Agrociencia

BIOMETRIC EVALUATION OF FRESHWATER TURTLES IN LOS RÍOS REGION IN SOUTHEASTERN MEXICO

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Citation: Sánchez-López AJ, Zenteno-Ruíz CE, Hernández-Gómez RE, Castillo-Domínguez A. 2026. Biometric evaluation of freshwater turtles in Los Ríos region in southeastern Mexico. **Agrociencia.** https://doi.org/ 10.47163/agrociencia.v60i4.3317

Editor in Chief:
Dr. Fernando C. Gómez-Merino

Received: December 16, 2025.
Approved: May 26, 2026.
Published in Agrociencia: June 22, 2026.

ABSTRACT

In the state of Tabasco, there are nine species of freshwater turtles, all of which have a conservation status under NOM-059-SEMARNAT-2010. An alternative for the recovery of these populations is management for their conservation. This study characterized freshwater turtles in captivity at División Académica Multidisciplinaria de los Ríos (DAMR), in the municipality of Tenosique de Pino Suárez, Tabasco, Mexico, as part of the evaluation of their potential for reproduction and management within a Management Unit for Wildlife Conservation (UMA). The species under study were the Mesoamerican slider (*Trachemys venusta*), the furrowed wood turtle (*Rhinoclemmys areolata*), and the Tabasco mud turtle (*Kinosternon leucostomum*). Body measurements were taken, and physical characteristics were evaluated using a pre-established form. The turtles were marked using an adaptation of the Cagle (1939) method. A total of 113 individuals were analyzed: 76 furrowed wood turtles, 32 sliders, and five Tabasco mud turtles, with densities of 0.751, 0.316, and 0.049 individuals per m^2, respectively. The sliders presented a shell length-weight (SL-P) ratio of $P = 0.1935SL^{2.8195}$ and a female-to-male sex ratio of 1:1.8. The Mesoamerican sliders displayed a SL-P ratio of $P = 0.1325SL^{2.9222}$ and a sex ratio of 1.2:1. The Tabasco mud turtle presented a ratio of $P = 0.5159SL^{2.3777}$ and a sex ratio of 4:1. The prevalence of physical conditions was evaluated for each species and for the total number of turtles, where 42 % (n = 47) presented a good condition and 58 % (n = 66) displayed irregular physical characteristics. In the latter, the highest percentage of findings corresponded to erosion of the shell and plastron, while the least observed were malformation of the mouth and loss of eyes. Data analysis suggests that conditions are suitable for species conservation and for completing the necessary procedures to establish a UMA in the future.

Keywords: body biometrics, tagging, population density, UMA potential, captivity, *Trachemys venusta, Rhinoclemmys areolata, Kinosternon leucostomum*.

INTRODUCTION

Mexico, with its large abundance of species, marine and terrestrial ecosystems, and genetic resources, and harboring nearly 70 % of the variety of plants and animals on the planet, is ranked fifth among the 12 megadiverse countries in the world (SEMARNAT, 2018). However, a point of no return has been reached in the loss of terrestrial and marine biodiversity due to the absence of places in the Earth's biosphere without human footprints (Venter *et al*., 2016). In the search for solutions to minimize these effects, two correlated activities stand out: economic profitability based on the sustainable use of wildlife and the long-term conservation of species (Hernández-Silva *et al*., 2018).

By contrast, one of the most significant and growing problems in our country is the illegal trafficking of wildlife, which produces an incalculable environmental imbalance due to the lack of strategies to minimize this crime (Van Uhm, 2016; Arroyo-Quiroz and Wyatt, 2019). Wild animals are captured to be used as raw materials in the fashion industry, to be sold as pets, for consumption, and for alleged medicinal properties, beliefs, and aphrodisiacs (Quevans *et al*., 2013). Freshwater turtles in southeastern Mexico are intensely exploited as a food resource, as they are part of local culture and tradition, although their populations have been drastically reduced due to additional factors such as environmental contamination, deforestation, urbanization, and cattle breeding (Tellería, 2013).

