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THE SHORT-TERM BEHAVIORAL REACTIONS OF BOTTLENOSE DOLPHINS TO INTERACTIONS WITH BOATS IN DOUBTFUL SOUND, NEW ZEALAND

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ABSTRACT

Doubtful Sound is home to one of the southernmost resident populations of bottlenose dolphins (*Tursiops* sp.). This population regularly interacts with scenic cruises. During these interactions, dolphins tend to horizontally and vertically avoid vessels, especially when the behavior of these vessels is intrusive. This study aimed at understanding the behavioral reactions of individuals to these interactions that lead to the disruption of the school's behavioral state. Observing the behavioral events performed by individuals during an interaction can help define the short-term reactions elicited by the boat presence. I recorded the behavioral events performed by all individuals of focal schools. The frequency of occurrence of all events was compared depending on the presence of vessels, their behavior, and the behavioral state of the focal school. Dolphins tended to perform more side flops while interacting with powerboats, a behavior which may be used as a non-vocal communication tool. Moreover, the movement of dolphins became more erratic during interactions with all types of vessels. These effects increased when the boats were more intrusive while interacting. This study shows that the impact of interaction with boats can be minimized if the vessels respect the guidelines in place.

Key words: bottlenose dolphin, *Tursiops*, tourism impact, behavioral reaction.

Dolphin-watching activities are an increasing component of the coastal tourism sector (Hoyt 2001). In addition to dedicated dolphin-watching companies the sector includes operators offering scenic cruises that rely on sighting dolphins regularly (Higham and Lusseau 2004, Lusseau 2005*b*). This is the case in Doubtful

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Sound (45°30′S, 167°00′E), New Zealand, where the marine tourism sector is solely composed of scenic cruises that vary in length from a few hours to several days (Lusseau 2005*b*). These cruises target a small resident population of bottlenose dolphins (*Tursiops* sp.) as a key natural resource (Williams *et al.* 1993, Lusseau *et al.* 2003).

This industry provides a tremendous opportunity to educate the public about conservation issues that the targeted species face (Duffus and Dearden 1993, Forestell 1993). Moreover, it provides a way to utilize a relatively abundant natural resource in an apparently sustainable fashion because it does not involve its consumption (Duffus and Dearden 1993). However, concerns have been raised about the potential negative impact of dolphin-watching activities on the targeted populations (Baker and Herman 1989, Corkeron 1995, Nowacek *et al.* 2001, Van Parijs and Corkeron 2001, Williams *et al.* 2002, Lusseau 2003*c*, Constantine *et al.* 2004, Lusseau 2004). It seems that dolphins and whales tend to avoid vessels when the behavior of these vessels is not predictable (Nowacek *et al.* 2001, Lusseau 2003*c*). The predictability of tour boats seems to be the key factor explaining these avoidance tactics (Lusseau 2003*c*). These avoidance behaviors have been observed in a number of ways and have been likened to predator avoidance tactics (Williams *et al.* 2002, Lusseau 2003*a*). Studies showed an increase in dive intervals, increases in erratic movements, changes in acoustic behavior, and displacement (Corkeron 1995, Nowacek *et al.* 2001, Van Parijs and Corkeron 2001, Williams *et al.* 2002, Lusseau 2003*c*, Lusseau 2004, 2005*a*). These short-term reactions can lead to longer term impacts such as area avoidance (Salden 1988, Lusseau 2005*a*) or alteration of the population's behavioral budget (Lusseau 2004) which can have biologically significant consequences on the energetic budget and reproductive output of individuals and their population.

A recent study in Doubtful Sound showed that boat interactions altered the behavioral budget of the dolphin community (Lusseau 2003*a*). However the short-term mechanism leading to this long-term impact is not completely understood. It is not practical to sample the behavioral state of focal individuals (Mann 2000) because dolphins in this area form large schools (Lusseau *et al.* 2003). It is therefore necessary to assess behavioral disruption at the school level. The behavior of animals can also be sampled using behavioral events (Altmann 1974, Mann 2000), in other words by observing every single functional movement performed at the surface by individual dolphins. However, such a study necessitates an understanding of the functionality of these events in order to assess the influences of extrinsic factors on their frequency of occurrence. A recent study on the Doubtful Sound population (Lusseau 2003*b*) segregated their behavioral events into contextual clusters that ease the interpretation of the functionality of these events. This present study determines the short-term effects of boat interactions on the behavior of individuals within schools by sampling behavioral events. It aims at understanding the influence that boat interactions have on these dolphins by determining which events are more likely to be expressed or suppressed during interactions and linking these reactions to the context in which these events are usually used.

Methods

Field Techniques

I collected behavioral data in Doubtful Sound, New Zealand (45°30′S, 167°00′E) between June 2000 and May 2002. I conducted systematic surveys of the fjord using a 4.8-m aluminum boat powered by a four-stroke, 50-hp outboard engine.

