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Distribution and Status of *Podocnemis lewyana* in the Magdalena River Drainage of Colombia

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ABSTRACT. – We obtained evidence of the continued presence of *Podocnemis lewyana* in 18 different sites within the Magdalena River drainage of northern Colombia. However, abundances at most sites were low, even in areas where the species had previously been reported as common. Although hunting of adults is no longer commercially viable, local people consume individuals that are captured incidentally while fishing. Hunting of eggs during the incubation period each year continues to be intensive. Turtle abundances were negatively related to human densities throughout this area. In the Chicagua River, where turtle abundances were highest, we conducted standardized shoreline censuses of basking adults and documented abundances of approximately 6 individuals/km^2. Turtles often basked on mud banks, beaches, or emergent logs in aggregations made up of all size classes. Pilot trapping efforts also succeeded in capturing all size classes of turtles, which suggests that more intensive monitoring programs would be feasible. Given the evidence of declines in most areas of the range of this species, the current lack of regulation of its exploitation, and the projections for continued human population growth in this area, we recommend its International Union for Conservation of Nature (IUCN) status be changed from Endangered to Critically Endangered (CR A2acd).

KEY WORDS. – Reptilia; Testudines; Podocnemididae; *Pododnemis lewyana*; turtle; threatened species; status; distribution; abundance; Colombia

The freshwater turtle *Podocnemis lewyana* is endemic to Colombia and is the only member of the Family Podocnemididae that occurs northeast of the Andes Mountains (Sánchez-C et al. 1995). Despite its biogeographic interest, it has been little studied, with only a few publications on its biology since its original description (Hurtado 1973; Castaño-M 1986; Vargas-R et al. 2007; see also Gallego-G and Castaño-M, this volume). An undergraduate thesis project was conducted recently on *P. lewyana* in the Sinú River drainage (Gallego 2004), and in 2004, we began pilot studies on the basic biology of this species in the principal portion of its range, the Magdalena River drainage.

The original distribution of *P. lewyana* included the Sinú, Magdalena, and Ranchería rivers and their tributaries; although, it apparently has been extirpated from the Ranchería drainage of the Guajira peninsula (Hurtado 1973; Ernst and Barbour 1989). The current limits of its distribution are to the south, the municipality of Prado in Tolima Department; to the north, the Atlantic coast in Magdalena Department; to the east, the upper Cesar and Lebrija drainages in Cesar Department; to the west the Sinú River in Córdoba Department. It not only frequents the main channels of these rivers but also enters surrounding wetlands and canals. It occurs sympatrically with other freshwater turtles, such as *Trachemys callirostris callirostris*, *Rhinoclemmys melanosterna*, and *Kinosternon leucostomum* (Castaño-M 2002; Moll and Moll 2004).

Podocnemis lewyana is listed in the Red Book of Colombian Reptiles as endangered (EN A1acd + 2acd; Castaño-M 2002). However, as is true for most freshwater turtles in Colombia, there have been no studies using standardized methods to document its current distribution and status or to characterize its demographic or genetic population structure. The goal of this study was to document the presence of *P. lewyana* in various parts of the Magdalena River drainage and to identify sites with the highest abundances to begin monitoring those populations. Here we report data on abundance estimates, size distributions, and basking habits of *P. lewyana* in this area.

METHODS

The Magdalena River drainage covers 257,440 km^2, or 24% of Colombia's land surface. Although the Magdalena River makes up only 10% of the country's hydrologic system, it contains 70% of Colombia's wetlands and also is where 70% of Colombia's human population resides. The headwaters of the Magdalena River are in Huila Department, and the river passes through 722 different municipalities as it flows north to the Atlantic coast. Its 2 main tributaries, the Cauca and San Jorge rivers, arise in the departments of Cauca and Córdoba, respectively, and enter the Magdalena River in