Turtles are reptiles that belong to the order Testudines, anatomically unmistakable due to the presence of a dorsal shell and a bony ventral plastron, which provide protection against predators and climatic pressures. Continental turtles in Mexico are among the most diverse in the world (Cázares-Hernández, 2015). In Tabasco, they are part of the biotic heritage and have coexisted with local populations since ancient times. These communities value and appreciate them both for their nutritional importance and as part of their cultural heritage (Beauregard-Solís *et al*., 2010).

Tabasco has nine species of freshwater turtles, including the Central American river turtle (*Dermatemys mawii*), the Mesoamerican slider (*Trachemys venusta*), the giant musk turtle (*Staurotypus triporcatus*), the Central American snapping turtle (*Chelydra rossignoni*), the narrow-bridged musk turtle (*Claudius angustatus*), the furrowed wood turtle (*Rhinoclemmys areolata*), the white-lipped mud turtle (*Kinosternon leucostomum*), the Tabasco mud turtle (*Kinosternon acutum*), and the scorpion mud turtle (*Kinosternon scorpioide cruentatum*) (Beauregard-Solís *et al*., 2010). All these species have some conservation status under NOM-059-SEMARNAT-2010 (DOF, 2010).

Studies have been carried out in Tabasco on freshwater turtles, highlighting the evaluation of the physical condition of hickatees (*Dermatemys mawii*) and Mesoamerican sliders (*Trachemys venusta*) (Rangel-Mendoza and Weber, 2015). These investigations provide the basis for the implementation of wildlife conservation management in Mexico. In this context, four goals can be pursued: (1) maintain populations in a healthy state through monitoring, (2) increase populations through appropriate zootechnical practices, (3) enable sustainable use, and (4) control populations when they become harmful (Hernández-Silva *et al*., 2018).

The physical condition of individuals is an integrative indicator of health; its evaluation is non-invasive and enables systematic monitoring of prevalence (the proportion of the population presenting an ailment or condition), which is useful for management decision-making. However, further studies are still needed on the physical characteristics, habitat conditions, conservation, and management of other chelonian species.

Therefore, the main goal of this investigation was to identify, classify, and determine the prevalence of physical ailments in freshwater turtles kept in captivity in Los Ríos region of the state of Tabasco, Mexico, to generate baseline information for a management plan. The biometric assessment and evaluation of the physical condition of the initial populations were considered crucial for developing the management plan based on species requirements, particularly for infrastructure design and animal welfare considerations.

MATERIALS AND METHODS

Study site

This study was carried out between November 2021 and April 2022 at División Académica Multidisciplinaria de los Ríos (DAMR), in the municipality of Tenosique de Pino Suárez, Tabasco, Mexico (17° 29′ 15.63″ N, 91° 25′ 33.85″ W), at an altitude of 25 m (Figure 1). This area is located near the Aquaculture Production Unit (UPA), under RNPA number 27092543, property of DAMR.

