

Conservation

Confirmed presence of the Neotropical otter, *Lontra longicaudis*, in Laguna Bacalar, Quintana Roo, Mexico

Confirmación de la presencia de la nutria neotropical, Lontra longicaudis, en la laguna de Bacalar, Quintana Roo, México

Mildred Fabiola Corona-Figueroa ^a, John Alexander Giraldo-Mueses ^b,
José Rogelio Cedeño-Vázquez ^{a, *}, Delma Nataly Castelblanco-Martínez ^{c, d},
Carlos Alberto Niño-Torres ^c, Pablo M. Beutelspacher-García ^e,
Silvana Marisa Ibarra-Madriral ^f, Jonathan Pérez-Flores ^g

^a El Colegio de la Frontera Sur, Departamento de Sistemática y Ecología Acuática, Avenida Centenario Km 5.5, 77014 Chetumal, Quintana Roo, Mexico

^b Universidad del Tolima, Barrio Santa Helena Parte Alta, 730006299 Tolima, Ibagué, Colombia

^c Universidad Autónoma del Estado de Quintana Roo, División en Desarrollo Sustentable, Blvd. Bahía s/n Esq. Ignacio Comonfort, Col. del Bosque, 77019 Chetumal, Quintana Roo, Mexico

^d Consejo Nacional de Ciencia y Tecnología, Cátedras Jóvenes Investigadores, Av. Insurgentes Sur 1582, Col Crédito Constructor, Alcaldía Benito Juárez, 03940 Ciudad de México, Mexico

^e Independent Researcher, Martinica 342, Fracc. Caribe, 77086 Chetumal, Quintana Roo, Mexico

^f Geo Alternativa A.C., Quito Núm. 1260, Col. Providencia, 33460 Guadalajara, Jalisco, Mexico

^g El Colegio de la Frontera Sur, Departamento de Observación y Estudio de la Tierra, la Atmósfera y el Océano, Avenida Centenario Km 5.5, 77014 Chetumal, Quintana Roo, Mexico

*Corresponding author: rcedenov@ecosur.mx (J.R. Cedeño)

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Abstract

The Neotropical otter *Lontra longicaudis* is one of the least studied mammals of the Yucatán Peninsula and its presence in some water bodies of this region is questionable. Laguna Bacalar is the largest freshwater body located in the Yucatán Peninsula and faces several conservation problems due to its high potential for tourism development. We confirmed the presence of *L. longicaudis* in Laguna Bacalar by conducting interviews with residents, and the search for direct (sightings) and indirect (e.g., footprints) evidence of the species in 2013. We also include recent direct and indirect evidence (2019-2020). We classified the records into levels of certainty, according to the type of evidence (photographs, videos). We obtained 9 records of Neotropical otter through interviews (level 3), 3 sightings and 4 footprints (level 1), and 4 sightings (3 of these with level 2 and 1 with level 3 of certainty). It is necessary to increase the research effort to determine the conservation status and distribution of the Neotropical otter in the lagoon.

We recommend making efforts in terms of socialization and education to facilitate the conservation of the Neotropical otters and their habitat in Laguna Bacalar.

Keywords: Mustelidae; Yucatán Peninsula; Freshwater habitat; Aquatic mammal

Resumen

La nutria neotropical *Lontra longicaudis* es uno de los mamíferos menos estudiados en la península de Yucatán y su presencia en algunos cuerpos de agua de esta región es cuestionable. La laguna de Bacalar es el mayor cuerpo de agua dulce de la península de Yucatán y enfrenta varios problemas de conservación debido a su alto potencial de desarrollo turístico. Confirmamos la presencia de *L. longicaudis* en la laguna de Bacalar mediante entrevistas con los residentes locales y la búsqueda de evidencias directas (avistamientos) e indirectas (p. ej. huellas) de presencia de la especie en 2013. Incluimos observaciones directas recientes (2019-2020). Clasificamos la información por niveles de certeza, según el tipo de evidencia que la respalda (fotografías, videos). Obtuvimos 9 registros de nutria neotropical a través de entrevistas (nivel 3); 3 avistamientos y 4 huellas (nivel 1), y 4 avistamientos (3 con nivel 2 y 1 con nivel 3 de certeza). Es necesario incrementar los esfuerzos de investigación para determinar el estado de conservación y la distribución de la nutria neotropical en la laguna. Recomendamos realizar esfuerzos en cuanto a la socialización y a la educación para facilitar la conservación de esta especie y su hábitat en la laguna de Bacalar.

