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Ineffectiveness of a marine sanctuary zone to protect burrunan dolphins (*Tursiops australis* sp.nov.) from commercial tourism in Port Phillip Bay, Australia

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Over the past two decades, considerable growth in commercial cetacean-based tourism has exposed coastal cetacean populations to high vessel density. Since 1989, Port Phillip Bay, Victoria, Australia, has hosted a thriving dolphin-swim tourism industry comprised of three licensed vessels. This study assessed the effectiveness of the Ticonderoga Bay Sanctuary Zone, a protected area enacted under the Wildlife (Whales) Regulations 1998, to serve the resident dolphins as an area of 'respite' and 'refuge' from anthropogenic stress, including commercial tourism. Research was conducted onboard 104 dolphin-swim tours, with both tour operation and dolphin school behaviour recorded using a combination of continuous observations and 1-min scan samples. During all observed encounters within the sanctuary zone, tour operations contravened the site-specific minimal approach distance regulation. By also contravening generic permit conditions (compliance range 0–70%) to the level of unsatisfactory compliance consistent with that documented outside the sanctuary zone, tour operations did not exercise any additional caution during a dolphin encounter within the sanctuary zone. Recommendations for this industry include a shift from sole reliance on passive management strategies to a judicious management plan that includes enforcement to support the governing regulations.

Keywords: wildlife tourism; management; compliance; sanctuary zone; burrunan dolphin; Australia

Introduction

A rise in desire to seek active engagement with wildlife has spurred the growth of nature-based tourism (Krüger, 2005). There is vast opportunity for such interactions and tourism involving engagement with cetaceans (whales, dolphins, porpoises) has experienced exceptional growth (Connor, Campbell, Cortez, & Knowles, 2009). A general shift of mindset towards non-consumptive use of wildlife, along with a long-term preoccupation with cetaceans (Lockyer, 1990), expectations of friendly encounters and their coastal distribution makes certain cetacean species perfect candidates for tourism (Corkeron, 2004; Samuels, Bejder, Constantine, & Heinrich, 2003).

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Global endorsement of this industry is founded on its potential triple bottom line benefits and perceived ecologically benign nature (Amante-Helweg, 1996; Connor et al., 2009; Corkeron, 2006), however, concern for the potential consequences on targeted individuals and populations has mirrored industry expansion. Concerns such as the direct threat of injury or death resulting from vessel collision (Wells & Scott, 1997), habitat alteration and pollution (Newsome, Dowling, & Moore, 2005) have been identified, along with subtle short-term changes in cetacean vocal and non-vocal behaviour (e.g. induced activity state transition, modified dive and respiration intervals, and altered group cohesion and phonation rates) in response to vessel engagement (Christiansen, Lusseau, Stensland, & Berggren, 2010; Lusseau, 2003; Nowacek, Wells, & Solow, 2001; Sousa-Lima & Clark, 2008; Williams, Trites, & Bain, 2002). There are indications persistent and frequent short-term behaviour changes can transition into long-term impacts, including area avoidance and changes in population behaviour budget that may result in quantifiable biologically significant repercussions at the population level (Bejder, Samuels, Whitehead, & Gales, 2006; Lusseau, 2005; Lusseau, Slooten, & Currey, 2006). Nevertheless, the long-term ecological ramifications associated with cumulative exposure to tourism for the most part remain unknown, with logistical constraints, data limitations (e.g. lack of pre-tourism phase data etc.) and confounding variables reducing the ability to investigate and detect any ecological costs on an industry-specific basis (Bejder & Samuels, 2003; Bejder et al., 2006; Corkeron, 2004), necessitating the implementation of cautious and judicious management of cetacean-based tourism.

Designation of spatial or temporal sanctuary zones is considered a strategic, precautionary option to supervise cetacean-based tourism within defined critical habitats or areas of intense tourism activity (Carrera, Favaro, & Souto, 2008; Hoyt, 2005; Lusseau & Higham, 2004; Reeves, 2000; Williams, Lusseau, & Hammond, 2006). Sanctuary zones have a long history as an ecosystem and wildlife conservation tool to manage recreational and commercial anthropogenic activities, evolving throughout their history to accommodate varying conservation objectives (McCool & Stankely, 2001; Reeves, 2000).