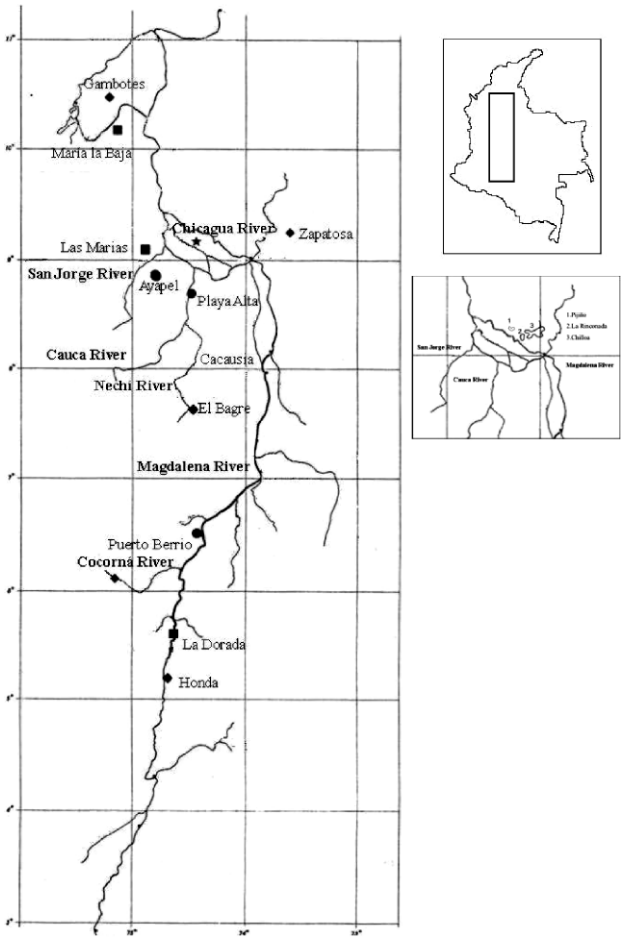

Figure 1. Map showing the locations of the 18 sites in the Magdalena River drainage where the status of *Podocnemis lewyana* populations was assessed.

Bolívar Department (Anonymous 2001). Mean annual temperature in the drainage is 28°C, with 74% mean relative humidity. The majority of the Magdalena River drainage originally contained humid tropical forest (Holdridge 1947), with the remainder composed of very humid and dry tropical forest life zones (Corpomojana 2002).

During this study, we visited 18 locations within the Magdalena River drainage (Fig. 1) during the *P. lewyana* egg incubation seasons (early February to May) of 2004 to 2006. The locations along the Magdalena River proper, from north to south, were the Dique Canal, including the Gambotes and María la Baja wetlands; Zapatosa wetland; the Chicagua River and Loba and Mompos branches of the Magdalena River; the Rinconada, Chilloa, and Pijiño wetlands; Puerto Berrío and the Cocorná River; La Dorada; and Honda. The locations on tributaries to the Magdalena were the Ayapel and Las Marías wetlands of the San Jorge River and El Bagre, Caucasia and Playa Alta of the Cauca River.

To document the presence of *P. lewyana* in these sites and to assess turtle abundances, we visited each location for 3 or 4 days. During each visit, we interviewed local fishermen concerning the presence and perceived abundances of *P. lewyana,* both in the local river habitat and in surrounding wetlands. We also asked fishermen as to whether exploitation of *P. lewyana* in their area was limited to personal consumption or also constituted a commercial activity. When possible, we attempted to verify their responses by visiting local markets. Searches of the shorelines of local water bodies also were conducted, both from a boat and by walking, in attempts to observe basking individuals.

Based upon the information obtained, we initiated a more intensive study of the population in the Chicagua River, where turtle abundances appeared to be higher. The Chicagua River (lat 9°07′N, long 74°37′W) flows north for approximately 70 km through the island formed by the division of the Magdalena River into the Mompos and Loba branches, with a mean channel width of 100 m (DMACC 1995). The land surrounding the Chicagua River is predominately cattle pasture, with very few remnant fragments of natural forest. Although there are a number of settlements along its length, it has a relatively low human population density compared with other regions of the Magdalena River drainage (Anonymous 2001). The mean annual temperature is 28°C with 80% relative humidity (Turbay et al. 2000) with a bimodal precipitation regime, with 2 dry seasons that occur from December until mid April and from July to August. The mean annual precipitation is 1.6 m (Anonymous 2001).