Palabras clave: Mustelidae; Península de Yucatán; Hábitat dulceacuícola; Mamífero acuático

Introduction

The Neotropical otter, *Lontra longicaudis* (Olfers, 1818), is an elusive mustelid, with a wide distribution from northwestern and northeastern Mexico to Uruguay, Paraguay, and northern Argentina (Larivière, 1999). This species inhabits rivers, streams with strong currents, and lagoons located between 0 to 3,000 m in altitude (Larivière, 1999; Rheingantz et al., 2021; Trujillo & Arcila, 2006). In Mexico, *L. longicaudis* occurs in the southern area of the state of Tamaulipas and the slope of the Gulf of Mexico, and in the northern area of Sonora, Chihuahua, and Durango, and the continental slopes of the Sierra Madre Occidental and Sierra Madre Oriental, southward to the border with Guatemala (Aranda-Sánchez, 2015; Gallo-Reynoso, 1997; Gallo-Reynoso & Meiners, 2018).

In Mexico, information about distribution, population status, ecology, and conservation aspects of *L. longicaudis* has been obtained from systematic studies mainly from the northwestern (Cruz-García et al., 2017; Gallo-Reynoso, 1997; Gallo-Reynoso et al., 2008; García-Silva et al., 2021; Rangel-Aguilar & Gallo-Reynoso, 2013), western (Brito-Ríos, 2017; Casariego, 2013; Espinoza-Medinilla et al., 1998; Gallo-Reynoso, 1989), central (Guerrero-Flores et al., 2013) and Gulf of Mexico (Macías-Sánchez, 2003; Santiago-Plata et al., 2013) regions. In Quintana Roo, this species has been reported for the Reserva de la Biosfera Sian Ka'an, Laguna Guerrero, Laguna Chile Verde, the north and northeastern portion of Chetumal Bay, and in the Río Hondo along the border with Belize (Calmé &

Sanvicente, 2009; Escobedo-Cabrera et al., 2002, 2009; Gallo-Reynoso, 1997; Morales-Vela & Olivera-Gómez, 1991, 1994; Morales-Vela et al., 2011; Orozco-Meyer, 1998). However, efforts to monitor this species in Quintana Roo have been scarce.

Neotropical otters are top predators in the trophic food chain of riverine systems, feeding predominantly upon fishes, but also consuming other groups of organisms (Santiago-Plata et al., 2013; Gallo-Reynoso et al., 2008). The communal latrines of this species represent a food resource for vertebrate and invertebrate communities, therefore playing an important role in the trophic chain (Laurentino et al., 2019). Populations of *L. longicaudis* have been extirpated in several areas of its historical distribution due to the fur trade, their capture and use as pets, and conflicts with fishermen (Gallo-Reynoso, 1989; Santiago-Plata et al., 2013). Nowadays, *L. longicaudis* is listed as Near Threatened by the International Union for Conservation of Nature (Rheingantz et al., 2021); as Threatened in the Official Mexican Norm 059 (NOM-059- ECOL-2010) (Semarnat, 2010), and included in the Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2019).

The Laguna Bacalar is located in the southern part of Quintana Roo, between the municipalities of Bacalar and Othón P. Blanco (Gómez-Pech et al., 2018). This lagoon and its surroundings have an enormous potential for tourism due to the attractive landscape and other environmental attributes (Semarnat, 2015). In 2018, around 90,000

tourists visited Bacalar, and tourism is expected to increase in the near future, which has serious implications on the transformation of land use in the human settlements near the lagoon (Gómez-Pech et al., 2018; Yanez-Montalvo et al., 2020).

