A first assessment of operator compliance and dolphin behavioural responses during swim-with-dolphin programs for three species of Delphinids in the Azores

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The popularity of swim-with wild dolphin programs around the world is fast growing, with the studies required to investigate their impact lagging behind. In the Azores, species targeted include the short-beaked common (*Delphinus delphis*), the bottlenose (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella frontalis*). To evaluate the effects of this activity on local dolphin populations, and thus provide support for management decisions, dolphin response data were collected onboard commercial boats off São Miguel Island between 2013 and 2015. All three species revealed high degree of neutral and avoidance behaviours, and very low approach rates. *Tursiops* showed higher frequency of neutral responses than *Delphinus*, while *Stenella* both avoided and approached more frequently than the other species. When boats intersected the path of dolphin groups, avoidance responses were more likely and the duration of swims was shorter. Swims were also shorter when animals were resting and travelling, and when groups were smaller. The operators generally complied with the legislation, except in respect to the number of swim attempts per dolphin group, which was higher than the legal maximum. Improvement of the current legislation and concurrent reinforcement of controls is essential to avoid detrimental long-term effects of this activity on dolphin populations in the Azores.

Key words: dolphin tourism, management, *Delphinus delphis, Tursiops truncatus, Stenella frontalis.*

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INTRODUCTION

Swimming with free-ranging dolphins (hereafter abbreviated as swim-with-dolphin) is offered commercially as an ecotourism activity in various parts of the world (Samuels et al. 2000). Swim-with-dolphin encounters pose similar or greater levels of disturbance than whale watching (Scarpaci et al. 2000; Courbis & Timmel 2009), an activity which has raised concerns in relation to potential negative effects on the long-term viability of cetacean populations (Christiansen &

Lusseau 2014; Meissner et al. 2015). Swim-with-dolphin programs generally involve more disruptive forms of interaction than conventional whale and dolphin watching. Thus, understanding of long-term effects is imperative. Surprisingly, despite their more intrusive nature the impact of these activities remains poorly investigated, with only a few studies currently available and focusing on the effects of swim-with programs on dolphin behavioural responses and group structure (Martinez et al. 2011; Peters et al. 2013; Peters & Stockin 2016). For example, Hector's (*Cephalorhynchus hectori hectori*), bottlenose (*Tursiops* spp.) and common dolphins (*Delphinus delphis*) in New Zealand and Australia were reported showing direct avoidance behaviour when subjected to swim-with operations (Neumann & Orams 2006; Martinez et al. 2011; Filby et al 2014).

A study of responses of bottlenose dolphins to swim-with-dolphin tourism in Port Phillip Bay, Australia, compared observations made during two study periods 15 years apart and showed evidence of increasing sensitivity to disturbance over this period. Both the sighting success and the mean encounter duration decreased between the two periods. The proportion of "neutral" encounters also decreased while the probability that dolphins would show either avoidance or approach behaviour was higher in the later study. Dolphins that were scored as resting before the encounters were particularly likely to show avoidance (Filby et al. 2014).

Several studies suggest that the strategy used by tour operators to approach dolphin groups affects with the dolphins' response. The *J-approach*, where the dolphin's path is intersected by the boat, generates greater avoidance reactions than a *parallel* approach (Martinez et al. 2011; Peters et al. 2013). Other factors, such as group size and age class have also been shown to influence dolphins' responses: smaller groups are more likely to avoid swimmers, while juveniles are more likely to engage (Neumann & Orams 2006; Peters et al. 2013).

In the Azores, swim-with-dolphin programs started in early 1990s in combination with whale watching tours, with tourists engaging in swim-with-dolphin activities in an opportunistic manner. As this activity became more popular and also provided anappealing economic revenue, operators started to offer dedicated swim-with-dolphins tours. Currently, there are twenty-four companies on four of the nine islands of the Archipelago, of which seven on the largest island São Miguel. On average two to three trips are scheduled daily by the operators with each trip lasting 2-3 hours. The variety of dolphin species and their high sighting frequency in the Azores (Silva et al. 2003, 2014) has facilitated the development of these activities. The target species are common (*Delphinus delphis*), bottlenose (*Tursiops truncatus*), Risso's (*Grampus griseus*), and Atlantic spotted dolphins (*Stenella frontalis*). Operators may target specific groups based on species, group size, activity state or distance from the harbour. For instance, operators tend to prefer Atlantic spotted dolphins and bottlenose dolphins over common dolphins, while large gatherings of surface feeding common dolphins are preferred over smaller ones. A shorter distance from the harbour is also preferred (Filipe Ferreira, tour company lookout, personal communication).

The fact that multiple species are targeted in the same area is different from the situation typical in other locations such as New Zealand and Australia, where dolphin operators mostly focus on a single species e.g. bottlenose dolphins in Gulf of St. Vincent (Peters et al. 2013) and Port Phillip Bay (Scarpaci et al. 2000; Filby et al. 2014), Australia; Hector's dolphins in Akaroa Harbour (Martinez et al. 2011) and Porpoise Bay (Bejder et al. 1999), common and bottlenose dolphins in Bay of Islands (Stockin et al 2008; Peters & Stockin 2016) and Mercury Bay (Neumann & Orams 2006), dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura (Markowitz 2012), New Zealand.

