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## Killer whales, *Orcinus orca* (Artiodactyla: Delphinidae) in Guatemala: sighting records, photographic match, and interaction with Bryde's whales, *Balaenoptera edeni* (Artiodactyla: Balaenoptera)

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### ABSTRACT

**Introduction:** Killer whales (*Orcinus orca*) have a global distribution, but many low-latitude populations such as the Eastern Tropical Pacific are not well studied.

**Objective:** Provide a review of killer whale sightings in the Exclusive Economic Zone of the Pacific of Guatemala, for which there has previously been little information.

**Methods:** We reviewed national and regional publications, as well as anecdotal records of killer whale sightings in Guatemala.

**Results:** We document five sightings spanning three decades (1990-2020). Four sightings were recorded between 2010 and 2020 and occurred within the San José Canyon or over the continental shelf. Group size varied from 1-15 individuals ( $\bar{x}$ :  $6 \pm 4.3$ ). We report a photographic match of three killer whale individuals from a single pod previously sighted in Cabo Corrientes, México, 11 years and 1 778 km apart. We also describe an interaction between a killer whale pod and two adult Bryde's whales (*Balaenoptera edeni*), in which the Bryde's whales followed a female killer whale and its calf.

**Conclusions:** This study represents a contribution to the knowledge of killer whales in the region. It highlights the importance of data collection from both scientific and anecdotal records and supports the need of establishing national and regional monitoring and conservation programs for cetaceans.

**Key words:** Central America; cetaceans; Eastern Tropical Pacific; orca; photo-ID; resighting.

### RESUMEN

**Orcas, *Orcinus orca* (Artiodactyla: Delphinidae) en Guatemala: registros de avistamientos, fotoidentificación e interacciones con ballenas de Bryde, *Balaenoptera edeni* (Artiodactyla: Balaenoptera)**

**Introducción:** Las orcas (*Orcinus orca*) tienen una distribución global, pero muchas poblaciones de bajas latitudes, como el Pacífico Tropical Oriental, no han sido bien estudiadas.

**Objetivo:** Proporcionar una revisión de los avistamientos de orcas en la Zona Económica Exclusiva del Pacífico de Guatemala.



**Métodos:** Revisamos publicaciones nacionales y regionales, así como registros anecdóticos de avistamientos de orcas en Guatemala.

**Resultados:** Documentamos cinco avistamientos que abarcan tres décadas (1990-2020). Registramos cuatro avistamientos entre 2010 y 2020 que ocurrieron en el Cañón de San José o sobre la plataforma continental. El tamaño de grupo varió de 1 a 15 individuos ( $\bar{x}$ :  $6 \pm 4.3$ ). Reportamos una coincidencia fotográfica de tres individuos de orcas de un solo grupo previamente avistado en Cabo Corrientes, México, con 11 años y  $\sim 1778$  km de diferencia. También describimos una interacción entre un grupo de orcas y dos ballenas de Bryde adultas (*Balaenoptera edeni*), en la que las ballenas de Bryde siguieron a una orca hembra y su cría.

**Conclusión:** Este estudio contribuye al conocimiento de las orcas en la región. Destaca la importancia de recopilar datos tanto de registros científicos como anecdóticos y apoya la necesidad de establecer programas nacionales y regionales de monitoreo y conservación de cetáceos.

**Palabras clave:** Centro América; cetáceos; foto-ID; orca; Pacífico Tropical Oriental; recaptura.

## INTRODUCTION

The killer whale, *Orcinus orca* (Linnaeus, 1758) is a widely distributed cetacean inhabiting all oceans (Forney & Wade, 2006). It is most frequently found in coastal temperate and polar waters of high productivity (Forney & Wade, 2006), where some populations have been well documented (e.g., Best et al., 2010; Dahlheim et al., 2008; Guinet et al., 2015; Jourdain et al., 2019; Pitman & Ensor, 2003). Despite recent advances in killer whale research in the Eastern Tropical Pacific (ETP; e.g., Denkinger et al., 2020; Guerrero-Ruiz et al., 2005; Pacheco et al., 2019; Vargas-Bravo et al., 2021), the distribution, ecology and behavior of killer whales in the region remains poorly understood. Records of killer whales are sporadic in Guatemala (Cabrera et al., 2012, Cabrera et al., 2014; Hill et al., 1991), and reports of sightings have mainly been anecdotal. To better understand killer whales in the region and establish a baseline of research, we review five killer whale sightings in Guatemala from 1990 till 2020, including three previously unreported. We also document photographic matches of a killer whale pod sighted 11 years and 1778 km apart. Finally, we describe a pair of Bryde's whales, *Balaenoptera edeni* (Anderson, 1878) following a killer whale pod.