Several governmental policies protect the Laguna Bacalar such as the establishment of defined environmental management units in order to maintain ecosystem connectivity and the conservation of biological diversity (Semarnat, 2015). Additionally, several lagoons interconnected with the Laguna Bacalar (e.g., Chile Verde) are included within the Natural Protected Area Santuario del Manatí-Bahía de Chetumal (DOF, 2008). Nevertheless, productive activities with low environmental impact are allowed in Laguna Bacalar, with restrictions that guarantee conservation and promote a minimum change in land use (Semarnat, 2015). Until now, information regarding *L. longicaudis* along the shoreline of Laguna Bacalar consisted in anecdotes told by people living in the surrounding area of the lagoon (Morales-Vela & Olivera-Gómez, 1991). Here, we compiled evidence that confirms the contemporary occurrence of *L. longicaudis* in this intense use touristic lagoon.

Materials and methods

The study area corresponds to the shoreline of Laguna Bacalar, which encompasses the lagoon itself, the surrounding wetlands (from 18°56'49.35" N, 88°08'58.97" W, and 18°31'37.27" N, 88°28'06.80" W), and the human settlements next to the lagoon (Xul-Ha, Bacalar, Aarón Merino Fernández, Buenavista, and Pedro Antonio Santos) (Fig. 1). The Laguna Bacalar has an area of 9,572.74 ha, and consists of 43% of surface waters and 49% of mangrove forest (*Rhizophora mangle*, *Conocarpus erectus* and *Laguncularia racemosa*); the remaining 8% corresponds to vegetation of tular (*Typha sp.*), secondary shrub and tropical deciduous forest, and cultivated pastures for cattle (Semarnat, 2015).

The origin of the Laguna Bacalar is not completely karstic, its physiognomy is the product of the tectonic dynamic that occurred at the Upper Miocene age along the lagoon and the Río Hondo (Ceballos-Martínez, 2002). This lagoon has a length of 54 km in a straight line from the southern to the northern orientation and a maximum width of 2 km; it communicates superficially with the Río Hondo through the Chac stream (Ceballos-Martínez, 2002), and through several shallow streams with the Laguna Chile Verde, which flows into Laguna Guerrero (Fig. 1) (Morales-Vela & Olivera-Gómez, 1991). The region is characterized by a subhumid warm climate, with an average annual temperature of 26.8 °C (range,

16.15 °C - 34.9 °C) and an accumulated average annual precipitation of 1,040.8 mm (range, 12 mm - 2,243.6 mm), which intensifies between June and September (SMN & Conagua, 2020). The municipality of Bacalar has a population of 41,754 inhabitants, being the town of Bacalar the main human settlement with 12,527 inhabitants (INEGI, 2020).

During April to August 2013, we conducted 30 semi-structured interviews with key inhabitants such as boatmen, fishermen and hosts from Xul-Há, Bacalar, Buena Vista, and Pedro Antonio Santos to gather information on the presence of *L. longicaudis* in the lagoon. The choice of the interviewees depended on the characteristics of each town visited in terms of people's occupation and proximity of the residences to the lagoon. In parallel, we conducted 16 field trips to the sites reported by the interviewees as potential areas of the Neotropical otter presence. The surveys consisted of navigations in kayak along the shore of the lagoon in search of evidences of *L. longicaudis* presence, such as shelters, latrines, feces, or footprints (Orozco-Meyer, 1998). When possible, we walked on ground to examine approximately 1 m of the lagoon edge, depending on the site characteristics. When footprints were found, we measured their length and width *in situ* and used field guides to verify the identification (Aranda, 2000; Reid, 1997). These field trips were carried out from May to August 2013, between 6:30 a.m. to 3:40 p.m.

To include recent data on the presence of *L. longicaudis* in the lagoon, we searched for published literature obtained from Google Scholar and information published between 2014-2020 in local newspapers, social media (e.g., Facebook, Twitter), and virtual databases (e.g., iNaturalist, GBIF) as secondary sources of information. All data were compiled in a database accompanied by the date, time, geographic coordinates, and the name of the observer, and included reliable records of opportunistic observations obtained in March, July, and September 2019.

We classified the records into indirect signs of the presence of Neotropical otter (e.g., footprints, feces, latrines, or shelters), and direct sightings (e.g., individuals of the Neotropical otter). We also assigned a level of certainty to each obtained record, as follows: level 1, indirect and direct records consisting in confirmed sightings with a high degree of certainty and corroborated with evidence (e.g., photographs, videos). We also included observations made by villagers with some supporting evidence (photographs, videos). Level 2, indirect and direct records made by coauthors, but without evidence (photographs or videos). Level 3, indirect and direct records without evidence or detailed descriptions obtained through interviews or observations made by villagers.