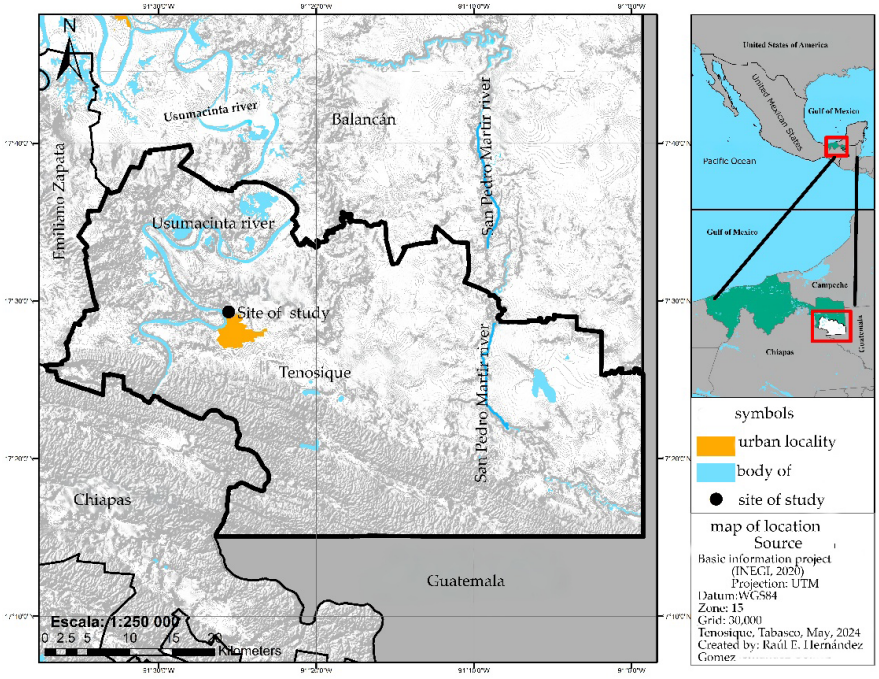

Figure 1. Geographic location of the study site in the municipality of Tenosique, Tabasco, Mexico.

Identification of species and capture

Species identification was carried out following the taxonomic classification of Casas-Andreu (1965) and the dichotomous keys described by Yvan *et al*. (1999) in the turtle identification manual of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), as well as the updated identification guides for southeastern Mexico (Díaz-Gamboa *et al*., 2022). The physical characteristics of each species were determined based on color tones and the morphology of the shell, head, and size.

Turtles were captured manually in the area by picking them up from the underside of the shell, holding them with four fingers on the plastron, and the thumbs securing the carapace (Gallina and López-González, 2011).

Tagging and taking biometric data

Technical data sheets were prepared using predetermined forms that include marking criteria and records of physical characteristics similar to those used by the Management Units for Wildlife Conservation (UMAS). In the state of Tabasco, notable UMAs include the Conservation of Endangered Species (CICEA), within the Academic Division of Biological Sciences; the Tabasco State Government turtle farm; the Arca de Noé turtle farm; and the Arroyo Tabasquillo turtle farm. These data sheets are a fundamental part of the administrative process for the Ministry of Environment, Natural Resources and Fisheries (SEMARNAP) to develop a management plan aimed at the future establishment of a wildlife conservation and sustainable use management unit within the DAMR.

The turtles were marked using an adaptation of the Cagle (1939) method, which consists of marking each specimen with structured notches on the shell, enabling permanent identification of the individual. The notching was performed on the marginal scutes of each turtle's shell using compact frame saws.

To obtain biometric data, a digital CGOLDENWALL scale with an accuracy of 0.1 g to 10 kg was used, along with a 100 cm flexible measuring tape; a binary table 45 cm in width, 1.1 m in length, and 70 cm in height for handling; and plastic containers 60 cm in length, 40 cm in width, and 32 cm in height to place the turtles. A clipboard was also used to record data in the biometric forms. Minimum and maximum values, as well as averages and standard deviations, were calculated. The recorded variables included species, weight, sex, length, curved shell length (CSL), and curved shell width (CSW). Physical characteristics of the shell, plastron, head, eyes, limbs, and tail, such as hardness, malformation, curvature, presence of algae, wounds, mutilations, and edemas, as well as the behavior, were determined.

Proportion of sex by species

To assess the sex ratio of males to females within each species, the turtle tail and plastron characterization method was utilized (Eckert *et al*., 2000), following the next formula:

$$P = a / b$$

where a is the number of females and b is the number of males (Chavarría-Pérez *et al.*, 2020)

Evaluation of the optimal and abnormal physical conditions

The prevalence of physical conditions, defined as the ratio of affected individuals to the total population and expressed as a percentage, was calculated for nine external physical conditions. These conditions include erosion of the shell and plastron; depressions and curvature; grooves, cracks, and notches; wounds on the shell, plastron, tail, and head; malformation and wounds of the nose; edema in the limbs; malformation of the mouth; and loss of eyes, all of which are indicators of poor health status (Rangel-Mendoza and Weber, 2015). For this study, the total turtle population was analyzed, and totals were subsequently calculated by species.