The Chicagua River population was studied from the beginning of February until the end of March in 2005 and 2006. The first year, an observer in a boat counted individuals from 1100 to 1400 hours, the peak period for *P. lewyana* basking activity, while searching the majority of the Chicagua's shoreline. Turtles observed basking were assigned to 1 of 3 categories, based upon their estimated sizes: small (<20 cm carapace length), medium (20–40 cm carapace length), and large (>40 cm carapace length). The sites where they were basking also were classified as being on emergent logs, beaches, mud banks, or pasture. In 2006, 2 sections of shoreline between the settlements of San Javier and Candelaria were selected for more standardized censusing. In these 2 transects of 22.5 and 21.6 km lengths, 2 observers simultaneously censused basking individuals along both shorelines. Because travel times to and from the study areas were reduced this year, the time available for censuses each day was extended an additional hour, from 1100 to 1500 hours. Each transect was censused on 7 occasions during the field season. During these censuses, the boat attempted to maintain a constant speed of approximately 10 km/h. The same size and basking site classification systems were used as in the previous year.

In addition, in 2006, 2 double-funnel net traps (Feuer 1980) were set in the Chicagua River. Captured *P. lewyana* individuals were marked by painting numbers on their carapaces, as well as by fixing plastic tags and cutting unique combinations of notches into their marginal scutes.

Table 1. Summary of the data obtained on the status of the *Podocnemis lewyana* populations in 18 sites of the Magdalena drainage.

River	Location	Coordinates, lat, long	Presence	Abundance
Magdalena	Gambotes	10°00′N, 75°20′W	Confirmed	Low
	María la Baja	9°57′N, 75°18′W	Anecdotal	Low
	Zapatosa	8°21′N, 74°57′W	Confirmed	Low
	Chicagua River	9°07′N, 74°37′W	Confirmed	High
	Loba branch	8°59′N, 74°33′W	Anecdotal	Low
	Mompos branch	9°14′N, 74°24′W	Confirmed	Low
	Puerto Berrío	6°26′N, 74°24′W	Confirmed	Intermediate
	Cocorná River	6°02′N, 75°10′W	Confirmed	Low
	La Rinconada	9°10′N, 74°10′W	Confirmed	Low
	Chilloa	9°09′N, 74°02′W	Anecdotal	Low
	Pijiño	9°20′N, 74°27′W	Confirmed	Low
	La Dorada	5°27′N, 74°40′W	Anecdotal	Low
	Honda	5°11′N, 74°44′W	Confirmed	Low
San Jorge	Ayapel	8°19′N, 75°08′W	Confirmed	Intermediate
	Las Marías	9°10′N, 75°50′W	Anecdotal	Low
Cauca	El Bagre	7°35′N, 74°48′W	Confirmed	Intermediate
	Caucasia	7°59′N, 75°12′W	Anecdotal	Low
	Playa Alta	8°04′N, 74°46′W	Confirmed	Intermediate

Marked turtles were released at their capture sites to begin a long-term mark-recapture program in this area.

Finally, in both 2005 and 2006, we searched the shorelines of the Chicagua River to identify the most important nest site locations for this population. Nests were located by detecting tracks left by nesting females and from evidence of predated nests.

RESULTS

Current Distribution in the Magdalena River Drainage. — In 2004, we observed some basking individuals in the Mompos branch of the Magdalena River, principally in the northeast section near the town of Santa Ana. We saw no individuals in the Loba branch; although, local people claimed one could still sporadically encounter *P. lewyana* there. We also observed some individuals in the nearby Pijiño and Rinconada wetlands and also documented nesting activity in the latter. In contrast, we observed considerable numbers of individuals in the Chicagua River, which confirmed the accounts of local people that this site maintains the highest abundances of *P. lewyana* in the region (see below).

In 2005, during a visit to the Cocorná River (a minor tributary of the Magdalena), we did not observe any live individuals but encountered the remains of 3 predated turtles that local people claimed were consumed by otters (*Lontra longicaudis*). Human consumption of *P. lewyana* in this area appears to be limited, and the community is currently organizing a protection plan for the species, together with local government authorities.