The same survey route was followed everyday until a school of dolphins was encountered. The route allowed for a complete survey of the fiord and even spatial effort. Effort was also evenly distributed across seasons. Once a school was detected the identity of individuals in the school was determined using photo identification. Then the behavioral state of the school was sampled every 15 min. The principal behavioral state (Appendix 1) of the school was categorized via scan sampling (Altmann 1974). The school was continuously scanned for a fixed period of 5 min; repeatedly scanning the school from "tail" to "head" (from individuals in the back of the schools to the ones at the head). The behavior of each individual was therefore sampled several times within a school sample. This exercise was repeated every 10 min, hence the 15-min interval between samples. These behavioral states were defined to be mutually exclusive and cumulatively inclusive (as a whole they described the entire behavioral budget of the dolphins) after a long-term quantitative study of the population's ethogram (Schneider 1999). These states were similar to the ones used in other studies (Shane 1990, Bearzi *et al.* 1999). Scan sampling of individuals within the school was preferred to focal school sampling because of the observer bias inherent to the latter technique (Mann 2000). Observations ended when the weather deteriorated, the focal school was lost, or the day ended, therefore the end of a sequence of observations was not dependent on the behavior of the focal school.

In addition to recording behavioral state, I recorded (for 1 h at a time) every behavioral event (see Appendix 2) I observed at the surface performed by individuals from the focal school. The sampling method was therefore different from the one used for behavioral states since all occurrences of events described in the ethogram (Appendix 2) were recorded. Both types of sampling could be carried out simultaneously because more than one observer was present onboard. The sampling period for behavioral events was limited to 1 h in order to minimize sampling bias due to observer fatigue. Sampling periods were spaced apart by at least 15 min. Events and their timing were recorded via the shortcut keys of a Psion 5 palmtop computer recorded by punching a shortcut code. Events were defined as a series of body movement that could be unambiguously identified as a unit. For example the event "tail-out dive" composed the following movements: dolphin surfaces, steeply arches its body above water, raises its tail above the water, dives with its tail re-entering the water last. These behavioral events do not represent the entire behavioral repertoire of the population, but are all events that always occur at the surface. Therefore these events could be observed every time they occurred.

Boat presence was recorded, along with the type of boat and whether the vessel violated the New Zealand Marine Mammal Protection Regulations (1992). These regulations established by the New Zealand government provide guidelines on how to interact with dolphins in order to minimize potential negative effects. Boat interactions violating the regulations (MMPR) were considered as intrusive because they impeded the movement of the school of dolphins. If a vessel was within 400 m of the focal school it was defined as interacting with the dolphins. Distances between tour boats and dolphins were measured using a Bushnell range finder and were estimated with a precision of 1–5 m. The 400-m limit was defined from a preliminary study, which showed that dolphins tended to break off from their school to bow-ride a vessel if the vessel was within 400 m of the school (Lusseau 2003*b*).

Samples were blocked by boat presence and behavioral state and a count was calculated for each behavioral event. Counts were normalized by sampling period and number of individuals present in the focal school (Lusseau 2003*b*). Standardized counts were then fourth root-transformed to be successfully normalized (Quinn and

Keough 2002). Dolphins were equally likely to interact with boats throughout the day (Lusseau 2005*b*) and school follows were also carried out throughout the day (Lusseau 2003*b*) which means that "control" and "impact" samples were equally likely to be observed throughout the day minimizing the need to control for other environmental variables such as time of the day.

The Effects of the Research Vessel

Land-based observations could not be carried out in Doubtful Sound because of the remoteness and topography of the fjord. However the effect of the observing vessel was still assessed using a regressive technique. The animals were exposed to several levels of "observation intensity" and the dependence of behavioral events on these levels was analyzed: (1) vessel following the focal school at close range (within 50 m), (2) vessel following the focal school from afar (between 100 m and 200 m), and (3) vessels drifting engine off (at least 100 m away from the dolphins). Such regressive techniques have been used widely in impact assessment study design where true control situations cannot be found (Morrison *et al*. 2001, Lusseau 2003*c*). To assess the effects of *Wilma Jane* a generalized linear model was fitted to control samples (samples without boats other than the research vessel present). The effects of behavioral state and the behavior of *Wilma Jane*, the research vessel, as well as their interactions were included in a multivariate analysis of variance (MANOVA). The effects of behavioral states were included in this model because the frequency of occurrence of behavioral events is known to vary from one state to another (Lusseau 2003*b*). Therefore this model allowed for controlling for unequal sample size for research vessel exposure across behavioral states. Significance was tested with a 0.05 level.

The Effects of Interactions with Other Boats

A similar approach was undertaken to assess the effects of boat interactions on the behavior of dolphins. The behavior of the observing vessel remained similar before, during, and after interactions between dolphins and other boats. Therefore any interactions between the effects of the observing vessel and the effects of other vessels were minimized. GLMs were determined for several parameters and the best model was selected using Akaike Information Criterion (AIC). AIC estimates the amount of information a model provides given the data, using the residuals sums of squares, and penalizes models for the number of parameters they use (Burnham and Anderson 1998). It therefore estimates which model provides the most parsimonious explanation of the data set. The smaller the AIC value for a model, the better the model fit the data. I tried to determine what feature of boat interactions (boat type *vs.* boat behavior) had the most effect on the behavior of the dolphins. I compared three models: (1) boat present *vs.* boat absent, (2) powerboat *vs.* kayak *vs.* no boat, (3) no boat *vs.* boat present, but do not violate the MMPR *vs.* boat present and violate the MMPR.