The Ticonderoga Bay Sanctuary Zone (TBSZ), a small (approx. 2000 m^2) sanctuary zone located inside Port Phillip Bay (PPB), Victoria, Australia, is designated under the Wildlife (Whales) Regulations, 1998, the legislation that governs all recreational and licensed tour operation interactions with whales (*def.* whales, dolphins, porpoises) in Victorian coastal waters (Hale, 2002; Wildlife (Whales) Regulations, 1998). Three licensed dolphin-swim vessels currently operate within PPB servicing around 12,000 tourists over the 6-month season. The Department of Sustainability and Environment is the government body responsible for industry management (DSE, 2009).

The TBSZ aims to provide a 'respite' and 'refuge' for resident dolphins from anthropogenic stress (Hale, 2002). To reduce the potential of negative short-term behaviour responses associated with close vessel proximity to cetaceans, the TBSZ site-specific regulation prohibits tour vessels from approaching a dolphin school closer than 200 m; an additional 150 m buffer from that required outside of the zone (Wildlife (Whales) Regulations, 1998). The regulation effectively means the dolphin school must approach the tour vessel for a close encounter to occur. Before 2004, the minimal vessel approach distance within the zone was 100 m, however, following an industry review, this distance was increased to 200 m and the western boundary extended (Hale, 2002).

The enforcement regime in PPB consists of a minimum of one undercover audit and up to three random on-water overt inspections per annum with no specific inclusions relating to enforcement inside the TBSZ (DSE, 2009). Consistent with the general ethos of the PPB

dolphin-swim industry management, the TBSZ site-specific regulation is supported predominantly by education (brochure and tour operation workshops), i.e. a passive management strategy. To encourage a commitment to comply, education, a resource efficient alternative to active management (i.e. enforcement/prosecution), works on an intellectual level (Sirakaya, 1997) that attempts to inform and rationalise a need for self-regulated compliance. A sole reliance on education and self-regulation has some merit based on success in several situations (Orams & Hill, 1998; Parsons & Woods-Ballard, 2003), however, Burgess (1992) and others (Dobson, 2006; Rowcliffe, de Meroda, & Cowlishaw, 2004) indicate these management strategies are rarely sufficient to achieve appropriate standards of compliance. Consistent with other wildlife tourism industries (Johnson & Acevedo-Gutiérrez, 2007; Quiros, 2007; Waayers, Newsome, & Lee, 2006), criticism along these lines has extended to the cetacean-based tourism industry with several studies, including within PPB, documenting unsatisfactory levels of compliance in self-regulated industries and those managed by education (Allen, Smith, Waples, & Harcourt, 2007; Scarpaci, Nugegoda, & Corkeron, 2003, 2004; Whitt & Read, 2006).

In light of this, the current study aims to utilise compliance analysis to examine the effectiveness of the TBSZ management framework in achieving its ecological goal. This is the first review of compliance within the TBSZ, despite the PPB industry being previously documented non-compliant to generic regulations (Scarpaci et al., 2003, 2004) and the recognised need to evaluate the overall effectiveness of designated sanctuary zones through continued, solid scientific evaluation (Berrow, 2003). This research is timely as the targeted species is a small resident dolphin population (approximately 80–100 individuals) of the newly classified *Tursiops australis* sp. nov. (burrunan dolphins) (Charlton-Robb et al., 2011). The TBSZ poses an ideal study subject due to its long-term designation and the consistency of ownership amongst individual dolphin-swim tour operations since industry and regulation inception.

Materials and methods

Study subjects, area, platform and effort

All licensed dolphin-swim tour companies within PPB, Victoria, Australia, operate inside the southern end of the bay. The TBSZ extends 500 m from the shoreline between the Point Nepean Rocks and Police Point (Figure 1) (Wildlife (Whales) Regulations, 1998). Data were collected onboard 104 dolphin-swim trips during the 2007–2008 austral summer to correspond with the industry peak season. Compliance behaviour was collected for all licensed tour vessels when circumstances permitted, as operators were likely to undertake interaction with the same dolphin school.

