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Leatherback turtles (*Dermochelys coriacea*) in the Gulf of Venezuela: an updated stranding assessment 2001-2014

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ABSTRACT. Leatherback turtle (*Dermochelys coriacea*) is highly impacted by fisheries' bycatch worldwide. This study updates and estimates the leatherback turtle stranding records from 2001 to 2014 in the Gulf of Venezuela. Eighty-seven stranded leatherback turtles were documented in the coast of the Gulf of Venezuela. Immature leatherback turtles were the most affected (85.5%) and the highest number of strandings were recorded during the dry season (56.3%). Our findings represent the minimum estimate of stranding events for the Gulf of Venezuela, especially considering the current lack of fisheries regulations. This is the latest update for the leatherback turtle strandings in the Gulf of Venezuela and could help to create new management solutions in the area aiming to minimize the impact on leatherback turtle populations in the Caribbean.

Key words: Immature, marine turtle, strand, IUU fishing, Guajira Peninsula, southern Caribbean.



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Tortugas cardón (*Dermochelys coriacea*) en el Golfo de Venezuela: una actualización sobre las evaluaciones de los varamientos 2001-2014

RESUMEN. La tortuga cardón (*Dermochelys coriacea*) está altamente impactada por las capturas incidentales a nivel global. Este estudio actualiza y calcula los registros de varamientos de la tortuga cardón desde 2001 hasta 2014 en el Golfo de Venezuela. Se contabilizaron 87 animales varados en la costa del Golfo de Venezuela. El segmento poblacional más afectado fueron los individuos inmaduros (85,5%) y el mayor número de registro de varamientos ocurrió en época de sequía (56,3%). Nuestros resultados representan el mínimo estimado de muertes por varamientos para el Golfo de Venezuela, especialmente dadas las condiciones actuales de ausencia total de regulaciones formales a las pesquerías. El presente trabajo representa la más reciente evaluación de los varamientos para esta especie en el Golfo de Venezuela, la cual podría ayudar a crear nuevas y mejores medidas de manejo en el área de trabajo, disminuyendo el impacto que afectan a las poblaciones de tortuga cardón en el Caribe.

Palabras clave: Juveniles, tortuga marina, varamiento, pesca INDNR, Península de La Guajira, Caribe sur.

The leatherback turtle (*Dermochelys coriacea*) is one of the five species of marine turtles that use the feeding ground areas in the Gulf of Venezuela (Guada and Sole 2000). It is currently listed as Endangered at regional level and also at national scale by the International Union for Conservation of Nature (IUCN) (NALWG 2019), and by the Red Book of Venezuelan species (Rondón-Medicci et al. 2015).

Most of the information about the species in the Gulf of Venezuela has been derived from stranding data (Acuña and Toledo 1994; García-Cruz et al. 2020). However, stranding trends are still in early stage of evaluation. Previous research found that there is still a lack of information regarding the seasonality and impacts of artisanal fishing over this species in the study area. This study aims to update the results presented by Barrios-Garrido and Montiel-Villalobos (2016) and merge records from 2001 to 2014 in the Gulf of Venezuela.

Following previous research and protocol, this study was carried out in the three main areas at the Venezuelan Guajira Peninsula (Gulf of Venezuela): the Upper Guajira; Middle Guajira; and Low Guajira (Barrios-Garrido and Montiel-Villalobos 2016) (Figure 1). We covered an extension of 188.7 km of coastline (11° 36' 27.5" N; 71° 53' 48.7" W) including 14 landing sites, villages and fishing ports. The Gulf of Venezuela has two distinct seasons: a dry season (100 mm mean rainfall from December to April) and a rainy season (200 mm mean rainfall from May to November) (Rodríguez and Morales 2000). Also, this marine area is considered a key foraging ground for leatherback turtles in Venezuela (Guada and Solé 2000; Barrios-Garrido and Montiel-Villalobos 2016).

