MASTERARBEIT

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Behavioral response of bottlenose dolphins (*Tursiops truncatus*) and short-finned pilot whales (*Globicephala macrorhynchus*) to whale watching boats off La Gomera, (Canary Islands)

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In collaboration with:

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Abstract

Whales and dolphins today are subject to increased vessel presence. The growing whale watching tourism has raised concern about the potential impacts on cetacean populations. Whale watching boats alter the behavior of cetaceans in many ways. Inter-species variation in behavioral response to boat presence has been documented, and vessel characteristics and boat-conduct were also found to have an influence. Off the coast of La Gomera (Canary Islands), bottlenose dolphins (*Tursiops truncatus*) and short-finned pilot whales (*Globicephala macrorhynchus*) are two frequently encountered species throughout the year. A whale watching boat platform was used to observe the behavior of these two species from October through December 2014. Interspecific variance in the type of reaction to whale watching boats was investigated, with a focus on pre-defined boat-related behaviors. The results showed that both species altered their behavior in different ways in the presence of the boat, whereby boat type played a role. Additionally, the manner of boat conduct and vessel speed apparently had an impact on the animal’s behavior and responsiveness varied among behavioral states.

1. Introduction

The propensity of wild delphinid species to interact with boats is widely known and forms a basis for the worldwide growing whale watching tourism. Small cetaceans react to boat presence by performing a variety of changes in behavior (Ritter, 2003; Constantine *et al.*, 2004; Nowacek *et al.*, 2001; Lusseau, 2003a, 2003b, 2005, 2006; Williams *et al.*, 2002, 2006; Mattson *et al.*, 2005; Feingold & Evans, 2014; Stockin et al., 2008). Such encounters have become a concern, and the short-term as well as long-term impacts of whale watching vessels have become a new field of research (Symons et al., 2014; Pirotta et al., 2014; 2015; Dans et al., 2008; Meissner et al., 2015; Visser et al., 2011; Constantine, 2004; Baş Akkaya, 2014). Interactions with boats can be defined as positive, indifferent or negative (David, 2002). Positive interactions include playful behaviors. Missing responses to boat presence can be a result of habituation and thus long-term consequences, with unknown biological effects also on a population level (Ritter, 2003). Negative interactions may be short-term avoidance behaviors such as swimming away from the boat or dissappearing by diving (Ritter, 2003; Papale et al., 2012; Nowacek et al., 2001; Lusseau, 2003a; Constantine et al., 2004; Williams et al., 2006; Dans et al., 2012; Christiansen et al., 2013). Killer whales (*Orcinus orca*) in the Johnston Strait, in Canada, increase their swimming speed and swim in a more direct line when boat number around them increases (Williams et al., 2002). Beluga whales (*Delphinapterus leucas*) in the St. Lawrence River, Canada, form tighter groups and change their vocal calls when encountered by vessels (Lesage et al., 1999). Such interference with the animals‘ communication system has also been described in other species (Jensen et al., 2009; Buckstaff, 2004; Nowacek et al., 2007; Erbe, 2002; Scheer & Ritter, 2013). Other short-term impacts are changes in the surfacing (i.e. breathing) pattern, i.e. witnessed in bottlenose dolphins (*Trusiops truncatus*) (Hastie et al., 2003) or collisions with the vessel (Van Waerebeek et al., 2009; Carrillo & Ritter, 2008). Long-term effects can result in decreasing food intake (Dans et al., 2008; Pirotta et al., 2015; Meissner et al., 2015; Symons et al., 2014; Lusseau et al., 2009) and hence decreasing fitness, potentially causing a decline in population size or migration to other habitats (Lussaeu, 2005; Allen & Reed, 2000; Bas Akkaya, 2014). How the animals react depends on various factors such as their current behavior, sex, age, learning as well as an individual’s experience (David, 2002; Lusseau, 2003a). It also depends on the type of boat and its characteristics (Baş Akkaya, 2014; Lusseau, 2003b; 2006; Nowacek *et al.*, 2001; Williams *et al.*, 2002*;* Mattson *et al.*, 2005). Delphinid species, for example, react differently towards different boat type, speed and conduct (Bas Akkaya, 2014; Lusseau, 2003b; Nowacek *et al.*, 2001; Williams *et al.*, 2002; Mattson *et al.*, 2005; Gregory & Rowden, 2001).

Off La Gomera, four to five boats set out to sea on a daily basis throughout the year, operated by four companies. Twenty-three cetacean species have been sighted in this area and have become an important tourist attraction (Ritter, 2003; 2007; Ritter et al., 2011), with the bottlenose dolphin (*Tursiops truncatus*), the short-finned pilot whale (*Globicephala macrorhynchus*) and the Atlantic spotted dolphin (*Stenella frontalis*) being the species most often encountered. Ritter (2003) observed the behavioural responses of the species towards the whale watching boats and witnessed unexpected low reaction in bottlenose dolphins, linking it to a possible habituation process.

Offshore populations of bottlenose dolphins are known to migrate over wide areas, whereas inshore populations often are residents (Wells & Scott, 1999). Their occurrence in coastal waters hence coincides with the prevalence of anthropogenic impacts and disturbances (Bas Akkaya, 2014; Nowacek *et al.*, 2001; Hastie *et al.*, 2003; Mattson *et al.*, 2005; Feingold & Evans, 2014). Bottlenose dolphins predominantly feed on small fish.

The short-finned pilot whales off La Gomera were also witnessed to show low response towards whale watching vessles (Ritter, 2003). However, in the population off Tenerife changes in behavioural states during boat encounters were documented by Scheer (1998), highlighting potential short-term effects. The short-finned pilot whale has a larger body size and is often sighted in association with bottlenose dolphins (Ritter, 2003). They have a complex social structure (Heimlich-Boran, 1993; Shane, 1995; Olsen, 2002). Family groups of mixed age from 15 to 50 individuals stay together for their whole life and rely on vocal communication to stay in contact over wide areas (Scheer, 2013; Hastie, 2013; Jirihai & Jarrett, 2006; Olsen, 2002). Their major feeding technique is deep dives of up to 27 minutes, when they predominantly feed on cephalopods (Olsen, 2002).

This study uses behavioral observations of bottlenose dolphins and pilot whales to determine the spectrum of responsive behaviors towards a whale watching boat.

2. Material and Methods

2.1 Study Area

La Gomera is part of the Western Canary Islands in the Atlantic Ocean, one of the major volcanic island chains in the world’s oceans (Schmincke, 1976). It lies 400 km from the north-west coast of the African continent (Morocco). The Canary Islands are steep volcanoes surrounded by near-shore deep water, lacking a shelf (Martin et al., 1992). The Canary current forms the eastern part of the Gulf Stream flowing along the African coast from north to south. The archipelago, in water depths down to 3000 m, forms a barrier to the current and forces it to slow down and form eddies on the leeward sides of the islands. As the Gulf Stream descends down the coast of Portugal and Africa it creates upwelling of cold nutrient-rich deep water. As the current reaches the Canary Islands it still is relatively cold, containing some of these nutrients. This explains the high productivity in this region. The Azores anticyclone, however, which drives the trade winds, influences the richness of the water when slowing down and letting the warm, nutrient-poor water from the central Atlantic enter the Canary Archipelago. La Gomera, lying on the western edge of the archipelago, is directly confronted with this nutrient exchange and forms large eddies off the southern coast as blocking the northern current. These eddies trap plankton and force nutrients upwelling. Large predators such as cetaceans are attracted to the nutrient pool and can therefore be seen off the coast of La Gomera in high variety throughout the year (Ritter, 2004).

The steep drop of the sea-bottom south of La Gomera reaches a depth of 2000m a mere 4-5 miles off the coast. The coastal structure itself is rocky and has steep cliffs with few sandy beaches and small bays, making colonization or usage of the coast by humans difficult. Nevertheless, there are two inhabited areas along the southern coast of La Gomera connected to the sea: Playa Santiago (28.01.65 N, 17.11.50 W), a small-town with about one thousand inhabitants and a port including a dockyard; Valle Gran Rey with several small villages spread along a 3-km-long coastline as well as into a 2-km-long valley inland and a harbour in Vueltas, inhabited by about 4000 people in total (Instituto National de Estadística). In between these two sites only a few other small settlements are located close to the coast: the Cantera Bay and La Rajita, which both are former fish canning factories, deserted since several decades. The settlement La Dama lies on top of the cliffs next to La Rajita, holding one of the biggest banana plantations bordering the sea. The EU Habitat Directive nominated the area south to the island as a Special Area of Conservation (SAC) in January 2002. This was declared to better protect the near-shore abundant bottlenose dolphin populations and loggerhead sea turtles (EU, 2002).

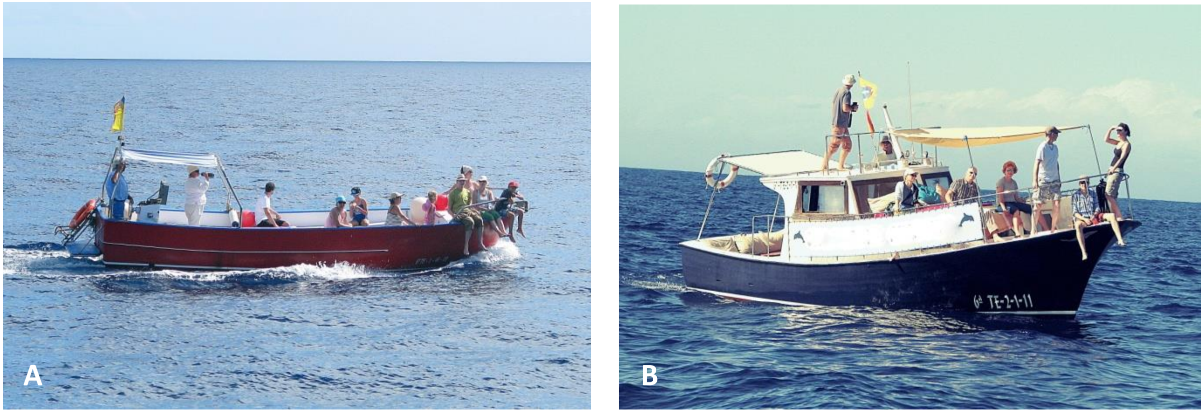
The climate of La Gomera is under oceanic influence and dominated by the north-eastern trade winds. The cold water upwelling off the African coast and the cold Canary current lead to water temperatures from 18° to 19°C in spring and 22 to 23°C in late summer to autumn. The year-round air temperture is about 20° to 22°C. This is somewhat colder than in other subtropical regions (Fernandopullé, 1976). In winter the cyclonic Atlantic weather system creates unstable conditions including rain and storms all over the archipelago. 80% of the rainfalls occur between October and March (Ritter, 2003). The steady trade winds from the north and the rocky orography of the island create a lee side off the south-western coast of the islands. This wind-poor region enables whale watching trips in calm waters (Beaufort 0-3) and attracts cetacean species such as pilot whales, which rest on the water surface for long time-periods (Heimlich-Boran, 1993). In winter, when storms coming from the west hit the island, whale watching trips can become impossible to conduct. The wind speed does not commonly relate to the swell. This can lead to high (2-3 m) waves in low wind speed conditions (Beaufort 0-1) or no swell at all during stormy weather. The Beaufort off La Gomera usually does not exceed 2 or 3, although sea breezes rising from differential heating of land and sea masses frequently occur (Fernandopullé, 1976). Other distinct weather conditions in the Canaries are the so-called *Kalima* or *Scirocco* winds coming from the African inland. These hot, dusty winds from the Sahara relate to southerly and easterly winds and create poor visibility (Fernandopullé, 1976), hindering whale watching trips for a period of days.

2.2 Whale Watching Trips- Data collection

The data were collected from several different whale watching boat platforms. The harbour of Valle Gran Rey, situated in the south-west of the island, is the stationary point for four licensed whale watching companies which operate whale watching trips year-round, mainly for visitors. Two of the companies run with two different vessels, whereby one of these companies provides tours with both at the same time.

2.2.1. Vessels

In this study, four different boats were used as observation platforms. Vessels of the small boat-type included a former 8.50 m long Canarian fishing boat (Picture 1A) and a 10m long downeast cruiser (Picture 1B) boat licensed for 5 to 12 passengers depending on boat size. One was equipped with a Deutz 113hp in-board diesel engine and the other with a Volvo Penta 190hp diesel engine.



Picture 1(A, B): Whale watching boat platforms of small boat type (A, B).

The larger vessel type was a 23.65 m long motor yacht (Picture 2). It was equipped with a Volvo MD 100A diesel engine (145hp) and licensed for up to 60 passengers.

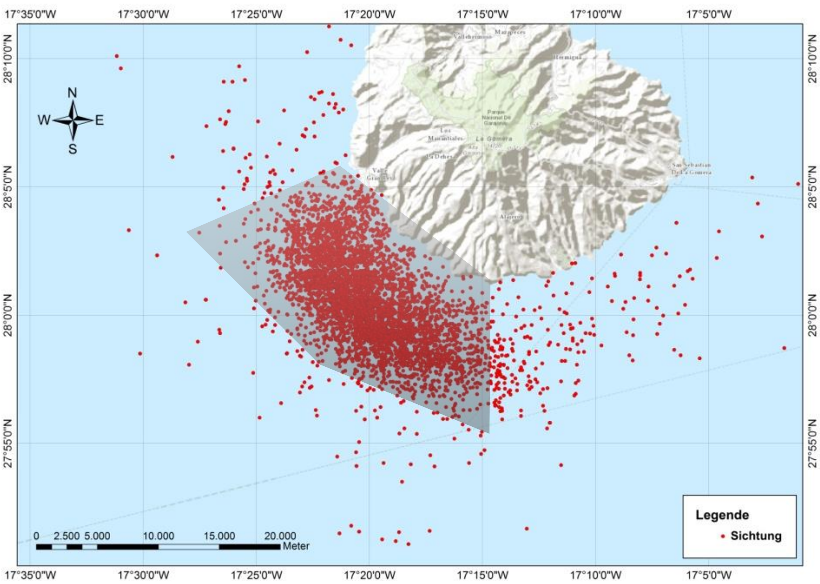
Picture 2: Whale watching boat platform of large boat type.

2.2.2. Tours

All whale watching trips were offered on a daily bases with each company operating six days a week. The trips typically took place once or twice a day starting at 9.00 or 10.00 am and between 14.00 and 16.00 pm. Additional tours in the early morning were partially offered on visitors‘ demand. The operating hours of the trips shifted depending on seasonally sunlight hours. One whale watching excursion lasted 3-4 h, but sometimes also from 6 up to 8 hours depending on the tour type. During high seasons (including Christmas holidays) the tours can be fully booked and the carrying capacities of the vessels reached.

2.2.3. Cetacean search

The research attendance onboard the operating vessels depended on the carrying capacity of the vessels. The excursions did not follow a specific track but were across the lee-side area of the island where the water was least affected by the wind. This area could extend up to 8nmi (14.8 km) off the coast and about 20nmi (37 km) of shore length from Valle Gran Rey to Playa de Santiago (Picture 3). Boat trip distances to the shore typically measured about 5nmi (9.3 km).



Picture 3: Survey area off the coast of La Gomera, Canary Islands (grey shaded= survey area; red points= cetacean sightings by MEEReV; © F.Ritter)

For the search of cetaceans, each boat held 2 to 5 experienced observers to scan the water surface visually. The scan was conducted with the naked eye and binoculars. The presence of cetaceans was indicated when fins, flukes, leaps or splashes appeared as well as flocks of seabirds close to the water surface (known to form interspecific feeding aggregations with dolphins). Boat navigators informed each other through VHF radios about cetacean sightings. The approach to the cetaceans was conducted according to local Whale Watching Regulations (Gobierno de Canarias, 1995; 2000; Carson et al., 2001).

