CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

A Compilation Project of the IUCN SSC Tortoise and Freshwater Turtle Specialist Group

Edited by

Anders G.J. Rhodin, John B. Iverson, Peter Paul van Dijk,
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***Podocnemis lewyana* Duméril 1852 –**
Magdalena River Turtle, Tortuga del Río Magdalena

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Podocnemis lewyana Duméril 1852 – Magdalena River Turtle, Tortuga del Río Magdalena

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Summary. – The Magdalena River Turtle, *Podocnemis lewyana* (family Podocnemididae), is a medium- to large-sized, sexually dimorphic endemic species of Colombia found in the Sinú and Magdalena drainages (including the lower Cauca, San Jorge, and Nechí tributaries). Females reach a maximum straight-line carapace length (SCL) of 50.0 cm, and males reach a maximum SCL of 42.4 cm. Females take 5–7 years to reach sexual maturity at approximately 27–30 cm SCL, while males appear to mature reproductively at around 3–4 years old, with an SCL of approximately 19–20 cm. The species has a relatively long generation time (10–12 years), implying that depleted populations are only slowly replaced and have a low capacity for recovery after a decline. Nesting occurs twice a year on exposed sandbars and beaches in December–February and July–August, with clutch size typically ranging from 12–22 eggs, with larger females laying up to 32 eggs. Eggs hatch after approximately 61 days (range = 52–89), with hatchlings averaging 4.2–4.6 cm SCL. Historically, eggs and meat of *P. lewyana* have been used by local communities as a source of protein. However, continued unsustainable capture of adults, excessive egg collection, and illegal trade have resulted in declines in distribution and population size across its range. In the Magdalena River basin, there are no government-designated protected areas that effectively control or mitigate these threats, thereby increasing the species' vulnerability. Genomic-scale genetic analysis has revealed marked population structure, with significant genetic differentiation between populations, especially between the Sinú and Magdalena drainages, and within the Magdalena drainage due to isolation-by-distance, yielding three distinct management units for the species. *Podocnemis lewyana* is an obligately aquatic, herbivorous species that consumes a wide variety of aquatic and terrestrial plant species; therefore, it probably plays a functionally important role as a seed disperser and germination facilitator, as well as being an important component of the nutrient cycling in its ecosystems.

Distribution. – Colombia. Restricted to the Sinú, San Jorge, Cauca, and Magdalena river drainages in northwestern Colombia. It is the only Podocnemididae species found northwest of the Andes Mountains, and occurs in 13 departments of Colombia: Antioquia, Atlántico, Bolívar, Boyacá, Caldas, Cesar, Córdoba, Cundinamarca, Huila, Magdalena, Santander, Sucre, and Tolima.

Synonymy. – *Podocnemis lewyana* Duméril 1852.

Subspecies. – None recognized.

Status. – IUCN 2026 Red List: Critically Endangered (CR A2acd+4acd; assessed 2016); CITES: Appendix II, as *Podocnemis* spp. (1975); Colombia: Critically Endangered (CR-E).

Taxonomy.— *Podocnemis lewyana* was described by Duméril (1852) based on three syntype specimens, with the type localities noted as Santa Fe de Bogotá (Colombia) and Venezuela. Later, Williams (1954) identified one of these syntypes as a specimen of the species *Podocnemis vogli* and designated another of the remaining syntypes from Santa Fe de Bogotá as a lectotype (MNHN 8985; Iverson 1995, 2022). No subspecies or synonyms are recognized. In a molecular phylogeny of the family Podocnemididae based on nuclear and mitochondrial DNA, it was proposed that *P. lewyana* is one of the species comprising the terminal clade of the genus: *P. unifilis* + (*P. erythrocephala* + *P. lewyana*) (Vargas-Ramírez et al. 2008). This proposal is inconsistent with the phylogenetic

Figure 1. Subadult Magdalena River Turtle, *Podocnemis lewyana*, from the Sinú River, Cordoba, Colombia. Photo by Jhonattan Vanegas / Wildlife Conservation Society / Turtle Survival Alliance.

resolution for the genus based on morphology proposed by Ferreira et al. (2018): *P. vogli* (*P. erythrocephala* (*P. expansa* (*P. unifilis* (*P. lewyana*, *P. sextuberculata*))).

Early genetic population studies of *P. lewyana* revealed relatively low levels of variation (Restrepo et al. 2008a; Vargas-Ramírez et al. 2006, 2007), weak population structure, and evidence of old and recent bottlenecks (Vargas-Ramírez et al. 2012). However, a more recent genomic-scale genetic analysis (Gallego-García et al. 2021) revealed marked population structure, with significant genetic differentiation among populations, especially between the Sinú and Magdalena drainages, due to isolation-by-distance along river segments that delimit specific management units. In the Magdalena River, the analysis identified two genetic clusters: one corresponding to the upper Magdalena and another including the middle and lower Magdalena River drainage. The dispersal barriers were clearly identifiable, with El Salto de Honda being the main barrier limiting gene flow between these two areas of the Magdalena River. In contrast, the Sinú River constituted a single, panmictic population (Gallego-García et al. 2021).

Podocnemis lewyana has a karyotype of 2n = 28, which is shared by all members of the genus (Rhodin et al. 1978).