Finally I also assessed the effect of boat presence on the likelihood of co-occurrence of events. For both control and boat-interaction samples I calculated a dissimilarity matrix of behavioral events using the Bray–Curtis dissimilarity index. I then assessed the correlation of both matrices using a Mantel test, permuting rows and columns 10,000 times (Mantel 1967).

Table 1. Number of samples recorded depending on the presence of boats and the behavioral state of the focal school. Samples characterized by behavioral transitions are represented by "x-Travel" and "Travel-x" in which "x" can be any of the four other behavioral states. See Appendix 1 for a definition of the behavioral states.

	Behavioral state							
Boat	Traveling	Resting	Milling	Diving	Socializing	x-Traveling	Traveling-x	Sum
Absent	162	35	23	98	98	95	78	589
Present	56	7	4	31	12	20	8	138
Sum	218	42	27	129	110	115	86	727

Results

During the study period I spent 137 d (879.2 h) looking for dolphins. I followed focal schools for 716.5 h (over 133 d) and recorded the occurrence of behavioral events for 204.2 h (over 74 d). Control samples represented the majority of the sampling period (172 h *vs.* 32.2 h). The observation period was divided in 783 samples based on behavioral state and boat presence. I discarded 56 samples that could not be categorized as one of the five behavioral states or as whether a transition from traveling to another behavior or a transition from another behavior to traveling. These two behavioral transitions were kept in the analysis because they could be significantly discriminated from other states from the occurrence of behavioral events (Lusseau 2003*b*). The analysis is therefore based on 727 samples (Table 1). The average length of a sample was 15.8 min (SE = 0.38, range = 2.1–81.7 min).

The Effects of Interactions with the Observing Vessel

The position of the research vessel was recorded for 414 control samples. No statistically significant effect of the research vessel could be detected (Table 2). All control samples were therefore considered similar thereafter.

The Effects of Interactions with Boats

All characteristics of tour boat interactions significantly altered the behavior of individuals within the focal schools. The sole presence of boats affected four behavioral events and significantly interacted with the effect of behavioral state (Table 3, 4).

Table 2. Multivariate analysis of variance, using a generalized linear model, assessing the effect of both the presence of the research vessel and the behavioral state of the focal school on the frequency of occurrence of the 35 behavioral events.

Effect	Wilk's λ	Pillai trace	Hotelling-Lawley trace	*F*-statistic	df	*P*-value
Constant	0.812	0.188	0.231	2.41	36, 375	<0.001
Behavioral state	0.855	0.145	0.169	1.76	36, 375	0.006
Research vessel	0.909	0.091	0.100	1.05	36, 375	0.401
Interaction	0.898	0.102	0.114	1.19	36, 375	0.218

Table 3. Multivariate analysis of variance, using a generalized linear model, assessing the effect of both the presence of vessels and the behavioral state of the focal school on the frequency of occurrence of the 35 behavioral events.

Effect	Wilk's λ	Pillai trace	Hotelling-Lawley trace	*F*-statistic	df	*P*-value
Constant	0.241	0.759	3.145	67.03	32, 682	<0.001
Behavioral state	0.450	0.713	0.901	3.04	192, 4039	<0.001
Boat presence	0.910	0.090	0.099	2.11	32, 682	<0.001
Interaction	0.672	0.380	0.416	1.46	192,4039	<0.001

Table 4. Univariate ANOVAs testing the effects of both the interaction between the presence of boats and behavioral state and the main effect of the presence of boats on each behavioral event. Only events significantly altered by the effect are represented. See Appendix 2 for a definition of the events.

Effect	Event	*F*-statistic	df	*P*-value
Interaction	Change of direction	3.15	6, 713	0.005
	Side flop	4.25	6, 713	<0.001
	Tail-out dive	3.44	6, 713	0.002
Boat presence	Eye out	4.32	1, 713	0.038
	Pounce	4.93	1, 713	0.027
	Side flop	26.61	1, 713	<0.001
	Snaggle	5.51	1, 713	0.019

Violations of the MMPR significantly interacted with the effect of behavioral state (Table 5, 6). Finally the type of vessel interacting with the dolphins also had a significant effect on four behavioral events (Table 7, 8). The presence of violations of the MMPR during an interaction seemed to be the variable best at explaining the variation in the occurrence of behavioral events inherent to boat interactions (Table 9). However the AIC difference with the type of vessel interacting was not large enough to discredit this variable as an explanation for the observed variation (Burnham and Anderson 1998). On the other hand the sole presence of vessels did not provide the same amount of information as the previous two characteristics (Table 9).

Bonferroni *post hoc* tests (all *P*-values <0.01) on the statistically significant univariate analyses showed that individuals were more likely to side flop when interacting

Table 5. Multivariate analysis of variance, using a generalized linear model, assessing the effect of both violations of the MMPR and the behavioral state of the focal school on the frequency of occurrence of the 35 behavioral events.

