vessels were conducted on-board dolphin-swim tour vessels that operate in the southern end of PPB across two time frames: 1) period 1 (P1): 1998 - 2000, (utilising Scarpaci's unpublished data); and 2) period 2 (P2): 2011 - 2013, (utilising data collected in this study). P2 data collection followed methods utilised in P1 for consistency and to enable comparison of results, and are

detailed below. In some instances, P1 and P2 data were amalgamated to give a long-term data set (LTDS).

Dolphins observed in apparent association, moving in the same direction and usually engaged in the same activity were defined as a group (Shane, 1990). The perimeter of the group was established via the use of a 10 m-chain rule between members (Smolker et al., 1992). Four vessels conducted swims with groups containing animals of all age class: 1) adult (i.e. apparently fully grown individuals (> 2 m, range 2.27 – 2.78 m, Charlton-Robb et al., 2011)); 2) juvenile (i.e. approximately two-thirds the length of an adult and not travelling in the echelon position alongside an adult); 3) calf (i.e. approximately half the length of an adult, and still travelling in the echelon position alongside an adult, presumed to be its mother); and 4) neonate (i.e. young calves still showing foetal folds, a floppy dorsal fin, exhibit extreme buoyancy, when surfacing lift the whole head above water and always positioned in close relation to an adult (presumed to be its mother)).

Dolphins' initial behavioural state was recorded as: 1) travelling (dolphins engaged in persistent, directional movement making noticeable headway along a specific compass bearing); 2) foraging (dolphins involved in any effort to pursue, capture and/or consume prey); 3) milling (dolphins exhibited non-directional movement and frequent changes in bearing prevented dolphins from making headway in any specific direction); 4) resting (dolphins observed in a tight group (< 1 body length between individuals), engaged in slow manoeuvres with little evidence of forward propulsion); and 5) socialising (dolphins observed chasing, copulating and/or engaged in any other physical contact with other dolphins, such as rubbing and touching, Filby et al., 2013).

The dolphins' responses to tour vessels were defined as: 1) approach (i.e. $> 50\%$ of the group approached the tour vessel, repeatedly interacting with the vessel and/or swimmers); 2) neutral (i.e. no apparent change in dolphin's behaviour); and 3) avoid (i.e. $> 50\%$ of the group changed their direction of travel away from the tour vessel or diving and surfacing away from the tour vessel, Constantine, 2001).

Tour operators used three approach types to approach dolphin groups, with definitions modified from Scarpaci et al., (2003): 1) parallel (i.e. tour vessel positioned to either side of a group - legal); 2) direct (i.e. tour vessel positioned directly into the middle of a group - illegal); and 3) J (i.e. tour vessel initially travelled parallel to a group, but then moved directly in front of the group - illegal, Appendix 3: Table B, Figure A). Proportion of approach types used for dolphin encounters was determined by dividing the total number of each approach type observed by the total number of approaches recorded for that encounter.

One min scan samples were used to collect data on dolphins' responses to tour vessels approaches, number of boats and dolphin's group size, composition and behaviour (Altmann, 1974). Tour vessel approach types and number of approaches per sighting were recorded via continuous observation. Once an approach was recorded, responses of the focal group were documented so that the influence of approach type on dolphin response could be determined.

Tour duration was deemed to be the time the tour vessel departed from dock for the purpose of conducting a dolphin-swim tour until the time the vessel returned to dock. Encounter time was defined as the time the tour vessel was within 100 m of the focal group. Distance (metres) between the tour vessel and the focal group was calculated using a Yardage Pro 500 range finder. Sighting success rate was defined as observing at least one dolphin group per trip, and calculated by dividing the number of trips where at least one dolphin group was observed by the total number of trips conducted. Swim length was calculated as the time (seconds) between the first swimmer entering the water and the last swimmer reboarding the vessel.

4.3.2 Data analysis

Statistical analysis was conducted using SPSS 20. All continuous data were tested for normality and homoscedasticity using Anderson-Darling and Bartlett's and Levene's tests, respectively. For the purpose of analyses, group composition was categorised and analysed as either calves absent or calves

present. Dolphins' responses were further categorised as: 1) effect (comprised of approach and avoid responses); and 2) non-effect (consisting of neutral responses). Based on a natural split in the data, group size was categorised as either small (1 - 9 animals) or large (> 10 animals). Results were considered statistically significant at $p \leq 0.05$.

Independent samples t-tests were used to determine if there was a significant difference between legal and illegal approaches for: number of approaches used; group size or number of boats present during an encounter. Differences between P1 and P2 for group size, encounter time, swim length, proportion of parallel approaches, proportion of J approaches and proportion of direct approaches were also assessed via independent samples t-tests.

Data from the LTDS were compared using ANOVAs to determine if swim length, tour vessel's approach number, the dolphins' group size and number of boats present varied with the legality of the approach type used by tour operators. ANOVAs were also run to establish whether the number of approaches used by tour operators was influenced by the dolphins' initial behavioural state or by the dolphins' response to tour vessels. Tukey's *post hoc* tests were run to determine where differences existed (Pallant, 2001).

Pearson's chi-squared tests were applied to the LTDS to detect whether there was a relationship between the dolphins' responses to tour vessels and approach type, legality of approach type, dolphins' group size, dolphins' initial behavioural state and dolphins' group composition. Pearson's chi-squared tests were also run to determine if the proportion of dolphins' responses, effect/non-effect responses, responses to parallel approaches, responses to J approaches, responses to direct approaches and sighting success rate differs between P1 and P2. Lastly, Pearson's chi-squared tests were applied to detect whether approach type used by tour operators was influenced by the dolphins' initial behavioural state.

4.4 Results

4.4.1 Field effort

Field effort and number of sightings was similar across both periods, with a researcher present on 128 and 178 dolphin-swim trips, respectively during P1 and P2. There were 107 dolphin sightings in P1 (mean tour duration = 3 hours 54 mins, SD = 28.9 min) and 104 in P2 (mean tour duration = 3 hours 22 mins, SD = 21.5 min).

4.4.2 Implications from a tour perspective

Sighting success rate decreased significantly ($\chi^2(1) = 4.35, p = 0.037$) from P1 (59.4%) to P2 (46.6%). Further, there was a significant ($\chi^2(1) = 4.91, p = 0.027$) decrease in sighting success rate within P2, from 58.0% in 2012 down to 37.7% in 2013. There was also a significant difference in mean encounter duration time per sighting between P1 and P2 ($t = 2.53, df = 173, p = 0.012$). The mean encounter time per sighting decreased from 34.8 min ($n = 107$) in P1 to 26.6 min ($n = 104$) in P2.

Swim length differed significantly between periods ($t = 8.41, df = 445, p = 0.000$). The mean swim time increased from 170.5 sec (SD = 103.7, $n = 331$) in P1 to 262.4 sec (SD = 151.4, $n = 263$) in P2. In the LTDS, direct approaches resulted in significantly longer swim times (mean = 239.0 sec, SD = 160.6) than J (mean = 204.7 sec, SD = 156.0) or parallel approaches (mean = 204.3 sec, SD = 121.2) ($F(2,591) = 3.10, p = 0.046$). Tukey's *post hoc* test identified that direct approaches resulted in significantly longer swims than parallel approaches ($p = 0.039$).

4.4.3 Tour vessel approaches

During P1 and P2, a total of 564 and 446 tour vessel approaches were made to dolphin groups, respectively. The mean number of approaches per sighting decreased from 7 in P1 to 4 during P2. Parallel approaches were the most frequently used approach type, in both P1 (63.1%, $n = 440$) and P2 (61.0%, $n =$

272). However, compliance deteriorated across periods, with illegal approaches increasing from 36.9% ($n = 215$) in P1 to 39.0% ($n = 174$) during P2.

The proportion of approaches per sighting for any of the 3 approach types did not vary between P1 (parallel: $n = 107$, mean = 0.70, SD = 0.25; J: $n = 107$, mean = 0.08, SD = 0.15; and direct: $n = 107$, mean = 0.22, SD = 0.24) and P2 (parallel: $n = 96$, mean = 0.69, SD = 0.32, $t = 0.10$, $df = 181$, $p = 0.920$; J: $n = 96$, mean = 0.05, SD = 0.11, $t = 1.81$, $df = 194$, $p = 0.072$; and direct: $n = 96$, mean = 0.26, SD = 0.29, $t = 0.97$, $df = 201$, $p = 0.334$).

For the LTDS, there was a significant difference in boat approach type used by tour operators, depending on boat approach number ($F(2,941) = 13.01$, $p = 0.000$, range = 1 - 21). Tukey's *post hoc* test revealed that as the number of approaches increased, J approaches (mean = 5.80, SD = 4.31) were significantly more likely to be used than parallel approaches (mean = 4.01, SD = 3.27, $p = 0.000$). Tukey's *post hoc* test also identified that number of direct approaches (mean = 4.83, SD = 3.84) were significantly higher than number of parallel approaches ($p = 0.006$). A significantly higher number of approaches were used during illegal (mean = 5.10, SD = 3.99) than during legal approaches (mean = 4.01, SD = 3.27) in the LTDS ($t = 4.32$, $df = 630$, $p = 0.000$). The proportion of legal approaches decreased for the LTDS as the number of approaches increased (Figure 4.1).

For the LTDS, approach type used by tour operators was significantly influenced by group size ($F(2,941) = 7.29$, $p = 0.001$). Tukey's *post hoc* test identified that group sizes for J approaches (mean = 15.01, SD = 15.26, $n = 98$) were significantly larger than for direct (mean = 10.66, SD = 10.10, $n = 255$, $p = 0.002$) or parallel approaches (mean = 10.74, SD = 9.76, $n = 591$, $p = 0.001$). However, there was no significant relationship in the LTDS between legal (mean = 10.74, SD = 9.76) and illegal (mean = 11.87, SD = 11.90) approaches used by tour operators and dolphins' group size ($t = 1.51$, $df = 361$, $p = 0.133$).

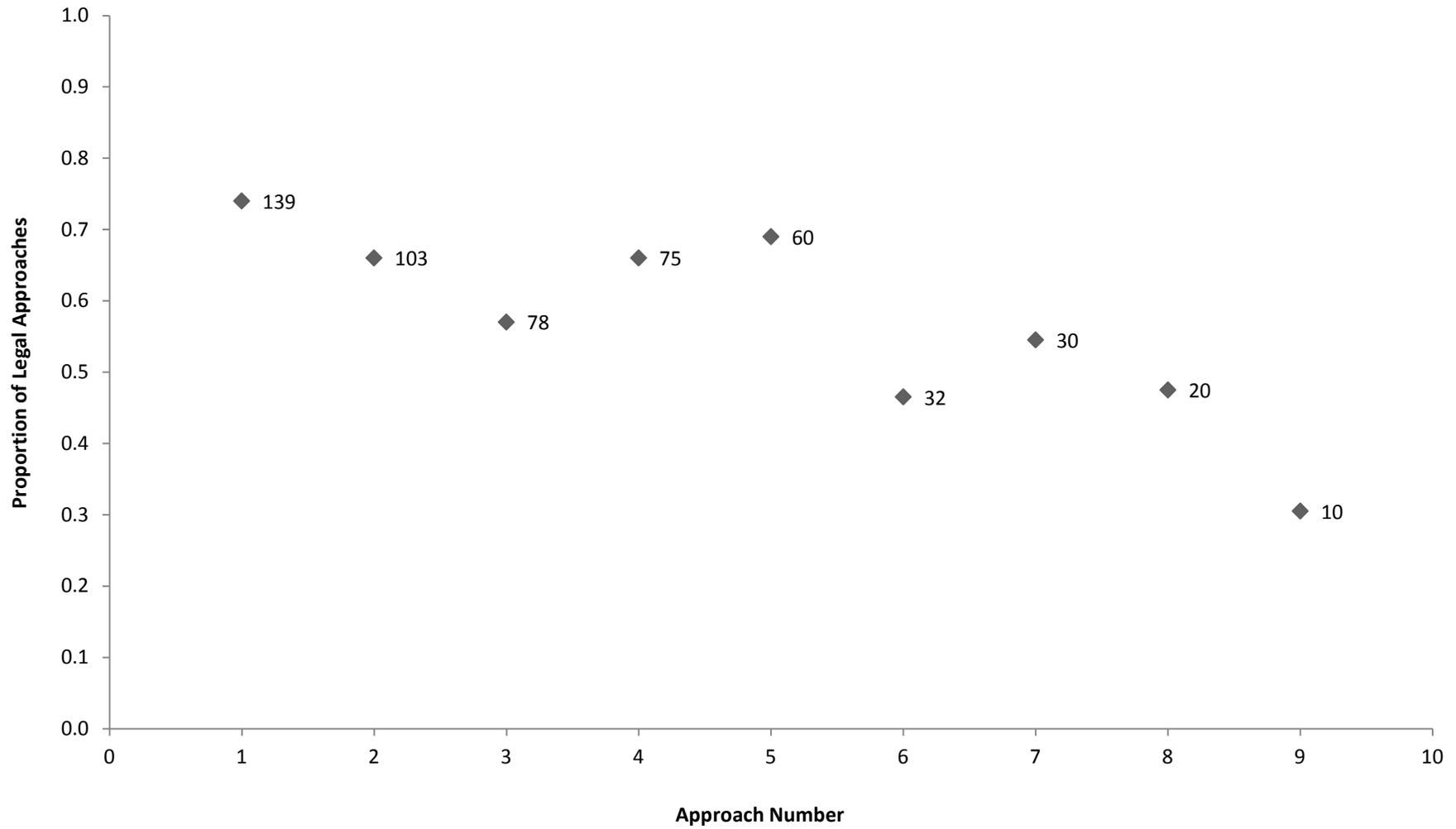


Figure 4.1 Proportion of legal approaches towards dolphins made by tour operators for each approach (long-term data set).
Number of legal approaches for each approach number shown next to ◆

In the LTDS, approach type did not vary significantly with the number of boats present ($F(2,941) = 0.99, p = 0.373$). However, more boats were present for J approaches (mean = 2.28, SD = 1.47) than for parallel (mean = 2.02, SD = 1.80) or direct approaches (mean = 2.03, SD = 1.49). More boats were present in the LTDS for illegal (mean = 2.10, SD = 1.49) than for legal number of approaches (mean = 2.02, SD = 1.80), however this result was not significant ($t = 0.67, df = 942, p = 0.504$).

Approach types used by tour operators did not vary significantly in the LTDS with dolphins' initial behavioural state ($\chi^2(8) = 7.54, p = 0.479$). However, the number of approaches made by tour vessels in the LTDS varied significantly with dolphin's initial behavioural state ($F(4,939) = 5.95, p = 0.000$). Tukey's *post hoc* tests identified that the number of approaches was significantly greater for socialising groups (mean = 5.53, SD = 4.36) than for travelling (mean = 4.47, SD = 3.59, $p = 0.041$), foraging (mean = 3.88, SD = 3.31, $p = 0.004$) or resting groups (mean = 1.76, SD = 1.03, $p = 0.001$). The number of approaches was also significantly greater for travelling than for resting groups ($p = 0.017$).

4.4.4 Responses of dolphins to tour vessel approaches

Dolphins' responses to tour vessel approaches varied significantly between periods ($\chi^2(2) = 274.86, p = 0.000$). Avoidance and approach responses to tour vessels increased from P1 (3.3%, $n = 19$ and 10.8%, $n = 63$, respectively) to P2 (10.0%, $n = 36$ and 56.5%, $n = 204$, respectively), whilst neutral responses decreased from 85.9% ($n = 501$) in P1 to 33.5% ($n = 121$) in P2. Dolphin effect and non-effect responses to tour vessel approaches differed between periods ($\chi^2(1) = 272.55, p = 0.000$). Effect responses to tour vessels increased from 14.1% ($n = 82$) in P1 to 66.5% ($n = 240$) in P2, whilst non-effect responses decreased from 85.9% ($n = 501$) in P1 to 33.5% ($n = 121$) in P2.

Dolphins' responses to parallel, J and direct approaches varied between P1 ($n = 583$) and P2 ($n = 361$) ($\chi^2(2) = 191.00, p = 0.000, \chi^2(2) = 27.89, p = 0.000$ and $\chi^2(2) = 62.01, p = 0.000$, respectively, Figure 4.2).

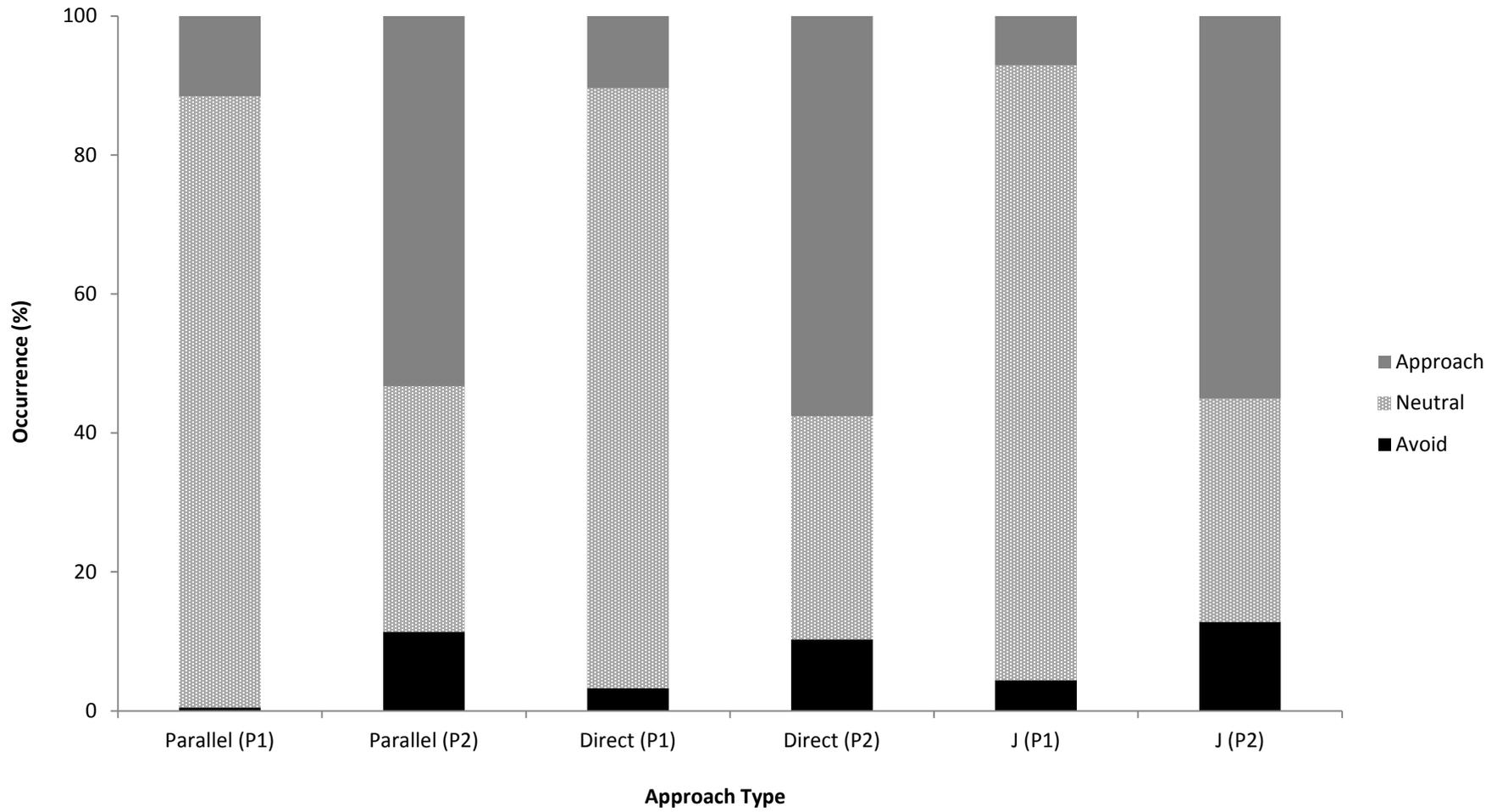


Figure 4.2 Dolphin responses to tour vessels as a function of approach type for period 1 ($n = 583$) and period 2 ($n = 361$).

For the LTDS, dolphins' responses to tour vessels approaches varied significantly with approach type, ($\chi^2(4) = 10.55, p = 0.032$), with parallel approaches resulting in the highest approach response (64.8%, $n = 173$). In contrast, when J (8.2%, $n = 22$) or direct approaches (27.0%, $n = 72$) were used, dolphins were less likely to approach. Within approach types, the greatest incidence of avoidance occurred when direct (9.0%, $n = 23$) and J approaches (8.2%, $n = 8$) were used, with parallel approaches resulting in the lowest level of avoidance by dolphins (4.1%, $n = 24$). Dolphins' responses to tour vessels was significantly affected by whether approaches were legal or illegal ($\chi^2(2) = 9.15, p = 0.010$). Legal approaches resulted in the highest levels of neutral (63.3%) and approach (64.7%) responses. Conversely, dolphins most frequently responded to illegal approaches with avoidance (56.4%). Approach number also significantly affected dolphin's responses to tour vessels in the LTDS ($F(2,941) = 4.20, p = 0.015$). Dolphins were significantly more likely to approach (mean = 3.88, SD = 3.07) tour vessels when less approaches were attempted, than to exhibit neutral responses (mean = 4.64, SD = 3.76, Tukey's *post hoc* test: $p = 0.011$).

Group size was significantly larger in P2 ($t = 3.11, df = 594, p = 0.002$, mean = 13, SD = 12.56, range = 1 – 60) than in P1 (mean = 10, SD = 9.11, range = 1 – 60). In the LTDS, dolphins' responses to tour vessels varied significantly with group size ($\chi^2(2) = 18.63, p = 0.000$). Small groups avoided tour vessels (78.2%, $n = 43$) more frequently than large groups (21.8%, $n = 12$, Figure 4.3).

Dolphins' initial behavioural state also had a strong effect on dolphins' responses to tour vessels in the LTDS ($\chi^2(8) = 115.02, p = 0.000$). The most frequent response of travelling, foraging and socialising groups was neutral (66.4%, 79.4% and 66.3%, respectively, Figure 4.4). Resting groups most frequently avoided tour vessels (52.9%), approaching tour vessels the least (0.7%). Milling groups most frequently responded to tour vessels by approaching (64.7%). On 64.7% and 20.6% of occasions that tour vessels approached resting or feeding dolphin groups, respectively, dolphins changed their behaviour, exhibiting an effect response.

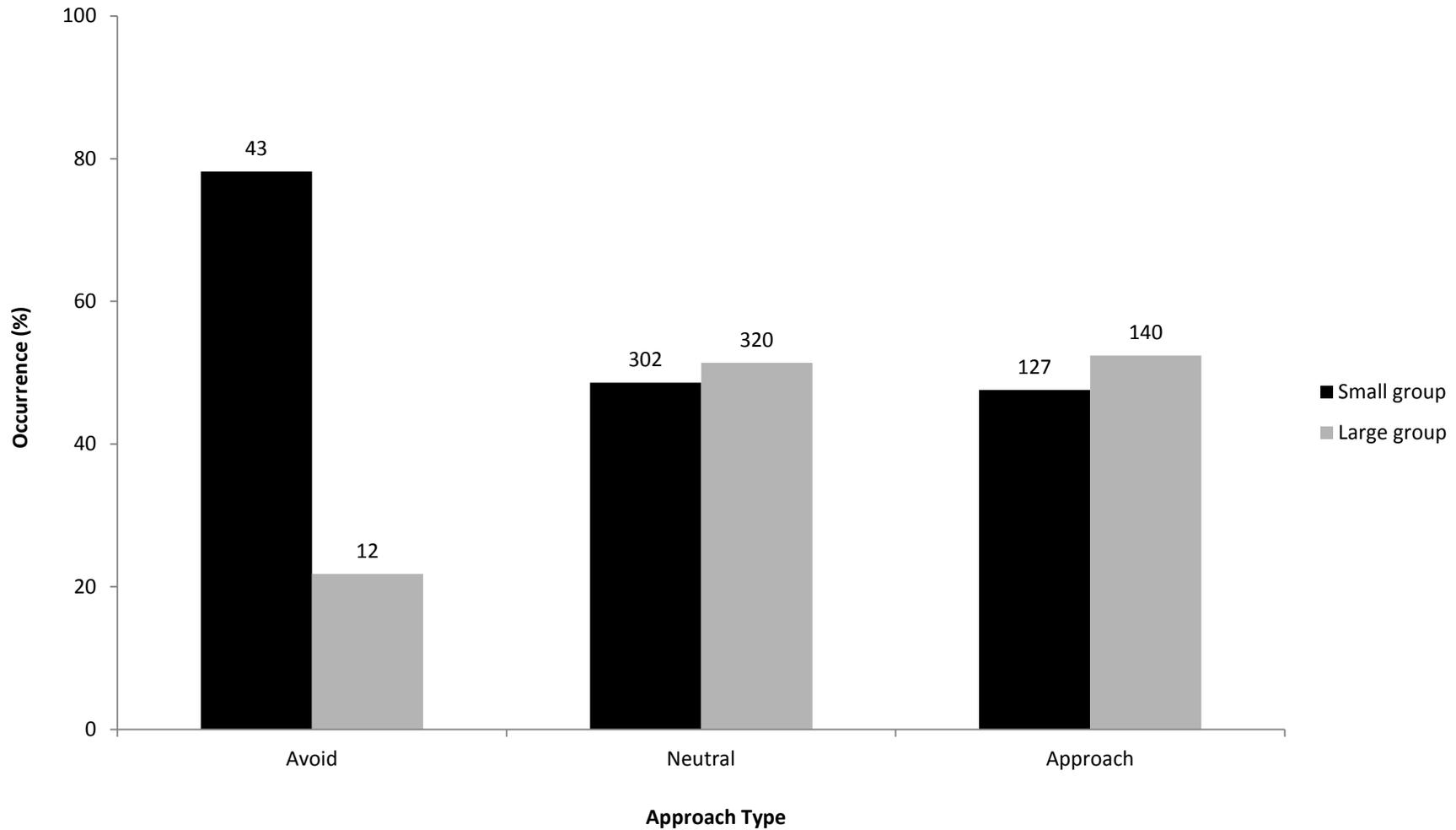


Figure 4.3 Dolphin responses to tour vessel approaches as a function of dolphins' group size in Port Phillip Bay, Australia (long-term data set). *Sample size for each category shown above bars.*

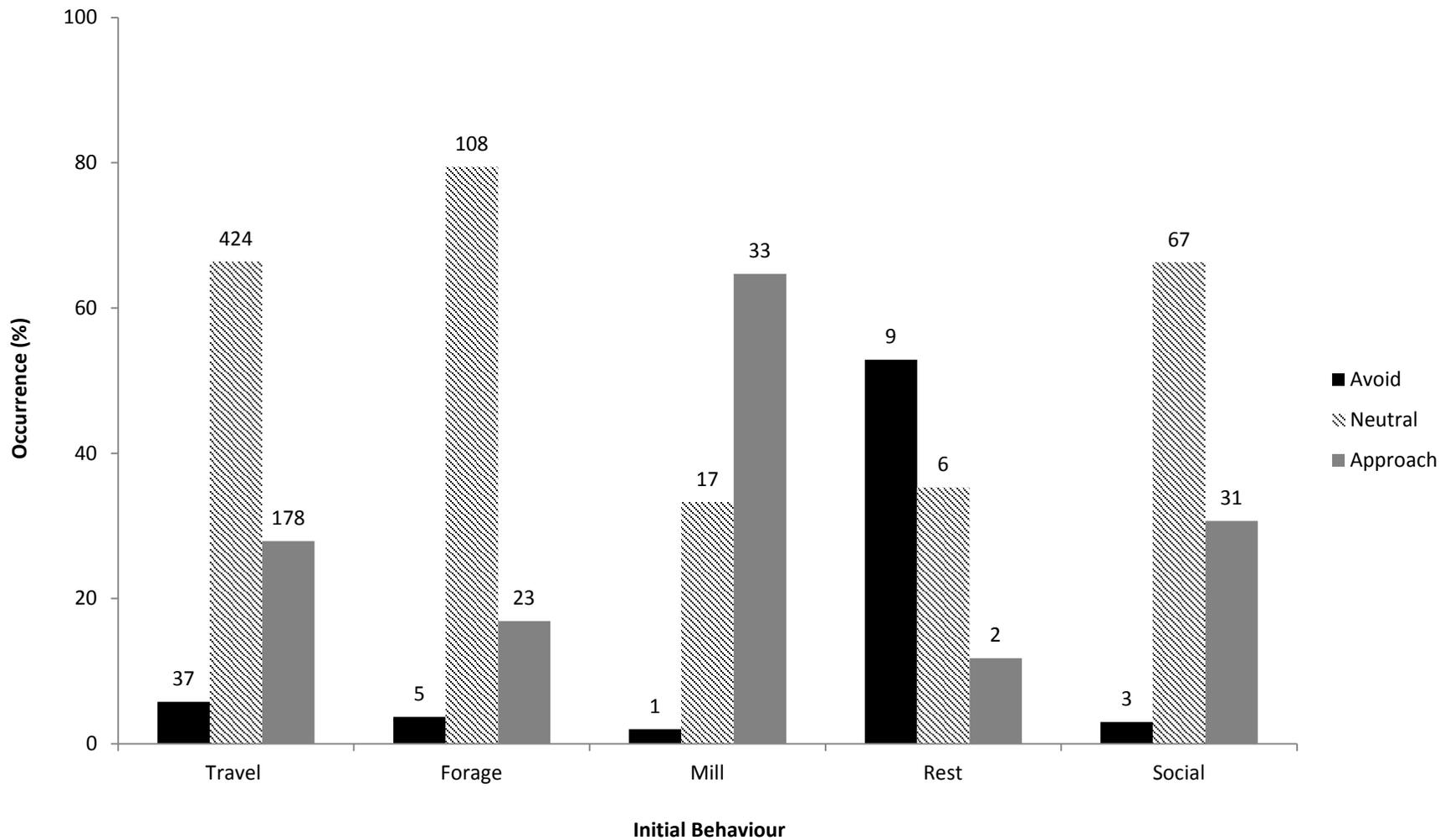


Figure 4.4 Dolphin responses to tour vessel approaches in relation to initial behavioural state in Port Phillip Bay, Australia (long-term data set). *Sample size for each category shown above bars.*

4.4.5 Age composition of dolphins interacting with tour vessels during swims

There was a significant difference in group composition (calves absent vs calves present) between P1 and P2, ($\chi^2(1) = 26.49$, $p = 0.000$), with calves more likely to be present during a swim in P2 (56.9%, $n = 149$) than during P1 (35.1%, $n = 104$). For the LTDS, dolphin responses to tour vessels was significantly affected by group composition ($\chi^2(2) = 16.44$, $p = 0.000$). Dolphins were more likely to avoid (70.9%) or respond neutrally to (58.5%) tour vessels when calves were absent, compared to 29.1% avoidance and 41.5% neutral responses when groups contained calves. Groups with calves present were more likely to approach (53.6%) tour vessels than groups where calves were absent (46.4%) in the LTDS.

4.5 Discussion

4.5.1 Responses of Burrunan dolphin's to dolphin-swim tour vessels

The findings reported herein reveal that the Burrunan dolphins in PPB have altered their responses to tour vessels over time. Dolphin responses to tour vessels were influenced by the approach type used by tour operators: dolphins approached tour vessels more frequently when legal approaches were used and exhibited higher levels of avoidance to illegal approaches. However, tour operators in PPB are historically non-compliant in utilising legal approaches (Chapter Two; Filby et al., 2015). Consequently, non-compliance has negative impacts for both the targeted species and the industry, as illegal approaches result in more frequent avoidance responses by the dolphins, which may subsequently decrease both customer viewing opportunities and satisfaction. As the dolphins gained cumulative experience, their responses to tour vessels changed, with dolphins showing an increase in avoidance and approach responses (effect) towards tour vessels over time. These dolphins are forced to expend a greater level of time and energy avoiding or approaching boats, shifting from a non-effect to an effect response, which consequently may decrease their biological fitness (Bejder et al., 1999).

Sighting success rate decreased over time and may reflect a decrease in the number of dolphins using southern PPB. This could possibly be a precursor to abandonment of the bay by the dolphins as vessel traffic continues to disturb core biological activities (e.g. feeding and resting, Arcangeli & Crosti, 2009; Christiansen et al., 2010; Constantine et al., 2004; Steckenreuter et al., 2012; Stockin et al., 2008). Potentially, sensitive animals may depart from southern PPB during the tourism period leaving non-sensitive animals, the 'risk takers'. These 'risk takers' are more likely to approach tour vessels, possibly explaining the increase in approach responses to tour vessels from P1 to P2.

The increase in approach responses may also be a consequence of bow-riding behaviour, with many delphinid species exhibiting responsive movements towards vessels in order to bow-ride (Filby et al., 2010). However, it is important to recognise that just because these dolphins approach the tour vessels; it does not imply no detriment, long-term consequence (Martinez et al., 2011). These 'risk taker' groups that approach tour vessels become the main foci of the tour operators and as a result, these groups frequently cease their initial behaviour (namely, resting and foraging) in the presence of tour vessels. Consequently, behaviours that are vital to the fitness of the population are being disturbed, and this could lead to long-term population level consequences, as has been reported for other delphinids (Bejder et al., 2006a; Higham et al., 2008; Lusseau & Bejder, 2007; Steckenreuter et al., 2012). When resting behaviour is disrupted, the survival of calves is put at risk, as nursing often takes place while animals are resting (Stensland & Berggren, 2007). Further, these 'risk taker' groups are at risk of habituation, whereby their responses to stimuli that were once key to their survival progressively wane (i.e. over time, they approach vessels more frequently, thereby increasing their risk of vessel strike, Stone & Yoshinaga, 2000).

Alternatively, the dolphins encountered by tour vessels may be 'resource dependent' on southern PPB. Scarpaci et al., (2000b) identified this region as important for nursery groups given available shelter and productivity. Hence, groups with calves present could be resource dependent on southern PPB and, as a consequence, exposed to frequent encounters with tour vessels. The

increase in encounters with groups containing calves from P1 to P2 could be suggestive of this. If this is the case, there is the risk that resource dependent groups may become habituated over time, as they are exposed cumulatively to tour vessels.

In 2012, avoidance levels heightened at 13%, possibly due to chronic impacts of dolphin-swim tourism, or alternatively, because of an increase in non-compliance by tour operators with regulations over time (Chapter Two; Filby et al., 2015). Regardless of what regulatory changes were made, how tour operators approach dolphins has not changed temporally (Chapter Two; Filby et al., 2015; Scarpaci et al., 2003; Scarpaci et al., 2004). However, how dolphins respond to tour operators has altered over time. Dolphins that approach tour vessels more frequently may have become habituated and be more susceptible to vessel strike, while the increase in avoidance may have resulted in the movement of sensitive animals away from optimal foraging and breeding areas.

Regardless of why dolphins have changed their responses to tour vessels, dolphin groups have decreased their neutral responses to tour vessels over time, meaning that when tour vessels approach their initial behavioural state changes. This could have significant impacts on the population, given disturbance that interrupts biologically significant behaviours (i.e. resting and feeding) may carry energetic costs that can affect individual fitness and have long-term consequences for the population (Christiansen et al., 2010; Lundquist et al., 2012; Peters et al., 2013).

4.5.2 Implications from a tour perspective

Between P1 and P2, the quality (sighting success, encounter time and dolphin sightings per trip) of dolphin-swim tours in PPB deteriorated. This corresponds with an increase in non-compliance (Chapter Two; Filby et al., 2015) over the same period, implying that the industry in PPB may be non-sustainable. Dolphins approached tour vessels more frequently when legal (i.e. Parallel) as opposed to when illegal (i.e. J and Direct) approaches were attempted.

Furthermore, legal approaches resulted in the highest levels of neutral responses by dolphins.

The significant increase in swim duration from P1 to P2 indicates that dolphin tolerance to swimmer presence increased over time. This may be a consequence of the cumulative exposure of dolphins to the industry. The dolphins studied in P2 have been subject to tourism for a longer period of time and hence may exhibit a higher degree of habituation. Habituation to tourism has been reported for other delphinid species including: Hector's dolphins (*Cephalorhynchus hectori*) in Akaroa, New Zealand (Martinez et al., 2011); dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand (Markowitz et al., 2009) and for Atlantic spotted dolphins (*Stenella frontalis*) in the Bahamas (Ransom, 1998). Alternatively, the increase in mean swim time may reflect amendments made to the regulations between these two periods. In P1, the regulations allowed tour operators an unlimited number of approaches to dolphins; during P2, tour operators were limited to 5 approaches per trip. The limited number of approaches in P2 may be correlated with the longer swim times, as tour operators keep tourists in the water for longer so that the tour vessel can reposition itself closer to the dolphins. This hypothesis is supported by the increase over time in tour operators' non-compliance with the condition that tour operators must not reposition the vessel whilst tourists are in the water (Chapter Two; Filby et al., 2015).