In Puerto Berrío we saw one female that had been captured by a fisherman. Although the species is not considered abundant, it is still possible to observe occasional basking individuals in both the river and nearby wetlands. The capture of *P. lewyana* there is usually incidental during fishing activities, rather than the result of hunting specifically directed toward turtles. This community, under the direction of a local governmental authority, is currently conducting a head-starting program that involves transferring natural nests for artificial incubation and releasing neonates in wetland habitats.

In La Dorada, the consensus of local people was that *P. lewyana* is rare there, it being exceptional to observe an individual. They also agreed that it was formerly abundant, both in the river and the adjacent wetlands, and that overhunting is what led to its no longer being a commercially exploited species in this region. In Honda, *P. lewyana* apparently has never been considered abundant because this section of the Magdalena River is very turbid and fast flowing.

In 2006, at the Dique Canal, we observed one individual in the Gambotes wetland and none in María la Baja. Local people in both locations concurred that the species was formerly common but is now rare. When fishermen occasionally capture an individual in their nets, they retain it for consumption or sale. In the Zapatosa wetland, we observed one juvenile, and in Chilloa, we saw no individuals. In both locations, local people maintain that *P. lewyana* was formerly abundant but is now rare.

In the Ayapel wetland of the San Jorge River, we confirmed the presence of *P. lewyana* by observing one juvenile. Local people informed us that the species is not common in that wetland but is more abundant in several tributary canals, e.g., Caño Bravo. In Las Marías, although we saw no individuals, local people reported that they frequently captured *P. lewyana* incidentally while fishing.

In Playa Alta, just above the Cauca River's confluence with the Magdalena River, we observed basking individuals along the shoreline. Also, in El Bagre in the Nechí River (a tributary to the lower Cauca), we encountered 2 individuals that had been netted by fishermen. In both sites, local people claimed that the species is still abundant, and, although there is no hunting effort directed specifically toward *P. lewyana*, it is common to take them incidentally. Our results concerning the continued pres-

ence and estimated abundances of *P. lewyana* in these 18 sites are summarized in Table 1.

Podocnemis lewyana in the Chicagua River. — In 2005, we made 816 sightings during 26.7 hours of searching; whereas, in 2006, we made 1789 sightings in 35.3 hours of searching. In 2006, the estimated abundances of individuals in the 2 transects were not significantly different (Mann-Whitney U_s, $p > 0.10$), with an overall mean, standard deviation of 5.8 ± 2.1 basking adults observed/km^2. Given that in both years, the variance in the number of turtles seen exceeded the median number seen, we concluded that this population has an aggregated distribution (Krebs 1999), with groups composed of 30 or more individuals in all size classes occasionally encountered.

In 2006, the proportion of individuals classified into the 3 size classes in the 2 transects did not differ significantly ($G = 2.23$, $df = 2$, $p > 0.10$), so the data were pooled. However, these pooled proportions differed significantly from those documented during the more extensive shoreline searches conducted in 2005 ($G = 37.5$, $df = 2$, $p < 0.001$), with more larger individuals seen in the 2 transects selected for study in 2006.

We also documented differences in the frequencies of use of different basking sites between the shoreline searches of 2005 and the transect censuses of 2006 ($G = 125.1$, $df = 3$, $p < 0.001$). Although mud banks were the most used sites for individuals in all size classes in both years, smaller turtles made greater use of beaches as basking sites in the transects censused in 2006 than did those observed during the wider shoreline searches in 2005.

During 336 trap hours in 2006, we were able to capture 18 individuals (8 males, 7 females, and 3 juveniles) that we marked and released at their capture sites. Although none were recaptured, 3 were later identified by their marks while basking along the shorelines. During the searches for nest-site locations, we found beaches where the probability of encountering a *P. lewyana* nest was high but also documented that the species does not restrict its nesting to such habitat. Nests also were located in mud banks, pasture, cultivated fields, and open areas near houses located along the shoreline. Local inhabitants made intensive searches along the river banks at this time of year to harvest eggs.