Results

We obtained 9 records of *Lontra longicaudis* sightings in different areas of the Laguna Bacalar through interviews (level 3 degree of certainty; Fig. 1). Additionally, between 2013 and 2020, we compiled 11 records of the species during surveys, opportunistically or by review of secondary sources, consisted of indirect (footprints, $n = 4$; Fig. 2) and direct (sightings, $n = 7$; Fig. 3) records (Table 1). Indirect and direct records with evidence (photographs, videos) correspond to level 1 degree of certainty (Table 1). Also, we recorded 4 sightings, 3 with level 2 degree of certainty and made by a villager with level 3 degree of certainty (Table 1). Detailed results are described below.

Interviews. We conducted 30 interviews to key people between 15 and 85 years old, but the majority (37%) were between 35-50 years old. The main activities of the interviewees in Bacalar town were workers of the hotel sector (37.7%) and boat captains (20%), while in Buena Vista and Pedro Antonio Santos villages were mostly farmers (40%). Of the total sample, only 16 interviewees (53.3%) indicated sightings of *L. longicaudis* in different environments such as in the water, mangrove forest, docks, and beaches at 4 sites: Bacalar town, 'Los Rápidos', Pedro Antonio Santos, and the Laguna Mariscal (Fig. 1).

Additionally, interviewees indicated that they have seen *L. longicaudis* in the study area at least once or twice in their lives (average age = 36 years old, range = 15-85). Among the people who have had direct sightings of Neotropical otters, 36.7% have seen solitary individuals, while 6.7% have seen pairs and 10% have seen groups larger than 4 individuals.

Surveys. The systematic search for *L. longicaudis* conducted in 2013 covered 51.2 km of shoreline, channels, and wetlands, with a total sampling effort of 114 h (7 h daily). We found 3 footprints of *L. longicaudis*, 2 of them close to each other in a small channel located on the eastern edge of the lagoon, on Isla de los Pájaros (Fig. 2A, B). These footprints indicated that the individual was running and measured 6-8 cm long and 5-6 cm wide. A third footprint was found in the Pedro Antonio Santos village and measured 7 cm long by 6 cm wide (Fig. 2C). Additional footprints were found but they were very old or not clear, and we decided not to include them. None of these individuals were observed, or their feces found during these surveys.

Opportunistic records. On 29th July 2020, another footprint was recorded by Pablo M. Beutelspacher-García (PMB-G) in the southern part of the lagoon near Xul Há (Fig. 2D). This footprint was 4 cm wide, and the