Increased swim length in P2 does not necessarily reflect a satisfactory swim, with tourists in PPB stating that they were not happy with the length of their dolphin-swim (Chapter Two; Filby et al., 2015). The mean swim time (3.5 min) documented in this study for Burrunan dolphins is low compared to swim times for other species (e.g. 9 min for dusky dolphin (Markowitz et al., 2009), 12 min for rough toothed dolphins (*Steno bredanensis*) in the Canary Islands (Nichols et al., 2002) and 25 min for Hector's dolphins (Martinez et al., 2011)). These findings indicate that Burrunan dolphins, similar to common dolphins (*Delphinus delphis*) in Mercury Bay, New Zealand (mean swim time of 3 min, Neumann & Orams, 2006), may not be receptive to dolphin-swim tourism. Alternatively, the low mean swim time reported for dolphins in PPB may be due to different swim

techniques used. Regulations in PPB require tourists to hold onto mermaid lines (these are approximately 15 m long and are streamed from the stern of a vessel, Figure 4.5) during their dolphin-swim, whereas all of the other dolphin-swims studies compared here used free swims. In PPB, a maximum of 10 people are permitted on to mermaid lines at a time, and every time swimmers swap over, a new short dolphin-swim encounter begins. In comparison, free-swims allow tourists to get in and out of the water with dolphins continuously, and this is counted as one longer dolphin-swim.

4.5.3 Group size of dolphins interacting with tour vessels during swims

Small groups of dolphins in PPB avoid tour vessels significantly more frequently than do larger groups. Smaller groups may see tour vessels as a potential threat and hence avoid tour vessels more frequently than larger groups. Delphinids often form larger groups in situations of threat or danger, in an attempt to provide increased vigilance and predator protection via group defence (Gygax, 2002; Zaeschmar et al., 2014). Hence, dolphins travelling in larger groups in PPB may perceive potential threats, such as tour vessels, as less threatening than do small groups, explaining the higher approach rate to tour vessels by large groups. The theory that dolphins find safety in numbers is supported by Leitenberger (2001) and Neumann and Orams (2006) who also reported that boat avoidance was significantly correlated with dolphin group size, with smaller groups more likely to avoid vessels than larger groups. Half of dolphin groups encountered in PPB were small (less than 9 animals) and were significantly more likely to avoid tour vessels than larger groups (10 or more animals), adding support to the theory that the population of Burrunan dolphins in PPB may not be well suited to the dolphin-swim tourism industry.

4.5.4 Age class of dolphins interacting with tour vessels during swims

Groups containing calves were more likely to be present during dolphin-swims in P2 than in P1. Simultaneously, tour operators compliance with the condition



Figure 4.5 Swimmers holding onto mermaid lines during dolphin-swims in Port Phillip Bay, Australia. Photos: Author

in the regulations 'must not swim with calves' decreased by 14.3% across this time frame (Chapter Two; Filby et al., 2015). Hence, the greater number of calves observed during dolphin-swims in P2 may reflect tour operators approaching groups with calves present more frequently than in P1, rather than these groups responding by approaching vessels. Potentially, tour operators may enable swimming with groups containing calves more frequently in P2 by necessity. The significant decrease in sighting success over time will conceivably increase pressure on tour operators to let their customers swim with the first group they encounter in P2, regardless of age class composition. Potentially, groups containing calves may respond to tour vessels by approaching and bow-riding because of their inability to manoeuvre rapidly enough or dive sufficiently to avoid tour vessels (Wells & Scott, 1997). However, this approach response by groups containing calves may increase calves' susceptibility to disturbance by approaching vessels.

The significant increase of groups containing calves interacting with tour vessels during dolphin-swims over time is of concern, as neonates and calves are particularly vulnerable to collisions with vessels (Dwyer et al., 2014; Laist et al., 2001; Martinez & Stockin, 2013; Stone & Yoshinaga, 2000). Dolphins in P2 have been repeatedly exposed to tourism and thus may be displaying long-term behavioural changes such as habituation, which could lead to an increase in accidental collisions (Hawkins & Gartside, 2008). Habituated dolphins may display reduced wariness and let their calves interact with tour vessels more closely and frequently than non-habituated individuals (Bejder & Samuels, 2003). Consequently, these individuals become more vulnerable to vessel strike, especially calves due to their inexperience and reduced capacity to avoid vessels (Laist et al., 2001; Martinez & Stockin, 2013; Wells & Scott, 1997). Furthermore, vessels that get too close to dolphin groups can interrupt the nursing behaviour of young calves, which may cause disruption to social behaviours (Samuels et al., 2003; Wells et al., 2008).

Port Phillip Bay is an important area for breeding for this small population of Burrunan dolphins that is listed as threatened, with as many as six calves born in the austral summer of 2012 - 2013 (Filby, unpublished data). However, there

is a history of calf mortality due to vessel strike in PPB (Warren-Smith & Dunn, 2006). Given high levels of non-compliance (Chapter Two; Filby et al., 2015; Scarpaci et al., 2003; Scarpaci et al., 2004) and the significant increase in effect responses to tour vessels by dolphins reported herein, a shift from passive (i.e. minimal enforcement presence and reliance on outreach material) to active (i.e. officers policing waters within PPB on a daily basis and sanctioning fines for breaches of regulations/loss of permits for multiple breaches) management in PPB is warranted. If active management cannot be implemented due to resource limitations, then it is suggested that the continued existence of the dolphin tourism industry be questioned since it may not be appropriate for this particular population in PPB.

4.6 Conclusions

Burrunan dolphins in PPB have altered their responses to tour vessels over time, with dolphins showing an increase in effect responses towards tour vessels across 15 years. Combined with a decrease in sighting success, these results suggest that the population of dolphins in PPB is not well suited to the dolphin-swim industry. Management of the industry must consider not only how to regulate and enforce how tour vessels approach dolphins, but also how dolphins respond to tour vessels. Even seemingly positive encounters could have deleterious long-term effects on the population by detracting from biologically significant behaviours such as foraging, nursing and resting. This study highlights the importance of long-term data sets, as the results from either period alone are insufficient to give an indication of the effects the dolphin-swim industry has on this population. However, by examining the short-term comparative studies concurrently, this study has gained valuable insight into behavioural changes that have occurred over time, and responses resembling habituation have been detected.

Chapter Five

Effects of dolphin-swim tour vessels on the behaviour of Burrunan dolphins (*Tursiops australis*)



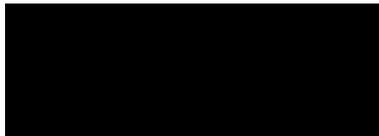
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Filby et al. (in review) Effects of dolphin-swim tour vessels on the behaviour of Burrunan dolphins (*Tursiops australis*). *Endangered Species Research*.

**Declaration of co-authorship and co-contribution: papers
incorporated in thesis by publication**

Declaration by: Nicole Erin Filby

Signature:



Date: 26th of October 2015

Paper Title: Effects of dolphin-swim tour vessels on the behaviour of Burrunan dolphins (*Tursiops australis*)

In the case of the above publication, the following authors contributed to the work as follows:

Name	Contribution %	Nature of Contribution
Nicole Filby	75	Study concept, experimental design, fieldwork, data collection, statistical analysis and interpretation, manuscript writing,
Carol Scarpaci	10	Study concept, experimental design, manuscript editing
Fredrik Christiansen	10	Advice on statistical analysis and interpretation, manuscript writing, manuscript editing
Karen Stockin	5	Manuscript editing

Declaration by co-authors

The undersigned certify that:

1. They meet criteria for authorship in that they have participated in the conception, execution or interpretation of at least that part of the publication in their field of expertise;
2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. There are no other authors of the publication according to these criteria;
4. Potential conflicts of interest have been disclosed to **a)** granting bodies, **b)** the editor or publisher of journals or other publications, and **c)** the head of the responsible academic unit; and
5. The original data is stored at the following location(s):

Location(s): College of Engineering and Science, Victoria University, Melbourne, Victoria, Australia

and will be held for at least five years from the date indicated below:

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Nicole Filby		11 th of September 2015
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5.1 Abstract

Burrunan dolphins (*Tursiops australis*) are frequently targeted by tourism operations in Port Phillip Bay, Australia, yet there is a paucity of data on the potential effects of this industry on this species. Thus, this study aimed to provide first insights into whether dolphin-swim tour vessels in Port Phillip Bay affect the behaviour of Burrunan dolphins via the use of Markov chain models. The presence of dolphin-swim tour vessels affected all four behavioural states of the dolphins. When tour vessels were present, the time Burrunan dolphins spent foraging was significantly reduced, with average foraging bout length decreasing by 1.8 min, foraging recovery time increasing by 10 min, and the probability of transitioning from foraging to milling increasing four-fold compared to control conditions. Conversely, dolphins spent significantly more time socialising in the presence of tour vessels, with average socialising bout length increasing by 3.7 min, socialising recovery time decreasing by 86%, and the probability of transitioning from socialising to socialising increasing by 23.3%. The reduction in time spent foraging when dolphin-swim tour vessels are present could lead to a decrease in dolphins' rate of energy acquisition, whilst the increase in socialising could increase dolphins' energy expenditure. Collectively, this may lead to reduced biological fitness with population level consequences. However, although the short-term activity budget of the dolphin population was significantly affected, dolphin-swim tour vessels did not significantly affect the cumulative behavioural budget of Burrunan dolphins, indicating that this industry may be sustainable, and highlighting that it cannot always be assumed that cetacean tourism has negative effects on the targeted population.

5.2 Introduction

In recent decades, interest in wildlife tourism has grown significantly worldwide. Cetacean-based tourism is one of the fastest growing global industries, occurring in over 119 countries (Hoyt, 2001). It is the largest current economic activity dependent upon cetaceans (Parsons, 2012), with over USD\$2.1 billion generated in revenue worldwide in 2008 (O'Connor et al., 2009). In Australia more than 1.6 million tourists participate each year, contributing over \$29 million to the Australian economy (O'Connor et al., 2009). These human interactions with cetaceans have the potential to increase participants' knowledge levels and pro-conservation actions (Chapter Two; Filby et al., 2015), enhance participants' values for the targeted species (Orams, 1997) and improve participants' well-being (Curtin, 2006). Further, it is an economically viable alternative to whaling and viewing cetaceans in captivity. However, the rapid expansion of this industry has raised concerns over impacts on the targeted species (Bejder et al., 2006a; Higham & Bejder, 2008; Higham et al., 2014; Lusseau & Bejder, 2007).

Short-term responses of cetaceans to tourism include changes in: behaviour (Allen & Read, 2000; Arcangeli & Crosti, 2009; Christiansen et al., 2013; Constantine et al., 2004; Dans et al., 2008; Lusseau, 2003a; Lusseau et al., 2009; Meissner et al., 2015; Peters et al., 2013; Steckenreuter et al., 2012; Stockin et al., 2008; Williams et al., 2006); swimming speed and direction (Christiansen et al., 2014; Janik & Thompson, 1996; Lemon et al., 2006; Nowacek et al., 2001; Timmel et al., 2008; Williams et al., 2002); respiration and dive characteristics (Janik & Thompson, 1996; Lusseau, 2003b; Miller et al., 2008; Ng & Leung, 2003; Nowacek et al., 2001; Richter et al., 2006); group cohesion (Bejder et al., 1999; Hastie et al., 2003; Miller et al., 2008; Nowacek et al., 2001; Tosi & Ferreira, 2009); communication (Buckstaff, 2004; Luís et al., 2014; Pirotta et al., 2015; Scarpaci et al., 2000a; Sousa-Lima & Clark, 2008; Van Parijs & Corkeron, 2001) and habitat use (Allen & Read, 2000; Bejder et al., 1999; Bejder et al., 2006a; Courbis & Timmel, 2009). These impacts raise concerns relating to the sustainability of cetacean-based tourism as short-term changes can lead to long-term consequences (Christiansen & Lusseau, 2015).

Long-term exposure to tourism may affect cetaceans by: increasing stress (Romano et al., 2004); increasing daily energetic costs (Christiansen et al., 2013; Christiansen et al., 2014; Williams et al., 2006); causing short-term displacement from habitat (Bejder et al., 2006b); decreasing reproductive success (Bejder, 2005) and/or increasing mortality rates (Courbis & Timmel, 2009; Dans et al., 2008) for individuals and their populations (Constantine, 2001; Lusseau & Bejder, 2007). However, responses vary greatly depending on the target species, the type of tourism undertaken and the location (Orams, 2004).

The population of dolphins that inhabit Port Phillip Bay (PPB) has recently been identified as a new species, the Burrunan dolphin (*Tursiops australis*) based on multiple lines of genetic and morphological evidence (Charlton-Robb et al., 2011; Charlton-Robb et al., 2015). Burrunan dolphins are endemic to Australia and are recognised as threatened under the Victorian Flora and Fauna Guarantee Act, 1988. This population is considered vulnerable to extinction due to its small size (approximately 80 - 100 individuals) (Charlton-Robb et al., 2015; Hale, 2002; Warren-Smith & Dunn, 2006), genetic distinctiveness (Charlton-Robb et al., 2011; Charlton-Robb et al., 2015), restricted home range, female natal philopatry (Hale, 2002) and anthropogenic pollution (e.g. individuals may become highly contaminated with mercury, Monk et al., 2014). This population's vulnerability is further exacerbated by their high site fidelity in the southern coastal waters of PPB (Scarpaci et al., 2000b; Scarpaci et al., 2003). This coastal distribution (Chapter Three; Charlton-Robb et al., 2011) increases their risk of exposure to a number of threats, including a non-compliant commercial dolphin-swim industry (Chapter Two; Filby et al., 2015; Scarpaci et al., 2004) and vessel strike (Dunn et al., 2001) due to the high level of vessel (commercial and recreational) activity in the bay. Given the aforementioned, the population of Burrunan dolphins in PPB may be especially vulnerable to human disturbance.

The PPB dolphin population has been exposed to commercial dolphin-swim tourism since 1986 (Jarvis & Ingleton, 2001). Currently, three licenced swim-with dolphin tour operators, comprising four vessels operate in PPB. In addition,

there is a fourth company which is licenced for dolphin watching both within and outside the bay. Swim-with-dolphin tours operate between October and May each season, with each vessel running a maximum of two trips daily. The swim-with-dolphin tour vessels are generally on the water from 0830 to 1800. There is also a large number of other vessels which utilise the bay on a daily basis including: container ships; ferries; commercial fishing boats; cruise ships; recreational boats; yachts; jet skis and kayaks. Over weekends, particularly during summer months, there is a pronounced increase in the number of recreational vessels utilising PPB (Weir et al., 1996), subsequently increasing the need for additional enforcement officers during this period to ensure adherence to the Wildlife (Marine Mammal) Regulations, 2009.

Interactions with dolphins in Victorian waters are governed by the Wildlife (Marine Mammal) Regulations, 2009, and there are specific regulations pertaining to the swim-with-dolphin tourism industry. The Department of Environment, Land, Water and Planning is currently the body responsible for enforcing these regulations. However, the swim-with dolphin tourism industry in PPB is historically non-compliant with regulations (Chapter Two; Filby et al., 2015; Scarpaci et al., 2004). This negatively impacts this industry as dolphins approach tour vessels more frequently when legal approaches are utilised and exhibit higher levels of avoidance to illegal approaches (Chapter Four; Filby et al., 2014).

Recent research reveals that the way dolphins respond to dolphin-swim tour vessel approaches has changed over time, with significant increases in approach (i.e. > 50% of a group approached the tour vessel, repeatedly interacting with the vessel and/or swimmers) and avoidance (i.e. > 50% of a group changed their direction of travel away from the tour vessel vessel) responses from 1998 to 2013 (Chapter Four; Filby et al., 2014). Thus, these dolphins are forced to expend greater levels of energy during tourism interactions (Chapter Four; Filby et al., 2014). This is of concern, given that recent research indicates that PPB is an important foraging and nursery ground for Burrunan dolphins (Chapter Three; Scarpaci et al., 2010a) and that groups

containing calves are those most likely to avoid tour vessels (Chapter Four; Filby et al., 2014).

Within the published literature there are currently no data describing the effects of dolphin-swim tourism on the behavioural states of Burrunan dolphins. However, research utilising Markov chain modelling for bottlenose dolphins (*Tursiops* spp.) indicates that social, rest and forage behaviours substantially decrease in the presence of tour vessels (Christiansen et al., 2010; Lusseau, 2003). Understanding whether tourism activities affect the behavioural budget of the PPB population of Burrunan dolphins is of critical importance as this threatened population is in the presence of tour vessels for much of the day, especially over the busy summer months.

The aim of this study was to assess the short-term effects of tour vessels on the surface behaviour of Burrunan dolphins in PPB. Using Markov chain analyses, the effects of tourism on behavioural budgets will be assessed, as this can then be interpreted in terms of energetic costs, providing information on the biological significance of an impact on the population. Further, this study aimed to determine whether disturbances caused by this industry affect the seasonal activity budget of the population, by calculating the cumulative exposure of Burrunan dolphins to dolphin-swim activities in PPB. Findings will be used to inform management and provide tailored recommendations that can be implemented into a management framework for this population.

5.3 Materials and methods

5.3.1 Study site

Port Phillip Bay (38°05'S, 144°50'E) is situated on the south-eastern coast of Victoria, with the major metropolitan cities of Melbourne (37°48'49"S, 144°57'47"E) and Geelong (38°09'0"S, 144°21'0"E) bordering its coastline (Figure 5.1). It is the largest bay in Victoria, covering 1,940 km². The bay has an oceanic climate, supporting a diverse and dynamic ecosystem, with high biodiversity. With a maximum depth of 24.0 m (mean = 13.6 m) the bay

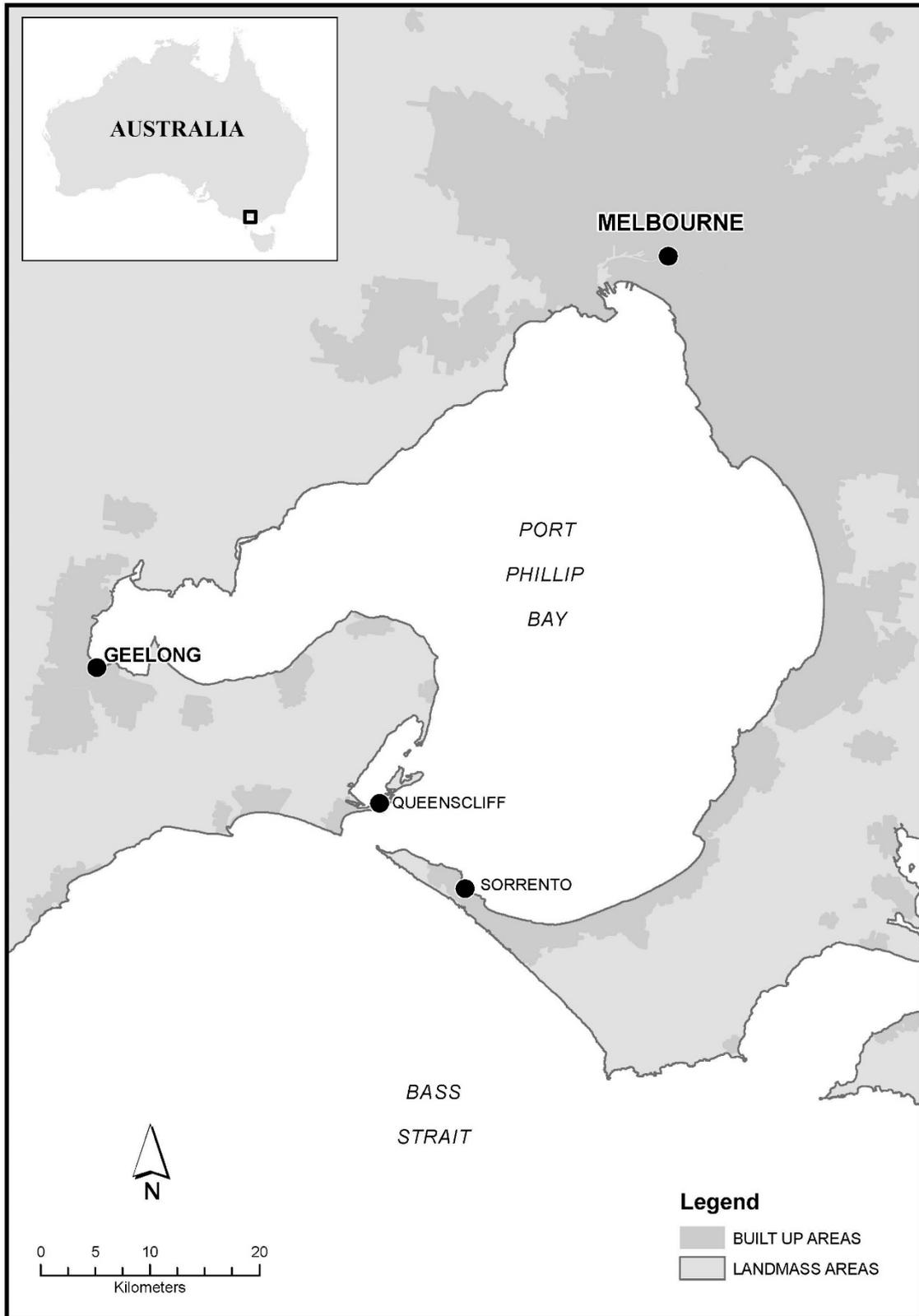


Figure 5.1 Location of Port Phillip Bay, Victoria, Australia, depicting Queenscliff and Sorrento where the dolphin-swim tour vessels depart.

provides a relatively shallow environment. Burrunan dolphins display high site fidelity in the southern end of PPB (Scarpaci et al., 2003; Scarpaci et al., 2004; Warren-Smith & Dunn, 2006), frequently foraging in this region (Chapter Three). With dolphins frequently observed in southern PPB year round, tour vessels operate in this region, departing from Sorrento and Queenscliff (Figure 5.1).

5.3.2 Data collection

Behavioural observations of dolphin groups in PPB were conducted between November 2010 and May 2013, using focal-group follows. A dolphin group was defined as two or more animals in which no individual was further than 10 m from its nearest conspecific (Smolker et al., 1992). Data were collected from two observation platforms: 1) an acoustically conservative independent research vessel, the *Pelagia*, a 6.5 m platform, powered by two 100-horsepower, four stroke Yamaha engines (Figure 5.2); and 2) a tour vessel the *Maureen M*, of 10.88 m length and with a 110 horsepower engine (Figure 5.2). Only surveys conducted in sea states of Beaufort 3 or less were used in the analysis.

From both observation platforms the study area was searched non-systematically to locate dolphins (Hartel et al., 2014; Stockin et al., 2008). Once dolphins were detected the research vessel slowed to an approach speed (~ 2 – 4 knots) and manoeuvred towards the group in a consistent manner that minimised impacts on the dolphins (Lusseau, 2003a). Thus, dolphins were always approached from the side and rear, with the research vessel moving in the same direction as the group. Further, rapid changes in speed, shifts of gear and change of course by the research vessel were avoided (Christiansen et al., 2010). When conducting a follow, the speed of the research vessel always matched that of the group, and a distance of 50 m or more from the focal group was always maintained. This protocol was maintained when tour vessels were present and thus the state of the research vessel remained consistent in all control and impact scenarios. Consequently, any differences in observed behaviour would relate only to the presence of the tour vessel. In contrast, tour vessels usually approached dolphins at higher speeds and to a much closer

range (< 5 m), approaching groups using J (tour vessel initially travelled parallel to a group, but then moved directly in front of the group) and direct approaches (tour vessel positioned directly into the middle of a group), in addition to parallel approaches (tour vessel positioned to the side of a group, Chapter Four; Filby et al., 2014, Appendix 3: Table B, Figure A).

During a focal follow (regardless of the observation platform) the time, behavioural data and presence/absence of tour vessels were recorded every 3 min using focal-group scan sampling (Altmann, 1974). Five behavioural states were identified (Table 5.1) modelled on Shane et al., (1986) and modified from the definitions used by Filby et al., (2013) and Scarpaci et al., (2010). The predominant behaviour was determined as the behavioural state in which more than 50% of dolphins were involved (Stockin et al., 2008; Stockin et al., 2009). These behavioural states were mutually exclusive and, collectively, described the entire behavioural repertoire of the dolphins observed. Focal follows terminated when the weather deteriorated, animals were lost (10 min elapsed without a sighting) or when daylight hours ended, and the end of an observation was not therefore dependent upon the behaviour of the focal group (Ingram & Rogan, 2002).

Control scenarios were defined as situations where only the research vessel was within 300 m of the focal group, whereas situations when a tour vessel was within 300 m of the group were treated as impact scenarios. This distance of 300 m is consistent with Wildlife (Marine Mammal) Regulations, 2009. For analyses, scan samples up to 15 min post an interaction where a tour vessel was present within 300 m of the focal group were classified as impact scenarios, whereas scans greater than 15 min post an interaction where a tour vessel was present were deemed as control sequences. Observations from the research vessel were used to collect data in both control and impact scenarios, whereas observations from aboard the tour vessel were used only to collect data from impact scenarios. Due to the small sample size, it was not possible to test the effect of different numbers of tour vessels on dolphin behaviour.



Figure 5.2 Research vessel (*Pelagia*) and tour vessel (*Maureen M*) utilised for surveys in Port Phillip Bay, Victoria, Australia. Photos: Victorian Marine Science Consortium (*Pelagia*) and author (*Maureen M*).

Table 5.1 Behavioural states used to assess the behavioural budget of Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Victoria, Australia (modified from Filby et al., 2013; Scarpaci et al., 2010a and Shane et al., 1986).

Behavioural State	Definition
Travel	Consistent and directional movement, making noticeable headway along a specific compass bearing, with short, relatively constant dive intervals
Forage	Perusal, capture and/or consumption of prey, as defined by observations of two or more of the following: erratic movements at the surface; multi-directional diving; coordinated deep diving; fish chasing; and rapid circle swimming. Prey often observed at the surface
Mill	Non-directional movement. Frequent changes in bearing prevented dolphins from making noticeable headway in any specific direction. Individuals surfaced facing various directions
Rest	Low activity level, with surfacing slow (slower than the idle speed of the observing boat) and more predictable than those observed in other behavioural states. Tight groups (< 1 body length between individuals) observed, with little evidence of forward propulsion
Social	Chasing, copulating, petting, rubbing, genital inspections, play and any other physical contact between individuals. Aerial behaviours such as breaching frequently observed

5.3.3 Effect of tour boat interactions

5.3.3.1 Transition probabilities

Markov chains were used to investigate the effect of tour vessels on the behaviour of Burrunan dolphins while taking into account the temporal dependence between behavioural states (Christiansen et al., 2010; Lusseau, 2003a). A first-order Markov chain was used, which estimates the transition probabilities between preceding and succeeding behavioural states. The time series of behavioural states resulting from each focal follow was first tallied into two contingency tables, one for control and one for impact situations. From the resulting matrices, the transition probability, p_{ij} , between the preceding behavioural state i and the succeeding behavioural state j was estimated (Christiansen et al., 2010; Lusseau, 2003a):

$$p_{ij} = \frac{a_{ij}}{\sum_{j=1}^n a_{ij}}, \sum_{j=1}^n p_{ij} = 1$$

where n is the total number of behavioural states, a_{ij} is the number of transitions observed from behavioural state i to j . The effect of tour vessels on the transition probabilities between behavioural states was tested by comparing the control and impact contingency tables, using a chi-squared test. The effect of tour vessels on each transition probability was tested by comparing each control transition to its corresponding impact transition, using a 2-sample test for equality of proportions with continuity correction.

5.3.3.2 Behavioural budgets

By Eigen analysing the contingency tables, the dolphins' behavioural budgets (i.e. the proportion of time dolphins spend in each behavioural state) were estimated in the presence and absence of tour vessels (see Lusseau (2003a) for details of analysis). The two behavioural budgets were compared using a

chi-squared test and 2-sample tests for equality of proportions were used to compare each control behavioural state proportion to its corresponding impact proportion.

5.3.3.3 Average bout length

The average bout length (i.e. number of transitions that the dolphins spent in each behavioural state) of each behavioural state, t_{ii} , was estimated in the presence and absence of four vessels (Guttorp, 1995):

$$t_{ii} = \frac{1}{1 - p_{ii}}$$

where p_{ii} is the probability that a dolphin group remained in a given behavioural state at the next time step. By multiplying t_{ii} with the sample interval length (i.e. 3 min) the bout length, expressed in minutes, was derived. The standard error (SE) around each bout length estimate was calculated (Guttorp, 1995):

$$SE = \sqrt{\frac{p_{ii} * (1 - p_{ii})}{n_i}}$$

where n_i is the number of transitions with i as preceding behavioural state. The average bout length for each behavioural state was compared using a t-test.

5.3.3.4 Recovery time

The average time it took a dolphin group to return to a given behavioural state, the recovery time, was estimated in the presence and absence of tour vessels (Stockin et al., 2008):

$$E(T_j) = \frac{1}{\pi_j}$$

where T_j is the number of transitions required to return to state j given that the dolphins are currently in state j , and π is the steady-state probability of each behavioural state in the Markov chain. By multiplying T_j with the sample interval length (i.e. 3 min), the recovery time (min) was derived.

5.3.3.5 Tour vessel exposure

Simulations were run to estimate the yearly exposure of individual dolphins to tour vessels, based on the daily number of dolphin-watching trips throughout the year: winter = 0 trips per day; spring = 3 trips per day; summer = 6 trips per day; and autumn = 4 trips per day. The number of dolphins in the PPB population was set at 100 (Charlton-Robb et al., 2015; Warren-Smith & Dunn, 2006) and then estimated the yearly frequency, f_d , of interactions with tour vessels for each individual dolphin, d (Christiansen et al., 2015):

$$f_d = \sum_{w=1}^W \text{Bernoulli}(E_w)$$

where W is the total number of dolphin-watching trips in the year (i.e. 1,187) and E is the probability of encountering an individual dolphin d on a given trip w , assumed to be 46.6% (Chapter Four; Filby et al., 2014). The cumulative interaction time (min) with tour vessels throughout the year was then estimated

by randomly allocating a duration to each interaction, f_d , based on the distribution of observed encounter durations (mean = 27 min, SD = 17, min = 2, max = 92, $n = 104$) between dolphin-watching vessels and dolphins in PPB, and summing up the result (Christiansen et al., 2015).

5.3.3.6 Cumulative behavioural budgets

Based on the estimated exposure to tour vessels through the year, the dolphins' cumulative behavioural budget was estimated (Christiansen et al., 2010; Lusseau, 2003a). This budget takes into account the proportion of time that dolphins spend with tour vessels throughout the year. By comparing the cumulative behavioural budget to the dolphins' undisturbed behavioural budget (i.e. their control budget) it is possible to measure the effect of vessel interactions on the dolphins' yearly behavioural budget. The cumulative behavioural budget was estimated (Christiansen et al., 2010; Lusseau, 2003a):

$$\text{Cumulative budget} = (a * \text{impact budget}) + (b * \text{control budget})$$

where a is the proportion of daytime hours (ranging from 0 to 1) that dolphins spend with tour vessels (thus following a behavioural budget similar to the impact chain) on average through the year (cumulative interaction time/(365 days * 12 hours * 60 min)), and b is the remaining proportion of time per day (1- a) that dolphins spend without tour boats present (thus following a behavioural budget similar to the control chain).

All analyses were performed in R 3.0 (R Core Team 2013).

5.4 Results

5.4.1 Field effort

From November 2010 to May 2013, 112 hours over 96 days were spent undertaking focal follows. A total of 153 (research vessel = 50; tour vessel =

103) independent Burrunan dolphin groups were observed. The mean observation time per group from the research vessel was 80 min (SE = 11.2, range = 2 to 291 min, $n = 50$) and 27 min (SE = 1.7, range = 2 to 92 min, $n = 103$) from the tour vessel. During the study period, a total of 1912 behavioural transitions were recorded, of which 951 and 961 were control and impact transitions, respectively. Due to small sample size ($n = 65$) of transitions involving the behavioural state 'rest' this state had to be excluded from the analyses leaving 923 (50.0%) and 924 (50.0%) for control and impact transitions, respectively. These transitions were collected over 47 control sequences and 102 impact sequences. Control sequences (mean = 64.3 min, SE = 9.4, range = 5 to 251 min) were on average 35 min longer than impact sequences (mean = 29.2 min, SE = 1.8, range = 5 to 89 min).

5.4.2 Effect of tour boat interactions

5.4.2.1 Transition probabilities

Tour vessel interactions significantly affected dolphins' behavioural state transitions (Goodness-of-fit test, $\chi^2 = 116.60$, $df = 9$, $p = < 0.001$). However, observed effects were not homogenous amongst all transitions, with 4 transitions being significantly influenced by the presence of tour vessels (Figure 5.3). Transitions Travel \rightarrow Mill ($\chi^2 = 10.06$, $p = 0.002$), Forage \rightarrow Mill ($\chi^2 = 4.52$, $p = 0.033$) and Social \rightarrow Social ($\chi^2 = 9.17$, $p = 0.002$) all increased significantly when tour vessels were present with dolphins. Conversely, the other notable transition, Social \rightarrow Travel ($\chi^2 = 6.03$, $p = 0.014$), decreased significantly in the presence of tour vessels. The magnitude of difference in transition probability was not homogenous for all transitions. Dolphins were twice as likely to start milling after being in a travel state (Travel \rightarrow Mill: 12.7% - 6.9%) and 4 times more likely to commence milling when originally foraging in the presence of tour vessels (Forage \rightarrow Mill: 9.7 - 2.7%). Dolphins were 23.3% more likely to stay in a socialising state (Social \rightarrow Social: 66.4 - 43.1) when tour vessels were present. The probability of travelling after being in a socialising state decreased by 17.9% in the presence of tour vessels. When an increase in transition

probability was detected, milling and/or socialising were the most frequently observed succeeding behavioural states (Figure 5.3).

5.4.2.2 Behavioural budgets

The behavioural budget of Burrunan dolphins was significantly affected by the presence of tour vessels (Goodness-of-fit test, $\chi^2 = 46.74$, $df = 3$, $p = < 0.001$; Figure 5.4). Dolphins spent significantly more time milling ($\chi^2 = 19.62$, $p < 0.001$) and socialising ($\chi^2 = 16.90$, $p < 0.001$) when in the presence of tour vessels, to the detriment of foraging ($\chi^2 = 8.59$, $p = 0.003$) and travelling ($\chi^2 = 15.78$, $p < 0.001$).

5.4.2.3 Average bout length

Average bout length varied considerably between control and impact situations (Table 5.2). Average bout length for travelling dolphins decreased significantly by 3.0 min (95% CI: 2.9 to 3.1 min; $t = 43.30$, $p < 0.001$, $df = 1096$) when tour vessels were present. Bout length also decreased significantly by 1.8 min for foraging dolphins (95% CI: 1.5 to 2.1 min; $t = 10.91$, $p < 0.001$, $df = 251$) in the presence of tour vessels. Furthermore, when tour vessels were present, average bout length for socialising dolphins increased significantly by 3.7 min (95% CI: 4.1 to 3.3 min; $t = 17.06$, $p < 0.001$, $df = 192$).

5.4.2.4 Recovery time

Foraging dolphins took longer to return to their initial behavioural state in the presence of tour vessels, with the time required to return to foraging extending by 31.9%, from 21 to 31 min (Table 5.3). Conversely, when tour vessels were present there was an 86.0% reduction in the amount of time socialising dolphins took to return to their initial behavioural state compared to control situations.

