Site fidelity of a Newly Identified *Orcinus orca* Specimen in Costa Rica (Family: Delphinidae)

Fidelidad de sitio de un nuevo ejemplar identificado de *Orcinus orca* (Familia: Delphinidae) en Costa Rica

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Abstract

Orcinus orca, as apex predators, exert a significant influence on ecosystem dynamics, serving as an indicator of ecosystem health. The implementation of tracking systems based on orca specimen identification has emerged as a highly effective conservation strategy. This study represents the first individual identification of an orca in Costa Rica. A male orca specimen was identified based on two cuts in the dorsal fin, enabling tracking for four years across four sightings in three different locations. The establishment of a tracking system for orcas is crucial for understanding their ecology, behavior, and susceptibility to anthropogenic pressures. For this, a collaboration between scientific research and citizen science is needed. The ultimate objective of this study is to create a comprehensive catalog of orcas in Costa Rica.

Keywords: keystone species, ecology, Costa Rican Pacific, killer whales, citizen science, marine mammals, monitoring.

Resumen

Orcinus orca, como depredadores topes, tienen una gran influencia en la dinámica del ecosistema, siendo indicadores de su estado de salud. La implementación de sistemas de seguimiento basados en la identificación de especímenes de orcas ha surgido como una estrategia de conservación eficiente. Este estudio representa la primera identificación de una orca en Costa Rica. Se identificó un espécimen macho de orca basado en dos cortes en la aleta dorsal, lo que permitió su seguimiento durante cuatro años a través de cuatro avistamientos en tres ubicaciones diferentes. El establecimiento de un sistema de seguimiento para las orcas es crucial para comprender su ecología, comportamiento y susceptibilidad a las presiones antropogénicas. Esta implementación requiere colaboración entre la investigación científica y las iniciativas comunitarias. El objetivo final de este estudio es crear un catálogo identificativo de orcas en Costa Rica.

 Palabras clave: especies clave, ecología, Pacífico costarricense, ballenas asesinas, ciencia ciudadana, mamíferos marinos, monitoreo.

Orcinus orca, also known as killer whale, is a top predator that strongly influences marine ecosystem dynamics (Heithaus et al., 2008) through top-down control of its prey (Baum et al., 2009). They have been proposed as ecosystem sentinels due to their adaptability to environmental conditions and their role in shaping ecosystems (Hazen et al., 2019). Male orcas present the largest dorsal fin in marine mammals, showing sexual dimorphism where the male dorsal fin is erect and the female dorsal fin is distinctly falcate (Mesnick y Ralls, 2018). Because of male physical competition, many scars and cuts are present in the dorsal fins, allowing specimen identification to be easier than in female specimens.

Anthropogenic pressures strongly affect marine ecosystems (Williamson y Guinder, 2021; Moullec et al., 2021; Poloczanska et al., 2013), establishing the need for efficient marine management and conservation strategies.

Tracking systems based on orca specimen identification provide an effective conservation strategy (Hays et al., 2019). The information gathered by these systems offers valuable insights into the ecology and behavior of orcas (Ford, 2017). Their movements can be correlated with their prey movements, offering a better understanding of marine ecosystem dynamics (Athayde et al., 2023; Wright et al., 2017). In addition, anthropogenic pressures can significantly affect orcas' movements (van Weelden et al., 2021; Machernis et al., 2018); therefore, analyzing these data could highlight the resilience or vulnerability of orcas to it.

Research on orcas is an emerging field in Costa Rica (Castro-Azofeifa, 2021). This report is the first to identify a male specimen in Costa Rica using a tracking system based on photographs and video recordings. This study aims to contribute to the establishment of a comprehensive catalog of orcas identification in Costa Rica. Such effort supports the Sustainable Development Goal (SDG) 14 Life Below Water, by enhancing our understanding of marine biodiversity and promoting the conservation and sustainable use of marine resources. Addi-tionally, it aligns with SDG 13: Climate Action by facilitating the development of a management system to assess the impacts of climate change on marine biodiversity, thereby improving management and conservation strategies.

The Orcas en Costa Rica project is a pioneering initiative dedicated to studying tropical orcas in the Pacific region of Costa Rica. In collaboration with tour operators, fishermen, citizen science, and research efforts, orca sightings from 1997 to 2024 have been reported. The database includes sighting dates, coordinates, and lunar cycle during each observation. To ensure authenticity, every documented sighting was supported by visual evidence in the form of photographs or videos. This database was subjected to rigorous examination. Photographs or videos of good quality that allowed the observation of the morphology of the organisms were selected. Therefore, the visual evidence for specimen identification was based on the dorsal fin or any notable scars on the specimen's body.