Description. — The Magdalena River turtle, *Podocnemis lewyana*, is a sexually dimorphic species, with adult females larger and heavier than males, mea-

Figure 2. Adult female (*left*) and male (*right*) *Podocnemis lewyana* from the San Juan channel, Santander, Colombia. Photos by Grupo Herpetológica de Antioquia.

Figure 3. Subadult *Podocnemis lewyana* from the Sinú River, Cordoba, Colombia. Photo by Jhonattan Vanegas / Wildlife Conservation Society / Turtle Survival Alliance.

Figure 4. Adult female *Podocnemis lewyana* from the Chicagua River, Colombia. Photo by Alejandra Cadavid.

suring up to 50.0 cm SCL, and males up to 42.4 cm SCL (Gallego-García and Castaño-Mora 2008; Ceballos et al. 2013; Vergara-Ríos et al. 2015; TTWG 2025). In the middle Magdalena sector (municipalities of Yondó, Puerto Berrío of the Antioquia Department, and Cimitarra of the Santander Department), juvenile body sizes ranged from 4.5–15 cm (minimum size for sexing) and 41–400 g (n = 414); females ranged from 15–45 cm SCL and from 280 g–10.4 kg (n = 292); and males ranged from 15–34.8 cm and from 220 g–4.20 kg (n = 189). In addition to size dimorphism, males have longer, thicker tails (Iverson 1995), and the cloaca is more distant from the marginal scales; females have a depression in the back of the carapace, while males have a depression in the center of the plastron (Hurtado 1973). The anal notch in males is more pronounced than in females and is U-shaped, whereas in females it is V-shaped (Gallego-García 2004). Finally, there is color dimorphism in the head scales: in males, they are grayish-brown, while in females, they are reddish-brown (Gallego-García 2004).

The carapace has 24 marginal scales, five vertebral scales, and eight costal scales. In adults, the carapace is oval and flattened, usually without keels or cervical indentations, although juveniles may have keels (Ernst and Barbour 1989; Iverson 1995). The edge of the carapace is slightly raised on the sides but may be level along the posterior end (Castaño-Mora and Medem 2002). The carapace is wider in the posterior region and varies in color from gray to olive brown, occasionally with dark spots (Ernst and Barbour 1989). The plastron is smaller than the carapace and is usually yellow-green, with dark spots on the anterior and central regions (Castaño-Mora and Medem 2002).

Podocnemis lewyana has the most elongated head of all congeners and a groove between the orbits, typical of

Figure 5. Juvenile *Podocnemis lewyana* from the Magdalena River, Villa Vieja, Huila, Colombia. Photo by Jessica R. Bock.

Figure 6. Hatchlings of *Podocnemis lewyana* from Puerto Berrio, Antioquia, Colombia. Photos by Jessica R. Bock.

all *Podocnemis* species. The upper jaw is slightly rounded and lacks grooves in the rhamphothecae. The interparietal scale is very wide and heart-shaped. Individuals have subocular scales and two barbels on the lower jaw.

Neonates and juveniles have olive-gray heads with a creamy-yellowish band between the posterior edges of the orbit and the tympanum (Iverson 1995). In adults, the head is brown, as is the region between the posterior edges of the orbit, while the tympanum is a lighter color, especially in males. Across all size classes, the neck and limbs are gray to olive-green, while the jaws range from yellow to bone color, and the neck is yellowish. Medem (1958) mentioned that in the departments of Córdoba and Bolívar, some animals were found to have kyphosis, that is, a deformity of the dermal bone of the carapace.

Distribution. — *Podocnemis lewyana* is endemic to Colombia and occurs in the drainages of the Sinú, San Jorge, Cauca, and Magdalena rivers. It occurs in 13 departments of Colombia: Antioquia, Atlántico, Bolívar, Boyacá, Caldas, Cesar, Córdoba, Cundinamarca, Huila, Magdalena, Santander, Sucre, and Tolima (Rueda-Almonacid et al. 2007; Páez et al. 2022; TTWG 2025). Castaño-Mora and Medem (2002) noted that this species had apparently been extirpated from the Ranchería River (Department of La Guajira), citing Hurtado-Sepúlveda (1973); subsequent visits to this drainage have not detected the species, nor found any indication that local people recognize it (Ortiz-Yusti et al. 2014). The species occurs at altitudes ranging from sea level to 500 m a.s.l. It is the only Podocnemididae found northwest of the Andes Mountains (Castaño-Mora and Medem 2002; Páez et al. 2009a).

Its range to the east may have been extended by its introduction into the Tarra River of Venezuela by Colombian colonists (Pauler and Trebbau 1995). In addition, King and Krakauer (1966) noted that 10 *P. lewyana* individuals that were part of the pet trade were released in southeastern Florida, USA, but apparently without resulting in successful establishment of an exotic population there. Release of individuals of *P. lewyana* that enter the international pet trade is probably quite common, but so far the only case of successful establishment outside its natural range in Colombia is the Tarra River in Venezuela (Rivas et al. 2012).