DISCUSSION

We confirmed the continued presence of *P. lewyana* in 12 of the locations we visited in the Magdalena drainage and obtained anecdotal evidence of its continued presence in the remaining 6 sites. However, in most sites, its abundance was apparently low, even in areas where it was formerly considered abundant. Contamination of the river drainage and changes in its hydrology related to deforestation may be factors that have negatively affected *P. lewyana* populations throughout its range (Rueda-A 2001). Also, some sites have experienced additional specific problems, such as in the Cocorná River, where fishing with dynamite was common in the 1970s and 1980s. This practice has been shown to cause atrophy of the reproductive system of the turtles present (Hurtado 1973; Rueda 2001).

Nevertheless, it seems likely that the principal factor leading to the decline of *P. lewyana* in the Magdalena River drainage has been the intense harvesting of adult turtles that occurred in this region over the past century (Fals 2002). In most sites, people reported that they used to hunt for *P. lewyana* in the river but that they now prefer to hunt for *Trachemys callirostris* in wetland and canal habitats because the harvest rate is higher. Although *P. lewyana* is also occasionally captured incidentally in these hunts, it is more common to obtain an individual by incidental capture while fishing in the river. Throughout the Magdalena drainage, whenever *P. lewyana* are captured, they are consumed, regardless of their size. In addition, the intensive harvest of *P. lewyana* eggs continues each year.

In both this study and Gallego (2004), higher human densities were associated with lower abundances in local *P. lewyana* populations. For example, in the Loba branch of the Magdalena River, *P. lewyana* is now almost never seen. This branch is the preferred route for river traffic and has a dense human population living along its shoreline. Nearby, in the Chicagua River, where fewer people live, the abundance of *P. lewyana* is much higher. Unfortunately, the overall trend in northern Colombia is for increasing urbanization of shoreline habitat surrounding water bodies where *P. lewyana* occurs.

This situation is alarming given that freshwater turtles are highly vulnerable to prolonged increases in mortality of older age classes (adults and subadults), given their life histories. Their low annual probability of reproducing successfully because of the high predation rates on nests and neonates (Congdon et al. 1983; Iverson 1991; Escalona and Fa 1998) requires that adult freshwater turtles reproduce repeatedly over a number of years to maintain stable densities (Congdon et al. 1993, 1994; Galbraith et al. 1997; Tucker and Moll 1997; Heppell 1998). Also, there is evidence that freshwater turtles do not express density-dependent responses (increases in survivorships or fecundity of surviving individuals) in response to significant increases in adult mortality (Brooks et al. 1991; Galbraith et al. 1997). Thus, it is likely that even an incidental capture of adults as part of subsistence hunting may cause population declines or at least prevent recovery from past commercial harvesting (Crouse et al. 1987; Congdon et al. 1993, 1994; Close and Seigel 1997). Also, while protecting incubating eggs may not be a highly effective management strategy for turtles (Crouse et al. 1987; Doak et al. 1994; Mitro 2003), it is equally true that constant reductions in recruitment because of human nest predation also may reduce the viability of turtle populations (Chaloupka and Limpus 2001).

Thus, efforts to identify those *P. lewyana* populations that have suffered least from human impacts are critical. In the Chicagua River, counting basking individuals along the shoreline proved to be a simple, low-cost method to estimate abundances (Soini 1998), and its efficiency was even greater when 2 observers simultaneously counted individuals on each shoreline, as we did in 2006. By combining information obtained from interviewing local people with the results of these shoreline surveys, we rapidly were able to select 2 transects for study that yielded abundance estimates that were considerably higher than those previously reported for other populations of *P. lewyana* (Gallego 2004; Castaño-M et al. 2005).

In both years of monitoring the Chicagua River, most turtles were classified as subadults (i.e., as belonging to the small size class). Medium-sized individuals were the second most frequently observed size class and probably included both reproductive males and subadult females. We assume that the large size class was composed entirely of reproductive females, given that the species is sexually dimorphic, with females the larger sex (Castaño-M 2002). Studies of other turtle populations reported that medium (Alford 1980) or large-sized individuals predominated (Chase et al. 1989; Pilgrim et al. 1997) and Gibbs and Amato (2000) suggested that a size distribution skewed in favor of small individuals may be indicative of a threatened population. However, with our limited data, such speculation would seem premature.