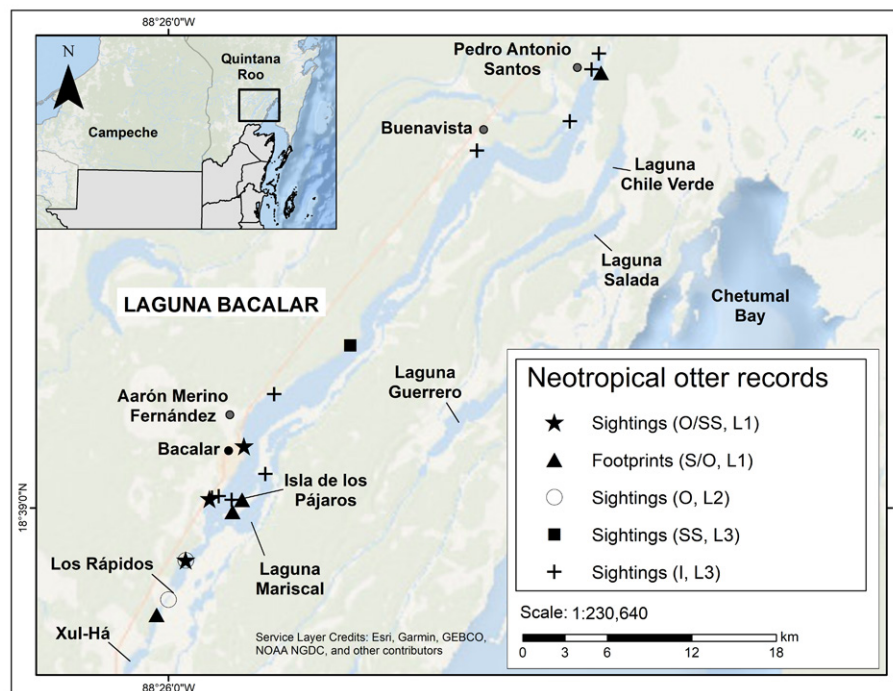


Figure 1. The coastline of Laguna Bacalar where Neotropical otter (*Lontra longicaudis*) sightings and footprints were recorded between 2010, 2013 and 2020. Methods: O = opportunistic, SS = secondary sources, S = surveys, I = interviews. L1, L2 and L3 correspond to the certainty levels.

plantar surface was more evident as a Neotropical otter. All following sightings of *L. longicaudis* were obtained opportunistically and recorded during daylight hours at a short distance from the west shore of the lagoon. Sightings 1 (Table 1; Fig. 3A): on 8th March 2019 an adult *L. longicaudis* was observed swimming on the southwest side of the lagoon by Pablo M. Beutelspacher-García (PMB-G) at 16.54 h in an area of mangroves and aquatic grasses. Days later (March 13th and 14th, 2019) and around the same time, PMB-G observed an adult Neotropical otter in the same place again. We do not have evidence to indicate whether it was the same or a different individual; however, we consider both sightings as different records (Table 1: sighting 2 and 3). Sighting 4: this sighting was made on September 1st 2019 by Silvana Marisa Ibarra-Madriral (SMI-M) corresponding to an adult *L. longicaudis* observed in Los Rápidos, an area where the lagoon narrows about 5 m, with an average depth of 4 m, increasing the water flow (1.03 to 2.06 m/s) compared to the rest of the lagoon.

Secondary sources. The following records correspond to opportunistic sightings. Sighting 5: an adult of *L. longicaudis* was sighted by a villager in 2010, who contacted Jonathan Pérez-Flores (JP-F); however, no details of the observation were obtained. Sighting 6: on 31st August

2019 a villager recorded a 46-second video of an adult *L. longicaudis* in the southern end of the lagoon. The video showed the individual swimming, breathing, and moving southward (Fig. 3B-D). José Rogelio Cedeño-Vázquez (JRC-V) contacted the villager to retrieve the information and video about this sighting. Sighting 7: on 12th April 2020 a 55-second video of an adult *L. longicaudis* was recorded near the shoreline of Laguna Bacalar by a local villager. The individual was swimming, breathing, and moving northward (Fig. 3E-G). The video was broadcast on social media and a journalist contacted Delma Nataly Castelblanco-Martínez (DNC-M) to write a note about the sighting in a local newspaper.

Discussion

We report the presence of the Neotropical otter in the Laguna Bacalar through photographs of an individual and 4 footprints, complemented with secondary information obtained through interviews with local inhabitants and videos recorded by villagers.

Although the raccoon (*Procyon lotor*), and other mustelids such as the greater grison (*Galictis vittata*) and the tayra (*Eira barbara*) have been recorded in the area (Lorenzo et al., 2008; Pozo de la Tijera, 1997; Pozo de