Swim-with-dolphin operators in the Azores release tourists, equipped with a mask and snorkel but no fins, into the water within 10 m of dolphin groups. In New Zealand, swimmers are also provided with snorkelling gear (Martinez et al. 2012) while in Australia, there is more variability, free snorkelling, underwater scooters or the use of a rope are offered by different operators (Zeppel 2007; Peters et al. 2013). In Australia, mermaid

lines are used. These are 15 m long ropes which swimmers hold while pulled by a slowly moving boat. Mermaid lines were found to minimize inappropriate approaches by swimmers towards the dolphins; thus reducing dolphins' behavioural changes and possibly disturbance (Peters et al. 2013; Filby et al 2014).

Regulations are important for managing tourist operations and to minimize potential impacts. However, this offers no specific guidance on how to approach dolphin groups: the regional legislation states only that the type of approach and the distance to the group is the exclusive responsibility of the boat skipper, based on his/her evaluation of the dolphins' behaviour and of the sea state. However, limitation is placed on the number of swim attempts per group of dolphins (maximum of 3), the number of swimmers per swim attempt (maximum of 2), and the duration of each swim episode (maximum of 15 minutes). A recent proposal for amending this legislation suggests a limit of only one swim-with-dolphin boat at any time per group of dolphins, and no swim attempts are to be made in the presence of other whale watching boats. Further, at the first sign of disturbance from the dolphins, the swimmers should return to the boat and no further swim attempts should be allowed. The legal definition of 'disturbance' is a horizontal and/or vertical displacement of the group or part of it.

Given the lack of detailed knowledge of industry operational practices and the effects of swim-with-dolphin operations in the Azores, this study aims to provide an insight into swim-with-dolphin operations off São Miguel Island. Specifically, we test the operator's preference for species or group size and explore the relationship between different boat approaches and dolphins' response and resulting swim durations for participants. We also investigate the extent of compliance with existing guidelines. This study offers first insights into swim-with dolphin However, to be able to issue effective guidelines, it is imperative to understand the effects these activities have on subjects, bearing in mind these may be species, habitat and operation dependent.

In the Azores, all matters related to whale and dolphin watching, including swim-with-dolphin programs, are regulated by regional legislation (Decreto Legislativo Regional 13/2004/A) first issued in 1999, and currently under revision.
operations at a location where several dolphin species are the subject of tourism focus.

MATERIALS AND METHODS

Field data collection

Boat-based data were collected off the south coast of São Miguel Island (N 37º39', W 25º26'), Azores, during swim-with-dolphin operations between June and September of 2013 to 2015 (Figure 1).
Whale watching companies rely on land-based lookouts to detect cetaceans. Each company has its own lookout, usually located in a fixed land station along the south coast of the island. To its own lookout, usually located in a fixed land station along the south coast of the island. To cover as much area as possible, we chose two whale watching companies departing from two different harbours (Ponta Delgada and Vila Franca do Campo) for our study.

Typically, each company carried out separated trips for observation and swim-with-dolphin activities. Each swim-with-dolphin tour included one or more *group encounters*, during which the boat approached a group of dolphins while attempting to place patrons in the water (*swim attempt*). If successful, a swim attempt led to a *swim episode* in which one or more swimmers were released in the water.

We used group focal scan sampling (Altmann 1974; Mann 1999) to examine the dolphins'