2.2.4. Sighting effort

For this research project a total of 55 whale watching trips were conducted. This involved an average of about 245 survey hours with a total sighting duration 36 h 17 min. The average duration of one trip was 4.5 h (minimum 3 h; maximum 8 h). During October, 10 whale watching trips were conducted with a sighting duration of 6 h 45 min. Another 40 watching trips were conducted in the following months, with a sighting duration of 15 h 20 min in November and 14 h 12 min in December. Five trips (10.9%) resulted in no sighting, leading to 89% successful trips in the overall time period.

The above included 25 boat trips with a small vessel and 26 boat trips with a large vessel (see Methods, 2.2.1. Vessels). This led to 15.5 h total sighting duration for small boat-type and almost 19 h sighting duration for the large boat-type. The average sighting duration for the former was 26min (+/-15.3) and for the latter 18min (+/-18.0).

Bottlenose dolphins and pilot whales were sighted throughout the study, with 51 sightings for each species (total n=102). Most sightings were made in good weather conditions at Beaufort 2-3. Only a few trips took place at more challenging Beaufort 3-4 conditions. During the study period, four whale watching companies launched their boats to search for whales, which lead to additional boat presence during 22% of the sightings. 78% of cetacean encounters were conducted with only the operating boat present within a 300 m radius of the focal group

2.3 Behavioral Observations & Sampling

The behavioral observations were conducted from 22 October to 23 December 2014. Protocols were taken as surveys and group-follows (Mann, 1999) and behavioral states of the focal group were collected with a 3-minute scan sampling method (Altmann, 1974). The boat-related behavior was recorded on focal group one-zero sampling basis for every minute (Altmann, 1974; Mann, 1999). Emphasis was given to the boat-related behavior (BRB) together with the vessel action and the spatial relationship between the boat and the animal.

2.3.1. Sampling

Each sampling started when the focal group was closer than 300 m to the boat and ended when the animals were out of sight or left. Distances were measured by eye (previous visual training of distance recognition with fixed objects in the harbour area). The whale watching regulations and the time limits of the provided whale watching excursions limited the attendance of each focal group to about 30 minutes if a cetacean was continuously present. Additional data collection included boat-speed for each 3-minute-scan, the estimated group size, the group composition, the group structure and other boats present within a 300 m range of the cetacean.

2.3.2. Material

Each sighting was categorized in affinity of the animals towards the boat regarding their behavioral response (Ritter, 2003) and was located via GPS coordinates. The sighting categories were based on those described by Würsig et al. (1998). For the record of the behavioral data a digital voice-recorder (Olympus VN-732PC) was used with USB connection to the PC for the immediate transfer of the recorded data after survey. Boat speed and GPS coordinates were collected via nautical instruments.

2.4 Definitions

Group

A group was considered as two or more individuals of the same species located in the same area (see Mann, 2000). As bottlenose dolphins and short-finned pilot whales communicate over ranges of kilometers (Jensen et al., 2009) this area included all individuals of each species visible with the naked eye from the observation platform at any one time. Smaller aggregations of individuals within a group were termed as *subgroups* (see Ritter, 2003).

Group sizes were categorized as small (<10 individuals), medium-sized (10-15) and large groups (>15).

Group composition

The different age classes occurring within a group: *newborns* are very small individuals with often lighter pigmentation shades than other group members, swimming in close association with an adult and possibly with visible fetal folds; *calves* are individuals measuring less than or equals ½ to 2/3 of an adult body length and swimming constantly in association with an adult; *juveniles* are independently swimming individuals of a body size between a calf and an adult; adults are all other individuals appearing in about the maximum body length documented for the species (see Tyack et al., 2012; Shirihai & Jarrett, 2006).

Group structure

The group structure describes the spatial relationship among group members, as a function of the average distance between individuals within a group. There are four categories (after Weaver, 1987): *tight* – mean distance between the animals is one body length or less; *loose* – mean distance between individuals is 2-5 body lengths; *dispersed* – mean distance between individuals is 5 body lengths or more and *widely dispersed* – more than 50m distance between individuals.

Behavioral states	
Behavior	**Definition**
Dive (D)	most or all animals repeatedly leave the surface for longer periods of time (minutes)
Milling (MI)	movement into changing directions within the group
Mixed (MIX)	different behaviors among group members
Socializing (SOC)	Dominated by interactions between animals: high activity, frequent direct physical contact between two or more individuals, chasing, rubbing, copulation, etc.
Travel (TR)	continuous movement into +/- one direction with frequent surfacing
Travel-dive (TR-D)	continuous movement into +/- one direction with frequent diving periods between surfacing-times
Species-specific behavioral states	
Bottlenose dolphin	
Surface-feeding (SU-FE)	high activity, animals chasing prey (e.g. fish), fast and erratic movements, often with (also active) seabirds present
Resting (RE)	slow movement with no constant direction, low activity, animals mostly close to surface
Travel-fast (TR-F)	fast (>5kn) movement into +- one direction with higher surfacing frequency, often appearing with the whole body above the surface when surfacing
Shot-finned pilot whale	
Resting (RE)	slow or no directional movement close to the surface, animals frequently floating on the surface, low activity
Travel-fast (TR-F)	fast movement into one direction with higher surfacing frequency and higher breathing activity

Table 1: Ethogram of behavioral states for bottlenose dolphins (*Tursiops truncatus*) and short-finned pilot whales (*Globicephala macrorhynchus*) (Weaver, 1974; Shane, 1994).

Boat-related behavior	
Behavior	**Definition**
Approach (APP)	Reduction of the distance between animals and boat, the latter maintaining the constant direction or being motionless (animals within 100m from the boat)
Scouting (SCO)	Brief approach toward the boat up to a few meters and then moving away.
Bowriding (BOW)	Swimming close to the bow or in the pressure wave of the boat.
Wake riding (WKR)	Swimming in the wake behind the boat.
Spyhop (SPY)	Lifting the eyes above water while in an upright position.
Orientation towards the boat (ORI)	Animal(s) floating or swimming slowly at the surface turning the head towards the boat.
Accommodation of speed (ACS)	Change of the speed of animal(s) in accordance to changes in boat speed (while animal(s) close to the boat).
Accommodation of direction (ACD)	Change of direction of animals(s) in accordance to changes in boat direction (while animal(s) close to the boat).

Table 2: Boat-related behaviors for bottlenose dolphins (*Tursiops truncatus*) and pilot whales (*Globicephala macrorhynchus*) (see Ritter, 2003).

Boat action & speed

Four categories were established: *speed-up* – the motor is driven to increase the speed of the boat, hence leading to a faster spin of the boat propeller; *deceleration* – the motor is moderated to decrease the speed of the boat, hence leading to a slower spin of the boat propeller; *no change* – the motor is neither driven nor moderated, hence, no change in the speed of the boat and the spin of the boat propeller and *neutral* – the engine is disengaged from the boat propeller. The boat speed was recorded via navigational instruments of the boat's cockpit. *Low speed* included velocity from 1 to 4 knots (~0.5 to 2 m/sec). *High speed* was defined as velocity from 5 to 8 knots (~2.5 to 4 m/sec).

Sighting category

The recorded cetacean behavior from all samples during a sighting was categorized according to its degree of boat-relatedness. After Ritter (2003) and Würsig et al. (1998) categories were defined as: *avoidance, no response, proximity* and *interaction*. Definitions are given in Table 3. These categories derived from consensual ranking of each sighting through

- The occurrence of boat-related behavior frequency
- The average and minimum distance of the group or single individual to the boat (not regarding boat generated change of distance) and
- The duration of the sighting.

Sighting categories	
Category	**Definition**
Avoidance	Movement away from the boat or disappearing by diving.
No Response	No apparent response to the approach by the boat. Animal(s) keep(s) a certain distance without disappearing. Boat-related behaviors rare or missing.
Proximity	Movement of animal(s) towards the boat. Short distances (<10 m) between animals and boat possible. Boat-related behaviors possible, but not frequent.
Interaction	Movement of animal(s) towards the boat occurring frequently. Boat-related behaviors frequent, i.e. during ≥50% of samples.

Table 3: Sighting categories for bottlenose dolphins (*Tursiops truncatus*) and pilot whales (*Globicephala macrorhynchus*) (Ritter, 2003).

2.5 Data analysis

Sighting effort was calculated for the survey hours by multiplying the mean duration of a whale watching trip with the total number of trips conducted. The sighting success was calculated out of the sum of record times for each encounter with pilot whales or bottlenose dolphins. Encounters with other species were excluded from the data set. Successful trips included sightings of bottlenose dolphins or pilot whales in which the encounter within 300m of distance lasted at least 6 minutes. Records outside these criteria were disregarded from the analysis.

2.5.1. Data preparations

Within the period of data collection the independence of observations could only partially be secured as identification of focal groups was given by eyesight. Hence, subsequently sampled groups of one species might belong to the same focal group if identification could not be assured i.e when animals reappeared after a longer time, had migrated under water and split up into subgroups without notice. However, sightings of different locations or time but of the same group within the same survey were put together as one. Each 3-minute sample was analysed for the occurrence of boat-related behavior with associated boat action by a one-zero sampling method (Altmann, 1974). The one-zero sampling for each boat-related behavior was taken for each minute within a sample to analyze repeated events.

2.5.2. Categorizations

For analysis of behavioral reaction towards different boat speeds, three categories of boat speed were formed: *idle* (0kn but engine turned on), *low speed* (1-4kn) and *high speed* (5-8kn). In reference to the whale watching regulations of the Canary Islands distances to the boat were categorized into ≤20m, 20-60m and 60-300m from the boat when analyzing the occurrence of *avoidance* behavior.

2.5.3. Statistical analysis

Due to an inhomogenous distribution of data sets for each species, the analysis of only nominal variables and the existence of zero values (0,2-23,5% in four different variables), non-parametric methods were chosen. For small sample sizes exact tests were used for evaluation. In order to analyze if recorded observations fit an expectation a Chi²-test of goodness-of-fit was conducted (Exact test of goodness-of-fit for small sample sizes; n<20). For comparison of two data sets, sample sizes were evened out to identical sets by choosing random samples by the statistical program (SPSS, Statistical Package for the Social Sciences, IBM software). An analysis of the relationship between the compared data sets was conducted via a Chi^2-test of independence (Fisher's exact test for small sample sizes; $n<20$). Statistical tests and graphics were executed with the SPSS program (SPSS Statistics version 22).

2.5.4. Null-hypotheses

Among others, the Null-hypotheses are:

- There is no difference in boat-related behavior frequency between pilot whales and bottlenose dolphins
- There is no difference in sighting category frequency between pilot whales and bottlenose dolphins
- There is no difference in frequency of different boat-related behaviors towards different boat types
- Each behavioral state elucidates boat-related behavior in equal frequencies
- The boat-related behavior frequency is not affected by a change of boat actions

3. Results

3.1. Behavior

A total of 830 behavioral samples were collected, 310 (37%) from bottlenose dolphins and 520 (63%) from short-finned pilot whales. The occurrence of behavioral states varied significantly among the species (Fisher's exact test, $p<0.01$). In the bottlenose dolphin samples, behavioral states were observed in significantly different frequencies ($X^2(5, n=301)=241.93$, $p<0.01$) (Figure 1). Milling behavior (46%) was recorded most frequently, whereas travelling (16%), surface feeding (9%) or socializing (5%) occurred only a few times. Resting behavior was rarely sighted.

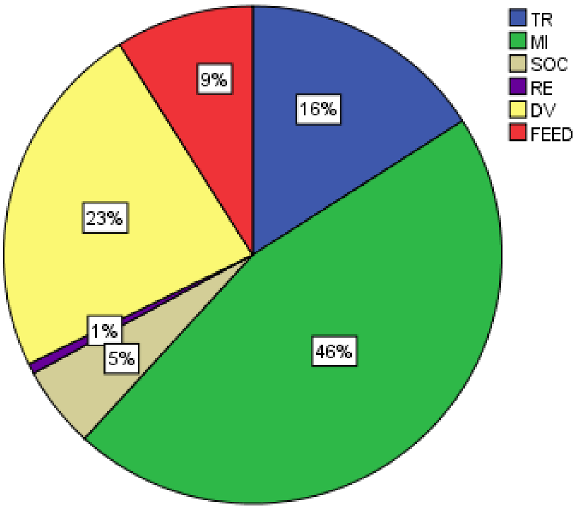


Figure 1: Total occurrence of behavioral states of bottlenose dolphins (*Tursiops truncatus*) from 18 October to 24 December 2014 off La Gomera, Canary Islands (TR= travelling, MI= milling, SOC= socializing, RE= resting, DV= diving, FEED= feeding/surface-feeding).

Pilot whales also showed a significantly different frequency of behavioral states than expected (X^2 (5, N=509)= 230.32, $p<0.01$) (Figure 2).

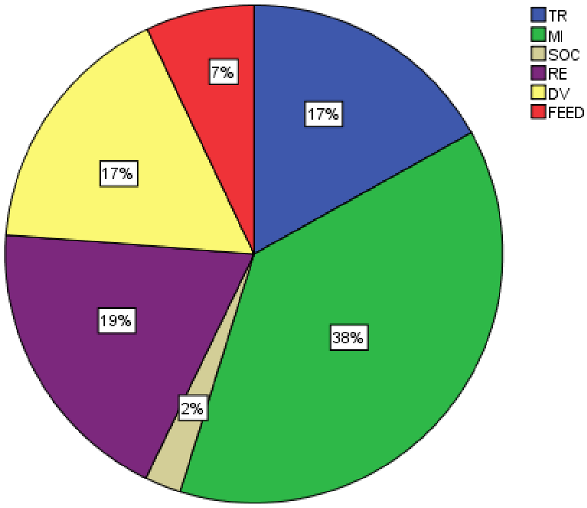


Figure 2: Total behavioral state frequency of short-finned pilot whales (*Globicephala macrorhynchus*) from 18 October to 24 December 2014 off La Gomera (Canary Islands) (TR= travelling, MI= milling, SOC= socializing, RE= resting, DV= diving, FEED= feeding/travel-diving).

During many of sightings, pilot whales were observed travelling (38%). Milling (19%), diving (17%) or resting (17%) behavior were recorded in approximately the same number of samples but less than travelling. Travel diving (7%) and socializing (2%) occurred in less than 10% of the samples. In four encounters the groups were seen travel-diving, with diving durations of up to 12 min.

3.2. Bottlenose dolphin

Group size varied from 1-30 individuals (n=310). Most of the time the bottlenose dolphins (Picture 4) appeared in smaller groups of up to 10 individuals (sightings n=235; 67%). When feeding and diving behavior could be observed, animals frequently stayed close to shore (1-2nmi off the coast). During 57% of encounters the dolphins were very active at the surface, performing tailslops or headslaps and aerial behaviors such as leaps, breaches or synchronized leaps. The dolphins were often seen in mixed groups with other cetacean species such as Atlantic spotted dolphin (n=1), pilot whale (n=12) and twice mixed with both of these species together.

Picture 4: Bottlenose dolphin (*Tursiops truncatus*)
off La Gomera, Canary Islands (December 2014).

3.2.1 Behavioral states with reaction

The bottlenose dolphins showed a significant difference in reactiveness in different behavioral states (Fisher's exact test; $p<0.01$). More frequent reactions to the boat were recorded when the animals were socializing (69% of samples) or milling (67% of samples). A high percentage of samples with responsive behaviors was also recorded when the animals were travelling (60%). Fewer behavioral reactions were observed during feeding (48%) and diving behavior (31%). Due to the rare occurrence of resting behavior (n=2 sightings), no assessment of the reactions was possible. The relative occurrence of reaction within each behavioral state is visualized in Figure 3.