The estimated historical indigenous range of *P. lewyana* (Area of Occupancy, AOO) was ca. 66,926 sq. km, and the estimated historical indigenous Extent of Occurrence (EOO) was ca. 188,057 sq. km (TTWG 2025). Less than 20% of its range is in the Sinú River drainage. Current AOO is inferred to be significantly decreased from historical estimates, but has not been formally assessed.

Habitat and Ecology. — Individuals of *P. lewyana* are primarily observed along riverbanks, although they also occur in streams, swamps, and other flooded areas connected to rivers. Within these habitats, they can be observed basking on beaches or in ravines, along the shorelines or on fallen trees (Gallego-García and Castaño-Mora 2008; Restrepo et al. 2008b). This essentially fully aquatic turtle (it only comes ashore to nest or bask) inhabits primary, secondary, and tertiary rivers, and associated lagoons, swamps, and marshes of adjacent floodplains (Páez et al. 2009a, 2012, 2024; González-Zárate et al. 2014). In areas where the species is still found, turtles exhibit an aggregated distribution pattern comprised of individuals of all size classes (Restrepo et al. 2008; Páez et al. 2015, 2024, in prep.), and can be seen basking, alone or in small or large groups, on fallen tree trunks in the water or on riverbanks (Muñoz-Castro 2023). Hatchlings and post-hatchlings have a vocal repertoire that consists of seven types of sounds recorded in captivity, with frequencies ranging from 76 to 24,000 Hz (del Río-García 2022).

Reproduction. — The species has two nesting seasons per year: *verano*, generally between December and February, and *veranillo*, approximately between July and August. Both seasons coincide with the hydrological cycles, when river levels drop and sandy or gravel beaches and sandbanks form, allowing females to excavate sand or soil to deposit their eggs. However, there is also evidence that they may use pastures or areas of riparian vegetation for nesting (Páez et al. 2012). Correa-Hernández et al. (2010) documented that most nests are laid in sandy soils in open areas, and fewer in loam or grassy substrates, and that distances to the nearest water range from less than 1 m to 40 m (n = 81).

It is not yet clear whether individual females nest in both periods each year. However, within a nesting season, we documented wide variances around the regression line of the clutch size/female SCL relationship (Páez et al. 2015). Such variation often results from females of a given body size producing progressively smaller clutches when they re-nest over the course of a single season (Bernal et al., 2004; Daza, 2004).

The nest chambers are asymmetrically bottle-shaped, with oval entrances leading to chambers that were sloped off to one side. Frequently, the depth to the first egg is 10 cm while the depth of the nest chamber ranges from 13–27 cm (Correa-Hernández et al. 2010; Ceballos et al. 2014).

Clutch size generally varies with female size, with large females laying up to 32 eggs; however, they generally lay between 12–22 eggs (Dahl and Medem 1964; Medem 1965; Castaño-Mora 1986; Páez et al. 2012; Ceballos et al. 2014).

In the Magdalena River drainage, the mean incubation temperature of 65 nests was 32.8°C and was related to the incubation period, which is often 59–61 days, with a documented range of 54–89 days (Correa-Hernández et al. 2010; Bock et al. 2024). In the Sinú, the average incubation temperature across 69 monitored nests was