Field data collection

Once a dolphin school was sighted, the tour vessel would move inside the encounter zone (inside of 300 m from the dolphin school) and the time was taken (hh:mm:ss). A dolphin school was defined as an aggregation of dolphins observed together at one instance in the field (Connor, Mann, Tyack, & Whitehead, 1998), with the members of the school established through the use of a 10 m-chain rule (i.e. all individual dolphins were located $<$10 m from each other and were collectively classified as one school) (Smolker, Richards, Connor, & Pepper, 1992). Continuous observations commenced at this point to document the tour vessel location within PPB (utilising a Global Positioning System - GPS), and tour

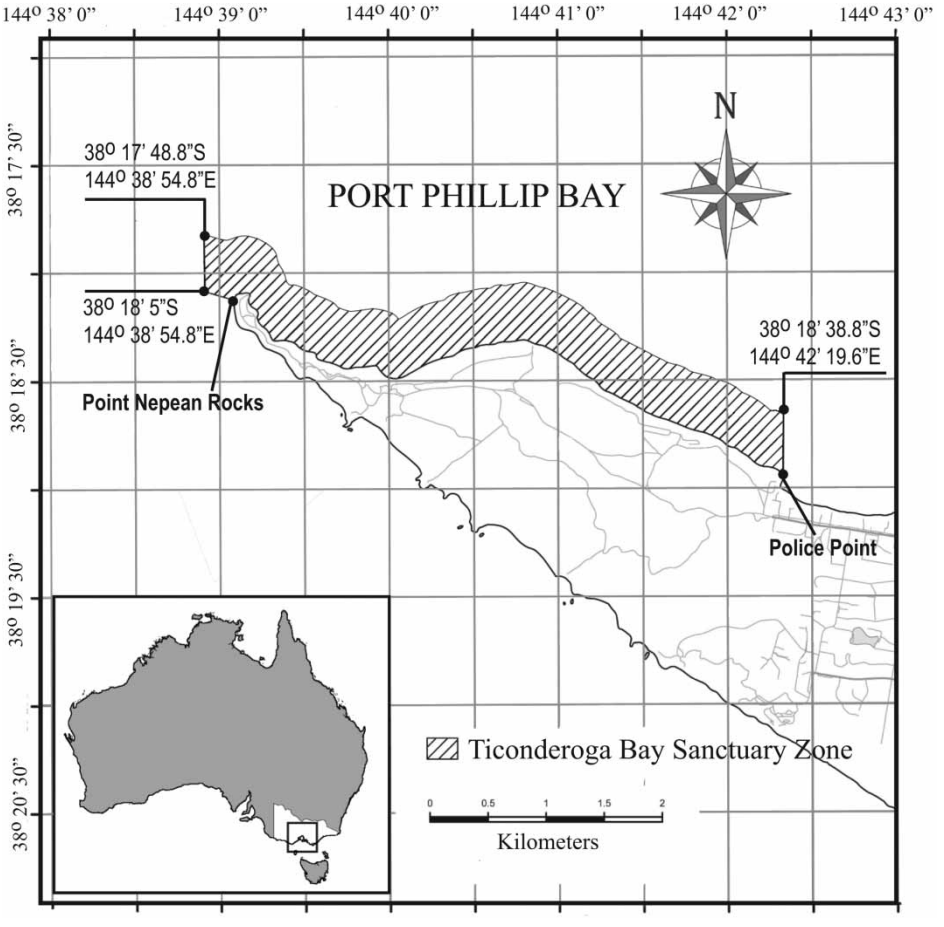

Figure 1. TBSZ, located in the southern section of PPB, Victoria, Australia.

operation compliance (condition-specific methodological requirements listed below). Simultaneously, when required, 1-min scan samples (Altmann, 1974) commenced to assess tour/recreational vessel density within close proximity of the observer's tour vessel (<500 m) and the observer's tour vessel's proximity to land. Additionally, a GPS waypoint was taken after every tour vessel approach; a vessel approach was defined as the steady movement of the vessel towards the dolphin school. Data were recorded until the tour vessel left the encounter zone with no intention to re-approach the dolphin school and the time was documented. When, during a dolphin encounter, a tour vessel moved in and out of the TBSZ, the time was recorded at the point the vessel entered and exited the zone to accurately assess the collective period of time tour vessels spent with a dolphin school within each area. A Yardage Pro 500 range finder was used to determine all distance measures unless circumstances prevented its use; in which case a visual estimate by two independent observers was taken.

The following regulatory conditions were assessed while a tour operation was under observation, however, Condition 1 was specific to the TBSZ. Based on precedence set by Allen et al. (2007) in a comparable industry, an 80% rate of obedience was considered satisfactory compliance.