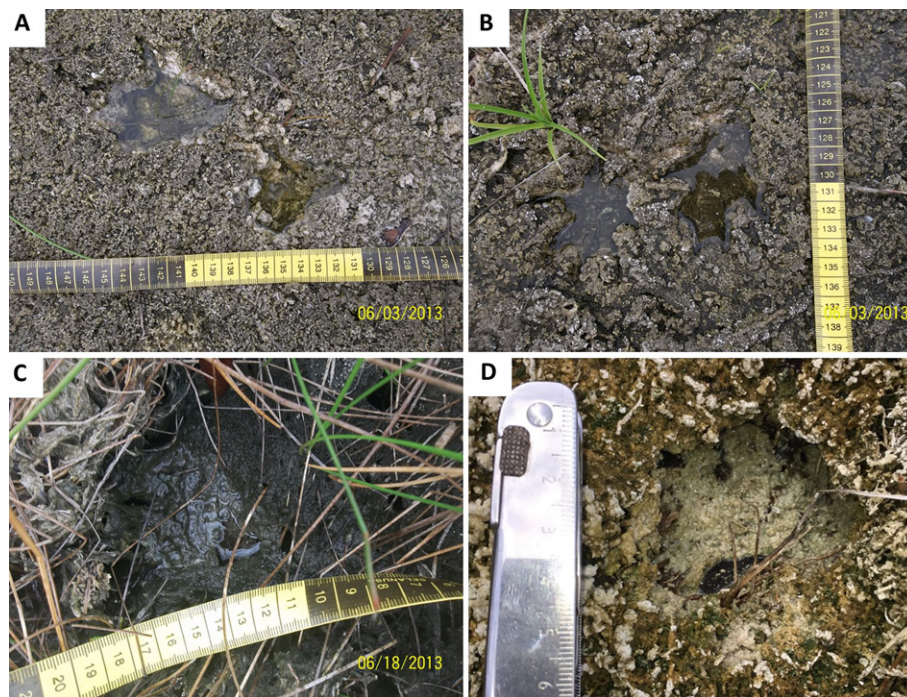


Figure 2. Indirect records of the Neotropical otter (*Lontra longicaudis*) in Laguna Bacalar. A and B: footprints found in the Isla de los Pájaros; C: footprint found in the northern zone near to Pedro A. Santos; D: footprint found in the southern zone between Xul-Há and Los Rápidos. See Table 1 for more details.

la Tijera et al., 1991), the possibility of confusing the sets of footprints of these species with *L. longicaudis* were demoted based on the measurements obtained in the field, which were consistent with the identification guides (Aranda-Sánchez, 2015; Gallo-Reynoso & Casariego, 2005; Reid, 1997). The Neotropical otter's front and

hind feet have very short and thick claws whereas the hind claws are relatively longer. In deep footprints, it is possible to distinguish the interdigital membrane on both front and hind feet (e.g., Fig. 2A, B). In contrast, footprints of the greater grison, tayra, and raccoon have short and thin claws (Aranda-Sánchez, 2015); in addition, raccoon tracks present elongated, rounded and long toes without an interdigital membrane.

The videos and photographic records are evidence of individuals with the distinctive external characteristics of *L. longicaudis*: a medium-size mammal, dark grayish-brown pelage, with a long tail, and a relative small and flat head (Larivière, 1999). Additionally, greater grison, tayras, and raccoons are predominantly terrestrial (Chávez-Tovar, 2005a, b; Valenzuela-Galván, 2005). The sightings described in this study consisted of swimming individuals of *L. longicaudis*, which is a common behavior on their habitat (Kruuk, 2006). The reported footprints were also found close to the aquatic habitat of *L. longicaudis* (Gallo-Reynoso & Casariego, 2005; Kruuk, 2006; Muñis & Oliveira, 2011).

We confirmed the presence of *L. longicaudis* in all the locations on the shoreline of Laguna Bacalar that were previously indicated by interviewees, except for the Laguna Mariscal. Previous authors reported the presence of *L. longicaudis* in nearby places, such as Río Hondo, Laguna Guerrero and Laguna Chile Verde (Calmé y Sanvicente, 2009), indicating the possibility of dispersion between water bodies. The Neotropical otter can move between streams that converge in different rivers, covering not only the course of water bodies, but also terrestrial environments (Gallo-Reynoso, 1989). The findings presented here indicate that *L. longicaudis* occurs in the western area of the Laguna Bacalar, which is connected to other karstic freshwater bodies, such as Laguna Milagros, Río Hondo (through the Chac stream), and Mariscal and Chile Verde brackish lagoons. Our observations suggest that *L. longicaudis* could benefit from this complex natural corridor, based on hydrological connections as means of dispersal and probable foraging behavior (Hernández-Arana et al., 2015).