We evaluated leatherback turtle stranding data and merged stranding network databases: for 2001-2007 assessed by Barrios-Garrido and Montiel-Villalobos (2016); plus data collected between 2008-2014 by the NGO Marine Turtle Working Group in the Gulf of Venezuela. We

assessed each stranded animal based on formal stranding register: GPS location, biometrical measurements, and life stage of the stranded turtle (immature or adult-size animals) (see details in Barrios-Garrido and Montiel-Villalobos 2016). A t-test was conducted to determine differences among the number of records during the years of the sampling period.

We evaluated the geographical and temporal (annually and quarterly) distribution of the strandings across the three main areas. Additionally, strandings were classified as: 0 (alive); 1 (alive, but subsequently died); 2 (dead, fresh carcass); 3 (dead; carcass fair; decomposing but internal organs intact); 4 (dead, carcass poor condition; advanced decomposition); 5 (dead, mummified carcass with skin holding bones together); 6 (dead, disarticulated bones) (Meager and Limpus 2012). Finally, strandings were categorized based on the cause of stranding: unknown or human activity-linked (e.g., bycatch) (Kotch et al. 2006).

We found 87 stranded leatherback turtles along the coastline of the Gulf of Venezuela. The highest number of encounters was reported in 2003 (25.3%, n = 22) and 2013 (17.2%, n = 15) (Figure 2), while in 2004, 2010 and, 2012 no stranding events were documented. Significant differences were found among the number of records throughout the years of the sampling period (t-value = 4.24; df = 10; p = 0.001719).

The highest percentage of strandings was recorded during the dry season (56.3%, n = 49); with most encounters documented in February and April (52.9%, n = 46) (Figure 2). Finally, most stranding encounters were in categories 3 to 6 (78.9%, n = 15) and four among the categories 0 (5.5%, n = 1), 1 (5.5%, n = 1), and 2 (11.1%, n = 2). The majority of the strandings' causes were unknown (63.2%, n = 55) and the remains presented evidence of human interactions (36.8%, n = 32), mainly bycatch and intentional take.

Leatherback strandings were more frequent in the Low Guajira (58.6%, n = 51), followed by the Upper Guajira (33.3%, n = 29), with sporadic

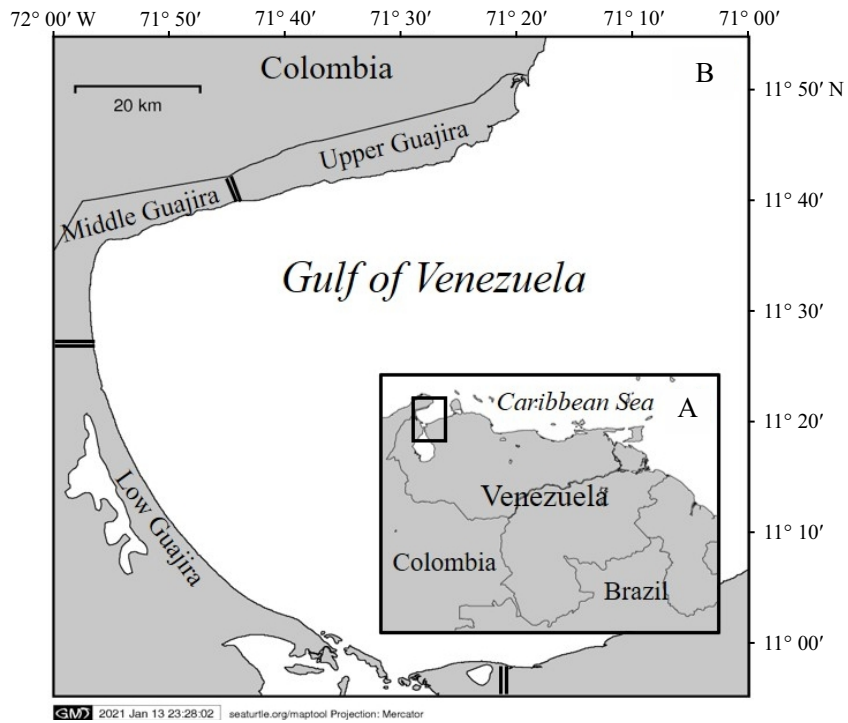


Figure 1. A) Geographical location of the study area. B) Detailed map including the three main locations in the Gulf of Venezuela separated by double-lines (Upper Guajira, Middle Guajira, and Low Guajira). Map created using Maptool (2002. SEATURTLE.ORG, Inc. Available at <http://www.seaturtle.org/maptool/>).