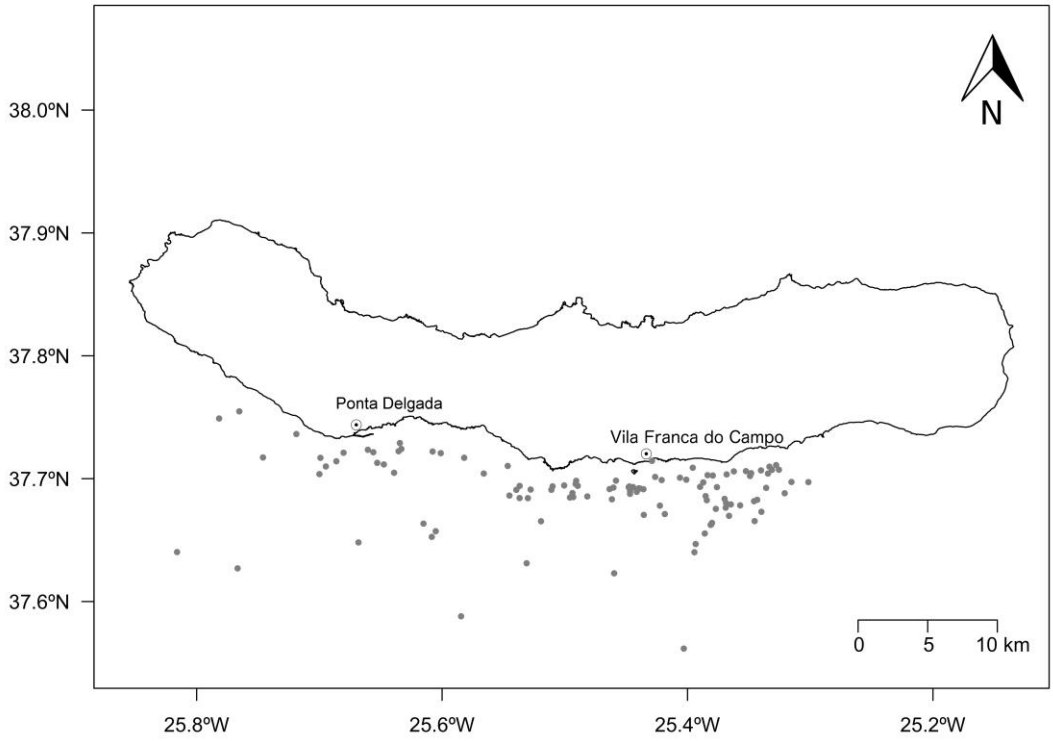

Fig.1. Dolphin groups encounters during swim-with-dolphin operations between 2013 and 2015 off the south coast of São Miguel with each dot representing a dolphin group.

response to the activity. A group was defined as existing when >50% of individuals were engaged in the same activity state, were heading in the same direction when travelling and were within 5 body length of each other. We performed an initial scan on first observation of the group and then again, prior to the boat engaging directly with the group. Data collected included the initial activity state, group size best estimate and the presence of calves and newborns. Vessels were always farther than 100 m from the dolphin group when these assessments were made. A second scan was completed when swimmers were released into the water. In addition to the parameters recorded for the initial scan, we recorded the dolphins' behavioural responses, the type of boat placement, the number of swimmers and their placement relative to the dolphin group.

The probability of sampling the same group was low given the fact that samples regarded not just one species, but all dolphin species encountered by the operators, e.g. a morning tour could include a group of common dolphins and the afternoon a group of bottlenose dolphins. Typically, the activity was performed with just one group per tour. Four activity state categories (foraging, resting, travelling and socialising) were defined based on Neumann (2001) and Stockin et al. (2009), summarised in Table 1. A calf was defined as an individual of approximately one-half or less in size than an adult and consistently associated with an adult (Fertl 1994). Newborns were defined as individuals showing visible foetal folds, consistently associated with an adult (Shane 1990).

Table1. Definition of activity states recorded during swim-with-dolphins operations between 2013 and 2015 off São Miguel island, Azores (adapted from Neumann 2001 and Stockin et al 2009).

Activity state	*Definition*
Foraging	Individuals engaged in coordinated directional movements and prolonged dives in an attempt to pursue and capture prey. Cohesiveness of the group often varied and changes in heading and circling movements could be observed during cooperative foraging. When actual feeding occurred close to the surface, aerial activity was observed. Seabirds were often associated with feeding dolphins.
Resting	Involved slow movements up to absence of forward propulsion. Close distance range between individuals, regular surfacing patterns and absence of active surface behavior were observed.
Travelling	An individual or group following a consistent direction over time.
Socialising	Included high frequency of active surface events such as breaching, head slapping, and tail slapping concerning at least two individuals (mother-calf excluded). Chasing and body contact is observed.

Recording the time swimmers entered the water and re-boarded the boat allowed the duration of each swim episode to be calculated. When the swimmers entered the water, we recorded the dolphins' response as: 1) *neutral*, dolphins did not show any apparent change of behaviour; 2) *avoidance*, dolphins changed their path direction or dived away from the swimmers or increase their speed and either changed direction or dived; 3) *approach*, at least one dolphin of the group changed direction and swam within 5 m of at least one swimmer (Martinez et al. 2011).

Data analysis

To investigate whether encounter frequency of different dolphin species for swim-with operations reflected their prevalence in the area or was instead affected by operator preference, data collected during swim-with-dolphin operations were compared with observations from an opportunistic open database (MONICET, www.monicet.net) using a Chi-square test. The MONICET database is compiled from regular whale watching activity and includes data since 2009.

Dolphin response to swimmers was analysed with a Generalised Estimating Equation (GEE) model for multinomial responses using the exchangeability time ("time.exch") correlation structure, recommended for nominal responses (Toulomis 2015). The full model contained the three-levels response variable (neutral, avoidance and approach) and six explanatory variables: species, year, group size, activity state, boat placement and presence of calves/newborns. The model was rerun excluding non-significant explanatory variables. Similarly, we applied a GEE model with exchangeable correlation structure to explore the duration of swim episodes with the same six explanatory variables. In the exchangeable correlation structure, the within-cluster observations (in this case the group encounter) are assumed to be equally correlated. This structure was preferred over the first-order autoregressive, which assumes that correlations are a function of time, i.e. correlation of successive swim attempts would decrease over time, and that measurements are equally spaced in time. This was not the case in the present study, as sampling depended on the activity; hence no standardization of intervals between swim attempts was applied. We did not include the variable "swimmers placement" due to its high

collinearity with boat placement. We chose this latter because effects from boat approach would occur earlier than those due to swimmers. Moreover, rules of best practice regarding boat manoeuvres would be easier to implement. Only the most frequent levels of "boat placement" and "swim episode duration" were included in the models. Waldts and QIC tests were used to select the best models. We determined compliance rates in respect to both current and proposed legislation. All analysis was performed in R using "geepack" (Højsgaard et al. 2006) and "multgee" (Toulomis 2015) packages.