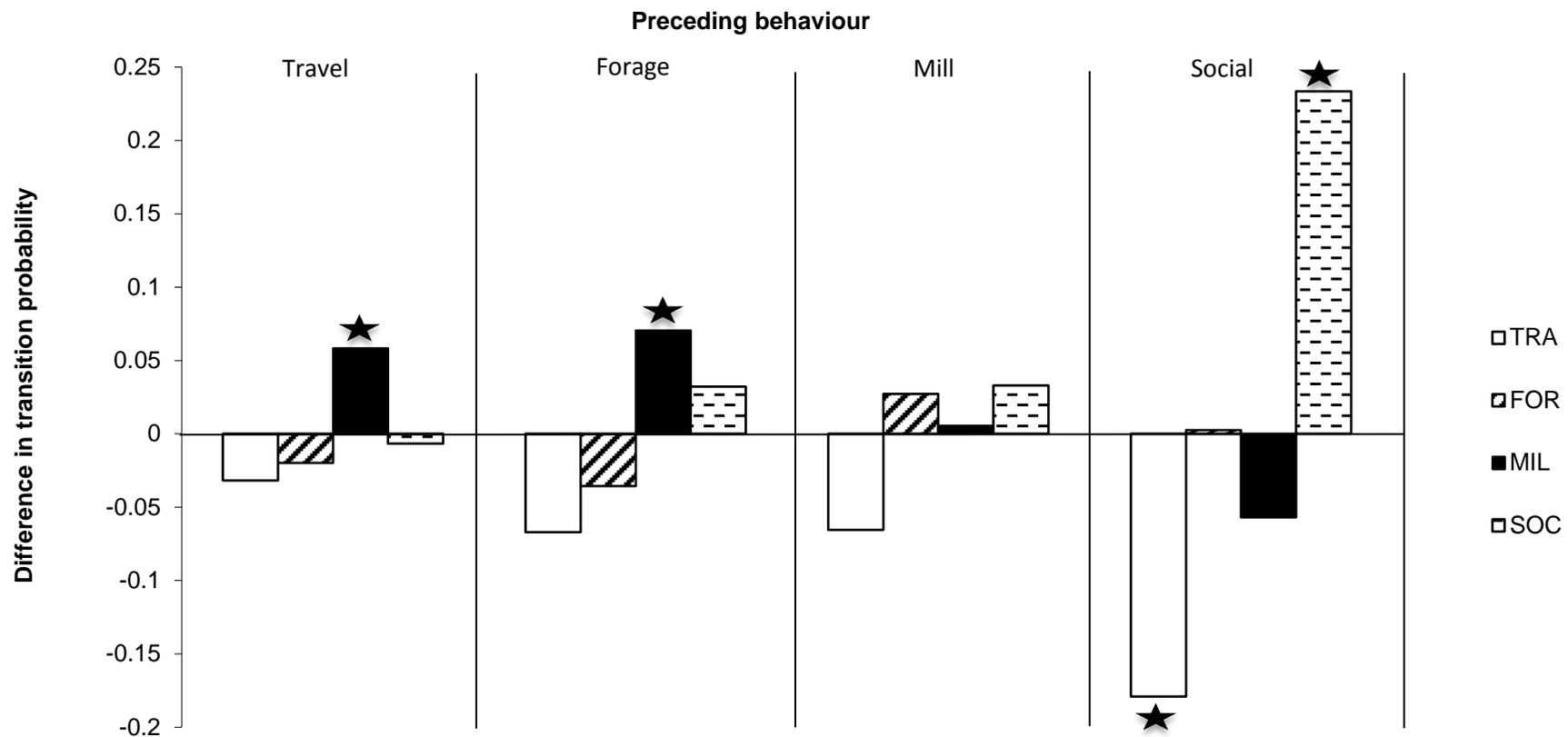


Figure 5.3 Differences in transition probabilities between control (research vessel only present) and impact (research vessel and tour vessel(s) present) situations for Burruran dolphins' (*Tursiops australis*) behavioural states. Vertical lines separate each preceding behavioural state, and bars represent the succeeding behavioural states (refer to legend). Transitions with a significant difference ($p < 0.05$) are denoted with a ★.

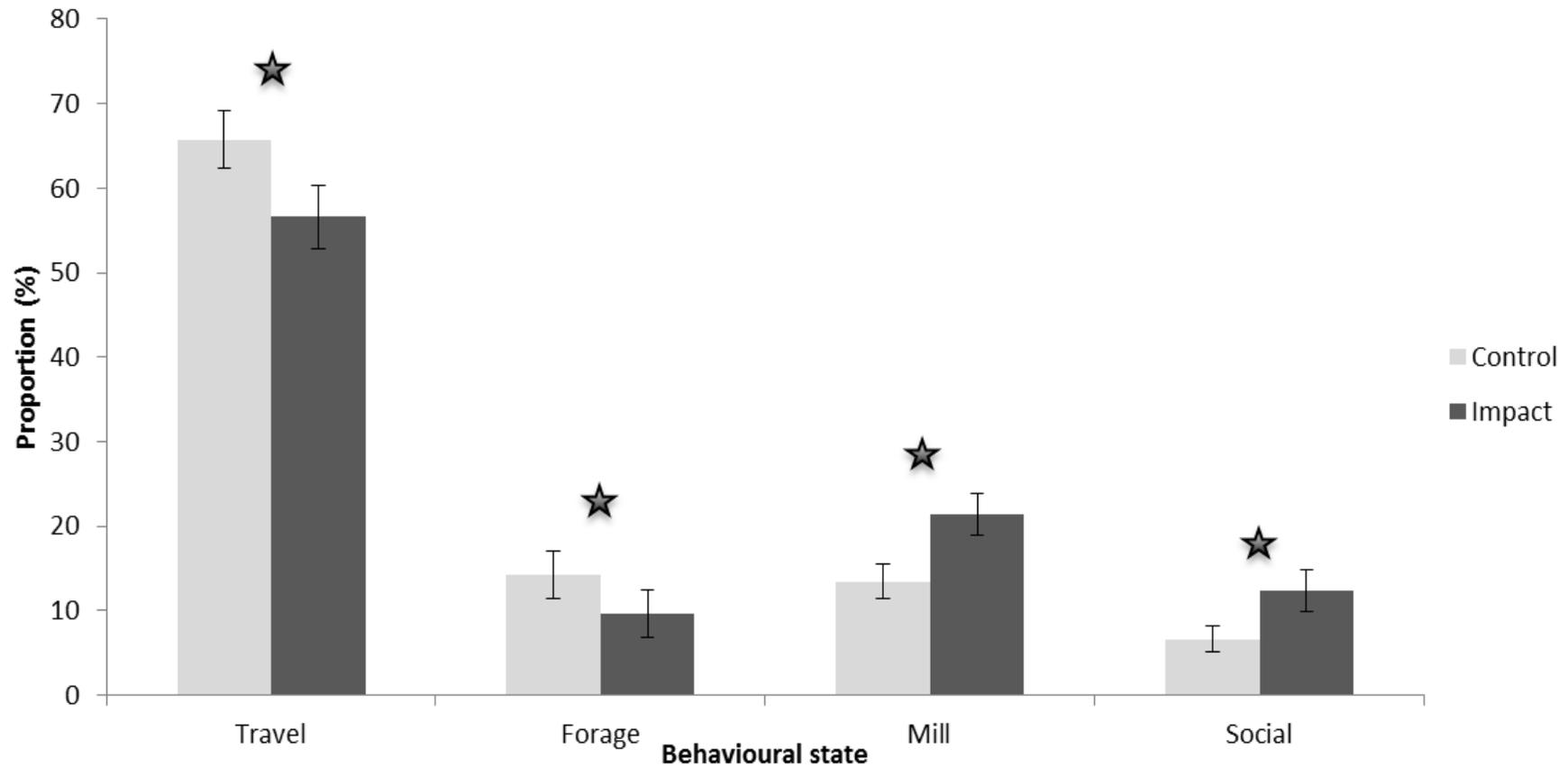


Figure 5.4 Effect of tour vessel interactions on the behavioural budget of Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Australia. Proportion of time spent in each behavioural state during control (research vessel only present) and impact (research vessel and tour vessel(s) present) situations. Error bars represent 95% confidence intervals. (★) indicates significant differences ($p < 0.05$).

Table 5.2 Average bout length (min) of Burrunan dolphins (*Tursiops australis*) during control (research vessel only present) and impact (research vessel and tour vessel(s) present) situations in Port Phillip Bay, Australia.

Behavioural state	Control	SE	Impact	SE
Travel	18.40	0.05	15.40	0.05
Forage	13.24	0.10	11.44	0.13
Mill	6.91	0.14	7.00	0.11
Social	5.27	0.18	8.93	0.13

Table 5.3 Average time (min) for Burrunan dolphins (*Tursiops australis*) to return to their initial behavioural state in control (research vessel only present) and impact (research vessel and tour vessel(s) present) situations in Port Phillip Bay, Australia. \uparrow/\downarrow indicate difference in time (min) that it takes dolphins to return to their initial behavioural state between control and impact situations.

Behaviour	Control - Initial Behavioural State Resumed	Impact-Control	Impact - Initial Behavioural State Resumed
Travel	4.57	\uparrow 0.73	5.30
Forage	21.13	\uparrow 9.90	31.03
Mill	22.33	\downarrow 8.29	14.04
Social	45.09	\downarrow 20.85	24.24

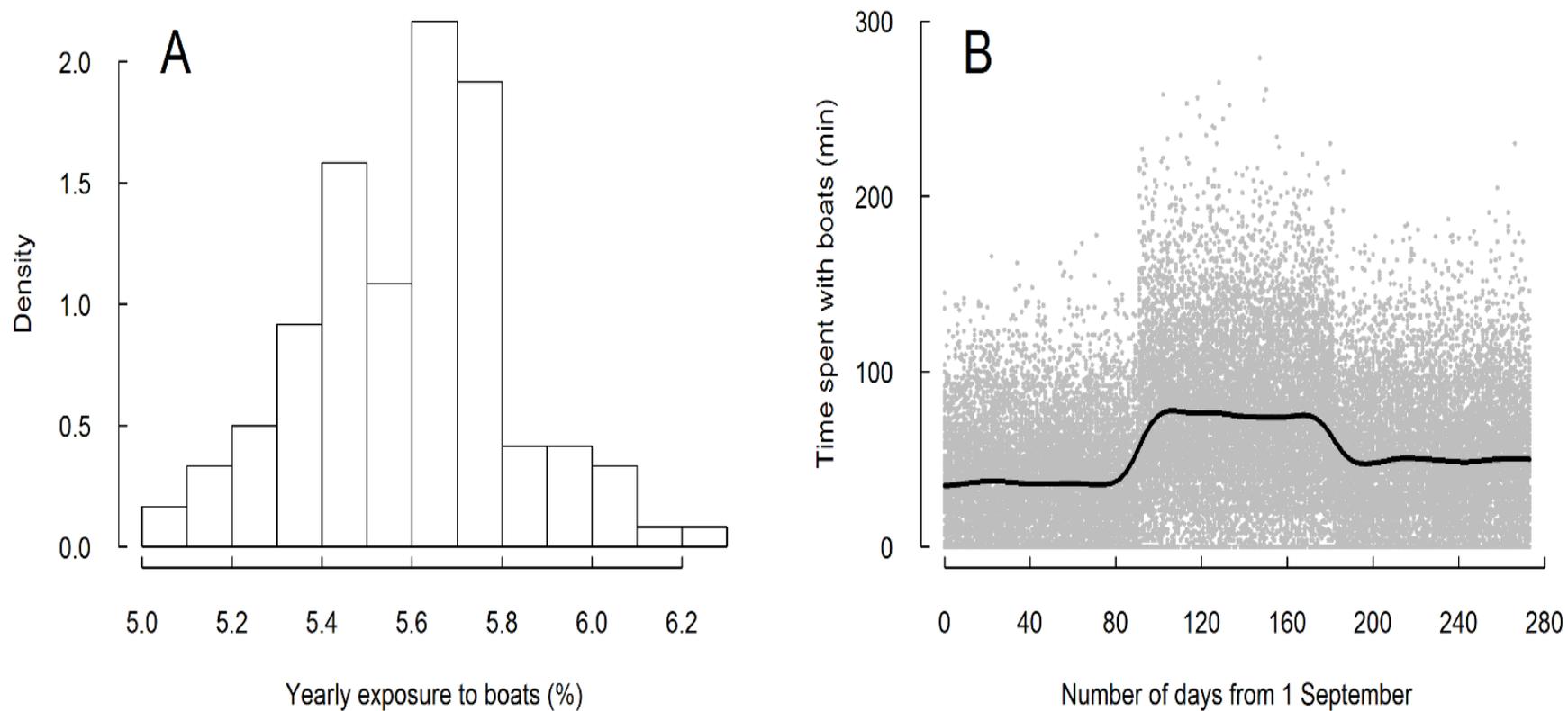


Figure 5.5 (A) Density histogram of the cumulative exposure (proportion of time spent with four vessels) of individual dolphins to swim-with-dolphin vessels through the year. **(B)** Seasonal variation in exposure (time spent with vessels) for individual dolphins through the year. A cubic smoothing spline (black solid line) has been fitted, with degrees of freedom set to 20. Since there were no trips in winter, those data have been omitted. The figures are based on model estimates.

5.4.2.5 *Tour vessel exposure*

The yearly estimated cumulative exposure to tour vessels varied between individuals (Figure 5.5A). Throughout the year, the average proportion of time individual dolphins spent with tour vessels each day was 5.6% (range: 5.0 - 6.2%) or 40 min. The estimated exposure of Burrunan dolphins to dolphin-swim boats varied through the year and also between individuals (Figure 5.5B), as a function of seasonal variation in the number of dolphin-swimming trips.

5.4.2.6 *Cumulative behavioural budgets*

There was no significant effect of tour vessels on the cumulative behavioural budget of dolphins (Goodness-of-fit test, $\chi^2 = 0.23$, $df = 3$, $p = 0.973$).

5.5 Discussion

This study aimed to determine if dolphin-swim tour vessels in PPB affect the behaviour of Burrunan dolphins. Findings add support to the growing body of research that expresses concerns over the potential impacts of the cetacean-based tourism industry (e.g. Christiansen et al., 2010; Lundquist et al., 2012; Lusseau et al., 2009; Meissner et al., 2015; Stockin et al., 2008; Williams et al., 2006). As with many of these previous studies, significant changes in the behaviour of Burrunan dolphins were detected as a consequence of interactions with dolphin-swim tour vessels in PPB. Transition analyses using Markov chains found that the presence of tour vessels significantly affected all four of the behavioural states of dolphins analysed. Of importance, when tour vessels were present the time Burrunan dolphins spent foraging was significantly reduced with average foraging bout length decreasing, foraging recovery time increasing and the probability of transitioning from foraging to milling increasing four-fold compared to control conditions. This decrease in time spent foraging during tourism activities could be of importance and result in a decrease in dolphins' rate of energy acquisition (Christiansen et al., 2013). This is of concern given that Burrunan dolphin exposure to tour vessels in PPB is greatest over the austral summer, coinciding with their peak calving season. Disruptions to foraging behaviour during this time is likely to have greater effects on pregnant

or lactating dolphins as they have increased energetic expenses (Kastelein et al., 2002; Reddy et al., 1991). Further, disruptions to foraging may also reduce the time available for females to nurse their calves which may decrease reproductive success and ultimately reduce fitness at both individual and population levels (Stensland & Berggren, 2007).

The small dolphin group sizes in PPB (average group size was 5 animals, Chapter Three) may mean that this population has a higher probability of their foraging behaviours being interrupted by the presence of tour vessels, especially when foraging cooperatively. With more than half of groups encountered in PPB containing less than 5 animals, it is unlikely that some animals continue to forage whilst the rest of the group interacts with tour vessels. This may explain why foraging levels are significantly reduced in the presence of tour vessels (Chapter Three). Alternatively, specific foraging strategies within this population may make them more susceptible to disturbance from tour vessels whilst foraging. However, foraging strategies of this population are unknown and require further research.

In 39% of observations, tour vessels were observed manoeuvring through a group of dolphins, approaching dolphin groups illegally (Chapter Four; Filby et al., 2014). On such occasions it is highly probable that animals within the group would become separated, their communication efficiency would be affected by the underwater engine noise, and prey, if present, would scatter (Guerra et al., 2014; Jensen et al., 2009; Scarpaci et al., 2000a; Williams et al., 2006). For each of these scenarios it would take time for individuals within the group to re-establish contact, thus potentially explaining the significant increase in foraging recovery time for dolphins in the presence of tour vessels that was detected herein, especially if they were foraging co-operatively. Further, the close proximity of dolphin-swim tour vessels to foraging groups is likely to interfere with foraging efficiency (Dans et al., 2008) which may partially explain the reduction in time spent foraging.

Regardless of why disruptions to foraging behaviours occur when tour vessels are present, this is likely to lead to a substantial decrease in energy gain opportunities for these individuals. To reduce disruptions to Burrunan dolphins' foraging bout lengths, recovery time and transition probabilities, it is recommended that management should start to actively enforce compliance with regulations within areas highlighted as foraging hotspots (Chapter Three) for Burrunan dolphins within PPB. Given that Burrunan dolphins are most sensitive to the presence of tour boats when they are foraging, it is recommended that management regulate the total number of times tour vessels are allowed to interact with dolphins that are in a foraging state per day, by defining an acceptable limit.

When tour vessels were present dolphins spent significantly more time milling to the detriment of travelling as well as to foraging. For many delphinid populations travelling is the predominate behaviour observed in control situations (Filby et al., 2013; Hanson & Defran, 1993; Jones & Sayigh, 2002; Neumann, 2001) and this is also the case for the population of dolphins in PPB (Chapter Three). Previous work suggests that dolphins often engage in travelling in order to locate prey (Dans et al., 2008; Dans et al., 2012; Hanson & Defran, 1993; Shane, 1990). If this is true, then dolphins in PPB that engage in increased levels of milling in the presence of tour vessels may spend less time travelling searching for prey, which could ultimately reduce the health of the population through reduced prey consumption.

Socialising behaviours were significantly disrupted by the presence of dolphin-swim tour vessels, with average socialising bout length increasing as a consequence of the probability of transitioning from socialising to socialising increasing when dolphin-swim tour were vessels present. Socialising bout lengths may be longer in the presence of tour vessels if dolphins have learnt over time to use tour vessels as a cue to find conspecifics (Martinez, 2010). This is a likely scenario in PPB given that mating behaviours were frequently observed whilst dolphins were socialising around tour vessels. Given that socialising dolphins are attractive to tour vessels because their active surface behaviour is exciting for tourists to observe, it is likely that tour operators target

groups that are socialising. The increase in socialising behaviours documented in the presence of tour vessels could increase dolphins energy expenditure, which may mean that the biological fitness of the population is reduced (Christiansen et al., 2014). Collectively, when combined with the reduction in time spent foraging when tours vessels are present, this increase in socialising behaviour may lead to reduced biological fitness with population level consequences (Christiansen et al., 2015) as has been documented for other populations (Bejder et al., 2006a; Currey et al., 2009; Lusseau et al., 2006; Williams et al., 2006).

Although the short-term activity budget of the dolphin population was significantly affected, dolphin-swim tour vessels did not significantly affect the cumulative behavioural budget of Burrunan dolphins, with the estimated average cumulative time that individual dolphins spent with tour vessels each day being only 40 min. Thus, although immediate behavioural disruptions caused by dolphin-swim tourism vessels were significant, this study reveals that it cannot always be assumed that cetacean tourism has negative effects on the targeted population (Christiansen & Lusseau, 2015; New et al., 2013). Indeed, the cumulative behavioural budget results of this study suggest that the dolphin-swim tourism industry within PPB is not having long-term effects of biological significance on this small population of Burrunan dolphins, indicating that this industry may be sustainable in its present status. This conclusion would not have been reached if cumulative effects on the dolphins had not been considered. Thus, this study highlights the importance of determining cumulative exposure to tour vessel disturbance when evaluating the effects of tour vessels on a targeted population (Christiansen & Lusseau, 2015; Christiansen et al., 2015).

The individual exposure rate (5.6%) of the PPB dolphins documented here is relatively low compared to exposure rates of other dolphin populations globally, which are often exposed to recurring and prolonged interactions with tour vessels throughout daylight hours, often through most of the year (Christiansen et al., 2010; Williams et al., 2006). This low exposure rate may explain why a non-significant impact on the cumulative activity budget of dolphins was

identified in this study. Presently, the Wildlife (Marine Mammal) Regulations, 2009, limit the number of dolphin-swim permits in PPB and restrict tour vessels to approaching dolphins only 5 times per trip. The cumulative impact of the tourism industry on this population being non-significant may in part be due to these regulations, as they effectively limit the time tour vessels spend with dolphins. The Wildlife (Marine Mammal) Regulations, 2009, were developed based on scientific input (Hale, 2002; Scarpaci et al., 2004), providing an example of researchers and managerial bodies working together successfully to develop protection for a cetacean population. Alternatively, the non-significant cumulative impacts identified herein could be due to the ability of dolphins to compensate for time lost in their behavioural budget (e.g. foraging) when tour vessels are present, as has been suggested by New et al., (2013) for bottlenose dolphins (*Tursiops truncatus*) in the Moray Firth, Scotland.

A limitation of this study was that transitions involving the behavioural state 'rest' had to be excluded from the analyses due to small sample size. It could be assumed that because Burrunan dolphins spend such a small proportion (1.8%, Chapter Three) of their time during the day resting that it is not a critical component of their daytime behavioural budget. Conversely, it could be argued that because dolphins spend such limited time resting during the day any disturbance could be detrimental. Thus, it is recommended that future research on this population obtain a larger sample size for focal follows. This will increase the probability of capturing the proportion of time dolphins spend resting more accurately and allow 'rest' behaviours to be included in analyses. This would enable a more comprehensive assessment of the potential effects of the tourism industry on Burrunan dolphins. This is important given that a number of other studies (e.g. Christiansen et al., 2010; Lundquist et al., 2012; Lusseau, 2003a; Stockin et al., 2008) found that 'rest' behaviours of delphinids significantly decreased in the presence of tour vessels. Disturbance to resting has been shown to: reduce energy reserves; induce physiological stress; cause an increase in heart rate and energetic costs; reduce time available for nursing and could increase the risk of predation due to decreased alertness (Christiansen et al., 2010; Constantine et al., 2004; Stensland & Berggren, 2007). Thus a decrease in 'rest' behaviours caused by the presence of tour

vessels could have significant consequences, possibly leading to a long-term decrease in survival and reproductive success for both individuals and the population (Lusseau et al., 2006).

5.5.1 Management implications

Because the population of Burrunan dolphins in PPB is small, genetically isolated and is listed as threatened, it is strongly urged that management adopt a precautionary approach, capping the number of dolphin-swim permits at its current level of four until such time as biologically valid data are available for resting behaviour for Burrunan dolphins in PPB. If dolphin-swim tourism intensity were to increase, the cumulative exposure levels for dolphins would subsequently increase, potentially acting as a selection force for this population by influencing the fitness of individuals that utilise habitats where exposure to tour vessels is higher (Milner et al., 2007). By increasing the number of permits by even one vessel, significant long-term impacts on a population can occur as was discovered in Shark Bay, Western Australia, for a population of bottlenose dolphins (*Tursiops* sp.) (Bejder et al., 2006a). By applying the precautionary principal and instigating a moratorium, management can help ensure the ongoing sustainability of the dolphin-swim industry in PPB allowing tourists the rare experience to swim with dolphins in the wild, whilst simultaneously increasing their pro-environmental beliefs and biocentric values by implementing effective on-board education (Chapter Two; Filby et al., 2015). This study provides first insights into the management of dolphin-swim tour vessels interactions with Burrunan dolphins, however further research is required to determine what thresholds of interactions are sustainable for this population. The findings presented are vital for helping management effectively protect Burrunan dolphins from avoidable adverse effects of tourism, and by providing baseline information, future research may determine whether effects on the population are changing over time.

Chapter Six

Conclusions and recommendations for dolphin-swim tourism in Port Phillip Bay, Victoria, Australia



6.1 Introduction

Since its inception in California, USA, in the 1950s, the desire to view cetaceans in their natural environment has meant that cetacean-based tourism is one of the fastest growing tourism industries globally (Zeppel & Muloin, 2009). Cetacean-based tourism currently generates over USD\$2.1 billion in revenue worldwide (O'Connor et al., 2009), occurs in over 119 countries (Hoyt, 2001) and involves more than 13 million participants annually (Christensen et al., 2009; Finkler & Higham, 2004; Hoyt, 2001). Thus cetacean-based tourism has developed as an economically viable alternative to unsustainable consumptive uses of cetaceans (e.g. whaling, Chen, 2011; Hoyt, 2001). However, initially little consideration was given to the effects of tourism on target species or how to manage the industry as it was perceived to be less harmful than whaling (O'Connor et al., 2009).

The short-term responses of cetaceans to tourism are now well documented (e.g. Bejder et al., 2006a; Courbis & Timmel, 2009; Janik & Thompson, 1996; Nowacek et al., 2001; Parsons, 2012; Pirodda et al., 2015; Stockin et al., 2008) and this growing body of literature indicates that cetacean-based tourism is not benign. These short-term effects raise concerns relating to the sustainability of cetacean-based tourism as they may lead to long-term impacts. However, for most populations it remains unclear whether short-term behavioural responses to tourism interactions result in long-term biological consequences for the target species. This is due in part to the difficult nature of obtaining long-term data sets, which requires substantial financial support, manpower and foresight. Further, long-term studies on cetaceans are often difficult due to the lack of baseline behavioural, abundance and distribution data for most populations (Bejder & Samuels, 2003). Not surprisingly, only a few long-term studies have been conducted. Results from them indicate that short-term behavioural changes and avoidance tactics may have serious long-term consequences such as: habitat displacement from preferred habitats (Bejder et al., 2006a; Bejder et al., 2006b; Lusseau et al., 2006); sensitisation to tour boat approaches (Constantine, 2001); declining population size (Bejder et al., 2006a; Currey et al., 2009; Lusseau et al., 2006); decreased reproductive success (Bejder, 2005;

Fortuna, 2007) and increased mortality rates (Courbis & Timmel, 2009; Dans et al., 2008) for individuals and their populations (Lusseau & Bejder, 2007).

The difficulties in determining the long-term effects of tourism on cetaceans make managing this industry complex, and management must be considered on a case by case basis due to the inherent differences in political, economic, social, cultural and ecological contexts in each place where cetacean-based tourism occurs. In most instances, management of cetacean tourism is initiated after the industry begins operating, meaning that baseline data on a population's abundance, distribution, habitat use and behaviour are often unavailable. This is the case in Port Phillip Bay (PPB), Victoria, Australia, where there is a thriving dolphin-swim industry that has been in operation since 1986 (Jarvis & Ingleton, 2001). This industry was in operation for 12 years before management implemented the Wildlife (Whales) Regulations, 1998, as a strategy to manage tourism interactions. The target species, the endemic and threatened Burrunan dolphin (*Tursiops australis*), generates considerable revenue for the local economy and is part of the wider cetacean-based tourism industry that is worth over \$29 million to the Australian economy (O'Connor et al., 2009; Valentine et al., 2004).

The lack of baseline data for most cetacean populations makes it difficult to establish conservation parameters that may be utilised by management to gauge the potential effects of the industry on the target population. To counteract these difficulties, Higham et al., (2008) proposed a generalised management framework, whereby once tourism begins, natural scientists need to collect data in control and impact scenarios and social scientists need to evaluate tourists' knowledge, satisfaction and biocentrism. By providing feedback from this research to management and tour operators, such a framework aims to promote sustainability. Management can use this information to review management strategies and, if necessary, make amendments based on scientific advice. Subsequently, tour operators need to modify their behaviour in accordance with changes to management strategies and can incorporate information from visitor surveys to improve their tours.

Thus, this thesis aimed to investigate the effectiveness of current management strategies for the PPB dolphin-swim industry. This was achieved by collecting components of the data proposed in Higham et al., (2008) generalised management framework. Assessment of tour operators' compliance with regulations, dolphins' responses to tour operator approaches (legal vs illegal), dolphin-swim participants' knowledge, satisfaction and biocentrism levels, and dolphin behaviour and habitat use were utilised as evaluation tools to assess the effectiveness of management strategies. In addition, this study provides the first assessment of whether Ticonderoga Bay Sanctuary Zone (TBSZ) is an effective management strategy, providing information on whether the dolphins utilise this area for critical behaviours such as foraging and resting. Effectiveness of regulations as a management tool is also examined by assessing compliance of tour operators to regulations with a longitudinal perspective. Finally, this study makes a significant scientific contribution by identifying and quantifying potential effects the dolphin-swim industry may have on the behaviour of the PPB dolphin population.

This concluding chapter provides an overview of the thesis. The significance of the research findings, recommendations for management, limitations of the study and recommendations for future research are discussed.

6.2 Significance and contributions of research findings

This study was unique, representing the first comprehensive assessment of how tourism affects the behaviour of Burrunan dolphins, and assessing the different management strategies that are, or could be, used to sustainably manage the dolphin-swim industry in PPB. To achieve this aim, all data chapters were inter-related in order to provide an understanding of different management strategies, while providing a more complete representation of the issues posed by the tourism industry. In Chapter Two it was investigated whether regulations are an effective management tool by longitudinally assessing dolphin-swim tour operator compliance with regulations. Once it was determined that compliance levels were negligible, a novel management strategy, that is, whether dolphin-swim participants can evoke tour operator

compliance was investigated in Chapter Two. Here, it was explored whether providing interpretation during dolphin-swim tours is a management strategy that can be utilised to increase participants' biocentric values, making patrons more likely to take conservation actions. The results from Chapter Two provided information that allowed parts of Chapter Three and Four to be addressed: did tour operators follow regulations whilst inside TBSZ to a satisfactory level and what percentage of tour boat approaches were legal and illegal? Chapter Three addressed the efficiency of TBSZ as a management strategy and identified other areas that management could implement as Marine Protected Areas (MPAs) for this population of dolphins. Further, Chapter Three focused on gathering baseline behavioural data for Burrunan dolphins, which in turn allowed the aims of Chapter Four and Five to be addressed, i.e. assessing the responses and short-term behaviour of Burrunan dolphins during tour vessel interactions.

Meeting the aims of the proposed research, this thesis has led to a significant contribution towards a better understanding of the effectiveness of different management strategies utilised in the PPB dolphin-swim industry, which can be applied to other cetacean-based tourism industries. Information provided will enable management and tour operators to better understand the effects this industry has on the endemic and threatened Burrunan dolphin, and allow for best practice management strategies to be implemented based on scientific merit. It is hoped that this will allow management to improve the sustainability of the PPB dolphin-swim industry.

Until now, research had focused primarily on a single management strategy, the effectiveness of regulations (Howes et al., 2012; Scarpaci et al., 2003; Scarpaci et al., 2004). Comparing preliminary work by Scarpaci et al., (2003) and Scarpaci et al., (2004) with data collected herein permitted a longitudinal study which revealed that dolphin-swim tour operators in PPB exhibit historical non-compliance with regulations. Amending regulations over time so that they were simpler and easier to understand did not improve compliance levels, and it is therefore concluded that regulations in the PPB dolphin-swim industry are not an effective management tool. It is proposed that in the absence of government

enforcement (which is the case in many instances, due to lack of funding) there needs to be a shift from ownership (i.e. accountability for their actions that affect dolphins and the marine environment) falling solely on tour operators to ownership being shared by tour operators, management and tourists collectively.

Given tour operators' non-compliance with regulations this study then investigated whether tourists can be a force to drive tour operator compliance. Results revealed that dolphin-swim tourists are happy to comply with regulations and do not want to have a negative impact of the target species. Thus, if properly educated, dolphin-swim participants can be used by management as a tool to increase tour operator compliance, thereby making the industry more sustainable. Results indicate that the opportunity to learn about conservation is likely to enhance the dolphin-swim tour experience, thus economically benefiting the industry by encouraging repeat business and generating positive reviews on social media. By giving tourists what they actually want, commercial operators are empowered to conserve the sustainability of the industry while potentially increasing revenue.

This study has added significantly to the small body of literature that examines the human dimensions of dolphin-swim tourism highlighting the importance of understanding tourist demographics, motivation, biocentrism, knowledge and satisfaction levels for the successful management of the industry. Via the use of social science questionnaires delivered to dolphin-swim participants, this study has revealed that dolphin-swim tours can be an effective vehicle for education, can promote pro-environmental beliefs, can raise participants' biocentric levels and lead to increased environmental awareness in participants. This study has demonstrated that data obtained from social science questionnaires can be used as a management tool, informing management as to what type of conservation information is desired by participants.

Given that there is a paucity of data available on Burrunan dolphins, the baseline data documented in this study provides first insights into the behavioural activity of this population of dolphins in the absence of tour vessels.

By providing this information, management is informed about what constitutes 'normal' behaviour for this population, enabling changes to be detected and allowing management strategies to be adjusted accordingly. This study identified that PPB is a significant habitat (i.e. part of a species range that is essential for survival and maintaining healthy population growth) for Burrunan dolphins, being an important region for nursery groups and for foraging dolphins.

The findings presented herein are of importance because many studies recommend managing cetacean tourism, however there is a paucity of information available on the effectiveness of these proposed management strategies (Scarpaci et al., 2010b). The first evaluation of whether TBSZ is an effective management tool is provided in this thesis, as until now its effectiveness was assumed. This study revealed that TBSZ is of proven importance for foraging dolphins. Thus, TBSZ should be maintained as a management strategy as it provides an area where disruptions to dolphins are minimised whilst they are engaged in the biologically critical behaviour of foraging.

Using data obtained from the activity budget, it was then possible to identify critical habitats necessary for the survival of the Burrunan dolphin population within southern PPB by identifying habitats that are regularly used for feeding. Two other hotspots for foraging Burrunan dolphins were objectively identified (Popes Eye (PE) and Rosebud West to McCrae (RW-MC)). The Department of Environment, Land, Water and Planning (DELWP) can now make informed decisions as to whether they select to implement additional MPAs in these areas as further management tools. This identification of habitats needing protection by linking dolphins behaviour and habitat use is of importance as interactions between tourism activities and cetaceans are often negative, and identification of critical habitats is the first step towards the establishment of effective MPAs. In PPB, disruptions to dolphins during dolphin-swim interactions is greatest whilst they are foraging, and so by providing information on foraging hotspots for this species, management can make scientific-based decisions

regarding the best locations for MPAs, to reduce impacts from the dolphin-swim tourism industry.

Meeting the objectives of this thesis has also led to a significant contribution towards a better understanding of the long-term responses (i.e. avoidance, neutral and approach) of Burrunan dolphins to dolphin-swim tour boat approaches. Comparing preliminary unpublished work by Scarpaci allowed a second longitudinal study to be conducted, which showed that dolphin responses to tour boat approaches have altered over time. Over 15 years dolphins' responses to tour vessels changed, with dolphins exhibiting an increase in avoidance and approach responses towards tour vessel approaches. These dolphins are forced to expend a greater amount of time and energy avoiding or approaching boats, and as a consequence their biological fitness may be reduced by detracting from core biological activities such as foraging and resting. Indeed, results revealed that initial dolphin behaviour had a strong effect on how dolphins responded to tour vessels, with resting groups the most likely to exhibit avoidance.

How dolphins respond to tour vessels is correlated with boat approach type. Illegal approaches resulted in highest levels of avoidance by dolphins. Conversely, when tour operators utilised legal approaches, dolphins were more likely to approach tour vessels, and legal approaches also resulted in the highest level of neutral responses by dolphins. These results inform management that adherence to regulations not only reduces effects of vessel approaches on dolphins, but also increases the probability of having an interaction with a dolphin group. Indeed, these results inform management that the regulation in the Marine Mammal (Wildlife) regulations, 2009, pertaining to legality of approach types (Condition 1. Part 3, 9(1a, b, c)) is a valuable regulation and useful management tool. However, this regulation needs to be enforced in order to fulfil its managerial purpose of reducing disruptions to dolphins, as compliance levels to this regulation are currently unsatisfactory.

The importance of long-term research is highlighted, as behavioural responses detected here would be undetected in short-term studies. This longitudinal study

provides valuable insight into changes to dolphins' responses that have occurred over time, with results indicating that dolphin tolerance to swimmers' presence has increased over time, and that dolphins are exhibiting signs of habituation towards dolphin-swim tour vessels. By providing information on dolphins' responses to tour vessel approaches over time, there is now a broader spectrum of research findings available (i.e. from the early stages of the tourism industry to 27 years since its inception). This information should aid management agencies in other regions develop management policies for commercial dolphin-based tourism for Burrunan dolphins and apply the precautionary principal in: 1) Locations where this data is unavailable (e.g. Gulf St Vincent, South Australia, where Burrunan dolphins have been observed but resident/transient status unknown (Peters et al., 2013); and 2) prior to the establishment of commercial dolphin-based tourism.

This study has advanced understanding of how tourism affects Burrunan dolphins, being the first study to examine their behaviour in both the absence and presence of tour vessels. Findings reveal that dolphin-swim tourism in PPB has an impact on Burrunan dolphins, with foraging and socialising behaviours significantly disrupted during tour boat interactions. While the biological and long-term consequences of these effects could not be measured, the reduction in time spent foraging when dolphin-swim tour vessels are present could potentially lead to a decrease in dolphins' rate of energy acquisition. Likewise, the increase in socialising may further increase dolphins' energy expenditure. Collectively, this could result in reduced biological fitness with population level consequences.

Although the short-term activity budget of the dolphin population was significantly affected, dolphin-swim tour vessels did not significantly change the cumulative behavioural budget of Burrunan dolphins. This indicates that the management strategies that are currently in place are to some degree effective and that this industry may be sustainable if it is managed correctly. Results presented herein highlight that it cannot always be assumed that cetacean tourism has negative effects on the target population, and reinforces the need to assess the potential effects of cetacean-based tourism on a case by case basis.