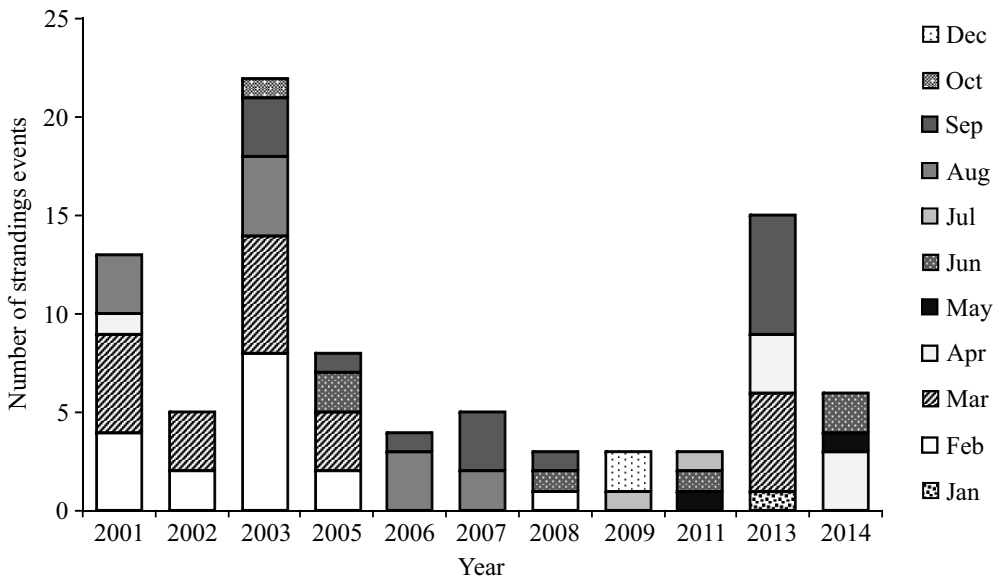


Figure 2. Annually and monthly stranding events of leatherback turtles (*Dermochelys coriacea*) between 2001 and 2014 along the coastline of the Gulf of Venezuela (N = 87).

events in the Middle Guajira (8.0%, $n = 7$) (Figure 3). Mean curved carapace length (CCL \pm SD) was $125.6 \text{ cm} \pm 21.4$, ranging between 80-195 cm ($n = 55$). Based on the measurements taken, most of the stranded turtles were immatures (85.5%, $n = 47$) with only 14.5% ($n = 8$) adults.

Eighty-seven stranded leatherback turtles have been documented in the coast of Gulf of Venezuela. The number of encounters found was low compared with leatherback bycatch in Trinidad Tobago and the Eastern Caribbean (Gass and Eckert 2006; Connor Blades et al. 2019). The number of leatherback turtles stranded found was likely a conservative estimate, especially considering that fisheries-related mortality is usually partially reported (Hamann et al. 2010; Hamelin et al. 2017; Connor Blades et al. 2019). Further research is necessary to understand how this is affecting the species regionally.

Most of the stranded turtles were documented in the Low and Upper Guajira, possibly linked to local currents, tides, winds converge in both areas, and offshore fisheries in the Low Guajira (Barrios-Garrido and Montiel-Villalobos 2016). Only seven leatherbacks were documented in the Middle Guajira, may be related to biophysi-

cal characteristics of this area (Rojas-Cañizales et al. 2020). Winds and sea currents have an important role in where or whether a marine turtle get stranded or not (Epperly et al. 1996). It is necessary to assess local oceanographic variables to understand how leatherback turtle carcasses move within the Gulf of Venezuela to monitor key stranding areas.