RESULTS

Target species and approach techniques

Data were collected on 135 trips run over 104 days between 2013 and 2015. We recorded a total of 225 independent group encounters. Only one trip resulted in no dolphin encounters. Operators approached common dolphins on 110 occasions, bottlenose dolphins on 62 and spotted dolphins on 34. Risso's dolphins were approached only 3 times. Mixed species groups of common with spotted or bottlenose dolphins were also approached (12 and 4 times, respectively). No statistical analysis was carried out using data from mixed groups or for Risso's dolphins because of the small sample sizes.

The frequency of approaches to the various species was not significantly different from their sighting frequency in the overall whale-watching trips, as recorded in the larger MONICET database (N swim-with dataset = 206, N whale watching dataset = 1265; Dd: X^2= 0.0861, df = 1, p = 0.769; Tt: X^2 = 0.3125, df = 1, p = 0.576; Sf: X^2= 1.1108, df = 1, p = 0.291). However, operators did select smaller groups for swim attempts: the median group size of approached dolphin groups was significantly smaller than that recorded in the whale watching database (Table 2). Calves and newborns were present during the majority of the swim attempts. Dolphins approached thr boat in only 1% of cases. Five different approach techniques were used by the skippers (Figure 2). The *J-approach* strategy (a) was the most frequently used (50%, N = 1367): the boat would move parallel to the group at first, then accelerate in order to pass ahead of it and quickly position itself transversal to their track. The second most frequent (35%, N = 1367) type of approach involved the boat moving and stopping *parallel* to the group of dolphins (b). During 9% (N=1367) of approaches, the boat would pass through and stop *centred* to the group (c). Other less frequent strategies used were approaching and placing the boat directly *to the front* of the group facing their path (4%, N = 1367) or *to the back* (1%, N = 1367). In less than 1% (N = 1367) of cases the boat remained

Table 2. Differences between group sizes of dolphins approached for swim operations (SWD) and those recorded during regular whale watching (WW). Group size is given as median (1st quartile, 3rd quartile). Percentage of calves and newborns observed during swim operations are reported for each species. Dd=common dolphin, Tt=bottlenose dolphin, Sf=Atlantic spotted dolphin.

		Group size			
	% calves	***SWD***	***WW***	***U***	***P***
Dd	72	17.5 (10-30) n= 110	30 (15-50) n= 658	41528.5	<0.001
Tt	52	15 (10-25) n= 62	20 (10-40) n= 355	12941	0.012
Sf	79	30 (17-46) n= 34	50 (30-80) n= 252	5257.5	<0.01