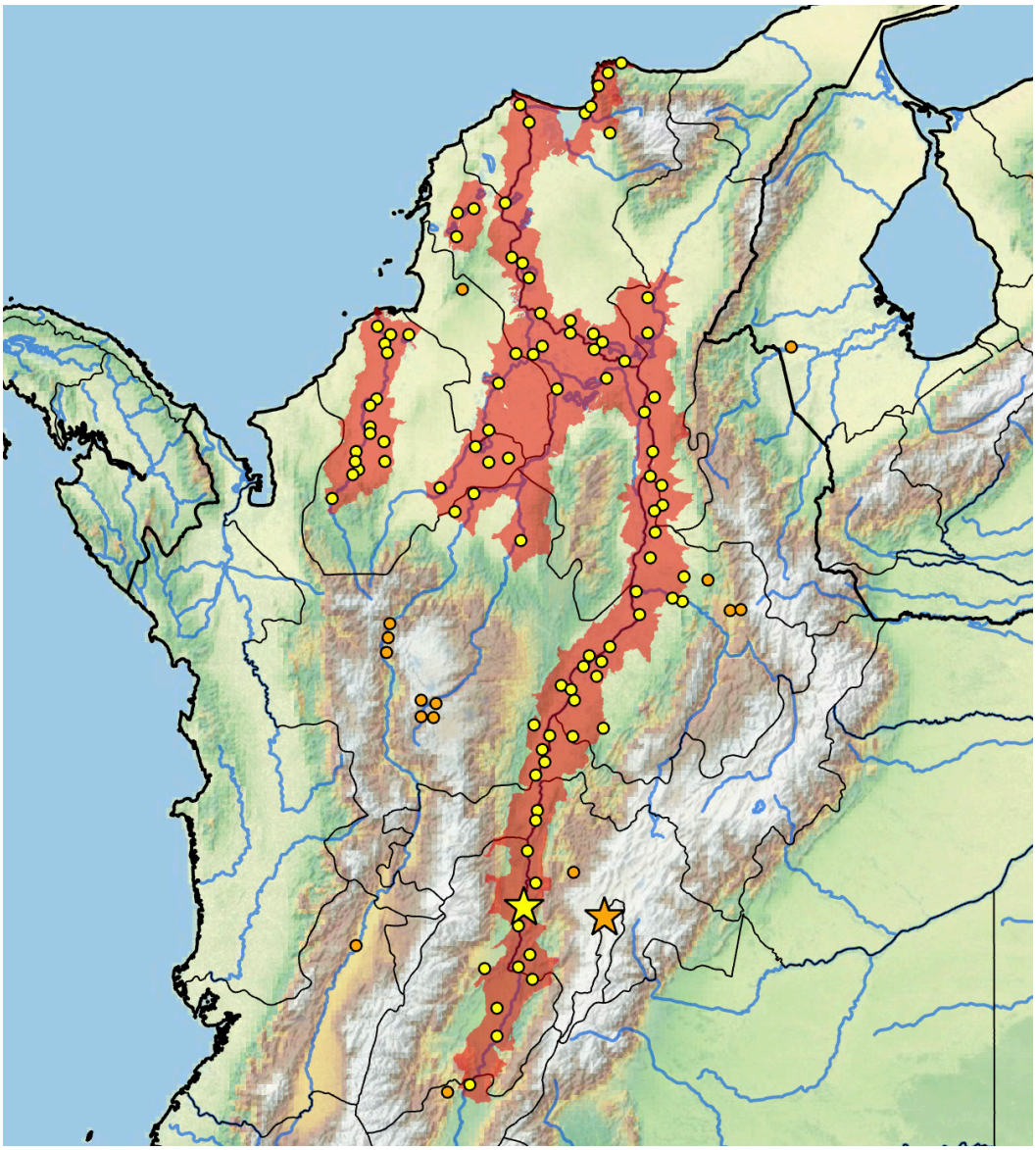

Figure 7. Estimated historical indigenous distribution of *Podocnemis lewyana* in Colombia. Yellow dots = museum and current and historical occurrence records of presumed native populations based on literature and online records (Páez et al. 2009a; TTWG 2025); orange dots = presumed trade-related or other translocated or introduced non-native records; yellow star = restricted type locality (TTWG 2025); orange star = erroneously restricted type locality (Williams 1954; TTWG 2025). Colored shading = estimated historical indigenous range. Distribution is based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments) constructed around localities and then adding HUCs that connect point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs, based on TTWG (2025) and adjusted based on data from the authors. Map by Chelonian Research Foundation.

33.2°C, with an average incubation period of 52 days (Páez et al. 2012).

Eggs vary from roundish to ellipsoidal, with a slightly flexible parchment texture and a pallid, rosy-gray color that, in a few days following oviposition, turn chalk white. Egg size ranges from 31–45 mm in length and 32–44 mm in width, and the average weight is 26 g (Correa-Hernández et al. 2010; Ceballos et al. 2014; Páez et al.2015b). Generally, neonate SCL ranges from 25–49 mm, with an average of 42.5 mm, and body mass ranges from 10–23 g, with an average of 16.2 g (n = 350).

Females take from 5–7 years to begin laying eggs, reaching sexual maturity at an SCL of approximately 27–30 cm, while males seem to enter the reproductive phase at around 3–4 years old, at an SCL of around 19–20 cm (Páez et al. 2015a; Forero-Medina, unpubl. data). Consequently, this species has a long generation time (10–12 years), implying that depleted populations are only slowly replaced and have a low capacity for recovery after a decline (Páez et al. 2015a).

Sex Determination. — As in other species of the family Podocnemididae, the sex of individuals of *P.*

Figure 8. Typical habitats of *Podocnemis lewyana* in Colombia, as well as various threats to those habitats. *Top row left*: Tertiary river tributary to the Carare river in Santader, only used by the species during the high water level seasons. *Top row right*: Carare River, a secondary river, tributary of the Magdalena River in Santander, used all year with abundant shoreline vegetation and dead wood for basking. *Second row left*: Shoreline of the Magdalena River in Antioquia showing severe reduction of the shoreline vegetation. *Second row right*: Magdalena River showing almost complete transformation of the natural shoreline vegetation for oil palm plantations. *Third row left*: Magdalnea River in Cundinamarca, showing a large but low nesting area along the shoreline. *Third row right*: Important nesting area emergent in the middle of the Magdalena River in Cundinamarca. *Bottom row left*: Magdalena River showing shoreline vegetation transformed to pasture for ranching. *Bottom row right*: Magdalena River in Cundinamarca with sand and gravel mining at the nesting areas. Photos by Viviana M. Cartagena.