Unfortunately, no pre-tourism behavioural data exist for the PPB population and thus it is unknown by how much dolphins' behavioural budget may have changed to date. However by using results of this study DELWP can now base management decisions on stronger scientific merit and minimise the effects of tourism activities on this endemic and threatened species.

6.3 Management recommendations

The population of Burrunan dolphins in PPB is small (approximately 80 - 100 individuals, Hale, 2002) and given their genetic distinctiveness (Charlton-Robb et al., 2011; Charlton-Robb et al., 2015), restricted home range and female natal philopatry (Hale, 2002), this population is extremely vulnerable to anthropogenic impacts. Thus, it is vital that management adopts a precautionary approach and that research-informed recommendations (as discussed in this section) are incorporated into management so that tourism impacts are minimised. Being endemic, the protection of Burrunan dolphins is the sole responsibility of the Australian government. The Wildlife (Marine Mammal) Regulations, 2009, were developed to protect all cetaceans within Victorian waters, however results presented here indicate that there are a number of actions that would improve the management and sustainability of the dolphin-swim industry in PPB. Certain aspects of the Wildlife (Marine Mammal) Regulations, 2009, need to be defined, enforced or clarified. Based on results presented in Chapters Two, Three, Four and Five, recommendations (below) are made to improve the management of this industry in order to alleviate short-term disturbance on this population by tour vessels and help with their conservation.

6.3.1 Education

With a history of non-compliance (Chapter Two; Filby et al., 2015) and a lack of government enforcement, there needs to be a shift from ownership falling solely on tour operators to ownership being shared between tour operators and tourists. This study has revealed that tourists, if properly educated, can be used as a means to increase tour operators' compliance, as tourists are happy to

comply with regulations and they don't want to have a negative impact of the targeted species. However, the findings here (Chapter Two; Filby et al., 2015) indicate that dolphin-swim tours are only partially meeting their goal to educate tourists about marine wildlife, foster an appreciation for Burrunan dolphins and help tourists understand that they have a responsibility towards protecting dolphins and the marine environment.

Conclusions presented here (Chapter Two; Filby et al., 2015) will be provided to DELWP and to tour operators so they can gain a better understanding of their audiences' knowledge, motivation, satisfaction and biocentric levels. This will enable more relevant interpretation to be delivered during dolphin-swim tours. By delivering more specific interpretation, management has the opportunity to increase participants' biocentric and satisfaction levels, and improve the sustainability of the dolphin-swim industry in PPB by informing tourists why regulations are in place. Thus, it is recommended that the educational material on-board all dolphin-swim vessels in PPB be reassessed. In order to achieve interpretation that provides in-depth information to tourists is interesting and puts the welfare of the dolphins and the marine environment at the fore, it is recommended that the following be implemented by management:

- 1) **Incorporate topics of interest to dolphin-swim participants**, as well as topics on which they would like more information (as identified in Chapter Two results, Section 2.4.5) into the interpretation provided on-board dolphin-swim tours;
- 2) **Provide information on conservation activities** (e.g. picking up rubbish) during interpretation that participants have shown interest and intent in doing (detailed in Chapter Two results, Section 2.4.3);
- 3) **Provide information on relevant sections of the Wildlife (Marine Mammal) Regulations, 2009**, in order to make tourists aware that the regulations are in place to protect the dolphins, as well as themselves, and that interactions with dolphins in the wild should be up to the animals. If tourists are aware of why regulations are in place their

expectations will be managed, they will value the encounter and the need for such regulations, and so they will be more satisfied and appreciative when interactions with dolphins do occur (as discussed in Chapter Two). Thus the experience for dolphins and tourists alike will be improved; and

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- 4) **Schedule interpretation at specific times of the tour**, (e.g. explain regulations prior to the dolphin-swim and deliver conservation information after dolphin encounters). This will maximise information absorbed and retained by tourists (as identified in Chapter Two).

Based on the findings from Chapter Two (Filby et al., 2015), and the above recommendations, this study has developed interpretation (see Appendix 10). It is strongly urged that management makes it compulsory for tour guides to deliver this interpretation during dolphin-swim tours. By developing a structured, comprehensive interpretation program, with input from researchers, stakeholders and the governing body for the industry (i.e. DELWP), tour operators have the opportunity to increase customer satisfaction by meeting their need and expectation for knowledge during dolphin-swim tours. If implemented, this interpretation is likely to enhance, rather than detract from the experience (Chapter Two; Filby et al., 2015). Economically, this will benefit the industry as satisfied customers are more likely to bring repeat business to the industry, and from a managerial perspective the experience should be improved for both tourists and dolphins. Thus the industry is more in control of its own destiny and need not feel it is governed by regulations and compliance but rather could grow by education and customer satisfaction. This represents a win-win situation should tour operators choose to use this information in a positive way. It is hoped that by utilising this interpretation as a management strategy, the conservation potential of this industry will be increased. If this novel management strategy of informing tourists about regulations and why they are in place helps to improve tour operators compliance with regulations in PPB, then other cetacean-based tourism industries around the world can use this management strategy.

Based on the findings of this study, other recommendations that incorporate educational components that management (i.e. DELWP) can utilise to increase the sustainability of this industry include:

- 1) **Initiation of compulsory annual training programs for staff of tour companies.** These training programs should be delivered by DELWP and researchers to all staff that work on-board the dolphin-swim tour vessels in PPB, and could be held before the start of each season (i.e. in late September). Training should aim to raise staff awareness of all regulations pertaining to interactions with dolphins and what interpretation needs to be provided during each tour. Training should incorporate information on the biology and conservation of the target species (see Appendix 10) and actions that participants can take to become involved in conservation activities (e.g. brochures and websites participants can visit). By delivering compulsory training programs, management have the power to increase the depth of knowledge being delivered to dolphin-swim participants by tour guides, whilst reducing the amount of incorrect information being conveyed;

- 2) **Provision of education and interpretative materials to recreational vessel users of PPB.** Information delivered to recreational operators should aim to raise awareness that there are dolphins in the area, and that there are regulations in place dictating how recreational boat users should interact around them (e.g. approach distance). Publicising regulations and the consequences for non-compliance, on recreational boat licenses and through outreach material (e.g. in boating magazines) could help improve recreational boat drivers use of TBSZ and other MPAs, as recreational boat users often have high-levels of non-compliance (Giles & Koski, 2012). Currently, there is minimal interpretation material on dolphins within PPB and thus provision of more land-based interpretation is recommended. For example, interpretation boards should be implemented at boat ramps (e.g. Queenscliff and Sorrento) and on piers (e.g. Point Lonsdale, Queenscliff, Portsea,

Sorrento, Blairgowrie, Rye) in areas where dolphins are frequently sighted; and

- 3) **Inform tour operators that they are likely to obtain better interactions with dolphins if they utilise legal approaches.** Results presented here (Chapter Four; Filby et al., 2014) demonstrated that dolphins approached tour vessels more frequently when legal, compared to illegal, approaches were attempted. If tour operators are informed by management that utilisation of legal approaches is more likely to attract dolphins they may reconsider their approach types, as using legal approaches is more likely to result in an interaction with dolphins and therefore, higher customer satisfaction and repeat business. In addition, tour operators also need to be made aware that non-compliance has negative impacts for both the targeted species and the industry, as illegal approaches result in more frequent avoidance responses by dolphins, which may subsequently decrease both customer viewing opportunities and satisfaction. It is likely that the passive management of this industry has resulted in unsatisfactory levels of compliance due to a lack of information exchange between management and industry. Thus, an effective management strategy for achieving higher compliance with regulations may be via sharing of knowledge, i.e. what does and does not work. Tour operators, management agencies and researchers all have critical roles to play if this is to be achieved.

6.3.2 Implementation of a Marine Protected Area Network

Minimising dolphins' interactions with vessels in critical habitats is an important management tool for reducing impacts of anthropogenic impacts (Baş et al., 2014; Simmonds et al., 2004). This study has identified three important habitat areas for foraging Burrunan dolphins within southern PPB that management can now prioritise as needing protection (as discussed in Chapter Three). Results presented in this thesis support management strategies that aim to reduce access by tourism vessels to preferred foraging habitats. Thus, it is recommended that the following management actions be implemented:

- 1) **The boundary of PE Marine National Park be extended** from its current radius of 100 m from its centre to a 1000 m (Chapter Three, Figure 3.9 and Section 3.5.3). The proposed increase in size of PE Marine National Park is small and modest in comparison to the area that dolphins use in PPB and has the potential to minimise disturbance to foraging dolphins without greatly restricting tour operators. To further minimise disturbance to foraging dolphins, it is recommended that management makes PE Marine National Park a no swimming-with or approaching dolphins' zone for dolphin-swim tour operators;

- 2) **Implementation of a new MPA between RW-MC** (see Appendix 11 for location and co-ordinates of proposed RW-MC MPA), with seasonal closures over summer when calves are born and when recreational vessel traffic peaks. Further, it is recommended that speed within this area is restricted to 5 knots (no wake), up to 1500 m offshore (Chapter Three, Figure 3.9 and section 3.5.3). Reducing speeds of vessels around dolphins has three advantages: 1) it enables dolphins to detect and avoid vessels; 2) it minimises the severity of injury if a vessel strike does occur; and 3) it allows vessel operators to detect and avoid the paths of the dolphins (Currie et al., 2015). This proposed MPA at RW-MC is a reasonable mitigation measure to help protect this species given that it lies within non-essential transportation routes and has been highlighted in this study as a critical area for foraging Burrunan dolphins (as detailed in Chapter Three); and

- 3) **Incorporation of TBSZ, PE and RW-MC into a multi-site management strategy, forming a MPA network for Burrunan dolphins with southern PPB.** A MPA network is defined by the International Union for Conservation of Nature (IUCN-WCPA, 2008) as: 'a collection of individual MPAs operating cooperatively and synergistically, at various spatial scales and with a range of protection levels that are designed to meet objectives that a single MPA can-not achieve'. Creating the MPA network in southern PPB to encompass these proposed MPAs is a management strategy that would reduce the time tour operators and

recreational vessels interact with Burrunan dolphins whilst they are engaged in the critical behaviour of foraging, thereby reducing disruption to dolphins whilst individuals are acquiring energy. Designation of critical habitat for species that are listed as threatened under the *Endangered Species Act*, has been significantly associated with improving population trends (Taylor et al., 2005). Thus, implementation of the proposed MPA network, which protects critical foraging habitat for Burrunan dolphins, is the key to the long-term conservation of this species.

This proposed MPA network for Burrunan dolphins in southern PPB should be considered as a management strategy as it will reduce pressure on dolphins whilst they are undertaking critical activities such as feeding. It is recommended that immediate action by DELWP is undertaken to implement this proposed MPA network and that their boundaries delineated with surface on-water markers (e.g. similar to boundary markers for TBSZ, Figure 6.1) as distances can be difficult to estimate over water. Involvement of all stakeholders that visit the proposed MPAs is essential when discussing the expansion to the size of PE Marine National Park and the addition of the RW-MC MPA so that they can be effectively implemented without negatively affecting stakeholder operations. If stakeholders are initially involved, and their recommendations are incorporated, there is increased likelihood of compliance with regulations (Charles & Wilson, 2009).

It is recommended that management establishes a long-term commitment to constantly monitor, enforce, evaluate and if necessary, update and adapt MPAs to deal with changing conditions because the way dolphins utilise their habitat may change over time (Hartel et al., 2014; Hooker & Gerber, 2004). Furthermore, management also needs to consider that the effectiveness of MPAs is dependent on both compliance with regulations and active enforcement (Edgar et al., 2014). Therefore, it is strongly urged that the DELWP is more active in enforcing compliance and issuing fines as tour operators are currently not abiding by regulations within TBSZ (as detailed in Chapter Two and Filby et al., 2015). Lastly, the results described here have implications for the conservation of other dolphin-based tourism industries where management

may be able to use similar strategies when deciding where to implement MPAs or MPA networks.



Figure 6.1 Ticonderoga Bay Sanctuary Zone boundary marker. Photo: Author

6.3.3 Amendments to regulations

The findings of this study are vital for helping management effectively protect this endemic and threatened population of Burrunan dolphins from avoidable adverse effects of tourism. Given tour operators' non-compliance with regulations (Chapter Two; Filby et al., 2015), the significant increase in effect responses to tour vessel approaches by dolphins across a 15 year timeframe (Chapter Four; Filby et al., 2014) and the disruptions to foraging and social behaviours during interactions with tour vessels (Chapter Five) detected in this study, it is strongly urged that the following inclusions and/or amendments are made to the Wildlife (Marine Mammal) Regulations, 2009:

- 1) Incorporate specific criteria pertaining to the content of interpretation delivered during dolphin-swim tours into the**

regulations. Management can achieve this by setting definitions of exactly which topics should be included during tours (see Appendix 10 for suggestions), listing criteria that need to be addressed during each dolphin-swim tour to ensure that sufficient educational material is provided. This will ensure that all tour companies provide consistent and correct information on Burrunan dolphins and their environment, and by being less ambiguous, this regulation will be easier to enforce. Currently, the regulations stipulate that tour operators must provide information on the biology and conservation status of dolphins and the threats they face. However, the level of 'information' required is vague and undefined. Given that dolphin-swim tourists in this study indicated that they did not learn enough and were interested in finding out more about dolphins and marine conservation, this amendment to the regulations is likely to enhance the dolphin-swim experience for participants;

- 2) **Restrict tour vessels from interacting with foraging dolphins.** In Australia management guidelines (i.e. the Australian National Guidelines for Whale and Dolphin Watching, 2005, at a federal level and the Wildlife (Marine Mammal) Regulations, 2009, at a state level for Victoria) currently do not address the different behavioural states of dolphins. Given that this study revealed that Burrunan dolphins are most sensitive to the presence of tour boats when foraging (Chapter Four; Filby et al., 2014; Chapter Five) it is recommended that tour operators are prohibited from interacting with foraging dolphins, and that approach distance to foraging groups is increased in order to minimise disturbance to these groups from tour vessels.

From the perspective of tour operators, sighting success rate decreased over a 15 year period and this may reflect a decrease in the number of dolphins using southern PPB. This could be a precursor to abandonment of the bay by dolphins as vessel traffic continues to disturb core biological activities (i.e. feeding and resting). Thus, it is in the best interests of tour operators to reduce disturbance to foraging groups in order to ensure the sustainability of the dolphin-swim industry in PPB. It

is believed that a prohibition on interacting with foraging dolphins is the most effective management approach as it is difficult to regulate and enforce the number of encounters tour vessels have with foraging dolphins each trip/day. Further, management can reduce disruption by tour vessels to foraging groups by defining an acceptable approach distance for foraging dolphins as *Tursiops* sp. have been documented feeding considerably less when boats approached groups at a distance of 50 m compared to 150 m (Steckenreuter et al., 2011);

3) **Prohibit tour operators from approaching closer than 300 m to resting groups.** Initial dolphin behaviour had a strong effect on dolphins' responses to tour vessel approaches, with resting groups the most likely to exhibit avoidance (Chapter Four; Filby et al., 2014). Given that dolphins in PPB spent such limited time resting (1.8% of their observed diurnal activity budget, Chapter Three), any disturbance could be detrimental for this population. Prohibiting tour operators from approaching closer than 300 m from resting groups is especially important for groups containing calves (calves were present in almost half of observations, Chapter Three). This is because when resting behaviour is disrupted, the survival of calves is put at risk, as nursing often takes place whilst animals are resting (Stensland & Berggren, 2007). Given the high degree of difficulty in estimating distance between vessels and cetaceans (Baird & Burkhart, 2000), combined with the ease of use and relatively low costs of commercially available range finders, it is suggested that such instruments be utilised by tour operators to make compliance with this regulation achievable; and

4) **Place a moratorium on the number of dolphin-swim permits (capping it at its current level of four).** Although the cumulative behavioural budget of Burrunan dolphins does not alter significantly in the presence of tour vessels, the disruptions to foraging and socialising behaviours is of concern. If dolphin-swim tourism intensity were to increase, the cumulative exposure levels for dolphins would consequently escalate, potentially acting as a selection force for this

population by influencing the fitness of individuals that utilise habitats where exposure to tour vessels is higher (Milner et al., 2007). By increasing the number of permits by even one vessel, significant long-term impacts on a population can occur (Bejder et al., 2006a). By instigating a moratorium, management can help ensure the on-going sustainability of the dolphin-swim industry in PPB, allowing tourists the rare experience to swim with dolphins in the wild, whilst simultaneously increasing their pro-environmental beliefs and biocentric values by delivering effective on-board interpretation (Chapter Two; Filby et al., 2015).

The results of this study found that the Burrunan dolphins' cumulative behavioural budget was not significantly affected by dolphin-swim tourism in PPB. This result is likely due to the low level of tourism within PPB. Thus it is recommended that dolphin-swim permits be capped at low levels in other locations where dolphin-tourism with Burrunan dolphins occurs (e.g. Gulf St Vincent, Peters et al., 2013). Furthermore, if dolphin-based tourism is instigated in other areas with Burrunan dolphins, permits should be capped at a low number, at least until it can be established that the level of tourism activities has no potentially detrimental effects on the population. If it is determined that tourism activities are not disturbing the population, then managers can permit an extra trip/permit. It is important that any proposed amendments to the regulations by management should be monitored by trained independent researchers.

6.3.4 Enforcement of regulations

Currently the Wildlife (Marine Mammal) Regulations, 2009, are not acting as an effective management strategy because tour operators are historically non-compliant with regulations (Chapter Two; Filby et al., 2015). Thus, the regulations are currently protective in name only, as they are not achieving their underlying conservation goals of protecting dolphins. This finding warrants a shift from passive to active management in PPB to ensure the sustainability of this industry. It is imperative that the DELWP enforce monitoring, with significant

financial penalties applied on a daily basis if regulations are breached, with loss of permits a real consequence for repeat offenders. Kessler and Harcourt (2013) state that the only way to ensure compliance with regulations for boat-based whale-watching was for authorities to conduct on-water enforcement. Based on the findings presented here, it is suggested that management focus on enforcing the following regulations in order to minimise disruption to the population that could have significant long-term effects:

- 1) *Wildlife (Marine Mammal) Regulations, 2009, Part 5, 16(2)* - **Tour operators must provide information on the biology, conservation status, and threats facing dolphins:** Independent observers are required on-board dolphin-swim tours to monitor whether interpretation delivered by tour guides is meeting criteria that should be addressed during each dolphin-swim tour (if this recommended amendment is incorporated into the regulations). Monitoring interpretation delivered during tours is necessary because as demonstrated in this study (Chapter Two; Filby et al., 2015) it cannot be assumed that just because regulations are in place they are effective. Independent observers on-board dolphin-swim tours should not be an expensive management strategy for DELWP as there are no on-water vessel costs. Further, as part of the permitting process, management can make it obligatory for tour operators to have observers on-board. To maximise their service, these independent observers could also document compliance with other relevant regulations and issue (discretely) on-the-spot fines for breaches;
- 2) *Wildlife (Marine Mammal) Regulations, 2009, Part 5, 16(2)* - **Tour operators must not approach a dolphin within 200 m whilst in TBSZ:** Tour operators do not apply any additional caution to encounters with dolphins within TBSZ, breaching regulations to unsatisfactory levels of compliance (Chapter Two; Filby et al., 2015; Howes et al., 2012). Thus TBSZ currently does not act as an effective management tool because it does not provide an area where dolphins can have refuge from tourism interactions. However, results presented in Chapter Three reveal that TBSZ is an important foraging area for dolphins and that implementation

of this sanctuary zone was an effective management idea. Thus, enforcement of regulations within TBSZ is required to ensure that dolphins can engage in critical behaviours (such as foraging) whilst in this area, otherwise this management strategy, of a MPA, is redundant. Active management is urgently required for TBSZ so that it actually provides dolphins with a refuge area. Given that this sanctuary zone covers only a small area that is close to the shoreline, monitoring should be relatively inexpensive and simple, and is achievable by having land-based observers that can enforce compliance with regulations. Shore-based monitoring for TBSZ will allow for compliance of all tour operators with regulations to be assessed in this area but with minimal personnel; and

- 3) *Wildlife (Marine Mammal) Regulations, 2009, Part 5, 17(15)* - **Must not swim with a calf**: Tour operators are historically non-compliant with this regulation, with recent research indicating that current compliance levels are at an all-time low (Chapter Two; Filby et al., 2015). Although tour operators breached this regulation in almost half of observed cases, no enforcement was apparent. During this study it was observed that within the dolphin-swim industry many tour guides had the misconception that a 'calf' was an animal that is a few weeks old, still displays foetal folds, has a flaccid dorsal fin and exhibits extreme buoyancy when surfacing, when in fact this is a neonate. Instead, a 'calf' is defined as 'a young animal that is less than half the average length of an adult female of the same species' in the *Wildlife (Marine Mammal) Regulations, 2009*, (pp 2). Therefore, it is strongly urged that tour guides are educated about the correct definition of a 'calf'. This information should be delivered during the recommended annual training program.

The significant increase over time of groups containing calves interacting with tour vessels during swims is of concern, as neonates and calves are particularly vulnerable to collisions with vessels (Dolman et al., 2006; Dwyer et al., 2014; Laist et al., 2001; Martinez & Stockin, 2013; Stone & Yoshinaga, 2000). Furthermore, vessels that come too close to dolphins

groups can disrupt nursing behaviour of young calves (Samuels et al., 2003; Wells et al., 2008). The population's reproductive success and long-term fitness may be affected if tour operators continue to conduct swims in groups where calves are present. Once tour guides are properly educated on how to determine a 'calf', it is strongly recommended that significantly heavier fines are imposed on tour operators who are observed by an independent on-board observer to be breaching this regulation. Furthermore, it is recommended that it should be compulsory (i.e. incorporated into the regulations) for guides to inform tourists what a 'calf' is during a dolphin-swim tour (see Appendix 10).

Tour operators in PPB seem genuinely concerned about the well-being of dolphins and have been cooperative, allowing the utilisation of their vessels as a platform to collect data during this study. However, their compliance with regulations does not reflect their attitudes and this is an issue management needs to address urgently. In order to monitor compliance cost-effectively, management could: 1) install cameras on-board each tour vessel that give 360 degree views, so that officers can review tour vessel interactions with dolphins from their offices without having to have an expensive on-water presence and/or 2) install GPS/satellite trackers on-board each tour vessel in order to determine when tour vessels breach regulations by entering MPAs. If active management cannot be implemented due to resource limitations, then the persistence of the dolphin tourism industry should be questioned since it may not be suitable for this particular population in PPB.

6.3.5 Summary for management

Although regulations are in place to manage the dolphin-swim industry in PPB, this study has shown that multiple management strategies are required to ensure the population of Burrunan dolphins is offered maximum protection and to ensure the longevity of the industry. DELWP must not rely solely on regulations (as tour operators are non-compliant) but need also to utilise multiple management strategies such as education, implementation of MPAs and active strategies (e.g. issuing fines and/or loss of permits for breaches). The

recommendations for management discussed here are designed so that dolphins are afforded maximum protection whilst enabling a sustainable dolphin-swim industry to continue. These recommendations are substantial but warranted based on the findings presented here: a historically non-compliant dolphin-swim tourism industry (Chapter Two; Filby et al., 2015), increased levels of effect responses by dolphins to tour vessel approaches overtime resulting in increased energy expenditure (Chapter Four; Filby et al., 2014) and disruption of critical behaviours during interactions with tour vessel (e.g. foraging and socialising, Chapter Five).

Given the extensive list of management recommendations presented in this thesis, it is suggested that the best management practice would be to instigate a research program that is set-up to inform management and which collects consistent data over time. Given that the cetacean-based tourism industry is worth millions of dollars to the Australian economy (IFAW, 2004; Jarvis & Ingleton, 2001; Valentine et al., 2004) this research program could be funded by industry but managed via DELWP. Funding for the research program could be achieved by initiating a levy system, where a small percentage of each dolphin-swim ticket sold (e.g. 1% of the total ticket price) is put towards continuing dolphin research and conservation initiatives. Alternatively, management could reduce the pressure of dolphin-swim tourism on this population by having fewer tourists who pay more money for the experience, with some of the additional costs from increased ticket prices going towards research and/or conservation.

Based on the generalised management framework for cetacean tourism proposed by Higham et al., (2008) it is suggested that management of dolphin-swim tourism in PPB would be improved by defining Limits of Acceptable Change (LAC). LAC is generally tied to population effects and can be determined by evaluating quantitative criteria (e.g. behavioural budget) and comparing this over time to determine whether tourism is likely to be sustainable or not. This LAC assessment would be the responsibility of the research program and managers. LAC data would need to be collected annually. Management would also need to set a consistent time period for

evaluation of changes relative to LAC. A five year interval is suggested as this would allow for active responses to change in a dynamic system.

This proposed research program would need to be on-going as long-term monitoring is necessary to detect any alterations in the way dolphins utilise their core habitat. That is, to determine whether hotspots for foraging dolphins change over time. Further, long-term research is necessary for detecting any changes in dolphin behaviour during interactions with tour vessels as this may reduce the population's biological fitness. In addition, ongoing, long-term research is essential to ensure that the management regimes in place (i.e. Wildlife (Marine Mammal) Regulations, 2009) are providing effective levels of protection for Burrunan dolphins and that the levels of interactions with tour vessels are sustainable.

6.4 Study limitations

The methodology of this study aimed to minimise the potential effects of the research vessel on the dolphins, using an acoustically conservative research vessel that was driven slowly and predictably around dolphins, and using techniques that required no physical contact with the dolphins. Even under these circumstances, the research boat will have had some impact on the dolphins' behaviour. Thus, it must be acknowledged that the group follows conducted from the research vessel meant that no *true* control data (in which no boats were close to the dolphins) could be collected. As explained in Chapter Three, it was not possible to undertake land-based theodolite surveys due to the large study area, wide distribution of dolphins within PPB and the fact that dolphin occurrence close to shore was not predictable. However, whilst the potential effects of the research vessel cannot be ignored, it proved to have less effect on dolphin behaviour than dolphin-swim tour vessels, as discussed in Chapter Five.

Additionally, no pre-tourism data exists for this population and thus the important baseline data collected in Chapter Three may not necessarily be an accurate reflection of how dolphins behave in PPB in the absence of tourism

activities. The absence of pre-tourism baseline data is a challenge that faces many tourism impact studies on cetaceans and thus this situation is not unique to PPB. It is important to consider the possibility that sensitive, less tolerant individuals may have already been displaced since the commencement of tourism operations in 1986. Given that this study has shown that PPB provides important foraging areas for Burrunan dolphins (Chapter Three) these sensitive animals may be displaced away from critical habitat (Bejder et al., 2006a). If this is the case, the implication is that this research would have studied only the responses of individuals within PPB that are more tolerant or perhaps habituated to tourism activities. Thus, it may be that the cumulative effects on the dolphins' behavioural budget being detected as non-significant (Chapter Five) may be a result of sensitive individuals having already departed PPB.

In this study, 'encounters' were defined as starting when tour vessels were within 300 m of the focal group. This distance was based on the Wildlife (Marine Mammal) Regulations, 2009. However, it is highly probable that dolphins responded to vessels before, or perhaps after, tour vessels reached this distance. Thus, this definition of where an 'encounter' begins lacks biological realism, as dolphin responses are generally graded rather than all responses occurring exactly at 300 m. This limitation is the case in numerous other studies investigating vessel impacts on cetaceans (e.g. Constantine et al., 2004; Guerra, 2013; Lundquist et al., 2012; Stockin et al., 2008). In the absence of a reasonable alternative, basing a definition on a figure given by regulations at the very least gives consistency.

A potential source of bias originates from the low number of observations of resting behaviours. This low sample size made it difficult to identify where (if any) resting hotspots occur, and thus it could not be determined whether certain areas are important to protect for resting dolphins (Chapter Three). Furthermore, due to small sample size, transitions involving the behavioural state 'rest' had to be excluded from the Markov analyses (Chapter Five). The exclusion of 'rest' behaviours from analyses meant that examination of the effects of the tourism industry on the entire behavioural repertoire of this population could not be conducted. Thus, it is possible that additional effects of

tourism activities on Burrunan dolphins went undetected. Given that Burrunan dolphins spend such a small proportion of their time during the day resting (Chapter Three), any disturbance to resting behaviour could be detrimental.

During this study, frequent strong winds (above 15 knots) arose in winter, which restricted the number of days in the field and resulted in a small sample size for winter. Winter scans had to be omitted from analyses examining behavioural variation across seasons due to this small sample size (Chapter Three), which limited any chance of detecting changes in dolphins' behavioural patterns across all seasons.

Another limitation in this work was that response rate to the social science questionnaires was exceptionally low (< 6%). As explained in Chapter Two (Filby et al., 2015), participants who are already biocentric are more likely to participate in the study, and thus it is likely that the dataset was positively biased.

This study, which spanned three field seasons, detected some spatial patterns and indicated how dolphins utilise their habitat. However, dolphins' habitat use and distribution is known to be variable. Therefore, to ensure that the presented data reflect patterns that occur regularly, it is imperative that data be collected over a longer time frame.

6.5 Recommendations for future research

This study has demonstrated that the current levels of tourism activity in PPB is having short-term effects on the behaviour of Burrunan dolphins, and that over the long-term, the population's responses to tour vessel approaches has changed detrimentally. In order for management to ensure the long-term sustainability of the dolphin-swim industry in PPB for this small, threatened population of dolphins, it is vital that some important knowledge gaps be bridged. Thus, as a consequence of research presented here, it is recommended that future research focus on the following topics:

6.5.1 Use of social science data to improve tour operators' compliance with regulations

Delivering interpretation on-board dolphin-swim tours is a useful tool that management can use to increase tourists' knowledge of dolphins and the marine environment. This study attempted to fill part of the knowledge gap surrounding the human dimensions of cetacean-based tourism and whether dolphin-swim tourism increases tourists' biocentric values and pro-conservation behaviours. However, there is still a lack of information available on this topic, and it is hoped that this study will facilitate additional research in this area. To this end, it is recommended that researchers continue to use the questionnaires utilised here. This will provide a larger and more representative sample size and enable results to be compared, allowing a broader depth of understanding on dolphin-swim participants' motivation, knowledge, satisfaction and biocentric levels to be obtained. If implemented by management, on-going monitoring is required to determine if changing the interpretation delivered during dolphin-swim tours (as suggested in Appendix 10) is effective.

Furthermore, if the suggested interpretation material (Appendix 10) is implemented future research should assess whether there is an increase in tour operators' compliance levels that corresponds with an increase in tourists' increased knowledge of regulations and why they are in place (i.e. to protect the target species). This can be facilitated by continuing collection of compliance data as in this study and that by Scarpaci et al., (2003) and Scarpaci et al., (2004) so that results can be compared. If compliance levels do improve, this management strategy of informing tourists about regulations and why they are in place can be applied to other cetacean populations that are targeted by tourism globally.

6.5.2 Examination of life history traits

It is necessary for management bodies to understand the life history of a species as this can have important conservation implications (Chivers, 2002). Life history information enables an understanding of how susceptible a population may be to anthropogenic effects (e.g. fisheries mortality, tourism,

contamination) and also how a population can recover (Chivers & Myrick, 1993; Wells et al., 2005). Given that life history traits may influence population growth, stability and/or recovery, an understanding of Burrunan dolphins' reproduction is certainly important. Thus, it is recommended that future research assess the life history parameters of this population, in particular information on the growth and reproduction of Burrunan dolphins should be collected. In addition, data describing number of neonates and mating strategies should be collected, and age at sexual maturity estimated. Furthermore, pregnancy rate, conception and gestation times in females and the size of the female breeding population should be determined. This research should be undertaken immediately, as it will take numerous years to accurately assess calving rates, mortality rates and age at sexual maturity for this population. Carcass recovery and post-mortem examinations should be a priority. Furthermore, investigation into age-based segregation should also be undertaken, as the behaviour, group size, distribution and movements of groups containing calves are often quite different to those without calves (as documented in this study; Cañadas & Hammond, 2008).

6.5.3 Investigation of range and distribution

Managing human impacts on this coastal population of Burrunan dolphins requires information on the distribution patterns of the population. This study reveals that Burrunan dolphins are distributed primarily within the southern end of PPB, however the full extent of their range still remains unknown. Infrequent sightings of known individuals outside this range have been documented, with individuals observed exiting PPB through the rip, the entrance to Bass Strait, and heading east along the Victorian coastline (personal observation). Burrunan dolphins have also been observed in the northern waters of PPB in winter months, towards Melbourne CBD (personal observation; Mason, 2007). It has been speculated that Burrunan dolphins may exhibit seasonal migration, as over the winter months the Gippsland Lakes population increases from approximately 50 resident dolphins to over 150 animals (Charlton-Robb et al., 2015). Photo-identification of both populations throughout all seasons is recommended to confirm this suggestion. It is also recommended that more

extensive surveys be conducted throughout the winter months within all areas of PPB, along with areas outside of PPB along the Victorian coastline, to enable a better understanding of individual dolphins' ranges. This information is necessary as optimal protection by management requires the year-round distribution of the population to be encompassed.

6.5.4 Assessment of abundance and site fidelity in Port Philip Bay

Determining trends in abundance is an integral part of management strategies. Abundance estimates are vital for detecting population declines and are required to determine how vulnerable the population may be to different threats. However, Burrunan dolphins' abundance remains largely unknown, with no published data providing population estimates for this species. The population estimate of approximately 80 to 100 individual Burrunan dolphins within PPB was made 14 years ago, and is based on un-published photo-identification data collected by the Dolphin Research Institute from 1997 - 2001 (Hale, 2002). To date, no dedicated photo-identification studies for Burrunan dolphins exist within the published literature. However, partial unpublished photo-identification catalogues exist (e.g. Filby, unpublished data, Dolphin Research Institute, unpublished data) for Burrunan dolphins, and thus it is suggested that where data collection methodologies allow, mark-recapture models be applied to this data in order to determine a current population estimate.

It is strongly recommended that photo-identification, from both research and opportunistic platforms (i.e. tour vessels) be under-taken on an on-going basis, so that population estimates can be up-dated frequently. To do this, managers, tour operators, researchers and non-government organisations will need to work together to provide a comprehensive photo-identification catalogue. Once established, such a catalogue would allow for a better understanding of the tolerance levels of identifiable individuals to vessel interaction. Calculation of exposure levels for identifiable individuals may also be determined. A photo-identification catalogue will also provide important information on Burrunan dolphins' life history traits.

6.5.5 Identification of other anthropogenic impacts

For management to help maintain population numbers and identify what level of tourism is sustainable for Burrunan dolphins, other threats to this population need to be identified and assessed. Currently, limited empirical data exist on other sources of anthropogenic disturbance to dolphins and their environment in Victoria. The potential threats of competition with fisheries, aquaculture, fisheries by-catch, habitat degradation (e.g. channel dredging), recreational boating traffic, gas and oil-mining exploration with seismic activity (in Bass Strait) and acoustic pollution should be investigated in future studies. Results from this research should then be overlaid with species distribution to help identify areas of greatest concern so that if necessary they can be incorporated into MPAs. In addition, few studies have focused on quantifying tour vessels' acoustic disturbance on cetaceans. Given that sounds produced from engines and sonar from navigation systems covers the same bandwidth used by most marine vertebrates (Stocker, 2002), it is possible that the foraging reduction reported in numerous studies during interactions with tour vessels (e.g. Chapter Five; Christiansen et al., 2010; Dans et al., 2008; Stockin et al., 2008; Williams et al., 2006) may be linked to underwater noise and thus future research on this population should investigate this issue.

It is also recommended that future research involves experimental design to determine at what distance foraging dolphins are disturbed by the presence of a vessel. Information from such research could be used to inform management as to what precise approach distance should be adopted by tour operators when engaging with foraging dolphins. Future research should also assess the potential effects of recreational vessels on the behavioural budget of Burrunan dolphins, as recent research indicates that for some populations of dolphins recreational vessels, including ferries, can cause significant disturbance to their behaviour (Baş et al., 2014; Martinez, 2010). In southern PPB two ferries travel between Queenscliff and Sorrento every hour between 6am and 8pm, passing within 100 m of PE Marine National Park, the area identified in this study as the primary foraging hotspot for dolphins. Thus, it is critical that future research also investigates potential effects of ferries on Burrunan dolphins' behaviour, and if

effects are detected, that the ferry route be altered so that it doesn't pass as close to PE.