The Neotropical otter does not strictly mark its terrestrial boundaries, instead, it uses scent marks, such as spraints, mucus, urine and feces for intraspecific communication and for habitat selection (Michalski et al., 2021; Roberts et al., 2016). Neotropical otters have high site fidelity, and their home range varies from 2 to 7 km in length (Gallo-Reynoso, 1989; Roberts et al., 2016). In addition, sex, food availability and the reproductive season generally determine the size of the otters home range (Blundell et al., 2000; Gallo-Reynoso, 1989; Kruuk, 2006). In this study, we collected direct and indirect records of Neotropical

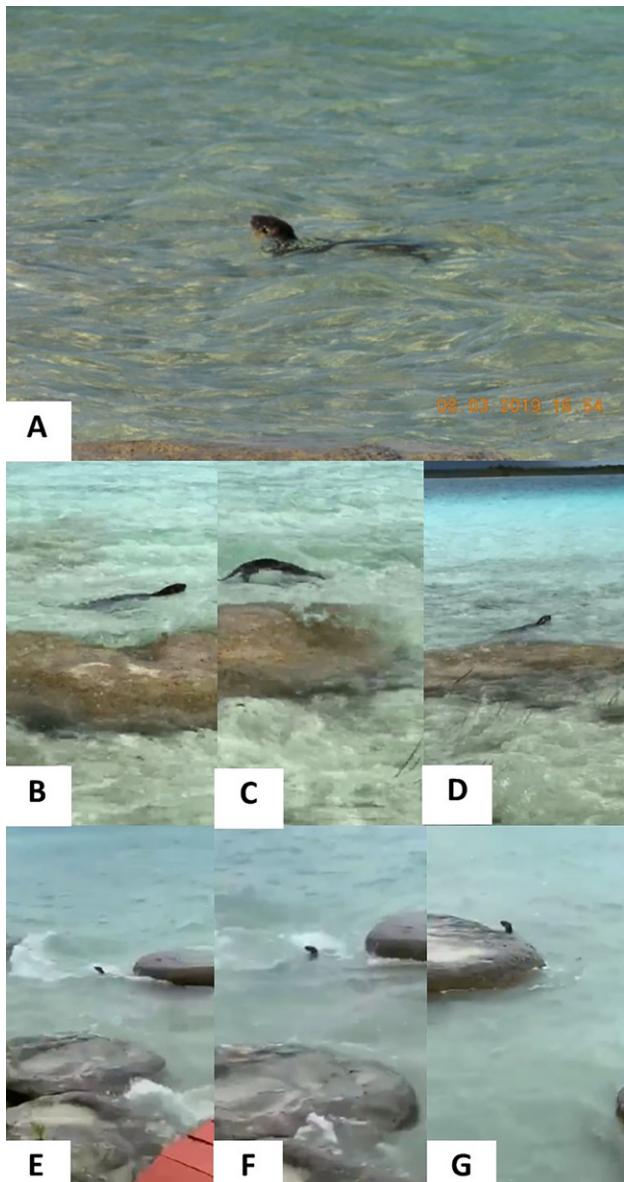


Figure 3. Direct records of the Neotropical otter (*Lontra longicaudis*) in Laguna Bacalar. A: An individual observed on March 8, 2019; B-D: video captures of the otter found in front of a residence located in the southern coast of the Laguna Bacalar, on August 31, 2019; E-G: video captures of the otter observed swimming in the lagoon, in an area near the Bacalar town, on April 12, 2020 (during the quarantine due to COVID-19).

otters confirming its presence, but questions about how this species uses the habitat available in Laguna Bacalar and surroundings remain unresolved.

Previous research on the diet of *L. longicaudis* indicates preference for fish; nevertheless, mollusks, insects, crustaceans, amphibians, reptiles, birds and small mammals are also consumed (Gallo-Reynoso, 1997; Juárez-Sánchez et al., 2019; Platt & Rainwater, 2011; Santiago-Plata et al., 2013). Since Laguna Bacalar is an important habitat for several freshwater fish species (Arce-Ibarra, 2011; Gamboa-Pérez, 1991; Valdez-Moreno et al., 2019), there is a considerable availability and diversity of prey for the Neotropical otter. Other important potential prey for the species such as insects (e.g., Coleoptera; Morón-Ríos, 2011), amphibians (Bufonidae, Hylidae) and reptiles (Dermatemydidae, Emydidae, Geoemydidae, Kinosternidae, Iguanidae, Colubridae) (Pozo de la Tijera et al., 1991; Pablo M. Beutelspacher-García pers. obs.) are also part of the native fauna of the Laguna Bacalar ecosystem. The knowledge about feeding habitats of *L. longicaudis* in the area, including diet composition, prey preference, and seasonal variability is absent. Therefore, future studies on the Neotropical otter diet in this lagoon conducted in different climatic seasons would be informative to better understand the ecological role of the species in this region.