Figure 9. Communal basking by *Podocnemis lewyana* along the Magdalena River at Villa Vieja, Huila, Colombia. Photo by Jessica R. Bock.

lewyana is influenced by the thermal regime experienced by embryos during the first two-thirds of embryonic development (Páez et al. 2015b). A constant laboratory temperature of 33.4°C results in an equal ratio of males and females in a nest; this pivotal temperature appears to be among the highest reported for a turtle species (Páez et al. 2009b). Average temperatures above this value result in a higher proportion of females (Pattern Type Ia or MF), and for populations in the Magdalena drainage, a constant temperature 1°C above the pivotal temperature produced an all-female sex ratio (Correa-Hernández et al. 2010; Páez et al. 2015b; Gallego-García and Páez 2016). Neonatal phenotype (sex, body size, initial growth rate, and performance) is influenced by the interaction of preovulatory maternal effects (egg size and levels of testosterone and 17β-estradiol in the yolk) and incubation temperature (Páez et al. 2009b; Correa-Hernández et al. 2010; Páez et al. 2015b). Incubation temperature also affects embryo survival and incubation duration (Páez et al. 2009b). Gómez-Saldarriaga et al. (2016) showed that the temperature before the thermosensitive period affects its duration and, therefore, influences sex determination. Sanchez-Ospina and Rodriguez (2014) conducted a histological description of the reproductive system of male and female hatchlings from the Magdalena River turtle.

Movement Patterns. — Individual turtles move by swimming between different bodies of water (from main rivers to secondary and tertiary rivers to wetlands and channels connecting them) as they grow, and annually, depending on their reproductive phase (González-Zarate et al. 2014; Alzate-Estrada et al. 2020; Páez et al. 2024).

Home ranges and the magnitude of daily movements depend on body size, sex, and reproductive condition. In general, this species has a small home range (between 10.3–14.6 ha) and moderate movement compared to some of its congeners (an average nesting migration of 13.8 km for females) and exhibits high fidelity to the sites it uses for feeding, refuge, and reproduction (Alzate-Estrada et al. 2020).

Diet. — *Podocnemis lewyana* is mainly herbivorous; however, in captivity, it also has been observed consuming animal-derived material, including small fish (Methner 1989; Páez et al. 2012). Neustophagia has not been observed (Rhodin et al. 1981). In the upper Magdalena region, González-Zárate (2010) identified the principal plant species that comprised the diet of *P. lewyana* at that location. The local species identified were *Anacardium excelsum, Anadenanthera colubrina, Annona muricata, Attalea butyracea, Cecropia peltata, Erythrina fusca*, *Ficus insipida, Guadua angustifolia, Guazuma ulmifolia, Inga laurina, Maclura tinctoria, Musa x paradisiaca, Musa balbisiana, Ochroma pyramidale, Pseudobombax septenatum, Psidium guajava, Tabernaemontana arborea, Vismia baccifera,* and *Zygia longifolia*. According to Muñoz-Castro (2023) and González-Zarate (2010), in the upper Magdalena, the plant species most frequently consumed are *Leucaena leucocephala, Samanea saman, Maclura tinctoria,* and *Pithecellobium dulce*. Stomach contents of seven adult females collected in the field during the nesting season contained 99% vegetable matter by volume, with only limited fragments of insect and snail body parts, implying they are only accidentally omnivorous (C. Lenis, unpubl. data).

Due to its herbivorous diet, *P. lewyana* helps keep water oxygenated by consuming plant material, thereby keeping floating vegetation clear in water bodies, especially lentic ones. Given its diet and aquatic habits, this species might also play a functionally important role as a seed disperser and germination facilitator, and in nutrient cycling within its ecosystems, as it constitutes biomass available to coexisting species (e.g., predators, decomposers).

Natural Predation. — *Podocnemis lewyana* eggs are predated by the Colombian Black and White Tegu (*Tupinambis teguixin*) and domestic animals such as pigs and dogs. Neonates and other size classes are preyed upon by the American Crocodile (*Crocodylus acutus*), the Wolf Fish (*Hoplias malabaricus*), and possibly large birds visiting the nesting areas (Páez et al. 2012; Cárdenas-Arévalo et al. 2019). Local people also report that the River Otter (*Lontra longicaudis*) may depredate nests and individuals in the water (Cárdenas-Arévalo et al. 2019).

Parasites and Commensals. — A study by Lenis and Vélez (2011) confirmed a previous report (Brooks 1976) of the infestation of *P. lewyana* stomachs by the digenean *Neodeuterobaris prichardae* and reported four new species of digeneans occurring in *P. lewyana* stomachs (*Nematophila venezuelensis, Pseudonematophila momposina*), large intestines (*Nematophila argentinum*), and small intestines (*Telorchis hagmanni*). Correa-Hernández et al. (2010) documented that nests can be

infested by several ant species that attack both eggs and hatchlings. Sarcophagid and phorid flies and coleopterans are probably opportunistic scavengers of eggs. In the same study, fungal species were observed, with hyphae growing on the external and internal surfaces of intact eggshells, presumably affecting embryonic development by impeding gas exchange and calcium uptake.

Population Status. — Some populations in the upper San Jorge River have already been extirpated (Vargas-Ramírez et al. 2006; Cárdenas-Arévalo 2019) and severely reduced in several municipalities along the Magdalena–Cauca drainage (Restrepo et al. 2008). Several studies have documented that higher human densities were associated with lower abundance in local *P. lewyana* populations (Gallego-García 2004; Restrepo et al. 2008; Páez et al. 2015, 2024, in prep.). Ethnozoological approaches have also documented perceptions by local people about population declines of *P. lewyana* both in the Sinú and Magdalena drainages associated with habitat loss and degradation and human consumption (Vallejo-Betancur et al. 2018; Páez et al. in prep).

