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INTRODUCTION

Whalewatching is one of the most rapidly growing and economically attractive tourist activities worldwide and provides for the "sustainable use" of cetacean populations (IFAW *et al.*, 1997). If properly managed, it can bring benefit to local economies, scientific research, educational purposes, public awareness, recreational activities and, ultimately, the whales themselves (IFAW, Tethys and Europe Conservation, 1995).

In Latin America, whale watching has shown strong, steady growth since 1998, increasing at an average rate of 11.3% per year (1998-2006) (Hoyt and Iniguez, 2008). According to Hoyt and Iniguez (2008), this is three times the rate of world tourism and 4.7 times the rate of Latin American tourism over approximately the same period. In Brazil, the average annual growth rate of whale watchers is 4% and in 2006 it was the second whale watch country in terms of numbers of whale watchers (228,946). The size and the rapid growth of the whalewatching industry has been motivated a complex debate regarding the best practies for the activity in order to prevent impacts on cetacean populations.

Southern right whales

The southern Brazilian coast is an important wintering area for southern right whales (*Eubalaena australis*). From July to November right whales approach the coast to give birth, nurse their calves and apparently mate (Palazzo and Flores, 1996, 1998; Simões-Lopes *et al.*, 1992; International Wildlife Coalition/Brazil, 1999). This right whale population was severely depleted by commercial whaling until 1973, when appeared to be extirpated from the Brazilian coast (Palazzo and Carter, 1983). Since the early 1980s, when whales were 'rediscovered' in the southern Brazilian coast, the population has been monitored by the Brazilian Right Whale Project (Projeto Baleia Franca - IWC/Brasil). Their main concentration area is along the central-southern coast of Santa Catarina State, from Cabo de Santa Marta, Laguna (28º36'S, 48º49'W) to Santa Catarina Island (27º25'S, 48º30'W) (Simões-Lopes *et al.*, 1992; Palazzo and Flores, 1996, 1998; International Wildlife Coalition/Brazil, 1999). Most groups sighted in this region are mother-calf pairs (Simões-Lopes *et al.*, 1992; Palazzo and Flores, 1996, 1998; International Wildlife Coalition/Brazil, 1999; Groch, 2000) with an increasing sighting frequency of social groups (Acosta *et al.*, 2007; Correa and Groch, 2008).

Whalewatching in Santa Catarina and legislation

In 1999, the regular presence of right whales along the southern coast of Santa Catarina State stimulated the establishment of whalewatching activities. In this area boats must operate in agreement to the national legislation. Because right whales approach the coast, shore based whalewatching has also been conducted, by tourism agents, local fishermen, residents and tourists.

In Brazilian waters, Southern right whales, as all cetaceans, are protected from harassment since 1987 (Federal Decree No. 7643), and were declared a State Natural Monument of Santa Catarina in 1995. In 1997, considering the need to regulate the recently emerged whalewatching tourism in Brazil the Edict 117 was stablished. According to this Edict *it is forbidden to all vessels operating in Brazilian jurisdictional waters:*
a) approach any whale species (cetaceans of the order Mysticeti, sperm whale Physeter macrocephalus, and orca Orcinus orca) to less than 100 meters of the closest animal, with engines operating, but under obligation in neutral when approaching humpback whales Megaptera novaeangliae, and turned off or in neutral for other species;

b) resume or engine operation to go away from the whale before clearly sighting the whale(s) at the surface, or in a distance of at least 50 meters from the vessel;
c) chase any whale, with engine operating, for more than 30 minutes, even when respecting the above mentioned distances;
d) interrupt the path of any cetacean of any species, or try to direct or alter its movement;
e) intentionally penetrate in a group of cetaceans of any species, dividing or dispersing it;
f) make excessive noises, such as music, any kind of percussion, or others beyond those generated by the normal operation of the vessel, when less than 300m from any cetacean;
g) dump overboard any sort of detritus, substance or materials when less than 500m of any cetaceans, in addition to all other pollutant dumping prohibitions contained in the laws.
h) approach an individual or group of whales if approached by at least two other vessels at the same time.

Right Whale Environmental Protection Area

On September 2000, the right whales' main concentration area in Santa Catarina was protected by the Right Whale Environmental Protection Area (EPA). This Conservation Unit[1] was created in accordance with a specific recommendation of the 1998 IWC Scientific Committee special meeting on right whales (IWC, 2001), aiming at ensuring the protection of right whales in Southern Brazil. The EPA has an area of 156.100 hectare along 130km of coast.

For the adequate development of the whalewatching activity in the EPA, and to ensure the conservation and management of the right whale population along the coast of Santa Catarina State, the surface behavioral responses of right whales to the whalewatching activities have been monitored since 1999, and since 2002 theodolite tracking techniques have been applied (Groch *et al.* 2003, 2005). Results from an analysis of movement patterns of right whales in relation to boat approaches collected in 2002 suggested that during most of the whalewatching cruises, right whales appeared to have ignored the presence of the boats and didn't interrupt their behavior, so that no clear evidence of immediate disturbance to this right whale population was detected (Groch *et al.* 2005). Data collected between 2003 and 2008 are under analysis (Correa, *ongoing analysis*). Preliminary analysis of respiration rates sampled in 2006 found no significant differences between rates during boat approaches and in no-whalewatching days, neither between before, during and after boat approaches (Correa and Groch, 2007).

Notwithstanding the preliminary results available regarding whales behavior in relation to boats in Santa Catarina, the increasing overall interest by the whalewatching activity in the Right Whale EPA both by tourists and local residents has been resulting in more boats operating in the region, which can put in risk the protection of these whales if the activity is not properly managed.

The Right Whale EPA has as one of its legal attribution to regulate the whalewatching activities, ensuring the protection of right whales**.** For this reason, in 2006, taking the IWC Cape Town whalewatching workshop (IWC, 2004) results and recommendations into consideration, the Brazilian Environmental authority (IBAMA), after a proposal made by the Right Whale Project, established six area closures in the Right Whale EPA (IN N° 102/2006). The definition of the areas took into account the scientific desirability of having control areas free of boat-based whalewatching activities, as well as other management issues that would favour land based whalewatching. The proposal for the adoption of this area closures was presented to the IWC Scientific Committee in 2006 (Groch and Palazzo, 2006) and the adoption of this measures was commended by the Committee in 2007.

Besides establishing several procedures to avoid harassment of cetaceans by tourism operations, the Edict 117/96 also states that:
During operation of commercial tour vessels inside Conservation Units where cetaceans regularly occur, such Unit will determine:
a) the registration of vessels regularly engaged in operation inside the Conservation Unit, including its Navy registration number, name, size, propulsion type and passenger capacity, as well as qualifications and address of its responsible person(s);
b) the maximum number of vessels which are allowed to simultaneously operate inside the Conservation Unit;

[1] Conservation Units in Brazilian law are any legally established protected areas such as National Parks, Reserves, and Environmental Protection Areas.

c) in the case of units with know areas of regular cetacean use, the route(s) and speed(s) for vessel traffic inside such areas.

With the except of the registration of vessels, the above recommendations were not yet implemented in the Right Whale EPA. With the aim of determining a general statistics for the whalewatching activities in the EPA, allowing for further development of adequate management and conservation measures for right whales, the EPA director has been requesting operators to provide a monthly summary on the whalewatching cruises (no. of cruises, whales sighted and tourists onboard) conducted in the area. In this paper we present information gathered by the EPA since 2005 as well as previous information collected by the Right Whale Project since the establishment of the whalewatching activity in 1999. The aim is to evaluate the development of the activity over the ten years of implementation, and the implications for the conservation of right whales.

METHODS

Data from 1999 to 2001 were compiled as a result of a partnership between the Right Whale Project and the whalewatching operator. Data from 2002 to 2004 were collected as a result of the land-based monitoring of the interactions between whales and the whalewatching boats conducted by the Right Whale Project. Data from 2005 to 2008 were provided by the whalewatching operators to the Right Whale EPA, following a standardized data form. Figures for the period 1999-2001 represent the totality of whalewatching cruises conducted in the right whale EPA. However, data corresponding to the period 2002-2004 were collected opportunistically, and may not represent all the cruises conducted in the period.

In order to analyze the possible implications of the increase in the number of whalewatching cruises on the right whale population in the region, data collected by the Right Whale Project during systematic aerial surveys conducted in the peak of the breeding season for photoidentification of right whales in the area were used. We used the number of whales sighted during aerial surveys as a reference number of whales present in the region because of the consistency of data.

RESULTS

At least 572 cruises were conducted in the Right Whale EPA, between July and November of 1999 to 2008, corresponding to the first 10 years of the development of the boat based whalewatching activity in the region (Table 1). A total of 5025 passengers were reported to be on this cruises, which includes tourists, tourism agents and residents. Because of the systematic of the monitoring made from 2002-2004, figures for the number of passengers are not available.

From 1999 to 2008, the number of cruises increased 13 times, and the number of passengers engaged in the whalewatching cruises increased 14.6 times.

Table 1

Summary of whalewatching cruises, number of passengers, whale-boat encounters and number of whales sighted during cruises conducted from 1999 to 2008 in the Right Whale EPA.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
No. Whalewatching cruises[1]	14	44	38	45	38	14	82	51	64	182	572
No. Passengers	141	491	366	-	-	-	695	573	696	2063	5025
No. encounters Ribanceira/Ibiraquera	0	28	24	10	2	4	8	14	38	167	295
No. encounters - other bays[2]	14	27	14	35	36	9	74	37	26	15	287
Mean no. whales/ whalewatching cruises[3]	4.3	5.9	3.9	3.6	2.0	2.9	3.6	5.7	13.3	11.8	7.6
No. Mother/calf pairs sighted (%)	100	84.3	98.7	89.1	84.2	97.6	93.88	92.1	79.67	84.3	90.4

[1]number of whalewatching cruises may not match the total number of whalewatching cruises/bay because in some cruises there where encounters with whales in more than one bay;

[2] includes NI (location not informed) sites;
[3]not all sightings were reported; include double counting's along the season.

In the Right Whale EPA there are tree main harbors from which the whalewatching boats can be launched, which are: Garopaba, Porto - Imbituba, and Laguna). The most used harbors by the whalewatching operators are Garopaba and Porto-Imbituba. The whalewatching cruises are generally conducted towards a bay where the location of whales is previously known. Opportunistic encounters with whales during the trip towards the bay do occur, however this whales are usually difficult to approach because they are moving between bays. Because this encounters are rare and mostly not reported, we here included only encounters inside or in front of the bays.

Whalewatching observations were conducted in 18 bays along 50km of coast in the Northern section of the EPA. In some occasions, the location of the encounter was not specified so these encounters were included as 'NI' (location not informed). Most of the encounters occurred at Ribanceira/Ibiraquera bay (50.7%, N=295) (Table 1 and Figure 1).

The mean number of whales sighted per whalewatching cruise was 7.6 for the whole period. This number may include whales sighted in more than one bay during the same cruise. Figures by year are presented in Table 1.

There was only one boat operating in the region in 1999 and by 2008 a total of six boats were registered in the EPA, though not all of them operating regularly. During the monitoring made by the Right Whale Project, there were no records of more than two boats approaching an individual or group of whales at the same time, though more than two boats could be in the same bay approaching different whales.

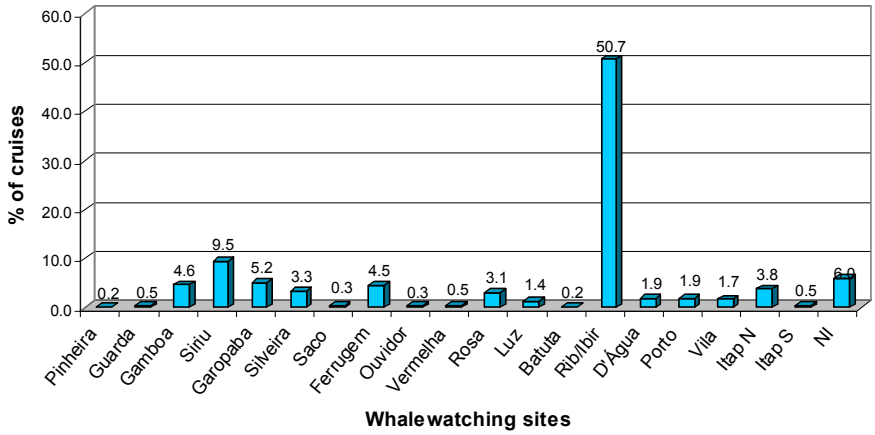

Figure 1 – Number of whalewatching cruises conducted by bay from 1999 to 2008 (NI= location of the cruise was not available).

In table 2 the number of whales sighted during aerial surveys made by the Right Whale Project is presented. The area of surveys includes the Right Whale EPA as well as adjacent areas, covering a total of 400km of coast. From the total, 11.6% of the sightings occurred in Ribanceira/Ibiraquera bay, and 34.6% of the sightings were of mother/calf pairs, which in terms of number of individuals represents 69.2% of the total number of whales sighted. In 90.4% of the boat-whale encounters the target groups were mother/calf pairs. Because the information presented by the whalewatching operators is not always collected by an experienced biologist, numbers from 2005 to 2008 may not be precise. Nevertheless, this data is consistent with data from previous years.

Figure 3 shows figures for whalewatching cruises and sightings during aerial surveys in Ribanceira/Ibiraquera bay (a) in comparison with other bays (b). The number of whalewatching cruises has been increasing in Ribanceira/Ibiraquera bay at the same proportion as the number of whales sighted in this bay during aerial surveys in all years but 2008, when the number of whalewatching cruises was 5 times higher. The number of encounters in other bays appears not to be related to the number of whales present in the bays, and is probably related to the proximity of the whalewatching boat launching ports to these bays (Garopaba and Porto).

Table 2
Number of whales sighted during aerial surveys for photoidentification of right whales in southern Brazil.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Total no. whales aerial surveys	20	24	44	128	112	83	71	196	114	101	893
No. Mother/calf pairs aerial surveys	10	11	22	41	26	35	21	49	54	40	309
No. Whales aerial surveys - Rib/Ibir	2	10	8	0	0	4	10	0	36	34	104

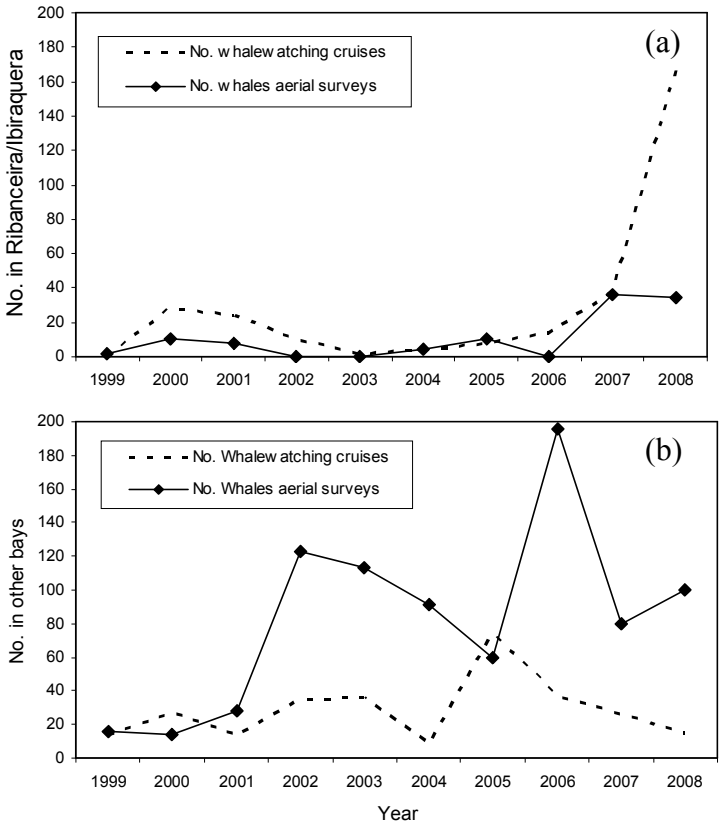

Figure 2 – A comparison of whalewatching cruises with sightings from aerial surveys conducted from 1999 to 2008 in (a) Ribanceira/Ibiraquera bay and (b) other bays.

DISCUSSION

During the last 10 years whalewatching activities have been increasing in the Right Whale EPA, as well as the number of whales. Groch *et al.* (2005) reports an increase of 14%/year for the right whale population from 1987 to 2003. The resighting of some females along the Southern Brazilian coast (Palazzo *et al.*, 1999; Groch*, ongoing research*) indicates that at least some females return regularly to this nursing area

and present at a three year calving interval (Groch, 2005). According to Groch *et al.* (2005) 10% of the whales identified in this area have been resighted, most of them females. The authors also found that 71% of the resightings were recorded in 2003. Data analysed by Groch *et al.* (2005) comprises the period from 1987 to 2003. Photoidentification data from 2004 to 2008 are under analysis (Groch, ongoing analysis), however a preliminary analysis of some photos show that more resightings will be found. Hence, it's likely that in some occasions the same individuals are being approached by the whalewatching boats throughout the years.

In a study made with data collected in 2002 in the Right Whale EPA, Groch *et al.* (2005b) found that right whales mother/calf pairs show different reactions in different bays, which could be a result of having different perception on the acoustic *stimuli* made by the whalewatching boats. According to the authors, in some instances right whales may appeared not to react to boat approaches but sometimes they simply appeared indifferent to the presence of a boat.

According to Watkins (1986) right whales can show habituation to relatively non-disturbing *stimuli*. The author also found that right whales are less easily disturbed than other species of whales. According to Richardson *et al.*, 1995, many reactions of cetaceans to ships or boats are presumably reactions to noise but responsiveness may vary widely between and within-species, according to physical and biological factors, which must be considered in determining the radius of responsiveness and zone of noise influence. Underwater sound appears to be the primarily *stimuli* of reaction by whales (Watkins, 1986; Novacek *et al.*, 2004). However, there is limited information on noise produced by small boats typically used in coastal waters (Richardson *et al.*, 1995), as well as on the frequency range of hearing and sensitivity of baleen whales (Ketten, 1994; National Research Council, 2004).

An attention should be drawn by the fact that, according to data presented here, the whalewatching operations in Santa Catarina have been conducted mostly towards mother/calf pairs and most whalewatching cruises have been concentrated in one bay. Groch (2005) found that mother/calf pairs can spend between 25 to 64 days in the region, moving between bays. According to Taber and Thomas (1982) the time mother/calf pairs spend on the nursery ground is of great importance for calf growth and development. During this period, females probably do not feed and channel most of their energy into nursing and taking care of their calves.

Studies of anthropogenic impacts on cetaceans have been developed in many places all over the world. Most of them found some significant change in cetacean behavior, but almost all stated without exception that the long-term, biological meaning of these changes is not clear (Richter *et al.*, 2000). Effects of anthropogenic disturbance may range from temporary changes in behavior (Gauthier and Sears, 1999; Bejder *et al*., 2006) to possible interference with feeding (Richardson *et al*., 1990; Johnson, S.R. 2002; Jahoda *et al.* 2003), reproduction (Miller *et al.*, 2000; Weller *et al.*, 2002; Bejder *et al*., 2006b) or migration (Heckle *et al.*, 2001).

Partial or complete area closures are already used as management tools in relation to southern right whales in Argentina (San José Gulf Marine Park, Chubut Province, Argentina), Australia (Great Australian Bight Marine Park, South Australia) and South Africa (Cape Province). However, the long-term effectiveness of area closures is difficult to evaluate.

The adoption and enforcement of the closure areas in the Right Whale EPA aimed at allow for further improvement in gathering knowledge about the short- and long-term effects of boat-based tourism on southern right whales in Brazil (Groch and Palazzo, 2006). Two of the area closures are located in adjacent bays to Ribanceira/Ibiraquera, one south and the other north of the bay, which can become a refuge area for right whales target in Ribanceira/Ibiraquera.

The Right Whale EPA have been annually improving the data collection forms, in order to provide more precise and detailed information which could be relevant to the managing of the boat-based whalewatching tourism in the EPA. This information in addition to long-term monitoring of this right whale population is valuable tool for the development of appropriate management of whales in this area. It's hoped with the design and implementation of adequate management measures to ensure both the species' survival and the sustainability of the whalewatching industry.

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