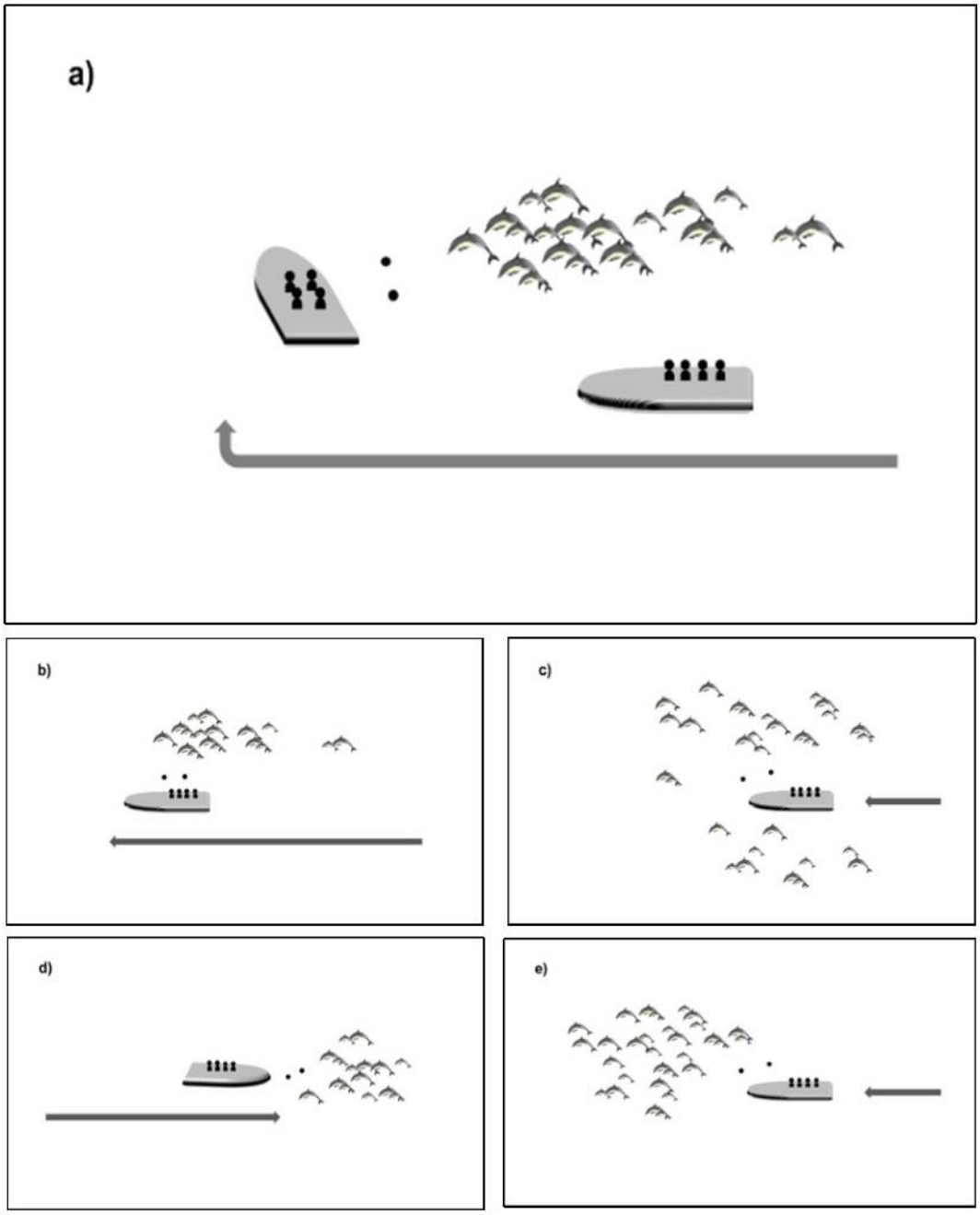

Fig.2. Boat placement strategies used to approach dolphin groups in the Azores: a) J-approach, b) parallel, c) centred, d) to the front, e) to the back.

Table 3. Compliance with current and proposed (*) guidelines during swim-with-dolphins operations between 2013 and 2015 off São Miguel island, Azores.

Rule	***Set Value***	***Median***	***Maximum***	***Compliance***
Nr swimmers in the water	2	2	7	77%
Nr swim attempts with one group	3	6	23	33%
Duration of swim episode	15	2	15	100%
Stop interaction on avoidance*	-	-	-	29%

stationary near the dolphins long enough to allow a second swim turn. Swimmers entered the water mostly to the front (50.7%, N = 1355), parallel (35.2%, N = 1355) or in the middle (11.22%, N = 1355) of the group. In few cases, swimmers were placed behind the dolphin group (1.4%, N = 1355) or were at some distance from it requiring participants to swim to get to the group (1.4%, N = 1355).

The percentage of each approach strategy varied between species. The *J-approach* was most often used to approach bottlenose dolphins (43%, N = 683), while both the *centred* approach (65%, N = 129) and *parallel* (61%, N = 472) were most often used to approach common dolphins. Spotted dolphins were approached with almost equal percentages of all techniques. Approach strategies varied significantly as a function of group size for common ($KW = 20.162$, df = 2, $p < 0.001$) and spotted dolphins (Sf: $KW = 14.0502$, df = 2, $p < 0.001$). A posthoc Dunn's test showed that for these two species, the *centred* approach was used significantly more frequently with the larger groups ($p < 0.01$, Figure 3).

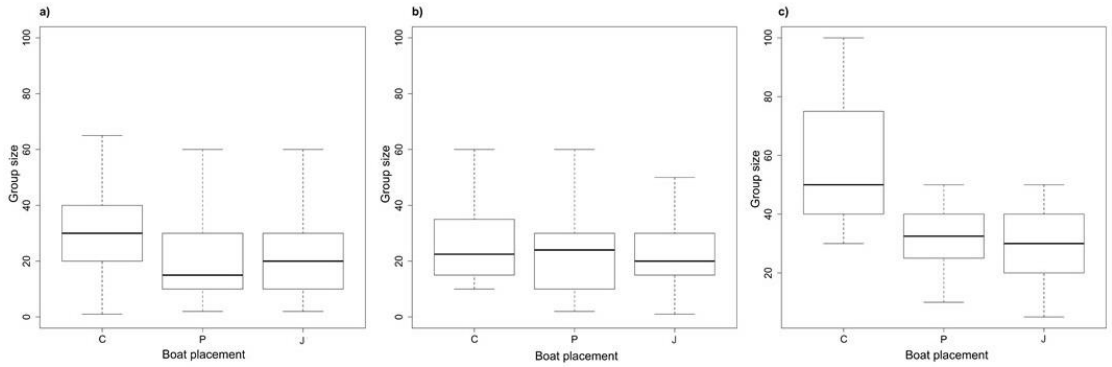

Fig.3. The three most frequent boat placement strategies as a function of dolphins group size for each species (a) common dolphin, b) bottlenose dolphin, c) Atlantic spotted dolphin). Note: C=centred, P= parallel, J= J-approach. Horizontal lines are medians, vertical lines are the range of values, and boxes are the interquartile ranges.

Compliance with regulations

Compliance with current and proposed regulations is reported in Table 3. The median number of swimmers entering the water during each swimming episode was 2, which is the maximum number specified by the current regulation. In 23% of the episodes, 3 or more (up to 7) swimmers were in the water concurrently. On average, swim episodes lasted about 2 minutes, regardless of the species. (This includes the time of placing the swimmers in the water and recovering them back into the boat).

