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# **Report**

## **Excursion Azores (Portugal) 2021**

### **Data obtained during whale watching in the waters south of Pico**

## **Part I**

# **Behavior of sighted cetaceans**

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## 1. Abstract

Land- and boat-based surveys were conducted to collect data during whale-watching in May, June and July 2021. Occurrence, distribution and behavior of cetaceans south of Pico Island (Azores) were determined. 87 schools of Delphinids and 103 individuals of large whales, corresponding to 13 species were sighted. Sperm whale (*Physeter macrocephalus*), Common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*) and Sei whale (*Balaenoptera borealis*) were the most frequently sighted species. 49 different behavior patterns were recorded. The majority, 34 behavior, were observed from two or more species. 15 behavioral patterns were observed only once from a single species. The common dolphin showed the biggest range of behaviors with a number of 30 different patterns only recorded from this species. Followed by Risso's dolphin which showed 27 behaviors. Lunge feeding, defensive behavior, and horizontal tail strikes were seldom observed.

## 2. Introduction

Places that were once popular for whaling are nowadays often used for whale-watching. The Azores' archipelago developed into a hotspot of whale-watching since Espaço Talassa began as the first operator in the early 1990s. Tourism is growing rapidly, and also whale-watching activities (Visser et al., 2011b). The Azores archipelago is a destination for nature tourism and one-third of the guests practice whale-watching by boat. A wide variety of species can be observed here. 28 different species have been recorded in the Azores (Silva et al., 2014), which has also contributed to this growth. Besides whale-watching operators are frequently trying to sensitize tourists to the need for whale protection, this being also one of the main intentions of Espaço Talassa in Lajes do Pico on the island of Pico (Koehler, 2014; Jefferson et al., 2015).

Information on residency, distribution, abundance, and behavioral patterns of cetaceans remains limited (Cechetti et al., 2018). The knowledge comes mostly from a series of large-scale international surveys. However, they did not cover mid-atlantic waters. Surveys are costly, and surveying large areas of offshore waters comprises many logistic and operational difficulties. The use of other data sets constitutes a valuable alternative for investigating how cetaceans use these areas (Silva et al., 2014). Whale-watching activities offer a source of valuable data and funding for cetacean research. Some limitations, e.g. the study area may not be equally covered, or findings from this research may not represent the entire research area, need to be discussed. Nevertheless, collected data on marine life as a "by-product" of whale-watching may contribute crucial data for understanding the occurrence of cetaceans around the island of Pico and other Azorean islands (Bron et al., 2019). Precise knowledge of the distribution and the behavior of the species is important for the efficient protection of whales. Whale-watching tours are offered possibly year-round. Therefore, it is a potential tool for detecting

long-term changes. The excursion aims to gain some data on the behavior of the whale species observed in the waters of the south coast of Pico.

### 3. Material and Method

In 2021 the University of Hildesheim, Department of Biology, carried out the excursion to the Azores with 4 groups. From May 17<sup>th</sup> to June 5<sup>th</sup> followed a group every week. The last group took place from June 28<sup>th</sup> to July 9<sup>th</sup>. Each group consisted of 12 people, students and lecturers, altogether. The boat surveys are led by two skippers that represent the maximum capacity of 14 participants for the whale-watching boat. Each boat tour for observations took three hours and occurred in the morning or the afternoon, respectively. A de-briefing after every boat-tour was carried out. All sightings were reviewed and questions answered. A comparison with the notes made on board was performed. The sighted whale species and their behavior were documented. On each excursion, boat- and shore-based surveys were conducted mainly off the south coast of Pico Island to collect data.

#### 3.1. Study area

The Azores archipelago is one of the two autonomous regions of Portugal and is composed of nine volcanic islands. They are located in the North Atlantic about 1500 km west of Lisbon (Bussmann, 2013). The archipelago is divided into the eastern, central and western group. Pico belongs to the central group, the study area is the southern coastal area of these island. The starting point for the observation trips is Lajes do Pico.

#### 3.2. Period of observation

The surveys took place during whale-watching tours, executed within three months. 15 days in May, eight in June, and six in July (Tab. 1). The total observation period are 29 days.

*Tab. 1: Period of surveys*

Excursions 2021	Date	No. of days	No. of observations	
			Boat based	Land based
May/June	17.5.-5.6.	20	24	2
June/July	28.6.-9.7.	9	10	1
Total no.		29	34	3

### **3.3. The field station**

Since 1989 the field station Espaço Talassa has welcomed scientists and photographers. 30 years of experience at the sea of the Azores combined with one of the best ten spots for whale-watching in the world. They have the logistics to optimise each trip to the archipelago, even if it is short. Their major request is the execution of sustainable, responsible travel and education.

### **3.4. Documentation**

For each sighting, data was recorded including date, time of the day, species sighted, numbers of individuals (if possible), gender (if possible), the behavior observed, and every other important observation. Monitored behavior was noted with repetitions and duration. The number of individuals in a group of dolphins was estimated. The bigger the pod the more difficult the counting. Every participant of the excursion gave an estimation of the number of dolphins. Out of these estimations, the average was noted as the estimation of the number of individual for this group. Every evening the observations of every participant were checked and noted. Therefore, it was ensured that no observed species or behavior was left out.

### **3.5. Technical equipment**

Cameras with a 70 to 200 mm lense were used. Videos were recorded underwater with a gopro Hero7 action camera. Notepads or tablets were used to write down every sighting and behavior. The coordinates of sightings were taken by a camera of the type Sony alpha 6600 via bluetooth with the App Imaging Edge Mobile from Sony on a Smartphone of the Samsung Galaxy series. With this technique the time and place of the species appearing and disappearing was noted. Furthermore, the route that the whale-watching-boat took was documented by a tracking app.

## **4. Results**

### **4.1. Observed behavior**

The field data, summoned during the survey, include 49 different behaviors. In table 2, the denomination and description of all observed behavior patterns are registered in alphabetical order, disregarding the frequency of occurrence or temporal succession. Own denomination were given when this behavioral patterns were not described in the literature or required a different bearing. This 6 behaviors are marked as own definitions.