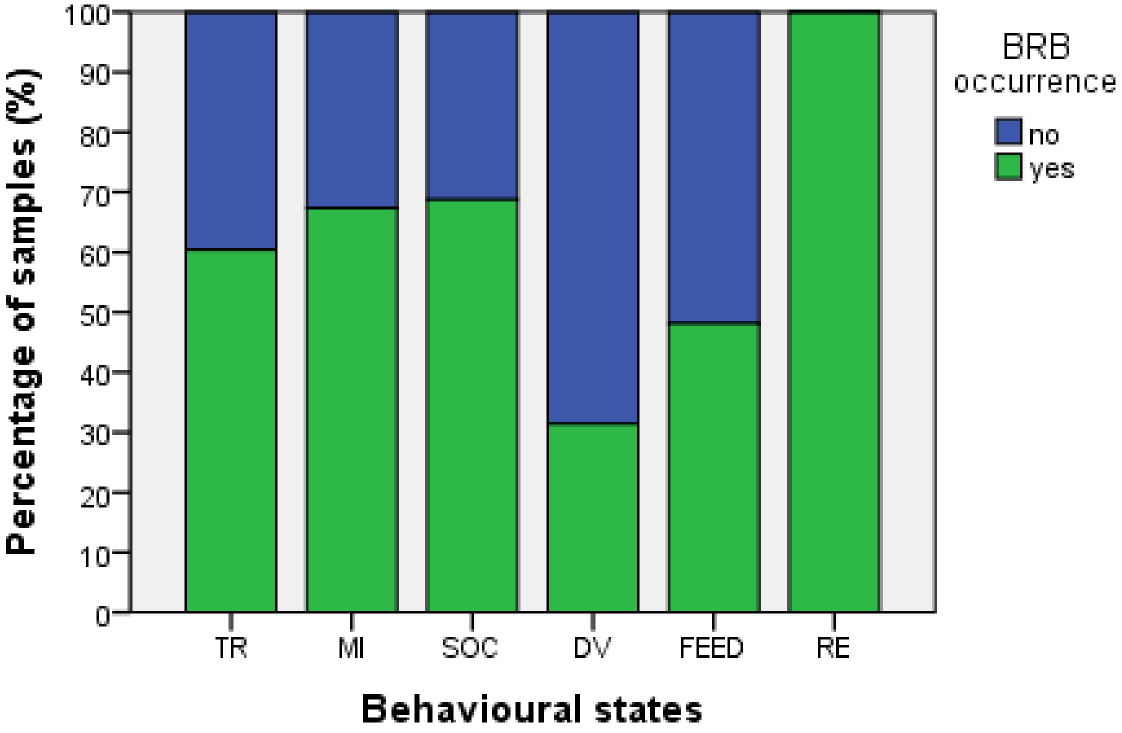


Figure 3: Percentage of samples with/without boat-related behavior (BRB) in bottlenose dolphins (*Tursiops truncatus*) per behavioral state, from 18 October to 24 December 2014 off La Gomera (Canary Islands) (TR=travelling, MI=milling, SOC=socializing, DV=diving, FEED=surface-feeding, RE=resting).

3.2.2 Reaction to the boat

Boat-related behaviors occurred in significantly different proportions ($X^2(5, n=206)=279.,24$, $p<0.01$) (Figure 4). The most frequent reaction was *bowriding* (60%). *Spyhopping* (5%) and *accommodation to speed* (7%) and *direction* (6%) were sighted less. No dolphin was sighted wake-riding during the observation period.

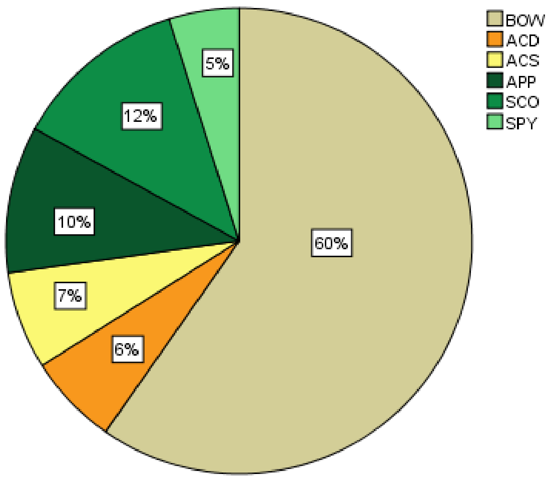


Figure 4: Relative frequency of boat-related behavior of bottlenose dolphins (*Tursiops truncatus*) from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approach; SCO= scouting; BOW= bowriding; SPY= spyhopping; ACS= accommodation to speed; ACD= accommodation to direction).

The proportions of the recorded sighting categories were significantly different ($X^2(3, n=310)=150{,}41$, $p<.01$) (Figure 5). *No reaction* (46% of sightings) and *proximity* (39%) occurred most frequently, whereas *interaction* (8%) and *avoidance* (7%) were less often recorded.

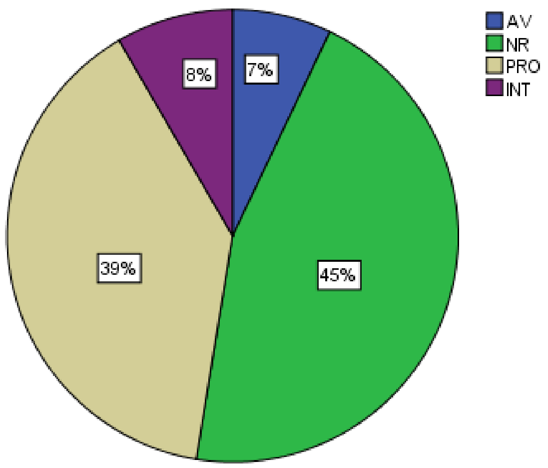


Figure 5: Relative frequency of sighting categories of bottlenose dolphins (*Tursiops truncatus*) from 18 October to 24 December 2014 off La Gomera (Canary Islands) (AV= avoidance; NR= no reaction; PRO= proximity; INT= interaction).

3.2.3. Reaction to different boat types

The affinity towards the whale watching boat differed significantly between the different boat types (Fisher's exact test, $p<.01$) (Figure 6). In large boats, *proximity* (62%; $X^2(1, n=110)=6.145$, $p=0.01$) and *interaction* (78%; $X^2(1, n=23)=7{,}35$; $p<0.01$) as sighting categories occurred significantly more than with small boats. *No reaction* occurred more often towards a small boat (64% no reaction; $X^2(1, n=128)=10.125$, $p<0.01$).

Boat-related behavior frequencies did not differ significantly between boat types (Fisher's exact test, $p=0.11$). Nevertheless, in total they were recorded more frequently with large boats (60% of samples; n=114) than with small boats (40%; n=76).

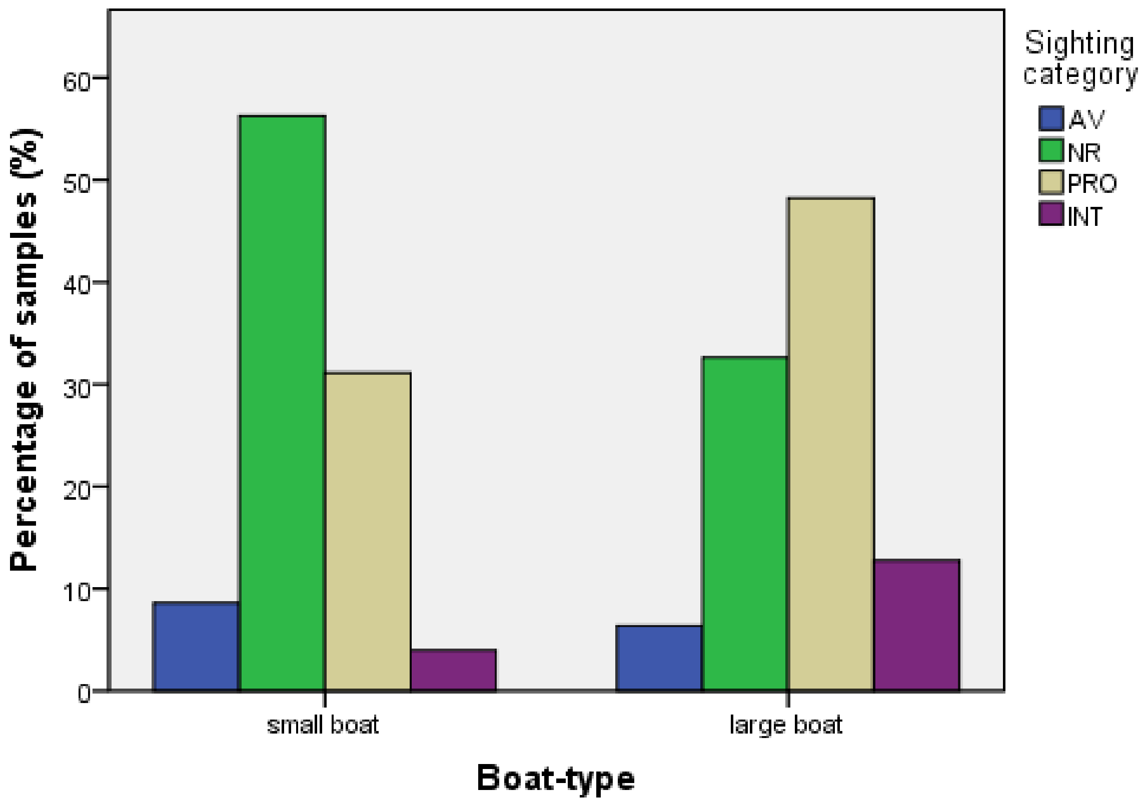


Figure 6: Relative frequencies of sighting categories in bottlenose dolphins (*Tursiops truncatus*) per boat type from 18 October to 24 December 2014 off La Gomera (Canary Islands).

3.2.4. Reaction to different boat actions

Bottlenose dolphins did not show significantly different reactions when the boat changed its velocity (Fisher's exact test, $p=0.25$). The relative proportion of each boat-related behavior that occurred in relation to three different boat actions is illustrated in Figure 7. Eighty % of the recorded *approach* behavior (samples) occurred in *no change* and could not be recorded when the boat decelerated. *Scouting* occurred in 50% (of samples) during deceleration and in 33% when speeding-up. Bowriding was sighted about equally for all three boat actions. *Accommodation to direction* occurred more frequently when the boat speeded-up (67% of samples).

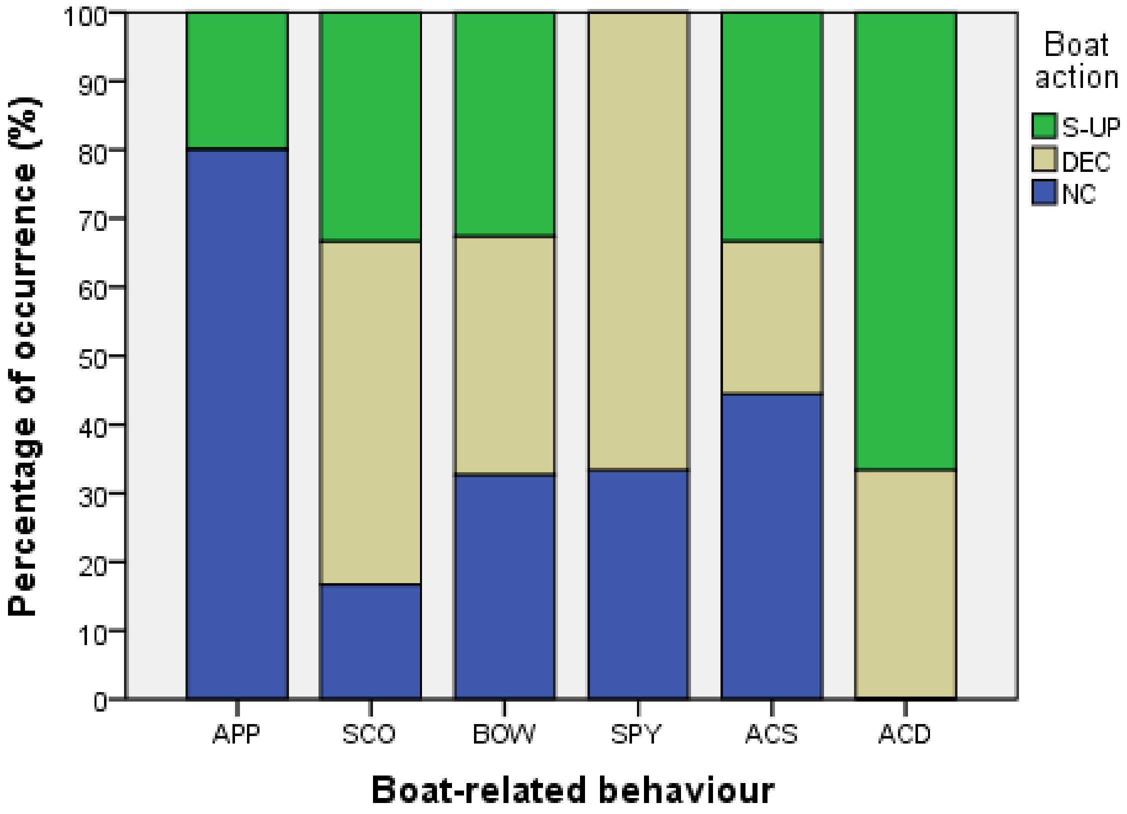


Figure 7: Relative frequency of boat-related behaviors in bottlenose dolphins in relation to different boat actions of from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approach, SCO= scouting, BOW= bowriding, SPY= spyhop, ACS= Accommodation of speed, ACD= Accommodation to direction; S-UP= speeding up, DEC= deceleration, NC= no change).

Reactions were most frequent when the vessel maintained a stable course and speed (72% of samples with reaction). The occurrence of various boat-related behaviors did not change significantly when *speeding up* or *decelerating* (Fisher's exact test, p=0.25). The most dominant reaction of the bottlenose dolphin was *bowriding* (51% of BRB in NC, 65% in DEC, 60% in S-UP). When the engine of the boat(s) was turned off, no visible reaction in the dolphin behavior was recorded.

No significant difference was found in the occurrence of boat-related behavior in relation to different boat speeds (Fisher's exact test; p=0.18). When the boat was *idling* the animals showed *bowriding* behavior more freuquently (55%) as well as with approaching the boat (23%). *Spyhopping* did not occur in *idle* and swimming *speed* or *direction were accommodated* only once. Boat-related behavior occurrence in *idle* is visualized in Figure 8 ($X^2(4, n=47)= 44.8, p<.01$).

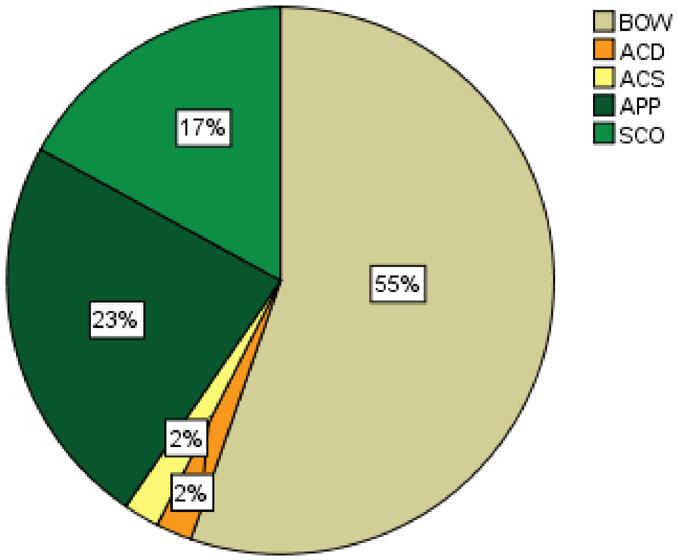


Figure 8: Boat-related behavior frequency of bottlenose dolphins (*Tursiops truncatus*) when the vessel was in *idle*, from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approaching, SCO= scouting, BOW= bowriding, SPY= spyhopping, ACS= Accommodation to speed, ACD= Accommodation to direction).

When the boat was at *low speed* all boat-related behaviors were documented but also with significantly different proportions and predominance in *bowriding* occurrence ($X^2(5, n=89)=165{,}9, p<.01$) (Figure 9). When the boat drove at *high speed* only a few times bottlenose dolphins showed boat-related behavior (18% of samples in high speed n=30) however with no significant different proportions to *low speed* (Fisher's exact test; p=0,18). *Bowriding* (60%; n=18) could be observed most often (Figure 9).