Condition 1

Site-specific minimal approach distance *r.5(6)(b): Tour vessel does not approach to within 200 m of a whale inside the TBSZ.*

A triple-zoned template was used to determine tour operation compliance to this condition (Figure 2). The legal zone represents the minimum approach distance as designated by regulation. In order to assess the extent of the tour vessel approach violation, two prohibited zones were designated i.e. 'first prohibited zone' (200–100 m) and 'second prohibited zone' (100–50 m), the latter of which equates to the approach distance regulation for waters outside of the TBSZ. When an encounter commenced outside the TBSZ, but progressed to within the zone, the observer assessed compliance to this condition.

Condition 2

Tour vessel approach method *r.5 (7)(2)(b)(i and ii): The permit holder must ensure that the tour vessel does not approach a whale head-on, or is not in the path of a whale.*

Three-approach methods based on Scarpaci et al. (2003, 2004) were used to assess operational compliance. During a legal 'parallel' approach, the tour vessel was positioned to either side of a dolphin school, providing the dolphins with a voluntary choice to engage in an encounter. During an illegal 'j' hook approach, alternative term – leapfrog (Williams et al., 2002), the tour vessel passed the dolphin school at a distance and then hook-turned into the path of the oncoming dolphins. During an illegal 'direct' approach, the tour vessel penetrated directly into the middle of a dolphin school from any approach angle.

Condition 3

Swim/Approach foetal fold calf *(i) r.8 (8)(1)(h): Tour vessel must not approach or swim with a foetal fold calf; (ii) r.8 (8)(1)(i)(i and ii): A whale-swim must discontinue if a foetal fold calf is detected.*

A 'foetal fold' calf was defined as any individual that was closely associated with a fully grown dolphin, was either approximately one-half the size of its accompanying adult and/or

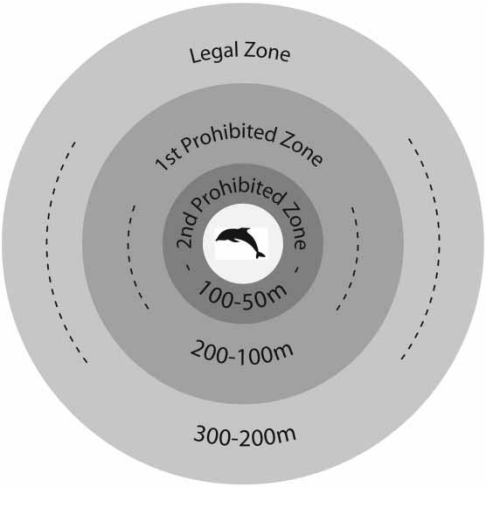

Figure 2. Assigned areas used for data collection on the tour vessel approach distance to a dolphin school within the TBSZ.

had visible foetal fold lines (Scarpaci et al., 2003). A foetal fold calf was only recorded when the calf was clearly visible to the observer by the unaided eye. Two measures were used to assess compliance to this condition: (i) did tour operations have prior knowledge of the presence of a foetal fold calf before initiating an approach/swim, and (ii) did tour operations discontinue a dolphin-swim following discovery of a foetal fold calf. To ascertain prior knowledge, the following criteria was used:

(a) the foetal fold calf was clearly visible to the observer's unaided eye prior to an approach, thus the crew should also have been able to observe it;

(b) the crew indicated to customers that a foetal fold calf was present prior to a swim being conducted.

Condition 4

Tour vessel distance from land *r.8 (8)(1)(b): The permit holder must not conduct a whale-swim within 100 m of the low water mark.*

When swimmers were in the water, the distance of the tour vessel from the shoreline was recorded every minute. For practicality, the distance was only recorded when the tour vessel was inside of 200 m from the shoreline.

Condition 5

Tour vessel repositioning *r.8 (8)(1)(d): A permit holder must not reposition a tour vessel during a whale-swim.*

A reposition was defined as any deliberate manoeuvring of the tour vessel during a dolphin-swim that was not motivated by safety concerns. Data were recorded per swim as either legal or illegal.

Data analysis

GPS waypoints were converted into image files using MapInfo Professional with additional details added, using Adobe CS5. Data were analysed using descriptive and inferential statistics ($p < 0.05$) as per Zar (1999). Non-parametric inferential statistical procedures were required as data did not conform to underlying assumptions of parametric procedures and the sample sizes varied.

