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Wildlife tourism: Underwater behavioral responses of South American sea lions to swimmers

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ABSTRACT

The aim of the present study was to describe the type of interaction between swimmers and sea lions, during tourist trips, at a small colony in Northern Patagonia, Argentina. Particularly we explored if sea lions would show agonistic behaviors towards people, or behaviors that potentially poses a danger, and to detect which interaction may produce such behavior. Underwater sea lions behavior was recorded by videotapes, and significant behavioral sequences were determined by two-event sequences analysis. During the resting period, sea lions swim around and look at the swimmer most of the time, and vice versa. During the pupping period, sea lions breathe more frequently during these behavioral sequences. During both seasons, the sequences including *bites* as the target behavior were significant (Adjusted residuals z-scores larger than 1.96 at the $p < 0.05$ level). These sequences consisted mainly in a sea lion allowing a swimmer to touch it and then biting him/her and a sea lion allowing a swimmer to touch it and then going away. Although these bites did not finished in cutting wounds, they represent potential risk of injuries. These results support the recommendation of no allowance of physical contact, or at least no looking for physical contact actively.

1. Introduction

Wildlife watching is one of the fastest growing sectors of tourism worldwide. It covers a spectrum of opportunities for tourists to interact with non-domesticated animals in their natural environment. This type of tourism generates economic and social benefits, by means of direct and indirect incomes but also stimulating local development (Tapper, 2006). In this context, marine mammals and the marine environment have driven a significant part of this growth, representing a large industry nowadays. In particular, whale watching generated U.S.$2.1 billion in total expenditures in 2008, growing at a rate of 3.7% per annum between 1998 and 2008 (O'Connor et al., 2009). Whales, dolphins and porpoises are the main target for this industry, however pinniped-focused tourism (seals and sea lions) has also expanded due to several behavioral traits these animals present: species are generally colonial, providing a viewing spectacle, their annual attendance patterns at sites are predictable, and they exhibit interactive and 'playful' behaviors which appeal to the public (Kirkwood et al., 2003). Viewing experiences with pinnipeds range through guided tours on-shore, boat cruises, and swimming and scuba diving interactions.

Pinniped-focused tourism is largely unregulated, in comparison with whale-watching. However, guidelines are necessary for conservation goals, to ensure the impact of tourist presence is minimal and does not affect population sustainability. Possibly generated by a large history of exploitation and populations depletion, most concerns about pinniped-based tourism, focused on the negative impacts of tourism on individualsí fitness and population sustainability. Among them, it can be mentioned changes in behavior, site abandonment, stampeding, disturbance to suckling bouts and reduced reproductive rates (Cowling et al., 2014). However, tourists interacting with wild marine mammals very close, like swimming and diving with, may be exposed to unpredictable reactions and potential injury. This area of research has received less attention, and it is also needed to generate guidelines and minimize risks.

In Patagonia, Argentina, the World Heritage Protected Area Península Valdés (PV), represents an important target for national and international tourism year-round. The presence of elephant seals *Mirounga leonina* and sea lions *Otaria flavescens*, promoted the creation of wildlife reserves in the 60′s which attracted the first visitors to the area. Later, Southern Right Whales *Eubalaena australis* and Maguellan penguins *Spheniscus magellanicus*, promoted the rapid development of the tourism industry. At present more

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than 250,000 tourist come every year to watch whales, and a similar figure visit the penguins. Pinnipeds are a secondary attraction, however the rapid growth of the industry promoted the diversification of activities, looking for novel and alternative attractions like diving and swimming with marine mammals.

At present, a small colony of sea lions located very close to one of the main urban centers, Puerto Madryn, is being visited by tourists year-round. The colony is visited mainly for viewing sea lions from a small cliff (20 mts approx.). However, an experimental boat-based swimming and diving program started in 2005. The whole tour consists in carrying tourists to the proximity of the colony, sailing in a small boat, stop sailing at a distance of 70 mts from the shore where sea lions are located, and allowing tourists entering the water and snorkeling. Tourists may swim a short distance to approach sea lions but most of times sea lions are attracted to tourists by curiosity.

The aim of the present study was to describe the type of interaction between swimmers and sea lions, in particular if sea lions would show agonistic behaviors towards people, or behaviors that potentially poses a danger, and to detect which interaction may produce such behavior. It is expected that results of this study may serve for avoiding undesired behaviors and considered at the moment guidelines and regulations were to be stablished.

2. Materials and methods

2.1. Study area

The study was carried out at Punta Loma, 12 km from Puerto Madryn (Fig. 1). In this site, South American sea lions are present during the whole year. The site is under protection and managed as a Natural Protected Area administered by the Department of Conservation and Protected Areas of the Chubut Province. This protection level implies that a limited number of activities can be done, like visiting and watching sea lions by land, the existence of an exclusion zone for boats traffic, and the presence of rangers controlling that people walk by habilitated paths.

The colony is mainly a haul-out site but a small breeding area is formed during the austral summer. The number of pups born at this colony increased at an annual rate of 15% between 1970 and 2002 (Dans et al., 2004). Even that, the nonbreeding fraction still represents more than 80% of the total number (Grandi et al., 2008). During the pupping period, the total number of sea lions is close to 500 and this figure may be doubled during the winter (unpublished data).

Commercial swim-with sea lions trips were monitored by researchers from June 2011 to March 2012. During this period 8 companies operated, although they were not active at the same time, depending on the number of tourists visiting the zone. The maximum number of boats in the surroundings of the colony was three, and the maximum number of tourists engaged in a swim-with sea lion was 20 per bout, with a maximum of six tourists per boat plus the scuba divers guides.

2.2. Sampling methodology

During tours, underwater sea lions behavior was recorded by videotapes, taken by scuba-diving personnel of the company engaged in the tour. Tourists only did snorkeling. Observations were made on these underwater videotapes. Personnel engaged in recording videos were previously instructed by researchers. The recording protocol consisted of picking up a sea lion at random and following it as long as possible. During the follow, the sea lion could approached a tourist or vice versa. If the sea lion went away, another sea lion was chosen and followed. Videotapes from different tours and days were stored and then facilitated to researchers.

Table 1
Events defined for behavioral sequences analysis during the interactions between sea lions and swimmers.

Code	Description (the action refers to what a sea lion does)
S	swims around or very close to a swimmer
CS	leaves a swimmer and get close to another
LS	looks at a swimmer without any movement
TN	touches a swimmer with the nose
TF	touches a swimmer with the flip
LT	keeps quiet when a swimmer touches it
A	goes away when a swimmer touches it
PB	plays with bubbles
Bi	bites
Br	goes to the surface, breathes and dives again
KS	goes to the surface, breathes and keeps at the surface
SEX	mimics copulatory behavior with a swimmer

The study focused on which behavioral events occur, how often they occur and in what order they occur, during the interaction. Then, data consist of a continuous record of successive events. Events were defined as short lasting behaviors (Altmann, 1974; Lehner, 1998). Based on preliminary observations on underwater sea lions behavior, 12 events, mutually exclusive and exhaustive, were defined (Table 1). Videotapes were reproduced in a computer. Each individual follow was observed continuously, recording each time a behavioral event occurred. The occurrence of events was recorded by using the program Etholog®.

2.3. Data analysis

Sequences were extracted as double- entry tables by using the same program, extracting one table for each individual follow. As 12 events were defined, each table consisted of 12 files and 12 columns. These tables conformed transitional frequency matrices, where each cell contained the number of times a given behavior *G* was followed by a target behavior *T*, files representing given behaviors and columns target behaviors (Bakeman and Gotman 1997; Nowacek, 2002; Slooten, 1994). It must be denoted that in some instances, a behavior may be followed by the same behavior, and these occurrences are represented on the diagonal of the matrix.

	T_1	T_2	T_3	⋯	⋯	⋯	T_{12}
G_1	$x_{G_1T_1}$	$x_{G_1T_2}$	$x_{G_1T_3}$				
G_2	$x_{G_2T_1}$	$x_{G_2T_2}$	$x_{G_2T_3}$				
G_3	$x_{G_3T_1}$	$x_{G_3T_2}$	$x_{G_3T_3}$				
⋮							
⋮							
⋮							
G_{12}							

These matrices were exported to excel files for further analysis. Matrices corresponding to sequences sampled from June to December were combined and assigned to the “resting period”, while those sampled from January to March, were combined and assigned to the reproduction or “pupping period”. The proportion of time each event occured was obtained following Dans et al. (2012) and Grinstead and Snell (1997).

In order to detect if first-order sequences (given event *G*, target event *T* occurs immediately after) really exist, we tested if observed transitional probabilities deviate significantly from their expected values. We used a z score to compare observed versus

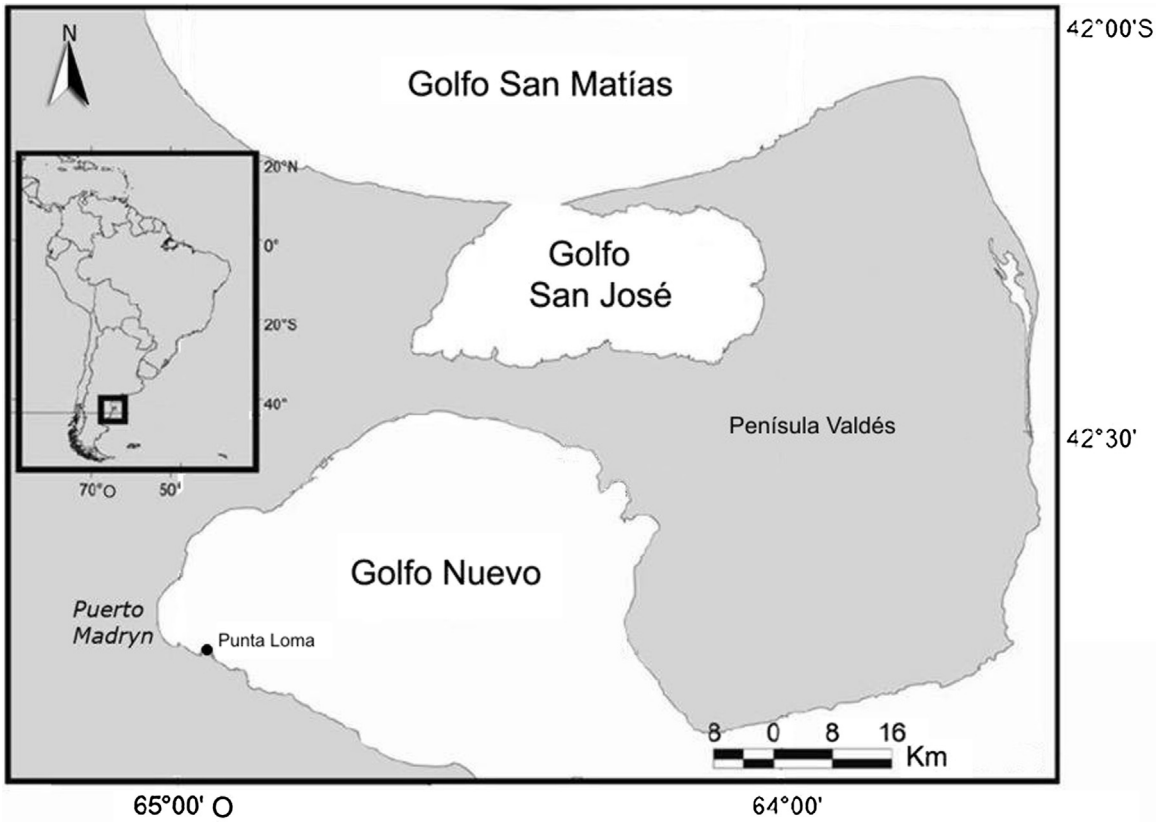

Fig. 1. Map indicating the location of the study site, Punta Loma, Chubut Province, Argentina.

expected transitional frequencies (Bakeman and Gotman, 1997). The expected values m_{GT} and z-scores z_{GT} were computed as follows:

$$m_{GT} = \frac{x_{G+}x_{+T}}{x_{++}}$$

where x_{G+} is the sum of the observed frequencies in the Gth row, x_{+T} is the sum of observed frequencies in the Tth column, and x_{++} is the total number of tallies in the matrix, and

$$z_{GT} = \frac{x_{GT} - m_{GT}}{\sqrt{m_{GT}(1-p_{G+})(1-p_{+T})}}$$

where p_{G+i} is x_{G+} divided by x_{++} and p_{+T} is x_{+T} divided by x_{++}. Adjusted residuals (z-scores) larger than 1.96 or lower than −1.96 indicate the observed occurrence is significantly different from the null hypothesis at the $p < 0.05$ level, with the null hypothesis being that the two behaviors are not sequentially related.

3. Results

Data were collected from 466 focal follows, 207 during the resting period and 259 during the pupping period. Most follows were recorded in January and February (Table 2). Follows lasted 38 s at most. From these follows, a total of 712 two events sequences were extracted for the pupping period and 816 for the resting period.

During the resting period, sea lions swim around and look at the swimmer most of the time, representing 28.3 and 16.8% of the total behavioral events scored (S and LS behaviors in Fig. 2). A sea lion "biting" a swimmer was the third more frequent behavioral event, while a sea lion exhibiting copulatory behavior was observed with a very low frequency (B and SEX behaviors in Fig. 2).

Most of times a sea lion swam around for a while and then look at the swimmer, or vice versa, or swam around a swimmer

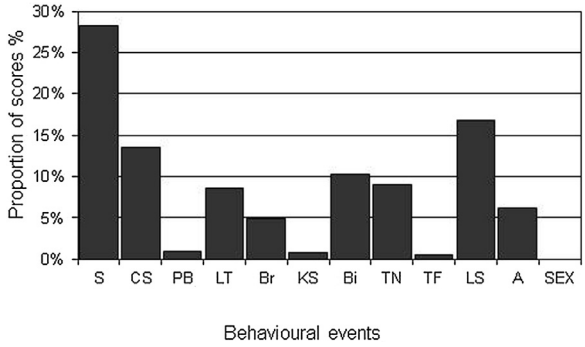

Fig. 2. Occurrence of each behavior (event) defined for sea lions interacting with swimmers during the resting period (June to December). See Table 1 for behavioral events captions.

and then left him/her and went to another swimmer. Some transitions (16 out of 144) were most frequent than expected by chance, then behaviors involved were sequentially related (z-scores larger than 1.96, $p < 0.05$). These transitions are represented in Fig. 3. Among them, the sequences *swims around* followed by *looks at the swimmer* (z-score 6.31), *looks at the swimmer* followed by *touches with the nose* (z-score 2.72), and *touches with the nose* followed by *swims around* (z-score 4.47), are all significant, which indicates sea lions showed the behavioral sequence S → LS → TN → S, which means a sea lion swims around the swimmer, looks at him/her, touches him/her with the nose and swims around him/her again. Additionally the sequences including *bites* as the target behavior were also significant, *touches with the nose* followed by *bites* (z-score 2.26), and *keeps quiet and allows to be touched* followed by *bites* (z-score 2.04). The sequence *bites* followed by *swims around* was significantly larger than expected (z-score 3.34) and then sea

Table 2
Number of individual sea lion focal follows by season and month recorded by video tapes during diving tours.

	Pupping season			Resting season						
	January	February	March	June	July	August	September	October	November	December
Number of focal follows	141	86	32	7	7	13	28	60	49	43

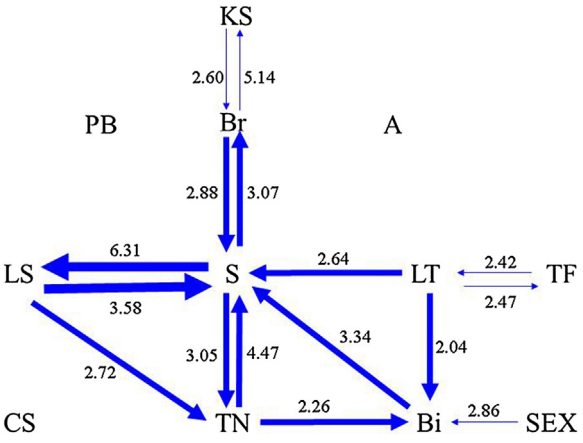

Fig. 3. Two-event sequences diagram of sea lions interacting with swimmers during the resting period, showing transitions with z-scores higher than 1.96. Arrows width represents the probability with which transitions occurred.

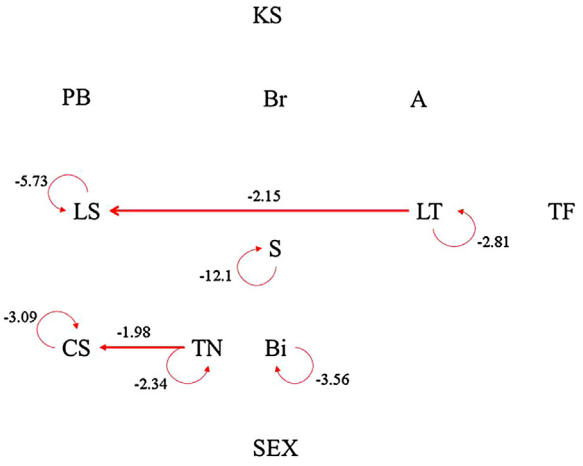

Fig. 4. Two-event sequences diagram of sea lions interacting with swimmers during the resting period, showing transitions with z-scores lower than −1.96. Arrows width represents the probability with which transitions occurred.

lions showed the whole sequence S → LS → TN → Bi → S, which may indicate that once a sea lion bites it returns to swimming around the swimmer. Also, when a sea lion keeps quiet and allows being touched, it bites LT → Bi or swims around the swimmer LT → S. It seems that when a sea lion allows to be touched, it does not allow to be touched again.

Other sequences occurred less than expected (8 out of 144), and then behaviors involved may be negatively related. These sequences are represented in Fig. 4. For example when a sea lion allows being touched it does not look at the swimmer thereafter (z-score −2.15).

During the pupping period, sea lions breathe at the surface, swim around a swimmer or look at a swimmer most of times, occurring in 26.3, 12.4 and 11.8% of total scores (Br, S and LS in Fig. 5). The behavior *copulatory* occurred more frequently than during the resting period, although with a very low frequency (0.5% of total scores).

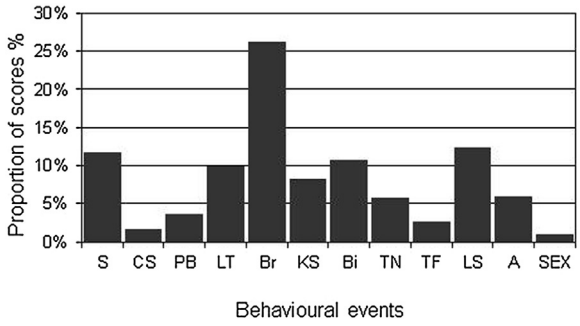

Fig. 5. Occurrence of each behavior (event) defined for sea lions interacting with swimmers during the pupping period (January to March). See Table 1 for behavioral events captions.

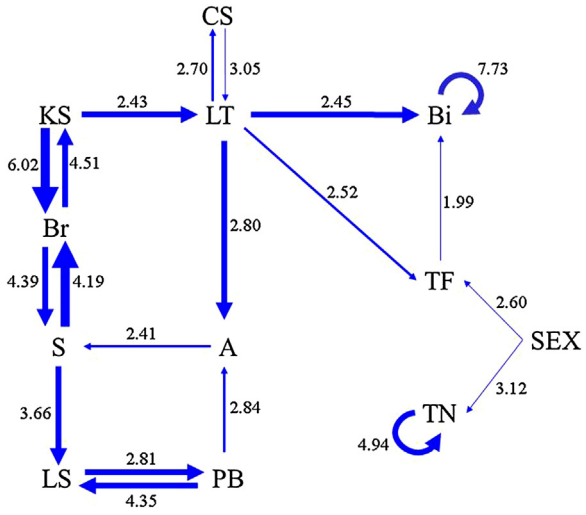

Fig. 6. Two-event sequences diagram of sea lions interacting with swimmers during the pupping period, showing transitions with z-scores higher than 1.96. Arrows width represents the probability with which transitions occurred.

Taking into account two-event sequences, some of them were very frequent, mostly involving the behavior "*breathes*". It was very common to observe a sea lion swimming around a swimmer and then breathing, breathing a couple of times, and keeping at the surface and breathing. Some transitions showed significant differences from the null hypothesis (21 out of 144), then behaviors were sequentially related (Fig. 6). These sequences were a sea lion allowing a swimmer to touch it and then biting him/her (z-score 2.4) and a sea lion allowing a swimmer to touch it and then going away (z-score 2.8). Other transitions were less frequent than expected (Fig. 7).

4. Discussion

The human dimensions of wildlife tourism have been increasingly recognized as a necessity for management (Higham and Lück, 2007; Pont et al., 2015). This is of particular concern giving the rising importance of public safety issues due to the increased risk to human from visitor-wildlife interactions. Issues include the protection of visitors from potential aggressive behavior and the

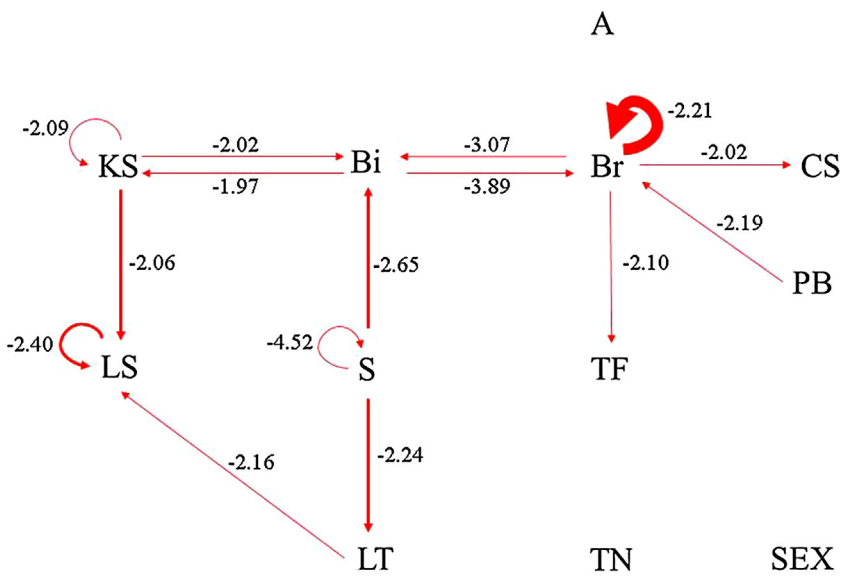

Fig. 7. Two-event sequences diagram of sea lions interacting with swimmers during the pupping period, showing transitions with z-scores lower than −1.96. Arrows width represents the probability with which transitions occurred.

prevention of transmitting diseases between visitors and the animals. The present paper represents an attempt of approaching this subject considering the case of pinnipeds-based tourism, which has an important growth, but scarcely explored from this point of view.

The paper describes for first time South American sea lions behavior underwater when interacting with swimmers, and how the behavioral pattern can be used to predict and avoid undesirable or risky behaviors. Here we found a way that can help managers to adopt measures with scientific-based information. This methodology could also be applied to other cases.

Most of behavioral sequences involve physical contact between swimmers and animals. Additionally the sequences including *bites* as the target behavior were also significant, which indicates that a sea lion may bite given that previously it touches a swimmer with the nose or it allowed a swimmer to touch it. This behavior may have an exploratory function. Although these bites did not finished in cutting wounds, they represent potential risk of injuries. These results support the recommendation of no allowance of physical contact, or at least no looking for physical contact actively.

The responses described in the previous paragraph may be interpreted in the context of the concept of habituation. Habituation has been described as any situation where wildlife comes to tolerate the presence of humans without any obvious signs of physiological or behavioral response. Habituation has been defined as "*a decrease in the strength of a response after repeated presentations of a stimulus that elicits that response*" (Mazur, 2006). Higham and Shelton (2011) proposed that habituation must be differentiated from avoidance/approach, tolerance and sensitization. The responses observed here are clearly avoidance/approach behaviors, and then they cannot be described as habituation. Most of animals interacting with swimmers are juveniles; therefore they have not enough time to be "habituated" to the presence of humans.

Swimmers may attract only a fraction of sea lions in the colony, and possibly those individuals being more inquisitive. Then behavioral sequences described here do not represent the way that all sea lions interact with swimmers, but the way that some individuals do. This deserves a special consideration in the case of swimming in another site or inclusively another colony. Behavioral pattern and responses may vary spatially and among individuals. Even interacting individuals may be the same, there is evidence that behavior changes temporally, since scores and responses were different depending on the interaction took place during the resting or the pupping season. Therefore the social context also will condition the responses.

With the increase of both tourism and pinniped numbers, the chance of interactions with these animals increased. However, pinniped-focused tourism is largely unregulated and guidelines are rare. Reasons for the low priority given to tourism related research include opinion that "pinnipeds habituate to humans and will adapt to close approaches" and that "regulations are likely to restrict the industry unnecessarily" (Kirkwood et al., 2003). In the case of swimming with South American sea lions, it is evident that animals do not habituate to human presence. However the effects of observed behavioral responses are difficult to be predicted in the long term. Further research needs to examine potential impacts of the tours on interacting animals as well as sea lions ashore.

5. Conclusions

In the case of land-based approaches, some management measures were taken to minimize human disturbance, which may be enforced or not, with the presence of rangers, and they mainly include specific sites to approach and see animals. Swim-with experiences represent a risk for tourists since a physical contact may exist, however it is a less addressed issue, and no regulation or code of conduct takes it account. The present paper represents one of few cases of research about swim-with experiences that can be used to base some regulations or protocols.

Some recommendations for regulation and management arise from this study. A critical aspect is how the way people interact with sea lions will be controlled. In the case rules are stablished, monitoring them will be difficult unless an observer swims at the same time. A voluntary code of conduct and constant capacitation of operators seems to be the best tool.

The whole swimming-with-sea lions trip includes also approaching the colony by a boat, and this is a potential source of disturbance. It is well known in other species and places that boat and ship traffic may affect the haul out pattern with energetic consequences. For example, harbor seals (*Phoca vitulina*) in Alaska, USA, flush into the water more frequently depending on the distance of cruise ships (Jansen et al., 2010), and fur seals in the Bay of Plenty, New Zealand, would rest less and become more alert when

a vessel is closer (Cowling et al., 2015). Therefore the activity needs an integral management scheme, taking into account the effects on both animals and humans.

Conflict of interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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