Regulations specify a maximum of 3 swim attempts per dolphin group, but the median number observed was 6, and 67% of the groups were approached more than 3 (up to 23) times. Only twelve swim attempts (N = 1367) were not followed by the release of swimmers into the water.

The new regulations under discussion propose that at the first sign of disturbance, swimmers should return to the boat and no further swim attempts should be made. We considered avoidance reactions as a sign of disturbance, and found that only 29% of the encounters would potentially follow this rule. The other proposed rule is that only one swim-with dolphin boat is allowed per group and that whale watching have priority over the swim-with activity. Compliance in this case could not be investigated as information was not available for encounters given the fact that it was not always possible to distinguish the activity of all boats arriving and departing during dolphin response data collection.

Effects of swim-with-dolphin operations

For all three species, dolphin response to swimmers was either avoidance (49.6%, N = 1354) or neutral (47.8%). Only in 2.6% of cases did the dolphins approach the swimmers. Atlantic spotted dolphins showed a high degree of avoidance (52%), but also the highest percentage of approach (10%, Figure 4a).

The GEE model for multinomial responses showed that three variables: species, activity state

Table 4. Dolphin responses to swim-with programs resulting from multinomial GEE with time.exch correlation structure. N=neutral, Av=Avoidance. Sf=Atlantic spotted dolphin, Tt=bottlenose dolphin.

Parameters	***Coefficient Estimate***	***Standard Error***	***Z***	***P***
beta01	3.2087	0.6839	4.69	<0.001 ***
Species				
Sf: N	-1.0202	0.9001	-1.13	0.257
Tt: N	1.4949	0.7530	1.99	0.047 *
Boat placement				
Parallel: N	0.3651	0.5589	0.65	0.514
J-approach: N	1.3924	0.7759	1.79	0.073
Activity state				
Foraging: N	0.0237	1.0432	0.02	0.982
Travelling: N	-0.8044	0.8764	-0.92	0.359
Resting: N	-1.1568	0.5349	-2.16	0.031 *
beta02	2.8709	0.6550	4.38	<0.001 ***
Species				
Sf: Av	-0.6729	0.8936	-0.75	0.451
Tt: Av	1.2178	0.7551	1.61	0.107
Boat placement				
Parallel: Av	0.2643	0.5031	0.53	0.599
J-approach: Av	1.5136	0.7262	2.08	0.037 *
Activity state				
Foraging: Av	-0.3205	1.0011	-0.32	0.749
Travelling: Av	-0.1126	0.8520	-0.13	0.895
Resting: Av	-0.8512	0.5323	-1.60	0.110

and boat placement were significantly correlated with dolphin response (Table 4). In particular, a neutral response was more likely for bottlenose than for common dolphins (Figure 4a). Groups of resting dolphins were less likely to respond in a neutral way than socialising groups (Figure 4b). Avoidance responses were more likely when the boat intersected the path of the dolphins than when it stopped centrally to the group (Figure 4c).

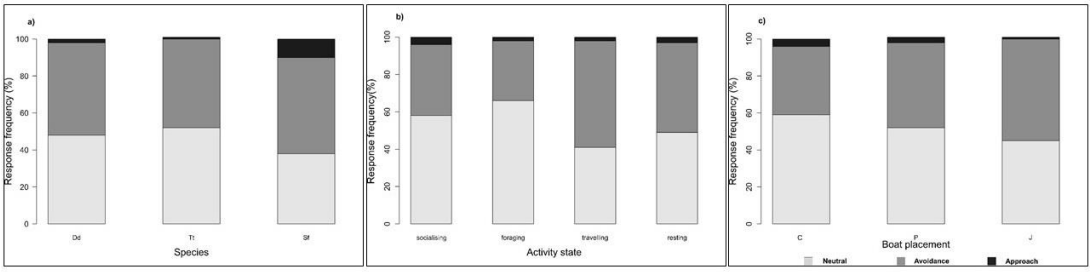

Fig. 4. Dolphins' response during swim-with-dolphin operations in relation to species (a) activity state (b) and boat placement (c). Dd=common dolphin, Tt=bottlenose dolphin, Sf=Atlantic spotted dolphin; C=centred, P=parallel, J=J-approach.

Three of the five explanatory variables had significant effects on the duration of the swim episodes: group size, activity state and boat approach technique (Table 5). Swim episode duration tended to increase with larger groups (Figure 5a). When the operator was using the J-*approach*, the duration of the swims was shorter than when the boat was centrally placed in the group (Fig. 5b). Foraging groups also resulted in longer swim episodes compared with travelling or resting dolphins (Figure 5c).

Table 5. Effects of swim-with programs on the duration of swim episodes resulting from the GEE model with exchangeable correlation structure.