Results

Occurrence

In total, 59 tour vessel encounters with dolphin schools within PPB were recorded over 104 trips during the 2007–2008 austral summer. The mean duration per trip was 3 h 17 min ($\pm$SD 45 min, Range, 2.15–4.05, $n = 104$). Of these encounters, 49 (83%) occurred exclusively in waters outside of the TBSZ and 10 (17%) occurred either fully (50%), or in part, within the zone (50%) (Figure 3). Each licensed tour vessel operation was observed undertaking a dolphin encounter within the TBSZ on more than one occasion ($n = 4$; $n = 3$, $n = 3$). On 7 of the 10 occasions, the tour vessel moved into the TBSZ to pursue a dolphin interaction. During the remaining three occasions, the tour vessel moved within the TBSZ during an interaction that was initiated outside of the zone.

The median duration of all dolphin encounters varied dependent on the location of the interaction. Those exclusively inside the TBSZ (median = 26 min, IQR = 24–33, $n = 5$);

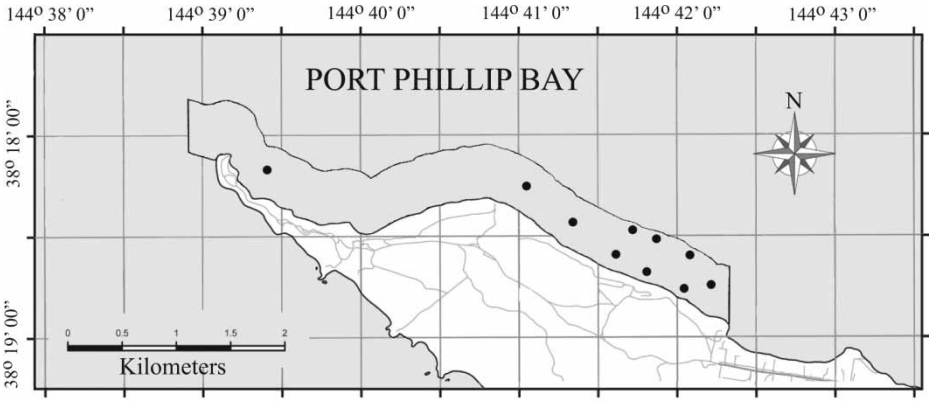

Figure 3. The location of initial tour vessel approach to a dolphin school inside the TBSZ.

those exclusively outside of the TBSZ (median = 24 min, IQR = 16–27, $n = 49$); and interactions that occurred across both areas (median = 19 min, IQR 13–20, $n = 5$). There was, however, no significant difference (Kruskal–Wallis $\chi^2_2 = 2.40$, $p = 0.301$) in the duration of time spent with a dolphin school according to the interaction locality.

Vessel traffic

At least one recreational vessel (median = 4, IQR = 2–5, $n_{\text{scan samples}} = 125$) was present within 500 m of the tour vessel during 90% ($n = 9$) of all dolphin-tour vessel interactions within the TBSZ. In contrast, one or more recreational vessels (median = 2, IQR = 1–3, $n_{\text{scan samples}} = 495$) were present during 51% ($n = 25$) of interactions outside of the TBSZ. The median number of recreational boats present during a dolphin-interaction was significantly greater (Mann–Whitney $U = 10{,}876.50$, $p = <0.001$) inside than outside of the TBSZ.

General compliance to regulations

Condition 1: site-specific minimal approach distance

In total, 418 tour vessel approaches were documented inside PPB. A tour vessel approached a dolphin school inside the TBSZ on 57 occasions, accounting for 13.6% of the total approaches made by tour operations under observation. All tour vessel approaches were made to within the second prohibited zone (100–50 m) of the dolphin school.

Once an approach was made, the likelihood of placing swimmers to conduct a dolphin-swim was identical (58%) whether inside or outside of the TBSZ. The 33 swims conducted within the TBSZ accounted for 13.6% of the total dolphin-swims ($n = 242$) observed during this study period; the remaining 86.4% ($n = 209$) of swims occurred outside of the TBSZ.