An orca male was identified based on two cuts in the dorsal fin (**Figure 1**), positioned around the middle of the total length of the dorsal fin and at its superior extreme. The eye patch showed a high level of resemblance, but due to the variability of the angles of the pictures, it could not be used in the identification process.

Figure 1: AM1 was sighted on January 12, 2021, in the North Pacific off the coast of Costa Rica. Photography provided by Sierra Goodman.

Figure 2. AM1 was sighted on April 6, 2023 (left) and July 28, 2023 (right), both in the South Pacific off the coast of Costa Rica. Visual evidence provided by Zancudo Lodge (left) and Francisco Tours (right).

This specimen was identified at four different locations (**Table 1**) within a time-lapse of four years, with two sightings in January 2021 (**Figure 1**), two sightings in February and July 2023 (**Figure 2**), and one sighting in April 2024 (**Figure 3**). The code AM1 was assigned to the specimen. This male was previously identified in the region performing local displacements be-

tween Peru, Mexico, Ecuador and Costa Rica (Pacheco et al., 2019). This record is the first to provide a site fidelity linked to Costa Rica. This report is part of an initiative to create a catalog for *Orcinus orca* identification in Costa Rica.

Figure 3. AM1 was sighted on February 2, 2024, in the North Pacific off the coast of Costa Rica. Photography provided by Luis Kraemer.

Table 1. AM1 sightings identification, including the date (day, month, year) and location (latitude and longitude).

Day/Month/Year	Latitude	Longitude
11/01/21	9.55	-85.10
12/01/21	8.34	-84.06
06/04/23	8.08	-83.37
28/07/23	10.00	-86.11
09/02/24	8.00	-83.33

This male was previously identified in the region performing local displacements between Peru, Mexico, Ecuador and Costa Rica (Pacheco et al., 2019). This record is the first to provide a site fidelity linked to Costa Rica. This report is part of an initiative to create a catalog for *Orcinus orca* identification in Costa Rica. Other regions, have already created these catalogs (Mrusczok, 2022; Olson y Gerrodette, 2008; Dahlheim, 1997). By developing a comprehensive database of individual orcas in Costa Rica, their movements can be tracked to provide insights into their behavior and health status over time. This dataset will facilitate comparative studies of orca populations in other regions, contributing to a broader understanding of their ecological roles and responses to environmental changes. However, tracking systems based on visual evidence have several disadvantages. Photographs and videos must be of high quality to allow the identification of patterns in the body of the orca. Additionally, it is necessary to broadcast the importance of sharing sighting evidence with communities.

Consequently, projects such as Orcas en Costa Rica can create knowledge based on a significant volume of high-quality information. To overcome these limitations, future research could explore integrating technologies, such as drone surveillance (Fettermann et al., 2022) or satellite tagging (Vukelic et al., 2018), which can provide more consistent monitoring of orcas' movements. Therefore, it is essential to explore the use of citizen science. Engaging in these strategies empowers local communities to contribute valuable data, enriches research efforts, and expands our database. Involving communities in scientific endeavors can reduce conflicts between humans and wildlife through increased awareness and sympathy for marine species.

Citizen science represents a valuable tool for the development of research on marine mammals. This is because the data collection process is typically opportunistic, as evidenced by this research. Therefore, the involvement of the public can significantly enhance the likelihood of obtaining valuable information about the species in question. The use of citizen science to collect data from local communities has been demonstrated to be an efficacious approach in Costa Rica with other marine mammals, such as manatees. (Cubero-Pardo et al., 2024). Furthermore, it provides an opportunity for the local population to be involved in the process of obtaining crucial information for the conservation of the species, including ecological niche (Garrido-Priego et al., 2023), occurrence (Castro-Azofeifa, 2021), and other characteristics.

These strategies should aim to preserve orcas and support the economic growth of local communities by crafting solutions that promote sustainable tourism, responsible fishing practi-

ces, and community engagement in conservation efforts. Effective conservation requires a collaborative approach that integrates scientific research and community-based initiatives to create a resilient environment.

Acknowledgements

Ethics, Conflict of Interest, and Funding Statement

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