6.5.6 Investigation of potential long-term consequences of short-term effects of dolphin-swim tourism

It is vital that research continues, especially if there are modifications to regulations, MPAs or the number of permits. Although data presented here provide the longest investigation of dolphin-swim interactions with Burrunan dolphins in PPB, it does not qualify as a long-term study because *Tursiops* sp. can live 45 – 50 years (e.g. Hohn et al., 1989; Wells & Scott, 1999). By conducting on-going tourism research that provides a longitudinal dataset, management will have the ability to detect long-term changes that may have biological impacts. Long-term data sets on dolphin responses to tourism interactions will allow management to evaluate behaviour modification by dolphins to changes in regulations/management strategies, and if changes are detrimental to dolphins, management will be informed and can implement adaptive management strategies. Permits to view and swim with Burrunan dolphins in PPB undergo renewal every 6 years, with the current permits expiring on the 30th of June 2019. A scientific monitoring program should be undertaken prior to, and post, permit renewals or changes to management strategies and/or regulations, so that comparisons may be made. This would enable management to make any decisions regarding permitting and regulations, and their effectiveness, based on sound scientific advice.

It is recommended that behavioural data on Burrunan dolphins be collected in a control site (e.g. Gippsland Lakes, with a resident population of approximately 50 Burrunan dolphins) without a commercial dolphin-swim tourism industry. This will allow for comparison of behavioural responses between control and impact sites, potentially providing information on whether sensitive individuals have left the impact site, and inform managers on how far impact site dolphins' behaviour has deviated from the norm (e.g. Bejder et al., 2006b).

Where possible, it is recommended that future research on this population obtain a larger sample size for 'rest' behaviours, allowing this behavioural state to be included in analyses. Nocturnal surveys, using night vision binoculars, may help determine if resting occurs more frequently at this time. Gathering a larger sample size for 'rest' behaviours will enable a more comprehensive assessment of the potential effects of the tourism industry on Burrunan dolphins to be undertaken. Further, this will allow for identification of areas of critical importance for resting dolphins that can be highlighted as needing protection (if these exist).

In summary, for management to be effective, on-going scientific research on Burrunan dolphins is required, and it is emphasised that this research needs to be undertaken with cooperation between management, industry and researchers. Management agencies need scientific information to make informed decisions yet cetacean research is expensive and frequently underfunded (Parsons et al., 2015). To enable the above recommendations for future research to be undertaken, it is suggested that as part of the permitting system DELWP make it obligatory for tour operators to take researchers on-board. Currently it is up to the discretion of individual tour operators whether researchers are allowed on-board their vessels.

6.6 Concluding statement

This thesis investigated the effects of the dolphin-swim tourism industry on Burrunan dolphins whilst simultaneously highlighting deficiencies in management and suggesting alternative management strategies. The knowledge obtained in the present study has provided further insight into the behaviour of Burrunan dolphins and the effects the tourism industry has on the PPB population. By undertaking behavioural observations, valuable information has been gained that can be used to aid management decisions in protection of the population of dolphins inhabiting PPB. Collectively, the chapters of this thesis demonstrate that the population of Burrunan dolphins is significantly impacted by the dolphin-swim tourism industry in PPB (i.e. increased avoidance to tour vessel approaches over time, responses resembling habituation, and

disruptions to foraging and socialising behaviours during interactions with tour vessels). However, this industry does have positives, as dolphin-based tourism in PPB generates considerable socioeconomic benefits, is capable of generating funds for cetacean conservation, has the power to significantly increase tourists' biocentrism and plays an important role in educating participants about the endemic and threatened Burrunan dolphin and their marine environment. This study suggests that if managed, this industry can be sustainable as no cumulative effects on the dolphins' behaviour were detected.

Given the historically non-compliant tourism industry in PPB, management need to consider alternative strategies to regulations for managing this industry if they are to mitigate negative effects while creating a sustainable industry (e.g. use social science data to educate tourists about regulations in order to reduce pressure on tour operators to non-comply with regulations and/or implement MPAs in areas that dolphins are known to forage). This study has highlighted a number of management issues that are of critical importance because they are not currently performing their function of protecting this population of dolphins. This work has identified and recommended a number of management strategies that can mitigate effects of dolphin tourism on this population of dolphins and create a more sustainable industry in PPB. Results indicate that a holistic approach is required to successfully manage dolphin-based tourism, utilising strategies that incorporate: social sciences, education, compliance, habitat use and behavioural information and enforcement. Fundamental to the success of effective management is the development of respectful working relationships between management (i.e. DELWP), stakeholders and researchers. Finally, the need for adaptive management regimes is emphasised. It is hoped that information provided in this thesis will be used by management and industry to engage in pro-active management in the immediate future in order to ensure the sustainability of not only this endemic and threatened population of Burrunan dolphins but also of the dolphin-swim industry.

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Appendix 1

Locations within Australia where swim-with cetacean tourism occurs

State	Location	Targeted Species	References
New South Whales	Port Stephens	Bottlenose dolphins (<i>Tursiops</i> sp.)	Allen et al., 2007
	and Forster	Common dolphins (<i>Delphinus delphis</i>)	Steckenreuter et al., 2012 Zeppel, 2009
Queensland	Great Barrier Reef	Dwarf Minke Whale (<i>Balaenoptera acutorostrata</i>)	Birtles et al., 2002
	Mooloolaba	Humpback whales (<i>Megaptera novaeangliae</i>)	Mangott et al., 2011
South Australia	Baird Bay	Bottlenose dolphins (<i>Tursiops</i> sp.)	Zeppel, 2009
	Glenelg	Bottlenose dolphins (<i>Tursiops</i> sp.) Common dolphins (<i>Delphinus delphis</i>)	Peters et al., 2013

State	Location	Targeted Species	References
South Australia	Kangaroo Island	Bottlenose dolphins (<i>Tursiops</i> sp.)	Zeppel, 2009
Victoria	Sorrento and Queenscliff	Burrnan dolphins (<i>Tursiops australis</i>)	Howes et al., 2012 Scarpaci, 2004 Weir et al., 1996
Western Australia	Bunbury and Mandurah	Bottlenose dolphins (<i>Tursiops</i> sp.)	Zeppel, 2009 Perrine, 1998
	Rockingham	Bottlenose dolphins (<i>Tursiops</i> sp.)	Orams, 1996 Weir et al., 1996

Appendix 2

Relevant sections of the Australian National Guidelines for Whale and Dolphin Watching 2005

Key elements of the *Australian National Guidelines for Whale and Dolphin Watching 2005* (DEH, 2005) include:

- Recommended approach distances and operating procedures for vessels in the vicinity of whales and dolphins (provision of a 'caution zone' where vessels must travel at a no-wake speed (i.e. less than 5 knots) whilst operators assess the behaviour of the animals at 150 m from the nearest animal; 'no approach zones' to the rear and in path of the animals and within 50 m of the nearest animal; and cessation of approach if the animal is evidently distressed or disturbed);
- A limit of three vessels permitted in the 'caution zone' at any one time;
- Vessels should not deliberately drift into the path of travelling animals;
- Vessels should move at a slow speed when within the 'caution zone' and avoid sudden or repeated changes in direction;
- Vessels should avoid making sudden or excessive noise, and intentional noise with the purpose of attracting animals is strictly prohibited;
- Vessels should be maintained in order to reduce the level of noise created;
- Restricting the animals' course and movement is not permitted;
- Pods containing calves should not be approached (with a calf being defined as an animal which is less than half the length of the mother to which it usually remains in close proximity);
- Vessels should not deliberately encourage animals to bow ride;
- Swimmers and divers should not deliberately enter the water in close proximity to a whale (< 100 m) or dolphin (< 50 m);
- Only permitted or licenced operators may conduct swim operations in the vicinity of whales or dolphins;
- Guidelines for aircraft operating in the vicinity of cetaceans; and

- Prohibiting the feeding of wild cetaceans (the current feeding programs that are licenced by government agencies must be accompanied by stringent management and research programs).

The Federal guidelines (DEH, 2005) also recommended that the following issues be considered when developing management measures for vessels, especially on a regional basis:

- Limit the duration that vessels spend in the vicinity of animals;
- Limit the cumulative time vessels spend with a pod/population per day;
- Specify the time required between successive vessel approaches on a regional basis;
- Establishment of 'no approach' times (e.g. when the animals are likely to be feeding, resting, etc.);
- Creation of temporal and/or spatial exclusion zones; and
- Research on the species biology and behaviour, habitat use and ecology of animals should be conducted.

Specific issues to be considered when developing or reviewing permitted swimming operations, detailed in the Federal guidelines (DEH, 2005), include:

- Limiting the number of licences issued;
- Limiting the number of swimmers allowed in the water;
- Limiting the maximum amount of time allowed to be spend with a pod/population per day (e.g. maximum time for each interaction; time required between successive swim attempts; and maximum cumulative watching time from all vessels/swimmers);
- Establishment of 'no approach' times (e.g. when the animals are likely to be feeding, resting, etc.);
- Creation of temporal and/or spatial exclusion zones;
- Limiting the distance of swimmers to animals; and
- Mermaid lines or boom nets should be used during swims.

Appendix 3

Relevant regulations of the Wildlife (Maine Mammal) Regulations, 2009

Table A. Conditions stipulated in the Wildlife (Maine Mammal) Regulations, 2009.

* A calf was defined as any individual that was less than half the length of an adult female.

Condition	Wildlife (Marine Mammal) Regulations, 2009
1. Do not approach a dolphin head-on, or cut in front of a dolphin's path (see Table B and Figure A)	Part 3, 9(1a, b, c)
2. Tour vessel must not approach a dolphin closer than 100 m more than 5 times each tour	Part 5, 17(5)
3. Must ensure that a tour vessel does not approach within 300 m of another tour vessel when they are within 100 m of a dolphin group	Part 3, 9(4)
4. (i) Must not swim with a calf*	Part 5, 17(15)
(ii) If a calf is detected during a swim, tour vessel must move > 100 m away from group	Part 5, 17(16)

Table A Continued. Conditions stipulated in the Wildlife (Maine Mammal) Regulations, 2009.

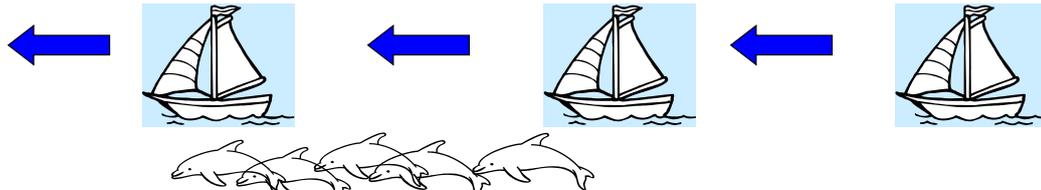
* A calf was defined as any individual that was less than half the length of an adult female.

Condition	Wildlife (Marine Mammal) Regulations, 2009
5. Tour operators must not approach a dolphin within 200 m whilst in Ticonderoga Bay Sanctuary Zone	Part 5, 16(12)
6. Must not reposition a tour vessel during a dolphin-swim	Part 5, 17(11)
7. Must ensure that no more than 10 people participate in a dolphin-swim	Part 5, 17(14)
8. Tour operators must provide information on the biology and conservation status of and threats facing dolphins	Part 5, 16(2)

Table B. Definitions of approach types used by tour operators in PPB, Victoria (modified from Scarpaci et al., 2003) (diagrams depicted below in Figure A).

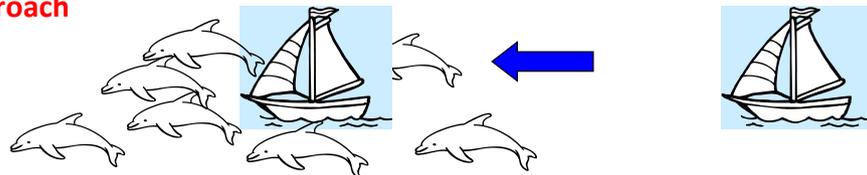
Approach Type	Definition	Legality
Parallel Approach	Tour vessel positioned to either side of a group of dolphins	Legal
Direct Approach	Tour vessel positioned directly into the middle of a group of dolphins	Illegal
J Approach	Tour vessel initially travelled parallel to a dolphin group, but then moved directly in front of the group	Illegal

Legal: parallel approach



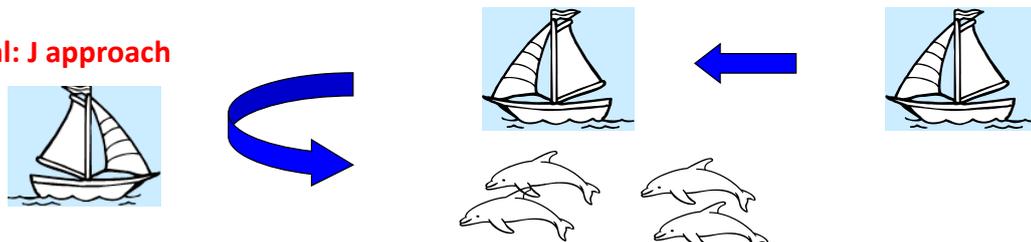
The tour vessel was positioned parallel to either side of a school of dolphins.

Illegal: direct approach



The tour vessel positioned directly into the middle of a school of dolphins.

Illegal: J approach



The tour vessel initially travelled parallel to a dolphin school but then moved directly into the path of the school

Figure A. Approach types used by swim-with-dolphin tour vessels within Port Phillip Bay, Victoria, Australia. Modified from Scarpaci et al., (2003).

Appendix 4

Behavioural states used to assess the behaviour of Burrunan dolphins (*Tursiops australis*) in Port Phillip Bay, Victoria, Australia.

State	Definition
Travel	Consistent and directional movement, making noticeable headway along a specific compass bearing, with short, relatively constant dive intervals
Forage	Perusal, capture and/or consumption of prey, as defined by observations of two or more of the following: erratic movements at the surface; multi-directional diving; coordinated deep diving; fish chasing; and rapid circle swimming. Prey often observed at the surface
Mill	Non-directional movement. Frequent changes in bearing prevented dolphins from making noticeable headway in any specific direction. Individuals surfaced facing various directions
Rest	Low activity level, with surfacing slow (slower than the idle speed of the observing boat) and more predictable than those observed in other behavioural states. Tight groups (< 1 body length between individuals) observed, with little evidence of forward propulsion
Social	Chasing, copulating, petting, rubbing, genital inspections, play and any other physical contact between individuals. Aerial behaviours such as breaching frequently observed

Appendix 5

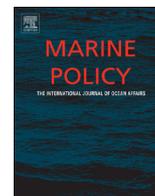
Chapter Two publication



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Social science as a vehicle to improve dolphin-swim tour operation compliance?



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ABSTRACT

This study investigates whether tourists can be a force to evoke compliance, via conducting social science and compliance studies simultaneously. Tourist demographics, motivation, biocentrism, knowledge and satisfaction levels were obtained from 511 questionnaires collected from dolphin-swim tourists between 2011 and 2013. Simultaneously dolphin-swim tour operator's compliance to regulations was assessed via 282 surveys collected from 1998 to 2013. Of the 8 dolphin-swim regulations assessed, tour operators demonstrated satisfactory compliance to 2 of the regulations. Conversely, tourists were happy to comply with regulations as they don't want to have a negative impact on the targeted species. The importance of understanding the human dimensions of dolphin tourism for the successful management of the industry is highlighted, as it enables interpretation to be developed that increases tourists education and biocentric levels. Tourists can be used as a vehicle for increasing tour operator compliance, enabling the industry to become more sustainable, whilst simultaneously encouraging economic growth.

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1. Introduction

Cetacean-based tourism is defined as any tourist activity with the primary purpose of watching or swimming-with cetacea (whales and dolphins) and is one of the fastest growing industries in the world [1]. Cetacean-based tourism generated over US\$2.1 billion in revenue worldwide in 2008 [2], making it the largest current economic activity dependent upon cetaceans [3]. In Australia, income derived from cetacean-based tourism has risen substantially, with a growth of 8.3% in the last decade [2,4]. In 2008, more than 1.6 million tourists participated in cetacean-based tourism in Australia, and the industry is now worth over \$29 million to the Australian economy [2,5]. However, the rapid expansion of this industry has raised concerns over the impacts these operations have on the targeted species, the marine environment and the sustainability of this tourism industry [6]. Long-term studies indicate that short-term behavioural changes and avoidance tactics may have long-term consequences (e.g., decreased reproductive success [7] and increased mortality rates [8,9]) for individuals and their populations [10].

In order to counteract the negative impacts of cetacean-based tourism, tours have the potential to positively influence participant's experiences and perceptions of the targeted species and their environment to facilitate responsible environmental behaviour amongst participants [11–13]. Research indicates that cetacean tourism interpretation that is carefully designed and delivered, can effectively increase visitor knowledge, influence attitudes, encourage behaviour modification, and contribute to a rewarding touristic experience [1,14–18]. However, limited research focuses on the human dimensions of dolphin tourism and its potential to increase tourist's biocentric values and pro-conservation behaviours [15,19,20]. Indeed, this is the first study to evaluate whether there are long-term increases in participation biocentrism due to participation in a dolphin-swim tour. The research also evaluates factors that can promote education and what type of information is desired by tourists.

Interpretation not only helps protect the environment but can also increase visitor enjoyment and lead to longer-term benefits in participants, such as greater environmental awareness and involvement in conservation organisations (e.g., [1,15,19,21,]). It has been suggested that interpretation on-board vessels has the potential to help protect cetaceans via changes in tourist's behaviour, and may be more important than regulations in ensuring long-term environmentally conscious and sustainable practices [16,22,23]. Dolphin-swim tourism compliance is negligible globally [24–26], with the industry in PPB historically non-compliant

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due to failed management [27,28]. Non-compliance is driven by the pressure faced by tour operators to satisfy customers and meet expectations [24] and facilitated via a lack of enforcement [28]. In the absence of government enforcement, the question remains: how can tour operators be encouraged to comply to regulations so that the industry remains sustainable? If tour operators are informed about what their patrons want, and this is aligned with sustainable practice, then there is the potential for tourists to be used as a force to drive tour operator compliance. Irrespective that the dolphin-swim industry can be governed by regulations, levels of compliance can be low. Therefore, alternative strategies are required to improve compliance and mitigate impacts that dolphin-swim industries may pose to target species. In other sectors, social science questionnaires have determined that individuals are willing to pay more for environmentally friendly products, and that good eco-performance generates competitive advantages, such as increased word of mouth intention [29–31].

This manuscript explores whether tourists themselves can evoke compliance, via conducting social science and compliance studies simultaneously. The objectives of this paper were to investigate whether social sciences (specifically customer questionnaires) can provide the opportunity to encourage tour operator compliance. Specifically, this study aimed to evaluate dolphin-swim participant's demographics, motivation, biocentrism, knowledge and satisfaction levels before, after and 6 months post a dolphin-swim tour. Finally, this study aimed to compare compliance across two time frames to determine whether stricter and simpler amendments in the regulatory requirements motivated tour operations to improve compliance levels.

2. Methods

2.1. Study site

Port Phillip Bay (hereafter PPB) is home to approximately 120 individual dolphins, recently identified as a genetically and morphologically isolated sub-species of bottlenose dolphin; the Burrunan dolphin (*Tursiops australis*) [32]. To interact with Burrunan dolphins, tourists on-board dolphin-swim tour vessels engage in a 3.5 h tour of the southern end of PPB (38°05'S, 144°50'E), on the south-eastern coast of Victoria, Australia.

2.2. Questionnaire design

Questionnaires were designed around six core components: factors that motivate tourists to participate in a dolphin-swim tour; participant's biocentric values; participant's level of conservation activity; participant's perceived knowledge about dolphins, participant's interest levels on topics about dolphins and their environment; and participant's satisfaction with the dolphin-swim tour. Questionnaires were voluntary and only distributed to participants over the age of 18. The experimental design employed a number of scaled items (previously tested in other marine wildlife encounter programs, e.g., [5,16,33–35]). Closed-response questions were rated using 5-point Likert-type scales, which enabled participants to respond to a range of variables related to their experience, biocentric values, and their knowledge about dolphins and their environment. A 75% questionnaire completion rate was required to be included within the study.

Questionnaires were distributed to dolphin-swim tourists: pre dolphin-swim (hereafter PRE) (completed one week or less prior to dolphin-swim tour); post dolphin-swim (henceforth POST) (completed within a day of participation); and 6 months post dolphin-swim (hereafter 6 MP) (completed 6 months or more after the dolphin-swim tour). Questionnaires were accessible

online, through the survey monkey website. PRE- and POST questionnaires were distributed to dolphin-swim tourists via a link embedded into an email from the dolphin-swim companies. 6 MP questionnaires were distributed by the primary researcher (NF) via email to tourists who had participated in either of the first two questionnaires. NF was on-board dolphin-swim tours to encourage participation and answer any questions.

2.3. Compliance data collection

Observations of tour operator compliance to regulations were conducted on-board dolphin-swim tour vessels in PPB across two time frames (period 1: 2007–2008; and period 2: 2011–2013). Data was recorded for distance between tour vessels, repositioning of tour vessels during a dolphin-swim, interactions with dolphin groups within Ticonderoga Bay Sanctuary Zone (TBSZ), and number of swimmers, using 1 min scan samples [36]. TBSZ is a small (approx. 2000 m²) sanctuary zone inside PPB [37], extending 500 m offshore from Point Nepean (38°17'56.9"S, 144°38'54.8"E; 38°18'5"S, 144°38'54.8"E) to Police Point (38°18'46.8"S, 144°42'19.6"E; 38°18'56.6"S, 144°42'19.6"E) [38]. Continuous observations were used to record approach type (Table 2), number of approaches and whether education was provided. An encounter was defined as the period during which a dolphin-swim vessel was engaged in interaction with a dolphin group (within 300 m), as described in Scarpaci et al. [27]. Distance was determined using a Yardage Pro 500 range finder. As stated in the Wildlife (Marine Mammal) Regulations [38], a calf was defined as any individual that was less than half the length of an adult female. Tour operator compliance to the Wildlife (Maine Mammal) Regulations [38] was assessed for the conditions listed in Table 1, with compliance deemed satisfactory if 80% or higher [25,27,28].

2.4. Statistical analyses

Participant's biocentrism, satisfaction, interest and motivation were based on an indicator value, calculated as the mean response to statements on the Likert-type questions. Scores of 1–2.9 were considered non-biocentric, 3–3.9 represented a neutral attitude, and scores of 4–5 were deemed biocentric [11]. Scores from PRE, POST and 6 MP questionnaires were compared using Mann Whitney U tests to determine if biocentrism, satisfaction, interest and motivation varied between time frames [39]. Results were considered significant at $p \leq 0.05$.

A modified four-item New Environmental Paradigm (NEP) scale was utilised, as designed by Luzar et al. [40]. The NEP was used to assess participant's biocentric values regarding conservation of the marine environment, and participant's biocentric values in terms of motivation and intent to become involved in marine conservation. Each answer received a value from 1 to 5, and participants with scores of 3–3.9 were deemed to have neutral biocentric values, scores of less than 2.9 represented negative biocentric values, and scores of 4–5 represented positive biocentric values.

3. Results

Questionnaires were conducted from February 2011–October 2013. The response rate was 5.7% ($n=511$), accounting for 40.1% ($n=205$), 41.1% ($n=210$) and 18.8% ($n=96$) for PRE, POST and 6 MP, respectively. Participants were most likely to complete POST and 6 MP questionnaires (11.7%, $n=49$) followed by PRE and 6 MP questionnaires (7.6%, $n=32$) and PRE and POST questionnaires (2.6%, $n=11$). Less than 1% (0.7%, $n=3$) of participants completed all 3 questionnaires.

Table 1
Definitions of conditions stipulated in the wildlife (marine mammal) regulations [38] that were assessed.

Condition	Regulations	How compliance was assessed
1. Do not approach a dolphin head-on, or cut in front of a dolphin's path	Part 3, 9(1a, b, c)	When a tour vessel was within 100 m of a dolphin group and moved in a steady direction towards the group it was deemed an approach. Three approach types were observed (Table 2)
2. Tour vessel must not approach a dolphin group closer than 100 m more than 5 times each tour	Part 5, 17(5)	Number of approaches tour vessels undertook per trip recorded
3. Must ensure that a tour vessel does not approach within 300 m of another tour vessel when they are within 100 m of a dolphin group	Part 3, 9(4)	Distance between tour vessels assessed when vessels were within 100 m of a dolphin group and another tour vessel was within 300 m
4. Must not swim with a calf	Part 5, 17(15)	Observer considered crew had opportunity to observe presence of a calf prior to a swim (i.e., calf was clearly visible to observers unaided eye, or staff indicated to customers that a calf was present)
5. Tour operators must not approach a dolphin within 200 m whilst in TBSZ	Part 5, 16(12)	Distance between tour vessels and dolphins recorded when tour vessels within TBSZ
6. Must not reposition a tour vessel during a dolphin-swim	Part 5, 17(11)	Recorded any manoeuvring of tour vessel during a dolphin-swim that was not motivated by safety concerns
7. Must ensure that no more than 10 people participate in a dolphin-swim	Part 5, 17(14)	Number of swimmers (within 300 m of dolphins) recorded every minute until conclusion of dolphin-swim
8. Tour operators must provide information on the biology and conservation status of and threats facing dolphins	Part 5, 16(2)	Recorded whether staff provided information on dolphins during tour. If staff provided information on species name, home range and threats facing the dolphins in PPB they were deemed to be compliant to this condition

Table 2
Definitions of approach types used by tour operators in PPB, Victoria (modified from Scarpaci et al. [27]).

Approach type	Definition	Legality
Parallel approach	Tour vessel positioned to either side of a group of dolphins	Legal
Direct approach	Tour vessel positioned directly into the middle of a group of dolphins	Illegal
J approach	Tour vessel initially travelled parallel to a dolphin group, but then moved directly in front of the group	Illegal

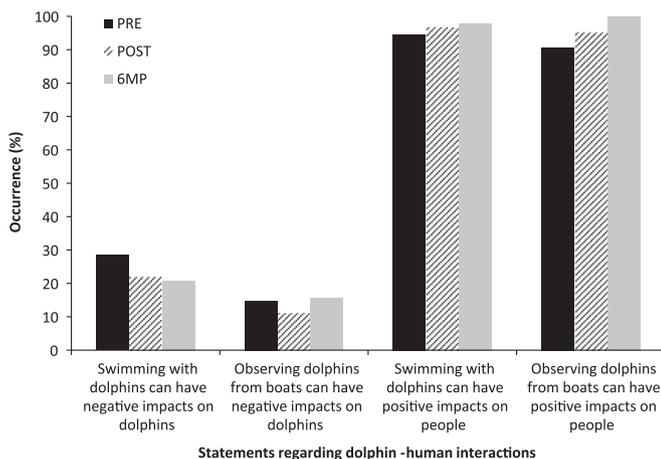


Fig. 1. Participant's views on dolphin-swimming (agree and strongly agree).

3.1. Demographics

Respondents were primarily from Victoria, Australia (85.0%, $n=182$), followed by international travellers (8.9%, $n=19$) and travellers from other states of Australia (6.1%; $n=13$). The international composition of travellers varied (Europe=3.4%; UK=2.8%; USA/Canada=1.9% and Asia=0.9%). Majority of respondents were female (69.3%, $n=142$), while males accounted for 30.7% ($n=63$). Age of respondents ranged from 18 to 71 years old (mean=39, $SE=0.893$). Respondents were generally well educated with 75.7% ($n=155$) of participants post-secondary qualified and of these, 62.5% ($n=128$) qualified to tertiary standards. The intent of participants was to swim with free-ranging dolphins (94.7%, $n=195$). Respondents independently organised and travelled to the dolphin-swim tour site. The majority (73.2%, $n=150$) of respondents had not previously fed, swam with or interacted with dolphins in other locations. For the majority of

patrons, this was their first encounter with dolphins in PPB (89.8%; $n=184$). Almost all participants felt that swimming with dolphins was beneficial for them and posed no impact on the dolphins (Fig. 1). The potential impact of swimming with, and observing dolphins from boats, was further disregarded by participants across time, although this was not significant, $H(2)=3.106$, $p=0.212$ and $H(2)=0.053$, $p=0.974$, respectively.

The majority of participants did not frequently engage in environmental activities, with almost half (49.7%, $n=94$) of participants having never participated in conservation activities and 43.9% ($n=83$) having never made a monetary donation to an environmental cause. Most participants had visited an aquarium or zoo at least once (41.7%, $n=79$ and 45.0%, $n=85$, respectively), and approximately 80% of participants had watched a marine documentary on dolphins.

3.2. Visitor motivation factors

Prior to the dolphin-swim trip, factors that motivated tourists to select a tour boat company were: activities offered (75.6%, $n=155$); environmental beliefs and company awards (61.5%, $n=126$); and cost (60.5%, $n=124$). Participants were not motivated to select a tour boat company based on: dolphin sighting guarantee (26.3%, $n=54$); size of boat (24.4%, $n=50$); or number of people (44.9%, $n=92$). There was a significant difference ($t(4)=4.168$, $p=0.014$) between factors that participants ranked as important and those not considered as important.

Irrespective of the time frame, factors important to participants do not change (i.e., POST and 6MP tour the most important factors when participating in a dolphin-swim were still: seeing dolphins in their natural environment; knowledgeable staff; and opportunities to see dolphins) (Table 3). Tourists were motivated to partake in a dolphin-swim tour more for the dolphin experience (94.7%) than for the overall environment experience (78.3%). Getting close to dolphins was not of high importance when participating in a dolphin-swim, and

Table 3

Factors of very-high importance to participants when participating in a dolphin-swim (PRE, POST and 6 MP).

	Category	PRE (%)	POST (%)	6 MP (%)
Large numbers of dolphins to see	Dolphin experience	45.5	30.9	20.0
Getting close to dolphins	Dolphin experience	68.2	63.3	44.2
Opportunity to see dolphins	Dolphin experience	92.6	87.7	89.5
Seeing dolphins in their natural environment	Dolphin experience	94.7	93.3	92.7
Interesting information about dolphins	Knowledge	80.4	75.2	87.3
Knowledgeable staff	Knowledge	94.2	89.5	94.7

significantly declined in importance by a third from PRE (mean=3.92, $SD=0.887$) to 6 MP (mean=3.49, $SD=0.886$, $U=6602$, $p=0.000$). Observing large numbers of dolphins was also not an important factor to participants when deciding to participate in a dolphin-swim tour, with the level of importance decreasing significantly by a half from PRE (mean=3.45, $SD=1.054$) to 6 MP (mean=3.00, $SD=0.863$, $U=6735$, $p=0.000$).

3.3. Visitor biocentric attitudes and values towards dolphins and their environments

The modified NEP scale (Table 4) includes declarations about conservation, and is modelled to reveal negative and positive values amongst participants regarding conservation of the marine environment, assisting with marine conservation programs, conservation of dolphins and marine wildlife. Results revealed that participant's biocentric values concerning marine conservation were positive and relatively high, and that this increased significantly over time from PRE (mean=4.59, $SD=0.631$) to POST (mean=4.66, $SD=0.609$, $U=315470$, $p=0.008$), and from POST to 6 MP (mean=4.54, $SD=0.707$, $U=147789$, $p=0.005$).

Participants NEP values were neutral regarding their intent to become more involved in marine conservation issues; make donations to environmental organisations; join wildlife/dolphin preservation organisations; donate time assisting with wildlife conservation; remove litter that could harm wildlife; decrease their personal water pollution levels; assist in protection of dolphins where possible and tell others about the need to conserve our oceans (Table 5). However, respondents were most likely to engage in minimal effort/low commitment conservation activities (e.g., pick up rubbish (mean=77.4%) or tell others about the need to care for our oceans (mean=65.6%)) than activities that require ongoing commitment and monetary donations (e.g., join a wildlife or dolphin preservation organisation (mean=16.5%)). Participants biocentric intent to be involved in conservation activities increased significantly over time from PRE (mean=3.11, $SD=1.275$) to POST (mean=3.33, $SD=1.275$, $U=1101277$, $p=0.000$), and from PRE to 6 MP (mean=3.26, $SD=1.204$, $U=543733$, $p=0.011$).

3.4. Visitor motivation to adopt pro-active conservation initiatives

The majority of PRE participants had never participated in conservation activities (59.7%). After the dolphin-swim tour, participants levels of conservation activity increased by 9.7%, with half of participants now involved in conservation activities (Table 6). Level of responses for "I do not ever intend in participating in conservation activities" PRE was 7.0% but declined to 1.4% of participants 6 MP (Table 6). After the dolphin-swim tour, the number of participants who have never participated in conservation activities declined by 8.3% from 32.5% (PRE) to 24.2% (6 MP).

3.5. Visitor's knowledge and interest in dolphins

Visitors perceived their knowledge levels about dolphins had increased POST. The majority of PRE respondents had a perceived

Table 4

Mean NEP values for biocentric values—marine conservation.

Biocentric values—marine conservation	
PRE	4.60
POST	4.66
6 MP	4.55

Table 5

Mean NEP values for biocentric values—intention.

	Overall biocentric values—intention	Minimal effort	Time and money output
PRE	3.11	3.66	2.56
POST	3.34	3.89	2.79
6 MP	3.26	3.83	2.68

slight level of knowledge about dolphins (48.2%, $n=91$) and this shifted to a perceived moderate level of knowledge POST (59.3%, $n=115$) and 6 MP (68.4%, $n=65$).

Results reveal that the time participants are most interested in topics about dolphins is post dolphin-swim (Table 7), with interest levels increasing for all factors from PRE responses, and declining for all 6 MP responses for majority of topics. The most popular learning category POST was dolphin's intelligence and strange characteristics (79.7%). Participant's level of interest increased significantly from PRE to POST for topics regarding: daily activities of dolphins; details about individual dolphins; breeding and rearing of young dolphins; dolphin distribution and population numbers; dolphins diet; dolphin conservation; and dolphin strandings and rescues (Table 7). Across the three sampling periods (PRE, POST and 6 MP), conservation topics held the highest levels of interest to customers and humanisation and indigenous topics held the lowest level of interest (Table 7). As seen in Table 7, there was no significant difference in participant's interest levels from PRE to 6 MP.

The majority of respondents indicated that harming dolphins should be punishable as an offence and believed that it is not ok to feed dolphins (Table 8). Temporally, participants were in highest agreement with statements that were conservation based, and patrons conservation levels regarding the importance of protecting dolphins increased significantly across time from PRE to 6 MP (Table 8), indicating that participants have high biocentric values. Participants environmental ownership (i.e., that their daily actions could affect dolphins and the marine environment) increased significantly across time from PRE to POST (Table 8).

3.6. Visitor satisfaction with dolphin-swim tour

Participants were highly satisfied with how close they got to dolphins, the dolphin swim rules they had to follow, the sea conditions and interest of information given (Table 9). Participants

Table 6
Participant's current state of conservation activity.

	PRE (%)	PRE (n)	6 MP (%)	6 MP (n)
I am already involved in conservation activities	40.3	52	50.0	36
I will get involved in conservation activities	3.9	5	2.7	2
I have been thinking about participating in conservation activities for less than six months	14.7	19	4.2	3
I have been thinking about participating in conservation activities for more than six months	34.1	44	41.7	30
I do not ever intend in participating in conservation activities	7.0	9	1.4	1

Table 7
Participants level of interest (very-highly interested) for topics about dolphins (PRE, POST and 6 MP tour).

	Category	PRE (%)	PRE–POST	POST (%)	POST–6 MP	6 MP (%)	PRE–6 MP
Daily activities of dolphins	General	48.4	↑*	63.1	↓*	52.1	↑
Details about individual dolphins	General	50.0	↑*	59.9	↓	52.2	0
Dolphins intelligence and strange characteristics	General	73.1	↑	79.7	↓	71.3	0
Breeding/rearing of young dolphins	General	50.0	↑*	63.1	↓	56.4	↑
Dolphin distribution and populations numbers	General	46.7	↑*	66.3	↓	57.5	↑
Dolphins diet	General	36.6	↑*	50.3	↓	47.8	↑
Dolphin social habits	General	66.7	↑	74.9	0	73.4	↑
Dolphins relationships with other species	General	66.1	↑	74.3	↓	70.2	↑
Dolphins importance in the ecosystem	General	62.3	↑	74.8	↓	65.9	↑
Marine environment conservation	Conservation	63.5	↑	70.6	0	71.3	↑
Dolphin conservation	Conservation	62.9	↑*	74.4	↓	69.1	↑
Dolphin stranding's and rescues	Conservation	49.5	↑*	62.6	↓	58.5	↑
Dolphin features that are similar to humans	Humanisation	52.7	↑	65.2	↓	50.0	0
Dolphins interactions with aboriginals	Indigenous	39.3	↑	47.5	↓	43.6	↑

* Statistically significantly different at $p < 0.05$.

Table 8
Participants biocentric values (or levels of knowledge) (agree–strongly agree) regarding dolphins (PRE, POST and 6 MP tour).