Neotropical otters can be found in areas with certain levels of anthropogenic disturbance, as long as there are food availability and places for refuge, and extensive

aquatic networks (Gallo-Reynoso, 1997; Gallo-Reynoso et al., 2019; Larivière, 1999). However, the effect of environmental degradation needs to be further investigated at population level since it can affect refuge availability and space use patterns (Pardini & Trajano, 1999; Rheingantz et al., 2017). Although we did not measure environmental and habitat quality variables in the lagoon during this study, previous studies have indicated an incipient contamination of Laguna Bacalar and the Yucatán Peninsula waters due to agricultural practices, local wastewater contamination, and intensive tourism (Aranda-Cirerol et al., 2011; Tobón-Velázquez et al., 2019; Yanez-Montalvo et al., 2020). Considering the increasingly growing tourism and economic development of the Laguna Bacalar (Gómez-Pech et al., 2018; Ibarra-Madriral et al., 2020), we suggest developing future studies on habitat quality to describe the human-related factors that could affect the lagoon as a suitable habitat for this species.

It is interesting to note that most of the opportunistic encounters with Neotropical otters occurred recently (2019-2020), suggesting an increase in population or improvement in conservation status. In this sense, a long-term monitoring program is needed to investigate changes in species abundance and distribution. Such studies can indicate connectivity between water bodies (Hernández-Arana et al., 2015), which could contribute to the proposal and establishment of effective strategies for the conservation of this species and habitat management, also expanding the polygon of the Natural Protected Area Santuario

Table 1

Neotropical otter (*Lontra longicaudis*) records along the shoreline of Laguna Bacalar in 2010, 2013, and between March 2019 and April 2020. See the text for more details about certainty level criteria.

No.	Date and time	Type of record	Method	Type of evidence	Certainty level
1	03 Jun 2013, 17.30 h	Indirect (footprints)	Survey	Photograph (Fig. 2A)	1
2	03 Jun 2013, 13.20 h	Indirect (footprints)	Survey	Photograph (Fig. 2B)	1
3	18 Jun 2013, 13.20 h	Indirect (footprints)	Survey	Photograph (Fig. 2C)	1
4	29 Jul 2019, 09.45 h	Indirect (footprints)	Opportunistic	Photograph (Fig. 2D)	1
5	08 Mar 2019, 16.54 h	Direct (sighting 1)	Opportunistic	Photograph (Fig. 3A)	1
6	13 Mar 2019, 16.08 h	Direct (sighting 2)	Opportunistic	None	2
7	14 Mar 2019, 15.15 h	Direct (sighting 3)	Opportunistic	None	2
8	01 Sep 2019, undefined	Direct (sighting 4)	Opportunistic	None	2
9	? ? 2010, undefined	Direct (sighting 5) *	Secondary sources	None	3
10	31 Aug 2019, afternoon	Direct (sighting 6) †	Secondary sources	Video (Fig. 3B-D)	1
11	12 Apr 2020, afternoon	Direct (sighting 7) ‡	Secondary sources	Video (Fig. 3E-G)	1

Sources: *Martínez, R., pers. comm. (villager), †Salazar Cruz, R. E. (villager), ‡Medios Primer Mestizaje (local newspaper).

del Manatí-Bahía de Chetumal towards the northern of Laguna Bacalar could be considered in the future. Since the Neotropical otter is an elusive semi-aquatic mammal, we recommend using new methodological approaches to estimate the presence and relative abundance of the species such as camera traps (Barocas et al., 2016; Gallo-Reynoso et al., 2019; Wagnon & Serfass, 2016), environmental DNA (eDNA) (Beng & Corlett, 2020; Ma et al., 2016; Padgett-Stewart et al., 2016), and drones (Bushaw et al., 2019; Christie et al., 2016).

Finally, it is critical to know the conservation status of the Neotropical otter at the local level to implement future awareness campaigns and sensitize stakeholders to work towards the conservation of this species. Our study benefited from information obtained by citizens and journalists, therefore, a citizen science project addressing *L. longicaudis* status in Laguna Bacalar is essential to both monitor the species and involve local inhabitants in its protection.

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