Population density

Population density is an indicator that helps measure the level of satisfaction of organisms with the space available for interaction with the surroundings and with other individuals. This factor reflects their condition of well-being, indicating whether the population is clustered or dispersed. It is expressed in individuals per square meter and is calculated using the following formula:

$$D = N / S$$

where D is density, N is population abundance, and S is the surface area it occupies (expressed in m^2) (Mandujano-Rodríguez, 2011).

Length-weight ratio

The ratio between the curved shell length and the weight of the turtle was calculated using the formula proposed by Ricker (1975):

$$TW = aSL^b$$

where TW is total weight (in grams), a is a regression constant equivalent to the condition factor, SL is shell length (in centimeters), and b is the growth coefficient of the regression.

RESULTS AND DISCUSSION

Identification of species, capturing and tagging

Three species of tropical freshwater turtles were identified (*Rhinoclemmys areolata*, *Trachemys venusta*, and *Kinosternon leucostomum*), which are among the nine species

recorded for the state of Tabasco (Beauregard-Solís *et al*., 2010) and are endemic to the Neotropics (Ippi and Flores, 2001). Within the facilities of DAMR, a total of 113 individuals were recorded (Table 1).

Table 1. Composition and relative abundance of freshwater turtle species studied in Los Ríos region of Tabasco, Mexico.

Family	Scientific name	Common name	n	%
Emididae	*Trachemys venusta*	Central American slider	32	28
Geomydidae	*Rhinoclemmys areolata*	Furrowed wood turtle	76	67
Kinosternidae	*Kinosternon leucostomum*	Tabasco mud turtle	5	5

Analysis of biometric data of turtles

The *R. areolata* population presented a curved shell length (CSL) of 14 to 21 cm (18.65 ± 1.67 cm). In this species, the CSL with the highest frequency was 20 cm, and the lowest was 14 cm. The weight range for this species varied from 377 to 1248 g (761.17 ± 207.02 g). These data are similar to those obtained in another species of the same family (*R. pulcherrima*), with measurements in females of 17.1–23.6 cm and weights of 740–1870 g, while males presented lengths of 12.13–18.9 cm and weights of 240–690 g in captivity on the coast of Oaxaca (Rodríguez-Murcia *et al*., 2014).

Trachemys venusta presented CSL values ranging between 18 and 33 cm (23.12 ± 3.77 cm). The most frequent CSL was 23 cm, while the least frequent were 20, 26, 27, and 33 cm. The recorded weight ranged from 598 to 3242 g (1378.84 ± 686.57 g). This finding is consistent with descriptions reported in other studies, indicating shell lengths of up to 38 cm and weights between 1 and 3 kg (Guevara-Chumacero *et al*., 2017), a maximum shell length of 48 cm and a maximum weight of 5 kg (Lesher-Gordillo, 2019), and lengths between 20 and 60 cm (Gómez-Aguilar *et al*., 2018).

The species *K. leucostomum* recorded CSL values between 13 and 17 cm (14.77 ± 1.48 cm), with a weight interval of 226 to 478 g (318.22 ± 90.68 g). The highest CSL frequency recorded was 15 cm. The values for this species presented lower average length and weight (12.4 ± 1.52 cm and 273.3 ± 68.2 g) than those reported in another study conducted in Tabasco (Hernández-Guzmán *et al*., 2014). Similar records were reported in Ecuador and Colombia (Rodríguez-Murcia *et al*., 2014), with maximum shell lengths of 13.7 cm in females and 14.8 cm in males.

Sex ratio by species

The estimated sex ratio for *R. areolata* was 1:1.81 (female:male). These data are similar to those recorded in Mexico and Belize (Vogt *et al*., 2009), of 1:2 and 1:1.3, respectively. On the other hand, similar values have been reported for wild turtles in the Colombian Pacific region, as well as for *R. melanosterna*, with a ratio of 1:2.3 (Rengifo-Palacios *et al*., 2022).