	Category	PRE (%)	PRE–POST	POST (%)	POST–6 MP	6 MP (%)	PRE–6 MP
It's ok to keep dolphins in captivity	Utilisation for people	14.5	↓*	13.0	0	11.7	↓
It's ok to feed dolphins	Utilisation	19.3	↓*	9.2	0	9.5	↓*
It's ok to swim with dolphins	Utilisation	76.4	↑	79.5	0	79.8	↑
Dolphins are an important resource to Australia	Utilisation	83.9	↑	89.7	0	89.4	↑
Dolphins are more special than other wild animals	Humanisation	18.3	0	18.4	↑	22.3	↑
Dolphins have feelings	Humanisation	84.9	↑	89.7	0	90.4	↑
Dolphins have thoughts	Humanisation	85.4	↑	87.6	↑	92.6	↑
Dolphins are intelligent	Humanisation	97.9	0	97.3	0	98.9	0
Harming dolphins should be punishable as an offence	Protection	89.3	0	88.7	↑	92.5	↑
My daily actions affect dolphins	Ownership	45.7	↑	51.9	↑	64.9	↑*
My daily actions affect the marine environment	Ownership	67.6	↓	65.4	↑*	73.4	↑*
Dolphins are affected by events that occur in land environments	Conservation	91.4	↑	94.6	0	95.8	↑
It's important to protect dolphins	Conservation	95.2	↑*	97.8	0	96.8	0
It's important to protect the marine environment	Conservation	96.7	↑	99.5	0	99.0	↑

* Statistically significantly different at $p < 0.05$.

were not satisfied with information on how to help conserve dolphins and their environment, or the amount of time they swam with dolphins (Table 9).

3.7. Compliance

During period 1, there were 104 surveys conducted on-board tour vessels, resulting in 59 independent dolphin sightings. Mean tour duration was 3 h and 17 min ($SE=4.413$). During period 2, 178 surveys were conducted, resulting in 104 dolphin sightings. Mean tour duration was 3 h and 22 min ($SE=1.612$). Sighting success rate was 58.0% and 46.6%, respectively, for periods 1 and 2. During period 1, the total time dolphins were within 300 m of tour vessels was 25 h and 38 min (mean=22 min 8 s) compared to 46 h and 6 min (mean=26 min 35 s) for period 2. Of the 8 conditions assessed across 1998–2013, tour operators demonstrated satisfactory compliance to only 2 of the conditions (number of swimmers and education, Fig. 2).

4. Discussion

4.1. General discussion

A non-compliant dolphin-swim industry that does not satisfy the tourist expectation, could negatively deteriorate the experience, impact future sustainability and decrease future business potential. In PPB, the top three motivators to participate in a dolphin-swim tour for tourists were observing dolphins in their natural environment, opportunity to see dolphins and knowledgeable staff. Observing large numbers of dolphins and getting close to dolphins ranked the lowest motivator for participants to commit to a dolphin-swim tour. Furthermore, participants continued to assign decreasing value to these two factors across time, indicating that they are not important features in a tour from the perception of the participants. Indeed, across time, the majority of participants were highly satisfied with the proximity of the tour vessel to dolphins during the tour, reinforcing the fact that geographical proximity of dolphins to tourists is not important

Table 9
Participants level of satisfaction (very-highly satisfied) with various aspects of their dolphin-swim (POST and 6 MP tour).

	Category	POST	POST-6 MP	6 MP
Number of dolphins I saw	Dolphin	66.5	↓	63.1
How close I could get to dolphins	Dolphin	63.8	0	63.1
Health of dolphins	Dolphin	73.8	↑	76.9
Natural behaviour of dolphins	Dolphin	72.3	↓	70.5
Amount of time I spent watching dolphins	Dolphin-time	57.6	0	58.9
Amount of time I swam with dolphins	Dolphin-time	44.0	↓	40.0
How closely you observed the dolphins	Dolphin-proximity	63.3	0	64.2
Amount of watercraft in area	Experience	63.9	↓	61.0
Number of people in the water	Experience	71.2	↓	66.4
Space available on boat for visitors	Experience	76.9	↑	81.1
Sea conditions during tour	Experience	82.2	↑	85.3
Dolphin-swim rules I had to follow	Rules	80.6	↑	83.2
Interest of information given	Knowledge	80.1	↑	85.2
Information on how to help conserve dolphins	Knowledge	46.6	↑	60.0
Information on how to help conserve dolphins environment	Knowledge	46.6	↑	61.0
Overall satisfaction	General	83.8	0	83.1

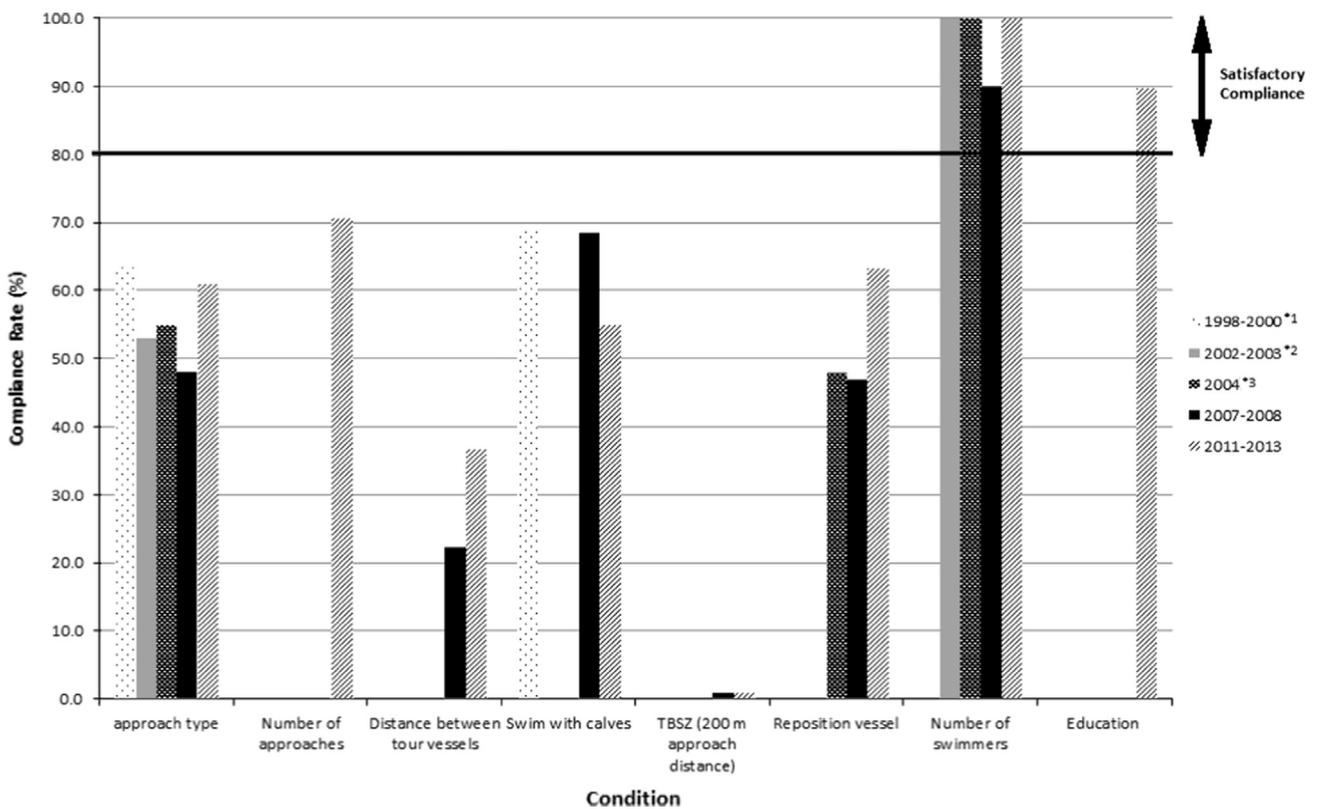


Fig. 2. Figure 2. Compliance rates to conditions stipulated in the Wildlife (Marine Mammal) Regulations for dolphin-swims in Port Phillip Bay Victoria, across 436 surveys, 1998–2013. *1 [27] *2 [28] *3 C.S. personal observations

for participant’s satisfaction, and that non-compliance by tour operators to this condition is not constructive for business.

Development of simpler regulations and stricter conditions did not motivate tour operations to improve compliance. However, participants were satisfied with the dolphin-swim rules they had to follow. Previous research indicates that participants want guidance and are likely to comply with rules and regulations once explained, because tourists do not want their actions to impose disturbance on targeted wildlife [41,42]. For example, Ballantyne et al. [17] found that when whale watching participants were aware that they had to abide by regulations in order to minimise impacts on the whales, the experience was made even more special for tourists. The Wildlife (Marine Mammal) Regulations [38] restricts approach type, the number of swims a tour operator can attempt per trip, and does not permit tourists to swim with calves. However,

tour operators fail to comply with these conditions and consequently, from 1998 to 2013 there has been an increase in dolphin’s avoidance to tour vessels [43]. This potentially could result in a decrease in the amount of time tourists observe dolphins under the water, ensuing in decreased customer satisfaction. Presently, less than 50% of participants were satisfied with the amount of time they swam with dolphins, however, customers indicated that they were happy to follow dolphin-swim rules. Thus, it is recommended that tour guides explain why regulations are in place in order to increase customer satisfaction and encourage business growth. To facilitate compliance (e.g., do not swim with a calf; only 5 approaches per dolphin group per tour) tourists should be advised that the intent of the regulations is to reduce disturbance to the dolphins. By explaining regulations to customers prior to the dolphin-swim, participant’s expectations will be managed, reducing

disappointment and increasing customer satisfaction. Furthermore, this will remove pressure from tour operators to breach regulations.

The small population size of the dolphins in PPB, increased number of tourists in the peak summer season, co-operative sighting strategies amongst tour operators, tour vessels alternating swimmers to interact with a single dolphin group and the lack of enforcement in southern PPB, has meant that frequently there are high concentrations (up to 10 vessels per group of dolphins) of traffic (tour and recreational vessels) around dolphin groups. This crowding creates a competitive scenario amongst tour operators for access to dolphins, triggering non-compliance to the prescribed minimum distances between tour vessels. The results presented indicate low customer satisfaction to number of boats around dolphins and implied participants experienced perceived crowding. Bell [44] reported that number of boats had a significant impact on the quality of visitor experience for visitors to Molokini Shoal Marine Life Conservation District, Hawaii, with two-thirds of respondents feeling crowded and 80% supporting management interventions that would limit the number of boats in the area. Therefore, satisfactory compliance is not only important to mitigate the effects of tourism on the targeted species but can also improve customer satisfaction that in turn, could provide economic growth *via* repeat business, word of mouth recommendations, and positive reviews through marketing websites (e.g., trip advisor).

Across time, participants valued knowledgeable staff and this remained a consistently important feature to patrons when deciding on participating in a tour. These results reinforce that education is wanted by participants, that they expect interpretation as part of their tour, and indicates that tour leaders are central to the tourist experience. However, tourists were only moderately satisfied with information they received on conserving dolphins and their environment. Importantly, for management, what tourists want (education) is not going to be an expensive outlay for tour operators and could be used as a vehicle to trigger positive action by tourists (e.g., join a dolphin/conservation group, or a dolphin stranding/rescue group) post dolphin-swim trip to encourage pro-conservative behaviours. This study also identified that the optimal time to conduct educational activities is after the dolphin-swim, as participants are most interested in different topics about dolphins and their environment at this time. These results concur with Ballantyne et al. [17], Hrycik and Forestell [22], and Lück [15] who found that during the “post-contact” phrase, whale-watching participants were most receptive to information on biology and conservation of cetaceans, were more likely seek further information and reconsider global environmental threats.

The lack of information provided to dolphin-swim participants affects the conservation potential of this industry [6]. The majority of PRE respondents had a slight perceived level of knowledge about dolphins and this increased to a moderate level for the majority of POST and 6 MP participants, indicating that participants perceived increase in knowledge levels lasts across time and is not superficial. Participants felt that they gained knowledge on-board the dolphin-swim tours, indicating that tours can be an effective way to educate people and raise their biocentric levels; although there is the potential for further increase here. Dolphin-swim tours can be a good vehicle for education, as demonstrated by the significant decrease across time in participant's level of agreement to the statement ‘it is OK to feed dolphins’. However, despite being ranked (PRE) as the second (knowledgeable staff) and fourth (interesting information), most important aspects of the tour service, a number of POST participants were dissatisfied with information provided on dolphin-swim tours in PPB. Although participants in this study were educated (over 60% tertiary qualified), their initial level of knowledge about dolphins was low (50%=none or slight), indicating that in order for

interpretation to be successful in promoting marine conservation ideals, tour operators in PPB need to provide basic information on the fundamentals of dolphin ecology and their marine habitat issues.

There was a 20% increase in the number of participants from PRE to POST and 6 MP who realised that their daily activities can affect dolphins, indicating that tour participation has made them more aware of the consequences of their actions. Furthermore, participant's biocentric values concerning marine conservation are positive and increase significantly across time. Therefore, it can be surmised that tours can be a vector for promoting pro-environmental beliefs. However, although the majority of participants had biocentric values, they were not members of environmental organisations and failed to demonstrate pro-conservative actions, revealing that positive biocentric values do not necessarily transcend to actions. Dolphin-swim participants were unwilling to outlay time, high levels of effort or finances to help conserve dolphins and their environment. However, participants were more likely to take conservation actions that require minimal amounts of time or effort (*i.e.*, remove litter that could harm wildlife). When participants perceive that their actions could have a direct impact on the environment, they have a higher intent to take action to help. Participant's commitment to biocentric action is dependent on the level of investment required, with minimal effort activities (e.g., communicate to others about the need to conserve the marine environment) being the most likely actions to occur.

A limitation of this study was that less than 1% of participants completed all three questionnaires. Furthermore, the response rate was exceptionally low (< 6%), indicating a positively biased data set, as people who are already biocentric are more likely to participate. Previous research examining the human dimensions of marine wildlife tourism *via* questionnaires received response rates in the range of 54–76% [11,15,18,35,45]. The aforementioned studies all distributed their questionnaires in person, and therefore the lower response rate received herein is likely due to the fact questionnaires were distributed online, whereby participants have no personal contact with the researcher and therefore, may feel less obliged to participate. Thus, it is recommended that future social science research, that collects data *via* questionnaires, be distributed in person to achieve a higher response rate and less biased sample. Alternatively, to increase participation rates, incentives such as price reductions on tour bookings, partial refunds or discounts on future tours could be offered.

Other recommendations that the authors suggest be implemented to increase participant's biocentric and satisfaction levels, improve the sustainability of the dolphin-swim industry in PPB and increase economic growth include: (1) tour operators incorporate topics of interest to participants (as detailed in results, Section 3.5) into the on-board interpretation; (2) tour operators target activities in their interpretation that participants have shown interest and intent in doing (detailed in results, Section 3.3); (3) interpretative material to be scheduled at specific times of the tour, (e.g., explain regulations prior to the dolphin-swim and deliver conservation information after dolphin encounters); and (4) initiate compulsory annual training programs, that are delivered by the managing body to staff of tour companies. Training should aim to raise staff's awareness of all regulations and what interpretation needs to be provided on the tour. Training should incorporate information on the biology and conservation of the targeted species, and actions that participants can take to become involved in conservation activities (e.g., brochures and websites participants could visit). By developing a structured, comprehensive interpretation program, with input from researchers, stakeholders, and the governing body for the industry, tour operators have the opportunity to increase customer satisfaction levels by meeting their need and expectation for knowledge during

dolphin-swim tours. Results presented herein suggest that the opportunity to learn about conservation is likely to enhance, rather than detract from the experience. Economically, this will benefit the industry as satisfied customers are more likely to bring repeat business to the industry. However, on-going monitoring is vital to determine if training programs are effective over time and to determine if there is an increase in tour operator's compliance corresponding with an increase in tourists increased knowledge.

4.2. Conclusions

With a history of non-compliance, and a lack of government enforcement, there needs to be a shift from ownership falling solely on tour operators to ownership being shared between tour operators and patrons. It appears as though tourists, if properly educated, can be used as a means to increase tour operator compliance, as tourists are happy to comply with regulations and they do not want to have a negative impact of the targeted species. This paper demonstrates how human dimensions of dolphin tourism are important for the successful management of the industry. By giving tourists what they actually want, commercial operators are empowered to conserve the sustainability of the industry while potentially increasing profit margins.

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Appendix 6.1

Visitor survey for dolphin swim programs: Pre dolphin-swim

This survey is part of a research project being conducted by the Victoria University (VU). By answering these questions, you will assist us in developing better management and interpretation programs that will benefit both dolphins and humans in the future.

All information given below is totally confidential, and your personal details will not be used or released to any sources (in accordance with the ethics and confidentiality agreement of VU).

For the following questions please tick the appropriate box:

1. Where do you live?

- Locally In Australia Post code: _____
 Outside Australia Country: _____

2. Are you part of an organised tour?

- Yes
 No

3. How are you participating today?

- Swimmer
 Observer

4. Gender:

- Male
 Female

5. Age: _____

6. Your highest educational qualification attained:

- Primary School
- High School
- Tafe Qualifications
- Bachelor Degree
- Post-Grad Qualification

7. Have you swam-with or interacted with dolphins in Port Phillip Bay before?

- No
- Yes, I have been _____ times

8. Have you previously feed, swam-with or interacted with dolphins?

- No
 - Yes
- If 'Yes' please write which species and where: _____

9. What factors are important to you when picking a tour boat company?

- Size of boat
- Cost
- Activities offered
- Number of people
- Guarantee
- Environmental beliefs & awards company has received

10. Please circle the number which indicates if you agree or disagree with the following statements, where:

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. Swimming with wild dolphins can have negative impacts on dolphins:

1 2 3 4 5

B. Swimming with wild dolphins can have positive impacts on people:

1 2 3 4 5

C. Observing wild dolphins from boats can have negative impacts on dolphins:

1 2 3 4 5

D. Observing dolphins from boats can have positive impacts on people:

1 2 3 4 5

11. Please circle the number that best indicates how you now feel about the following statements, where:

1 = No importance 2 = Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Conserving the marine environment:

1 2 3 4 5

B. Assisting with marine conservation programs:

1 2 3 4 5

C. Conservation of dolphins:

1 2 3 4 5

D. Conservation of marine wildlife:

1 2 3 4 5

12. Please circle the number that best matches your level of motivation/intent to do the following activities:

1=No intent 2=Slight intent 3=Moderate intent
4=High intent 5=Very high intent

A. Become more involved in marine conservation issues:

1 2 3 4 5

B. Make a donation to an environmental organization:

1 2 3 4 5

C. Join a wildlife or dolphin preservation organization:

1 2 3 4 5

D. Donate some time to assisting with wildlife conservation:

1 2 3 4 5

E. Remove litter that could harm wildlife/dolphins:

1 2 3 4 5

F. Decrease the amount of my personal water pollution:

1 2 3 4 5

G. Assist in the protection of dolphins where possible:

1 2 3 4 5

H. Tell others about the need to care for our oceans/animals:

1 2 3 4 5

13. Place a tick in the space that corresponds with your current state of conservation activity

A. ____ I have never participated in conservation activities

B. ____ I do not ever intend in participating in conservation activities

C. ____ I have been thinking about participating in conservation activities for more than six months

D. ____ I have been thinking about participating in conservation activities for less than six months

E. ____ I will get involved in conservation issues within the next ____ months

F. ____ I am already involved in conservation activities

14. How important are the following statements to you when deciding on, or participating in, a dolphin-swim?

1 = No importance 2= Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Experience the environment:

1 2 3 4 5

B. Opportunity for outdoor recreation:

1 2 3 4 5

C. Observing wildlife:

1 2 3 4 5

D. Opportunities to see dolphins:

1 2 3 4 5

E. Large numbers of dolphins to see:

1 2 3 4 5

F. Getting close to dolphins:

1 2 3 4 5

G. Seeing dolphins in their natural environment:

1 2 3 4 5

H. Interesting information about dolphins:

1 2 3 4 5

I. Knowledgeable staff:

1 2 3 4 5

15. Please indicate your level of knowledge about dolphins:

- None
- Slight
- Moderate
- High
- Expert

16. Please circle the number which indicates how many times in the past year you have participated in the following activity, where:

1 = No times 2 = Once 3 = 2 – 4 times
4 = 5 – 9 times 5 = 10+ times

A. Visited an aquarium:

1 2 3 4 5

B. Visited a zoo:

1 2 3 4 5

C. Watch a marine education show/read about this topic:

1 2 3 4 5

D. Made a monetary donation to an environmental cause:

1 2 3 4 5

E. Volunteered to help the environment in some way:

1 2 3 4 5

17. Please circle the number which indicates your level of interest for that particular topic about dolphins, where:

1 = No interest 2= Slight interest 3= Moderate interest
4= Very interested 5 = Highly interested

A. Daily activities of dolphins:

1 2 3 4 5

B. Breeding/rearing of young dolphins:

1 2 3 4 5

C. Dolphin distribution and population numbers:

1 2 3 4 5

D. Dolphins diet:

1 2 3 4 5

F. Features of dolphins that are similar to humans:

1 2 3 4 5

F. Dolphins importance in the ecosystem:

1 2 3 4 5

G. Dolphin conservation:

1 2 3 4 5

H. Marine environment conservation:

1 2 3 4 5

I. Dolphins intelligence and strange characteristics:

1 2 3 4 5

J. Dolphins relationships with other species:

1 2 3 4 5

K. Dolphin social habits:

1 2 3 4 5

L. Details about individual dolphins:

1 2 3 4 5

M. Dolphin interactions with Aboriginals:

1 2 3 4 5

N. Dolphin stranding and rescues:

1 2 3 4 5

18. Please circle the number which best matches how strongly you agree with the following statements about dolphins?

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. It's wrong to hunt dolphins for food:

1 2 3 4 5

B. It's okay for indigenous people to hunt dolphins for food:

1 2 3 4 5

C. Dolphins are intelligent:

1 2 3 4 5

D. Dolphins have thoughts:

1 2 3 4 5

E. Dolphins have feelings:

1 2 3 4 5

F. It's okay to feed dolphins:

1 2 3 4 5

G. It's okay to swim with dolphins:

1 2 3 4 5

H. It's okay to keep dolphins in captivity:

1 2 3 4 5

I. Harming dolphins should be punished as an offence:

1 2 3 4 5

J. Dolphins are more special than other wild animals:

1 2 3 4 5

K. My daily actions affect dolphins:

1 2 3 4 5

L. My daily actions affect the marine environment:

1 2 3 4 5

M. It's important to protect dolphins:

1 2 3 4 5

N. It's important to protect the marine environment:

1 2 3 4 5

O. Dolphins are affected by events that occur in land environments:

1 2 3 4 5

P. Dolphins are an important resource to Australia:

1 2 3 4 5

***Thank you for taking the time to complete this questionnaire.
Your information will greatly assist us in improving the interaction and
management practices and the quality of dolphin and wildlife experiences
that you and others can enjoy in the future.***

Appendix 6.2

Visitor survey for dolphin swim programs: Post dolphin-swim

1. Please circle the number which best indicates how important the following statements are to you when deciding on, or participating in, a dolphin-swim, where:

1 = No importance 2 = Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Opportunities to see dolphins:

1 2 3 4 5

B. Large numbers of dolphins to see:

1 2 3 4 5

C. Getting close to dolphins:

1 2 3 4 5

D. Seeing dolphins in their natural environment:

1 2 3 4 5

E. Interesting information about the dolphins:

1 2 3 4 5

F. Knowledgeable staff:

1 2 3 4 5

2. Please circle the number that best indicates how you now feel about the following statements, where:

1 = No importance 2 = Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Conserving the marine environment:

1 2 3 4 5

B. Assisting with marine conservation programs:

1 2 3 4 5

C. Conservation of dolphins:

1 2 3 4 5

D. Conservation of marine wildlife:

1 2 3 4 5

3. Please circle the number that best matches your level of motivation/intent to do the following activities:

1=No intent 2=Slight intent 3=Moderate intent
4=High intent 5=Very high intent

A. Become more involved in marine conservation issues:

1 2 3 4 5

B. Make a donation to an environmental organization:

1 2 3 4 5

C. Join a wildlife or dolphin preservation organization:

1 2 3 4 5

D. Donate some time to assisting with wildlife conservation:

1 2 3 4 5

E. Remove litter that could harm wildlife/dolphins:

1 2 3 4 5

F. Decrease the amount of my personal water pollution:

1 2 3 4 5

G. Assist in the protection of dolphins where possible:

1 2 3 4 5

H. Tell others about the need to care for our oceans/animals:

1 2 3 4 5

4. Please indicate your level of knowledge about dolphins:

- None
- Slight
- Moderate
- High
- Expert

5. Please circle the number which indicates if you agree or disagree with the following statements, where:

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. Swimming with wild dolphins can have negative impacts on dolphins:

1 2 3 4 5

B. Swimming with wild dolphins can have positive impacts on people:

1 2 3 4 5

E. Observing wild dolphins from boats can have negative impacts on dolphins:

1 2 3 4 5

F. Observing dolphins from boats can have positive impacts on people:

1 2 3 4 5

6. Please circle the number that reflects your level of satisfaction with your experiences today:

1 = Not satisfied 2 = Slightly satisfied 3 = Moderately satisfied
4 = Very satisfied 5 = Highly satisfied

A. Number of dolphins I saw:

1 2 3 4 5

B. How close I could get to dolphins:

1 2 3 4 5

C. Health of dolphins:

1 2 3 4 5

D. Amount of water-craft in the area:

1 2 3 4 5

G. Number of people in the water:

1 2 3 4 5

F. Space available on boat for visitors:

1 2 3 4 5

G. Amount of time I spent watching the dolphins:

1 2 3 4 5

H. Amount of time I swam with the dolphins:

1 2 3 4 5

I. Natural behaviour of the dolphins:

1 2 3 4 5

J. Dolphin-swim rules I had to follow:

1 2 3 4 5

K. How closely you observed the dolphins:

1 2 3 4 5

L. Sea conditions during the tour:

1 2 3 4 5

M. Interest of the information given:

1 2 3 4 5

N. Information on how to help conserve dolphins:

1 2 3 4 5

O. Information on how to conserve dolphins environment:

1 2 3 4 5

P. Overall satisfaction with your dolphin experience today:

1 2 3 4 5

7. Please circle the number which indicates your level of interest for that particular topic about dolphins, where:

1 = No interest 2= Slight interest 3= Moderate interest
4= Very interested 5 = Highly interested

A. Daily activities of dolphins:

1 2 3 4 5

B. Breeding/rearing of young dolphins:

1 2 3 4 5

C. Dolphin distribution and population numbers:

1 2 3 4 5

D. Dolphins diet:

1 2 3 4 5

F. Features of dolphins that are similar to humans:

1 2 3 4 5

F. Dolphins importance in the ecosystem:

1 2 3 4 5

G. Dolphin conservation:

1 2 3 4 5

H. Marine environment conservation:

1 2 3 4 5

I. Dolphins intelligence and strange characteristics:

1 2 3 4 5

J. Dolphins relationships with other species:

1 2 3 4 5

K. Dolphin social habits:

1 2 3 4 5

L. Details about individual dolphins:

1 2 3 4 5

M. Dolphin interactions with Aboriginals:

1 2 3 4 5

N. Dolphin stranding and rescues:

1 2 3 4 5

8. Please circle the number which best matches how strongly you agree with the following statements about dolphins?

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. It's wrong to hunt dolphins for food:

1 2 3 4 5

B. It's okay for indigenous people to hunt dolphins for food:

1 2 3 4 5

C. Dolphins are intelligent:

1 2 3 4 5

D. Dolphins have thoughts:

1 2 3 4 5

E. Dolphins have feelings:

1 2 3 4 5

F. It's okay to feed dolphins:

1 2 3 4 5

G. It's okay to swim with dolphins:

1 2 3 4 5

H. It's okay to keep dolphins in captivity:

1 2 3 4 5

I. Harming dolphins should be punished as an offence:

1 2 3 4 5

J. Dolphins are more special than other wild animals:

1 2 3 4 5

K. My daily actions affect dolphins:

1 2 3 4 5

L. My daily actions affect the marine environment:

1 2 3 4 5

M. It's important to protect dolphins:

1 2 3 4 5

N. It's important to protect the marine environment:

1 2 3 4 5

O. Dolphins are affected by events that occur in land environments:

1 2 3 4 5

P. Dolphins are an important resource to Australia:

1 2 3 4 5

9. What did you enjoy least about your experience with the dolphins today? _____

10. What did you enjoy most about your experience with the dolphins today? _____

If you are prepared to participate in a brief follow-up survey in six months' time, please write your details below: (All information will remain confidential)

Name:

Address:

Ph: (____)_____

E-Mail:_____

*Thank you for taking the time to complete this questionnaire.
Your information will greatly assist us in improving the interaction
and management practices and the quality of dolphin and wildlife
experiences that you and others can enjoy in the future.*

Appendix 6.3

Visitor survey for dolphin swim programs: Six months post dolphin-swim

1. Please circle the number which indicates if you agree or disagree with the following statements, where:

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. Swimming with wild dolphins can have negative impacts on dolphins:

1 2 3 4 5

B. Swimming with wild dolphins can have positive impacts on people:

1 2 3 4 5

H. Observing wild dolphins from boats can have negative impacts on dolphins:

1 2 3 4 5

I. Observing dolphins from boats can have positive impacts on people:

1 2 3 4 5

2. Please circle the number that best indicates how you now feel about the following statements, where:

1 = No importance 2 = Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Conserving the marine environment:

1 2 3 4 5

B. Assisting with marine conservation programs:

1 2 3 4 5

C. Conservation of dolphins:

1 2 3 4 5

D. Conservation of marine wildlife:

1 2 3 4 5

3. Please circle the number that best matches your level of motivation/intent to do the following activities:

1=No intent 2=Slight intent 3=Moderate intent
4=High intent 5=Very high intent

A. Become more involved in marine conservation issues:

1 2 3 4 5

B. Make a donation to an environmental organization:

1 2 3 4 5

C. Join a wildlife or dolphin preservation organization:

1 2 3 4 5

D. Donate some time to assisting with wildlife conservation:

1 2 3 4 5

E. Remove litter that could harm wildlife/dolphins:

1 2 3 4 5

F. Decrease the amount of my personal water pollution:

1 2 3 4 5

G. Assist in the protection of dolphins where possible:

1 2 3 4 5

H. Tell others about the need to care for our oceans/animals:

1 2 3 4 5

4. Place a tick in the space that corresponds with your current state of conservation activity

A. ____ I have never participated in conservation activities

B. ____ I do not ever intend in participating in conservation activities

C. ____ I have been thinking about participating in conservation activities for more than six months

D. ____ I have been thinking about participating in conservation activities for less than six months

E. ____ I will get involved in conservation issues within the next ____ months

F. ____ I am already involved in conservation activities

5. Please circle the number which best indicates how important the following statements are to you when deciding on, or participating in, a dolphin-swim, where:

1 = No importance 2 = Slight importance 3 = Moderate importance
4 = Very important 5 = High importance

A. Opportunities to see dolphins:

1 2 3 4 5

B. Large numbers of dolphins to see:

1 2 3 4 5

C. Getting close to dolphins:

1 2 3 4 5

D. Seeing dolphins in their natural environment:

1 2 3 4 5

E. Interesting information about the dolphins:

1 2 3 4 5

F. Knowledgeable staff:

1 2 3 4 5

6. Please indicate your level of knowledge about dolphins:

- None
- Slight
- Moderate
- High
- Expert

7. Please circle the number that reflects your level of satisfaction with your experiences today:

1 = Not satisfied 2 = Slightly satisfied 3 = Moderately satisfied
4 = Very satisfied 5 = Highly satisfied

A. Number of dolphins I saw:

1 2 3 4 5

B. How close I could get to dolphins:

1 2 3 4 5

C. Health of dolphins:

1 2 3 4 5

D. Amount of water-craft in the area:

1 2 3 4 5

J. Number of people in the water:

1 2 3 4 5

F. Space available on boat for visitors:

1 2 3 4 5

G. Amount of time I spent watching the dolphins:

1 2 3 4 5

H. Amount of time I swam with the dolphins:

1 2 3 4 5

I. Natural behaviour of the dolphins:

1 2 3 4 5

J. Dolphin-swim rules I had to follow:

1 2 3 4 5

K. How closely you observed the dolphins:

1 2 3 4 5

L. Sea conditions during the tour:

1 2 3 4 5

M. Interest of the information given:

1 2 3 4 5

N. Information on how to help conserve dolphins:

1 2 3 4 5

O. Information on how to conserve dolphins environment:

1 2 3 4 5

P. Overall satisfaction with your dolphin experience today:

1 2 3 4 5

8. Please circle the number which indicates your level of interest for that particular topic about dolphins, where:

1 = No interest 2= Slight interest 3= Moderate interest
4= Very interested 5 = Highly interested

A. Daily activities of dolphins:

1 2 3 4 5

B. Breeding/rearing of young dolphins:

1 2 3 4 5

C. Dolphin distribution and population numbers:

1 2 3 4 5

D. Dolphins diet:

1 2 3 4 5

F. Features of dolphins that are similar to humans:

1 2 3 4 5

F. Dolphins importance in the ecosystem:

1 2 3 4 5

G. Dolphin conservation:

1 2 3 4 5

H. Marine environment conservation:

1 2 3 4 5

I. Dolphins intelligence and strange characteristics:

1 2 3 4 5

J. Dolphins relationships with other species:

1 2 3 4 5

K. Dolphin social habits:

1 2 3 4 5

L. Details about individual dolphins:

1 2 3 4 5

M. Dolphin interactions with Aboriginals:

1 2 3 4 5

N. Dolphin stranding and rescues:

1 2 3 4 5

9. Please circle the number which best matches how strongly you agree with the following statements about dolphins?

1 = Strongly disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly agree

A. It's wrong to hunt dolphins for food:

1 2 3 4 5

B. It's okay for indigenous people to hunt dolphins for food:

1 2 3 4 5

C. Dolphins are intelligent:

1 2 3 4 5

D. Dolphins have thoughts:

1 2 3 4 5

E. Dolphins have feelings:

1 2 3 4 5

F. It's okay to feed dolphins:

1 2 3 4 5

G. It's okay to swim with dolphins:

1 2 3 4 5

H. It's okay to keep dolphins in captivity:

1 2 3 4 5

I. Harming dolphins should be punished as an offence:

1 2 3 4 5

J. Dolphins are more special than other wild animals:

1 2 3 4 5

K. My daily actions affect dolphins:

1 2 3 4 5

L. My daily actions affect the marine environment:

1 2 3 4 5

M. It's important to protect dolphins:

1 2 3 4 5

N. It's important to protect the marine environment:

1 2 3 4 5

O. Dolphins are affected by events that occur in land environments:

1 2 3 4 5

P. Dolphins are an important resource to Australia:

1 2 3 4 5

***Thank you for taking the time to complete this questionnaire.
Your information will greatly assist us in improving the interaction and
management practices and the quality of dolphin and wildlife experiences
that you and others can enjoy in the future.***



Appendix 7

Information for participants involved in research

You are invited to participate

You are invited to participate in a research project entitled 'Burrunan dolphin (*Tursiops australis*) tourism in Port Philip Bay (PPB), Australia: effects, implications and management'. This research involves people participating in dolphin watching tours. I would like to ask you to take a few minutes of your valuable holiday time and fill in the questionnaire. Please answer all questions and return the completed questionnaire to me or place in the confidential box provided.

This project is being conducted by a student researcher, Nicole Filby, as part of a PhD study at Victoria University under the supervision of Dr Carol Scarpaci from the Ecology and Sustainability group, School of Engineering and Science.

Project explanation

Wildlife managers are challenged with the need to manage animals targeted by tourism and the environment where they live whilst maintaining the economical and educational benefits of this industry (Tosi & Ferreira, 2009). The population of Burrunan dolphins in PPB is considered vulnerable to extinction due to its small size, genetic distinctiveness, restricted home range, females tendency to return only to their birthplace (Port Phillip Bay) in order to breed, high levels of human activity in the area, and a non-compliant commercial dolphin-swim industry (Charlton et al., 2006; Dunn et al., 2001; Hale, 2002; Warren-Smith & Dunn, 2006; Weir et al., 1996). This study will: 1) Measure the effectiveness of

a new condition stipulated in the 2009 dolphin-swim regulations to increase tourist education; 2) Determine if tourists' short and long-term nature/conservation based values increases due to dolphin swim tour participation; and 3) Determine the variables that promote education and tourist satisfaction during a dolphin swim tour.

What will I be asked to do?

Complete a set of three questionnaires: one before your dolphin-swim with tour; one immediately following the tour & a final questionnaire 6 months later (which will be distributed through email or mail contact). Each questionnaire will take approximately 10 minutes to complete. Participation is entirely voluntary and all information collected strictly confidential.

How will the information I give be used?

