



First record of direct interaction between a potential predator – *Orcinus orca* (Odontoceti, Delphinidae) – and a mother-calf pair of *Eubalaena australis* (Mysticeti, Balaenidae) in Brazilian calving grounds

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Abstract: In August 2019, the first record of a direct interaction of Southern right whale and killer whale was observed in the right whale wintering area in southern Brazil. Throughout the interaction, behavior was recorded and the respiratory rate of the female right whale was estimated at 0.75 blows per minute.

Key words: Interspecific interaction, Killer whale, Predation, Southern right whales.

Primeiro registro de interação direta entre um predador em potencial – *Orcinus orca* (Odontoceti, Delphinidae) – e um par mãe-filhote de *Eubalaena australis* (Mysticeti, Balaenidae) em área de reprodução brasileira. Resumo: Em agosto de 2019 a primeira ocorrência de uma interação direta entre baleia franca austral e orcas foi registrado na área reprodutiva da espécie no sul do Brasil. Ao longo da interação dados comportamentais foram obtidos e uma frequência respiratória de 0.75 borrfos por minuto foi estimada.

Palavras-chave: Baleia-franca-austral; Interação interespecífica; Orcas; Predação.

Southern right whales – *Eubalaena australis* (Desmoulins 1822) – undertake seasonal migrations to the Brazilian coast to mate, give birth and nurse their calves (Groch *et al.* 2005). Historically, the species occurs from Bahia state (13°03'36" S; 38°19'48" W) until Rio Grande do Sul (33°26'24" S; 53°11'24" W). The main concentration of right whales appears to be along the southern coast of Santa Catarina, primarily between Santa Marta Cape (28°36'00" S; 48°29'24" W) and Santa Catarina Island (27°49'84" S; 48°16'12" W), but few bays, like Ribanceira (28°10'48" S; 48°38'59" W), are highlighted, once in these areas higher density of whales were observed (Renault-Braga *et al.* 2018). However, at a national level the species is categorized as “endangered”, the southern right whale is not considered under threat at the hemispheric level, being listed as “least concern” on

the IUCN Red list. In Brazil, the the Right Whales Environmental Protection Area (Right Whale EPA) was created in 2000 to shelter the main concentration area of the Brazilian Southern Right Whales population. The breeding season occurs from July to November. Baleen whales’ migration focuses on direct benefits to the calf, reducing the risk of predation (Corkeron & Connor 1999). In breeding grounds, several behavioral strategies are used to avoid predation, like staying in shallow waters. It is a common behavior for southern right whales. *Polaris breach* is a more common initial strike of the predator that focuses to hit the bellies of the prey (Klimley 1994). Staying in shallow areas limits predators’ access to the whales’ bellies. Great sharks and killer whales – *Orcinus orca* (Linnaeus 1758) – are known as potential predators for southern right whales (Evans 1987).

The killer whale is a large top predator that feeds on a variety of prey, including marine mammals interacting with at least 20 species of cetacean, 14 pinnipeds, sea otters and dugongs worldwide. Among the baleen whales, interactions with killer whales was observed with bowhead whales (*Balaena mysticetus*), blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*), Bryde's whale (*Balaenoptera edeni*), humpback whales (*Megaptera novaeangliae*) and gray whales (*Eschrichtius robustus*) (Baldrige 1972; Mitchel & Reeves 1982; Whitehead & Glass 1985; Heide-Jorgensen 1987; Silber *et al.* 1990; Flórez-González *et al.* 1994; Goley & Straley 1994; Guinet *et al.* 2000; Mizroch & Rice 2006). The diet of killer whales changes among populations, and in the Antarctic waters, prey specialization is one of the characteristics that defines different ecotypes: types A and B-big (prey marine mammals), B-smal (prey penguins and other seabirds), C and D (prey different fishes) (Pitman *et al.* 2011). The diet of killer whales that occurs in Brazilian waters is poorly known, and only two cetaceans (*Pontoporia blainvillei* and *Phocoena spinipinnis*) have been reported as prey items of the species (Dalla-Rosa 1995; Ott & Danilewicz 1998). In other areas of the South America, like Peninsula Valdés, Argentina, killer whales preying southern right whales was already recorded (Sironi *et al.* 2008). Interactions among killer whales and southern right whales in Brazil were observed previously, but only indirectly, in a stranded calf with a bite scar in Rio Grande do Sul (Ott *et al.* 2017).

Since 1998, the Southern right whale population of Brazil has been monitored by land based stations in several bays among the Brazilian breeding ground (Groch 2000). This method consists in visual surveys to quantify and classify (based on reproductive status) right whales presents among the bays, followed by "focal sampling" method to study whales' behavior (Altmann 1974). The land base is located at elevated points on the coast along the breeding ground to enable a broad view of the bay. The number of monitored bay varied among the year according to funds available to execute the program, but bays that were previously defined as major occurrence areas were always monitored (i.e. Ribanceira, Porto, Vila, Itapirubá Norte, Itapirubá Sul located in Imbituba and Laguna, Santa Catarina) (Fig. 1) (Renault-Braga *et al.* 2018). The areas are monitored simultaneously by different field teams. Observers used 7x50 mm binocular to scan the area

for 30 minutes. At this moment all the whales present in the cove are recorded and the composition group (unaccompanied adults, mother-calf pairs, subadults) and number of whales are quantified. After that, a whale group are randomly selected to start the "focal sampling" that record the behavior in 50 minutes of observation. The behaviors state (TRAV – travelling, REST – resting, PLAY – Playing) are recorded each 5 min interval, and behavior events are recorded instantaneously (that include blows to define breath frequency) (Altmann 1974).

Along the study, it is common to observe other cetaceans, like Brydes' whales, humpback whales, bottlenose dolphins (*Tursiops gephyreus*), but killer whales were observed only in three occasions, two records in 2014 and one in 2019. The first record was on September 15 in 2014, at least one male adult of killer whale (considering the dorsal fin morphology), and two other killer whales was recorded travelling along the Praia do Porto, Imbituba, SC (28°13'12" S; 48°38'59" W). Next day, a second record occurred on Praia de Itapirubá Norte, Imbituba, SC (28°19'48" S; 48°48'0" W) with a group composed with a similar composition. We do not discard the possibility of the two records in 2014 be the same group considering the distance of the bays, the days of the records and the similarity of the group composition. In this both occasions it was not observed any interaction with right whales. The third record was on September 12 in 2019, in Imbituba. In this occasion it was recorded the first direct interaction among killer whales and a mother calf pair of southern right whales in Brazilian coast. This interaction was well documented, and the detail of this case is described here.

On September 19, 2019, during the regular monitoring a killer whales group composed by at least four individuals were registered at Ribanceira bay (28°10'48" S; 48°38'59" W) at 2:05 pm. Simultaneously, three southern right whales mother-calf pairs were also using the same bay. One of them has been observed for behavioral studies using the method "focal sampling" during the passage of the killer whales. The observation was recorded from 02:20 pm until 02:55 pm (35 minutes of sampling). The analysis of the frequency of behavioral states and the frequency of blows were conducted. The blow frequency recorded for the mother was 0.73 blow per minute, while the calf blow frequency was 1.47 blow per minute. Mother and calf were in the behavioral state of travelling, along the entire focal observation.

It is important to highlight that all groups present in the area probably notice the presence of the killer whales, once all of them starts to move away from the potential predator. One of the groups leave the area after the arrival of the killer whales, remaining two mother-calf's pairs in the bay. It is also important to report that the killer whales do not remained at Ribanceira bay, and no direct interactions were observed. They moved to south and was also recorded by the team that monitors the Porto bay at 02:52 pm (28°13'12"S; 48°38'59"W), and Vila bay at 03:32 pm (28°26'59"S; 48°38'59"W), until finally arrived to Itapirubá Norte bay (28°19'48"S; 48°48'0"W) (Fig. 1), where a well-documented interaction was video recorded (Fig. 2).

At 05:13 pm, four killer whales were spotted coming near the southern headlands of Itapirubá Norte. A mother-calf right whales pair was also coasting the southern headlands of the same bay, travelling to the south (Fig. 3). At 05:27 pm, both cetaceans started a direct interaction that lasted about seven minutes. The direct interaction was video recorded by a team that was observing the killer whale's group in land (white dot at Fig. 1) (but wasn't the land base station that is regular use by the monitoring program – yellow dot at Fig. 1). The distance from the land team and the cetaceans was estimated between 80-100 meters, which allowed us to be faithful in the behavior's records. All the behavior patterns and descriptions were analyzed from the video recorded, and by notes of each behavior using a "Ad libitum" method (Altmann 1974).

Initially, the killer whales were travelling to southeast, while the mother of right whale turns to east direction trying to put away from the coast (Fig. 3a), until suddenly it stops before meeting the killer whales. However, the calf starts to move away from the mother travelling to northeast, while killer whales still travelling to southeast until they meet each other (Fig. 3b). At this moment, the killer whale group split in 2:2 groups, where one of then kept travelling to south and the other one starts a direct interaction with the calf (Fig. 3c). Immediately, the mother turns and travel to the calf direction and approached they, staying together and not moving away (Fig. 3d) (Fig. 4). At this moment, the land team heard sounds typically produced by right whales, indicating that some vocalizations were taking place. It is important to highlight that this was an opportunistic observation. The right whale sound was heard by the observer on land, and no specialized equipment to capture sounds was used, so, there are no records of



Figure 1. Location of the land base stations monitored along the Southern coast of Brazil in Imbituba and Laguna, Santa Catarina state, Brazil. Red line represents the boundaries of the Right Whales Environmental Protection Area.

this vocalization to a better evaluation. After that, at 05:30 pm, the two killer whales swam away from the right whales while the other group travelled northwest (Fig. 3d). Finally, the four killer whales joined into a single group again but started to approach the right whales (Fig. 3e), initiating a second direct interaction at 05:32 pm (Fig. 3f). This second interaction was faster and apparently less intense (considering the intensity of surfaces behaviors). At 05:33 pm, right whales started a fast travelling to west direction, approaching to coast, and the killer whales travelled southeast at 05:34 pm and were not sighted any more (Fig. 3g). The blow rate of the mother was estimated using the recorded video. We estimate 0.75 blow per minutes for the mother, but we do not have good conditions to assume a blow frequency for the calf once in several moments they were behind the mother, precluding to record all blows.



Figure 2. Killer whales (*Orcinus orca*) near the southern headlands of Itapirubá Norte Bay on September 19, 2019, in Santa Catarina state, Brazil.

Despite there is no direct interactions on Ribanceira, our analysis of the blow rates frequency of the mother adult Right whale in Ribanceira (recorded by the focal sampling method) was very similar to the blow frequency recorded in Itapirubá, when the interaction were recorded (0.73 in Ribanceira and 0.75 in Itapirubá Norte). In South African right whale's breeding ground, the regular blow frequency is estimated in 0.46 blows per minute (Nielsen *et al.* 2019), considerably lower than we have recorded. The high blow frequency of the female may be a result of an escape behavior in response to a potential predator in both occasions. This kind of behavior is known as a high energy cost behavior, and it is known that there is a positive relationship between blow frequency and energy spend (Sumich 1983; Blix & Folkoe 1995). In Brazil, behavioral studies have been conducted using unmanned aerial vehicles to estimate blow frequency of right whales. Unfortunately, our records do not allowed to count killer whales blows with precision once we are not able to do an individual identification of each whale, and the counts of blows will not represents the breath frequency of a unique individual. We understand that this is an isolated event, and several other variables may influence the whales' behaviors, but we believe that the presence of a potential predator in the area is a rare situation, and our analysis may be used for producing a baseline for future comparisons. The blow frequency of the calf is influenced by their development stage (Danielsky 2015). The youngest tends to have higher blow frequency (Danielsky 2015). Once we cannot estimate the development

stage of the calf, we do not make any comparison of the calf blow frequency as it could be strongly bias due the lack of this information.

The response of baleen whales to predatory advances and attacks by killer whales was previously categorized into two distinct categories: fight, when the whales use an aggressive behavior against the killer whales, or flight strategies, when whales move away from the killer whales (Ford & Reeves 2008). In Argentina and South Africa, a typical response of southern right whales against killer whales attack was described previously. Most interactions involve multiple right whales (range 2–8), and basically the behavioral response was joining tightly together and roll, turn and thrash their tail flukes and flippers at the water's surface, creating considerable splashing and white water (Ford & Reeves 2008), which is classified as the fight category. The same pattern was previously described by North Atlantic right whales (*Eubalaena glacialis*) (Ford & Reeves 2008). In our register, we do not have any indication of a fight behavior. We have confirmed that the mother have joined with their calf, but without any aggressive behavioral event.

There are other records of killer whales along the Santa Catarina coast, but this is the first direct register of interaction among right whales mother-calf pair and a potential apex predator of right whales in Brazilian breeding grounds. There are no studies to describe killer whales seasonality and distribution along Santa Catarina coast. The information about occurrence is mainly informed by media and tourism, but the seasonality is strongly biased by the tourism season, that is higher in

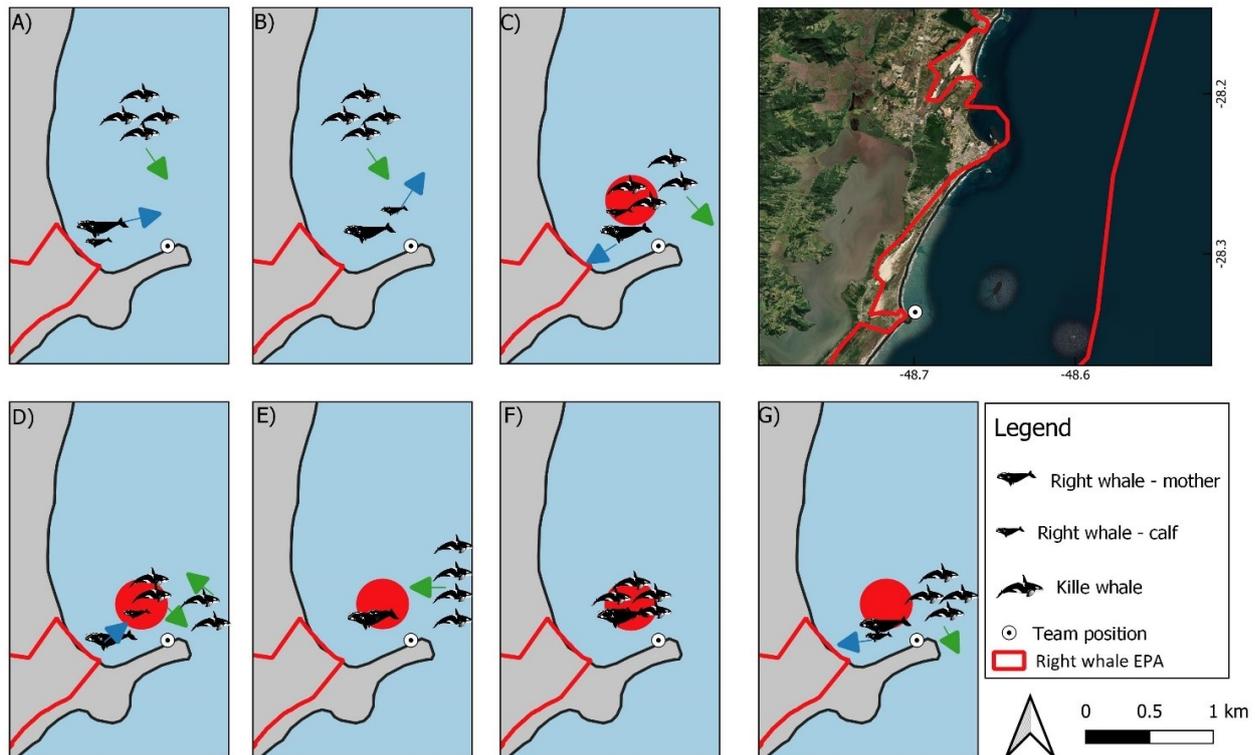


Figure 3. Sequence of the recorded interaction among a mother-calf pair of southern right whale (*Eubalaena australis*) and four killer whales (*Orcinus orca*) in Itapirubá Norte Bay, Imbituba, Santa Catarina. Blue arrows indicate the moves of right whales, while green arrows indicates killer whales moves, red dot shows the interaction area. Red line represents the boundaries of the Right Whales Environmental Protection Area.

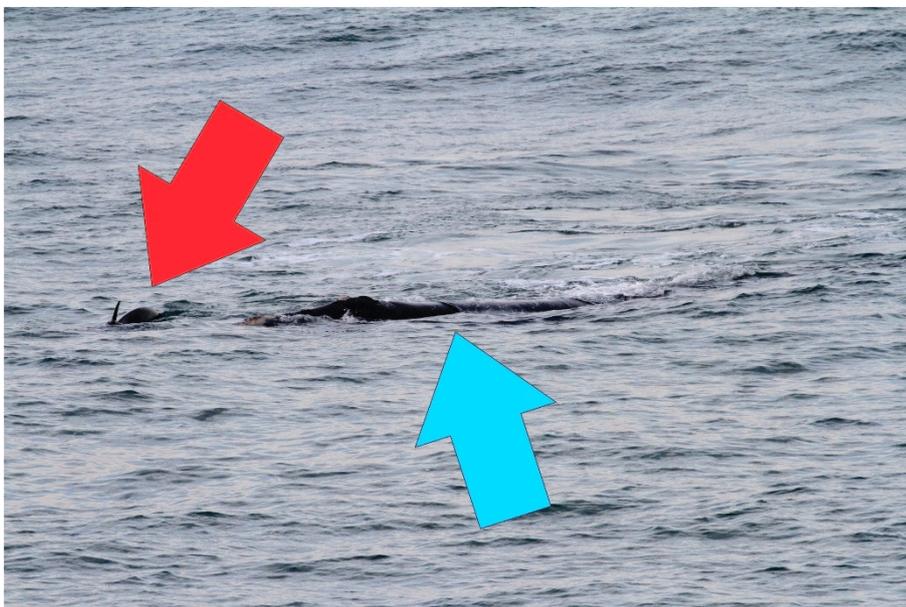


Figure 4. Moment of the interaction between right whale mother (*Eubalaena australis*) – Blue arrow – and a killer whale (*Orcinus orca*) – Red arrow – registered in Itapirubá Norte Bay, Imbituba Santa Catarina on August 12, 2019.

summer, once in this period, a lot of tourism boats are in activity. The strandings of killer whales in Santa Catarina were recorded from 1983 to 2014, with only two records (Vianna *et al.* 2016). Cetacean distribution has a strongly effect of the prey distribution (Friedlaender *et al.* 2006). We do not

believe that the recovery of right whales in Brazil may be influencing the occurrence of killer whales in this area yet, but this information must be further investigate. However, we cannot discard that a potential change in killer whales distribution in Brazil can elucidate possible pressures that the

species may have in Brazilian breeding ground in the future. This may directly influence the population recovery of the right whales southwest Atlantic population.

Acknowledgements: We are grateful to all those involved in the data collection. Funding from PETROBRAS Brazilian Oil Company, Santos Brasil, and SCPAR Porto de Imbituba was vital for data collection. The Southern Right Whale monitoring program is maintained by ProFRANCA – Projeto Franca Austral that is sponsored by Petrobras through Programa Petrobras Socioambiental.

Ethical statement

Collection of data were conducted following all applicable ethical regulations regarding experimentation with animals. Investigation was performed under permit 70880 issued by ICMBio/MMA.

References

- Altman, J. 1974. Observational study of behavior: Sampling methods. **Behaviour**, 4: 227-267.
- Baldrige, A. 1972. Killer whales attack and eat a gray whale. **Journal of Mammalogy**, 53: 898-900.
- Blix, A. S. & Folkow, L. P. 1995. Daily energy expenditure in free-living minke whales. **Acta Physiologica Scandinavica**, 153: 61-66.
- Corkeron, P. J. & Connor, R. C. 1999. Why do baleen whales migrate? **Marine Mammal Science**, 15: 1228-1245.
- Danielski, K. L. 2015. Áreas marinhas protegidas respondem às necessidades de suas espécies-alvo? Um estudo de caso na APA da Baleia Franca. **PhD thesis**, Universidade Federal do Paraná, Curitiba, Paraná, Brazil.
- Dalla-Rosa, L. 1995. Interações com a pesca de espinhel e informações sobre a dieta alimentar de orca, *Orcinus orca* Linnaeus 1758 (Cetacea, Delphinidae), no sul do Brasil. **Bachelor thesis**, Fundação Universidade de Rio Grande, Rio Grande do Sul, Brazil.
- Evans, P. G. H. 1987. **The natural history of whales and dolphins**. Facts on file, New York, 343 pp.
- Flórez-González, L., Capella, J. J. & Rosenbum, H.C. 1994. Attack of killer whales (*Orcinus orca*) on humpback whales (*Megaptera novaengliae*) on a South American Pacific breeding ground. **Marine Mammal Science**, 10: 218-222.
- Ford, J.K.B & REEVES, R.R. 2008. Fight or flight: antipredator strategies of baleen whales. **Mammal Review**, 38(1):58-86.
- Friedlaender, A.S., Halpin, P.N., Qian, S.S., Lawson, G.L., Wiebe, P.H., Thiele, D. & Read, A.J. 2006. Whale distribution in relation to prey abundance and oceanographic processes in shelf waters of the Western Antarctic Peninsula. **Marine Ecology Progress Series**, 317: 297–310.
- Goley, P.D. & Straley, J.M. 1994. Attack on gray whales (*Eschrichtius robustus*) in Monterey Bay, California, by killer whales (*Orcinus orca*) previously identified in Glacier Bay, Alaska. **Canadian Journal of Zoology**, 72: 1528-1530.
- Grock, K. R. 2000. Ocupação preferencial de áreas de concentração pela baleia franca austral, *Eubalaena australis* (Desmoulins, 1822), CETACEA, MYSTICETI, no litoral sul do Brasil. **MSc thesis**, Universidade Federal do Rio Grande do Sul, Rio Grande do Sul, Brazil.
- Grock, K. R., Palazzo Jr., J. T., Flores, P. A. C., Adler, F. R. & Fabian, M.E. 2005. Recent rapid increases in right whale (*Eubalaena australis*) population off southern Brazil. **Latin American Journal of Aquatic Mammals**, 4: 41-47.
- Guinet, C., Barrett-Lennard, L.G. & Loyer, B. 2000. Co-ordinated attack behavior and prey sharing by killer whales at Crozet Archipelago: strategies for feeding on negatively-buoyant prey. **Marine Mammal Science**, 16: 829-834.
- Heide-Jorgensen, M. 1987. **Occurrence and hunting of killer whales in Greenland**. Danbiu: Aps, 50 pp.
- Klimley, A. P. 1994. **The predatory behavior of the white shark**. American Scientist, Greenville 82(2): 122-133.
- Mitchel, E. D. & Reeves, R. R. 1982. Factors affecting abundance of bowhead whales, *Balaena mysticetus* in the eastern Arctic of North America, 1915-1980. **Biological Conservation**, 22: 59-78.
- Mizroch, S. A. & Rice, D. W. 2006. Have North Pacific killer whales switched prey species in response to depletion of the great whale populations? **Marine Ecology Progress Series**, 310: 235-246.
- Nielsen, M. L. K., Sprogis, K. R., Bejder, L., Madsen, P. T. & Christiansen, F. 2019. Behavioural development in southern right

- whale calves. **Marine Ecology Progress Series**, 629: 219-234.
- Ott, P. H., Sucunza, F., Wickert, J., Danilewicz, D. & Tavares, M. 2017. Evidences of attack of a killer whale on a calf Southern right whale in Southern Brazil. **Mastozoología Neotropical**, 24(1): 235-240.
- Ott, P.H. & Danilewicz, D. 1998. Presence of franciscana dolphins (*Pontoporia blainvillei*) in the stomach of a killer whale (*Orcinus orca*) stranded in southern Brazil. **Mammalia**, 62(4): 605-609.
- Pitman, R. L., Durban, J. W., Greenfelder, M., Guinet, C., Jorgensen, M., Olson, P. A., Plana, J., Tixer, P. & Tower, J. R. 2011. Observations of a distinctive morphotype of killer whale (*Orcinus orca*), type D, from subantarctic waters. **Polar Biology**, 34: 303-306.
- Renault-Braga, E. P., Groch, K. R., Flores, P. A. C., Secchi, E. R. & Dalla-Rosa, L. 2018. Area usage estimation and spatiotemporal variability in distribution patterns of southern right whales, *Eubalaena australis*, of southern Brazil. **Marine Ecology**, 39: e12506.
- Silberg, G. K., Newcomer, M. W. & Perez-Cortés, M. H. 1990. Killer whales (*Orcinus orca*) attack and kill a Bryde's whale (*Balaenoptera edeni*). **Canadian Journal of Zoology**, 68: 1603-1606.
- Sumich, J. L. 1983. Swimming velocities, breathing patterns, and estimated costs of locomotion in migrating gray whales, *Eschrichtius robustus*. **Canadian Journal of Zoology**, 61: 647-652.
- Sironi, M., López, J. C., Bubas, R., Carribero, A., García, C., Harris, G., Interrieri, E., Iñiguez, M. & Payne, R. 2008. Predation by killer whales (*Orcinus orca*) on southern right whales (*Eubalaena australis*) of Patagonia, Argentina: effects on behavior and habitat choice. **Journal of Cetacean Research and Management**, SC/60/BRG29 accessible at <https://ballenas.org.ar/descargas/publicaciones-cientificas/2008/> (Accessed 08/05/2022)
- Vianna, T. S., Loch, C.S. Castilho, P.V., Gaidzinski, M.C., Cremer, M.J., Simoes-Lopes, P.C. 2016 Review of thirty-two years of toothed whale strandings in Santa Catarina, southern Brazil (Cetacea: Odontoceti). **Zoologia** (Curitiba. Online). v.33, e20160089.
- Whitehead, H. & Glass, C. 1985. Orcas (killer whales) attack humpback whales. **Journal of Mammalogy**, 66(1): 183-185.

Received: July 2022

Accepted: December 2022

Published: December 2022