For *T. venusta*, the sex ratio in this study was 1:1.28 (female:male). This differs from that reported for *Trachemys scripta elegans* in Spain, where the proportion is 9:1 (Patiño-Martínez and Marco, 2005). This suggests that sex ratios in turtles, both in the wild and in captivity, can vary.

In *K. leucostomum*, the sex ratio was 4:1 (female:male), differing from that recorded for wild populations in Colombia (1:1.75) (Rodríguez-Murcia *et al*., 2014). In another species of the same family (*Kinosternon scorpioides*), a ratio of 1:1.6 has been reported in Costa Rica (Acuña-Mesén and Márquez, 1993). This difference is probably due to the low abundance of this species in the captivity area of the DAMR.

Evaluation of the physical conditions of the turtles

A total of 42 % (n = 47) of the turtles were recorded as having optimal physical conditions, while 58 % (n = 66) presented irregular physical characteristics. The most prevalent condition was erosion of the shell and plastron, with 17 % (n = 19), whereas the least prevalent were malformations of the mouth and loss of eyes, with 1 % (n = 1) each (Figure 2).

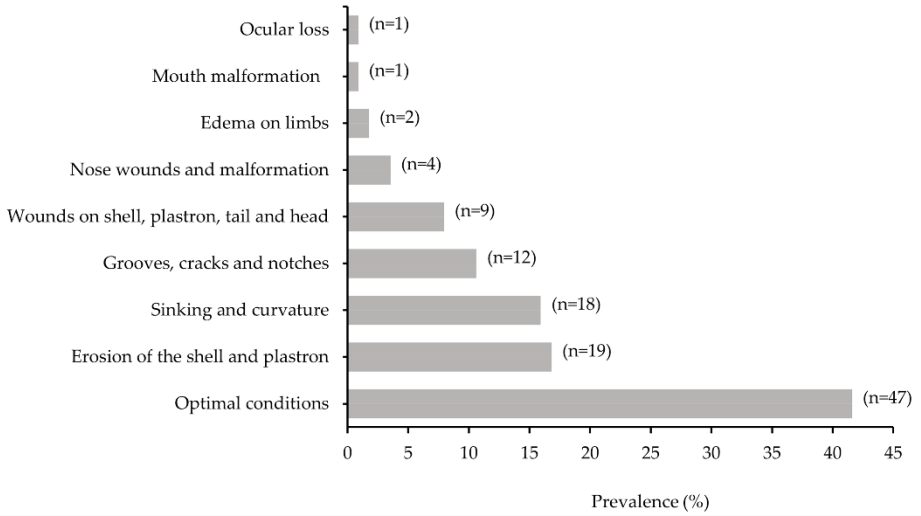

Figure 2. Prevalence of physical conditions in the total freshwater turtle population studied in Los Ríos region of Tabasco, Mexico.

The physical conditions observed in the analyzed individuals indicate that just over half present alterations related to confinement. Lesions on the shell and plastron showed a prevalence of 17 %, a recurring value in organisms under management and lower than that recorded for other species such as *Dermatemys mawii* in the Arca de Noé turtle farm (90 %), the Tabasco State Government turtle farm (55 %), and the Arroyo Tabasquillo turtle farm (75 %) (Rangel-Mendoza and Weber, 2015).

For the species *Rhinoclemmys areolata* (n = 76), 33 % (n = 25) presented optimal physical conditions, while 67 % (n = 51) showed irregular characteristics; the most prevalent were erosion of the shell and plastron, and the least frequent were malformations of the mouth and loss of eyes. This species presented the highest proportion of irregular physical conditions (Figure 3A). The limited available information on physical traits and the prevalence of abnormal conditions in *R. areolata* did not allow comparison with these results; however, there are studies on thermoregulatory behavior, temperament in captivity, and hematological parameters (Cassola *et al*., 2020) aimed at improving health status.