Condition 2: tour vessel approach method

The illegal 'j' approach ($n = 26$) was the most common approach type utilised by tour operators inside of the TBSZ, followed by the legal 'parallel' approach ($n = 23$), then the illegal 'direct' approach ($n = 8$). There was no significant difference in the approach method

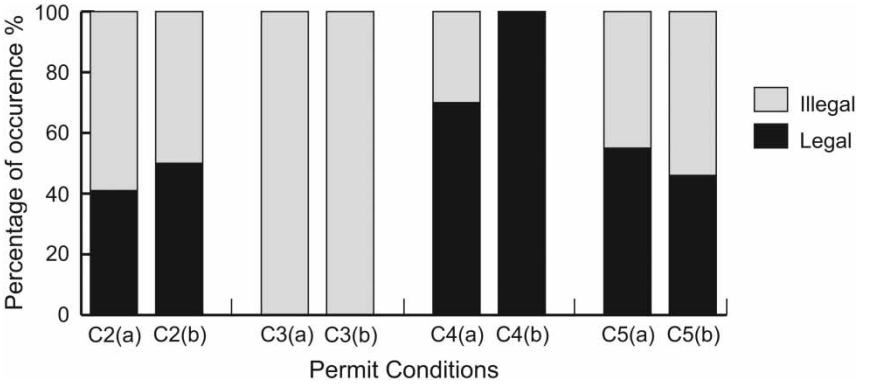

Figure 4. Tour operation compliance to generic permit conditions inside (a) and outside (b) of the TBSZ. C2 = Tour vessel approach method; C3 = Swim/Approach foetal fold calf; C4 = Tour vessel distance from land; and C5 = Tour vessel repositioning.

between tour operations ($\chi^2_2 = 0.146,\ p = 0.930$). The portion of legal approaches was higher outside of the TBSZ (49.3%, $n = 178$), than within the TBSZ (40.4%, $n = 23$), however, no statistical difference ($\chi^2_1 = 1.58,\ p = 0.208$) was found (Figure 4).

Condition 3: swim/approach foetal fold calf

A foetal fold calf was present during 32.2% ($n = 19$) of vessel-dolphin encounters observed inside PPB, with all three tour operations undertaking five or more encounters. This equates to 62 tour vessel approaches and 34 swims conducted with schools containing a foetal fold calf. Tour operation encounter rates with schools containing a foetal fold calf varied significantly between inside (60%, $n = 6$) and outside (26.5%, $n = 13$) of the TBSZ ($\chi^2_1 = 2.866,\ p = 0.09$). Furthermore, of the six encounters within the TBSZ, four were engaged with two foetal fold calves whilst only one encounter outside of the zone contained this number.

Compliance to both parts of this condition was irrespective of location (Figure 4). Tour operations at no time complied with part (i) of the regulation, with tour operations conducting 28 swims and 56 approaches towards dolphin schools containing a foetal fold calf irrespective of established prior knowledge. During the remaining swims and approaches, tour vessels contravened part (ii) of the regulation on all occasions, as a dolphin-swim/approach was not terminated on discovery of a foetal fold calf.

Condition 4: tour vessel distance from land

During 30% ($n = 3$) of interactions inside the TBSZ, a tour vessel moved to within 100 m of the low-water mark of the shoreline with a mean distance of 60 m ($\pm$SD 20.6 min, Range 37–96, $n_{\text{scan samples}} = 36$) between the tour operator and the shoreline. At no stage did the tour vessel move to within 100 m of the shoreline during the 49 interactions outside of the TBSZ (Figure 4).

Condition 5: tour vessel repositioning

Of the 242 dolphin-swims conducted in PPB, a tour vessel repositioned during 53.3%. Inside the TBSZ, a tour vessel repositioned during 45.5% of swims ($n = 15$) as compared

with 54.5% ($n = 114$) outside of the TBSZ, however, no statistical difference was found ($\chi^2_1 = 0.946,\ p = 0.331$) (Figure 4). Furthermore, there was no significant difference in level of obedience between licensed tour operations ($\chi^2_2 = 0.206,\ p = 0.902$).

Discussion

This study indicates the ability of the TBSZ to provide the PPB dolphins with a 'refuge' and 'respite' from anthropogenic activity is compromised by the dolphin-swim tour operation behaviour.