Parameter	***Coefficient Estimate***	***Standard Error***	***Wald***	***P***
Intercept	2.54014	0.19277	173.63	< 0.001***
Group size	0.00454	0.00181	6.30	0.0121 *
Activity state				
Foraging	0.47078	0.22641	4.32	0.0376 *
Travelling	-0.42777	19.12	0.09783	<0.001***
Resting	-0.37697	0.12528	9.05	0.0026 **
Boat placement				
Parallel	-0.26337	0.15115	3.04	0.0814
J-approach	-0.44053	0.16163	7.43	0.0064 **

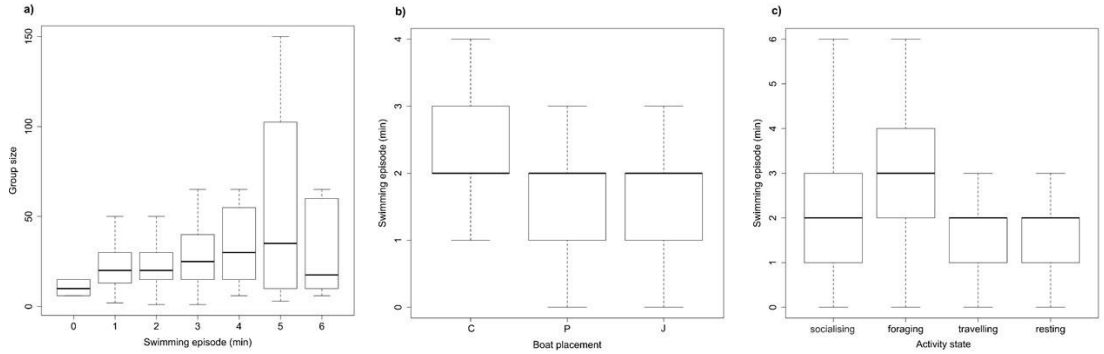

Fig. 5. Swim episodes' duration in relation to group size (a), boat placement (b) and activity state (c). C= centred, P=parallel, J= J-approach. Horizontal lines are medians, vertical lines are the range of values, and boxes are the interquartile ranges.

DISCUSSION

Species and group selection

Three dolphin species were the most targeted for swim-with-dolphin operations off São Miguel, Azores: common, bottlenose and Atlantic spotted dolphin. The sighting frequency of these species did not differ from that in the larger dolphin watching database. Despite the perception that certain species were preferred targets of the industry, the current analysis did not reflect this. However, other factors such as the distance from the coast could have had priority over species selection. For instance, the regular occurrence of a small group of bottlenose dolphins outside of Ponta Delgada (AC personal observation) makes them potential easy targets for commercial operations. A similar point was raised by Hartman et al. (2014), who called for restrictions on swim-with-dolphin activities after reporting Risso's dolphin females with calves using periodically a specific area off the south coast of Pico Island. Small resident populations targeted by tourism activities may be vulnerable to cumulative effects (Markowitz 2012), which could ultimately lead to displacement or even impacts on reproductive rates (Lusseau 2005; Bejder et al. 2006). Monitoring the impact of swim-with-dolphin activities should aim to measure whether particular groups of animals may be targeted more intensely than the general population and, may thus, require specific management measures to limit cumulative impacts.

Effects of swim-with-dolphin operations

The analysis of the dolphin response to swim-with-dolphin operation in the Azores revealed a high degree of neutral or avoidance reactions, and a very low approach rate for all three species. Atlantic spotted dolphins had the highest avoidance rates, followed by common dolphins, while bottlenose dolphins were more frequently neutral in their responses. Atlantic spotted dolphins also showed a tendency for higher approach rate, suggesting this species as the most variable in terms of responses.

We did not find evidence for the presence of calves and newborns affecting dolphin responses. However, the high percentage of swim attempts including these age classes might be the reason for this missed effect. The well documented vulnerability of calves, given their small size, dependency from adults and lack of experience of vessels (Stone & Yoshinaga 2000; Martinez & Stockin 2013; Dwyer et al. 2014) should motivate a precautionary approach. In New Zealand and Australia, for instance, a ban on swimming with groups containing calves has been enacted in national swim-with-dolphin regulations (Neumann & Orams 2006).

For all species, resting was associated with fewer neutral responses with a tendency for higher avoidance responses. The duration of swim episodes was also reduced when dolphins were resting and travelling as opposed to socialising. This is consistent with observations of bottlenose dolphins in Port Phillip Bay, Australia which also showed a high degree of

neutral responses from groups of individuals that were socialising and high avoidance when resting (Filby et al. 2014). In other mammals including humans, rest is fundamental for brain and cellular function (Tartar et al. 2006; Benington & Heller 1995; Inoué et al. 1995), hence decrease in resting may affect the physiology and metabolism of an individual. An example of resting disruption has been reported for Hawaiian spinner dolphins (*Stenella longirostris*), which use in-bay waters with sandy substrates to rest during the day and predominantly travel when outside the bays (Tyne et al. 2015). The presence of snorkelers, scuba divers and kayakers (Danil et al. 2005; Courbis & Timmel 2009) resulted in alteration of the spinner dolphins resting patterns (Courbis & Timmel 2009) which are unlikely to be replaced outside the bays where protection is lacking (Tyne et al. 2015). Common dolphins in the Azores have been observed resting and engaging in less energetic activities around midday (Cecchetti 2017). This information would be useful to address in management decisions, for example, regulating the timing of tours either avoiding this time range or delaying the tours.