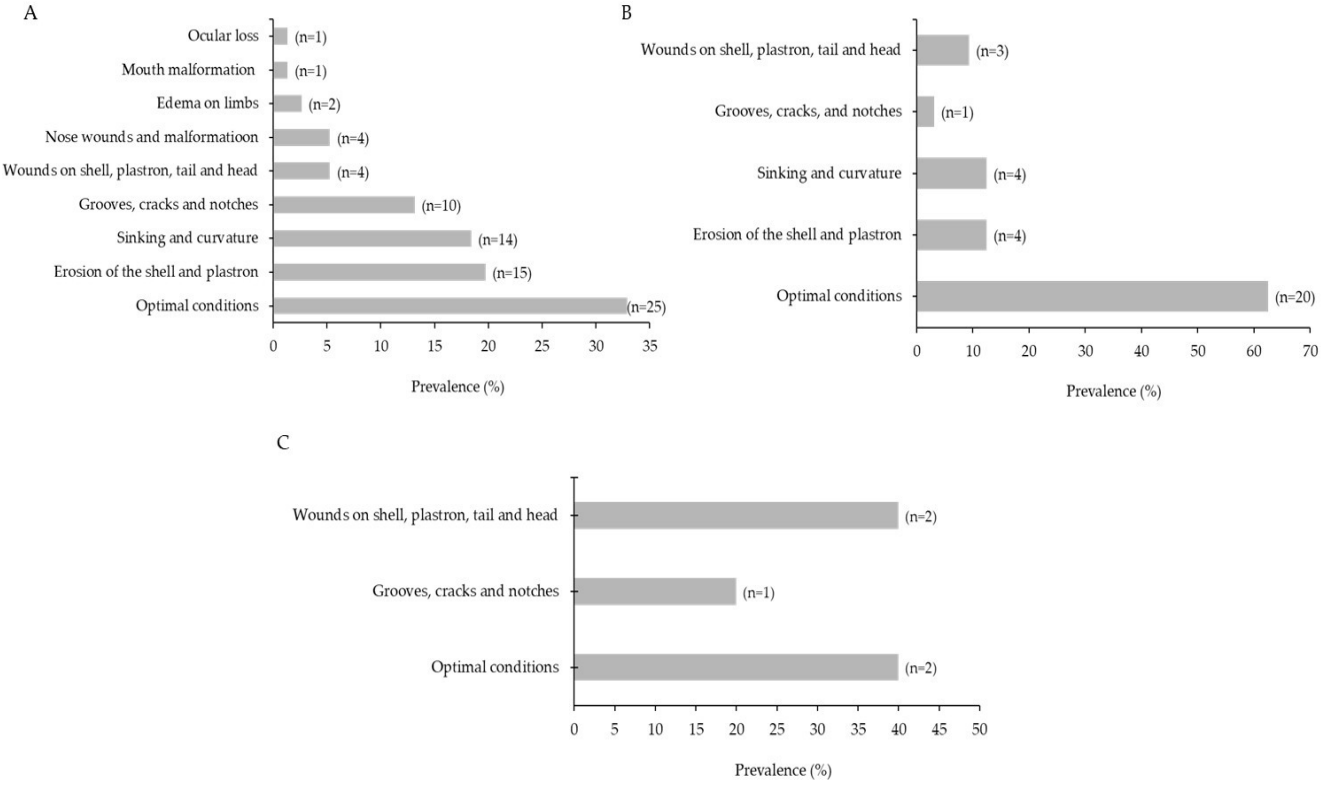

Figure 3. Species-specific prevalence of physical conditions in freshwater turtles from Los Ríos region of Tabasco, Mexico. A: *Rhinoclemmys areolata*; B: *Trachemys venusta*; C: *Kinosternon leucostomum*.

In *T. venusta* (n = 32), 62 % (n = 20) presented optimal conditions, while 38 % (n = 12) displayed irregular characteristics, highlighting erosion of the shell and plastron, as well as depression and curvature (Figure 3B). In *K. leucostomum* (n = 5), 40 % presented optimal physical conditions and 60 % showed irregular characteristics (Figure 3C). For this species, no studies were found on irregular physical characteristics and their prevalence that enable comparison of the observed degrees of impact.