Effect	Wilk's λ	Pillai trace	Hotelling-Lawley trace	*F*-statistic	df	*P*-value
Constant	0.358	0.642	1.796	39.17	31, 676	<0.001
Behavioral state	0.556	0.542	0.637	2.25	186, 4000	<0.001
MMPR violations	0.889	0.113	0.122	1.32	62, 1352	0.053
Interaction	0.500	0.664	0.726	1.31	372, 7621	<0.001

Table 6. Univariate ANOVAs testing the effects of the interaction between violations of the MMPR and behavioral state on each behavioral event. Only events significantly altered by the effect are represented. See Appendix 2 for a definition of the events.

Event	F-statistic	df	P-value
Change of direction	1.92	12, 706	0.029
Head butt missed	3.27	12, 706	<0.001
Side flop	3.31	12, 706	<0.001
Tail-out dive	2.17	12, 706	0.012
Vertical jump	2.06	12, 706	0.017
Turnaround	2.13	12, 706	0.014

with powerboats (Fig. 1a) and when boats were violating the MMPR while the school was socializing or diving (Fig. 2b). Dolphins were also less likely to snaggle when powerboats were present (Fig. 1c). The presence of kayaks decreased the chance to observe individuals diving with their tail out (TOD, Fig. 1d). While more TODs were observed when the school was resting and interacting with a boat that violated the MMPR (Fig. 2a). Dolphins were more likely to turnaround when interacting with kayaks (Fig. 1b) and to change of direction when interacting with a boat violating the MMPR while the school was traveling (Fig. 2c). Finally, the presence of boats did not significantly affect the co-occurrence of behavioral events (Mantel test, $r^2 = 0.714$, $P < 0.0001$).

Discussion

This is the second study showing that the research vessel used in Doubtful Sound did not significantly affect the behavior of dolphins (Lusseau 2003*c*). This vessel spent in excess of 2,400 h with dolphin schools in Doubtful Sound at the time of this study. During that time the MMPR guidelines were always strictly observed and interactions were terminated at any sign of avoidance. Moreover, an acoustic cue was devised to help dolphins predict the behavior of the research vessel (Schneider 1999). The tilt/trim engine was triggered twice before the boat accelerated and once when it changed of direction by more than 45°. The noise produced by the engine propagated well underwater and was within hearing range of the dolphins (Schneider 1999). This meant that the behavior of the boat was always predictable, which seems to be the key to minimize the impact of a boat interaction (Nowacek *et al*. 2001, Lusseau 2003*c*).

Table 7. Multivariate analysis of variance, using a generalized linear model, assessing the effect of both the type of vessel interacting with the focal school and the behavioral state of the focal school on the frequency of occurrence of the 35 behavioral events.

Effect	Wilk's λ	Pillai trace	Hotelling-Lawley trace	F-statistic	df	P-value
Constant	0.446	0.554	1.242	27.09	31, 676	<0.001
Behavioral state	0.631	0.427	0.497	1.74	186, 4000	<0.001
Vessel type	0.844	0.162	0.178	1.93	62, 1352	<0.001
Interaction	0.558	0.561	0.608	1.10	372, 7621	0.107

Table 8. Univariate ANOVAs testing the effects of the type of vessel interacting with the focal school on each behavioral event. Only events significantly altered by the effect are represented. See Appendix 2 for a definition of the events.

Event	*F*-statistic	df	*P*-value
Side flop	25.08	2, 706	<0.001
Snaggle	3.29	2, 706	0.038
Tail-out dive	5.39	2, 706	0.005
Turnaround	3.92	2, 706	0.020

However, it is worth noting that in both studies a regressive exposure technique was used and no true control samples could be obtained. It is possible that behavioral alteration is not a function of boat–dolphin distance and that therefore in all cases the dolphins had already altered their behavior because of the observing vessel presence. This means that the results I obtained looking at the effects of interactions with other boats are actually potentially conservative, yet effects were successfully detected.

The increase in side flopping during intrusive boat interactions could almost have been predicted from previous work (Lusseau 2003*a*, *b*). The impact assessment study on school's behavioral states showed that boat interactions tended to increase the likelihood that dolphins started to travel after an interaction (Lusseau 2003*a*, 2004). Side flops were described as non-vocal signals to communicate an intention to start traveling (Lusseau 2003*b*). These studies showed that in natural settings, at least with no other boats but the observing vessel present in the vicinity of the dolphins, side flopping only ever occurred during behavioral transition just at the onset of school travels. Observing more side flopping during boat interactions reinforces both conclusions. Moreover observing more side flops when powerboats were present and when interactions violated the MMPR reinforce the theory that side flops are utilized in conditions in which vocalizations cannot be used. Side flops were most often observed when powerboats (of any size) passed at close range (within 50 m) of the animals at fast speed, or when a boat was circling the focal school at fast speed. The noise emitted by the boats during such intrusive interactions is most likely masking bottlenose dolphin vocalizations (Erbe 2002). Side flopping is an acoustic cue as well, yet it may provide an efficient way to communicate in a noisy environment. All side flops performed during boat interactions were positioned between the stern of the boat and the school of dolphins (personal observation), reinforcing this hypothesis.

Table 9. Information provided by the three generalized linear models considering the three different characteristics of boat interactions. The information content of these models is estimated using Akaike Information Criteria (Burnham and Anderson 1998). AIC estimates the information content from both the Residual Sum of Squares of each model (RSS) and the number of samples obtained (*n*) and penalizes models for the number of parameters used (*K*).

Model	RSS	*n*	*K*	AIC
Boat presence	964.16	727	4	213.25
MMPR violations	950.30	727	4	202.73
Motorboat *vs.* kayak	952.20	727	4	204.18

Snaggling is another behavior that could be affected by noise emission (Fig. 1c). I hypothesized earlier that snaggling was used to gather acoustic information at the surface (Lusseau 2003*b*). The presence of a powerboat may temper the dolphin's ability to gather this information because of noise emission, explaining the decrease in snaggling when interacting with powerboats.

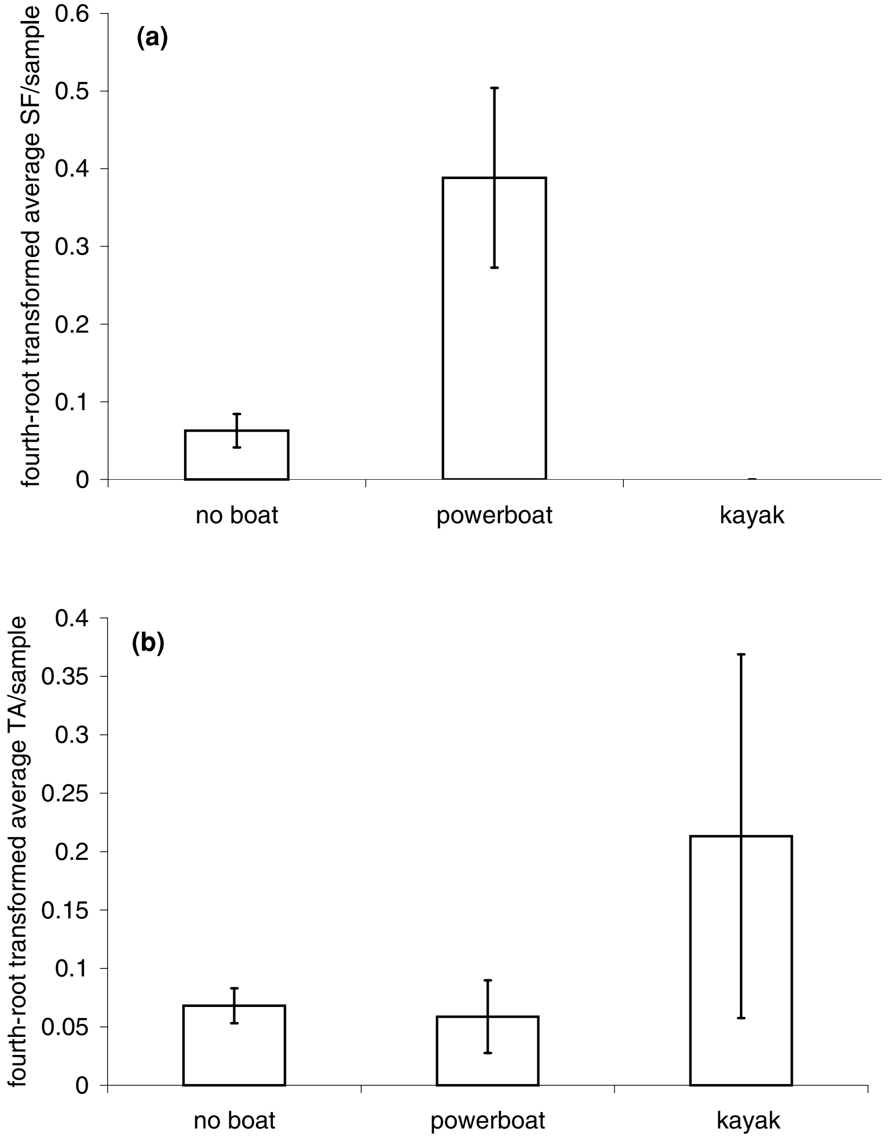

Figure 1. Average number of behavioral events observed depending on the type of boat interacting with dolphins: (a) side flops (SF), (b) turnaround (TA), (c) snaggle (SN), (d) tail-out dive (TOD). Transformed averages are represented so that all categories are graphed on the same scale. Error bars are 95% confidence intervals.

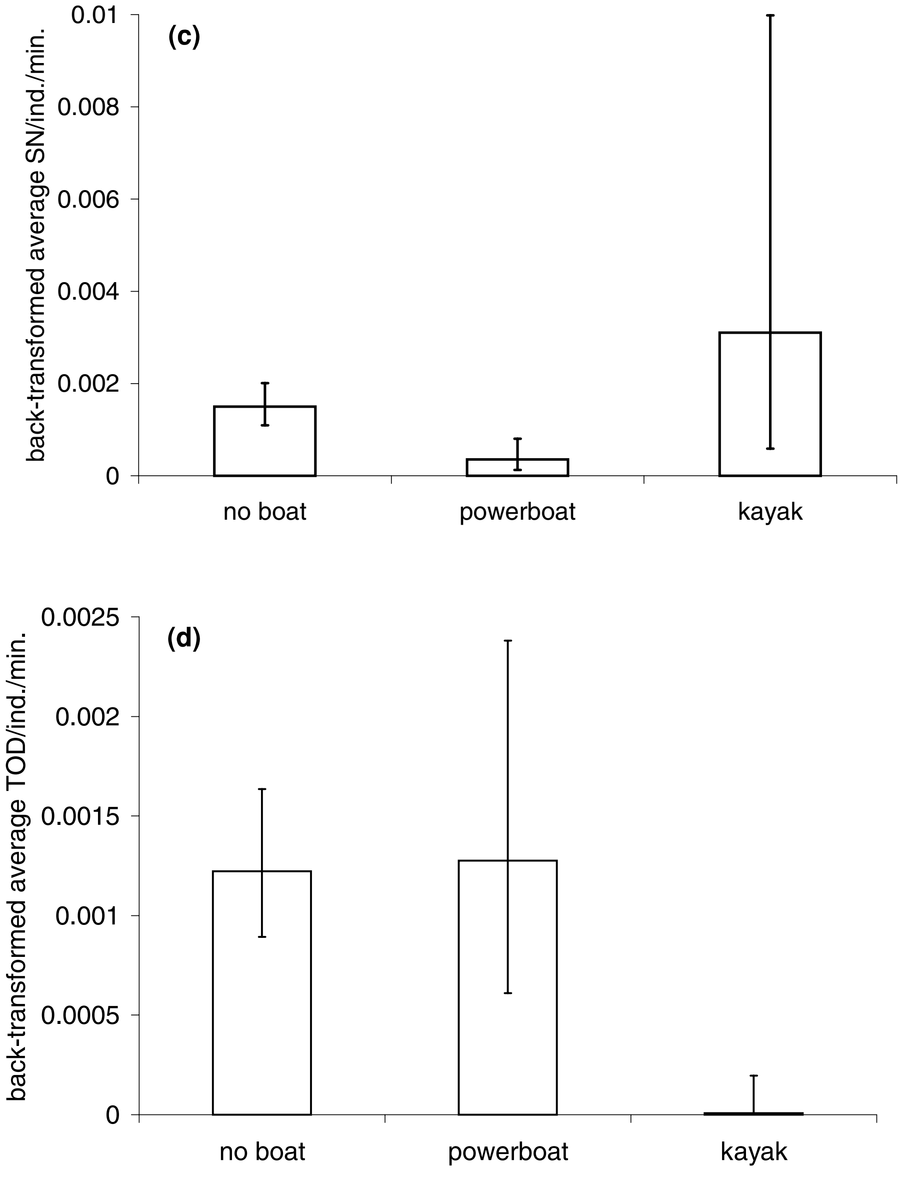

Figure 1. Continued.

Other behaviors showed that the movement of dolphins became more erratic in the presence of vessels (Fig. 1b, 2c). This behavior is typical of predator avoidance tactics (Williams *et al*. 2002), the dolphins trying to elude boat interactions by making their movement less predictable. This avoidance behavior tended to increase, not significantly, when boats violated the MMPR. MMPR violations were strongly

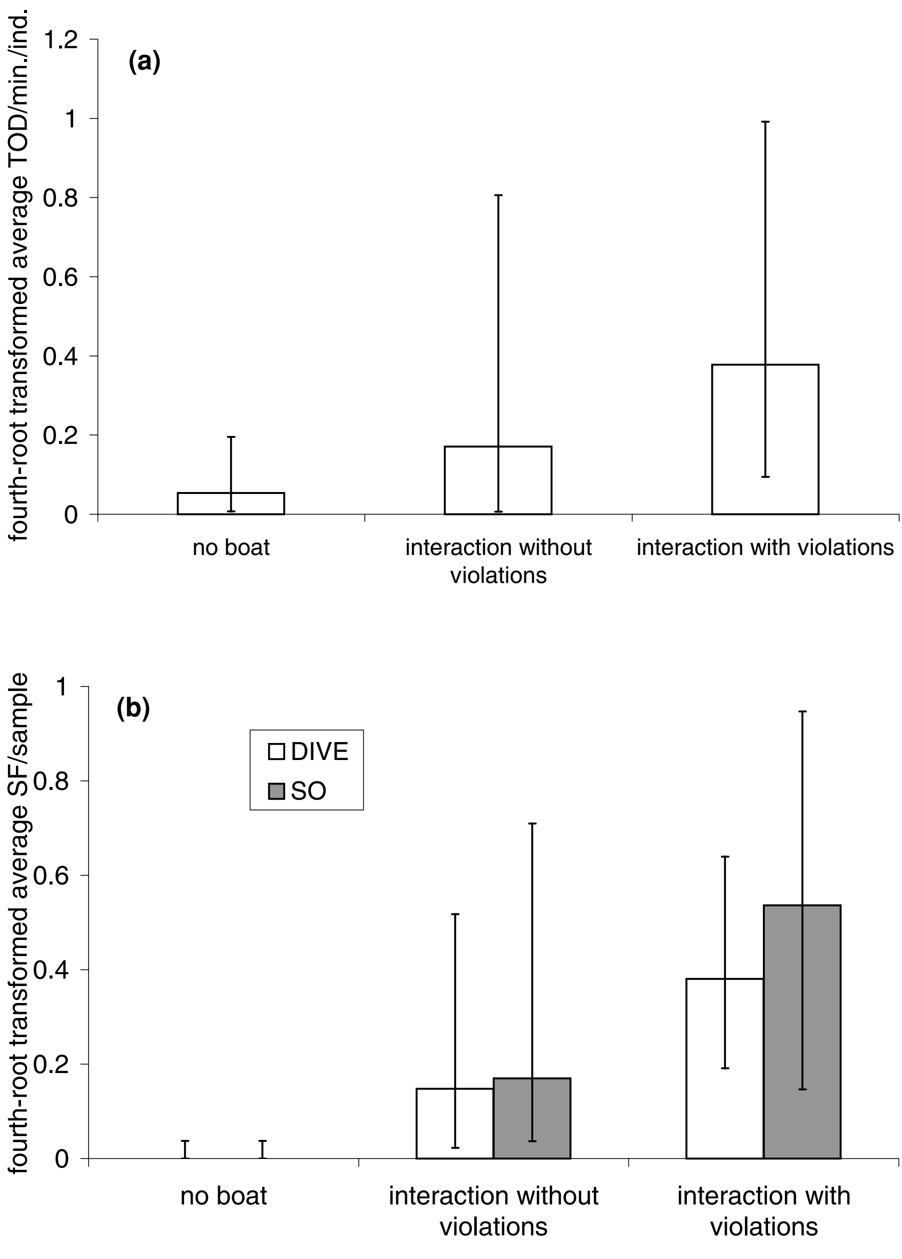

Figure 2. Average number of behavioral events observed depending on the presence of violations of the MMPR during the interaction with dolphins. (a) tail-out dive (TOD) when the school was resting, (b) side flops (SF) when the school was socializing (SO) and diving (DIVE), (c) change of direction (CD) when the school was traveling. Transformed averages are represented so that all categories are graphed on the same scale. Error bars are 95% confidence intervals.

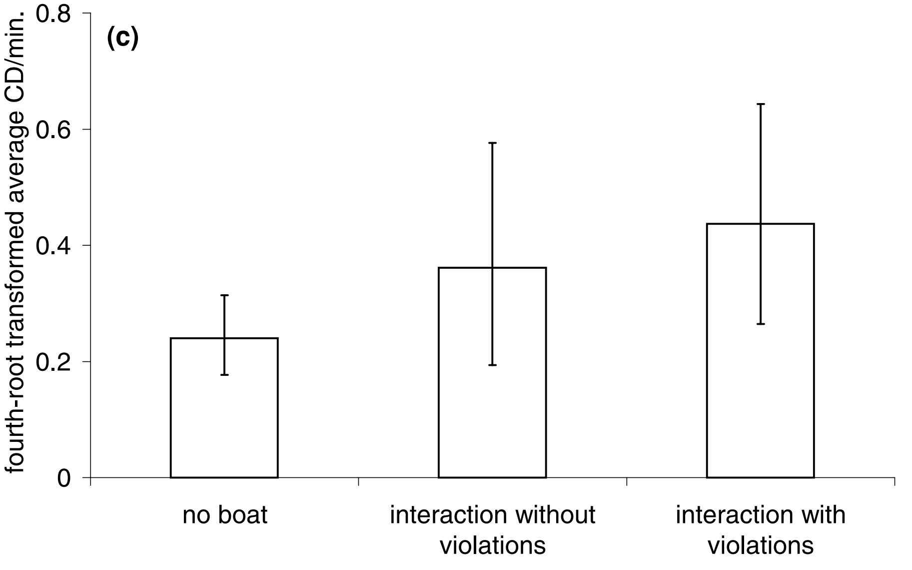

Figure 2. Continued.

linked to the general alteration of behavior during an interaction (Table 9). MMPR violations were also related to an increase in vertical avoidance during resting behavior (Fig. 2a). The frequency of occurrence of steep dives increased with the presence of violations. Dolphins tended to spend more time underwater during interactions that violated the MMPR (Lusseau 2003*c*). This additional behavioral information means that during resting dolphins most likely go deeper in the water column when interacting with an intrusive vessel. Again this vertical avoidance could be linked to an avoidance of boat noise (Fig. 1d), since it is not apparent during interactions with kayaks. In conclusion, it is recommended to respect the MMPR guidelines because they help to minimize the impact of interactions.

The short-term reactions observed during this study corroborate other impacts observed (Lusseau 2003*a,c*). This study provides strong indication that noise emission might be a key component of the impact of boat interactions. However, noise emission is not the sole problem because kayaks can also elicit avoidance responses. This study reinforces the conclusions reached by other recent work (Williams *et al.* 2002, Lusseau 2003*c*, Constantine *et al.* 2004) showing that the key component of a successful dolphin–boat interaction is the constant predictability of the vessel during the encounter.

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Appendix 1. Definitions of the behavioral states, abbreviations for each state are given in parenthesis.

State	Definition
Traveling (TR)	School is moving steadily in a constant direction (faster than the idle speed of the observing vessel). Swimming with short, relatively constant dive intervals. The school spacing varies.
Resting (REST)	School is moving slowly in a constant direction (slower than the idle speed of the observing vessel). Swimming with short, relatively constant, synchronous dive intervals. Individuals are tightly grouped.
Milling (MI)	No net movement. Individuals are surfacing facing different directions. The school often changes direction as well. Dive intervals are variable but short. The school spacing varies.
Diving (DIVE)	Direction of movement varies. School dives synchronously for long intervals. All individuals perform "steep dives," arching their back at the surface to increase their speed of descent. The school spacing varies. Diving most likely represented the "feeding" category in other studies (Shane 1990).
Socializing (SO)	Many diverse interactive behavioral events are observed such as body contacts, pouncing, and hitting with tail. Individuals often change their position in the school. The school is split in small subgroups that are spread over a large area. Dive intervals vary.

Appendix 2. Definition of behavioral events (adapted from Schneider 1999).

Event	Code	Definition
Active surfacing	AS	Rapid surfacing with spray, a major part of the back is visible during the surfacing.
Bubble blow	BB	Exhaling underwater, producing a stream of bubbles.
Bite	BI	One dolphin bites another.
Change of direction	CD	The focal school change of traveling direction by more than 45°and less than 180°.
Chase	CH	Two dolphins actively surfacing following one another.
Eye out	EO	Dolphin lifts its head above water until its eyes are exposed.
Fart blow	FB	Dolphin exhales above water with its blowhole contracted producing a fart-like sound.
Forced blow	FOB	Dolphin forcefully exhales above water produce a loud "chuff" sound.
Headbutt	HB	Two dolphins jump simultaneously and hit their heads together.
Headbutt miss	HBM	Similar to headbutt but without visible or audible contact between the two dolphins.
Head flop	HF	Dolphin jumps, clearing partially its body out of the water, and land on its side.
Horizontal jump	HJ	Dolphin clears its body out of the water, keeping its body in a horizontal position, and re-enters the water head first.
Lobtail	LT	Forcefully slaps the water surface with the tail.
Pounce	PN	One dolphin forcefully nudges another with its beak/shoulder/back.
Side flop	SF	Dolphin jumps clearing its entire body out of the water and lands on its side.
Sharking	SH	Dolphin swims horizontally at the water surface with its dorsal fin visible above water.
Snaggle	SN	Dolphin floats stationary at the water surface, its body horizontally flexed. Dolphin holds breath and contracts melon.
Spy-hop	SP	Dolphin stands vertically in the water with body partially out of the water.

Appendix 2. Continued.

Throat flop	TF	Dolphin jumps and lands on its throat.
Tail out	TO	Tail fluke is lifted clear out of the water, dolphins do not arch its back while surfacing (does stays at the surface), tails re-enter the water without splashing.
Tail-out dive	TOD	While surfacing dolphins arch its back and increase its angle of re-entrance. The tail is lifted out of the water and dolphin dives vertically.
Tail-out jump	TOJ	Dolphin jumps out of the water with its fluke lifted clearly into the air.
Tail slap	TS	Dolphin hits another with its tail fluke.
Tail-stock dive	TSD	While surfacing dolphins arch its back and increase its angle of re-entrance. Only the tail peduncle is lifted out of the water and dolphin dives vertically.
Twisted jump	TWJ	Dolphin twists itself around the longitudinal axis while leaping and re-enters the water head first or belly first.
Twisted surface	TWS	Dolphin twists itself around the longitudinal axis while surfacing actively and re-enters head first.
Upside-down lobtail	ULT	Dolphin is upside-down stationary at the surface, belly pointing upward, and forcefully slaps the water surface with its tail.
Vertical jump	VJ	Dolphin leaves the water vertically, clears its entire body out of the water, and re-enters the water head first in a vertical position.
Weak lobtail	WLT	Dolphin hits the water surface with its tail fluke. Dolphin does not move its tail-stock during the hit, only the tail moves vertically.
Rubbing	RUB	Dolphin rubs on a shallow pebble beach.
Startled		While surfacing dolphin shakes its entire body in an involuntary movement.
Back-flop	BF	Dolphin jumps and lands on its back.
Turnaround	TA	The focal school change of direction by 180°.
Carry weed	WE	Dolphin carries algae on its beak, fin, flippers, or tail fluke.