Tab. 2: Behavior sighted (after Arcangeli & Crosti 2009, Carwardine 2020, Cecchetti et al. 2019, Janik 2015, Kiefner 2002, Mann 2018, Perrin et al. 2009, Reeves et al. 2002, Shirihai & Jarret 2008, Still et al. 2019; Torres et al. 2018)

Denomination	Description	Exemplification
<b>1 Aggregation</b>	<ul style="list-style-type: none"> <li>• Association occurring by chance or because of the gathering of animals of different species</li> </ul>	<ul style="list-style-type: none"> <li>• Around clumped resources</li> <li>• Lost individual in a group of a different species</li> </ul>
<b>2 Aggressive behavior</b>	<ul style="list-style-type: none"> <li>• Social interaction with the intention of inflicting damage or other harm upon another individual</li> <li>• Predatory aggression</li> <li>• Antipredatory aggression</li> <li>• Intraspecific aggression</li> </ul>	<ul style="list-style-type: none"> <li>• Intra-species conflict determining access to limited resources</li> </ul>
<b>3 Approach boat</b>	<ul style="list-style-type: none"> <li>• Interrupting actual behavior to swim to the boat</li> </ul>	
<b>4 Association (functional Association)</b>	<ul style="list-style-type: none"> <li>• Temporary aggregations of individuals of different species involved in similar activities for a period</li> <li>• Seasonable, or coincidental</li> <li>• From minutes to years</li> </ul>	<ul style="list-style-type: none"> <li>• Cooperative hunting</li> <li>• Improves efficiency</li> <li>• Improved predator detection</li> </ul>
<b>5 Avoiding</b>	<ul style="list-style-type: none"> <li>• Moving away from the boat</li> <li>• Mostly fast swimming or leaping</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>
<b>6 Blowing/Spout</b>	<ul style="list-style-type: none"> <li>• The act of breathing</li> <li>• Also the visible misty cloud</li> <li>• Exhalation immediately followed by an inhalation</li> </ul>	<ul style="list-style-type: none"> <li>• Maintenance of life functions</li> </ul>
<b>7 Bow riding</b>	<ul style="list-style-type: none"> <li>• The activity of swimming or „riding“ on the pressure wave created in front of a boat or ship moving through the water</li> <li>• Positioning themselves to be lifted up and pushed forward by the circulating water generated to form a bow pressure wave of an advancing vessel</li> </ul>	<ul style="list-style-type: none"> <li>• Promotes efficient traveling</li> <li>• Limited energy needed, sometimes propelled along entirely by the pressure wave, no tail beats needed</li> <li>• At the periphery of the pressure wave or with slow-moving vessels tail beats are needed</li> </ul>
<b>8 Chasing</b>	<ul style="list-style-type: none"> <li>• Following another individual in pursuit</li> </ul>	<ul style="list-style-type: none"> <li>• play</li> </ul>
<b>9 Curiosity</b>	<ul style="list-style-type: none"> <li>• Exploration of objects never seen before</li> <li>• Play around with all sorts of apparently „useless“ things</li> </ul>	<ul style="list-style-type: none"> <li>• Improves the ability to respond rapidly to changing environments</li> <li>• Getting extra information is rewarding</li> <li>• To get to know something unknown</li> <li>• Mostly with juveniles</li> </ul>
<b>10 Defensive behavior</b>	<ul style="list-style-type: none"> <li>• Interception of intrusive individuals</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>
<b>11 Diving</b> Own definition	<ul style="list-style-type: none"> <li>• A deep dive to feed after several surfacing sequences</li> </ul>	<ul style="list-style-type: none"> <li>• Preparing to feed</li> <li>• Maintenance of life functions</li> </ul>
<b>12 Diving shallow</b>	<ul style="list-style-type: none"> <li>• Diving without showing the fluke to hide close under the surface</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>

<b>13 Diving torpedo</b> Own definition	<ul style="list-style-type: none"> <li>• Fast, long and flat-angled dive</li> <li>• Can take several meters</li> </ul>	•
<b>14 Drowning</b> Own definition	<ul style="list-style-type: none"> <li>• Thrust the body onto another one to deliberately push the other below the surface</li> </ul>	• Hunting strategy
<b>15 Feeding</b>	<ul style="list-style-type: none"> <li>• Any activity for the acquisition of nutrition and ingestion</li> <li>• Group diving in the same location</li> <li>• Surfacing in varying directions</li> </ul>	• Maintenance of life functions
<b>16 Feeding lunge</b>	<ul style="list-style-type: none"> <li>• Feeding strategy of rorquals</li> <li>• Approach the pray with a lunge, accelerating the body</li> </ul>	•
<b>17 Fighting</b>	<ul style="list-style-type: none"> <li>• Aggressive behavior</li> </ul>	•
<b>18 Fluking</b>	<ul style="list-style-type: none"> <li>• The activity of showing the fluke, especially when diving</li> <li>• Fluke rises vertically with some larger whales</li> <li>• Fluke rises to 45 degree with small whales before a deep dive</li> <li>• Sinking into the water without a splash or sound</li> </ul>	<ul style="list-style-type: none"> <li>• For a steep diving angle</li> <li>• Improves a faster deep-going dive</li> </ul>
<b>19 Follow the boat</b>	<ul style="list-style-type: none"> <li>• After the approach travel with the boat for a certain time</li> </ul>	•
<b>20 Herding</b>	<ul style="list-style-type: none"> <li>• Chasing fish together to a tighter school ("bait ball")</li> </ul>	•
<b>21 Hunting</b>	<ul style="list-style-type: none"> <li>• Any activity related to capture prey in the near environment</li> <li>• Predation event characterized by the attack of whales on aggregations of small prey</li> <li>• Milling (frequent changes of direction)</li> </ul>	• Maintenance of life functions
<b>22 Hunting interspecific cooperative</b>	<ul style="list-style-type: none"> <li>• individuals of different species</li> </ul>	<ul style="list-style-type: none"> <li>• Synchronized feeding leads to the enhanced benefit of every single animal</li> <li>• Improves efficiency of hunting</li> <li>• Cooperative food-herding producing a „bait ball“</li> </ul>
<b>23 Hunting intraspecific cooperative</b>	<ul style="list-style-type: none"> <li>• individuals of the same species</li> </ul>	<ul style="list-style-type: none"> <li>• Synchronized feeding leads to the enhanced benefit of every single animal</li> <li>• Improves efficiency of hunting</li> <li>• Cooperative food-herding producing a „bait ball“</li> </ul>
<b>24 Joining</b> Own definition	<ul style="list-style-type: none"> <li>• Gathering at or near the surface</li> </ul>	<ul style="list-style-type: none"> <li>• Females and juvenile gather</li> <li>• Whale bull visits a group of whale cows</li> <li>• Joining subgroups</li> </ul>
<b>25 Lactating</b>	<ul style="list-style-type: none"> <li>• Production of milk by a female mammal to feed its young</li> </ul>	• Maintenance of life functions

<b>26 Leaping /Breaching</b>	<ul style="list-style-type: none"> <li>Breaching with huge whales</li> <li>The activity of smaller toothed whales to clear completely or almost completely out of the water</li> <li>Leaving water with the beak, entering water with the beak first</li> </ul>	<ul style="list-style-type: none"> <li>Display or threat</li> <li>Social or individual play</li> <li>Removal of skin parasites</li> <li>Communication</li> </ul>
<b>27 Leaping (acrobatic)</b> Own definition	<ul style="list-style-type: none"> <li>With spins, somersaults, various inventive bends and contortions, a combination of flips, head twists, extra tail kicks in the air</li> </ul>	<ul style="list-style-type: none"> <li>May serve as a social facilitation function that helps to coordinate members of a school or pod</li> </ul>
<b>28 Leaping/ half-leap/Belly-flop/ lunging</b>	<ul style="list-style-type: none"> <li>Lunging with big whales</li> <li>The whale clears the water surface with less than 40 % of the body</li> </ul>	<ul style="list-style-type: none"> <li>Display or threat</li> <li>Social or individual play</li> <li>Removal of skin parasites</li> <li>Communication</li> </ul>
<b>29 Lining</b>	<ul style="list-style-type: none"> <li>The activity of a group of animals spreading out widely and move forward in a line abreast when suitable habitats are widely spaced</li> </ul>	<ul style="list-style-type: none"> <li>Reduce foraging competition</li> <li>Increase the probability that prey is detected</li> </ul>
<b>30 Logging</b>	<ul style="list-style-type: none"> <li>Lying motionless at or just below the surface, inactive and usually horizontally</li> <li>Entire pod behaves synchronously, tightly packed, sometimes touching each other</li> </ul>	<ul style="list-style-type: none"> <li>To rest</li> </ul>
<b>31 Mating</b>	<ul style="list-style-type: none"> <li>The pairing of opposite-sex</li> </ul>	<ul style="list-style-type: none"> <li>Reproduction</li> </ul>
<b>32 Peduncle arch</b>	<ul style="list-style-type: none"> <li>Arch the caudal peduncle before making a deep descent</li> </ul>	<ul style="list-style-type: none"> <li>Dorso-ventral oscillations of cetacean caudal flukes generate lift-based thrust for swimming</li> </ul>
<b>33 Playing</b>	<ul style="list-style-type: none"> <li>Comprises all aspects of non-survival related actions, particularly between two or more members of the same species</li> </ul>	<ul style="list-style-type: none"> <li>Seems to have no purpose but enjoyment</li> <li>Young animal learn motor and social skills</li> </ul>
<b>34 Porpoising</b> <b>Running</b>	<ul style="list-style-type: none"> <li>Traveling at high speed, making repeatedly low, arcing leaps clear of the water every time to take a breath</li> <li>Usually re-enters the water headfirst</li> </ul>	<ul style="list-style-type: none"> <li>Very fast locomotion</li> <li>Escape</li> </ul>
<b>35 Pursuit</b>	<ul style="list-style-type: none"> <li>A burst of speed just below the surface</li> <li>Often changing direction, twisting and turning</li> </ul>	<ul style="list-style-type: none"> <li>Capturing food items</li> <li>Individual feeding strategy, mostly toothed whales</li> <li>High speed pursuit</li> </ul>
<b>36 Resting</b>	<ul style="list-style-type: none"> <li>Slow movements up to absence of forward propulsion, floating stationary at the surface</li> <li>diving and surfacing in synchrony and at regular intervals, absence of active surface behavior</li> </ul>	

<b>38 Slapping chin/head</b>	<ul style="list-style-type: none"> <li>The activity of partially lunging out of the water and then slap the throat forcefully onto the surface</li> </ul>	<ul style="list-style-type: none"> <li>Communication</li> <li>The animal feels disturbed</li> <li>Exhibit vitality</li> </ul>
<b>37 Slapping flipper Pectoral slapping Flipper flopping Flippering</b>	<ul style="list-style-type: none"> <li>Capability of raising the flippers above water and slapping them vigorously against the surface</li> </ul>	<ul style="list-style-type: none"> <li>A gesture of threat, irritation</li> <li>Sign to gather</li> <li>Communication</li> <li>Hunting</li> </ul>
<b>39 Slapping tail/ lob-tailing</b>	<ul style="list-style-type: none"> <li>Lob-tailing with huge whales</li> <li>Lifting the tail clear out of the water, then slapping it down forcefully on the surface</li> </ul>	<ul style="list-style-type: none"> <li>Communication</li> <li>A gesture of threat, irritation</li> <li>Feeding-strategy</li> </ul>
<b>40 Socializing</b>	<ul style="list-style-type: none"> <li>Social behavior among two or more individuals within the same species</li> <li>Encompasses any behavior in which one member affects the other, due to an interaction among those members</li> <li>Very highly variable behavior</li> <li>Activity with vocal, tactile, and aerial behavior</li> </ul>	<ul style="list-style-type: none"> <li>Tight social bonds provide many advantages that includes the improved immune system, reduced risk of disease, reduced risk of predation, improved defence against harassment of males or aggressive conspecific, improved survival and reproduction</li> <li>Frequent physical contact accompanied by surface displays and no obvious movement</li> </ul>
<b>41 Spy-hopping Head-rise Eye-out</b>	<ul style="list-style-type: none"> <li>The activity of an animal that assumes a vertical position and raises its head above the water until its eyes are above or just below the surface</li> <li>Sinking below the surface without much splash</li> </ul>	<ul style="list-style-type: none"> <li>Scanning the surrounding area visually</li> <li>Curiosity</li> <li>Search for food</li> </ul>
<b>42 Surfacing</b>	<ul style="list-style-type: none"> <li>Breaking the surface most common in traveling whales</li> </ul>	<ul style="list-style-type: none"> <li>Emerge to breathe</li> </ul>
<b>43 Surfing</b>	<ul style="list-style-type: none"> <li>Riding a naturally generated wave or by passing boats or ships</li> </ul>	<ul style="list-style-type: none"> <li>Maybe part of some foraging pattern or patrolling the coastline</li> <li>Faster locomotion</li> </ul>
<b>44 Swimming/ dorsal</b>	<ul style="list-style-type: none"> <li>Swimming on the back of the body</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<b>45 Swimming/lateral Sharking</b>	<ul style="list-style-type: none"> <li>Swimming on the side of the body</li> <li><i>Physeter macrocephalus</i> swimming lateral and showing half of the fluke</li> </ul>	<ul style="list-style-type: none"> <li>Locomotion</li> </ul>
<b>46 Swimming/vertical</b>	<ul style="list-style-type: none"> <li>Swimming upright</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<b>47 Synchronous behavior</b>	<ul style="list-style-type: none"> <li>Occurs when two or more animals perform the same behavior at the same time</li> <li>Group members perform behaviors that are performed "simultaneously" or in "union"</li> </ul>	<ul style="list-style-type: none"> <li>Signal for cooperation or to reduce tension</li> <li>Involved with the advertisement or reinforcement of social bonds</li> <li>Lining with <i>Grampus griseus</i></li> </ul>
<b>48 Tail strike lateral Own definition</b>	<ul style="list-style-type: none"> <li>Striking horizontally with the tail to the left or right side</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<b>49 Traveling</b>	<ul style="list-style-type: none"> <li>Individual or group following a consistent direction over time</li> <li>Unidirectional movement</li> </ul>	<ul style="list-style-type: none"> <li>Movement between widely spaced suitable habitats</li> <li>Migration</li> </ul>

## 4.2. Assignment of whale species and observed behavior

Table 3 shows all recorded behavioral patterns during the observation period and all species are described performing them. The number of species showing this behavior is stated. Surfacing, blowing and diving was observed from all species. 15 different behavioral patterns were recorded from a single species only.

Tab. 3: Behavior and number of species showing it

Behavior	Species	Number of species
1 Aggregation	<i>Balaenoptera borealis</i> & <i>Delphinus delphis</i> <i>Balaenoptera borealis</i> & <i>Balaenoptera musculus</i> <i>Balaenoptera borealis</i> & <i>Balaenoptera physalus</i> <i>Balaenoptera musculus</i> & <i>Delphinus delphis</i> <i>Grampus griseus</i> & <i>Physeter macrocephalus</i> <i>Grampus griseus</i> & <i>Tursiops truncatus</i>	7
2 Aggressive behavior	<i>Grampus griseus</i>	1
3 Approaching boat	<i>Delphinus delphis</i> <i>Pseudorca crassidens</i> <i>Tursiops truncatus</i>	3
4 Association	<i>Delphinus delphis</i> & <i>Stenella coeruleoalba</i>	2
5 Avoidance	<i>Balaenoptera borealis</i> <i>Balaenoptera physalus</i> <i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Stenella coeruleoalba</i>	5
6 Blowing	All	13
7 Bow-riding	<i>Delphinus delphis</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	4
8 Chasing	<i>Balaenoptera musculus</i> <i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Tursiops truncatus</i>	3
9 Curiosity	<i>Balaenoptera borealis</i> <i>Balaenoptera physalis</i> <i>Delphinus delphis</i> <i>Physeter macrocephalus</i> <i>Pseudorca crassidens</i> <i>Stenella coeruleoalba</i> <i>Tursiops truncatus</i>	7
10 Defensive behavior	<i>Physeter macrocephalus</i>	1
11 Diving	all	13
12 Diving shallow	<i>Physeter macrocephalus</i>	1
13 Diving torpedo	<i>Grampus griseus</i>	1
14 Drowning	<i>Grampus griseus</i>	1
15 Feeding	<i>Balaenoptera physalus</i>	1
16 Feeding lunge	<i>Balaenoptera physalus</i>	1
17 Fighting	<i>Grampus griseus</i> & <i>Tursiops truncatus</i> <i>Grampus griseus</i>	2

<b>18 Fluking</b>	<i>Delphinus delphis</i> <i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Physeter macrocephalus</i> <i>Pseudorca crassidens</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>7</b>
<b>19 Follow-the-boat</b>	<i>Delphinus delphis</i>	<b>1</b>
<b>20 Herding</b>	<i>Delphinus delphis</i>	<b>1</b>
<b>21 Hunting</b>	<i>Balaenoptera physalus</i> <i>Delphinus delphis</i> <i>Pseudorca crassidens</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>6</b>
<b>22 Hunting interspecific cooperative</b>	<i>Delphinus delphis</i> & <i>Stenella coeruleoalba</i>	<b>2</b>
<b>23 Hunting intraspecific cooperative</b>	<i>Delphinus delphis</i> <i>Tursiops truncatus</i>	<b>4</b>
<b>24 Joining</b>	<i>Physeter macrocephalus</i>	<b>1</b>
<b>25 Lactating</b>	<i>Physeter macrocephalus</i>	<b>1</b>
<b>26 Leaping / Breaching</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Mesoplodon bidens</i> <i>Physeter macrocephalus</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>7</b>
<b>27 Leaping acrobatic</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>5</b>
<b>28 Leaping Belly flops</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Stenella coeruleoalba</i>	<b>3</b>
<b>29 Lining</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Pseudorca crassidens</i> <i>Tursiops truncatus</i>	<b>4</b>
<b>30 Logging</b>	<i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Pseudorca crassidens</i>	<b>3</b>
<b>31 Mating</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>4</b>
<b>32 Peduncle arch</b>	<i>Balaenoptera musculus</i> <i>Balaenoptera physalus</i> <i>Globicephala macrorhynchus</i> <i>Physeter macrocephalus</i> <i>Pseudorca crassidens</i>	<b>5</b>
<b>33 Play</b>	<i>Balaenoptera musculus</i> <i>Grampus griseus</i>	<b>2</b>
<b>34 Porpoising</b>	<i>Delphinus delphis</i> <i>Stenella coeruleoalba</i>	<b>2</b>

<b>35 Pursuit</b>	<i>Delphinus delphis</i> <i>Stenella frontalis</i>	<b>2</b>
<b>36 Resting</b>	<i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Physeter macrocephalus</i>	<b>3</b>
<b>37 Slapping Chin/Head</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>5</b>
<b>38 Slapping Flipper</b>	<i>Balaenoptera musculus</i>	<b>1</b>
<b>39 Slapping Tail/Lob-tailing</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Physeter macrocephalus</i> <i>Pseudorca crassidens</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>7</b>
<b>40 Socializing</b>	<i>Delphinus delphis</i> <i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Physeter macrocephalus</i> <i>Pseudorca crassidens</i> <i>Tursiops truncatus</i>	<b>6</b>
<b>41 Spy-hopping</b>	<i>Delphinus delphis</i> <i>Physeter macrocephalus</i> <i>Tursiops truncatus</i>	<b>3</b>
<b>42 Surfacing</b>	all	<b>13</b>
<b>43 Surfing</b>	<i>Delphinus delphis</i> <i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Stenella coeruleoalba</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>6</b>
<b>44 Swimming/dorsal</b>	<i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Tursiops truncatus</i>	<b>3</b>
<b>45 Swimming/lateral/Sharking</b>	<i>Balaenoptera musculus</i> <i>Balaenoptera physalus</i> <i>Delphinus delphis</i> <i>Grampus griseus</i> <i>Physeter macrocephalus (sharking)</i> <i>Tursiops truncatus</i>	<b>6</b>
<b>46 Swimming/vertical</b>	<i>Delphinus delphis</i>	<b>1</b>
<b>47 Synchronous behavior</b>	<i>Grampus griseus</i>	<b>1</b>
<b>48 Tail-striking horizontal</b>	<i>Delphinus delphis</i>	<b>1</b>
<b>49 Travelling</b>	<i>Balaenoptera borealis</i> <i>Balaenoptera musculus</i> <i>Balaenoptera physalus</i> <i>Globicephala macrorhynchus</i> <i>Grampus griseus</i> <i>Pseudorca crassidens</i> <i>Stenella frontalis</i> <i>Tursiops truncatus</i>	<b>8</b>

### 4.3. Sightings and observed behavior

Table 4 demonstrates the number of sightings, the number of behavior and the total time of observation recorded for each cetacean observed. With 39 sightings *Physeter macrocephalus* was the most sighted species during the trip. *Delphinus delphis* showed the biggest range of different behaviors and was observed the longest time. During the trip, two different species of banded whales were sighted, even though there were almost no behaviors to be noticed.

Tab. 4: Number of behavior, number of sightings, and total time of observation for each species

No	Species	No of sightings	No of behavior	Total time of observation [min]
1	<i>Mesoplodon bidens</i>	2	4	4
2	<i>Hyperoodon ampullatus</i>	1	3	12
3	<i>Pseudorca crassidens</i>	1	13	27
4	<i>Globicephala macrorhynchus</i>	5	11	49
5	<i>Stenella coeruleoalba</i>	11	15	50
6	<i>Stenella frontalis</i>	7	14	55
7	<i>Balaenoptera physalus</i>	5	11	83
8	<i>Balaenoptera musculus</i>	5	9	131
9	<i>Balaenoptera borealis</i>	8	7	157
10	<i>Tursiops truncatus</i>	12	25	183
11	<i>Physeter macrocephalus</i>	39	17	253
12	<i>Grampus griseus</i>	21	27	259
13	<i>Delphinus delphis</i>	28	30	286

Fig. 1 shows the relationship between the number of behavior and the number of sightings. The correlations coefficient is  $r = 0,68$ . The relationship between the number of behavior and the total time of observation is shown in Fig. 2. The correlation coefficient is  $r = 0,79$ .

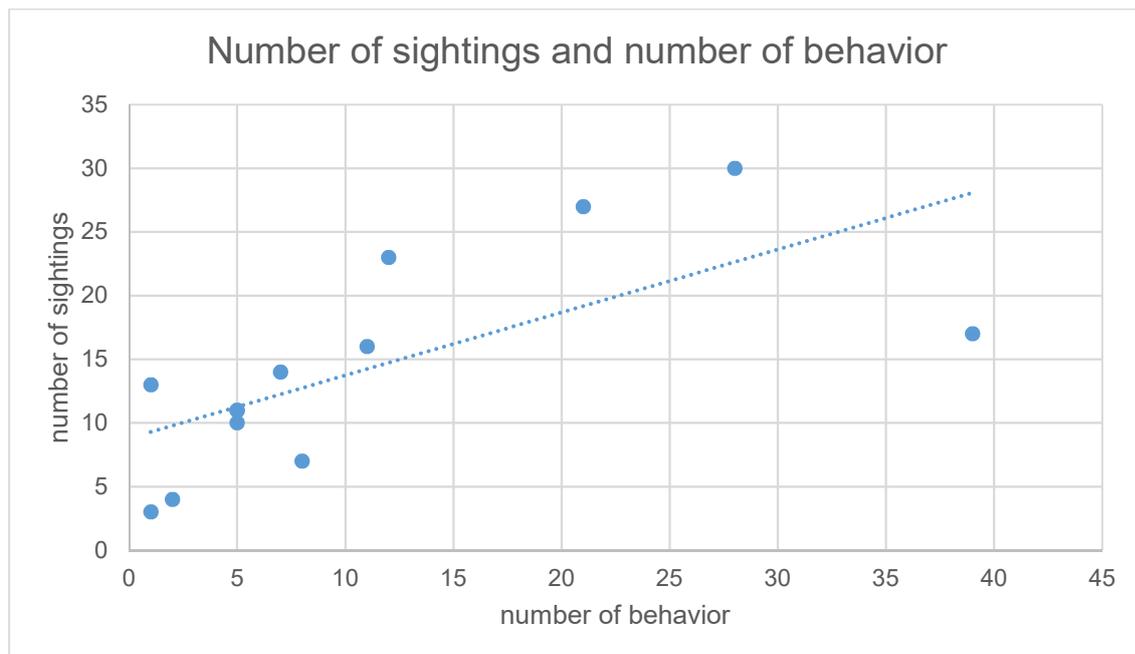


Fig. 1: Relation of the number of sightings and the number of behavior for all species

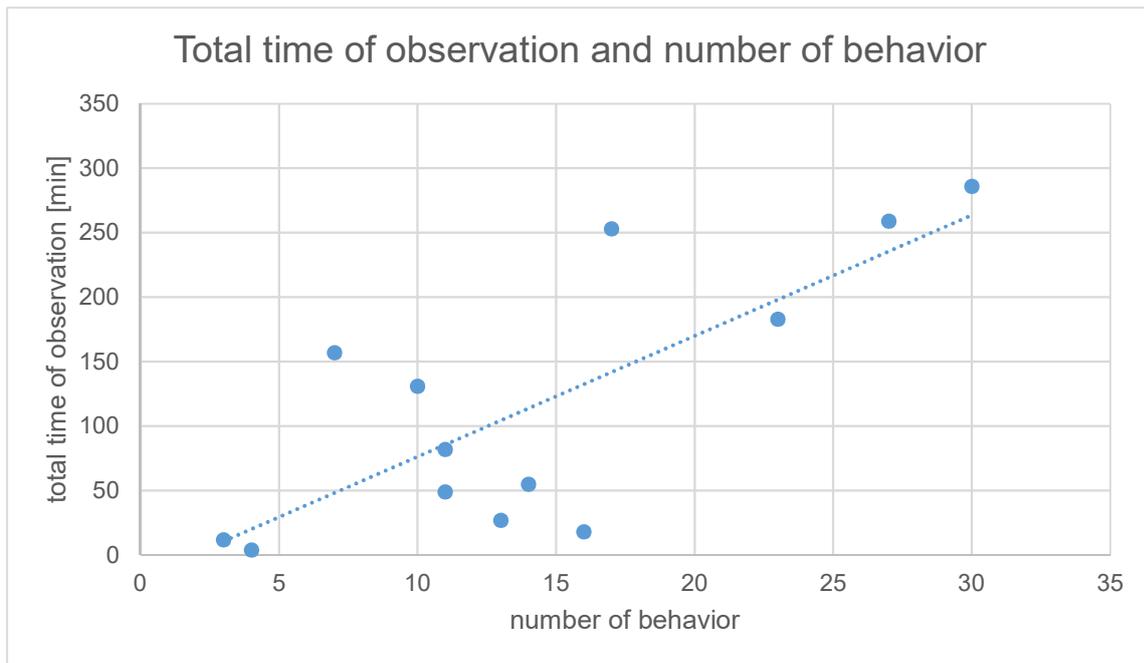


Fig.2: Relation of the total time of observation and the number of behavior for all species

#### 4.4. Short description of distinctive behavior

Detailed information on observed behaviors can be found in the table above; therefore, only a few unique behavioral patterns follow.

##### Lining

May 29<sup>th</sup> male Risso’s dolphins were observed swimming in a formation (Fig. 3). This behavior is sometimes observed in response to boat traffic (Hastie et al., 2003). In this case lining is a social behavior where the animals synchronize their behavior (Berta, 2015).



Fig. 3: Risso’s dolphins (*Grampus griseus*) lining (P.Zahn)

### **Play**

Figure 4 shows Risso's dolphin playing with a Portuguese man o' war (*Physalia physalis*) May 18<sup>th</sup>. This behavior was only once observed during this survey. In this case it might have been the exploration of an object.



Fig. 4: Risso's dolphin (*Grampus griseus*) playing (P.Zahn)

### **Porpoising**

In the Azores *Stenella coeruleoalba* rather avoids whale-watching vessels. To move away as fast as possible they show the behavior "porpoising" (Fig. 5) like seen on May 28<sup>th</sup>. They perform arcing leaps, breathing once with every jump.



Fig. 5: Striped dolphin (*Stenella coeruleoalba*) porpoising (P. Zahn)

### **Travelling fast**

*Tursiops truncatus* is seen often in small pods. On May 19<sup>th</sup> a much bigger group was observed travelling fast, a behavior less frequently shown (Fig. 6). They leap from time to time, therefore it is not porpoising behavior.



Fig. 6: Common bottlenose dolphin (*Tursiops truncatus*) travelling fast (P. Zahn)

### **Acrobatic leaping**

*Tursiops truncatus* tends to be active most of the time (Carwardine, 2020). They often perform aerial behaviour, like this acrobatic leaping (Fig. 7) shown on May 29<sup>th</sup>.



Fig. 7: Common bottlenose dolphin (*Tursiops truncatus*) acrobatic leaping (P. Zahn)

## **5. Discussion**

Cetaceans are under increasing pressure from anthropogenic activities (Silva et al., 2014). Cargo, commercial and recreational fishing, passenger transportation, and tourism are also some of the economic sectors that have an influence on the marine ecosystems in the Azores. Whales are

vulnerable to the impact of all these activities (Tobeña et al., 2016). The Azores offer a high diversity of cetaceans. Information on population size and habitat use of cetaceans is urgently needed for assessing the potential adverse effects of human activities. Understanding the distribution and the behavior of marine species is crucial to implement appropriate management and conservation measures. This study attempted to gain useful opportunistic data for cetacean behavior research.

## **5.1. Observed behavior**

49 different behaviours were observed. This is a considerable number with respect to the short period of the survey (29 days) and 13 species sighted. It emphasises the important role of the archipelago of the Azores for whale-watching as well as for whale research (Tobeña et al., 2016; Silva et al., 2003 and 2014). Most of the behaviour was observed during the study, sexual, parental, social, migration and feeding behaviour. The detection of cetaceans declines as a function of distance from the observation platform. It is influenced by species behaviour, school size, characteristics of the boat (height and speed), environmental conditions, and also number and experience of observers (Silva et al., 2014). It is to consider that monitoring whales is often possible only at the surface of the water. Boat-based surveys have a great advantage, because of the much higher mobility. Another advantage of whale-watching tours are the experienced skippers.

## **5.2. Assignment of whale species and observed behavior**

Three species showed between 20 and 30, ten species showed 10 to 19, and another three species showed less than 10 behavioral patterns. The majority of the sighted whale species gave insight into a high number of different behaviours. This is also a confirmation that sustainable whale-watching can lead to significant data on different aspects of cetacean research. This result is an indication that the region of the Azores is not only one of the world's most important hotspot of marine diversity but also a major place for whale research (Bron et al., 2020; Silva et al., 2014; Tobeña et al., 2016).

Surfacing, blowing, and diving was observed from every species. 31 different behaviors were shown from 2 to 8 species, while another 15 behavioral patterns were recorded from a single species respectively. That is almost one third (31 %) of the total sum of observed behaviours. Hofmann et al. (2004) observed the underwater behaviour of *Globicephala macrorhynchus* off Tenerife and obtained a similar result. From 11 valued encounters 17 behavioural patterns were watched and eight of these singly in one encounter only (47 %). *Grampus griseus*, *Physeter macrocephalus*, and *Delphinus delphis* are the species who showed most this unique behaviors, with 4 different behavioural patterns each. In this study, all observations from Beaked whales are in agreement with the literature, they showed the lowest number of sightings and behaviours. Also the total time of observation was lowest. Beaked whales are notoriously difficult to study. Reactions to vessels vary. They tend to be quite shy and

elusive (Carwardine, 2020). The sightings of this group are heavily affected by sea conditions (Tobeña et al., 2016; Visser, 2012).

### **5.3. Sightings and observed behavior**

Many people are highly attracted by cetaceans. Dolphins approach boats, ride in the bow wave and perform astonishing acrobatics, apparently of pure pleasure. Therefore, many people are interested in their behaviour. The Greeks already reported bow riding in the Mediterranean by what were likely Common bottlenose dolphins, Short-beaked common dolphins, and Striped dolphins (Wuersig et al., 2018). Behaviour may sometimes be useful for identification purposes (Carwardine, 2020; Still et al., 2019). Cetacean behaviour varies greatly between species. This was used as a first aim in this study to assist in the identification of the species.

The second aim was the investigation of how many different behaviour patterns were possible to observe. With 49 behaviors registered in 20 boat- and one land-based surveys the number appeared quite high. This study shows a high relation between the number of sightings ( $r=0,69$ ) and an even higher correlation between number of observed behaviour and the total time of observation ( $r=0,76$ ). The species with the longest observation period (more than 200 minutes) are the ones which showed the most behavioural patterns and also the most number of unique behavior.

#### Baleen whales

Baleen whales are highly migratory marine species. Their annual migrations between low-latitude wintering grounds and high-latitude summer feeding areas lead to their presence at middle-latitude around the Azores in spring and summer (Pérez-Jorge et al., 2020; Silva et al., 2014; Still et al., 2019). This is in agreement with this study.

All baleen whales in the Azorean environment spent a substantial part of their time feeding. Foraging comprised over 40 % of the behavioural budgets of Sei whales (Visser et al., 2011a). In this study, all individuals (32) of the three species of rorquals were observed travelling, with the exception of one *Balaenoptera physalis* that showed feeding behaviour. This Fin whale often changed course, indicating that it was hunting fish. All other six Blue, six Fin, and 19 Seiwhale headed in a westerly direction on a straight line, following the Pico island coastline. It was assumed that prey availability was low. Visser et al., (2011a) showed that the time window during which large baleen whales are in the Azores depends more on prey availability than on the current time of year. The timing of their presence is strongly related to the onset of the North Atlantic phytoplankton spring bloom (Visser et al., 2011a). Silva et al. (2014) suggested that the region of the Azores may be a transit area for Sei whales.

Baleen whales' annual migrations between low-latitude wintering grounds and high-latitude summer feeding areas lead to their presence at middle-latitude around the Azores in spring and summer (Pérez-

Jorge et al., 2020; Silva et al., 2014; Still et al., 2019). While migrating to their feeding grounds they showed the behaviors responding to this, travelling, avoiding boat, sometimes curiosity, peduncle arch and to a much lesser extent hunting and feeding.

### Sperm whale

Sperm whales are considered to be essentially teutophagus. Individuals of this species are frequently observed in the Azores all year round. They are among the most frequently sighted species around all islands of the archipelago and the main target of whale-watching activities (Bron et al., 2020: Silva et al., 2003 und 2014; Tobeña et al., 2016). They have two primary behavioural states: foraging and resting or socializing. *Physeter macrocephalus* make repeated dives when foraging. Family groups spread out over distances of one km or more (Carwardine, 2020). This is in agreement with this study. Most of the time *Physeter macrocephalus* was observed resting between feeding dives. During this study Sperm whales represented a number of social and parental behaviour when resting, e.g. joining, lactating, play, and lob-tailing in compliance with Oliveira (2014).

### Beaked whales

Beaked whales, are notoriously difficult to study. Reactions to vessels vary. They tend to be quite shy and elusive (Carwardine, 2020). Every sighting a few individuals close together in agreement with Carwardine (2020). Furthermore, their cryptic behaviour. They are deep divers with a prolonged diving period but a short resting time at the surface. In this study, only leaping was recorded from Sowerby's beaked whale. Silva et al. (2014) report for Mesoplodon species a year-round presence, but for *Hyperoodon ampullatus* only during summer month.

### Oceanic dolphins

The species of this group reveal the highest number of different behaviors. Each species with more than 10, but Short-beaked common dolphin (30), Risso's dolphin (27), and Common bottlenose dolphin (23) show most. For all dolphins the mean number of behavioral patterns are 19, while the remaining six species (Baleen whales, Beaked whales, Sperm whale) showed 9. Also *Physeter macrocephalus* showed 17 different behaviors.

### False killer whale

*Pseudorca crassidens* is an exuberant and fast-swimming cetacean (Carwardine, 2020). With 13 recorded behavioural patterns, False killer whale demonstrated a high number of observed behaviors, although this species was sighted only once. Most of the time travelling and social behaviour was observed. They also showed curiosity and approached the boat.

### Short-finned pilot whale

Short-finned pilot whales are mainly encountered in waters deeper than 1.000 m (Silva et al., 2014; Tobeña et al., 2016). Because of the nocturnal feeding behaviour, this species spends much of the day logging at the surface (Carwardine, 2020). This is in agreement with this study. The results of this study are also in agreement with Shane (1995) who found Short-finned pilot whales off Santa Catalina, California, traveling 73 % of the time. Because of the nocturnal feeding behaviour they were seldom very active during daytime, the behaviour mostly displayed were slow traveling, resting, socializing, surfing, which is in agreement with Sajikumar et al. (2014). Their reaction to boats varies according to location (Carwardine, 2020). During the observation avoiding the boat was recorded often.

### Common bottlenose dolphin

*Tursiops truncatus* was sighted 12 times, the number of different behaviour patterns recorded was 23. It is the species with the third most behaviors shown. They tend to be active most of the time and will leap, propoise, and perform other aerial behaviors (Carwardine, 2020). Which is in agreement with this study. Bow-riding, leaping, head- and tail-slapping were observed, as well as dorsal and lateral swimming.

### Risso's dolphin

Quérroul et al. (2008) report that *Grampus griseus* is rarely observed in association with one or the other dolphin species. This study confirms this, no association was observed with this species. This species is usually socializing, traveling or resting during the daytime. They show aggressive behaviour towards other species that also feed on cephalopods (Carwardine, 2020). In this survey, *Grampus griseus* represented the second most number of behavioural patterns. The diverse energetic behaviours registered in this study are leaping, also acrobatic leaping, head- and tail-slapping, lateral and dorsal swimming, which are in agreement with Pereira (2008). In this survey Risso's dolphins occurred in relatively small groups characterized by a high degree of synchrony and calm-surfacing, which confirms Hartman et al. (2009).

### Short-beaked common dolphin

In the Azores they use the area primarily for foraging and traveling (Cecchetti, 2018). Neumann (2001) described the group activity of *Delphinus delphis* with an overall proportion of 54.8 % traveling, 20.5 % milling, 17 % feeding, 7.3 % socializing, and 0.4 % resting. The observation of this study confirms that Short-beaked common dolphins spent most of their time traveling. Availability of prey is very likely governing the distribution.

In this study, *Delphinus delphis* displayed social behaviour very often, e.g. chasing, and mating. When feeding, they seldom approached the boat. Different behaviors were observed to obtain nutritional needs, e.g. hunting, herding, and pursuit. One feeding association with *Stenella coeruleoalba* was observed. It was the only interspecific cooperative hunting registered in this study.

Resting was not observed in this study, but sometimes aerial behaviour. This confirms Cecchetti et al. (2018). They reported that *Delphinus delphis* occasionally exhibits conspicuous behaviours above water and tends to approach moving boats. Aerially active, they frequently performs a variety of leaps and somersaults, as well as a fluke- and flipper-slappings (Carwardine, 2020). These behaviour also helped for their detection.

#### Atlantic spotted dolphin

*Stenella frontalis* is a highly acrobatic dolphin and capable of some exceptionally high leaps. As an avid bow-rider, it may swim far to join a vessel (Carwardine, 2020). In this study, Atlantic spotted dolphin represented 14 different behaviour patterns. Because this study took place early this year, the number of sightings (7) is low. Energetic behaviours have been observed, e.g. acrobatic leaps, somersaults, head- and tail-slapping, which is in agreement with Carwardine (2020).

#### Striped dolphin

This species is very acrobatic and breaches frequently. In some location *Stenella coeruleoalba* is especially nervous of vessels (Carwardine, 2020). In the region of the island of Pico, this species usually avoids whale-watching boats. If a vessel approaches their school, they often dash away at high speed. Though porpoising is the normal behaviour to watch here, and Striped dolphins are easy distinguished from other small dolphins. *Stenella coeruleoalba* and *Delphinus delphis* were once found forming an association to perform interspecific cooperative feeding. Then, together with other species, they approach boats. Therefore, 16 different behaviour patterns were observed, despite the low total time of observation, e.g. bow-riding, curiosity, fluking, leaping, surfing, and tail-slapping.

## **6. Conclusions**

This study illustrates the potential of using alternative sources of information to obtain meaningful data. Data used in this research was collected as a by-product of whale-watching, which was the primary purpose. The normal tourism activity favours the observation of different species (Pereira, 2008). This method is subject to various limitations. The study area may not be equally covered. Therefore, coincidence may play an important role. Findings from this research may not be representative of the entire research area. The boat surveys during the excursions were not designed

for the purpose of estimating cetacean abundance (Bron et al., 2018; Silva et al., 2014). Another disadvantage of this method may be that it provides information on the behavior of potentially disturbed whales (Magalhães et al., 2002).

Nevertheless, the activity of whale-watching offers a source of valuable data. It can be used for sighting surveys, e.g. to estimate the size of the population in the study area. It represents a cost-effective method to collect opportunistic data on the cetaceans. Otherwise, the information may be inaccessible, e.g. for rare species or incidental sightings. Whale-watching tours are often offered year-round and the data collected may be a potential tool for detecting long-term changes (Bron et al., 2018; Silva et al., 2014). The International Whaling Commission (IWC) describes in its whale-watching handbook the standard research methods used to study whales and dolphins. They recommend a few of these methods to be easily combined with whale-watching. One of these are boat surveys to study distribution and habitat use (IWC, 2020). The knowledge obtained here could be used for policies to effectively protect cetaceans and their habits or in the development of management plans for specific areas, e.g. the definition of a load capacity for whale-watching activities (Silva et al., 2003; Tobeña et al., 2016).

This study obtained data that may be helpful to a better understanding of the temporal distribution of the cetacean species and their common behavior sighted. The recorded behaviors are likely to show that sustainable whale-watching plays an essential role in maintaining high diversity. This study may therefore provide some initial insight into what behaviors may be observed in different cetacean species and the extent to which these may be influenced by whale-watching and tourist observations.

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