Rhinoclemmys areolata presented the highest prevalence of irregular physical conditions, mainly related to erosion and curvature of the shell and plastron (67 %, n = 51), compared with 38 % (n = 12) in *T. venusta* and 60 % (n = 3) in *K. leucostomum*. This may be related to the greater population density of this species or to nutritional deficiencies, such as vitamin and iron deficiencies (SEMARNAT, 2009). In addition, its more docile behavior and more terrestrial habits promote mechanical damage to the shell through contact with hard or artificial surfaces, which increases its vulnerability relative to the other species with which it shares its habitat, as it is less efficient for swimming or for remaining protected for prolonged periods in bodies of water (Vogt *et al*., 2009).

The wounds observed in these species, kept in a natural area with structural modifications, can be attributed to handling in captivity, water quality, habitat conditions, and terrestrial activities typical of these reptiles (courtship, mating, reproduction, and nesting) (Rangel-Mendoza and Weber, 2015).

Population density

The population density of the three turtle species was dispersed (Table 2). Regarding the density of turtles of the genus *Rhinoclemmys* in captivity, insufficient data were found in the scientific literature to enable a comparative analysis; however, regional and international references derived from master's and doctoral theses are available. For comparison purposes, data for *Rhinoclemmys nasuta* in the wild indicate a density of 0.244 individuals per m^2 (Giraldo *et al*., 2012), which is lower than that recorded for *R. areolata* in this study, although it was assessed over a larger area.

Based on this, researchers consider the population density of the three studied species adequate for their distribution area. Nevertheless, additional areas will be required in the future, as the current space is limited for reproduction, population growth, and the maintenance of a stable population.

Table 2. Population density and dispersion area of freshwater turtle species in Los Ríos region of Tabasco, Mexico.

Species	Density (individuals per m^2)	Dispersion area (m^2)
Trachemys venusta	0.316	3.16
Rhinoclemmys areolata	0.751	1.33
Kinosternon leucostomum	0.049	20.24

Length-weight ratio by species

Rhinoclemmys areolata presented a shell-weight ratio of $P = 0.1935SL^{2.8195}$, with a coefficient of determination of $R^2 = 80.71$ % (Figure 4A). *Trachemys venusta* showed a ratio of $P = 0.1325SL^{2.9222}$, with $R^2 = 97.64$ % (Figure 4B). *Kinosternon leucostomum* presented a ratio of $P = 0.5159SL^{2.3777}$, with $R^2 = 83.95$ % (Figure 4C).