A large portion of recorded leatherback turtles (85.5%) was immature. The Gulf of Venezuela is likely a migratory route and a foraging area. It is possible that the immature leatherbacks were using this area to move with adult individuals (Barrios-Garrido and Montiel-Villalobos 2016), in a similar way as previously documented by James et al. (2005) in Canadian waters. The number of immature leatherbacks stranded was alarming and could negatively impact Caribbean populations, as it occurred in the Eastern Pacific Regional Management Unit (Wallace et al. 2013). Further research such as satellite tracking is needed to understand the movements and the impact at regional scale of the stranding trend.

Most records documented occurred during the dry season. This seasonality might be related to the leatherback nesting season that starts in March

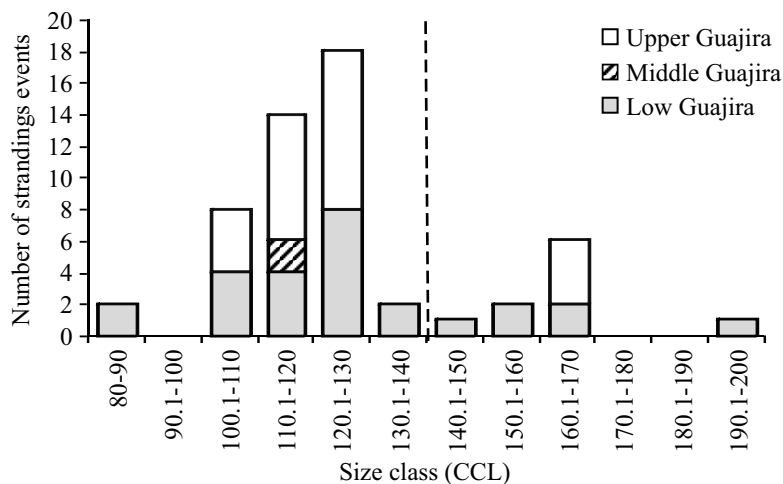


Figure 3. Size intervals (cm) of stranded leatherbacks (*Dermochelys coriacea*) found in the Upper Guajira, Middle Guajira, and Low Guajira ($N = 54$). Dashed line represents the minimum size (< 145 cm of CCL) recorded for leatherback nesters in Atlantic Ocean (Eckert 2002; Stewart et al. 2007).

at surrounding nesting beaches in the Caribbean (Rondón-Medicci et al. 2011, 2015; Borrero-Avellaneda et al. 2015). Leatherback turtles travelled extensively from the Caribbean throughout the Atlantic increasing the interaction with fisheries (Hays et al. 2004; Hamelin et al. 2017; Connor Blades et al. 2019). Moreover, these movements might be associated to local food occurrence and distribution (Fossette et al. 2008). Barrios-Garrido et al. (2020) reported an adult leatherback turtle that was tagged in French Guyana and found later in the Upper Guajira, therefore suggesting that leatherback turtles use the foraging area after reproductive seasons. It is necessary to study the connections between the Gulf of Venezuela and the nesting areas in the Caribbean and Atlantic to identify hotspots for the species and create regional management plans.

Most of stranded leatherbacks documented were found in an advanced state of decomposition (78.9%), being difficult to determine the cause of death (Veléz-Rubio et al. 2013). Commonly, stranding events are closely influenced by fishery interactions (Nicolau et al. 2016), which it is likely to be occurring in the Gulf of Venezuela; however, due to the nature of our data it is difficult to establish these interactions as the main cause of death. Currently, there is an information gap on the consequences of bycatch and intentional take in the area and its implications in the ecosystem. Applying standardized protocols could provide useful information in the future to better understand the main cause of strandings in the Gulf of Venezuela.

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