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**INTEGRATING CITIZEN-SCIENCE AND MOBILE WEB APP AS A TOOL FOR THE  
CONSERVATION OF CETACEANS IN SAN MATIAS GULF, RIO NEGRO PROVINCE,  
ARGENTINA**

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IN SAN MATIAS GULF, RIO NEGRO PROVINCE, ARGENTINA**

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**Abstract**

Citizen science programs are increasingly popular. This useful tool is an alternative way to obtain valuable information on wild populations, especially in areas in which the budget and logistics are limited. This study presents preliminary results of the first citizen science initiative aimed to gather information about cetacean biodiversity in the San Matías Gulf, Argentina. This platform, called E-WHALE, consists in a web form and an interactive map that allow citizens to observe in real time where the different species of cetaceans are in the San Matías Gulf. A total of 509 sightings of eight different cetacean species (four mysticetes and four odontocetes) were recorded during a period of nine months. Most cetacean sightings were recorded in the San Antonio Bay Marine Protected Area during the whale-watching season. This study demonstrates that with a strong

network of citizen science that involves the local stakeholders, it is possible to obtain data on cetacean species richness.

## **Introduction**

Citizen science is increasingly used to collect data. It is a powerful tool in which volunteers, citizens, children, students and tourists can collect large scale data and/or analyze data to contribute to research and gain an appreciation for the environment, ecosystem and species conservation (MacPhail et al. 2020; Sullivan et al. 2019; Schuttler et al. 2019). Citizen science has proven to be a tool that can improve conservation science, natural resources management and in the process the public is engaged while increasing awareness and encouraging public action (Silvertown et al. 2013). In marine ecosystems, this tool applied in marine mammal conservation programs, and particularly whales, have shown great results (Tonachella et al. 2012; Bruce et al. 2014; Embling et al. 2015; Chase et al. 2016; Cheeseman et al. 2017; Pirotta et al. 2020; Garcia-Cegarra et al. 2021). The increased availability of new technology has created opportunities for local people and commercial nautical operators (e.g. fishing vessels, whale watching vessels) to obtain photos and videos during their activities (Strutchers et al. 2015; Vukelic et al. 2018). However, there are potential biases in this opportunistic data, including species misidentification, unequal sampling effort and data duplication (Evans and Hammond 2004; Palacios et al. 2012). Nevertheless, through a review process the data can provide insight into aspects of the ecology and biology the species being studied (e.g., Hauser et al. 2006; Palacios et al. 2012).

In the northern hemisphere, citizen science has been widely used to monitor changes in wildlife populations over time (e.g. Bird surveys – eBird app), while in the southern hemisphere are still in an early stage of development (Barnard et. al 2017). However, this tool has been recently used to describe the cetacean's biodiversity in Antofagasta, northern region of Chile, with successful results (Garcia-Cegarra et al. 2021). In Argentina, there are extends remote coast regions and thus, data on richness and spatio-temporal distribution of cetaceans is limited. This includes the San Matias Gulf (SMG) (between latitudes 40°45'S and 42°14'S), located in the northern area of Patagonia, Argentina. Different human activities are developed in the SMG, among which the tourist activity, port and overseas transport and the commercial fishery stand out. This gulf has 345 km of coast that includes some areas where the population density is low, with only small

fishing communities, as well some towns that are summer tourist destination. In the northwest of SMG it is the San Antonio Bay (40°46'S, 65°02'W). This area constitutes an ecosystem of relevant biodiversity that has been strongly influenced by human activities (mainly tourism and fishing) for almost a century (González et al. 2003a). This coastal marine system has been protected since 1993 through the creation of the San Antonio Bay Marine Protected Area (SABMPA) to preserve their environment, biodiversity and cultural values. In this area, WW has started to develop since 2012 with southern right whale as the target species. The potential of WW growth in this area is supported by the increasing presence of whales during the last decade (Arias et al. 2018a, Crespo et al. 2019) and by the existence of capacities of tourist services based on summer tourism (Arias et al. 2016). Sport fishing and diving operators have been considering the WW as one alternative to diversify their activities and generate incomes throughout the year. In this context, WW was authorized by the government from 2012 and has been implemented through an experimental program with scientific monitoring (Arias et al. 2018b).

The first study assessing cetacean richness in SMG were developed between 1985-1996 and 2003-2013. This studies highlight the presence of common dolphin *Delphinus delphis*, dusky dophlin *Lagenorhynchus obscurus*, bottlenose dolphin *Tursiops truncatus* and the southern right whale *Eubalaena australis* (Crespo et al. 1997a; Crespo & Dans 2008; Svendsen 2013). In these surveys other cetacean species were recorded but less frequently: Commerson's dolphin *Cephalorhynchus commersonii*, killer whales *Orcinus orca*, franciscana *Pontoporia blainvillei* and long-finned pilot whales *Globicephala melas* (Crespo et al. 2004; Guerrero & Svendsen 2007; Guerrero et al. 2008; Svendsen et al. 2008a). Additional studies, based on by land-based surveys and strandings have described the presence of other species as: Strap-toothed Whale *Mesoplodon layardii*, Gray's beaked whale *Mesoplodon grayi*, southern bottle-nosed whale *Hyperoodon planifrons*, Cuvier's Beaked Whale *Ziphius cavirostris*, false killer whale *Pseudorca crassidens*, Burmeister's Porpoises *Phocoena spinipinnis*, sei whale *Balaenoptera borealis*, minke whale *Balaenoptera acutorostrata*, humpback whale *Megaptera novaeangliae*, sperm whale *Physeter microcephalus* and fin whale *Balaenoptera physalus* (González et al. 1988; Romero & Svendsen 2008; Svendsen et al. 2008b, 2011, 2014, 2017; Junin et al. 2018; Arias et al. 2018c).

Given that surveys along the entire SMG is an expensive task due to the large spatial area, opportunistic observations obtained from citizen scientists appear to be an alternative tool to

collect data and engage the community in the monitoring of cetaceans. Therefore, our main goal was to monitor cetacean biodiversity through citizen science observations obtained to investigate spatio-temporal patterns of cetaceans in the SMG.

## **Methods**

### *Study area*

The study area encompasses 345 km of GSM coast and adjacent waters from Puerto Lobos ( $42^{\circ} 00'S / 65^{\circ} 04'W$ ) to the mouth of the Río Negro river ( $41^{\circ} 02'S / 62^{\circ} 47'W$ ) (Fig 2), in Río Negro province, Argentina. This area includes the SABMPA located northwest of SMG ( $40^{\circ}46'S$ ,  $65^{\circ}02'W$ ) (Fig. 2). This Marine Protected Area presents a semidiurnal tidal regime with an amplitude between 6 and 9 m, that causes the approach of whales to the coasts during the high tide and move away during the low tide.

### *Data collection*

An online survey form was created in ArcGIS<sup>SM</sup> Survey123 Connect. Survey123 is a mobile app from ESRI that supports form-centric data collection. The survey was published on the Survey123 web platform and made accessible to the public. We used the Arcgis Experience Builder (ESRI, Environmental Systems Research Institute, Redlands, CA) web app in order to combine the web map and the survey123 form into one web app capable of running on mobile devices. The map was created in ArcGIS Pro (2021) and then published on ArcGIS online.

The citizen science online platform, called E-WHALE (<https://arcg.is/1Hb0TP1>), was launched in August 2021. This platform consists of a web form and an interactive map that allows citizens to see in real time where the different species of cetaceans in the SMG. The platform was promoted by local researchers, environment and tourism agencies of local governments, academic institutions, NGOs and whale-watching operators through newspapers and social media. In addition, to promote use by the community, billboards with information about E-WHALE and with a QR code to access the platform have been placed on the coastal strip of the SABMPA (Figure 1).



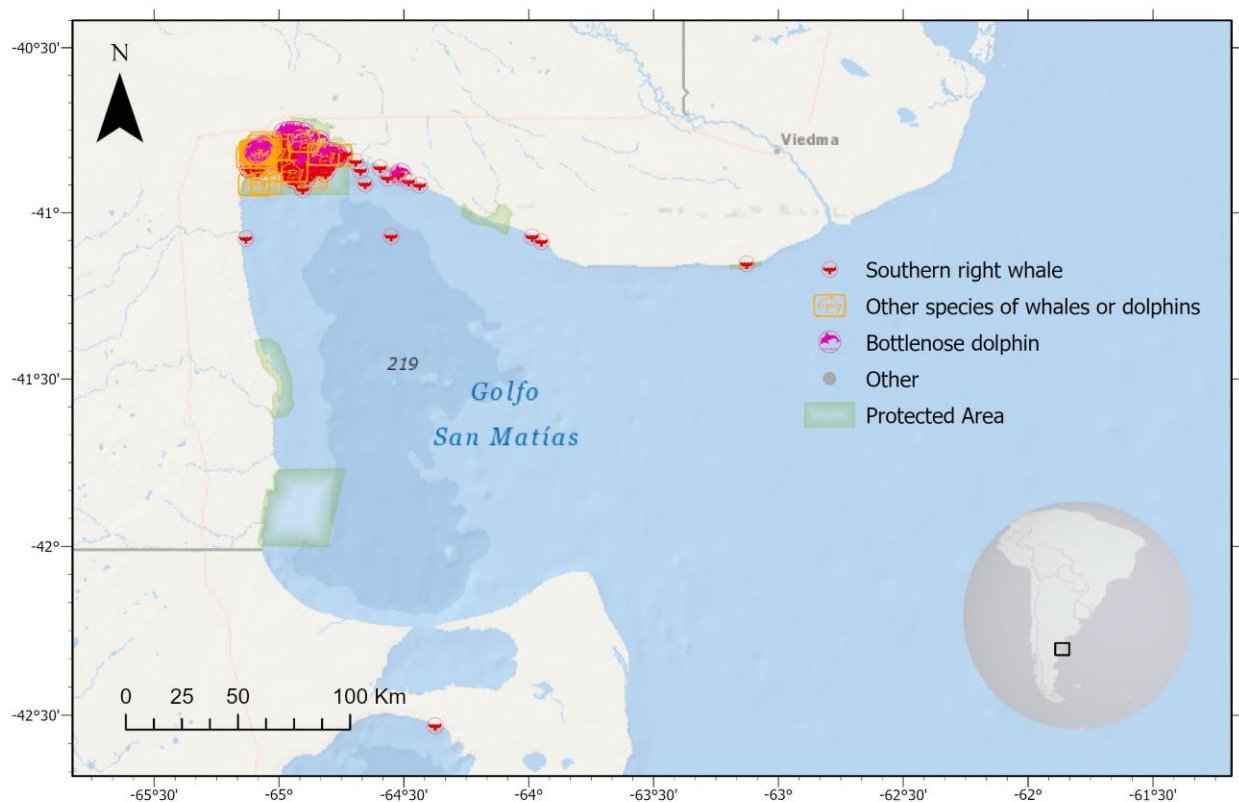
Figure 1. Billboard with information on the E-Whale platform on the SABMPA coast

Commercial nautical operators, local and tourist people provided opportunistic records on cetacean sightings. The participants registered the species observed, number of individuals, date and hour, weather conditions and geographical position in the E-WHALE web form. In addition, they recorded images of the animals observed and uploaded the images to E-WHALE. On some occasions, commercial nautical operators send this information through social media (WhatsApp) to M. Arias who then uploads this information into E-WHALE.

## Results

The citizen scientists recorded 509 sightings of 8 different cetacean species along the whole SMG between August 2021 and March 2022. Most cetacean sightings were from SABMPA and the

adjacent area (Figure 2). A total of 401 observations (78.78%) were registered by the whale-watching operators and the local researchers. The most frequently observed odontocete was *Tursiops truncatus* (n=51, 226 bottlenose dolphins), and the baleen whale with most sightings was *Eubalaena australis* (n=434, 1018 southern right whales) (Figure 3). The largest number of observations were made during the 2021 whale-watching season (Figure 4). Only common dolphin *Delphinus delphis* was observed in large groups of up to 120 dolphins. The other species of dolphins, as *Tursiops truncatus* and *Lagenorhynchus obscurus* were observed in small groups usually formed of up to five individuals while *Ornicus orca* was observed in groups of up to eight individuals. *Eubalaena australis* was mostly seen in pairs or as solitary individuals, while the other mysticetes species as *Balaenoptera acutorostrata*, *Balaenoptera borealis* and *Megaptera novaeglidae* were once to three times with no more than one or two individuals composing the group (Figure 5).





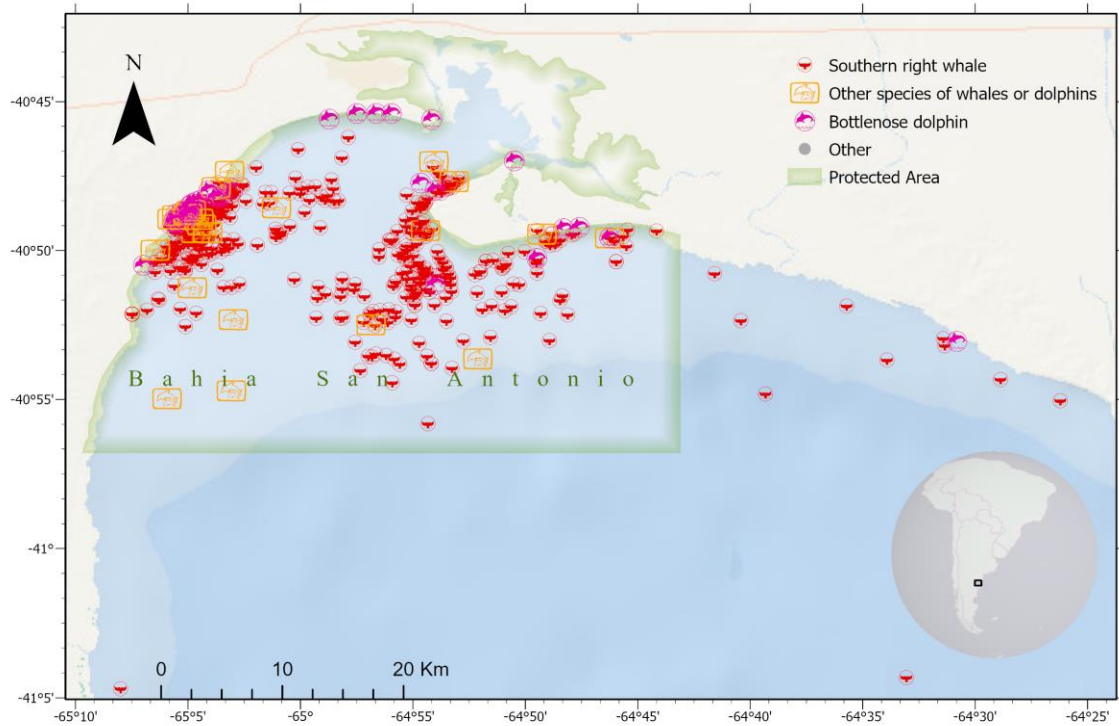


Figure 2. A) Study area within the San Matias Gulf showing the records of cetaceans collected by citizen science. B) Detail of the SABMPA

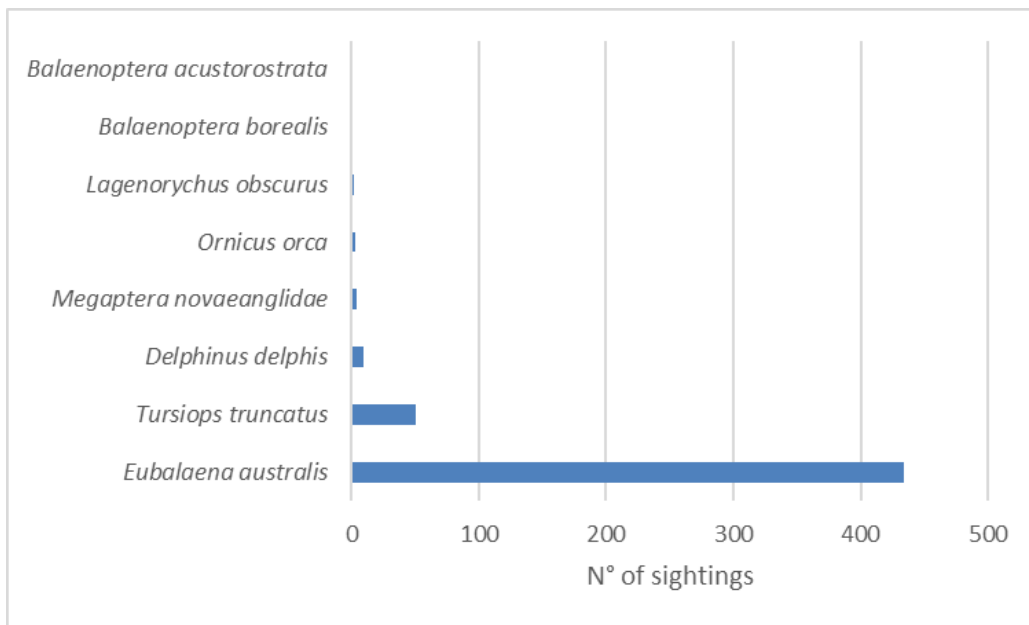


Figure 3. Frequency of observations for different cetacean species in San Matias Gulf between August 2021 and March 2022



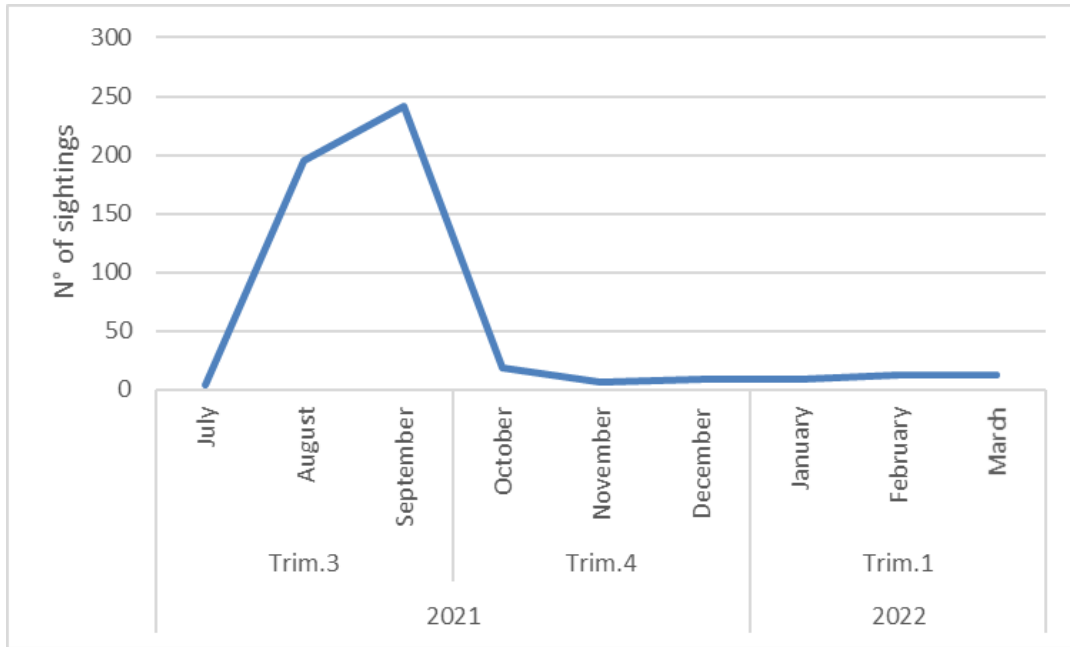


Figure 4. Frequency of observations for different month

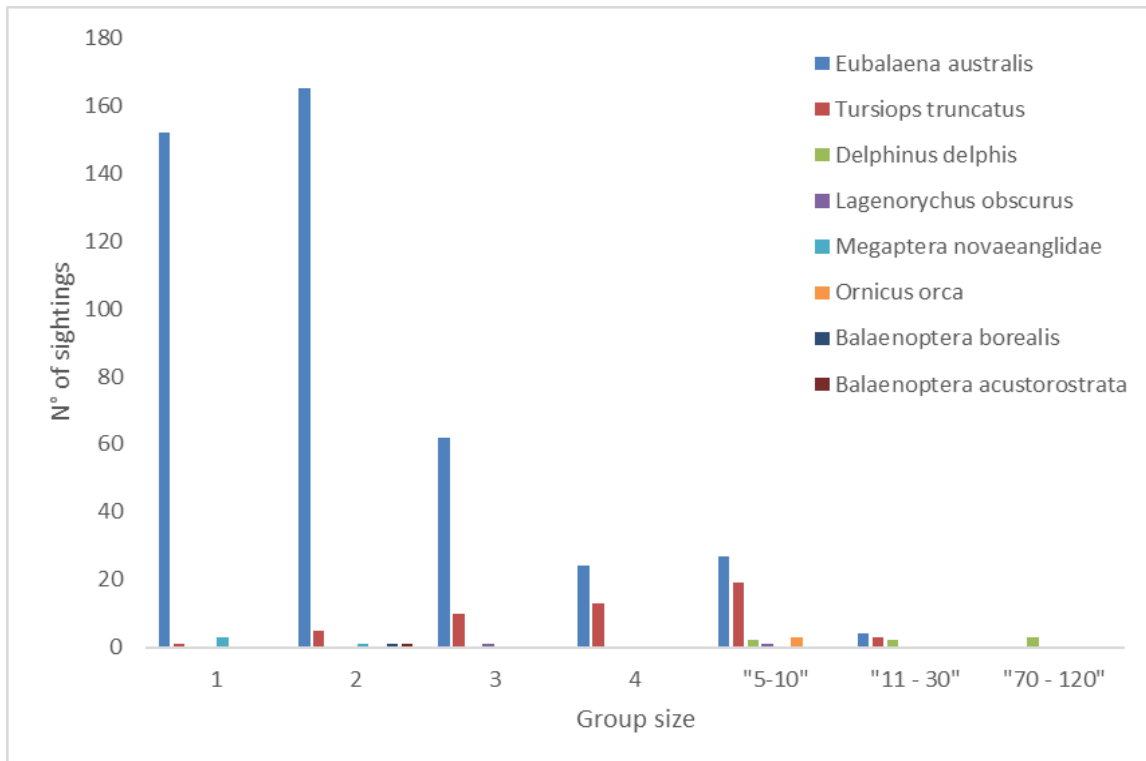


Figure 5. Group sizes observed in the eight species recorded

## **Discussion**

E-WHALE is the first citizen science initiative in Argentina aimed at cetacean monitoring. Carrying out citizen science through E-WHALE generated a double-win relationship in which data for the monitoring of cetacean species was obtained, involving the community in the process and sharing information about the biodiversity present in the visiting area through a novel and didactic tool. Thanks to the commitment of citizens and commercial nautical operators a total of eight cetaceans species were recorded during a period of nine month. This represents 47% of the species described so far in the SMG. Hence, this study demonstrates that with a strong network of citizen science that involves the local stakeholders it is possible to obtain data on cetacean species richness. This is especially useful in places where the areas of study are large and the budget and logistics are limited.

E-WHALE complements research activities that have been evolved during the las decades, focused on the SABMPA and SMG. Due to this previous research, there was a strong relationship with the nautical operators prior to the launch of E-WHALE. This was a key factor in building the sightings reporting network. Consequently, the number of sightings reported in SABMPA was higher compared to the other coast areas of the SMG. Future outreach activities are needed to extend E-WHALE to other coastal areas of SMG and improve the capacity of interested citizens that spend time at sea (e.g. sport fisherman) to gather scientific data on cetacean species.

Ultimately, this novel way of citizen science may provide valuable data of cetacean threats which would contribute to implement appropriate conservation strategies.

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