Turtles in the Chicagua River did not segregate according to size class, in contrast to observations reported for the Cocorná and Sinú rivers (Hurtado 1973; Gallego 2004), where larger individuals concentrated farther upstream. Hurtado (1973) suggested this was because of the presence of nesting beaches there. In the Chicagua River, suitable nesting habitat occurs throughout its entire length, as do *P. lewyana* aggregations composed of individuals from all size classes.

Mud banks were the most used basking sites for all size classes, probably because of their high availability in the Chicagua River at this time of year. Gallego (2004) reported that most *P. lewyana* in the Sinú River used emergent logs for basking and argued that the species avoids basking on shoreline habitats because of the risk of terrestrial predation (Boyer 1965; Pluto and Bellis 1986). Emergent trunks were scarce in the Chicagua River but when present, were always used for basking by turtles. Beach habitat also was not abundant along the Chicagua River but was the habitat where the largest aggregations of basking individuals were encountered.

Subsistence hunting is legal in Colombia, but the government agencies responsible for regulating such activities have not implemented adequate control programs or even begun monitoring activities. The results of our trapping efforts, although limited, show that mark-recapture methods may be used in the future to estimate densities of all 3 size classes of *P. lewyana* as a way of calibrating the estimates obtained from less-intensive censuses of basking individuals because monitoring and management programs for key populations of this species are clearly needed.

There are still areas within the historical range of *P. lewyana* where its continued presence has not yet been confirmed, but its extirpation from one river drainage has been documented (Hurtado 1973; Ernst and Barbour 1989), and it apparently has experienced marked declines in most sites where it still occurs. Although no precise demographic data are presently available for any population, we still propose that the Internation Union of Conservation of Nature (IUCN) classification of *P. lewyana* as endangered be reevaluated. We recommend its status be reclassified as critically endangered (CR A2acd) given the evidence we obtained in this study, the incipient stage of development of any form of management programs for the species, and the projections for continued human population growth in northern Colombia. There currently are no protected areas within the range of *P. lewyana*. A priority should be to conduct additional rapid shoreline censusing in other sites to identify other areas of relatively high abundances, such as those we documented in the Chicagua River, and attempt to give these sites some form of protected status, given that conservation efforts are more likely to be successful when directed toward populations that exhibit healthy densities of individuals (Harris et al. 2005).

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RESUMEN

Obtuvimos evidencia de la presencia actual de *Podocnemis lewyana* en 18 sitios diferentes dentro de la cuenca del río Magdalena al norte de Colombia. Sin embargo, la abundancia poblacional en la mayoría de estos sitios es muy baja, aún en áreas en donde la especie fue alguna vez reportada como común. Aunque la cacería de los adultos ya no es comercialmente viable, la gente local sigue consumiendo los individuos que sean capturados de forma incidental durante las jornadas de pesca. Cada año, la búsqueda humana de huevos durante el periodo de incubación continúa siendo intensa. En toda el área de estudio, las abundancias de las tortugas estuvieron negativamente relacionadas con las densidades humanas. En el río Chicagüa, donde las densidades de las Tortugas fueron mayores, desarrollamos censos estandarizados a lo largo de las orillas en donde se asolean los adultos. Allí, documentamos abundancias de aproximadamente 6 individuos/km^2. Las tortugas, en agregaciones de todas las clases de tamaños, muy frecuentemente se asolearon en

bancos de barro, playas, o troncos emergentes. Nuestros esfuerzos pilotos de captura en este río, fueron exitosos en atrapar tortugas de todas las clases de tamaños, sugiriendo la posibilidad de implementar un programa de monitoreo más intensivo. Dada la evidencia de declinación en la mayoría de las áreas que comprenden el rango de esta especie, la carencia actual de regulación de su explotación, y las proyecciones de un continuo crecimiento de las poblaciones humanas en esta zona, recomendamos que se cambie su estatus actual ante la IUCN de En peligro a En Peligro Crítico (CR A2acd).

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