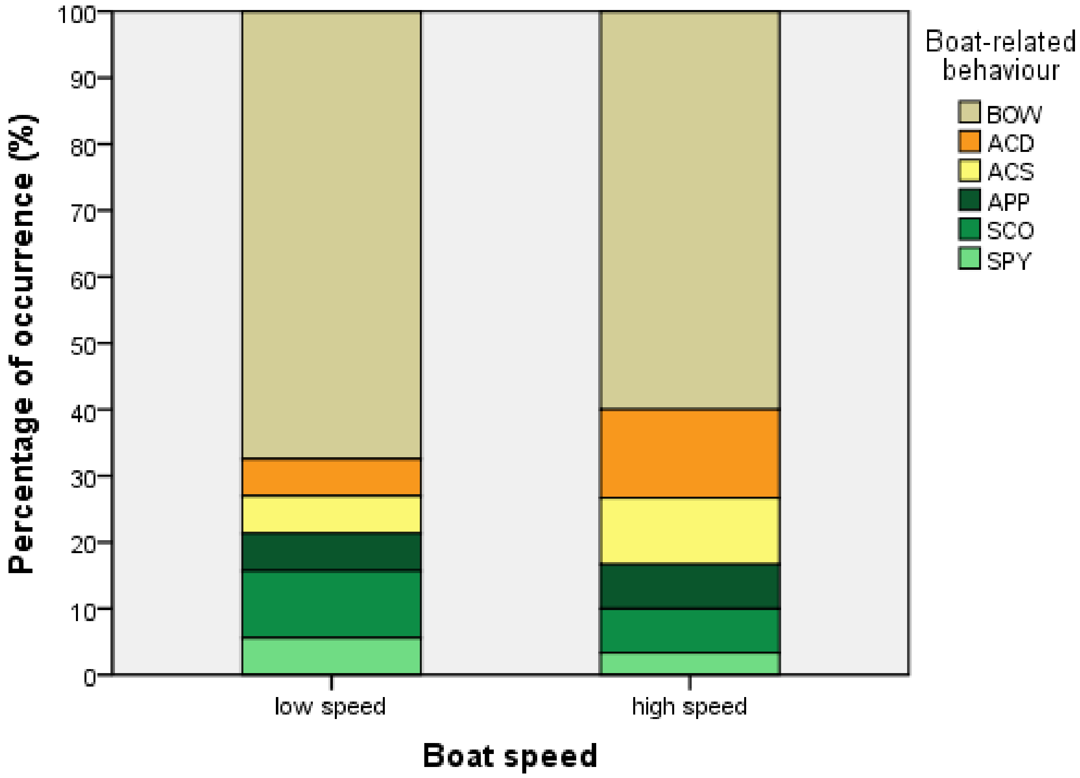


Figure 91: Boat related behavior frequency of bottlenose dolphins (*Tursiops truncatus*) during low boat speed and high speed, from October 18th to December 24th, 2014 off La Gomera (Canary Islands) (APP= approaching, SCO= scouting, BOW= bowriding, SPY= spyhopping, ACS= accommodation to speed, ACD= accommodation to direction).

3.2.5. Avoidance behavior

When the bottlenose dolphins were in *medium-sized* groups, *avoidance* behavior was recorded less (3.0% of total samples n=99) than when they were in *small* (9.1% of total samples n=187) or *large* groups (8.3% of total samples n=24). The boat was avoided more at *high speed* (6.3% of total samples n=32) and less at *low speed* (5.0% of total samples n=121) or *idle* (4.7% of total samples n=85).

Among all observed behavioral states the bottlenose dolphins showed *avoidance* behavior in feeding (3.7% of total samples n=27), travelling (2.1% of total samples n=48) and milling (1.4% of total samples n=138) and most out of diving behavior (24.3% of total n=74). No *avoidance* was observed when socializing or resting. The group composition did not seem to have any effect on *avoidance* behavior.

3.3. Pilot whales

Short-finned pilot whales (Picture 5) were seen most of the time in medium-sized groups from 10 to 15 individuals (46% of samples). Smaller or larger groups were less frequent (27% for each category). During most encounters the animals moved more or less parallel to the shoreline. Most groups were composed of animals of different developmental stages including juveniles (92% of samples), calves (75%) and sometimes newborns (4%).

Picture 5: Short-finned pilot whale (*Globicephala macrorhynchus*) off La Gomera, Canary Islands (December 2014).

3.3.1. Behavioral states with reactions

Pilot whales were in various behavioral states when encountered (see above, 2. Behavior). The tendency to react varied significantly for different behavioral states (Fisher's exact test; $p<0.01$). Most boat-related behaviors were performed when the whales were socializing (67% samples with BRB of total n=12). They also reacted during milling (36% BRB occurrence of total samples n=97), resting (36% of total samples n=85) or travelling (30% of total samples n=193) but less frequently so. The fewest behavioral reactions occurred when the animals were diving (12% of total samples n=86) or travel-diving (28% of total samples n=36). The relative occurrence of reaction within each behavioral state is visualized in Figure 10.

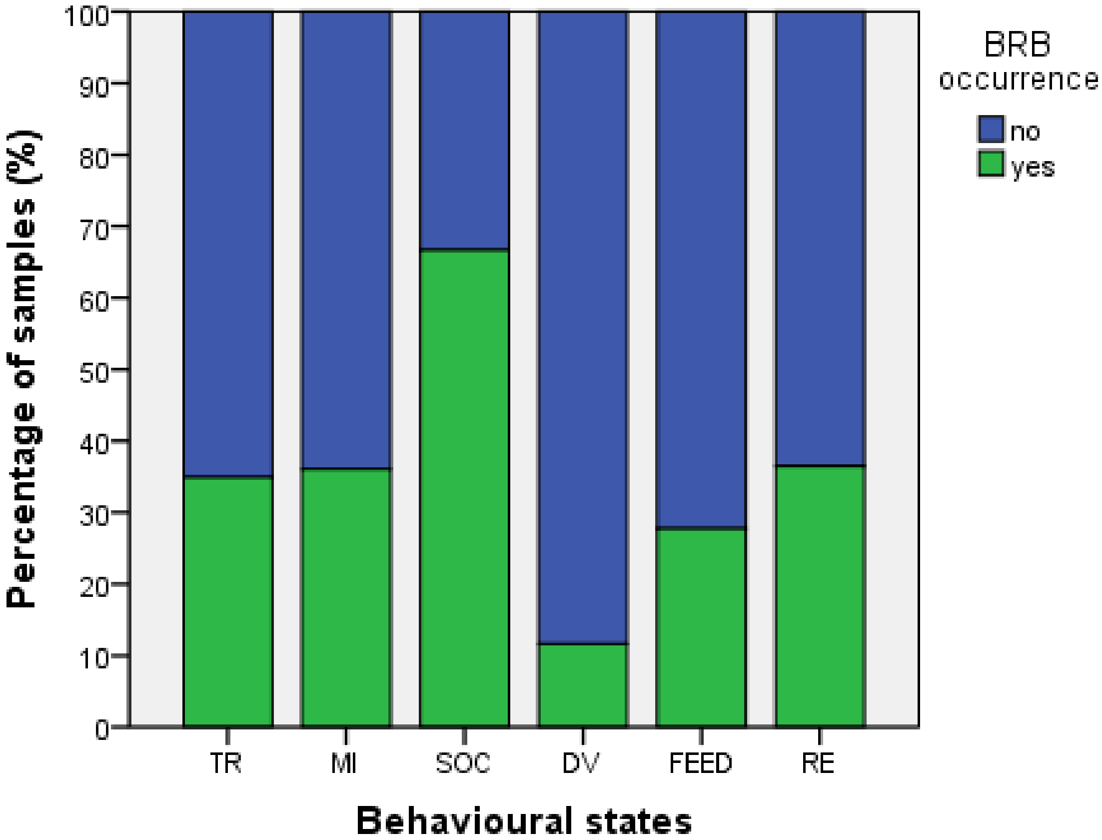


Figure 10: Relative amount of reaction of short-finned pilot whales (*Globicephala macrorhynchus*) within behavioral states from 18 October to 24 December 2014 off La Gomera (Canary Islands) (BRB= boat-related behavior, TR= travelling, MI= milling, SOC= socializing, DV= diving, TR-DV= travel-diving, RE= resting).

3.3.2. Reaction to the boat

An approaching boat caused significantly different frequencies of behavioral reactions ($X^2(5, n=173)=26.94$, $p<0.01$). *Bowriding* (25% of samples), *approaching* (23% of samples) and *spyhopping* (20% of samples) were recorded most often (Figure 11).

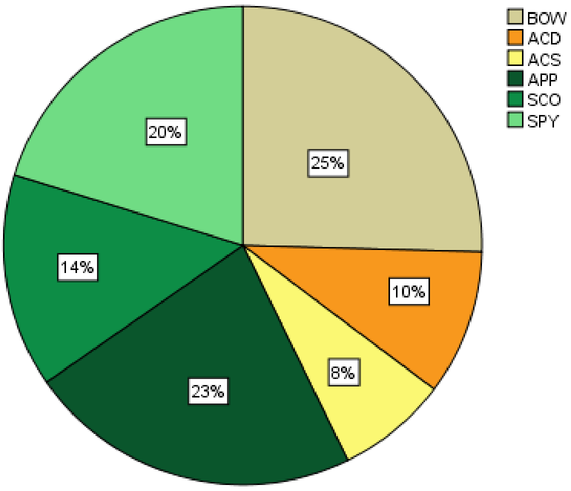


Figure 2: Boat-related behavior frequency of short-finned pilot whales (*Globicephala macrorhynchus*) from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approaching, SCO= scouting, BOW= bowriding, SPY= spyhopping, ACS= accommodation to speed, ACD= accommodation to direction).

In general, the pilot whales were rarely attracted by the boat and in 63% of the times did not change their behavior in reaction to the boat ($X^2(3, N=520)=461.65$, $p<0.01$), i.e. showed *no response* sighting categories. Interaction occurred in only 3% of the time. However, in 25% of all samples the pilot whales stayed near the boat (Figure 12).

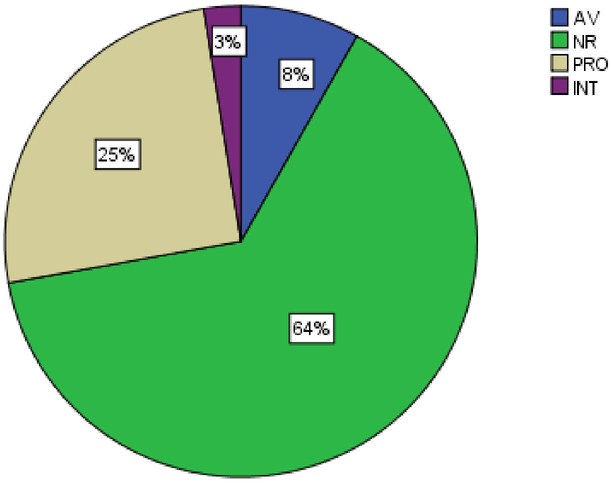


Figure 32: Frequency of sighting categories of short-finned pilot whales (*Globicephala macrorhynchos*) from 18 October to 24 December 2014 off La Gomera (Canary Islands) (AV= avoidance, NR= no reaction, PRO= proximity, INT= interaction).

3.3.3. Reaction to different boat types

When the pilot whales were encountered by a boat they did not show significantly different proportions of boat-related behaviors (Fisher's exakt test, p=0.41) or of sighting categories to the different boat types (Fisher's exact test, p=0.08). However, some difference in *avoidance* behavior was recorded, which occurred more frequently with small boats ($X^2(1; n=35)=4.83$, p=0.03) (Figure 13).

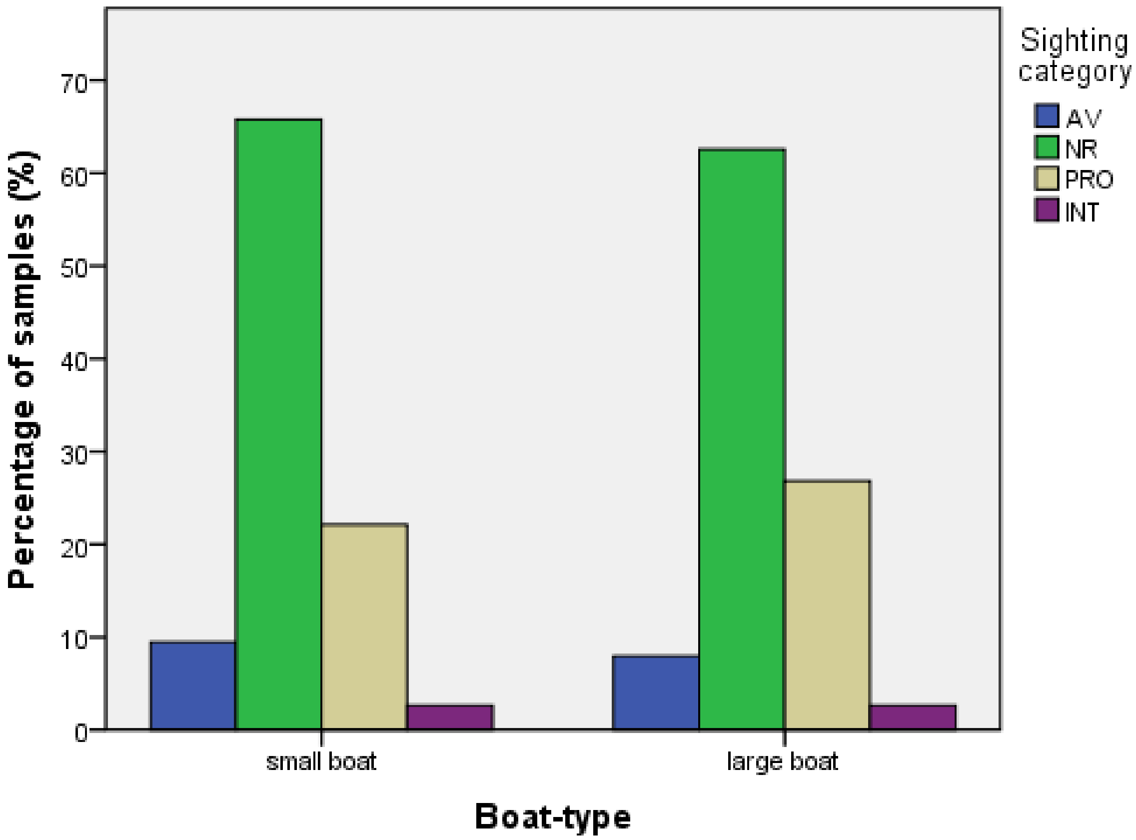


Figure 4: Sighting category frequencies of short-finned pilot whales (*Globicephala macrorhynchus*) per boat type from 18 October to 24 December 2014 off La Gomera (Canary Islands) (AV= avoidance, NR= no reaction, PRO= proximity, INT= interaction).

3.3.4. Reaction to different boat actions

Active changes of the vessel's velocity or direction were conducted only rarely. Hence, in most of the encounters boat-related behavior occurred when the boat did not change its velocity or direction (83% of samples). Boat-related behavior could be observed when the engine of the boat was turned off (11% of samples with reaction in boat actions). The proportions of BRB occurrence in boat action *no change* (NC) and when the engine was turned off (OFF) are visualized in Figure 14.