Despite consistent industry ownership and long-term familiarity with legislation, factors believed to improve operational compliance (McClanahan, Davies, & Maina, 2005), all tour operations inside the TBSZ penetrated the 200 m site-specific vessel approach distance regulation by >100 m during all observed dolphin encounters. Furthermore, no additional caution befitting the intention of the sanctuary zone was taken during the pursuit and interaction phase with a dolphin school. Tour operations displayed total non-compliance to the condition dictating the appropriate behaviour around foetal fold calves and unsatisfactory compliance to the vessel approach method, repositioning of the tour vessel and swim-with activities within 100 m of the low water mark. The latter condition equates to herding behaviour that was only documented in this location and had previously been identified as an area of concern for this location prior to the zone's inception and should have been curtailed by its designation (Weir, Dunn, Bell, & Chatfield, 1996). Considering these results most likely represent compliance at its best, as the researchers' presence was known to operators, they illustrate the TBSZ is ineffective with it unable to move past good intention to a realisation of genuine benefit for the protection of the PPB dolphin population.

Given 70% of interactions occurred well within the sanctuary zone boundaries and all approaches were made within the second dolphin prohibited zone (100–50 m), essentially a 100 m buffer, it is difficult to justify non-compliance as erroneous judgement arising from a lack of demarcation buoys and difficulties in estimating the distance across water (Baird & Burkhart, 2000). Furthermore, the degree of unsatisfactory compliance documented inside the TBSZ was comparable to that documented outside of the TBSZ, illustrating that tour operations utilise all parts of the bay in the same unsatisfactory manner. Placed in the context of previous PPB tour operation compliance studies (Scarpaci et al., 2003, 2004), these results reveal long-term unsatisfactory compliance. Consequently, the capacity of the Wildlife (Whales) Regulations to maintain the ecological integrity of the PPB dolphin population could be compromised, given the indication that non-compliant behaviour increases the proclivity for targeted species to exhibit short-term disturbance behaviour (Lusseau, 2003; Stamation, Croft, Shaughnessy, Waples, & Briggs, 2010) that could potentially transition into long-term biologically significant repercussions (Bejder et al., 2006).

Compliance choice is often described as a trade-off between the associated economic benefits of non-compliance with the risk of being detected and the severity of sanctions (Smith & Anderson, 2004). Management in PPB is currently obligated to meet only a minor enforcement commitment thus relying heavily on education to encourage voluntary compliance to a legislative framework. While recognising this passive strategy is most likely borne from resource limitations, it allows tour operations to interpret regulations *ad hoc* and exploit opportunities for dolphin encounters without fear of consequences.

It is possible that the pressure to meet swim-with tourist expectations, suggested to be a more difficult task than that needed to satisfy dolphin-watch industry customers (O'Neill, Barnard, & Lee, 2004), could be motivating non-compliance. Consequently, observed variation in compliance percentage between generic conditions likely reflects the associated level

of tourist benefit resulting from particular tour operation behaviours. Interestingly, it is also possible that deep and clear water close to the TBSZ shoreline (EPA, 2002) that is favourable for a close-swim encounter (herding behaviour), along with a high foetal fold encounter rate, an assumed customer benefit (Allen et al., 2007), may have enticed tour operations to augment customer satisfaction by capitalising on such benefits irrespective of legality and the TBSZ signficant status. The latter scenario suggests broader implications, as the specific ecological characteristics that validate a sanctuary zone's protective status may, in fact, be the qualities leading to its failure in the absence of effective management.

The effectiveness of education within the TBSZ could be compromised by a lack of scientific content strong enough to validate its designation and promote a level of acceptance by tour operations to override business objectives; scientific legitimacy is considered to be essential in influencing protected area acceptance and compliance success (Read, West, Haste, & Jordan, 2011). Variation in tour operation compliance levels documented between the TBSZ (0%) and that of the dusky dolphin tour operation with regard to the Kaikoura temporal exclusion zone (100%), for example, could be indicative of varying acceptance levels, given both industries are managed by education and economically reliant on their protected targeted species (Duprey, Weir, & Würsig, 2008). Upon review, the TBSZ designation was based on an arbitrary belief in the area's ability to act as a 'respite' and 'refuge' (Hale, 2002), lacking the degree of scientific validation that supports the Kaikoura temporal exclusion zone designation (for scientific validation details see, Duprey et al., 2008), as well as other comparable sanctuary zones (e.g. proposed multi-level sanctuary in New Zealand (Lusseau & Higham, 2004); Port Stephens-Great Lakes Marine Park speed restriction zones (Steckenreuter, Harcourt, & Möller, 2012)). Equally, the TBSZ minimal approach distance regulation, borne from a multi-use rather than preservation paradigm, does not afford the highest level of regulatory protection and also lacks evidence-based research to justify its enactment.