A quantitative analysis (Páez et al. 2015a) in the middle region of the Magdalena River, which involved four years of capture-mark-recapture effort at four sites, provided data on female body size growth and the average size of nesting females. A projection matrix was constructed from the data, and a Monte Carlo maximum-likelihood analysis indicated that the population was declining at an annual rate of 8.8%. An elasticity analysis revealed that the most important parameter for supporting population recovery would be increasing adult survival, followed by survival of large juveniles and subadult age classes, whereas improved egg and hatchling survival would have the least effect. Stochastic projections predicted local extinction at those sites within 3 turtle generations (approximately 30–35 years).

The same study estimated that annual survival rates increased with body size (Páez et al. 2015a). A continuation of this capture-mark-recapture study, using data from a 12-year monitoring program at the same four sites, allowed an assessment of changes in relative abundances, sex and size-class ratios, and individual body sizes and body conditions. This study also examined associations among these variables and differences among sites in hunting pressure and habitat degradation. To assess temporal and spatial demographic dynamics, variation in relative abundances was estimated from catch-per-unit-effort rates, which, in this case, was the total number of turtles captured over a full five-day sampling period with ten baited funnel traps. The results supported the hypothesis that hunting removes adult females from these sites, potentially reducing recruitment. The lack of evidence of widespread declines in body condition in all size classes suggested that habitat degradation might contribute less to population decline in this region than hunting pressure. The results also illustrated that even when recapture rates are low, monitoring turtles with standardized traps can provide insights into the conservation status of a population in ways that other relative abundance indices cannot (Paez et al. 2024).

A study on the demography of this species at Cambao (San Juan de Rioseco, Cundinamarca, Upper Magdalena River) estimated an abundant population size using occupancy models and data from 113 different sites. Detection was associated positively with habitat availability, low vegetation cover, and air temperature. As documented in many other comparable studies, the two classes most threatened during the reproductive seasons were eggs and adult females (Muñoz-Castro 2023).

Another demographic analysis in the same section of the Magdalena River (Páez et al., in prep.) evaluated the population status, reproductive activity, and threats facing *P. lewyana* in the municipalities of Chaguaní and Guaduas (Department of Cundinamarca). The study found a relative density of 10.4 individuals per km of shoreline, with an average population structure composed of 32.8% with SCL sizes <15 cm (juveniles), 48.9% with sizes between 15–30 cm (subadults and small adults), and 18.3% with sizes >30 cm (larger adults, mainly females). The proportions of size classes and the maximum number of individuals sighted varied between the rainy and reproductive seasons, with the percentage of adult individuals increasing to 49% during the dry season, as expected, since sampling was conducted in the vicinity of nesting areas. These estimates have a high degree of validity, as they are derived from 662 repetitions of 1 km transects conducted across different months and hours, under ideal climatic conditions for this sampling method (Páez et al., in prep).

In the Sinú River, there are no historical population studies of *P. lewyana* comparing conditions before and after the construction of the Urrá Dam. However, several ecological conditions and indirect lines of evidence suggest potential negative effects on the population (see Threats below). According to local people, after the dam became operational in 2000, the population of *P. lewyana* in the lower Sinú River decreased markedly, and the species became very rare, and then started to slowly recover after 2010. Gallego-García et al. (2021) found evidence of contemporary bottlenecks in the Sinú River, as well as endogamic reproduction (over the last 12 generations), which supports the evidence of substantial and marked population declines that have also been evidenced by demographic studies (Páez et al. 2015a, 2024).

A capture-mark-recapture population study led by the community of Cotocá Arriba was initiated in 2016 in the lower Sinú River. After eight years of sampling, their data enabled estimation of age-class survival parameters, and the resulting matrices for deterministic

and stochastic models indicated that the population is currently growing at an annual rate of approximately 7% (Forero-Medina et al., in prep.). This somewhat moderate growth, coupled with stochastic variation in vital rates, may increase the probability of extinction in the coming years, but critical thresholds for extinction are not projected to be reached within the next 35 years. This suggests that the population is slowly recovering, but conservation measures are still recommended, particularly those focused on reducing mortality among subadult and young adult turtles.

Threats to Survival. — Several factors threaten the long-term survival of the remaining populations of *P. lewyana*. These include, in order of importance: 1) commercial exploitation, and 2) traditional use for consumption. Many current populations throughout the species' range face heavy subsistence and commercial exploitation, and several appear to have disappeared or have low densities (Vargas-Ramírez et al. 2006; Páez et al. 2009a, 2015a, 2024; Cardenas-Arévalo et al. 2019).

Both eggs and individuals of all size classes of *P. lewyana* are used as a source of protein by local people throughout the species' distribution (Castaño-Mora and Medem 2002; Gallego-García and Castaño-Mora 2008; Páez et al. 2009a, 2012, 2015, 2024; Cárdenas-Arévalo et al. 2019; Muñoz-Castro 2023). Various capture techniques are used, including hunting nesting females with dogs, using cast nets and baited hooks, and manually capturing individuals at the bottom of bodies of water. In many areas, incidental capture by fishermen results in consumption.