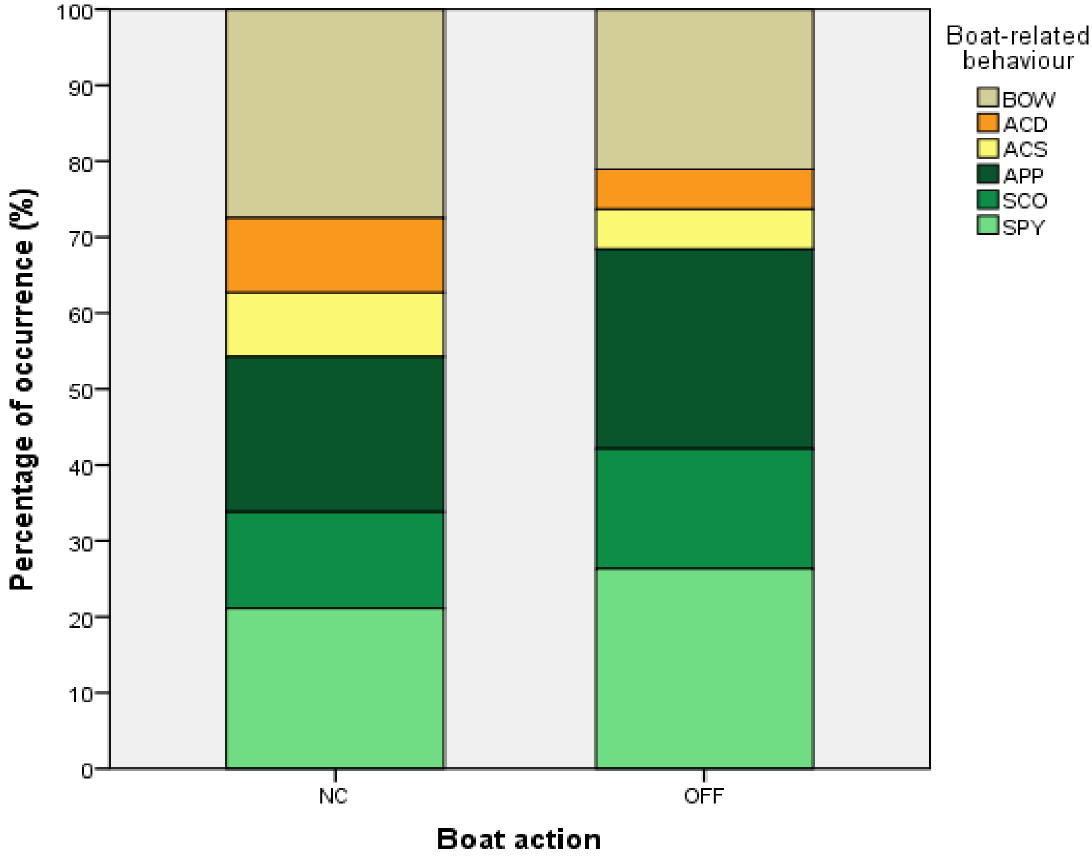


Figure 5: Boat-related behavior frequency of short-finned pilot whales (*Globicephala macrorhynchus*) in *no change* (NC) and *engine off* boat action (OFF), from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approaching, SCO= scouting, BOW= bowriding, SPY= spyhopping, ACS= accommodation to speed, ACD= accommodation to direction).

3 times (3 samples) boat-related behavior was observed when the boat sped up and 6 times (6 samples) when it decelerated.

Boat-related behavior occurred only twice when the vessel changed its direction. No change in behavior was recorded when the engine was turned on again.

Due to the low number of pilot whale observations at high speed a comparison of boat-related behavior frequencies could only be conducted for *idle* and *low speed*.

When the boat was in *idle* the pilot whales showed various reactions in significantly different frequencies ($X^2(5, n=113)=18.2, p<0.01$, see Figure 15). *Approach* (20% of samples), *scouting* (20%), *bowriding* (20%) and *spyhop* (25%) were seen more frequently. At *low* *speed*, these frequencies changed and *bowriding* occurred significantly more often (41% of samples) than any other boat-related behavior ($X^2(4, n=39)=11.4$, $p=0.02$). The animals never *scouted* when the boat was in *low speed*.

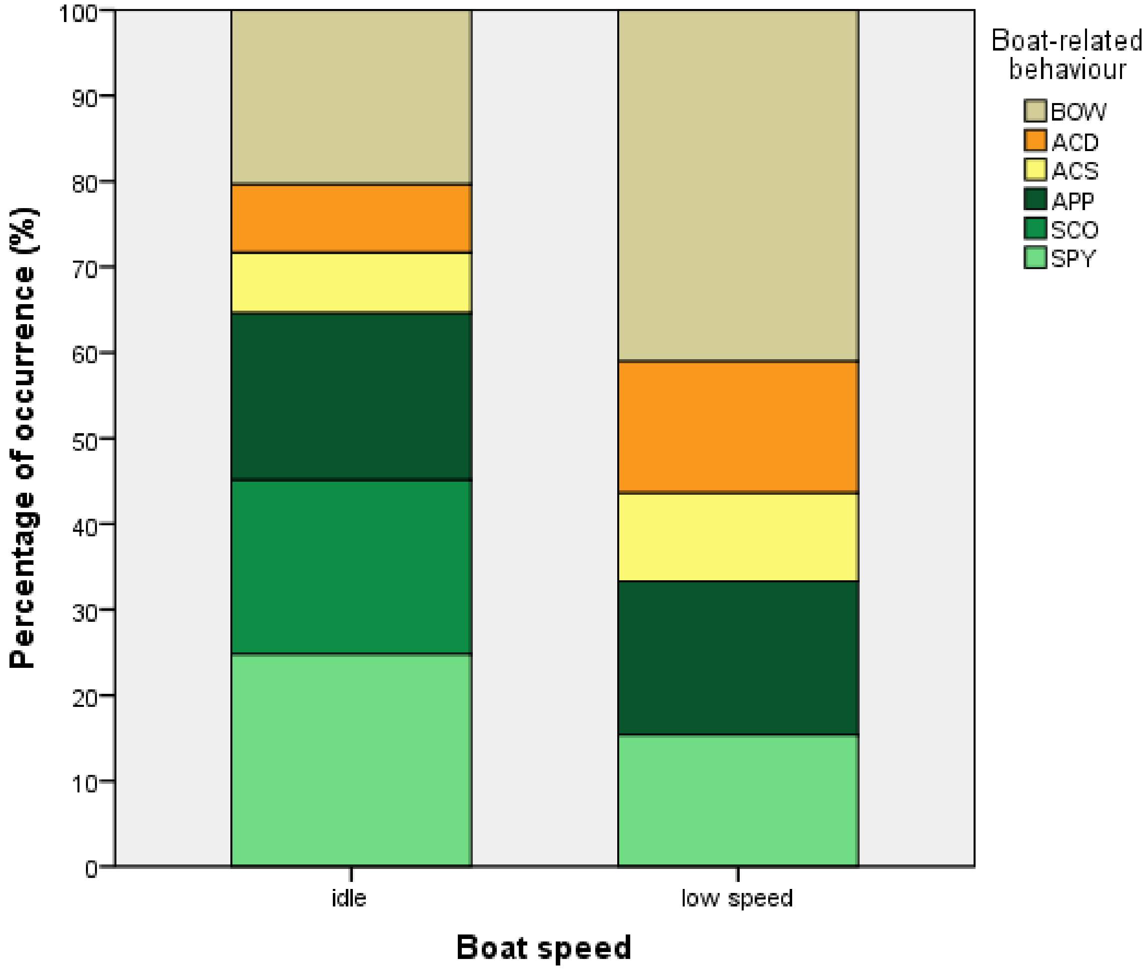


Figure 6: Boat-related behavior frequency of short-finned pilot whales (*Globicephala macrorhynchus*) when boat was in *idle* and *low boat speed*, from 18 October to 24 December 2014 off La Gomera (Canary Islands) (APP= approaching, SCO= scouting, BOW= bowriding, SPY= spyhopping, ACS= accommodation to speed, ACD= accommodation to direction).

3.3.5. Avoidance behavior

Small groups of pilot whales showed *avoidance* behavior more frequently (13% of total samples n=121) than *medium-sized* (8% of total samples n=231) or *large* groups (9% of total samples n=141). Boats were *avoided* more when at *high speed* (11.1% of total samples n=36) than at *low speed*. Among all observed behavioral states, pilot whales *avoidance* behavior (defined as sample cat.) was least sighted during milling (4.2% of total samples n=96) and resting (1.0% of total samples n= 80) (Figure 16).

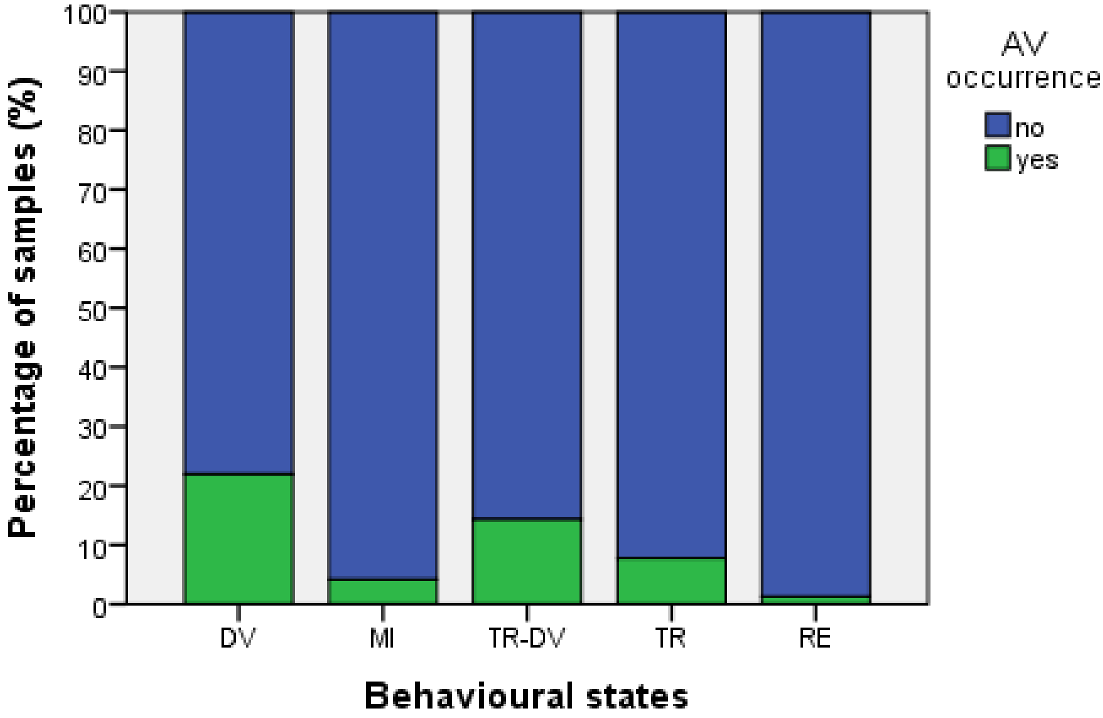


Figure 16: Avoidance behavior occurrence of pilot whales (*Globicephala macrorhynchus*) in different behavioral states from 18 October to 24 December 2014 off La Gomera (Canary Islands) (AV=avoidance, DV=diving, MI=milling, TR-DV= travel-diving, TR=travelling, RE=resting).

Different frequencies of avoidance in relation to group compositions were detected (although sample size varied strongly): when juveniles or calves were present, *avoidance* behavior occurred more frequently (J: 9.8% of total samples n=470; C: 8.3% of total samples n=360) as compared to when only adults were present (3.6% of total samples n=28).

4. Discussion

4.1. Method

Whale watching boats as observation platforms

A variety of cetaceans studies have been conducted from whale watching boats (Meissner, 2015; Senigaglia & Whitehead, 2012; Parsons et al., 2006; Ritter, 1999; 2002; 2003; 2004; 2007; 2011). Behavioral research conducted on-board such vessels holds advantages and disadvantages. The execution of a project is confined to the framework of the whale watching tour, e.g. the scientist cannot determine the route or duration of the survey or decide about the encounter modality. Hence the research question has to be adapted to the context.

Nevertheless, the collaboration of whale watching companies with scientific research projects creates advantages for both sides. A whale watching boat offers scientists a possibility to collect data on a regular basis at low cost (Hoyt, 1994). The presence of passengers and skilled cetacean spotters in the whale watching staff on-board facilitates the search for cetaceans and lowers the chance of missing out sightings. Moreover, a biologist on-board commercial vessel can enhance public awareness and educative aspects. Additionally, using pops (platforms of opportunity) reduces the number of vessels around the animal and therefore potentially decreases the disturbance and pollution impact on the animals (Hoyt, 1994). Studies of behavioral interactions between cetaceans and boats can be effectively carried out due to the proximity to the animals.

The whale watching boat-based method in this study can be seen as successful because it generated significant results, additionally creating a positive effect on public education as well as intensifying the collaboration between scientists and the local whale watching operators. Nonetheless, sufficient data could not be collected for certain aspects such as the investigation on the impact of boat speed and conduct due to the restricted time frame of this study. Hence, longer time periods for future studies in this research field are recommended.

Behavioral states under inspection

Bbehavioral states of cetaceans are difficult to sample in the field (Lusseau, 2003b). The key problem is the visibility of the animal from above the water surface. Clearly, most of the behaviors take place under water, making them inaccessible to observe from a boat or the shore. Nevertheless, the observation of the marine mammal behavioral states from above the surface can provide relevant information. In this study, behavioral states were selected that are frequently observable and applicable to different species and well defined by previous studies (Scheer, 1999; Shane, 1990).

Boat-related behavior as a study focus

"*Any behavior related to the boat is a re-action, as this behavior by definition would not occur if the boat wasn't there*." (Ritter, 2003, p.35). This type of reaction, a change in the natural behavior, can illustrate multiple motives and is an excellent indicator of the physical and sensual impact the boat puts onto the animal. In this study, specific behavioral reactions were chosen as being representative of the grade of alertness towards the boats. The simplest is a "glimpse" at the vessel (*spyhop*), which is generally assumed to represent visual inspection above the water line, especially when performed within 50 m from the boat. A "short investigation" of the object (*scouting*) represents a higher degree of attraction and interactive approach. "True" interaction, however takes place only when the following behaviors are shown: *approach, bowriding, accommodation of speed or direction*. This sequence of behaviors, observable from above the water, no doubt reflects a growing degree of attention by the animal towards the boat, and hence an increasing influence on natural behavior. Importantly however, these boat-related behaviors represent only a small part of all potential interactions because many are expected to occur underwater, out of the observer's sight (Mann, 2000).

In most studies, behavioral changes of cetaceans in reaction to boats are seen as a negative influence that can detrimentally affect outcome for the animals‘ fitness (e.g. Papale et al., 2012; Mattson et al., 2005; Lusseau et al. 2009; Pirotta et al., 2014; 2015; Baş Akkaya, 2014). Although some boat-related behaviors might appear to be positive or even "friendly" they clearly do impact natural behavior (Ritter, 2003) and thus affect energy budget. A constant "use" of a cetacean through boat encounters can lead to a gradual transition of an influence into a disturbance (Bejder et al., 2006; Lusseau, 2004). A disturbed animal will over the long-term gradually try to avoid contact with the interference factor and ultimately may shift its habitat to less disturbed areas (Bejder et al., 2006; Lusseau, 2004). In other circumstances repeated encounters may alter behavior in the sense of habituation or sensitization (Whittaker & Knight, 1998; Bejder et al., 2006; Gregory & Rowden, 2001; Ritter, 2003). Ritter (2003) suspected possible (medium-term) effects such as habituation to whale watching activities in some cetacean species off La Gomera. Also, long-term effects include a decrease of interaction or indifference towards whale watching boats possibly resulting in collisions (Van Waerebeek et al., 2007). Boats colliding with cetaceans are a widely documented problem and highlight the impact of increasing boat traffic (Van Waerebeek et al. 2007; Scheer & Ritter, 2013). Hence, boat-related behaviors as a study focus can yield crucial information on boat impacts on cetaceans.

Sighting categories

The categorization of each sighting for a grade of boat-relatedness of the cetacean's behavior provides information about the encounter type. A slight modification of the method used by Ritter (2003) was used here: each sample was given a category which in sum, combined with the average distance of the animal to the boat and total encounter duration, categorized the sighting. This difference must be considered when comparing the outcome of the two studies.