Recent research (Scarpaci, Nugegoda, & Corkeron, 2010), supports the TBSZ as an important dolphin foraging ground and the recent discovery that this relatively small dolphin population is one of only two known endemic populations of *T. australis* sp. nov. (Charlton-Robb et al., 2011) could lend strength to the species' conservation, with the TBSZ being an integral protective component. Furthermore, during this study's observational periods, a theoretically more stressful environment was evident with a high percentage of calf presence, a variable shown to increase the occurance of a short-term disturbance response (Nowacek et al., 2001; Stamation et al., 2010), and a greater recreational vessel density than that documented outside of the zone, potentially inhibiting dolphin navigation. These facts strongly suggest investigation into recreational vessel behaviour is necessary to complement this research.

Validation of the TBSZ, whilst important, may not, however, be sufficient to ensure satisfactory voluntary compliance, given the historical non-compliance of the PPB industry and research illustrating tourism compliance within ecologically significant sanctuary zones relying on self-regulation, and those managed by education, cannot generally be assumed (e.g. Robson Bight (Michael Bigg) Ecological Reserve (Jelinski, Kryeger, & Duffus, 2002); Stewallegn Bank National Marine Sanctuary (Wiley, Moller, Pace, & Carlson, 2008); The Indian River North/Packwood Place manatee slow-speed sanctuary (Sorice, Flamm, & McDonald, 2007)). Underpinning the TBSZ designation is an advanced legislative framework (i.e. regulations/licensing) that can enforce compliance and enable a paradigm shift away from the current reliance on education as the principle management strategy. To be effective, this would require a significant increase in in-field enforcement presence, a deterrent linked with an increase in the ecological effectiveness of marine protected

areas designated under various mandates (Guidetti et al., 2008; Kritzer, 2004). More severe punitive actions such as licence suspension/revocation may be required if non-compliance persists. While, this judicious management framework is achievable within the TBSZ, it is of concern, however, that a significant number of wildlife tourism industries globally do not have the benefit of a legal framework. It is plausible, given broad indications of unsatisfactory compliance within these industries (Allen et al., 2007; Waayers et al., 2006), that the viability of sanctuary zones in the absence of a legislative context is, therefore, questionable and highlights the need for compliance review of existing sanctuary zones.

The cost of enforcement could be subsidised through the introduction of strategies such as a tourist user-pay system and/or licence fee increase; the Ningaloo Reef whale shark tourism model might provide a template for such a system (Catlin, Jones, & Jones, 2012). To support on-water enforcement, the size and design of the TBSZ is conducive to land-based surveillance, a unique circumstance that could make enforcement of the zone more resource efficient. Furthermore, in addition to maintaining the minimum approach distance regulation, employment of demarcation buoys and enactment of the TBSZ as a 'no-swim' zone, a simple enforceable regulation, would support enforcement efforts and strengthen the preservation message. Only when satisfactory compliance levels are met can review be undertaken to assess the efficacy of regulations in facilitating the TBSZ ecological goal.

Designating the TBSZ as a 'no-swim' rather than 'exclusion' zone is a necessary trade-off to allow tour operations access to existing historical and natural attractions located within the TBSZ boundary. This strategy maintains product diversity, which could alleviate any business disadvantage and associated ramifications arising from reduced access to the dolphins, including a decrease in dolphin-swim operational compliance outside of the TBSZ, a situation that may also extend into other programmed activities (e.g. tourist swims with seals). Encouraging tour operations to utilise information on the TBSZ assets (significant foraging ground etc.) to assuage any tourist dissatisfaction associated with reduced access to the dolphins is also advocated, as research suggests tourists tend to support management actions that can be justified (Kessler & Harcourt, 2010; Mayes & Richins, 2009). In addition, effective management is also essential outside of the TBSZ to improve the general unsatisfactory level of compliance within PPB. These combined strategies account for the pressures on tourism operations and illustrate a need to ensure sanctuary zone designation is not detrimental to adjacent areas and that adjacent business activities complement the zone's ecological role.

The TBSZ has the advantage of a strong legislative framework to support its designation, yet this study has revealed unsatisfactory compliance with tour operations able to interpret regulations *ad hoc* without fear of repercussion. This outcome illustrates the importance of a multi-faceted management regime, with enhanced enforcement as a priority, to ensure a satisfactory level of compliance that will support the ecological intention of the TBSZ. Furthermore, the results of this study have implications for the successful management of both current and future designated sanctuary zones.

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