Results of this study will be published in scientific journals and in reports for government agencies and industry. The information gained will allow recommendations to be made to the Department of Sustainability and Environment to enhance the satisfaction level, knowledge and biocentric values of future participants by improving the educational information provided on board the dolphin swim with programs. The results will also be documented in the PhD thesis of Nicole Filby.

How will this project be conducted?

Data will be obtained from a 3-page Questionnaire administered by Nicole Filby and research assistants to all participants over the age of 18 participating in dolphin-swim-with tours (See All Dolphin Swims) departing from Queenscliff in PPB. The questionnaire should take about 10 – 15 minutes to complete. Clipboards & pens will be distributed with the Questionnaire. Questionnaires will be collected pre-tour, post-tour and 6+ months post tour (which will be

distributed through email or mail contact). The questionnaire seeks information through a number of scale-based questions.

All information that is obtained in connection with this study and that can be identified with you will remain confidential. Furthermore, participant confidentiality is guaranteed as a box will be provided for depositing the completed questionnaires and participants will be administered with an identification number, which they will place on two of their surveys in lieu of their names. Participant's data will be kept in storage within Victoria University grounds, in a secure (locked) filing cabinet.

Who is conducting the study?

Victoria University and the Department of Sustainability and Environment

Nicole Filby: Nicole.filby@live.vu.edu.au

Dr Carol Scarpaci: carol.scarpaci@vu.edu.au

Any queries about your participation in this project may be directed to the Principal Researcher listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics and Biosafety Coordinator, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 phone (03) 9919 4148. This research was conducted under Victoria University Human Ethics permit (HRETH no: 09/167).



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Appendix 8

Research opportunity for dolphin-swim participants and letter of gratitude

On behalf of Victoria University, The Victorian Marine Science Consortium and Sea All Dolphin Swims, I would like to thank-you for taking the time to participate in our research on 'Burrnan dolphin (*Tursiops australis*) tourism in Port Philip Bay (PPB), Australia: effects, implications and management'.

You are invited to participate one final time in this research project by filling out an online questionnaire through **Survey Monkey**. If you are keen to participate, this survey can be found here:

<http://www.surveymonkey.com/s/TDZKZY5>

By taking a few minutes of your valuable time and answering all questions in the survey you will help us determine the variables that promote education and satisfaction during a dolphin swim tour, assisting us in ensuring that the dolphin-swim interactions in Port Phillip Bay are as good as they possibly can be.

To thank-you for your assistance in our research, we would like to reward you with a small gift. Respondents will go in a draw to win Village or Hoyts Cinema gift passes. Once you have completed the survey please email Nicole Filby (Nicole.filby@live.vu.edu.au) your home address so we can mail you a movie pass if you are successful.

All information given is totally confidential, and your personal details will not be used or released to any sources.



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The population of Burrunan dolphins in Port Phillip Bay is vulnerable to extinction due to its small size, genetic distinctiveness, restricted home range, females' tendency to return only to their birthplace (Port Phillip Bay) in order to breed, and high levels of human activity in the area.



Help us sustainably manage this unique population of Burrunan dolphins and the environment where they live whilst maintaining the economical and educational benefits of this industry.

Appendix 9

Chapter Four publication



Original research article

Long-term responses of Burrunan dolphins (*Tursiops australis*) to swim-with dolphin tourism in Port Phillip Bay, Victoria, Australia: A population at risk



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Sustainability

ABSTRACT

This study investigated Burrunan dolphin responses to dolphin-swim tour vessels across two time periods: 1998–2000 and 2011–2013. A total of 211 dolphin sightings were documented across 306 surveys. Sighting success rate and mean encounter time with dolphins decreased significantly by 12.8% and 8.2 min, respectively, between periods. Approaches that did not contravene regulations elicited highest approach responses by dolphins towards tour vessels, whereas dolphins' responded to illegal approaches most frequently with avoidance. Small groups responded to tour vessels with avoidance significantly more than large groups. Initial dolphin behaviour had a strong effect on dolphin's responses to tour vessels, with resting groups the most likely to exhibit avoidance. Calves were significantly more likely to be present during swims in 2011–2013. Dolphin's responses to tour vessels changed across time, with effect responses (avoidance and approach) increasing significantly as dolphins gained cumulative experience. These dolphins are forced to expend a greater level of time and energy avoiding or approaching boats, shifting from a non-effect response to an effect response. Consequences of this include possible decrease in biological fitness by detracting from core biological activities such as foraging and resting. Combined with a decrease in sighting success between periods, the results imply that this population of dolphins, which is endemic to Australia and listed as threatened under the Victorian Flora and Fauna Guarantee Act 1988, may not be well suited to the dolphin-swim industry. The management implications of these results warrant a shift from passive to active management in Port Phillip Bay. The importance of long-term research is highlighted, given behavioural responses detected herein would be undetected in short-term studies.

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1. Introduction

Human interactions with free-ranging dolphins have the power to improve well-being (Curtin, 2006), enhance participant's values for the targeted species (Orams, 1997), and increase their knowledge levels and pro-conservation actions (Filby et al., in press). Cetacean-based tourism is one of the fastest growing industries worldwide, generating over US\$2.1 billion in

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revenue in 2008 (O'Connor et al., 2009). In Australia more than 1.6 million tourists participate each year, generating over \$29 million to the Australian economy, with a high growth rate of 8.3% per annum between 1998 and 2008 (O'Connor et al., 2009).

There is an underlying assumption that if dolphins choose to interact with tour vessels that there will be no detrimental effects. However, dolphin interactions with tour vessels can generate changes in dolphin: respiration patterns (Nowacek et al., 2001); swimming direction (Lemon et al., 2006); swimming speed (Timmel et al., 2008); diving times (Lusseau, 2003); phonation rates (Sousa-Lima and Clark, 2008); behaviour (Peters et al., 2013) and synchrony (Tosi and Ferreira, 2009). How dolphins respond to interactions with tour vessels will depend partly on their age, with calves being more inquisitive and less cautious of vessels, making them more susceptible to impacts (Constantine, 2001; Martinez and Stockin, 2013). Further, research indicates that dolphin's responses to dolphin-swim tour vessels are linked to boat approach type and presence of swimmers and vessels (Bejder et al., 1999; Constantine, 2001; Martinez et al., 2011; Neumann and Orams, 2006; Steckenreuter et al., 2012), with responses varying greatly between the type of tourism undertaken, targeted species and the location (Orams, 2004). These impacts raise concerns relating to the sustainability of this industry (Ziegler et al., 2012); with the limited number of long-term studies indicating short-term behavioural changes can have long-term consequences (e.g., decreased reproductive success (Bejder et al., 2006) and increased mortality rates (Dans et al., 2008) for individuals and their populations (Lusseau and Bejder, 2007)).

Whilst the long-term effects of increasing levels of swim-with dolphin tourism on free-ranging dolphins remain unknown, research suggests that habituation (i.e., a reduction in a behavioural response occurring when a stimulus is frequently repeated with no apparent punishment or reward, Allaby, 1994) often transpires (Constantine, 2001). Tolerance (i.e., no apparent response to a stimulus) is another frequently reported response by animals to human presence (Constantine, 2001), while displacement away from critical habitat has been reported for sensitive individuals (Bejder et al., 2006). Sensitisation may also occur, whereby there is a response increase as the animal learns that the stimulus does have significant consequences (Peters et al., 2013).

The population of dolphins in Port Phillip Bay (hereafter PPB) have recently been identified as a genetically and morphologically isolated species of bottlenose dolphin; the Burrnunan dolphin (*Tursiops australis*, Charlton-Robb et al., 2011). Burrnunan dolphins are endemic to Australia, with only two resident populations identified: one in PPB and the other in Gippsland Lakes, Victoria. Burrnunan dolphins in PPB display high site fidelity, using the southern coastal waters all year round, bringing them into frequent contact with humans (Scarpaci et al., 2003, 2000). Under the Victorian Flora and Fauna Guarantee Act 1988 this population is listed as threatened, and is considered vulnerable to extinction due to its small size (approximately 120 individuals), genetic distinctiveness (Charlton-Robb et al., 2011), restricted home range (which is in close proximity to a major urban centre, making them susceptible to numerous anthropogenic threats) (Hale, 2002), and female natal philopatry (Hale, 2002). Further, this population is at risk due to the considerable volume of vessel activity in the area (commercial and recreational vessels, (Dunn et al., 2001)), and exposure to a non-compliant commercial dolphin-swim industry (Filby et al., in press; Scarpaci et al., 2004).

The dolphin-swim industry in PPB began in 1986 (Jarvis and Ingleton, 2001). In 1995, a code of practice (COP) was established by tour operators and the Department of Conservation and Natural Resources to provide guidelines for responsible behaviour of tour boats around dolphins in PPB. This COP then formed the basis for the *Wildlife (Whales) Regulations* (1998), with regulations specific to the dolphin-swim tour industry. In order to increase tour operator compliance and improve overall protection of the targeted species (Hale, 2002), these regulations have been amended repeatedly over time to ensure industry sustainability (Scarpaci et al., 2004). In PPB there are currently 3 swim-with dolphin licenced tour operators, entailing 4 vessels, which run a maximum number of 2 trips per day per vessel.

Whilst numerous studies have examined and detected short-term behavioural changes of dolphins in response to tourism activities, few have utilised long-term methodologies to assess potential changes over extended time periods. Given the longevity of marine mammals and the changes that occur within the management of the dolphin-swim tourism industry over time, long-term studies are imperative. This is especially so when dealing with endemic, threatened species upon which an entire commercial industry is based. Herein, a novel long-term assessment approach was used to assess changes in dolphin behaviour over a 15 year period. The aim of this study was to investigate Burrnunan dolphins' responses to dolphin-swim tour vessels in PPB across time, in an attempt to detect temporal changes in dolphins' responses to tour vessels and determine how those changes may influence the population's reproduction, survival or population growth in the long-term. In particular, we assess whether the population shows any signs of habituation, sensitisation or tolerance to the dolphin-swim tour vessels with cumulative experience. Furthermore, boat approach type was examined to determine if dolphin's responses differ depending on legality of approach, to determine the effectiveness of the regulations that dictate how tour vessels approach dolphins. Last, we examine if there is a relationship between dolphin's responses to tour vessels based on their age class or their initial behavioural state.

2. Materials and Methods

2.1. Field methods

This study was conducted on the population of free-ranging Burrnunan dolphins that inhabit PPB (38°05'S, 144°50'E). Observations of dolphin's responses to tour vessels were conducted on-board dolphin-swim tour vessels that operate in the southern end of PPB across two time frames: (i) period 1 (hereafter P1, 1998–2000, primary researcher: CS); and (ii) period 2

(henceforth P2, 2011–2013, primary researcher: NF). P2 data collection followed methods utilised in P1 for consistency and to enable comparison of results. In some instances, P1 and P2 data were amalgamated to give a long-term data set (hereafter, LTDS).

Dolphins observed in apparent association, moving in the same direction and usually engaged in the same activity were defined as a group (Shane, 1990). The perimeter of the group was established through the use of a 10 m-chain rule between members (Smolker et al., 1992). Tour vessels conducted swims with groups containing animals of all age class: (i) adult (i.e., apparently fully grown individuals (>2 m (range 2.27–2.78 m, Charlton-Robb et al., 2011))); (ii) juvenile (i.e., approximately two-thirds the length of an adult and not travelling in the echelon position alongside an adult); (iii) calf (i.e., approximately half the length of an adult, and still travelling in the echelon position alongside an adult, presumed to be its mother); and (iv) neonate (i.e., young calves still showing foetal folds, a floppy dorsal fin, exhibit extreme buoyancy, when surfacing lift the whole head above water and always positioned in close relation to an adult (presumed to be its mother)).

Dolphins' initial behavioural state was recorded as: (i) travelling (dolphins engaged in persistent, directional movement making noticeable headway along a specific compass bearing); (ii) foraging (dolphins involved in any effort to pursue, capture and/or consume prey); (iii) milling (dolphins exhibited non-directional movement, and frequent changes in bearing prevented dolphins from making headway in any specific direction); (iv) resting (dolphins observed in a tight group (<1 body length between individuals), engaged in slow manoeuvres with little evidence of forward propulsion); (v) socialising (dolphins observed chasing, copulating and/or engaged in any other physical contact with other dolphins, such as rubbing and touching) (Filby et al., 2013).

The dolphins' responses to tour vessels were defined as: (i) approach (i.e., >50% of the group changed their behaviour and approached the tour vessel, repeatedly interacting with the vessel and/or swimmers); (ii) neutral (i.e., no apparent change in dolphin's behaviour); and (iii) avoid (i.e., >50% of the group changed their behaviour, changing their direction of travel away from the tour vessel or diving and surfacing away from the tour vessel) (Constantine, 2001).

Tour operators used three approach types to approach dolphin groups, with definitions modified from Scarpaci et al. (2003): (i) parallel (i.e., tour vessel positioned to either side of a group—legal); (ii) direct (i.e., tour vessel positioned directly into the middle of a group—illegal); and (iii) J (i.e., tour vessel initially travelled parallel to a group, but then moved directly in front of the group—illegal). Proportion of approach types used for dolphin encounters was determined by dividing the total number of each approach type observed by the total number of approaches recorded for that encounter.

One minute scan samples were used to collect data on dolphin's responses to tour vessels approaches, number of boats and dolphin's group size, composition and behaviour (Altmann, 1974). Tour vessel approach types and number of approaches per sighting were recorded via continuous observations. Once an approach was recorded, responses of the focal group were correlated to determine the influence of approach type on dolphin response.

Tour duration was deemed as the time the tour vessel departed from dock for the purpose of conducting a dolphin-swim tour until the time the vessel returned to dock. Encounter time was defined as the time the tour vessel was within 300 m of the focal group. Distance (metres) between the tour vessel and the focal group was calculated using a Yardage Pro 500 range finder. Sighting success rate was defined as observing at least one dolphin group per trip, and calculated by dividing the number of trips where at least one dolphin group was observed by the total number of trips conducted. Swim length was calculated as the time (seconds) between the first swimmer entering the water and the last swimmer reboarding the tour vessel.

2.2. Statistical analysis

Statistical analysis was conducted using SPSS 20. All continuous data were tested for normality and homoscedasticity using Anderson–Darling and Bartlett's and Levene's tests, respectively. For the purpose of analyses, group composition was categorised and analysed as either calves absent or calves present. Dolphin's responses were further categorised as: (i) effect (comprised of approach and avoid responses); and (ii) non-effect (consisting of neutral responses). Based on a natural split in the data, group size was categorised as small (1–9 animals) or large (>10 animals). Results were considered statistically significant at $p \leq 0.05$.

Independent samples *t*-tests were used to determine if there was a significant difference between legal and illegal approaches for: number of approaches used; group size; or number of boats present during an encounter. Differences between P1 and P2 for group size, encounter time, swim length, proportion of parallel approaches, proportion of J approaches and proportion of direct approaches were also assessed via independent samples *t*-tests.

Data from the LTDS were compared using ANOVAs to determine if swim length, tour vessel's approach number, the dolphins' group size and number of boats present varied with the legality of the approach type used by tour operators. ANOVAs were also run to establish whether the number of approaches used by tour operators was influenced by the dolphins' initial behavioural state or by the dolphins' response to tour vessels. Tukey's post hoc tests were run to determine where differences existed (Pallant, 2001).

Pearson's chi-squared tests were applied to the LTDS to detect whether there is a relationship between the dolphins' responses to tour vessels and approach type, legality of approach type, dolphins' group size, dolphins' initial behavioural state, and dolphins' group composition. Pearson's chi-squared tests were also run to determine if the proportion of dolphin's responses, effect/non-effect responses, responses to parallel approaches, responses to J approaches, responses to direct

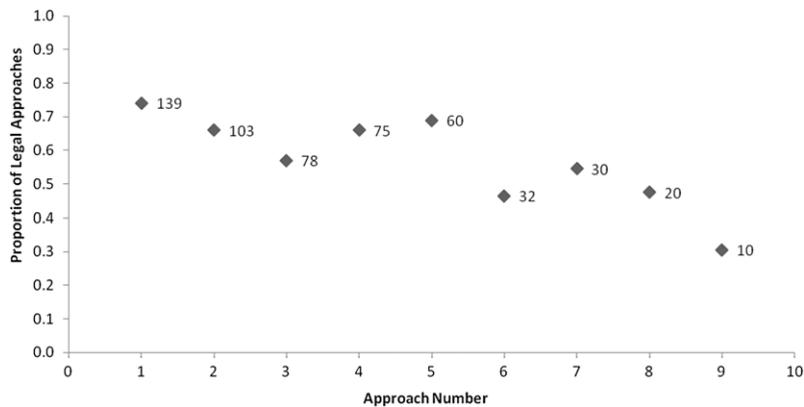


Fig. 1. Proportion of legal approaches towards dolphins made by tour operators for each approach (LTDS).

approaches and sighting success rate differs between P1 and P2. Lastly, Pearson's chi-squared tests were applied to detect whether approach type used by tour operators was influenced by the dolphins' initial behavioural state.

3. Results

Field effort and number of sightings were similar across both periods, with a researcher present on 128 and 178 dolphin-swim trips, respectively during P1 and P2. There were 107 dolphin sightings in P1 (mean tour duration = 3 h 54 min, SD = 28.9 min), and 104 in P2 (mean tour duration = 3 h 22 min, SD = 21.5 min). Sighting success rate decreased significantly ($\chi^2(1) = 4.349$, $p = 0.037$) from P1 (59.4%) to P2 (46.6%). Further, there was a significant ($\chi^2(1) = 4.908$, $p = 0.027$) decrease in sighting success rate within P2, from 58.0% in 2012 down to 37.7% in 2013. There was also a significant difference in mean encounter duration time per sighting between P1 and P2 ($t = 2.531$, $df = 173$, $p = 0.012$). The mean encounter time per sighting decreased from 34.8 min ($n = 107$) in P1 to 26.6 min ($n = 104$) in P2.

Swim length differed significantly between periods ($t = 8.405$, $df = 445$, $p = 0.000$). The mean swim time increased from 170.5 s (SD = 103.7, $n = 331$) in P1 to 262.4 s (SD = 151.4, $n = 263$) in P2. In the LTDS, direct approaches resulted in significantly longer swim times (mean = 239.0 s, SD = 160.6) than J (mean = 204.7 s, SD = 156.0) or parallel approaches (mean = 204.3 s, SD = 121.2) ($F(2, 591) = 3.1$, $p = 0.046$). Tukey's post hoc test identified that direct approaches resulted in significantly longer swims than parallel approaches ($p = 0.039$).

During P1 and P2, a total of 564 and 446 tour vessel approaches were made to dolphin groups, respectively. The mean number of approaches per sighting decreased from 7 in P1 to 4 during P2. Parallel approaches were the most frequently used approach type, in both P1 (63.1%, $n = 440$) and P2 (61.0%, $n = 272$). However, compliance deteriorated across periods, with illegal approaches increasing from 36.9% ($n = 215$) in P1 to 39.0% ($n = 174$) during P2.

The proportion of approaches per sighting for any of the 3 approach types did not vary between P1 (parallel: $n = 107$, mean = 0.695, SD = 0.251; J: $n = 107$, mean = 0.083, SD = 0.147; and direct: $n = 107$, mean = 0.224, SD = 0.235) and P2 (parallel: $n = 96$, mean = 0.691, SD = 0.316, $t = 0.101$, $df = 181$, $p = 0.920$; J: $n = 96$, mean = 0.050, SD = 0.109, $t = 1.812$, $df = 194$, $p = 0.072$; and direct: $n = 96$, mean = 0.259, SD = 0.293, $t = 0.968$, $df = 201$, $p = 0.334$).

For the LTDS, there was a significant difference in boat approach type used by tour operators, depending on the boat approach number ($F(2, 941) = 13.008$, $p = 0.000$, range = 1–21). Tukey's post hoc test revealed that as the number of approaches increased, J approaches (mean = 5.80, SD = 4.310) were significantly more likely to be used than parallel approaches (mean = 4.01, SD = 3.265, $p = 0.000$). Tukey's post hoc test also identified that number of direct approaches (mean = 4.83, SD = 3.837) were significantly higher than number of parallel approaches ($p = 0.006$). A significantly higher number of approaches were used during illegal (mean = 5.10, SD = 3.992) than for legal approaches (mean = 4.01, SD = 3.265) in the LTDS ($t = 4.321$, $df = 630$, $p = 0.000$). The proportion of legal approaches decreased for the LTDS as the number of approaches increased (Fig. 1).

For the LTDS, approach type used by tour operators was significantly influenced by group size ($F(2, 941) = 7.287$, $p = 0.001$). Tukey's post hoc test identified that group sizes for J approaches (mean = 15.01, SD = 15.256, $n = 98$) were significantly larger than for direct (mean = 10.66, SD = 10.102, $n = 255$, $p = 0.002$) or parallel approaches (mean = 10.74, SD = 9.764, $n = 591$, $p = 0.001$). However, there was no significant relationship in the LTDS between legal (mean = 10.74, SD = 9.764) and illegal (mean = 11.87, SD = 11.899) approaches used by tour operators and dolphins' group size ($t = 1.506$, $df = 361$, $p = 0.133$).

In the LTDS, approach type did not vary significantly with the number of boats present ($F(2, 941) = 0.988$, $p = 0.373$), however more boats were present for J approaches (mean = 2.28, SD = 1.470) than for parallel (mean = 2.02, SD = 1.799) or direct approaches (mean = 2.03, SD = 1.489). More boats were present in the LTDS for illegal (mean = 2.10, SD

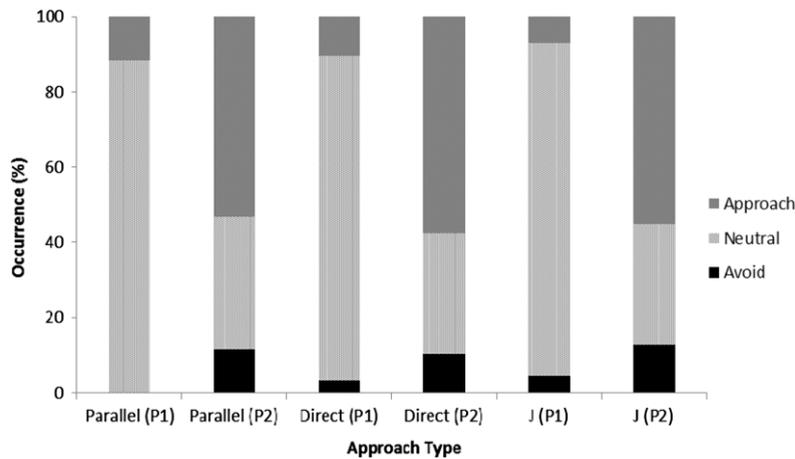


Fig. 2. Dolphin responses to tour vessels as a function of approach type for P1 ($n = 583$) and P2 ($n = 361$).

= 1.485) than for legal number of approaches (mean = 2.02, SD = 1.799), however this result was not significant ($t = 0.669$, $df = 942$, $p = 0.504$).

Approach types used by tour operators did not vary significantly in the LTDS with dolphins' initial behavioural state ($\chi^2(8) = 7.543$, $p = 0.479$). However, the number of approaches made by tour vessels in the LTDS varied significantly with dolphin's initial behavioural state ($F(4, 939) = 5.954$, $p = 0.000$). Tukey's post hoc tests identified that the number of approaches was significantly greater for socialising groups (mean = 5.53, SD = 4.360) than for travelling (mean = 4.47, SD = 3.587, $p = 0.041$), foraging (mean = 3.88, SD = 3.307, $p = 0.004$) or resting groups (mean = 1.76, SD = 1.033, $p = 0.001$). The number of approaches was also significantly greater for travelling than for resting groups ($p = 0.017$).

3.1. Responses of dolphins to tour vessel approaches

Dolphin responses to tour vessel approaches varied significantly between periods ($\chi^2(2) = 274.863$, $p = 0.000$). Avoidance and approach responses to tour vessels increased from P1 (3.3%, $n = 19$, and 10.8%, $n = 63$, respectively) to P2 (10.0%, $n = 36$, and 56.5%, $n = 204$, respectively), whilst neutral responses decreased from 85.9% ($n = 501$) in P1 to 33.5% ($n = 121$) in P2. Dolphin effect and non-effect responses to tour vessel approaches differed significantly between periods ($\chi^2(1) = 272.548$, $p = 0.000$). Effect responses to tour vessels increased from 14.1% ($n = 82$) in P1 to 66.5% ($n = 240$) in P2, whilst non-effect responses decreased from 85.9% ($n = 501$) in P1 to 33.5% ($n = 121$) in P2.

The dolphins' responses to parallel, J and direct approaches varied between P1 ($n = 583$) and P2 ($n = 361$) ($\chi^2(2) = 191.004$, $p = 0.000$, $\chi^2(2) = 27.886$, $p = 0.000$, and $\chi^2(2) = 62.005$, $p = 0.000$, respectively) (Fig. 2).

For the LTDS, dolphin responses to tour vessel approaches varied significantly with approach type, ($\chi^2(4) = 10.546$, $p = 0.032$), with parallel approaches resulting in the highest approach response (64.8%, $n = 173$). In contrast, when J (8.2%, $n = 22$) or direct approaches (27.0%, $n = 72$) were used, dolphins were less likely to approach. Within approach types, the greatest incidence of avoidance occurred when direct (9.0%, $n = 23$) and J approaches (8.2%, $n = 8$) were used, with parallel approaches resulting in the lowest level of avoidance by dolphins (4.1%, $n = 24$). Dolphins' responses to tour vessels was significantly affected by whether approaches were legal or illegal ($\chi^2(2) = 9.145$, $p = 0.010$). Legal approaches resulted in the highest levels of neutral (63.3%) and approach (64.7%) responses. Conversely, dolphins most frequently responded to illegal approaches with avoidance (56.4%). Approach number also significantly affected dolphin's responses to tour vessels in the LTDS ($F(2, 941) = 4.204$, $p = 0.015$). Dolphins were significantly more likely to approach (mean = 3.88, SD = 3.069) tour vessels when less approaches were attempted, than to exhibit neutral responses (mean = 4.64, SD = 3.760, Tukey's post hoc test: $p = 0.011$).

Group size was significantly larger in P2 ($t = 3.113$, $df = 594$, $p = 0.002$, mean = 13, SD = 12.557, range = 1–60) than in P1 (mean = 10, SD = 9.114, range = 1–60). In the LTDS, dolphins' responses to tour vessels varied significantly with group size ($\chi^2(2) = 18.627$, $p = 0.000$). Small groups avoided tour vessels (78.2%, $n = 43$) more frequently than large groups (21.8%, $n = 12$, Fig. 3).

Dolphins' initial behavioural state also had a strong effect on dolphins' responses to tour vessels in the LTDS ($\chi^2(8) = 115.016$, $p = 0.000$). The most frequent response of travelling, foraging and socialising groups was neutral (66.4%, 79.4% and 66.3%, respectively) (Fig. 4). Resting groups most frequently avoid tour vessels (52.9%), approaching tour vessels the least (0.7%). Milling groups most frequently responded to tour vessels by approaching (64.7%). On 64.7% and 20.6% of occasions that tour vessels approached resting or feeding dolphin groups, respectively, they changed their behaviour, exhibiting an effect response.

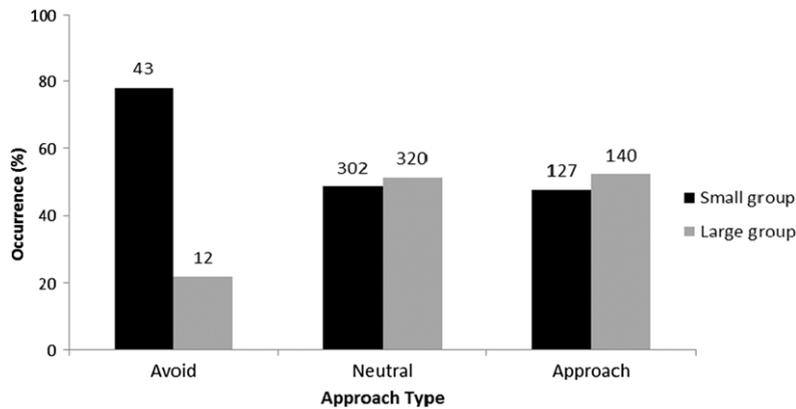


Fig. 3. Dolphin responses to tour vessel approaches as a function of dolphins' group size in Port Phillip Bay, Australia (LTDS). Sample size for each category shown above bars.

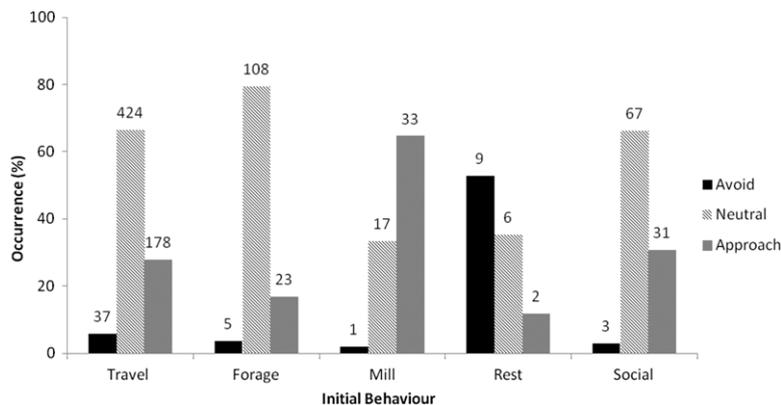


Fig. 4. Dolphin responses to tour vessel approaches in relation to initial behavioural state in Port Phillip Bay, Australia (LTDS). Sample size for each category shown above bars.

3.2. Age composition of dolphins interacting with tour vessels during swims

There was a significant difference in group composition (calves absent vs calves present) between P1 and P2, ($\chi^2(1) = 26.493, p = 0.000$), with calves more likely to be present during a swim in P2 (56.9%, $n = 149$) than during P1 (35.1%, $n = 104$). For the LTDS, dolphin responses to tour vessels were significantly affected by group composition ($\chi^2(2) = 16.440, p = 0.000$). Dolphins were more likely to avoid (70.9%) or neutrally (58.5%) respond to tour vessels when calves were absent, compared to 29.1% avoidance and 41.5% neutral responses when groups contained calves. Groups with calves present were more likely to approach (53.6%) tour vessels than groups where calves were absent (46.4%) in the LTDS.

4. Discussion

4.1. Responses of Burrunan dolphins to dolphin-swim tour vessels

The findings reported herein reveal that the Burrunan dolphins in PPB have altered their responses to tour vessels across time. Dolphin responses to tour vessels were influenced by the approach type used by tour operators: dolphins approached tour vessels more frequently when legal approaches were used and exhibited higher levels of avoidance to illegal approaches. However, tour operators in PPB are historically non-compliant in utilising legal approaches (Filby et al., in press). Consequently, non-compliance has negative impacts for both the targeted species and the industry, as illegal approaches result in more frequent avoidance responses by the dolphins, which may subsequently decrease both customer viewing opportunities and satisfaction. As the dolphins gained cumulative experience, their responses to tour vessels changed, with dolphins showing an increase in avoidance and approach responses (effect) towards tour vessels across time. These dolphins are forced to expend a greater level of time and energy avoiding or approaching boats, shifting from a non-effect to an effect response, which consequently may decrease their biological fitness (Bejder et al., 1999).

Sighting success rate decreased across time and may reflect a decrease in the number of dolphins using southern PPB. This could possibly be a precursor to abandonment of the bay by the dolphins as the vessel traffic continues to disturb core

biological activities (e.g., feeding and resting, Arcangeli and Crosti, 2009; Christiansen et al., 2010; Constantine et al., 2004; Steckenreuter et al., 2012; Stockin et al., 2008). Potentially, sensitive animals may depart from southern PPB during the tourism period leaving non-sensitive animals, the “risk takers”. These “risk takers” are more likely to approach tour vessels, possibly explaining the increase in approach responses to tour vessels from P1 to P2. The increase in approach responses may also be a consequence of bow-riding behaviour, with many delphinid species exhibiting responsive movements towards vessels in order to bow-ride (Filby et al., 2010). However, it is important to recognise that just because these dolphins approach the tour vessels; it does not imply no detriment, long-term consequence (Martinez et al., 2011). These “risk taker” groups that approach tour vessels become the main target foci of the tour operators and as a result, these groups frequently cease their initial behaviour (namely, resting and foraging) in the presence of tour vessels. Consequently, behaviours that are vital to the fitness of the population are being disturbed, and this could potentially lead to long-term population level consequences, as has been reported for other delphinids (Bejder et al., 2006; Higham et al., 2009; Lusseau and Bejder, 2007; Steckenreuter et al., 2012). When resting behaviour is disrupted, the survival of calves is put at risk, as nursing often takes place while animals are resting (Stensland and Berggren, 2007). Further, these “risk taker” groups are at risk of habituation, whereby their responses to stimuli that were once key to their survival progressively wane (Stone and Yoshinaga, 2000) (i.e., over time, they approach vessels more frequently, thereby increasing their risk of vessel strikes).

Alternatively, the dolphins that tour vessels encounter may be “resource dependent” to southern PPB. Scarpaci et al. (2000) identified this region as important for nursery groups given available shelter and productivity. Hence, groups with calves present could be resource dependent to southern PPB and, as a consequence, exposed to frequent encounters with tour vessels. The increase in encounters with groups containing calves from P1 to P2 could be suggestive of this. If this is the case, there is the risk that resource dependent groups may become habituated over time, as they are exposed cumulatively to tour vessels.

In 2012, avoidance levels heightened at 13% possibly due to chronic impacts of dolphin-swim tourism, or alternatively, because of an increase in non-compliance by tour operators to regulations across time (Filby et al., in press). Regardless of what regulatory changes were made, how tour operators approach dolphins has not changed temporally (Filby et al., in press; Scarpaci et al., 2004, 2003). However, how dolphins respond to tour operators has altered over time. Dolphins that approach tour vessels more frequently may have become habituated and be more susceptible to vessel strike, while the increase in avoidance may have resulted in the movement of sensitive animals away from optimal foraging and breeding areas.

Regardless of why dolphins have changed their responses to tour vessels, dolphin groups have decreased their amount of neutral responses to tour vessels across time, meaning that when tour vessels approach, their initial behavioural state changes. This could have significant impacts on the population, given disturbance that interrupts biologically significant behaviours (i.e., resting and feeding) may carry energetic costs that can affect individual fitness and have long-term consequences for the population (Christiansen et al., 2010; Lundquist et al., 2012; Peters et al., 2013).

4.2. Implications from a tour perspective

Between P1 and P2, the quality (sighting success, encounter time and dolphin sightings per trip) of dolphin-swim tours in PPB has deteriorated. This corresponds with an increase in non-compliance (Filby et al., in press) across the same temporal scale, implying that the industry in PPB may be non-sustainable. Dolphins approached tour vessels more frequently when legal (i.e., parallel) as opposed to when illegal (i.e. J and direct) approaches were attempted. Furthermore, legal approaches resulted in the highest levels of neutral responses by dolphins.

The significant increase in swim duration from P1 to P2 indicates that dolphin tolerance to swimmer's presence has increased over time. This may be a consequence of the cumulative exposure dolphins have acquired to the industry. The dolphins studied in P2 have been subject to tourism for a longer period of time and hence may exhibit a higher degree of habituation. Habituation to tourism has been reported for other delphinid species including: Hector's dolphins (*Cephalorhynchus hectori*) in Akaroa, New Zealand (Martinez et al., 2011); dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand (Markowitz et al., 2009); and for Atlantic spotted dolphins (*Stenella frontalis*) in the Bahamas (Ransom, 1998). Alternatively, the increase in the mean swim time may reflect amendments made to the regulations between these two periods. In P1, the regulations allowed tour operators an unlimited number of approaches to dolphins; during P2, tour operators were limited to 5 approaches per trip. The limited number of approaches in P2 may be correlated with the longer swim times, as tour operators keep tourists in the water for longer, so that the tour vessel can reposition itself closer to the dolphins. This hypothesis is supported by the increase across time in tour operator's non-compliance to the condition that tour vessels must not reposition the vessel whilst tourists are in the water (Filby et al., in press).