In several fishing villages, turtles are considered important in traditional medicine. For example, the consumption of turtle meat is believed to help mothers recover after pregnancy, cure skin and eye diseases, confer longevity and strength, and serve as an aphrodisiac (Vallejo-Betancur et al. 2018). Because the breeding season of *P. lewyana* spans or ends just before Lent, hunting of these animals increases considerably during this time to meet local and regional demands for "white meat" (Páez et al., pers. obs.).

3) Destruction and degradation of the riparian forest, aquatic habitats, and nesting beaches. A threat that is becoming increasingly evident is habitat degradation and fragmentation caused by the draining of water bodies to increase land for livestock or agriculture, as well as sedimentation, the reduction of the water surface area due to the invasion of aquatic plants such as water hyacinth (*Eichhornia crassipes*), and mercury pollution due to increasing artisanal mining throughout northern Colombia. All these factors constitute direct threats to the survival and/or natural movements of *P. lewyana* (Castaño-Mora 1997; Rueda-Almonacid 1999; Castaño Mora and Medem 2002; Zapata et al. 2014; Cárdenas-Arévalo et al. 2019; Bock et al. 2021). In addition, pastures for cattle ranching and plantations have replaced the original forest along shorelines across almost the entire range of the species (rice, oil palm, plantains, etc.). Cattle and water buffalo frequently trample incubating nests when they cross nesting beaches to drink from the river (Páez et al. 2016; Bock et al. 2021). In rural areas with agricultural activity, especially when it is extensive (for example, in the upper Magdalena), pollution of beaches and waterbodies is frequent.

Figure 10. Adult *Podocnemis lewyana* being sold in the local consumption trade, Barbacoas Channel, Yondó, Antioquia, Colombia. Photo by Grupo Herpetológica de Antioquia.

4) Hydrobiological changes caused by dams (Gallego-García and Castaño-Mora 2008; Vargas-Ramírez et al. 2006, 2007; González-Zarate et al. 2014; Páez et al., in prep.). In addition, large dams have been built on the Sinú River and several tributaries of the Magdalena River. When water is released for energy production during the dry seasons, many exposed beaches are flooded. These episodes of high water can last for several days, probably longer than eggs can withstand submergence. Although the impact of these events has not been quantified at the demographic level, it is highly likely that thousands of eggs are flooded and destroyed each year (Gallego-García and Castaño-Mora 2008; Cárdenas-Arevalo et al. 2019; Páez et al. in prep.).

5) Climate change (Gallego-García and Páez 2016; Bock et al. 2021). The phenomenon of temperature-dependent sex determination (TSD) has significant con-

sequences for the persistence of most turtle species in the context of global climate change. It could lead to either relative feminization or masculinization of populations, depending on whether average nest temperatures increase due to global warming or decrease due to cooling from periodic flooding of nesting sites (Gallego-García and Páez 2016). Global climate change may also result in higher embryonic mortality (i.e., lower recruitment of individuals into the population) due to abrupt changes in water levels and consequent flooding of nesting sites before embryos complete development (Bock et al. 2021). Also, climate change may reduce or alter the geographic range of *P. lewyana* (Ortiz-Yusti et al. 2014), potentially detrimental to its long-term survival.

Conservation Measures Taken. — *Podocnemis lewyana* is currently assessed as Critically Endangered (CR A2acd+4acd) on the IUCN Red List (Páez et al. 2016) and is considered to be among the 30 most threatened freshwater and terrestrial turtle species worldwide (TCC 2025). It is currently also assessed as Critically Endangered (CR E) in the Colombian Reptile Red Book (Morales-Betancourt et al. 2015). It has been included in CITES Appendix II since 1975, as have all *Podocnemis* spp.

Although Colombian law prohibits the commercial exploitation of *P. lewyana*, including eggs and hatchlings (Resolution No. 0219 of 1964 of the Ministry of Agriculture), this legislation is not effectively enforced, leaving the species unprotected. *Podocnemis lewyana* is covered by the National Program for the Conservation of Marine and Continental Turtles (MMA 2002, Morales-Betancourt et al. 2015); however, these regulations or plans have not been implemented, enforced, or registered consistently and systematically, resulting in high levels of illegal overexploitation. Fortunately, several private (civilian) protected areas coincide with a small percentage of the species' distribution. Also, numerous environmental education programs led by NGOs and/or academic research groups have been implemented; some include head-starting components that involve community participation.

In the Sinú River, community conservation programs have focused on rescuing eggs on beaches prone to flooding caused by the altered hydrological regime from the Urrá hydroelectric dam. In Cotocá Arriba (Lorica), the community program *Tortugas del Sinú* has rescued 1,170 nests from flooding and incubated 20,199 eggs, resulting in 17,073 hatchlings returned to the river since 2013 (Forero-Medina, unpubl. data). Most of these eggs would otherwise have perished, as they do not tolerate prolonged submersion underwater. The community also hosts a Community Education Center specializing in freshwater turtles and tortoises. Every year, they receive over 250 people as guests, including students, teachers, researchers from various NGOs, members of community-based associations, primarily tourism and fishers' associations, and representatives from governmental institutions, including municipal administrations and the departmental government. This work is focused on reducing turtle consumption in the region. In 2015, the "*Plan de Manejo para la tortuga de río Podocnemis lewyana en la cuenca del río Sinú*" was published under the collaboration of national and international organizations (Gallego-García and Forero-Medina, 2014).