Comparing two delphinid species

Comparing two delphinid species requires considering a species-specific difference in surface activity. "*The types and intensity of boat-cetacean interactions are a function of the species and the individual, i.e. its size, habitat, gregariousness and its age, experience and activity"(David, 2000).* The pilot whales' movements are less erratic than those of the bottlenose dolphins and they are also more easily detected from a distance due to their larger body size. Surface activity generally is lower and usually of longer duration the latter simplifying the identification of behaviors. Conversely, this may also lead to over-estimation of their occurrence.

4.2. Reactions in relation to different behavioral states

Behavioral states

The observation of frequent travel behavior in both species underlines that the survey area off La Gomera is as a popular feeding and resting ground especially for pilot whales and bottlenose dolphins (Tobeña et al., 2014; Heimlich-Boran, 1993). Travelling behavior occurs when food or conspecifics need to be located, when moving from resting to foraging grounds, when avoiding predation or possibly also to enhance thermoregulation (Shane, 1990; Baş Akkaya, 2014).

The bottlenose dolphins‘ behavior was unpredictable and behavioral states often changed during an encounter. The high preponderance of milling behavior could reflect boat disturbance, a behavioral transition also detected in previous studies (Constantine et al., 2004; Stockin et al., 2008; Lemon et al., 2006; Dans et al., 2008). Bottlenose dolphins in New Zealand as well as Dusky dolphins in Argentina have been observed to alter their behavior, changing from milling to travelling when encountered by boats (Lusseau, 2003b; Dans et al., 2008). This may illustrate the variability of behavioral response between different populations but may also illustrate the influence of habitat structure: A fjord (as in NZ) or a cove (as in AR) may provide less horizontal escape possibilities than in open water, forcing the animals to travel in a certain direction to avoid the disturbing factor (see also Lusseau, 2005). In bays in New Zealand and Australia common dolphins and bottlenose dolphins have been reported to shift behavior to milling after a boat encounter (Lemon et al., 2006; Stockin et al., 2008). Constantine et al. (2004) observed milling as a transition behavior between other behavioral states occurring in boat encounters (see also Lemon et al., 2006). The predominant observation of milling behavior in the bottlenose dolphins off La Gomera may be related to such a transition. It would highlight the intensity of boat impact on natural behavior and the dolphins’ awareness of the boat presence. As this area serves as an important feeding ground for the species, during the day disruption of their behavior may affect feeding efficiency and hence have biological consequences such as reducing fitness. Future research on boat-related behavioral transitions should apply Markov-chain models, for example (see Lusseau, 2003b). Regarding the high amount of diving in relation to other behaviors one interpretation is that the dolphins showed vertical avoidance strategies (Ritter, 2003; Frid & Dill, 2002). The high amount of travelling observed in this study may be related to locating prey and hence with foraging function (Degrati et al., 2008), illustrating the importance of the area as a feeding ground.

No strong prevalence of specific behavioral states was observed for the pilot whales. Nonetheless, travelling behavior occurred most frequently, supporting the findings of other studies (e.g. Shane, 1995, Baird, et al. 2002). As the major feeding activities of pilot whales apparently occur during night-time (Mate, 1989; Baird, et al. 2002), the overall less active behavior during the day along with the frequent observation of resting and socializing, may reflect that. Nonetheless, a habituation process may also be involved. If travel behavior and widely dispersed group structures are related to feeding activities also in pilot whales (Shane, 1995; Scheer, 1998), then the groups studied here might have been involved in foraging behavior more than expected. This would underline that boat disturbance during the day may also interfere with the pilot whales' feeding sufficiency, which would be a cause for concern. Scheer (1998) investigated changes in behavioral states of short-finned pilot whales off Tenerife when encountering a whale watching vessel. The pilot whales increased travelling, diving and socializing behavior as a response. This study was unable to determine whether the travelling and diving behavior here occurred in response to the boat encounter or illustrated transition behaviors, such as in bottlenose dolphins. The overall lower reactiveness and stability in behavior observed of pilot whales (see also Ritter, 2003) weakens this hypothesis. Nonetheless, it should be taken into account in future research effort.

Dolphins and whales have to rest to compensate the energy consumed during foraging or migrating. Pilot whales are known for that behavior and are therefore more frequently encountered (Shane, 1995; Heimlich-Boran, 1993; Heide-Jørgensen et al., 2002; Ritter, 2003). This is ascribed to their larger body size and their deep-diving foraging technique. Bottlenose dolphins, however, apparently rest less (Constantine et al., 2004; Lusseau, 2003b; Ingram & Rogan, 2002). Some of the studies highlight the strong currents and the frequent disturbance by boats as plausible causes (Ingram & Rogan, 2002; Papale et al., 2012). A comparable situation was found during this study: the dolphins exhibited almost no resting behavior. This could be an effect of high boat traffic or an increased need to search for prey in these waters. Another possibility is that the animals changed their resting behavior as soon as the boat approached but at a distance undetectable to the observer (Papale et al., 2012). This would nonetheless also indicate the bottlenose dolphin population off La Gomera already suffers more extensively from the impact of boat presence.

Boat-related reactions

Investigating the tendency of reactions towards a boat in relation to certain behavioral states may provide information about the animals‘ sensitivity to vessel impact and the biological significance of potential disturbance. How the animal reacts largely depends on its initial behavioral state (Ritter, 2003). In several studies of bottlenose dolphins, researchers found significantly more frequent interaction with the boat when the animals were milling versus feeding behavior (which included diving behavior in some studies) (Ritter, 2003; Constantine et al., 2004; Papale et al., 2012). The pilot whales, in contrast, as recorded by Ritter (2003), showed no significant difference in reactiveness across different initial behavioral states. The present study yielded similar results for the bottlenose dolphins but somewhat difference results for pilot whales. The latter were most sensitive to the boat’s presence during socializing behavior. Accordingly, socializing individuals within a group that show playfulness and interaction with conspecifics and are not focussed on feeding or travelling may be more curious towards the boat. As in the study of Ritter (2003) pilot whales showed unexpectedly high behavioral sensitivity during resting. This potentially reflects observer bias: encounters with resting pilot whales were longer, providing more time for the animals to react and stay in stable proximity to the boat throughout the encounter. This, in turn, may trigger behavioral reaction more easily.

Regaining energy on the water surface helps the animals avoid stress and maintain overall fitness. This is particularly the case in marine mammals that may suffer from anthropogenic stress factors interfering with feeding sufficiency. Consequently, energy consumption has to be adjusted to the lower intake, reducing overall fitness. A resting marine mammal observed from a vessel should thus warrant special caution and disturbance reduced to a minimum (e.g. Visser et al., 2011; Stockin et al., 2008).

Comparison of species

The two species in this study showed a difference in behavioral state reactiveness (Fisher’s exact test, $p<0.01$). During travel behavior the bottlenose dolphins reacted less than half as often as the pilot whales. Although in this study the travel speed was not a criterion previous studies report that pilot whales travel at an average speed of 3 knots which is slower than the average travel speed of bottlenose dolphins (5kn) (Wells et al.; 2013; Aguilar Soto et al., 2008; Williams et al., 1992). The whale watching boat operator generally prefers slower moving cetaceans because it simplifies navigation and enhances observation quality. This may have influenced the more intense reaction of pilot whales, i.e. creating a bias due to longer lasting encounters. However, pilot whales in the Canary Islands have been previously observed to alter their behavior readily during travelling when encountered by a vessel (Scheer, 1998). A travelling bottlenose dolphin off the coast of La Gomera during the day is most likely migrating between foraging sites or following fish swarms (Tobeña et al., 2014; Reynolds et al., 2000). Hence, encountering travelling bottlenose dolphins might interfere with their foraging activities, decreasing interest in interaction with the boat and disturbing an important behavior.

Boat-related behavior was significantly reduced during diving behavior in both species. In such cases the animals may have directed their attention more on the interaction with conspecifics or on prey under water rather than with the boat. The presence of the vessel during diving behavior as well as travelling behavior may thus pose a greater disturbance to the animals than previously thought. Regarding the full range of behavioral states, the boat's presence may interfere with under water communication and hence pose a major disturbance (e.g. Nowacek et al., 2007; Lesage et al., 1999; Roussel, 2002).

4.3. How did they react?

The impact of a boat encounter on cetacean behavior cannot be determined merely by investigating whether there is a reaction or not. It is also important to record what this behavioral reaction looks like. In several studies on boat-dolphin interactions, researchers focused on the transition of one behavioral state to the other or on the change of behavior intensity as a result of the boat encounter (Lusseau, 2003b; 2004; 2009; Symons et al. 2014; Scheer, 1998; Baş Akkaya et al., 2014; Mattson et al., 2005; Stockin et al., 2008; Lemon et al. 2006; Constantine et al., 2004; Papale et al., 2012; Meissner et al., 2015; Dans et al., 2008). Other studies focused on other aspects of the behavioral reaction such as changes in swim speed or direction, surfacing times or breathing intervals (Nowacek et al., 2001; Hastie et al., 2003; Williams et al., 2002; Bejder et al., 2006). All of these approaches are designed to investigate the possible negative impact of the boat encounter or boat traffic in a conservational aspect e.g. possible long-term effects on dolphin behavior and fitness. Within the present study another focus was placed on specific behavioral reactions that occur in relation to the boat and that are interaction oriented. Some other studies have examined similar behavioral reactions, but most did not use the interaction-oriented research approach (Würsig et al., 1998; Williams et al., 1992).

Delphinids species all live in groups and have developed complex social structures along with highly developed communication systems (e.g. Janik, 2009; Gowans et al., 2007). Different foraging techniques such as the group-orientated hunting in epipelagic zones exhibited by the Delphininae subfamilies compared to the vertically deep-diving hunt strategy reaching into mesopelagic zones exhibited by some of the Globicephalinae subfamilies do not seem to influence the mutual appearance of interaction behavior. Hence, boat-related behavior might rather be correlated to social or playing behavior (Ritter, 2003). The function of a behavioral interaction with the boat for the whale is unclear. One interpretation is that it is simply the outcome of a playful interaction and curiosity towards a foreign object (e.g. Lusseau, 2005; Williams et al., 2002). Boat-related behaviors such as bowriding or wake-riding are related to an energy gain (Alexander, 2004; Williams et al., 1992). The dolphins use the hydrodynamic power when riding the waves created by the larger moving object and thus save energy (Alexander, 2004; Williams et al., 1992). In the present study, however, bowriding was mainly interpreted as a playful interaction (compare Ritter, 2003). Many studies describe a preference of bottlenose dolphins for bow- or wake-riding behavior as a response in boat encounters, resembling the present findings (e.g. Rogan et al., 2000; Constantine et al., 2004; Würsig, 2008; Lemon et al., 2006). This led to rating the bottlenose dolphin as showing strong interest with boat interactions here.

In most studies spyhopping (Picture 6) is interpreted as a visual inspection of the environment above the water surface (Shane, 1990; Pitman & Durban, 2012, also following the definition by Shane, 1990). This behavior may also illustrate the attempt to get visual contact with the people on-board: these species are known for their interest to interact with humans, often in an affiliative way (e.g. Scheer, 2010; Orams, 1997; Reynolds et al., 2000). Another plausible reason for spyhopping next to the boat may be an acoustical attraction to the noise produced by the people and the vessel above the water surface.

Picture 6: A spy-hopping young short-finned pilot whale (*Globicephala macrorhynchus*) off the coast of La Gomera, Canary Islands.

The pilot whales performed this behavior significantly more often than the bottlenose dolphins, but in contrast showed less bowriding. During encounters in which *spyhopping* occurred juveniles and calves accompanied the group and resting behavior was observed frequently in combination. Hence, these conditions may play a role. The present investigation resulted in an overall rating of pilot whales as being inclined to interact with the boat, yet less than bottlenose dolphins. This comparison resembled findings of previous studies (Ritter, 2003; Würsig et al., 1998). Nevertheless, among all boat-related behaviors recorded in this study, *bowriding* was a rather "popular" interaction for pilot whales as well. This was not detected in the long-term study by Ritter (2003). A seasonal variation in the willingness to interact may have caused this difference (Shane, 1995; Heimlich-Boran, 1998).

Regarding the boat-relatedness of the two species‘ behavior a comparable degree of *avoidance* behavior in the boat's presence could be detected. The dolphin encounters, however, more frequently ended up in a *proximity* to or *interaction* with that boat than those with the pilot whales. This may reflect the playful behavior of the dolphins. The high proportion of no reaction in the pilot whale encounters even exceeded the findings of Ritter (2003). He witnessed close proximity and no reaction of the species throughout the survey and described them as a result of a habituation process. As the species is confronted with intense whale watching tourism especially off the coast of Tenerife (Scheer, 1999), he considered the more sensitive contact accomplished with whale watching off La Gomera as a possible reason for the animals‘ acceptance of the vessel. The low reactiveness in this study may illustrate a habituation process in the sense of decreasing curiosity and interest due to frequent excessive boat encounter (Mattson et al. 2005; Constantine et al., 2004; Richter, 2006). Another explanation in the short-term is that, during the observation period the animals were foraging, supported by the fact that the groups mostly were seen *widely dispersed* (Ritter, 2003).

Avoidance

Concern about the anthropogenic impact of whale watching and other boat traffic on coastal habitats is growing (Constantine et al., 2004; Lusseau, 2005; Feingold & Evans, 2014). *Avoidance* behavior often occurred when the animals were feeding or travelling. During these behaviors the animals were focusing more on prey or conspecifics and were presumably more likely to be disturbed by incoming stimuli. Consequently, the least amount of *avoidance* was observed during milling behavior.

Regarding group-sizes and group composition only little difference in *avoidance* behavior was determined. The bottlenose dolphins seemed to be least disturbed when in *medium-sized* groups and pilot whales when in *medium* or *large* groups. This may relate to the group-effect theory which illustrates the benefit for the individual's survival by forming large groups (Mann et al., 2000; Feingold & Evans, 2014). Hence, social groups of delphinids such as bottlenose dolphins or pilot whales may form larger groups when being disturbed by a boat reflecting group protection behavior (Feingold & Evans, 2014; Mann et al., 2000; Rogan et al. 2000). The pilot whales were seen in company of young offspring much more frequently than the bottlenose dolphins (76% of the total encounters) and showed proportionally more *avoidance* to the boat in these cases. Pilot whales are known to build schools of different ages and to cultivate long parental care (Heimlich-Boran, 1994). Although compared with smaller delphinid species, pilot whales would seem to require less protection from predation, individuals with injuries by shark or killer whale teeth have been documented (Heimlich-Boran, 1994; unpublished data by Ritter et al., 2015). The slightly more negative response to the whale watching boat by groups with young individuals may relate to a higher caution regarding the offspring and their protection (Mann et al., 2000).

4.4. Distinction between boat types

There has been a strong debate about whether there is a certain boat feature that initiates reactions in cetaceans (David, 2002; Gregory & Rowden, 2001; Lusseau, 2003b; Baş Akkaya et al., 2014; Feingold & Evans, 2014; Pirotta et al., 2015; Dans et al., 2008; Rogan et al., 2000; Parsons et al., 2006; Mattson et al., 2005; Papale et al., 2012). The visual sense of cetaceans is not outstanding but good compared to other mammals and peculiarly utilized for closer inspections or visual communication with conspecifics (Herman, 1990). Hence, the size of an approaching boat may initially be measured acoustically from a distance based on sound production by the engine and propeller (Buckstaff, 2004; Erbe, 2002). Doubt has been cast that the size and presence of the motor plays a major role as a disturbance factor for cetaceans (David, 2002). Nonetheless, increasing negative reactions of cetaceans towards strong noises and high-volume sounds under water have been recognized (Buckstaff, 2004; Erbe, 2002; McKenna et al., 2012). As described in several studies, the noise production of boats depends on engine and propeller type (Erbe, 2002; McKenna et al., 2012). Larger and out-board engines are louder than smaller and in-board ones (Erbe, 2002; McKenna et al., 2012). Moreover, Erbe (2002) documented that the noise level increased with boat speed.