Increased swim length in P2 does not necessarily reflect a satisfactory swim, with tourists in PPB stating that they were not happy with the length of their dolphin-swim (Filby et al., in press). The mean swim time (3.5 min) documented in this study for Burrunan dolphins is low compared to swim times for other species (e.g., 9 min for dusky dolphin (Markowitz et al., 2009), 12 min for rough toothed dolphins (*Steno bredanensis*) in the Canary Islands (Nichols et al., 2002) and 25 min for Hector's dolphins (Martinez et al., 2011)). These findings indicate that Burrunan dolphins, similar to common dolphins (*Delphinus delphis*) in Mercury Bay, New Zealand (mean swim time of 3 min, Neumann and Orams, 2006), may not be receptive to dolphin-swim tourism. Alternatively, the low mean swim time reported for dolphins in PPB may be due to different swim techniques used. Regulations in PPB require tourists to hold onto mermaid lines (these are approximately

15 m long and are streamed from the stern of a vessel) during their dolphin-swim, whereas all of the other dolphin-swims studies compared here use free swims. In PPB, a maximum of 10 people are permitted on to mermaid lines at a time, and every time swimmers swap over, a new short dolphin-swim encounter begins. In comparison, free-swims allow tourists to get in and out of the water with dolphins continuously, and this is counted as one longer dolphin-swim.

4.3. Group size of dolphins interacting with dolphin-swim tour vessels during swims

Small groups of dolphins in PPB avoid tour vessels significantly more frequently than larger groups. Smaller groups may see tour vessels as a potential threat, and hence avoid tour vessels more frequently than larger groups. Delphinids often form larger groups in situations of threat or danger, in an attempt to provide increased vigilance and predator protection via group defence (Gygax, 2002; Zaeschmar et al., 2014). Hence, dolphins travelling in larger groups in PPB may perceive potential threats, such as tour vessels, as less threatening than small groups, explaining the higher approach rate to tour vessels by large groups. The theory that dolphins find safety in numbers is supported by Leitenberger (2001) and Neumann and Orams (2006) who also reported that dolphin group size was significantly correlated with boat avoidance, with smaller groups more likely to avoid vessels than larger groups. Half of dolphin groups encountered in PPB were small (less than 9 animals) and were significantly more likely to avoid tour vessels than larger groups (10 or more animals), adding support to the theory that the population of Burrunan dolphins in PPB may not be well suited to the dolphin-swim tourism industry.

4.4. Age class of dolphins interacting with dolphin-swim tour vessels during swims

Groups containing calves were more likely to be present during dolphin-swims in P2 than in P1. Simultaneously, tour operators' compliance to the condition in the regulations "must not swim with calves" decreased by 14.3% across this time frame (Filby et al., in press). Hence, the greater number of calves observed during dolphin-swims in P2 may reflect tour operators approaching groups with calves present more frequently than in P1, rather than these groups responding by approaching vessels. Potentially, tour operators may swim with groups containing calves more frequently in P2 by necessity. The significant decrease in sighting success across time will conceivably increase pressure on tour operators to swim with the first group they encounter in P2, regardless of age class composition. Potentially, groups containing calves may respond to tour vessels by approaching and bow-riding because of their inability to manoeuvre rapidly enough or dive sufficiently to avoid tour vessels (Wells and Scott, 1997). However, this approach response by groups containing calves may increase calves' susceptibility to disturbance by approaching vessels.

The significant increase of groups containing calves interacting with tour vessels during dolphin-swims across time is of concern, as neonates and calves are particularly vulnerable to collisions with vessels (Dwyer et al., 2014; Laist et al., 2001; Martinez and Stockin, 2013; Stone and Yoshinaga, 2000). Dolphins in P2 have been repeatedly exposed to tourism and thus may be displaying long-term behavioural changes such as habituation, which could lead to an increase in accidental encounters (Hawkins and Gartside, 2008). Habituated dolphins may display reduced wariness and let their calves interact with tour vessels more closely and frequently than non-habituated individuals (Bejder and Samuels, 2003). Consequently, these individuals become more vulnerable to vessel strike, especially calves due to their inexperience and reduced capacity to avoid vessels (Laist et al., 2001; Martinez and Stockin, 2013; Wells and Scott, 1997). Furthermore, vessels that get too close to dolphins groups can interrupt the nursing behaviour of young calves, which may cause disruption to social behaviours (Samuels et al., 2003; Wells et al., 2008).

PPB is an important area for breeding for this small population of Burrunan dolphins that is listed as threatened, with as many as six calves born in the austral summer of 2012–2013 (Filby, unpubl. data). However, there is a history of calf mortality due to vessel strike in PPB (Warren-Smith and Dunn, 2006). Given high levels of non-compliance (Filby et al., in press; Scarpaci et al., 2004, 2003) and the significant increase in effect responses to tour vessels by dolphins reported herein, there warrants a shift from passive (i.e., minimal enforcement presence and reliance on outreach material) to active (i.e., officers policing waters within PPB on a daily basis and sanctioning fines for breaches of regulations/ loss of permits for multiple breaches) management in PPB. If active management cannot be implemented due to resource limitations, then the authors suggest that the dolphin tourism industry be questioned since it may not be suitable for this particular population in PPB.

5. Conclusions

Burrunan dolphins in PPB have altered their responses to tour vessels across time, with dolphins showing an increase in effect responses towards tour vessels across 15 years. Combined with a decrease in sighting success, these results suggest that the population of dolphins in PPB is not well suited to the dolphin-swim industry. Management of the industry must consider not only how to regulate and enforce how tour vessels approach dolphins, but also how dolphins respond to tour vessels, as even seemingly positive encounters could have deleterious long-term effects on the population by detracting from biologically significant behaviours such as foraging, nursing and resting. This study highlights the importance of long-term data sets, as the results from either period alone are insufficient to give an indication of the impacts the dolphin-swim industry has on this population. However, by examining the short-term comparative studies concurrently, we gain valuable insight into behavioural changes that have occurred over time, and have detected responses resembling habituation.

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Appendix 10

Optional resource for dolphin-swim tour operators: interpretative material for Burrunan dolphin (*Tursiops australis*) interactions in Port Phillip Bay, Victoria, Australia

Research indicates that interpretation is best delivered in different phases during wildlife encounters, based on when participants are most receptive to different topics.

Thus, it is recommended that during the '**pre-contact**' phase (i.e. before dolphins are encountered, or at least before a swim is attempted) guides deliver information on: regulations that govern interactions with dolphins; safety; how a swim works; and equipment use. By explaining WHY regulations are in place, tourists are often more understanding, are happy to comply with regulations, and as a result leave the tour feeling more satisfied (this is because their expectations are managed).

Then, the optimal time to conduct educational activities is '**post-contact**' (i.e. after a dolphin encounter) as participants are most interested in different topics about dolphins and their environment at this time. During the '**post-contact**' phase participants are most receptive to information on biology and conservation of cetaceans, and are more likely to seek further information and reconsider global environmental threats. Thus, in order to achieve full potential in educating guests and encouraging pro-conservation attitudes, it is recommended that this information be delivered during the '**post-contact**' phase.

An example of an appropriate script that tour guides could deliver during dolphin-swim tours is detailed below.

PRE CONTACT

'Okay guys, as we are searching for the dolphins, we will just give you a little bit of information on the population that inhabit Port Phillip Bay and how we conduct swims with them.'

Taxonomy

'Does anyone know what species of dolphins we are looking for today?'

(the vast majority of people respond with 'bottlenose dolphins')

'That's a great guess, but the dolphins that inhabit southern Port Phillip Bay are actually Burrunan dolphins (*Tursiops australis*).

Until recently (2011) everyone thought that they were bottlenose dolphins because they look really similar, and only have slight differences in size and colouration from bottlenose dolphins.

A researcher from Monash University undertook genetic and morphological sampling of the dolphins that live in Port Phillip Bay and determined that they are morphologically and genetically distinct from the other two species of bottlenose dolphins. Dr Charlton-Robb named this new dolphin species 'Burrunan' after the local Australian aboriginals name for dolphins, as Burrunan means 'name of a large sea fish of the purpose kind'.

Range and Distribution

'We are really lucky to be able to interact with Burrunan dolphins because they are endemic to southern Australian coastal regions, meaning that they are not found anywhere else in the world.'

So far Burrunan dolphins been found in the inshore waters of Victoria, Tasmania, South Australia and researchers they think that there might also be Burrunan dolphins in southern Western Australia.

Only two resident populations of Burrunan dolphins have been identified, and both are within Victoria. One resident population is located here within Port Phillip Bay, where the population is estimated to be around 80 to 120 animals. The other resident population of Burrunan dolphins is located in the Gippsland Lakes, which is approximately 3 hours east of Melbourne on Victoria's east coast. The resident population in the Gippsland Lakes is much smaller, with approximately 50 animals.

Burrunan dolphins tend to spend the majority of their time in the southern coastal waters of Port Phillip Bay. It is likely that they spend the majority of their time in this area because it is close to the mouth of the bay (aka 'the rip'). Here, they can exploit foraging opportunities, as numerous migratory species (e.g. squid and barracouta), which these dolphins are known to consume, move in and out of Port Phillip Bay's narrow mouth.

Thus, a sanctuary zone, Ticonderoga Bay Sanctuary Zone, has been established along part of this coastline (*→ point out yellow boundary markers of the sanctuary zone if they are close enough to see*) in order to provide an area where the dolphins can forage and/or rest without disruption. Whilst within the sanctuary zone boats are not allowed to approach closer than 200 meters, and we legally cannot swim with the dolphins. So, if we do come across a pod whilst in Ticonderoga Bay Sanctuary Zone, make sure you jump up on the bow (front) of the boat or go up on the roof so that you can get a good look – the dolphins will often come over to see us and have a bow-ride and that is perfectly OK.'

Regulations

'Given that population numbers of Burrunan dolphins are so small it makes the population vulnerable, and thus the Department of Environment, Land, Water and Planning have developed the Wildlife (Marine Mammals) Regulations that detail how we are allowed to interact with the dolphins. These regulations are in place to protect the whales, dolphins and seals that live in Victorian waters (there are 25 species of whales, 3 species of dolphins and 6 species of seals that live or migrate through Victorian waters). The regulations help to ensure that our actions don't disrupt or stress these animals, ensuring that we can

continue to observe them in a safe and sustainable manner. The Wildlife (Marine Mammals) Regulations set out a number of regulations that govern our behaviour near the dolphins and are based on the biological requirements of the dolphins. For example, we are only allowed to approach a pod of dolphins from the side (i.e. a parallel approach), rather than zooming into the middle of a pod (i.e. a Direct approach), allowing these wild dolphins to decide if, and when, to approach and interact with us.

So, if we are lucky enough to find the dolphins today the swim will happen a little differently to our other snorkels. This won't be a 'free swim' like the ones at Popes Eye and the Seals – it will be a 'fixed' swim where you hold onto mermaid lines – those two ropes that float behind the boat, and the four ropes out the side hanging off the boom net. We are only allowed 10 swimmers in the water at a time – so we will get 6 people in the water at the back of the boat, and 4 people holding onto the ropes off the boom net. Each swim we will rotate the swimmers around so that everyone gets a go. The boat will remain stationary during the swim, making it easy for you to hold onto the rope and look out for the dolphins.

It is really important that you do not let go of these ropes whilst in the water with the dolphins – it is against the law, and there is an AUD\$10,000 fine that is payable by you if you do let go. The reason you have to hold onto these lines is so that the dolphins can choose whether they want to come and interact with us or not. Sometimes the dolphins will turn away, sometimes they'll dive deep, but MOST of the time they'll come straight under us. Knowing that the dolphins are choosing to come over and say hi to us makes the encounter that much more special!!

Swims often happen quite quickly (as the dolphins are often on the move), so please be aware that you will need to enter the water quickly once you get the go ahead from an instructor. But please try not to jump in and make a splash as this can scare the dolphins away.

The instructors will endeavour to point in the direction of the dolphins, so quickly look to us for guidance if you can't see the dolphins but remember your best chance of seeing the dolphins is if your face is in the water. Be sure to look in all directions down there, just in case they sneak past you.

Once a swim is over, the instructors will let you know when it is OK to let go of the mermaid lines and swim towards the back of the boat, where you can climb back on-board. If we ask you to come out of the water, please do so as quickly as possible as we might need to have another attempt as soon as possible.

Given that we hold onto the mermaid lines whilst in the water with the dolphins, you will not need your fins for this swim, only your mask and snorkel.

Under the Wildlife (Marine Mammals) Regulations we are only allowed to attempt 5 swims with the dolphins each trip. This allows us ample opportunity to swim-with and view the dolphins, whilst also ensuring that we don't spend too much time with the dolphins so that they can continue with their natural behaviours that are vital for their survival (e.g. foraging and resting).

If the dolphins swim up close to you (which often happens), we also ask that you do not reach out and touch the dolphins. They are wild animals and touching them is against the law. Often, the dolphins will swim right underneath you, or along-side you, so you will get an amazing experience without disturbing them and scaring them away by touching them.

If we are lucky enough to come across a pod containing a calf (an individual that is up to half the size of an adult, and swims right next to its mum) we are legally not allowed to swim with that pod of dolphins. This is because calves are extremely vulnerable, relying on their mums for their food, and we don't want to disrupt any nursing behaviours. Calves naivety may also increase risk of collision with vessels. Calves don't have the skills to survive on their own, so we want to reduce any chance of accidentally separating them from their mothers.

BUT if we are lucky enough to come across a pod containing a calf, head up onto the bow (front) of the boat because dolphins love to bow-ride and it's a

fantastic place to watch them and get a good, close look. The dolphins love bow-riding because it is like a free roller-coaster ride for them – they can move quickly through the water without expending much energy.

So as we travel along now, can we please ask that everyone keeps their eyes out on the water looking for dolphins, as we will have a much greater chance of sighting them with your help. If you think you see a fin, let one of the instructors know and we will come and have a look. Keep your eyes on the spot where you saw the dolphin surface, as the dolphins in a pod usually surface at the same time, and they will come up 3 or 4 times to breath before going back under the water for 3-4 minutes (although they can stay under the water for up to 15 minutes). Group size is highly variable, but here in Port Phillip Bay we usually see pods that have 5 – 15 animals (although on some occasions pods with 60 dolphins have been seen).'

POST CONTACT

‘Great job everyone on a fantastic swim!!! Now that we have had the opportunity to have a good look at the dolphins, I will give you a little bit of information on their behaviour, diet, conservation status, threats that this population faces and the things that we can do to help protect the dolphins and their environment.’

Behaviour

‘Dolphins are exceptionally intelligent and social animals, exhibiting high behavioural flexibility. Burrunan dolphins live in fluid fission-fusion societies, whereby the composition of groups may change within an hour to over a number of days. The dolphins that inhabit Port Phillip Bay exhibit five different behavioural states: travel; mill; social; rest; and forage.’

Travel

‘Whilst travelling, dolphins usually engage in synchronous and rhythmic movements with regular dive intervals and shallow submergence. The average travel speed of dolphins ranges between 4.3 km/hour to 9 km/hour, but they can

swim at speeds of up to 37 km/hour. Like most other dolphin populations, travelling is the behaviour observed most observed for Burrunan dolphins in Port Phillip Bay (63.9% - from 'control' behavioural budget in Filby 2015 thesis). It is likely that dolphins spent the majority of their time travelling in order to locate prey. Dolphins also spend time travelling in order to find conspecifics, as well as to avoid predators and maintain thermoregulation.'

Mill

'Milling dolphins exhibit slow, non-directional movement, with frequent changes in bearing preventing dolphins from making noticeable headway in any specific direction. Groups often change direction and dive intervals are short. Dolphins hanging around the boat and interacting with us are often engaged in milling behaviour.'

Social

'Whilst socialising, we often observe dolphins in spectacular aerial displays (sometime leaping out of the water in unison) and dolphins can be seen chasing each other, mating and/or engaged in physical contact with other group members. Dolphins can be quite aggressive, particularly males towards each other - there have been instances where males have fought so violently they have killed each other. Dominance or aggressive behaviours involve ramming, biting, and tail slapping, whereas affiliative behaviours include petting, rubbing, touching and moving in synchrony.

Groups of dolphins cooperate in a number of ways, including feeding, defence and childcare. Some female Burrunan dolphins in Port Phillip Bay form nursery groups, especially over the summer/autumn months when calves are born. These nursery groups provide; assistance with rearing of calves; increased foraging success; increased predator vigilance; and protection from sexual coercion by males.

We also observe male Burrunan dolphins in bachelor groups, whereby a number of males join forces and form temporary alliances in order to enhance their success at mating with females. Working together male dolphins in

bachelor groups herd receptive females, separating her from her group in order to force sexual intercourse. During these interactions males may display a series of aggressive or threatening displays, synchronise their behaviours, and/or vocalise frequently, with up to 8 males herding a single female. Social behaviours peak in Port Phillip Bay during March and April, when these mating displays are often seen.

Occasionally we get to see dolphins playing with small bits of kelp, placing it on their rostrums and passing it to each other – apparently for fun (but it may also be part of a foraging tactic).

The sociality of dolphins often extends beyond their own species. Here in Port Phillip Bay, Burrunan dolphins are frequently observed feeding cooperatively with seabirds (mostly the Australasian gannets that we saw/will see at Popes Eye Marine National Park, but gulls and terns also get involved). The dolphins herd fish into a bait ball underneath the surface, whilst the birds dive bomb from above, giving the fish little chance of escape.

Australian Fur Seals are also regularly seen hanging around Burrunan dolphin groups – often when they are feeding. The seals take advantage of the dolphin's hard work in herding up the fish, and come in for as easy feed.

There is also a very small population (approximately 15 animals) of common dolphins (*Delphinus delphis*) that reside further up in the bay near Mornington. On very rare occasions, mixed-species dolphin groups can be observed.'

Rest

'We rarely observe Burrunan dolphins resting in Port Phillip Bay (1.8%, from 'control' behavioural budget in Filby (2015) thesis) and this may be because the majority of their resting occurs at night, or because the approach of a vessel initiates a change from resting to other behaviours. When resting, dolphins are usually observed in a tight group, engaged in slow manoeuvres with little evidence of forward propulsion. Resting dolphins are usually observed floating

on the surface, however dolphins can also rest near the bottom of the seafloor by remaining immobile.'

Forage

'Dolphins exhibit a diverse array of specialised foraging behaviours that varies depending on the prey species targeted. Dolphins forage in groups and also individually, and here in Port Phillip Bay foraging takes up 16.4% of their daily activity budget (from 'control' behavioural budget in Filby (2015) thesis). Foraging behaviours often observed are: sudden erratic lunges or changes in direction by individuals, multi-direction diving within groups, and high speed swimming. They often cooperate as a group to herd fish shoals up against a shoreline or use their own bodies as a wall. The main aim is to slow down and trap the fish school, which they then attack from all sides.

The Burrunan dolphins in Port Phillip Bay frequently feed along the south-east coast (i.e. between Rye and Point Nepean → *point this area out to customers*), where the gradient of the seafloor is much steeper than the rest of the bay, making it easier for the dolphins to herd fish into shallower water where it is easier for them to catch them.

We also sometimes see Burrunan dolphins stunning fish with tails slaps or flicks, and if you are lucky today and we come across a group that is foraging in shallow water, you may get to see a dolphin with a fish in its rostrum (aka their mouth).

Sometimes the dolphins use their rostra to dig into the substrate and echolocating to detect prey which is hiding.'

Diet

'Burrunan dolphins are opportunistic feeders, and in Port Phillip Bay they are known to feed upon:

- Australian salmon (*Arripis truttaceus*)
- King George whiting (*Sillaginodes punctatus*)
- Garfish (*Hyporhamphus melanochir*)
- Snapper (*Pagrus auratus*)

- Yellowfin bream (*Acanthopagrus australis*)
- Squid (*Nototodarus gouldi*)
- Silver trevally (*Pseudocaranx dentex*)
- Flathead (*Platycephalus sp.*).

Reproduction

'Dolphins can live up to 40 - 50 years of age, with females reaching sexual maturity between 5 and 13 years. Gestation period is approximately 12 months and females only give birth to one live young, which is approximately one meter in length and weighing between 15 - 30kg. Calves are born tail first so that they do not drown and are quickly pushed up to the surface for their first breath. Females will only give birth again once their last calf has weaned, and this can be between 2 to 7 years. Calves are highly dependent on their mothers for the first few years of their life, with mothers providing their primary food source until they are 18 months to 3 years old. During their time with their mums, calves learn different foraging strategies and learn how to respond to real and perceived threats. Calves stay very close to their mother's side for their first few years of life. By swimming below the mid-section of their mum, calves can utilize 'drafting' whereby they take advantage of a slip stream and can have energy savings of up to 60%.

Here in Port Phillip Bay, there is a peak in calving during the summer months when the water is warmer, with neonates (calves that are up to a few weeks old, and still have foetal fold lines (pale vertical stripes) on their sides and a floppy dorsal fin from being curled up in the mother's womb) observed most frequently from December through to March.'

Conservation status

'Burrnan dolphins are listed as 'Threatened' under the Victorian Flora and Fauna Guarantee Act 1988. They are considered vulnerable to extinction due to their:

- Small population size
- Genetic distinctiveness

- Restricted home range (which is in close proximity to a major urban centre (Melbourne), making them susceptible to numerous anthropogenic threats)
- Exposure to anthropogenic pollution (e.g. they are highly contaminated with mercury)
- Female natal philopatry (i.e. their tendency to remain in a specific area in order to feed or breed).

As a top predator, dolphins play a vital role in the ecosystem, and are an indicator of the health of the rest of the marine environment.'

Threats

'Can anyone tell me what they think are the main threats facing dolphins in Victorian waters?'

(Wait for peoples responses/ideas and discuss the following if they are not suggested by customers)

- Pollution in the form of rubbish in our waterways is the largest threat facing dolphins in Port Phillip Bay. Many plastic rubbish items looks like prey items (e.g. jellyfish, squid, fish, etc.) to many marine mammals, and thus they consume them. Ingestion of marine debris can lead to starvation when the marine debris collects in the animal's stomach causing the animal to feel full. Malnutrition can also occur when ingested debris in the animal's system prevents vital nutrients from being absorbed. Further, internal injuries and infections may also result from ingestion.
- Plastic in the ocean actually never breaks down, but becomes small plastic particles called microbeads (they are generally between 1 and 5 mm). They can come from a variety of sources, including cosmetics, clothing, and industrial processes. Fish are unable to distinguish between food and microplastics and therefore indiscriminately feed on microplastics.
- The surface of microplastics has been proven to attract and absorb persistent organic pollutants (POPs) such as PCBs and DDT from the

marine environment. These POPs start accumulating in the food chain, transferring from species to species, with consequences ultimately for dolphins (as well as humans).

- Marine mammals can become entangled in marine debris (e.g. fishing line, plastic bags, six pack rings) causing serious injury or death. Entanglement can lead to suffocation, starvation, drowning, increased vulnerability to predators, or other injury. Marine debris can constrict an entangled animal's movement which results in exhaustion or development of an infection from deep wounds caused by tightening material.
- Incidental by-catch in fisheries is a significant threat. For example, 8 dolphins and at least 4 seals died during the first two voyages of the Super Trawler the Geelong Star in early 2015. With more dolphins having been killed since then.
- Competition for prey items with fisheries. Overfishing of many of our fish stocks, may mean that the dolphins' key prey species are being fished out, thus reducing the amount of food available to them.
- Pollution in the form of toxic effects of contaminants (e.g. the population in Port Phillip Bay are highly contaminated with mercury (which is attributable to chronic low dose exposure to mercury from the dolphin's diet. This illustrates the potential for low dose toxins in the environment to pass through marine food webs and potentially contribute to marine mammal deaths. Mercury is highly toxic and has detrimental health effects including neurological disorders, immunosuppression and reproductive disorders that can all lead to death)
- Boating and shipping noise (which can interfere with communication and foraging efficiency)
- Collisions with vessels (e.g. in 2011 two calves in Port Phillip Bay died from vessel strikes, and in 2001 another had its spine severed by a vessel propeller)

There are a number of other threats that currently face other dolphin and whale populations around the world:

- Habitat destruction and degradation is a current threat, but even more concerning is that we don't know enough about dolphin habitat needs.
- Illegal killing of dolphins has been occurring far too often. For example, in the Adelaide River, South Australia, a number of dolphins were recently shot and a calf was stabbed to death. This may be someone's idea of sport, or due to fishermen's perception that dolphins are 'stealing' fish from the commercial fish stocks.
- Hunting and live capture
- Accidental entanglement in shark nets (that have been erected to protect humans from the risk of shark attack)
- Consequences of climate change
- Tourism and provisioning programs (e.g. dolphins become habituated to being fed and then mothers don't teach calves the hunting skills they need for survival. At Monkey Mia in Western Australia, the behaviour of the dolphins has changed over the years and they are no longer wild dolphins as such. Mothers have been known to leave their young unattended as they get food handouts and there have been cases of these calves being attacked by sharks).
- Oil spills
- Disease such as Cetacean Morbillivirus (Symptoms of infection are often a severe combination of pneumonia, encephalitis (acute inflammation of the brain) and damage to the immune system, which greatly impair the cetacean's ability to swim and stay afloat unassisted. Cetacean Morbillivirus has been responsible for numerous mass mortality cases in cetacean populations.

These threats are very real, with several resident populations of dolphins showing population declines over the last two decades (e.g. bottlenose dolphins in Shark Bay, Western Australia and also over in the Mediterranean Sea) and with the Bajii (Chinese river dolphin) and Vaquita (from Mexico) listed as critically endangered, and likely to become extinct in the near future.

It is clear that there is a lot of work to be done to ensure that dolphins and whales continue to inhabit Australian waters.'

How we can help to conserve dolphins and their environment

‘Does anyone have any ideas on ways that we personally can help to protect dolphins and conserve the marine environment?’

(Wait for peoples responses/ideas and discuss the following if they are not suggested by customers)

(Note: participants are more likely to take conservation actions that require minimal amounts of time or effort)

- ‘Take 3 for the Sea: This is a really simple way to help dolphins and the marine environment. Every time you leave the beach, waterway or... anywhere, you can make a difference by taking 3 pieces of rubbish with you. It won’t cost you any money, or much effort or time. See: <http://www.take3.org.au/> (viewed 30th of June, 2015)
- We can greatly reduce the amount of marine debris in our oceans by preventing it from getting there in the first place! We encourage people to Refuse disposable plastic, and then to think about the 3 R’s: Reduce, Re-Use, and Recycle. An easy way to help is take reusable bags with you when you do your shopping instead of using plastic bags. See: <http://www.nrdc.org/thisgreenlife/0802.asp> (viewed 30th of June, 2015)
- Only eat sustainable fish, which you know is caught sustainably (thereby reducing demanding for products that may have by-catch wastage). You can get an app on your phone so it’s easy to know what you’re eating and whether it’s sustainable. Visit: <http://www.sustainableseafood.org.au/> (viewed 30th of June, 2015)
- As a recreational boat driver, drive slowly, always be on the lookout for marine mammals and obey regulations! (we often see jet-skis and other small boats zoom right through the middle of a pod of dolphins, which could result in mortality)
- If you come across a stranded whale or dolphin (that is, they are trapped in shallow waters or on-shore) you need to call the **Whale and Dolphin Emergency Hotline (1300 136 017)** as soon as possible. Historically,

Victoria has an average of between four to seven whale or dolphin strandings every year. See: Whale and Dolphin Stranding Fact sheet: http://www.depi.vic.gov.au/_data/assets/pdf_file/0004/205888/6.2_Cetacean_Stranding_Fact_Sheet_v3.pdf (viewed 30th of June, 2015)

- Tell other people what you learnt today – spread the word about the need to care for and protect our oceans and marine animals!!'

Additional Information

Taxonomy

Morphologically, Burrunan dolphins are distinct from the other two *Tursiops* species. They have a distinctive tri-banded colouration which is noticeably graded as follows: dark bluish-grey dorsally and on the sides of the head and body; light grey along the midline, extending as a pale shoulder blaze on the flank beneath the dorsal fin; and off-white ventrally, extending over the eye and above the flipper in some individuals; with no ventral spotting (Charlton-Robb et al., 2011). Burrunan dolphin's body length is smaller than common bottlenose dolphins and larger than indo-pacific bottlenose dolphins (Charlton-Robb et al., 2011). On average, Burrunan dolphins bodies are 2.57 m long (range 2.27 – 2.78 m), and their mean skull length is 493.58 mm (range 470 – 513 mm). Average rostrum size for Burrunan dolphins is 10.8 cm (range 9.4 – 12 cm), which is similar to common bottlenose dolphins rostrum size, but smaller and 'stubbier' than indo-pacific bottlenose dolphins (Charlton-Robb et al., 2011). Burrunan dolphins possess a falcate dorsal fin, which is similar to that of common bottlenose dolphins. Burrunan dolphins teeth are generally long and conical, and they have approximately 94 teeth (23 on the lower left; 23 on the lower right; 24 on the upper left; and 24 on the upper right) (Charlton-Robb et al., 2011). These cranial characteristics and external morphologies differ conspicuously from those of the other two bottlenose species in Australia, the common bottlenose dolphin and the Indo-Pacific bottlenose dolphin (Charlton-Robb et al., 2011).

Generally, fully-grown males are longer and heavier than females.

Just like human skin, dolphin skin constantly flakes and peels as new skin cells replace old cells. A dolphin's outermost skin layer may be replaced every two hours. This sloughing rate is nine times faster than in humans. This turnover rate ensures a smooth body surface and probably helps increase swimming efficiency by reducing drag (resistance to movement).

The senses

Dolphins have the sense of sight, hearing, taste and touch, but not smell. The senses are used in every facet of dolphin life as in other mammals, including navigation, feeding, breeding and communication.

Sound

Dolphins use a feature called echolocation to create acoustical pictures of their surroundings. They are able to produce intense, short, broadband pulses of ultrasonic sound (often referred to as clicks) which then bounce off objects in their path. Their hearing is also excellent, even though you have to look very hard to see any evidence of an external ear opening. The inner ear itself is adapted for hearing ultrasonic frequencies far beyond the range of human hearing - well over 100 kHz, which is greater than that of bats.

By sending out clicks a dolphin can learn much about its surroundings by how long it takes for the echo to come back. This tool is used primarily in the detection and tracking of prey. The intensity of sound as a dolphin closes in on its prey is so great that it is thought that they may be actually able to stun fish!

Sight

The dolphins' eye is very good at quickly detecting moving objects. The eye has evolved to give them a faster projection of a larger image, as well as large nerve fibres to rapidly send the information to the brain. Dolphins have a visual range of 180 degrees forwards, backwards and to the side, but they cannot see up. This is often why we see dolphins chasing fish belly-side up and why when bow-riding they turn on their sides and back to look at those humans watching

them! Dolphins also have a very interesting adaptation in that they can move each eye independently of the other!

Aerial vision is important in foraging. It is not uncommon to see dolphins look around above the surface of the water when they surface to breathe. One form of this behaviour is called spy-hopping, when the dolphin rises vertically out of the water, head-first. A common behaviour seen in Port Phillip Bay is a dolphin chasing a single fish that is leaping and skittering across the surface of the water. The dolphins are visually tracking these fish and this sort of behaviour has been documented elsewhere. Sight is also important in looking out for danger, particularly if a predator is rising from below or approaching from the side or rear. However, it requires the dolphin to be paying attention!

Taste

Dolphins have some ability to taste and are able to detect the four basic stimuli - sweet, sour, bitter and salt. It is thought that taste buds are like a chemoreception system that can be used for locating other dolphins, finding food, orientation, reproduction and stress sensitivity. Dolphins are especially sensitive to substances found in mammalian urine and faeces, so it is possible that they use information from this chemical trail to locate other dolphins. A female dolphin that is ready to breed releases some potent chemical stimuli that attract males. Bodily products, especially urine, are also thought to contain chemical indicators of physiological stress, which may alert others to the physical condition of a cetacean that has passed through the same waters before them. Taste buds can also be used to find food, as a large school of fish can leave a chemical trace that lingers for hours. In terms of orientation, many of the ocean's currents have distinct chemical traces that dolphins may use to navigate.

Communication

Dolphins produce high frequency whistles, clicks and squeaks, and do so singly, in bursts or in continuous streams. What we hear though, is not what the dolphins would hear, as most of their squeaks or clicks are far outside our hearing range. Dolphins' brains also process sound very fast and would probably hear a lot more detail within a squeak than we do.

It is thought that whistles may have evolved to help a group's ability to maintain contact when foraging over a large area, as whistles can travel greater distances than pulsed sounds such as clicks. A dolphin is able to echolocate and whistle at the same time, so that as it is searching for food it is also able to communicate whilst foraging. Whistling can accompany a variety of behaviours and situations. Dolphins whistle more when arriving at a familiar place, when feeding, under stress or when bow-riding. Dolphins also emit pulsed sounds at other dolphins that seem to be unfriendly, and they may scream and growl at each other!

It would seem that dolphins are not just making noise when they whistle, as there is evidence that a whistle can tell others about who you are. It is thought that each individual dolphin had a signature whistle that was sort of like a name. Cetaceans not only use clicks, squeaks and whistles to communicate, they also use body language. Dolphins have been known to clap their jaws together in conflict situations, and splashes and slaps made with the body may also be used as a form of communication. A common behaviour that we observe is tail slapping, which seems to be used in a number of situations. If a dolphin repeatedly tail-slaps towards a boat, it would seem that they may be 'telling' the boat to 'back off'! When they tail-slap in this manner and display other avoidance behaviour, this should be taken as the cue to leave the pod. On the other hand, dolphins have been seen to repeatedly tail-slap when there are no boats near them or even around. This could be linked with feeding or social behaviour.

Useful websites:

Wildlife (Marine Mammal) Regulations 2009, (viewed 30th of June, 2015):

<http://www.parliament.vic.gov.au/static/www.legislation.vic.gov.au-statbook.html>

Appendix 11

Proposed Rosebud West - McCrae Marine Protected Area

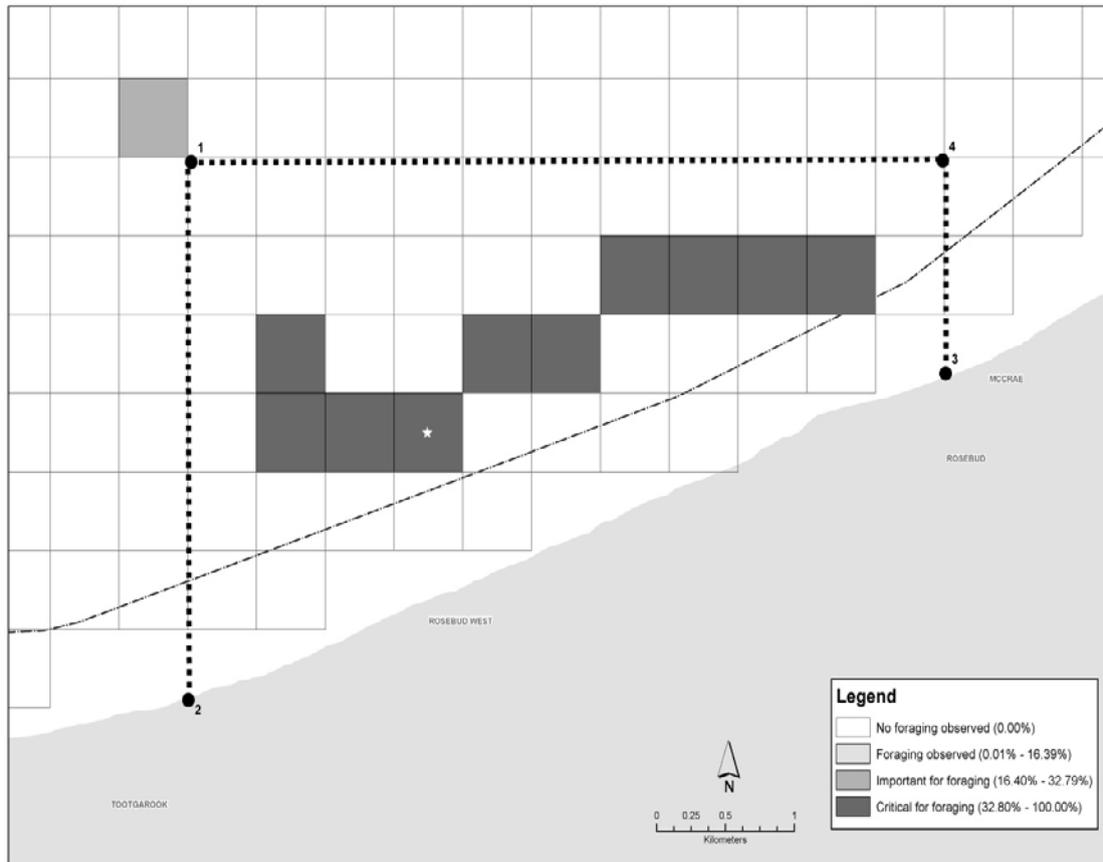


Figure B. Proposed Rosebud West - McCrae Marine Protected Area in region that is of critical importance for foraging Burrunan dolphins (*Tursiops australis*).

- 1) 144 51' 16.19 E, 38 20' 15.05 S
- 2) 144 51' 12.08 E, 38 22' 05.85 S
- 3) 144 55' 00.62 E, 38 21' 02.74 S
- 4) 144 55' 01.05 E, 38 20' 18.83 S