In the middle Magdalena River, in the localities of Puerto Parra and Barrancabermeja, three fisher associations and 81 fishers from the municipalities have worked since 2023 on a bycatch release and monitoring program for *P. lewyana*, as part of a larger initiative to preserve the Magdalena Catfish and other species (Forero-Medina et al., in prep.). These associations establish community agreements to respect fishing rules (gear types, times, and zones) and to release turtles that are incidentally captured during their daily fishing activities. In just 2.5 years and 963 fishing events, 237 individual turtles were incidentally captured but then released by fishers; 56% of these were females (Forero-Medina et al., in prep.).

Researchers collaborating with Fundación Biodiversa Colombia (P. McGovern) and Soy Conservación (A. Acosta Peña) are researching and conserving the species around Bocas de Barbacoas, Antioquia, and El Carmen de Magdalena, Magdalena. Recent efforts include using *P. lewyana* as a focal species to educate local youth about the importance of the Magdalena River and its wildlife, monitoring nesting beaches alongside local leaders, and conducting long-term capture-mark-recapture (P. McGovern, pers. comm.).

A community-based organization on the Claro Cocorná Sur River (municipality of Puerto Triunfo, Antioquia, middle Magdalena) has conducted a head-starting program since 2010 to reduce natural and human-mediated nest predation. Under this program, eggs are transported to the facility for *ex-situ* incubation, and hatchlings are subsequently reared for 1 to 5 months before their release. However, the eggs seem to be incubated below the pivotal temperature of *P. lewyana* (Ceballos et al. 2014), likely resulting in mostly male hatchlings, and some juveniles released into the river have been shown to be infested with *Salmonella* (Montoya-Díaz et al. 2025).

Conservation Measures Proposed. — In the Magdalena drainage, delimitation of Critical Habitats for the species (Rosenfeld and Hatfield 2006) is fundamental. That is, areas within its natural distribution that include habitats of substantial importance for the species that hold important populations, all age classes, a significant percentage of reproductive females, reproductive habitat, a management or evolutionary unit, etc. The identification and protection of these areas is vital for the species' persistence and for evaluating the potential impacts of small- or large-scale anthropogenic activities.

This delimitation would make it possible to identify not only which areas could be recommended as formally protected areas, but also where conservation, education, mitigation, or restoration programs should be focused. For example, during a demographic project conducted in the upper Magdalena, specifically in Cundinamarca and Tolima departments, a critical habitat for the species was identified that contains a large population with a relative density of 11.6 individuals/km (based on basking censusing), which is significantly higher than all other populations studied using the same methodology (Páez et al., in prep). There are initiatives to protect this area, at least from some of the threats the population currently faces.

Establishing protected areas along the wetlands associated with the Magdalena River could provide refuges for the species. Both the strict protection and/or sustainable use categories could provide important opportunities to protect and manage the species in collaboration with local communities. Additionally, recently established protected areas, such as the Barbacoas Regional Integrated Management District (IUCN category VI), should incorporate management actions for the species in their management plans.

Working with fishers along the Magdalena River to reduce bycatch consumption is a recommended measure that can be implemented alongside other support programs for these communities. When integrated into broader initiatives focused on sustainability and livelihoods, bycatch release programs can reduce extraction at the source.

In the Sinú River, despite evidence of moderate growth of *P. lewyana* populations, conservation actions focused on mitigating the effects of altered hydrological regimes and reducing consumption should continue to improve recruitment and survival of young adult and adult turtles, helping the populations to recover.

Proposed Research. — Researching most aspects of the biology and ecology of *P. lewyana* would be ideal, as all are needed to implement biologically grounded conservation and management programs. However, the analysis of population trends in size, structure, and distribution changes is fundamental. This type of research could also generate better data on the species' life history and ecological characteristics. Given the many threats this species faces across its range, it would be ideal to implement a well-designed, long-lasting, and scale-appropriate monitoring program that provides detailed information on population trends. Furthermore, more efforts are needed to provide public education about the severe threats facing this species and its declining populations and to raise awareness of the need to provide it with protection.

Captive Husbandry. — Currently, we are not aware of any captive husbandry or breeding programs underway in Colombia. Several projects collect and incubate eggs and then hold hatchlings for varying periods before their release, but no full-cycle captive efforts for reintroduction purposes are underway to our knowledge.

Current Research. — In 2025, an ongoing population study on *P. lewyana* was initiated during both the high-water and reproductive seasons in the municipalities of Chaguaní and Guaduas (Cundinamarca, Colombia, Upper Magdalena) (V.M. Cartagena and Páez, pers. comm.). During both seasons, visual counts of individuals have been conducted along 1 km transects across a 40 km stretch of river, recording nesting density on 10 beaches, and recording hatching success, nesting female size (inferred from track sizes), and documenting threats to the species. So far, these results have shown the population to be numerically significant, with breeding animals of varied sizes and documented recruitment. At present, this seems to be a natural population of *P. lewyana* that has the potential to persist over time and serve as a critical demographic unit for the species. Unfortunately, several anthropogenic threats with a high potential to affect both nesting sites and general foraging/shelter habitats have also been identified.

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