Bottlenose dolphins, as a very responsive and interactive species, have been speculated to prefer large and avoid smaller vessels (David, 2002; Lusseau, 2003b; Baş Akkaya, 2014). Lusseau (2003a) as well as Gregory and Rowden (2001) detected more negative behavioral response towards kayaks than larger motorized vessels such as whale watching and tour boats. Janik and Thompson (1996) also reported longer dive periods and avoidance behavior towards small boats. In this study, the dolphins off La Gomera came closer to the larger than the smaller whale watching boats. However, observations by Baş Akkaya (2014) showed less reaction by bottlenose dolphins towards smaller vessels such as fishing boats and strong avoidance behavior towards large high-speed ferries. These findings may reflect that speed and noise production are a more crucial disturbance factor than mere boat size. Lusseau (2003b) reported similar observations: bottlenose dolphins showed the same amount of avoidance behavior towards kayaks and large catamarans. He ultimately pinpointed vessel behavior as the likely trigger of the response. In another study, examining the strong negative reaction of dolphins towards jet-skis, the avoidance and high rate of collision with the animals were attributed to the unpredictability of the vessel's movements and its more "silent engine" (Buckstaff, 2004; Evans et al., 1992). Jet-skis were determined to be hardly detectable by the dolphins, again blaming their rather small engines and fast erratic movements (Evans et al., 1992; Buckstaff, 2004). All these findings point to the different behavioral response of bottlenose dolphins towards boat types as involving maneuverability and engine noise. Hence, the lower maneuverability of the larger whale watching boat in the present study, and possibly also its less disturbing sound under water, may have promoted the closer proximity of the dolphins to the larger boat.

Literature on the behavioral reactions of pilot whales to boats is scarce (Scheer, 1998; Ritter, 2003). Ritter (2003) reported a general low reactiveness of groups towards the boat. Studies on killer whales (*Orcinus orca*), another dimorphic odontocete species, reported no difference in response towards different boat sizes (Kruse, 1991). This resembled the indifference in reaction of the short-finned pilot whales towards different boat types in this study, potentially also reflecting a habituation process. However, due to the small sample size of this study, further research is recommended to consolidate these findings. Other factors may also determine reactions to boat types. High frequencies that can be produced by propellers of smaller vessels, for example (Erbe, 2002), may mask the pilot whales‘ vocal communication and be a stronger disturbance than that of the larger vessels (Buckstaff, 2004; Hastie et al., 2003; Jensen et al. 2011; Sayigh et al. 2013; Scheer et al., 2013). Hence, engine noise may also play a role for this species, explaining the higher avoidance behavior towards the small vessel in this study.

4.5. Response to boat actions and different velocity

The change in behavior of cetaceans when being encountered by a boat has raised speculations about the influence of the boat’s maneuverability and changing speed. Fast erratic movements and increasing engine noise are charged as disturbance factors (Nowacek et al., 2001; Janik & Thompson, 1996; Lusseau, 2003b; Lemon et al. 2006; Baş Akkaya, 2014; Papale et al., 2012; Evans et al., 1992; Mattson et al., 2005). The present study attempted to investigate the reaction to different boat actions and different boat speeds that occurred by chance.

Due to the whale watching boat-based method, only three boat actions were efficiently evaluated (*deceleration, no change, speeding-up*). The whale watching boat navigator has the responsibility to both navigate the boat following the whale watching regulations, to ensure the safety onboard and maximum comfort and entertainment for the participants. Considering these responsibilities and the rough weather conditions and swells that occurred throughout this study, the maneuvering the boat according to whale watching regulations was not always possible. This was reflected in changes in vessel direction and speed near animals.

The predictability of vessel movement is important to cetaceans. Cetaceans may sense the boat's behavior based on features resembling those of other large marine animals, but may also use previous experiences with boat encounters. This was suspected for beluga whales (*Delphinapterus leucas*) that fled from fast, erratically moving boats (Blane & Jaakson, 1994). Nowacek et al. (2001) recorded most changes in behavior of bottlenose dolphins when the boat approached the animals in an erratic manner. Janik and Thompson (1996) reported a decrease in surfacing when the whale watching boat followed the groups. Presumably, erratic changes in boat movement could also resemble escape behavior of a conspecific, initiating social species like most delphinids to go on alert. Lemon et al. (2006) recorded a transition of travel behavior to milling behavior when the boat decelerated in an approach, potentially triggering alertness. The bottlenose dolphins in this study were attracted to the boat when it accelerated, resulting in bowriding or accommodating the swimming direction, related to playful behavior.

The influence of different boat speeds on behavior could only partially be investigated in this study due to the whale watching regulations. Nonetheless, the bottlenose dolphin groups, if willing to interact, showed more highly boat-related behavior (*bowriding, accommodation to speed or direction*) with increasing boat speed. The playful behavior including the benefit of travelling fast with low energetic costs may help explain this (Williams, 1992; Alexander, 2004). The pilot whales were attracted to the bow of the boat at low speeds more than in idle. Presumably, the animals, as in other delphinds, may be attracted to a moving boat when in playful mood. Not much is known about the behavioral reaction of pilot whales to different boat speeds. However, the fact that the animals have been observed bowriding (Baird et al., 2002) and riding waves to lower their energetic costs indicates that pilot whales would also show boat-related behavior when in high speed.

Boats are louder under water at high than at low speed (Buckstaff, 2004; Erbe, 2002; McKenna, 2012). Acoustic features of different boat speeds will therefore influence behavioral reactions. As the dolphins did not show any reaction to the boat when the engine was turned off, they are clearly aware of engine sound. Bejder (1999) interpreted the sound of the motor as the attraction factor for the Hector's dolphins (*Cephalorhynchus hectori*) in

Porpoise Bay, New Zealand: they approached the boat from a distance further than the underwater visibility. This could conversely apply to pilot whales: boat-related behavior occurred when the engine was turned off and the animals came close to the vessel and even got in physical contact with it. When the engine was turned back on, however, *no reaction* or *avoidance* behavior were observed. Large mysticetes such as humpback whales (*Megaptera novaeangliae*) responded with vertical or horizontal avoidance behavior when approached by louder vessels (Scheidat, 2004; Au & Green, 2000). Regarding the overall calm, resting and slow-travelling habitus of the pilot whale groups during these encounters, the sound emission of the engine might have been a disturbance factor. When turned off, the boat seemed less disturbing. For further research on pilot whales regarding vessel maneuverability and speed changes during an encounter, using a whale watching boat as the research platform is not recommended. A land-based study or a long-term, boat-based approach would in this case be favourable.

5. Conclusion

This study investigates the interspecific variance of cetacean reactions to an anthropogenic impact – boat encounters – off the coast of La Gomera. It highlights that bottlenose dolphins and short-finned pilot whales alter their natural behavior in different ways when being approached by whale watching boats. Interspecific differences in attentive behavior, attraction to the boat and propensity to interact with boats were documented. The decisive factors causing the observed behavioral responses may be related to specific boat features such as boat type or conduct. The small sample size, however, hampers a definitive conclusion. Significant interspecific variance in the behavioral reactions of the two delphinid species to boat features was found. Further research is necessary to consolidate these findings. Overall, this study illustrates possible concepts for future research on the impact of whale watching boats as a potential disturbance for marine mammals that are being observed on a continuous basis.

Citation

- Aguilar Soto, N., Johnson, M. P., Madsen, P. T., Díaz, F., Domínguez, I., Brito, A., & Tyack, P. (2008). Cheetahs of the deep sea: deep foraging sprints in short-finned pilot whales off Tenerife (Canary Islands). *Journal of Animal Ecology*, *77*(5), 936-947.
- Alexander, R. M. (2004). Hitching a lift hydrodynamically-in swimming, flying and cycling. *Journal of biology, 3*(2), 7.
- Altmann, J. (1974). Observational study of behavior: sampling methods. *Behavior*, *49*(3), 227-266.
- Au, W. W. L., & Green, M. (2000). Acoustic interaction of humpback whales and whale-watching boats. *Marine Environmental Research*, *49*(5), 469-481.
- Bain, D. E., Williams, R., Smith, J. C., & Lusseau, D. (2006). Effects of vessels on behavior of Southern Resident killer whales (Orcinus spp.) 2003-2005. *NMFS Contract report*.
- Baird, R. W., Borsani, J. F., Hanson, M. B., & Tyack, P. L. (2002). Diving and night-time behavior of long-finned pilot whales in the Ligurian Sea. *Marine Ecology Progress Series, 237*, 301-305.
- Baş Akkaya, A., Amaha Öztürk, A., & Öztürk, B. (2014). Selection of critical habitats for bottlenose dolphins (*Tursiops truncatus*) based on behavioral data, in relation to marine traffic in the Istanbul Strait, Turkey. *Marine Mammal Science*.
- Bejder, L., Dawson, S. M., & Harraway, J. A. (1999). Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. *Marine Mammal Science, 15*(3), 738-750.
- Bejder, L., Samuels, A., Whitehead, H., & Gales, N. (2006). Interpreting short-term behavioral responses to disturbance within a longitudinal perspective. *Animal Behavior, 72*(5), 1149-1158.
- Blane, J. N. and Jaakson, R. (1994). The Impact of Ecotourism Boats on the St Lawrence Beluga Whales. Environmental Conservation, 21, pp 267-269.
- Buckstaff, K. C. (2004). Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. *Marine mammal science*, *20*(4), 709-725.

- Carlson, C. (2001). *A Review of Whale Watch Guidelines and Regulations Around the World: Version 2001*. International Whaling Commission.
- Carrillo, M., & Ritter, F. (2010). Increasing numbers of ship strikes in the Canary Islands: proposals for immediate action to reduce risk of vessel-whale collisions. *Journal of Cetacean Research and Management*, *11*(2), 131-138.
- Ciano, J. N., & Jørgensen, R. (2000). Observations on an interaction between a humpback whale (Megaptera novaeangliae) and pilot whales (Globicephala melas). *Marine mammal science*, *16*(1), 245-248.
- Constantine, R., Brunton, D. H., & Dennis, T. (2004). Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behavior. *Biological Conservation*, *117*(3), 299-307.
- Dans, S. L., Crespo, E. A., Pedraza, S. N., Degrati, M., & Garaffo, G. V. (2008). Dusky dolphin and tourist interaction: effect on diurnal feeding behavior. *Marine Ecology Progress Series*, *369*, 287-296.
- Dans, S. L., Degrati, M., Pedraza, S. N., & Crespo, E. A. (2012). Effects of tour boats on dolphin activity examined with sensitivity analysis of Markov chains. *Conservation biology*, *26*(4), 708-716.
- David L. (2002). Disturbance to Mediterranean cetaceans caused by vessel traffic. In: G. Notarbartolo di Sciara (Ed.), Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. A report to the ACCOBAMS Secretariat, Monaco, February 2002. Section 11, 21 p.
- Degrati, M., Dans, S. L., Pedraza, S. N., Crespo, E. A., & Garaffo, G. V. (2008). Diurnal behavior of dusky dolphins, Lagenorhynchus obscurus, in golfo Nuevo, Argentina. *Journal of Mammalogy*, *89*(5), 1241-1247.
- Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. *Marine mammal science*, *18*(2), 394-418.
- EU 2002. Official Journal of the European Communities. 9.1.2002
- Evans P.G.H., Canwell P.J., Lewis E. (1992). An experimental study of the effects of pleasure craft noise upon bottle-nosed dolphins in Cardigan Bay, west Wales. Proceedings of the 6th annual conference of the European Cetacean Society, San Remo, Italy 20-22 February 1993: 43-46.

- Feingold, D. and Evans, P.G.H. (2014). Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llyn a'r Sarnau Special Areas of Conservation 2011-2013. Natural Resources Wales Evidence Report Series No. 4. 124pp.
- Fernandopullé, D. (1976). Climatic characteristics of the Canary Islands. In *Biogeography and ecology in the Canary Islands* (pp. 185-206). Springer Netherlands.
- Frid, A., & Dill, L. M. (2002). Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology*, *6*(1), 11.
- Gobierno de Canarias (1995). Boletín Oficial de Canarias Número 148. Lunes, 20 de Noviembre de 1995.
- Gobierno de Canarias (2000). Boletín Oficial de Canarias Número 133. Viernes, 6 de Octubre de 2000. Decreto 178/2000.
- Gowans, S., Würsig, B., & Karczmarski, L. (2007). The Social Structure and Strategies of Delphinids: Predictions Based on an Ecological Framework. *Advances In Marine Biology*, *53*, 195.
- Gregory, P. R., & Rowden, A. A. (2001). Behavior patterns of bottlenose dolphins (*Tursiops truncatus*) relative to tidal state, time-of-day, and boat traffic in Cardigan Bay, West Wales. *Aquatic Mammals*, *27*(2), 105-113.
- Hastie, G. D., Wilson, B., Tufft, L. H., & Thompson, P. M. (2003). Bottlenose dolphins increase breathing synchrony in response to boat traffic. *Marine Mammal Science*, *19*(1), 74-084.
- Heide-Jørgensen, M. P., Bloch, D., Stefansson, E., Mikkelsen, B., Ofstad, L. H., & Dietz, R. (2002). Diving behavior of long-finned pilot whales Globicephala melas around the Faroe Islands. *Wildlife Biology*, *8*(4), 307-313.
- Heimlich-Boran, J. R. (1993). *Social organisation of the short-finned pilot whale, Globicephala macrorhynchus, with special reference to the comparative social ecology of delphinids* (Doctoral dissertation, University of Cambridge).
- Herman, L. M. (1990). Cognitive performance of dolphins in visually-guided tasks. In *Sensory abilities of cetaceans* (pp. 455-462). Springer US.
- Hoyt, E. (1994). Whale-watching worldwide: an overview of the industry and the implications for science and conservation. In *Eighth Annual Conference of the European Cetacean Society, Montpelier, France. European Cetacean Society* (pp. 24-29).

- Ingram, S. N., & Rogan, E. (2002). Identifying critical areas and habitat preferences of bottlenose dolphins *Tursiops truncatus*. *Marine Ecology Progress Series*, *244*(29), 247-255.
- Instituto National de Estadística, http://www.ine.es
- Janik, V. M., & Thompson, P. M. (1996). Changes in surfacing patterns of bottlenose dolphins in response to boat traffic. *Marine mammal science*, *12*(4), 597-602.
- Janik, V. M. (2009). Acoustic communication in delphinids. *Advances in the Study of Behavior*, *40*, 123-157.
- Jensen, F. H., Bejder, L., Wahlberg, M., Aguilar De Soto, N., Johnson, M. P., & Madsen, P. T. (2009). Vessel noise effects on delphinid communication.
- Jensen, F. H., Perez, J. M., Johnson, M., Soto, N. A., & Madsen, P. T. (2011). Calling under pressure: short-finned pilot whales make social calls during deep foraging dives. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1721), 3017-3025.
- Kruse, S. (1991). The interactions between killer whales and boats in Johnston Strait, BC. *Dolphin societies: Discoveries and puzzles*, 148-159.
- Lemon, M., Lynch, T. P., Cato, D. H., & Harcourt, R. G. (2006). Response of travelling bottlenose dolphins (*Tursiops aduncus*) to experimental approaches by a powerboat in Jervis Bay, New South Wales, Australia. *Biological conservation*, *127*(4), 363-372.
- Lesage, V., Barrette, C., Kingsley, M., & Sjare, B. (1999). The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River estuary, Canada. *Marine Mammal Science*, *15*(1), 65-84.
- Lusseau, D. (2003a). Male and female bottlenose dolphins *Tursiops* spp. have different strategies to avoid interactions with tour boats in Doubtful Sound, New Zealand. *Marine Ecology Progress Series*, *257*, 267-274.
- Lusseau, D. (2003b). Effects of tour boats on the behavior of bottlenose dolphins: using Markov chains to model anthropogenic impacts. *Conservation Biology*, *17*(6), 1785-1793.
- Lusseau, D. (2004). The hidden cost of tourism: detecting long-term effects of tourism using behavioral information. *Ecology and Society*, *9*(1), 2.
- Lusseau, D. (2005). Residency pattern of bottlenose dolphins Tursiops spp. in Milford Sound, New Zealand, is related to boat traffic. *Marine ecology. Progress series*, *295*, 265-272.