The *J-approach* generated the greatest percentage of avoidance reactions and the lowest proportion of approaches from dolphins. Other studies have reported similar results for bottlenose, common and Hector's dolphins (Scarpaci et al. 2003; Martinez et al. 2011; Filby et al. 2014). In the Azores, this was the approach technique most frequently used by tour operators. This may reflect the fact that the legislation does not specify how the operators should approach the dolphin group. However, guidelines from other regions are more specific. For example, in New Zealand and Australia, a *parallel* approach is mandatory because it was reported to cause less disturbance (Martinez et al. 2011; Filby et al. 2014). In our study, dolphins were less disturbed by the *centred* approach, possibly because it was used more often when groups were larger and when dolphins are feeding close to the surface or socialising. One of the functions of large groups is to increase predator protection (Inman & Krebs 1987). Since responses to human disturbance have been compared to anti-predator behaviour (Frid & Dill 2002), individuals in large dolphin groups would likely react less strongly to the potential threat. Larger dolphin groups have in fact been reported to approach swimmers and boats more frequently (Neumann & Orams 2006; Peters et al. 2013). Groups of spinner dolphins smaller than 25 individuals were observed avoiding entering Maku'a Beach, Hawaii, if the number of swimmers was high (Danil et al. 2005), and swimmers in Mercury Bay, New Zealand, had a higher chance of longer interactions with common dolphins when groups were larger than 50 individuals (Neumann & Orams 2006). However, this does not necessarily mean that the *centred* approach is *per se* the least disturbing, as greater number of animals are involved although to a lesser extent, so further studies are needed to explore this more in detail. In the present study, large group size was also related to increased duration of swim episodes, which is in line with the suggestion of lower perceived risk for dolphins when gathered in larger numbers.

Compliance with regulations

Operators never exceeded the 15 minutes maximum duration of each swim episode specified in the regulations. In fact, the mean duration of swim episodes was only 2 minutes for all species. However, this result appears to be determined by the avoidance response of dolphins rather than the choice of the operators. A short interaction time is usual for common dolphins, which have shown to be one of the least receptive species for swim-with tourism (Neumann & Orams 2006) when compared to dusky (8-9 minutes, Markowitz et al. 2009) and Hector's dolphins (25 minutes, Martinez et al. 2011). In the Azores bottlenose and spotted dolphins exhibited similar levels of receptivity to common dolphins. It is noteworthy however, that bottlenose dolphins were the ones more often approached with the most disturbing strategy (*J-approach*), compared to the other two species. Habituation and sensitisation due to cumulative experience of anthropogenic activity has been reported for some dolphin populations (e.g. Markowitz et al. 2009), though whether the bottlenose dolphins occurring out of Ponta Delgada harbour have developed some degree of

tolerance is hard to determine at this stage, thus further investigation is warranted.

Most of the operators followed the legislation for the number of swimmers simultaneously in the water, but not for the number of attempts per group. Regulations state that swimmers can be released into the water no more than three times per group of dolphins. Operators may increase the number of simultaneous swimmers or the number of swimmer releases, when they find a more receptive dolphin group. Neumann & Orams (2006) reported common dolphin encounters in Mercury Bay were longer if the number of swimmers did not exceed five. Hector's dolphins in Porpoise Bay did not show any avoidance reaction towards swimmers, whereas boats led to initial attraction followed by neutral and eventually avoidance behaviours (Bejder et al. 1999). In the Azores, operators usually made a large number of swim attempts, with little account being taken of the reaction of the dolphins, and often non-compliance with existing and proposed regulations. This likely reflects the low success of interactions, and is a way to counteract the short time dolphins stay in the presence of swimmers. Clearly, regulation in this area is premature without a reference to current practices and, ideally, to data on the impact of the different alternatives. It would be useful to investigate the impact of the number of swimmers *versus* the impact of the number of attempts performed to approach a group. This would help identify the least disturbing method, and potentially contribute to more effective regulations that are easier to interpret and that would result in higher compliance.

In order to increase the probability of compliance, especially those regarding the number of boats interacting with each group at any moment, and the type of activity they are engaged in, a clear definition of *group* must be specified. For instance, a group which is dispersed and includes many subgroups could be perceived as many different groups. Within the peer reviewed dolphin literature, group definitions are typically based on distance between individuals (e.g. 100m rule, Irvine 1981; 5 body-length, Smolker et al. 1992; 10-m rule, Acevedo-Gutiérrez & Stienessen 2004), on activity state and on direction of movement (Shane 1990). Standardization of a group definition would further aid enforcement as well as compliance matters.

CONCLUDING REMARKS

Currently, there are no Azorean guidelines advising on the best manner to approach dolphin groups. If a given type of approach is considered disturbing when observing dolphins, it would seem rational to assume it is also disruptive during swimming interactions. In light of the current results, it is clear that the *J-approach*, which is used with most frequency in the Azores, is a poor option. A *parallel* approach, is preferred while central placement should be reserved for large (at least >50 individuals) and dispersed groups. Resting groups of dolphins should be avoided. Further investigation on the effects of presence and number of calves should further be undertaken, and it would be advisable to apply a precautionary approach and, following the example of international regulation, avoid swimming with newborns.

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