Killer whale sighting records from Guatemala were obtained by reviewing national and regional publications and anecdotal records from third parties. We also provide additional

details of a sighting previously reported by the authors (Cabrera et al., 2012). The original observers from anecdotal records were contacted to obtain detailed information of the sighting, including date, coordinates or approximate location, estimated number of individuals, as well as photographic and/or video evidence.

Using photographs and videos, we identified age class and sex according to the following categories: adult male, individual showing relatively large erect dorsal fin; adult female, only differentiated if the individual was accompanied by a calf; calves, small size and marked association with another adult individual; juveniles, they can be females without associated calf, or young males whose dorsal fin is not fully developed (Vargas-Bravo et al., 2021).

To gain insights into possible movements of killer whale pods and individuals, good quality photographs were compared with the following regional photo-identification catalogs of killer whales: Black et al., (1997); Ellis et al., (2008); Olson & Gerrodette (2008). Experts in the area were also contacted to compare the photographs with unpublished catalogs from the Galapagos Islands (J. Denkinger & Alarcon, n.d.) and from the Mexican central Pacific (C. Ortega-Ortiz, personal communication, October 27, 2020).

**Killer whale sighting records:** We documented five killer whale sightings off Guatemala between the years 1990 and 2020 (Fig. 1A). Two sightings were recorded during separate

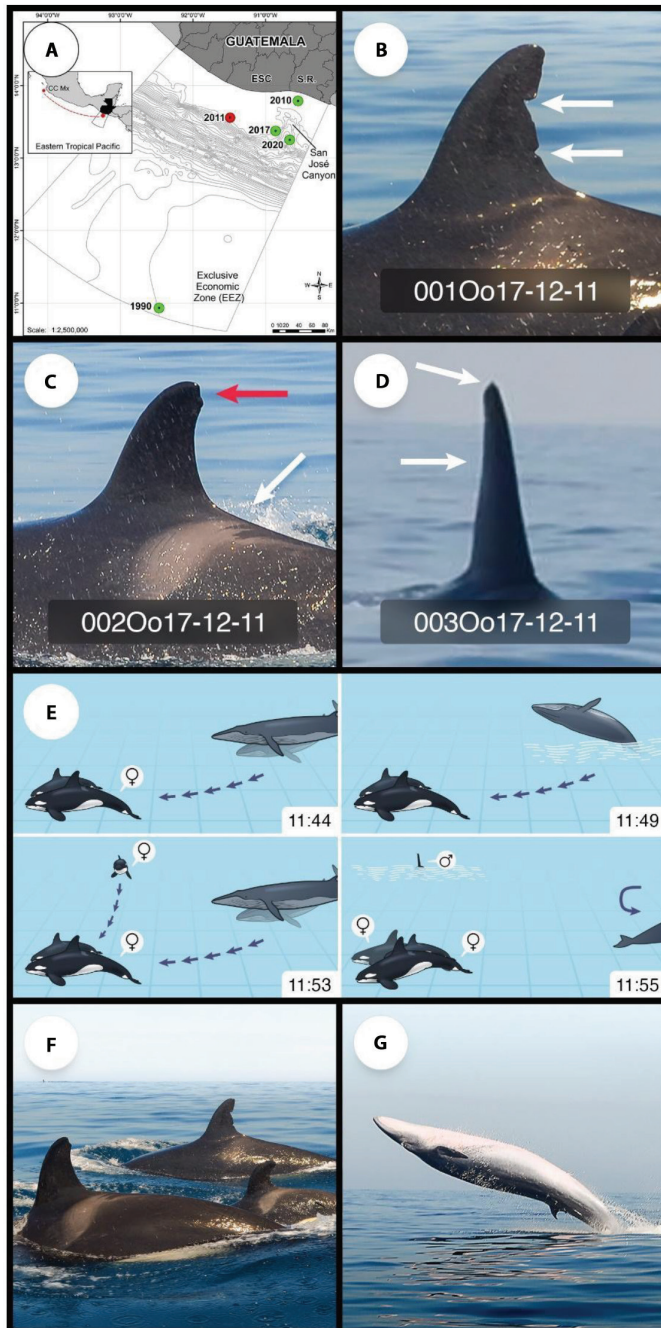
research surveys, two during whale watching activities, and one during a sport fishing trip. Four of the sightings were recorded during 2010 and 2020 and occurred within the San José Canyon or over the continental shelf off the coast of Escuintla and Santa Rosa. Four sightings occurred during the Guatemalan dry season equivalent to the Northern Hemisphere winter season (November to February). Below we describe the five killer whale sightings:

- #1 On September 1, 1990, a pod of five individuals was recorded 278 km from the coastline between Escuintla and Santa Rosa (10°56' N 92°28' W) during a cetacean research survey of the ETP conducted by the United States National Oceanic and Atmospheric Administration (Hill et al., 1991).
- #2 On February 14, 2010, a solitary adult male was observed traveling ~10 km from Monterrico coastline, Santa Rosa (13°47'12.1056"N 90°33'9.7812"W). The sighting occurred during a whale watching trip by the company Extremo a Extremo (P. Cabrera, personal communication, October 21, 2020).
- #3 On December 17, 2011, a pod of four killer whales consisting of one male, two females, and one calf was recorded by the authors during a research survey at 13°33'22.8"N 91°29'15.9"W, ~48 km off Escuintla (Cabrera et al., 2012).
- #4 On November 24, 2017, a pod of five to ten killer whales was recorded during a sport fishing trip off Guatemala. The exact location was not recorded but was approximately 13°22'N 90°51'W. The pod consisting of at least one male and several females and/or juvenile males was traveling and did not interact with the boat (C. Monteros, personal communication, October 16, 2020).
- #5 On January 25, 2020, a pod consisting of a minimum of ten (range 10-15) killer whales, was reported by the whale watching company Serviturismo Las Lisas. The pod consisted of at least two males

and several females/young males and calves. The sighting occurred in the San José Canyon, ~74 km off the coast of Santa Rosa (13°15'01.4"N 90°40'0.1"W). Some members of the pod, mainly the calves, swam under and around the boat (O. Marroquín, personal communication, January 26, 2020).

**Photographic match of a killer whale pod:** Through photo-identification, three adult individuals from the same pod photographed in 2011, were matched with a sighting photographed 11 years earlier, on August 15, 2000, as part of group No. 25.00 off Cabo Corrientes, Mexico (20°16'13.2"N, 105°45'24.6"W) consisted of seven individuals (Olson & Gerrodette, 2008). The shortest distance between sightings is ~1 778 km. The female in Fig. 1B matches E060 (Olson & Gerrodette, 2008) and was identified by two notches on the back of her dorsal fin. The female with a calf (E061, Fig. 1C) was identified by the unique pattern on its saddle patch, although a modification had occurred on the tip of its dorsal fin (red arrow). The male (E059, Fig. 1D) was identified by the beveled tip.

**Interaction between killer whales and Bryde's whales:** We observed a peculiar interaction between a killer whale pod and two adult Bryde's whales (Fig. 1E). The sighting occurred on December 17, 2011, and began at 11:20h when we recorded a "splash" at ~1 km from our vessel (65-foot frigate). Once in the area, at 11:33h, a female killer whale and a calf approached the vessel for a few minutes, swimming slowly, sideways, and near the water surface. A few minutes later, two Bryde's whales were observed swimming slowly at ~100 m from the killer whales. At 11:44h, when the killer whales started moving away from the boat, the Bryde's whales swam behind the killer whales and accelerated, a behavior that we consider as chasing or pursuit. During the observation, the Bryde's whales remained within ~100 m of the killer whales while traveling at high speed. One of the Bryde's whales breached



**Fig. 1.** A. Killer whale sightings off Guatemala. Location of Escuintla (ESC) and Santa Rosa (S.R.). Insert shows the location of the photographic match between our sighting #3 and group 25.00 reported by Olson & Gerrodette (2008); B-D. Killer whales from sighting #3 that match individuals E-060 (B), E-061 (C) and E-059 (D) from group 25.00. Arrows point to the original (white) and new (red) distinctive marks. Inserted numbers indicate the catalog number based on Cabrera et al. (2012); E. Schematic representation of killer whale-Bryde's whale encounter in 2011; including two Bryde's whale following killer whales, Bryde's whale breaching, two killer whales accompanying calf and retreat of Bryde's whales; F. Female killer whales positioning the calf between them; G. Bryde's whale breaching while following the killer whales.

twice, at 11:49h and 11:51h (Fig. 1G). The event lasted about 11 minutes, ending when a second female killer whale approached and positioned herself on the opposite side of the first female, positioning the calf in the middle (Fig. 1F). At 11:55h, the two Bryde's whales turned away from the killer whales. At 11:58h, we spotted the fin of a male killer whale at ~500 m away. The male slapped his tail at least three times, and then the two females and the calf dove and swam to join the male. The four killer whales continued to swim very close until they were out of sight. At no time did we observe a direct response or attack by the killer whales towards the Bryde's whales.