- Lusseau, D., Bain, D. E., Williams, R., & Smith, J. C. (2009). Vessel traffic disrupts the foraging behavior of southern resident killer whales Orcinus orca. *Endangered Species Research*, *6*(3), 211-221.
- Mann, J. (2000). Unraveling the dynamics of social life. *Cetacean societies: field studies of dolphins and whales. University of Chicago Press, Chicago, Illinois, USA*, 45-64.
- Mann, J., Connor, R. C., Barre, L. M., & Heithaus, M. R. (2000). Female reproductive success in bottlenose dolphins (*Tursiops* sp.): life history, habitat, provisioning, and group-size effects. *Behavioral Ecology*, *11*(2), 210-219.
- Martin, V., Montero, R., Heimlich-Boran, J.R. & Heimlich-Boran, S.L. (1992). Preliminary observations of the cetacean fauna of the Canary Islands. Proc. 6th Ann. Conf. ECS, San Remo, Italy. 61ff.
- Mate, B. (1989). Satellite-monitored radio tracking as a method for studying cetacean movements and behavior. *Report of the International Whaling Commission*, *39*, 389-391.
- Mattson, M. C., Thomas, J. A., & Aubin, D. S. (2005). Effects of boat activity on the behavior of bottlenose dolphins (*Tursiops truncatus*) in waters surrounding Hilton Head Island, South Carolina. *Aquatic Mammals*, (31), 133-140.
- McKenna, M. F., Ross, D., Wiggins, S. M., & Hildebrand, J. A. (2012). Underwater radiated noise from modern commercial ships. *The Journal of the Acoustical Society of America*, *131*(1), 92-103.
- Meissner, A. M., Christiansen, F., Martinez, E., Pawley, M. D., Orams, M. B., & Stockin, K. A. (2015). Behavioral Effects of Tourism on Oceanic Common Dolphins, Delphinus sp., in New Zealand: The Effects of Markov Analysis Variations and Current Tour Operator Compliance with Regulations. *PloS one*, *10*(1), e0116962.
- Migura, K. A., & Meadows, D. W. (2002). Short-finned pilot whales (*Globicephala macrorhynchus*) interact with melon-headed whales (*Peponocephala electra*) in Hawaii. *Aquatic Mammals*, *28*(3), 294-297.
- Nowacek, D. P., Thorne, L. H., Johnston, D. W., & Tyack, P. L. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review*, *37*(2), 81-115.
- Nowacek, S. M., Wells, R. S., & Solow, A. R. (2001). Short-term effects of boat traffic on bottlenose dolphins, *Turiops truncatus*, in Sarasota Bay, Florida. *Marine Mammal Science*, *17*(4), 673-688.

- Olson, P. A., & Reilly, S. B. (2002). Pilot whales Globicephala melas and G. macrorhynchus. *Encyclopedia of marine mammals (WF Perrin, B. Würsig, and JGM Thewissen, eds.). Academic Press, San Diego, California*, p.898-903.
- Orams, M.B. (1997). Historical accounts of human-dolphin interaction and recent developments in wild dolphin based tourism in Australasia. *Tourism Management,* 18(5): 317-326.
- Papale, E., Azzolin, M., & Giacoma, C. (2012). Vessel traffic affects bottlenose dolphin (*Tursiops truncatus*) behavior in waters surrounding Lampedusa Island, south Italy. *Journal of the Marine Biological Association of the United Kingdom, 92*(08), 1877-1885.
- Parsons, E. C. M., Lewandowski, J., & Lück, M. (2006). Recent advances in whale-watching research: 2004–2005. *Tourism in Marine Environments*, *2*(2), 119-132.
- Pirotta, E., Merchant, N. D., Thompson, P. M., Barton, T. R., & Lusseau, D. (2015). Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. *Biological Conservation*, *181*, 82-89.
- Pirotta, E., New, L., Harwood, J., & Lusseau, D. (2014). Activities, motivations and disturbance: An agent-based model of bottlenose dolphin behavioral dynamics and interactions with tourism in Doubtful Sound, New Zealand. *Ecological Modelling*, *282*, 44-58.
- Pitman, R. L., & Durban, J. W. (2012). Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (Orcinus orca), type B, in Antarctic Peninsula waters. *Marine Mammal Science*, *28*(1), 16-36.
- Reynolds, J. E., Wells, R. S., & Eide, S. D. (2000). *The bottlenose dolphin: biology and conservation* (Vol. 289). Gainesville, Florida: University Press of Florida.
- Richter, C., Dawson, S., & Slooten, E. (2006). Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. *Marine Mammal Science*, *22*(1), 46-63.
- Ritter, F. (2002). Behavioral observations of rough-toothed dolphins (Steno bredanensis) off La Gomera, Canary Islands (1995-2000), with special reference to their interactions with humans. *Aquatic Mammals*, *28*(1), 46-59.
- Ritter, F. (2003). Interactions of cetaceans with whale watching boats–implications for the management of whale watching tourism. *MEER eV, Berlin, Germany*.
- Ritter, F. (2004). 21 cetacean species off La Gomera (Canary Islands): Possible reasons for an extraordinary species diversity. In *European Research on Cetaceans: Proceedings*

of the... Annual Conference of the European Cetacean Society (Vol. 15, p. 270). European Cetacean Society.

- Ritter, F. (2007). Behavioral responses of rough-toothed dolphins to a dead newborn calf**.** *Marine Mammal Science*, 23(2): 429-433.
- Ritter, F., & Brederlau, B. (1999). Behavioral observations of dense beaked whales (Mesoplodon densirostris) off La Gomera, Canary Islands (1995-1997). *Aquatic Mammals*, *25*, 55-62.
- Ritter, F., Ernert, A., & Smit, V. (2011). A long-term cetacean sighting data set from whale watching operations as a reflection of the environmental dynamics in a multi-species cetacean habitat. In *Poster presented at the Annual Conference of the European Cetacean Society (ECS) in Cadiz (Spain)* (Vol. 21, p. 23).
- Rogan, E., Ingram, S., Holmes, B., & O'Flanagan, C. (2000). A survey of bottlenose dolphins (*Tursiops truncatus)* in the Shannon estuary.
- Roussel, E. (2002). *Disturbance to Mediterranean cetaceans caused by noise* (p. 18). ACCOBAMS.
- Sayigh, L., Quick, N., Hastie, G., & Tyack, P. (2013). Repeated call types in short-finned pilot whales, Globicephala macrorhynchus. *Marine Mammal Science*, *29*(2), 312-324.
- Scheer, M. (1999). Lautäußerungen und Verhalten von Kurzflossen–Grindwalen (Globicephala macrorhynchus) vor der Südwestküste Teneriffas. *University of Bremen, Germany*.
- Scheer, M. (2010). Review of self-initiated behaviors of free-ranging cetaceans directed towards human swimmers and waders during open water encounters. *Interaction Studies*, *11*(3), 442-466.
- Scheer, M. (2013). Call Vocalizations Recorded Among Short-Finned Pilot Whales (Globicephala macrorhynchus) Off Tenerife, Canary Islands. *Aquatic Mammals*, *39*(3), 306-313.
- Scheer, M., & Ritter, F. (2013). Underwater bow-radiated noise characteristics of three types of ferries: implications for vessel-whale collisions in the Canary Islands, spain.
- Scheer, M., Hofmann, B., & Behr, I. (1998). Interactions between whale watching vessels and shortfinned pilot whales (Globicephala macrorhynchus) off the southwest coast of Tenerife, Canary Islands: behavioral implications. *Unpublished report to Viceconsejería de Medio Ambiente. La Laguna, Tenerife, Canary Islands*.
- Scheidat, M., Castro, C., Gonzalez, J., & Williams, R. (2004). Behavioral responses of humpback whales (Megaptera novaeangliae) to whalewatching boats near Isla de la Plata,

Machalilla National Park, Ecuador. *Journal of Cetacean Research and Management*, *6*(1), 63-68.

- Senigaglia, V., & Whitehead, H. (2012). Synchronous breathing by pilot whales. *Marine Mammal Science*, *28*(1), 213-219.
- Shane, S. H. (1990). Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. *The bottlenose dolphin. Academic Press, San Diego, CA*, 245-265.
- Shane, S. H. (1995). Behavior patterns of pilot whales and Risso's dolphins off Santa Catalina Island, California. *Aquatic Mammals*, *21*, 195-198.
- Shirihai, H., & Jarrett, B. (2006). Whales, Dolphins and Seals: A Field Guide to the Marine Mammals of the World. Edited by Guy M. Kirwan. Published by A&C Black Publishers Ltd, 36 Soho Square, London W1D 3QY. p.79-82/157-158
- Stockin, K. A., Lusseau, D., Binedell, V., Wiseman, N., & Orams, M. B. (2008). Tourism affects the behavioral budget of the common dolphin Delphinus sp. in the Hauraki Gulf, New Zealand. *Marine Ecology Process-Series*, *355*, 287.
- Symons, J., Pirotta, E., & Lusseau, D. (2014). Sex differences in risk perception in deep-diving bottlenose dolphins leads to decreased foraging efficiency when exposed to human disturbance. *Journal of Applied Ecology*, *51*(6), 1584-1592.
- Tobeña, M., Escánez, A., Rodríguez, Y., López, C., Ritter, F., & Aguilar, N. (2014). Inter-island movements of common bottlenose dolphins *Tursiops truncatus* among the Canary Islands: online catalogues and implications for conservation and management. *African Journal of Marine Science*, *36*(1), 137-141.
- Tyack, P. L. (2012). Review of the Signature-Whistle Hypothesis for the Atlantic Bottlenose Dolphin 10. *The bottlenose dolphin*, 199.
- Van Waerebeek, K., Baker, A. N., Félix, F., Gedamke, J., Iñiguez, M., Sanino, G. P. & Wang, Y. (2007). Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. *Latin American Journal of Aquatic Mammals*, *6*(1), 43-69.
- Visser, F., Hartman, K. L., Rood, E. J., Hendriks, A. J., Zult, D. B., Wolff, W. J. & Pierce, G. J. (2011). Risso's dolphins alter daily resting pattern in response to whale watching at the Azores. *Marine Mammal Science*, *27*(2), 366-381.
- Wells, R. S., & Scott, M. D. (1999). Bottlenose dolphin *Tursiops truncatus* (Montagu, 1821). *Handbook of marine mammals*, *6*, 137-182.

- Wells, R. S., Fougeres, E. M., Cooper, A. G., Stevens, R. O., Brodsky, M., Lingenfelser, R., & Douglas, D. C. (2013). Movements and dive patterns of short-finned pilot whales (Globicephala macrorhynchus) released from a mass stranding in the Florida Keys. *Aquatic Mammals*, *39*(1), 61-72.
- Whittaker, D., & Knight, R. L. (1998). Understanding wildlife responses to humans. *Wildlife Society Bulletin*, *26*, 312-317.
- Williams, R., Trites, A. W., & Bain, D. E. (2002). Behavioral responses of killer whales (Orcinus orca) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology*, *256*(02), 255-270.
- Williams, T. M., Friedl, W. A., Fong, M. L., Yamada, R. M., Sedivy, P., & Haun, J. E. (1992). Travel at low energetic cost by swimming and wave-riding bottlenose dolphins. *Nature*, *355*(6363), 821-823.
- Würsig, B. (2008). Bow-riding. *Encyclopedia of marine mammals*, 133-134.
- Würsig, B. and M. Würsig. (1979). "Behavior and Ecology of the Bottlenose Dolphin, *Tursiops truncatus,* in the South Atlantic," *Fish. Bull.* 77: 399^112.
- Würsig, B., Lynn, S. K., Jefferson, T. A., & Mullin, K. D. (1998). Behavior of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. *Aquatic Mammals, 24*(1), 41-50.

Zusammenfassung

Wale und Delfine sind einem stetig wachsenden Bootsverkehr ausgesetzt. Die heutzutage stattfindende Zunahme an Tourismus und Walbeobachtungsbooten in den küstennahen Habitaten birgt mögliche Auswirkungen auf die Gesundheit der Tiere und könnte zu langfristigen Veränderungen in deren Verhalten führen. Walbeobachtungsboote verändern das Verhalten von Cetaceen in verschiedener Weise. Es wurde dokumentiert, dass diese Verhaltensreaktionen zwischen den Arten variieren und dass verschiedene Bootstypen und die Fahrweise eine Rolle spielen. Vor der Küste von La Gomera (Kanarische Inseln) werden Große Tümmler (*Tursiops truncatus*) und Indische Grindwale (*Globicephala macrorhynchus*) das ganze Jahr über von Booten gesichtet. Von Oktober bis Dezember 2014 wurde das Verhalten dieser zwei Arten mithilfe von Walbeobachtungsbooten dokumentiert. Dabei wurden artspezifische Unterschiede hinsichtlich vordefinierten bootsbezogenen Verhaltensweisen untersucht. Die Ergebnisse zeigten, dass die Arten je nach Bootstyp unterschiedlich reagierten und dabei die Fahrweise undGeschwindigkeit des Bootes sowie der Verhaltenszustand des Tieres eine entscheidende Rolle spielten.

Curriculum vitae

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EDUCATION

Feb 2013 – June 2015 — **University of Vienna, Austria**
Master of Science, Zoology

Feb 2009- Dec 2012 — **University of Vienna, Austria**
Bachelor of Science, Biology (Zoology)

2005-2008 — **Albertus Magnus Gymnasium, Vienna, Austria**
School leaving certificate

2000-2005 — **Canisius Kolleg, Berlin, Germany**
Jesuit-(High-)School (Gymnasium)

WORK/LIFE EXPERIENCE

Oct.-Dec. 2014 — **M.E.E.R.eV – MSc Project, Cetacean Research, La Gomera, Spain**

- Research Project about Interaction of different Odontocetes towards Whale watching boats
- Photo Identification of small cetaceans
- Public awareness, exhibition/boat guide

Feb.-Apr. 2013 — **Bosphorus Dolphin Project - PhD Assistance, Istanbul, Turkey**

- Research of Interaction between Bottlenosed Dolphins, Common Dolphins and Harbour Porpoise with boat traffic in the Bosphorus, Istanbul
- Boat/Land based cetacean monitoring, Photo-Identification, Theodolite/Pythagoras, Logger usage

Aug.-Sep. 2012 — **Sea Watch Foundation, New Quay, Wales, United Kingdom**

- Boat based marine wildlife research
- Land based marine wildlife monitoring
- Data collection/entry/analysis
- Sightings Assistant
- Bottlenosed dolphin Photo Identification

- Public awareness, presentation

July 2012/July-Sep 2013 **Sea Turtle Field Course, Fethiye, Turkey**
University Of Vienna/Universitesi Pamukkale

- Loggerhead sea turtle conservation and research
- Sea turtle hatchling conservation
- Sea turtle stranding network assistance
- Public awareness, presentation

July/Sep. 2011 **Behavioural Ecology Research Group –**
Department of Zoology, Oxford, Germany (Bavaria)

- Cognitive biology research assistance in crow lab
- Data collection/entering/analysis (New Caledonian crows, Carrion crows, Jackdaws)
- Animal welfare
- Experimental setup preparation

Sep 2009 **ORES – Ocean Research and Education Society, Canada**

- Marine mammal research
- Minke whale specification, Photo identification
- Boat handling (zodiac)
- Data collecting/organizing/analysing

ADDITIONAL INFORMATION

-full clean driver's license
-First Aid Certificate
-PADI Open Water Diver's license (2012)
-Very good level of fluent English, Broken French, (Motherlanguage: German), Beginning Spanish and Turkish
-computing skills: General knowledge of Windows XP/7/Vista, Microsoft software, Adobe Photoshop (+other photo processors)

REFERENCES: I am happy to supply these on request

Signature: