Behavioral responses of southern right whales to simulated swim-with-whale tourism at Península Valdés, Argentina

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ABSTRACT

Guidelines for sustainable tourism involving swimming with large whales are not well-developed, as most researchers have focused on programs involving swimming with delphinids. From September to November of 2005 and July to October of 2006, we collected behavioral data on southern right whales (*Eubalaena australis*) exposed to controlled interactions with swimmers at Península Valdés, Argentina. Whales were observed before, during, and after a series of directed interactions with three swimmers, and behavioral responses were quantified relative to group composition of whales (mother/calf pair, juvenile or adult/mixed group) and activity level of swimmers (calm or noisy). Resting and socializing decreased and traveling increased during interactions with swimmers. The composition of whale groups had a significant effect on the behavioral response of whales to swimmers. Responses were greater for mother/calf pairs than juveniles, while adult and mixed-age groups showed no significant changes in behavior. Swimmer activity level did not affect the whale's reactions. Increased levels of tourism activity are a concern for females that spend much of their time resting and rarely feed in this nursery ground. Additional research is needed to determine long-term effects of boats and swimmers on whales and to provide effective management guidelines for swimming with large whales.

KEY WORDS: SWIM-WITH, SOUTHERN RIGHT WHALE, *EUBALAENA AUSTRALIS*, TOURISM IMPACT, BEHAVIORAL RESPONSE

INTRODUCTION

Cetacean-watching activities have grown considerably in the last two decades (Hoyt 2001). Previous studies have demonstrated that increased boat activity and human presence in the water can change the behavior of large whales and increase their stress levels (Rose *et al.* 2003; IFAW *et al.* 1996). The majority of cetacean-watching tourism is boat-based and does not involve swimmers entering the water (Hoyt 2001). However, swimming with cetaceans is increasing, as tour operators attempt to provide tourists with more "intimate" interactions with the animals (Bejder and Samuels 2004). At least 29 commercial operators currently offer opportunities to swim with whales, and nine others may do so opportunistically (Rose *et al.* 2003). Swimming with large whales occurs in at least 20 locations globally, including several (Argentina and the Azores) where it is specifically prohibited (Rose *et al.* 2003). Despite the fact that swimming with whales is prohibited by federal law in Argentina, Rio Negro Province legalized swim-with-whale tourism in early 2006 and at least one commercial operation began offering the activity shortly thereafter. In Chubut Province, Provincial Law #2381/84 (modified by Provincial Law #2618/85) "Forbids approach and/or harassment, sail, swim and diving with any marine mammal species and their calves, inshore and offshore, in provincial waters during the whole year."

Previous studies have documented several areas of concern for dolphins in swim-with-dolphin operations. Demonstrated changes in behavior include increased avoidance of swimmers (Constantine *et al.* 2003), increased risk of injury or death due to food provisioning (Samuels and Bejder 2004), and increased vocalizations and echolocation (Scarpaci *et al.* 2000). Not only is there a clear risk of harassment for the animals, there may also be a risk of injury for the human participants (Samuels *et al.* 2000).

Valentine *et al.* (2004) noted that there have been few swim-with studies focused on large whales, and much of the analysis is based on limited data such as anecdotal or opportunistic interactions under uncontrolled conditions (Ritter and Brederlau 1999; Kiefner 2002; Magalhães *et al.* 2002). While data for other cetacean species may apply to large whales, there are enough behavioral differences between large and small cetaceans to warrant further investigation. Whereas small coastal delphinid species may spend much or all of their lives in a discrete area, large whales live long lives and make annual migrations spanning vast areas of the oceans. They typically spend only part of the year in areas where tourism occurs. The Scientific Committee of the International Whaling Commission has noted that the impact of tourism activity may vary by species or site, and each situation should be evaluated on its individual merits (IWC 2000).

Southern right whales (*Eubalaena australis*) migrate annually in the austral winter and spring to mate, give birth, and raise their newborn calves on the nursing grounds off Península Valdés, Argentina (Payne 1986; Payne *et al.* 1991; Cooke *et al.* 2001). The high cliffs of Península Valdés provide a unique opportunity to observe the effects of swim-with-whale tourism on southern right whales in an experimental setting. The Península extends out as a cape and forms two gulfs – Golfo San José to the north and Golfo Nuevo to the south. Adult females use the relatively protected waters of the gulfs to raise their calves during their first 3 months of life (Taber and Thomas 1982, Thomas and Taber 1984, Payne 1986). Juveniles spend much of their time socializing and resting (Sironi 2004), and adults engage in courtship and mating behavior (Payne 1986).

Most of the whales are distributed close to shore in shallow waters (Payne 1986) and are easily reached by boat, which has driven a rapidly expanding local whale-watching industry (Rivarola *et al.* 2001; Sironi *et al.* 2005). Tourism is one of the main industries in the Valdés area, a World Heritage site, and whale-watching is a primary tourist attraction (Sironi *et al.* 2005). The town of Puerto Pirámides is the only departure point for the whale-watch tours. The whale-watching season runs from June to December, with the majority of trips occurring in October and November (Sironi *et al.* 2005). The number of passengers on whale-watch boats has increased at an annual rate of 14% since 1991. In 2004 nearly 100,000 passengers paid to go on whale-watching tours from Pirámides (Sironi *et al.* 2005).

Previous studies at Península Valdés described short-term changes in the behavior and swimming speeds of right whales in response to boat approaches (Garciarena 1988; Campagna *et al.* 1995; Rivarola *et al.* 2001). These studies focused on the responses of whales to whale-watching vessels, and found that solitary whales and groups other than mother/calf pairs increased their swimming speeds in the presence of boats. Swim-with-whale tourism is different from whale-watching, however, because boats must approach very near to the whales before the swimmers enter the water. Additionally, the boat approaches described in previous studies were not controlled by the researchers and the behavior and movement of the whales were not compared before, during and after interactions.

Because right whales are distributed close to shore at Península Valdés, on-shore researchers can observe whales without affecting their behavior. The objective of this study was to describe the behavior of different age classes of right whales and quantify any behavioral changes that resulted from the presence and activity level of swimmers in the water.

METHODS

Data were collected from September through November of 2005 and August through September of 2006 from two different observation stations located on cliffs on the southern coast of the Península in Golfo Nuevo. The first station was located near Cerro Prisma (42° 35' 42.42"S, 64° 48' 42.64"W) and the second was at Playa Manara (42' 40" 33.24˚ S, 64' 59" 25.02˚ W). Both of these sites are within the El Doradillo Municipal Protected Area, where boat traffic is forbidden, so the research boat was the only potential source of human disturbance within several kilometers of the whales.

Study Design

The study was designed as a Before/During/After (BDA) comparison (Bejder and Samuels 2004), with the behavior of the whales before an interaction with boat and swimmers serving as the control data for behavior during and after the interaction. Data were collected on the behavioral state of the whale before the boat approached, during the boat approach and while the swimmers were interacting with the whale, and after the swimmers and boat left the area.

The Before segment (BI) was defined as all activity from the time we began tracking the whale from the cliffs to the time when the boat first approached within ~500 m of the whale. Ending the Before segment when the boat was 500 m from the whale was determined by an analysis of the distance at which the whales first responded to the approaching boat (see Lundquist *et al.* submitted to MMS July 2007). The During segment (DI) began when the boat was within 500 m of the whale, included the entire time the swimmers were in the water, and ended when the boat traveled more than 500 m from the whale. The After segment (AI) was the period of time after the interaction when the boat traveled more than 500 m from the whale. In cases when the whale swam more than 500 m away from the swimmers, the AI segment began immediately when the swimmers exited the water.

The number of swimmers entering the water was fixed at three, because dive operators felt that one dive master and two tourists was the most likely group size if the activity was legalized. Half of the interactions were designated as "Calm", with the swimmers entering the water smoothly and approaching the whales quietly. The other half were designated as "Noisy", with the swimmers splashing in the water, taking pictures of the whales, talking to one another and generally acting like excited tourists. All swimmers participating in the study were experienced divers.

We focused our observations primarily on mother/calf pairs and juveniles, because they are distributed close to shore, are the most abundant age classes at this nursery ground, are more easily approached by boats, and are thus presumably the whales with the highest risk of being disturbed. Mother/calf pairs and juveniles were also chosen because they are most likely to be encountered by swim-with-whale operations. For instance, Rivarola *et al.* (2001) found that mother/calf pairs were the selected target for all whalewatching trips at the end of the season at Península Valdés. Juvenile whales are curious and often seek encounters with boats. All other whale groups (adults or mixed adult/juvenile) were combined and analyzed separately.

Data Collection

We used focal animal observations (Altmann 1974; Martin and Bateson 1993) to record instantaneous point samples of the behavioral state of the focal whale at about two minute intervals before the boat approached (BI), during the boat approach and swimmer interaction (DI), and after the swimmers exited the water and the boat moved 500m or further from the whales (AI). The following mutually exclusive behavioral states were used to define the whales' behavioral budget: 1) resting, 2) traveling, and 3) surface active or social (Table 1). These definitions are similar to those used to describe the behavior of juvenile right whales (Sironi 2004) and mother-calf pairs (Thomas and Taber 1984), but with Surface Active and Social behaviors combined into a single category.

State	Definition
Resting	Whale is motionless and horizontal at surface of water; may also be drifting or slightly below water, surfacing only to breathe.
Traveling	Whale is moving from location to location, leaving visible surface swirls ("footprint") behind in its path.
Surface Active or Social	Whale is causing whitewater at the surface by rolling, breaching, tail- or flipper-slapping; Whale is actively rubbing, touching, or circling around another whale.

Table 1. Definitions of behavioral states of individual southern right whales

The researchers were split into two groups: one researcher was on board the boat with the divers and 2-4 researchers observed from the cliff-top observation site. The researcher on the boat was responsible for taking digital images of the focal whales for identification purposes, recording the reaction of the whale to the boat and swimmers, relaying instructions to the boat captain and swimmers prior to an approach, and recording incidental observations about the whales or swimmers (such as physical contact between them). Hand-held VHF radios were used to coordinate activities between the cliff-top observers and the boat with the swimmers.

The cliff-top team consisted of at least two people. The first was a theodolite operator, who was responsible for continuously tracking the focal whale and the boat using a Sokkisha DT-5A theodolite (30-power magnification) and relaying behavioral information. To eliminate inter-observer variability, the theodolite operator was always the same person. The theodolite was connected to a laptop computer running *Pythagoras* software (Gailey and Ortega-Ortiz 2002). The laptop was operated by the second researcher who was responsible for entering all theodolite and behavior information into the computer in real-time, as well as assisting in tracking the whale using a tripod-mounted 20x wide-angle telescope or binoculars. The behavioral state of the focal whale was recorded with each theodolite fix of the whale's position. In 2005, a third researcher was occasionally present to assist in tracking whales. In 2006, a full-time assistant was added to help track the whales and assist in data collection.

Each follow began by choosing a focal whale close to the cliff-top station, but as far away from the boat as possible (500 m or more), to ensure that the whale's behavior was undisturbed. Regardless of the number of whales or the composition of a group, the focal whale was followed exclusively. In the case of mother/calf pairs, the mother was always the focal whale. The focal whale's behavioral state was recorded every two minutes, on average, although when the whale was underwater and not visible the intervals were longer. After a minimum of 20 minutes of behavioral data was recorded for the BI segment, the boat was directed to begin approaching the focal whale.

The boat then approached the whale, and if it succeeded in getting close enough (10-20 m), the swimmers entered the water. The whale, boat and swimmers were then tracked for a minimum of 10 minutes during the interaction. Interaction time varied, depending on the reaction of the whales. Interactions were stopped at a maximum of 20 minutes of interaction behavior, because the dive operators felt it was the most appropriate length of time for tourists to be in the water. After 20 minutes of interaction were recorded for the DI segment, the swimmers exited the water, the boat moved away, and the whales were tracked for another 20 minutes for the AI segment. If the whale moved more than 3 km from the cliff station or was lost for some other reason, the observations ended and a new whale was selected.

When taking location fixes of multiple objects (whale, boat or swimmers), we alternated between objects and recorded one after another as quickly as possible to get a better estimate of relative positions. The time of boat approach, swimmer entry, swimmer exit and boat departure were recorded in Pythagoras to allow splitting the focal follow into the appropriate BI, DI, and AI segments. For each interaction we recorded whether the whale approached the boat (orienting and moving in the direction of the vessel), was neutral to the boat (no movement towards or away from the vessel), or avoided the boat (orienting and moving away from the vessel). We recorded the same approach, neutral and avoid responses to the swimmers when they entered the water.

Data Preparation and Filtering

Since the data were not collected at even intervals or for equal amounts of time in each case, there was a risk of over- or under-sampling if the values were used in raw form. A mean interval between observations was calculated, and both the behavior and movement data were interpolated using this mean interval. Behavior was assumed to remain constant between observations. That is, if a whale was observed traveling at time 0 and resting at time 1, any interpolated points that fell between the two had traveling as their behavior.

Focal follows were also filtered to include only those that had a minimum of 10 minutes of data in each of the BI, DI, and AI segments. For each of these whales, 10 minutes of each segment were randomly selected for analysis and all other data were disregarded in analyses described here. This ensured that equal amounts of time were compared for all analyses, which reduced the risk of over- or under-sampling. Behavioral transitions were then tallied based on the three 10-minute segments per whale.

Statistical Analysis

Since consecutive behavioral observations were not likely to be statistically independent, they were analyzed as a series of time-discrete Markov chains. To quantify the dependence of each behavior event on the preceding event in the behavioral sequence, we used first-order Markov chain analysis. Following the assumptions used by Lusseau (2003), defining a set of mutually exclusive and wholly inclusive behaviors allowed us to analyze temporal variations in behavior of the whales using Markov chains.

The Markov chain could then be used to build a matrix of preceding behavior (at time 0) versus succeeding behavior (at time 1) for each transition within the BI, DI and AI chains. The transition probability for each behavioral state transition could then be calculated by dividing the number of times a transition from preceding behavior i to succeeding behavior j was observed by the total number of times i was seen as the preceding behavior. By comparing the calculated probabilities between control and impact chains using a Z-test for proportions (Fleiss 1981), it was possible to test whether the interaction with boat and swimmers had a significant effect on the behavior of the whales.

The analysis described above was performed on the entire dataset, regardless of group composition (mother/calf pair, juvenile or other) or interaction type (calm vs. noisy). Due to small sample sizes for each group type and interaction type, it was not possible to accurately compare transition probabilities. To examine the effects of these parameters on behavioral transitions, Log-linear analysis (LLA) was performed using SPSS version 13.0.1 for Windows (SPSS Inc. 2004).

LLA allows the manipulation of the parameters (and the interactions between them) that are considered when fitting the model to the data. The analysis was conducted by including all possible combinations of parameters and interactions between parameters (Table 2). Maximum likelihood for the model is then approximated by G^2. Comparing the results for a specific model to the fully-saturated model gave the effect due to whichever parameter was missing from that model. Difference in G^2 and degrees of freedom between the two models were tested to determine if the parameter was significant or not. Akaike Information Criteria (AIC) values were calculated to choose the best-fitting model. AIC assists in selecting the most parsimonious model by rewarding a model for providing information and penalizing it for using extra parameters to do so (Anderson *et al.* 2000, Caswell 2001). This technique is described in detail in Lusseau (2003, 2004).

RESULTS

Work Effort

Over the 108 days of two field seasons, we had 36 days of field work. Many work days were lost due to weather, as the boat could not safely operate and put swimmers into the water and retrieve them when winds were higher than about 13 knots. In total, we attempted to approach 184 groups of whales (Figure 1). Groups listed as "No Swimmer Interaction" are those where the boat approached, but the whale evaded it to such a degree that the boat was not able to get close enough for swimmers to enter the water. Mother/calf pairs evaded the boat much more often than other group types: 27% for mother/calf pairs, 5% for juveniles and 7% for mixed groups.

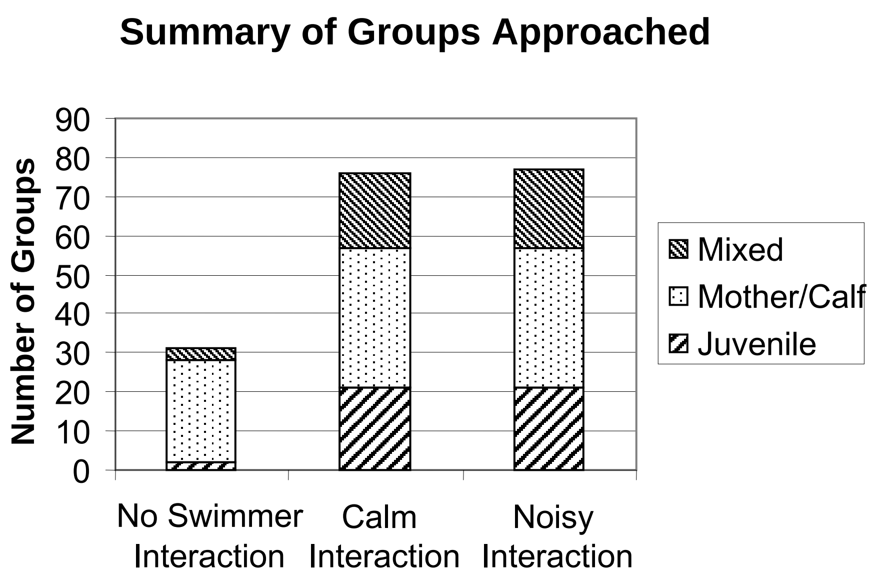

Figure 1. Number of groups approached by interaction type and group composition. Percentage of each interaction type is shown for each group type.

A total of 153 approaches with swimmer interactions were conducted. After applying the filtering criteria described in Methods, 93 interactions remained for analysis, including 38 mother/calf pairs, 25 juvenile groups, and 30 mixed groups. Most groups were filtered out because the DI segment was shorter than 10 min. In two instances the same mother/calf pair was involved in two interactions in one day. In both cases, the second interaction was filtered out of the analysis because it did not meet the criteria described in Methods. In two cases, an attempt was made to interact with the same mother/calf pair on different days. With one of the pairs, the whales were approached three times in 5 days but the boat could never get close enough for the swimmers to enter the water. With the other pair, swimmers entered the water twice, but the interactions were filtered out because they did not meet the criteria described in Methods. The only whale that had two interactions that were included in the analysis was a juvenile that was approached 3 weeks apart at two different locations. In the first interaction, the juvenile was alone, and in the second, it was part of an adult/mixed group.

Focal follow data included 32 hours of control data in the BI segment, 36 hours in the DI segment, and 23 hours in the AI segment. BI segments averaged 21 minutes (SD = 20 min, Range = 10-56 min), DI segments averaged 11 minutes (SD = 19 min, Range = 10-86 min), and AI segments averaged 23 minutes (SD = 22 min, Range = 10-40 min). The interaction with a DI segment of 86 minutes occurred early in the study when the swimmers entered the water multiple times in succession with a single whale. This interaction was filtered from the final data.

The mean length of time between behavioral state observations was 2.67 minutes (SD = 2.28 min.) in the BI segment, 1.85 min. (SD = 1.95 min.) in the DI segment, and 2.48 min. (SD = 1.95 min.) in the AI segment. These time differences indicate a slight observer bias during the DI period, which was probably due to the researchers attempting to track three objects (whale, boat and swimmers) at once. Additional data were collected during interactions in an attempt to obtain accurate distances between the objects. Because all means were about 2 minutes long, two-minute intervals were chosen as the interpolation time period for subsequent analyses. After interpolation, a random 10-minute bin was chosen from each BI, DI, and AI segment of each follow, resulting in 15.5 hours of data for each segment. A total of 465 transitions were then tallied within each segment.

Log-linear Analysis of Behavioral Model

We performed a series of log-linear analyses to determine which variables affected the behavior of the whales. Because there were small numbers of surface active and social behaviors recorded, it was necessary to consolidate all active behaviors (traveling, surface active/social) and compare them against resting behavior. The null model was that succeeding behavior (S) was dependent on preceding behavior (P), but independent of boat and swimmer presence (B), group composition (G) and interaction type (I). This corresponds to a model of (PS, BGIP) in SPSS (SPSS Inc. 2004). Models using every combination of these variables were tested using LLA. Boat presence (BPS, BGIP) and group composition (GPS, BGIP) significantly affected the behavior of the whales. The best model took both boat presence and group composition (BPS, GPS, BGIP) into account (AIC = -60.5, Table 2). The boat effect was stronger than the group composition effect, but using both explained more variance in the model (ΔAIC = 23.3).

The model that took into account boat presence, group composition and interaction type but not interactions between the variables (BPS, GPS, IPS, BGIP) was also found to be plausible (AIC = -58.1, ΔAIC = 2.4, Table 2). The interaction type term never had a significant effect when it was added to the model and therefore did not provide additional information regarding changes in behavior.

Model	AIC	ΔAIC
Boat + Group	-60.5	0
Boat + Group + Interaction type	-58.1	2.4
Boat + (Group x Interaction type)	-51.9	8.6
Group + (Boat x Interaction type)	-47.3	13.2
Boat	-37.2	23.3
Boat + Interaction type	-35.3	25.2
Boat x Group	-33.8	26.7
Interaction type + (Boat x Group)	-31.8	28.7
Boat x Interaction type	-24.2	36.3
Group	-16.2	44.3
Interaction type + Group	-13.3	47.2
Interaction type x Group	-7.7	52.8
Null model	2.8	63.3
Interaction type	4.7	65.2

Table 2. Akaike Information Criteria values for each model.

Behavioral Responses of Whales to Interactions with Swimmers

When all data were pooled and analyzed, regardless of group composition or swimmer activity level, swimmer interactions had a significant effect (Z-test for 2 proportions, $P < 0.05$) on four behavioral transition probabilities when comparing the BI and DI segments. Transitions from resting to resting (i.e., remaining in a resting state) and surface active/social to surface active/social both showed a significant decrease of

-29%. Resting to traveling transitions significantly increased by 24%, and surface active/social to traveling showed a significant increase of 26%. The results for all behavioral transitions are shown below, with negative numbers indicating a decrease in behavioral transition (Figure 2).

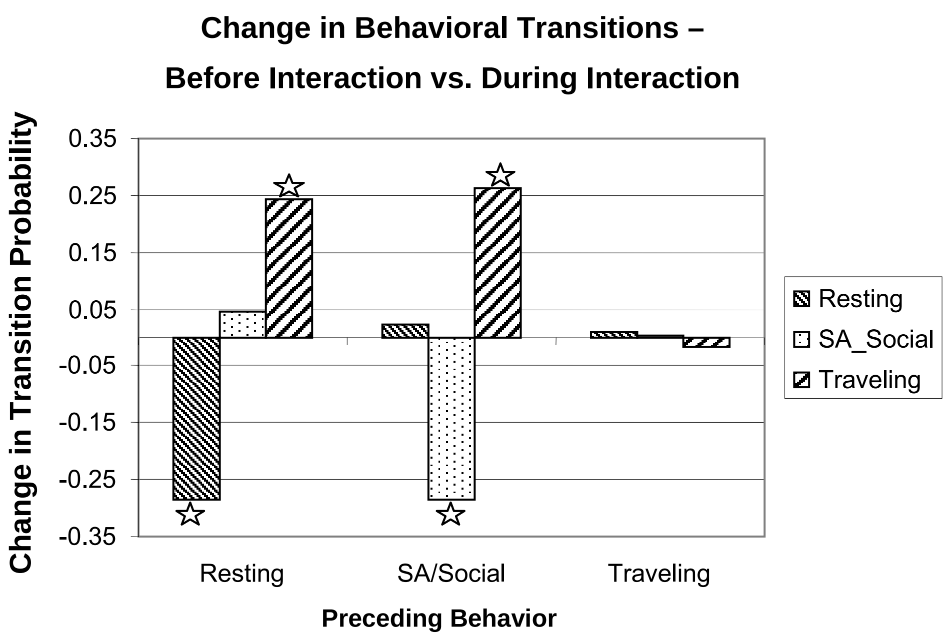

Figure 2. Difference in transition probability between BI and DI segments. Transition probabilities with significant differences ($p < 0.05$) are marked with a star.

Three transitions remained significantly altered when comparing the BI segment to the AI segment. Resting to resting (-10%) and traveling to traveling (-5%) both showed significant decreases. Traveling to resting showed a significant increase of 3% (Figure 3).

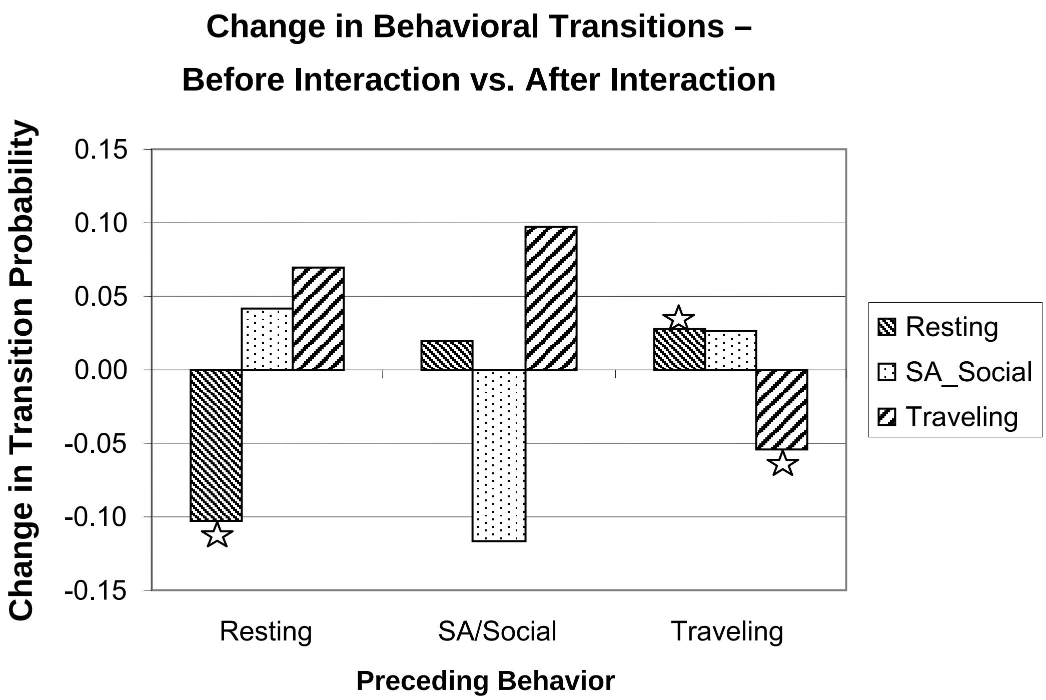

Figure 3. Difference in transition probability between BI and AI segments. Transition probabilities with significant differences ($p < 0.05$) are marked with a star.

Whales changed the proportion of time spent in each behavioral state during interactions. They spent significantly less time resting (-12%) and engaging in surface active/social behaviors (-9%), and significantly more time traveling (22%) in the DI segment (Figure 4). The whales returned to the same proportion of each activity after the interaction was over (Figure 4).

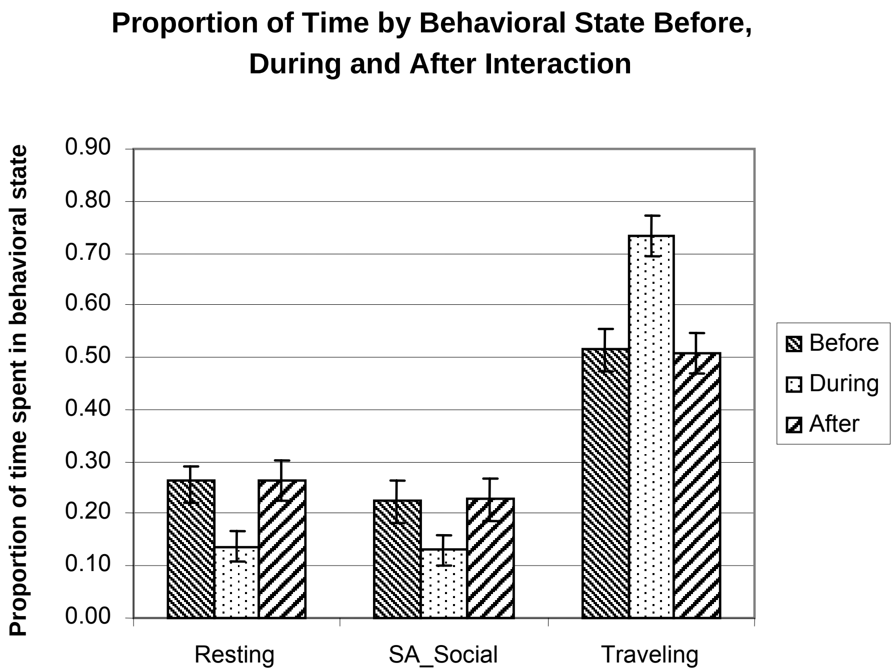

Figure 4. Proportion of time spent in each behavioral state before (BI), during (DI) and after (AI) interactions with swimmers. Error bars are 95% confidence intervals.

Behavioral Responses of Groups of Different Composition

For the analysis of the behavioral response of whale groups of different composition to interactions with swimmers, all traveling and surface active/social behaviors were aggregated into the category of active behaviors to compensate for small sample sizes. Behavioral transitions changed in the same direction in the three group types. Mother/calf pairs and juveniles significantly (Z-test for 2 proportions, $P < 0.05$) decreased resting to resting transitions (-31% and -24%, respectively) during swimmer interactions relative to the BI segment, and significantly increased resting to active transitions (31% and 24%, respectively). Other groups (adults or a mix of adults and juveniles) had a non-significant decrease in resting to resting transitions (-24%) and an increase in resting to active transitions (24%) (Figure 5). Behavior of whale groups was not significantly different before (BI) and after (AI) interactions with swimmers, although resting to resting transitions remained at a slightly decreased level (-11%, -9% and -8% for mother/calf, juvenile and other groups, respectively) and resting to active transitions remained at an elevated level (11%, 9% and 8% for mother/calf, juvenile and other groups, respectively).

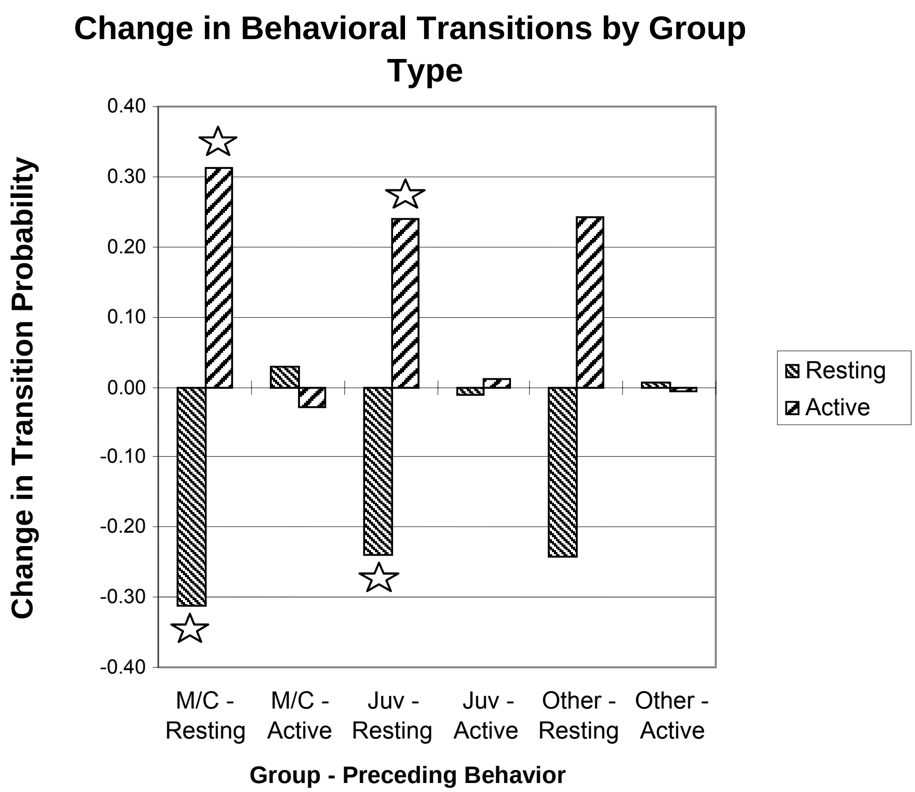

Figure 5. Difference in transition probability between BI and DI segments for groups of different composition. Transitions with significant differences ($p < 0.05$) are marked with a star.

Effects of Swimmer Activity Level

Whales that were initially resting were significantly affected by both calm and noisy interactions (Z-test for 2 proportions, $P < 0.05$). Transitions from resting to resting decreased significantly for both calm (-32%) and noisy (-25%) interactions relative to the BI segment, while resting to active increased significantly for calm (32%) and noisy (25%) interactions. However, whales that were initially active showed no significant change in behavior as a result of calm or noisy interactions when comparing BI and AI transitions. Resting to resting transitions remained at a slightly decreased level (-12% and -9% for calm and noisy interactions, respectively) and resting to active transitions remained at an increased level (12% and 9% for calm and noisy interactions, respectively) after the boat and swimmers left the whales.

Underestimation of Magnitude of Changes

The magnitude of changes shown here are underestimated, particularly for mother/calf pairs. There were 31 groups that we attempted to approach and swim with, but were unable to because the whales evaded the approaching boat. The majority (n = 26) of these groups were mother/calf pairs, and they typically swam away quickly, reorienting and staying underwater for a long time to avoid the boat. Sixty groups were eliminated from the analysis during data filtering, generally because the DI time period was too short to be of value. Of these 60 groups, 57% (34) were mother/calf pairs. Mother/calf pairs typically avoided the boat and swimmers and reduced interactions to less than 10 minutes. In total, 49.5% of all groups (91 of 184) and 61% of mother/calf pairs (60 of 98) that were approached evaded the boat or swimmers.

DISCUSSION

The behavior of southern right whales changed significantly during interactions with swimmers compared to their behavioral state before the interaction. The behavioral changes lasted throughout the interaction and some changes continued after the interaction had ceased. Group composition was an important factor in predicting the behavioral response of the whale to the interaction, while swimmer behavior had no obvious effect.

Overall Response of Southern Right Whales to Interactions with Swimmers

Whales were significantly more likely to cease resting or socializing and begin traveling when interacting with the boat and swimmers. Whales which were resting initially were 30% less likely to remain resting during the interaction with the boat and swimmers than if no interaction occurred. Changes in the proportion of time spent in each behavioral state resulted in less time being spent resting and socializing, and more time spent traveling. The reduction in resting time and increase in travel time has the potential to increase energy expenditure at a site where little food is available for the whales to replenish fat reserves (Payne 1986).

Previous studies at Península Valdés have described short-term behavioral changes in southern right whales (Rivarola *et al*. 2001) and dusky and Commerson's dolphins (Coscarella *et al*. 2003) when approached by whalewatching boats. The experimental interactions with swimmers presented in this study have also shown changes in behavioral patterns of right whales. While changes in whale behavior as a result of swim-with tourism may be short-lived, the overall effect of adding swim-with tourism to whale-watching, industrial boat traffic, fisheries, and other human activities at Península Valdés could have a detrimental long-term effect on the whales. Rowntree *et al.* (1998) found that attacks by kelp gulls (*Larus dominicanus*) reduced the proportion of time mother/calf right whale pairs spent in rest and slow travel by 39% and resulted in altered behavior for as long as 30-60 minutes after an attack. This raises concerns that right whales at Península Valdés are being subjected to a growing set of disturbance factors. Baker and Herman (1989) suggested that the cumulative effects of stress due to near-constant disturbance may reduce the individual fitness. Cumulative experience between bottlenose dolphins and swimmers in New Zealand increased avoidance of swimmers and decreased interactions (Constantine 2001).

During the 1980's, right whales shifted their distribution along the shoreline of Península Valdés and abandoned a preferred nursery area (Rowntree *et al*. 2001). Animals may change their distribution to avoid the swim-with activities, or be forced to cope with the effects of it because they are unable to avoid it (Bejder *et al.* 2006). Whether short-term changes add up to a significant deleterious effect in the long-term may be driven by the level of swim-with activity allowed, as reported for bottlenose dolphins in New Zealand (Lusseau 2004). If the number of permitted operators is limited (as it is with whale-watch activities at Valdés) and the tourism is confined to specific areas and times of year, the effects may be minimal. Alternatively, if the tourism occurs in a broad range of areas and many operators are permitted, the animals may become sensitized or habituated (Fowler 1999; Constantine 2001) or they may leave preferred areas for sub-optimal habitat (Reeves 1977; Gibeau *et al.* 2002).

Responses of Different Group Types to Interactions with Swimmers

The behavior of mother/calf pairs is significantly affected by interactions with swimmers. When undisturbed, mothers typically spend 79% of their time resting and traveling slowly (Rowntree *et al.* 1998). They are primarily fasting while on the nursery ground and depend on blubber supplies accumulated months before on the feeding ground for their energetic expenditures and the behavioral development of their calves (Rowntree *et al.* 1998). They are a group particularly vulnerable to disturbance, as the mothers are primarily fasting while nursing their calves and preparing them for the long journey to the feeding grounds at the end of the season (Payne 1986). Human disturbance has negative effects on the reproductive success of terrestrial mammals such as elk (*Cervus canadensis*) (Shively *et al.* 2005) and hoatzin chicks (*Opisthocomus hoazin*) (Mullner *et al.* 2004). Magellanic penguin (*Spheniscus magellanicus*) chicks appear to have a heightened adrenocortical response to handling when they have been previously exposed to tourists (Walker *et al.* 2005). If swim-with tourism becomes widespread and frequent enough to significantly alter the behavior of mother/calf pairs over the course of an entire calving season, it may have a negative effect on survival rates of calves. A study examining the energetic balance of right whale calves could provide information to determine the impact of swim-with tourism and other human activities on reproductive success and calf survival.

Juvenile right whales spend as much as one-fifth of their time resting and one-half of their time playing or socializing at Península Valdés (Sironi 2004). Juveniles are also observed in proximity of surface active groups where they may be learning courtship and mating behavior (Payne 1986; Kraus and Hatch 2001). Individuals in mixed groups often separated when the boat and swimmers approached. Interrupting resting and socializing bouts may result in deleterious effects on the development of the juveniles. The magnitude of the changes in behavior for adult/mixed-age groups was equal to that of juveniles, but was not statistically significant, most likely due to a small sample size.

Though adult/mixed-age groups were not significantly affected by swim-with tourism, they did respond negatively to approaches in some circumstances. For example, four of the 7 courtship groups with which we interacted were split up by the approach of the boat and swimmers. Such effects, if numerous or sustained over the season, may decrease the likelihood of conception. It is also undeniably dangerous for the swimmers to enter the water with whales that are as boisterously active as they are in courtship groups.

Effects due to the Behavior of Swimmers

Whales did not respond to differences in the activity level of the swimmers. The best predictor of a whale's reaction to swimmers was its initial behavioral state. If the whales were initially resting, they were significantly less likely to remain resting and more likely to begin traveling, regardless of how swimmers behaved. It is possible the whales detected the approach of the boat acoustically long before the swimmers entered the water and acted either "calm" or "noisy" in their presence.

Comparison Between Swim-with and Whale-Watch Tourism

There is an established and growing whale-watch industry in Puerto Pirámides, the only town on Península Valdés where whale-watching is offered. Many of the avoidance behaviors observed during this study were in response to the approach of the boat. The current whale-watch regulations in Chubut Province establish a minimum approach distance to right whales of 100 meters with engines on and 50 meters with engines off (Provincial Law #2381/84). These regulations are currently being revisited for a variety of reasons and the results of this study should be taken into account when the new whale-watch regulations are developed.

Because the swim-with boats must approach the whales close enough to put swimmers in the water within visual distance of the whales (in order for the activity to be considered "successful" by the tourists), we would expect the swim-with boats would have a greater impact on the whales than the whale-watch boats. The rate of speed of approach for swim-with boats is generally higher in order to approach the whales closely. With the addition of humans in the water, we would expect the overall effect of swim-with interactions on the behavior of the whales to be significantly greater than whale-watch tourism. This does not rule out, however, that whale-watch boats are affecting the whales in a similar manner from distances much greater than the current regulations permit. A comparative study between the effects of whale-watch boats and swim-with boats would be valuable.

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