**Killer whales are rare visitors in Guatemala:** Five opportunistic sightings collected over a span of 30 years suggests that killer whales are rare in Guatemala, and there are no indications of resident pods. Although no predatory behavior was observed in any of the reports, it is possible that the killer whales that approach the Guatemalan coast between November and February do so in search of humpback whale calves (Pacheco et al., 2019), or other cetaceans as it has been observed in the ETP (e.g., Flórez-González et al., 2007; Pitman et al., 2007; Testino et al., 2019). Killer whales from low latitude regions such as the ETP and Hawaii have been considered generalists feeding not only on marine mammals, but also on fish and turtles (e.g., Baird et al., 2006; Vargas-Bravo et al., 2021).

**A photographic match represents the longest time interval and distance recorded for a killer whale pod in the ETP:** The photographic match between three killer whale individuals sighted in Guatemala and previously in Mexico provides insights into killer whale's movements and behavior in the ETP. Although the minimum distance (1 778 km) between the two sights is well below previous reports (5 535 km (Guerrero-Ruiz et al., 2005) and 3 839 km (Pacheco et al., 2019)) for a single individual in the region, it represents the longest distance recorded for multiple individuals from the

same pod in the ETP. The time interval of 11 years between the sightings provides information on family association or cohesion. At least three of the seven killer whales originally recorded by Olson & Gerrodette (2008) as part of their group number 25.00 have potentially remained together for at least 11 years. In addition, the new photographs of the individuals can be used to update the original photo-identification catalog from Olson & Gerrodette (2008) particularly for those individuals with fin modifications, such as female E061.

**Interaction between Bryde's whales and killer whales.** To our knowledge, the described interaction between these two species has not been reported before. Previous report of Bryde's whales and killer whales interactions have involved either an attack of the killer whales (Alava et al., 2013; Silber et al., 1990), fleeing of the Bryde's whales (Ford & Reeves, 2008) or indifference in which both species moved away from one another (Villegas-Zurita et al., 2016). Although we did not observe any direct attack from the killer whales towards the Bryde's whales or any other species, the observed Bryde's whales behavior could be associated with an antipredatory response such as the "fight strategy" (Ford & Reeves, 2008), or an altruistic behavior such as "mobbing" (Pitman et al., 2017). However, these strategies have not been reported for Bryde's whales and other rorquals of the genus *Balaenoptera*, but only for whales with robust body shapes such as humpback whales (*Megaptera novaeangliae*) (Ford & Reeves, 2008; Pitman et al., 2017). Additionally, it is known that breaching represents an activity of high energy cost (Segre et al., 2020). The Bryde's whale breaches observed during the interaction could be associated with a demonstration of strength against potential predators or as a means of communication (Whitehead, 1985). Other behaviors such as social interaction including playing or curiosity could also be considered as an explanation. Given the novelty of the behavior, more research needs to be done in the future before drawing any conclusion.





**Implications for research and conservation:** Although the number of killer whale sighting records in Guatemala is limited, this information contributes to current efforts to increase knowledge on distribution, movements, and intra- and interspecific behaviors of killer whales in the ETP. The potential increase in killer whale sighting frequency over the past decade may be attributed to an increased sighting effort, which includes citizen science, whale watching, and research programs. This highlights the importance of establishing long-term monitoring programs of cetaceans in the country. The cross-border movements observed in some killer whales emphasize the need for international conservation efforts, as killer whales are not bound by political borders.

**Ethical statement:** the authors declare that they all agree with this publication and made significant contributions; that there is no conflict of interest of any kind; and that we followed all pertinent ethical and legal procedures and requirements. All financial sources are fully and clearly stated in the acknowledgments section. A signed document has been filed in the journal archives.

**Author contribution:** Conceptualization, AAC, JOW; Investigation, JOW, AAC, JCR; Formal analysis, JOW; Writing – Original Draft JOW, AAC; Writing – Review & Editing, All authors; Supervision, AAC; Funding Acquisition, AAC, JOW.

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