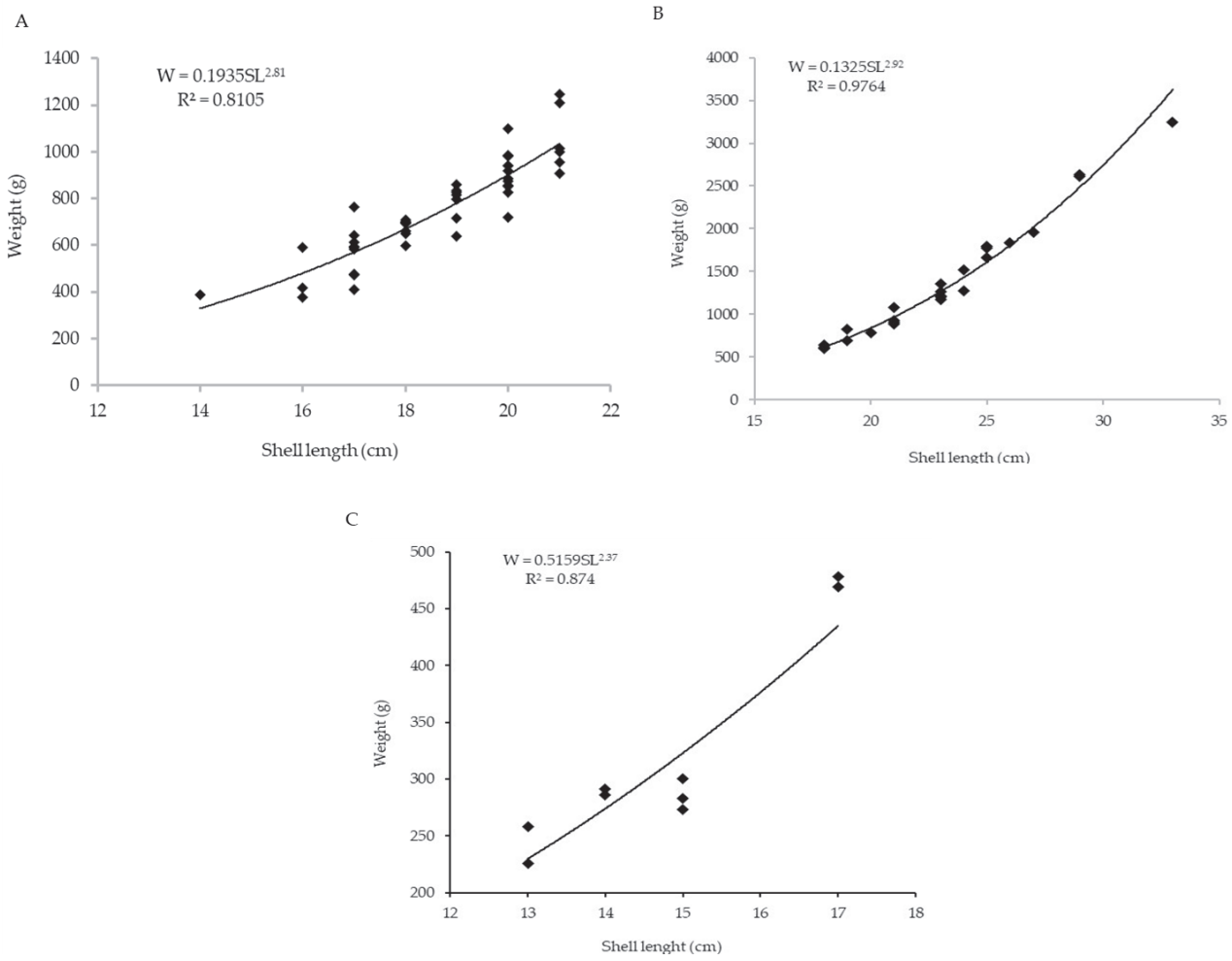

Figure 4. Species-specific shell length-weight (SL-W) ratio in captive freshwater turtles from Los Ríos region of Tabasco, Mexico. A: *Rhinoclemmys areolata*; B: *Trachemys venusta*; C: *Kinosternon leucostomum*.

The freshwater turtles in the DAMR presented an adequate length–weight ratio, indicating uniform growth in length and weight. This behavior is explained by the model in approximately 80 % for *R. areolata* and *K. leucostomum* and in 90 % for *T. venusta*. These values differ from those reported for *Rhinoclemmys nasuta* in the Colombian Pacific, with 96 % (Giraldo *et al*., 2012). For *T. venusta* and *K. leucostomum*, no comparative data were found; however, both species display similar behavior in the model, indicating adequate growth conditions.

CONCLUSIONS

The freshwater turtles in captivity at División Académica Multidisciplinaria de los Ríos (DAMR) generally present adequate physical conditions for their management, as they fall within the parameters established in similar management systems in Tabasco, which have proven effective in maintaining reproductive and long-lived populations. Based on the analyzed data and the review of applicable regulations (General Wildlife Law and the Standard Management Plan), it is concluded that the studied population can be integrated into a conservation scheme and the potential establishment of a Management Unit for Wildlife Conservation (UMA), which would contribute to fulfilling the objectives of reproduction, research, and environmental education within the DAMR.

ACKNOWLEDGEMENTS

The authors thank the División Académica Multidisciplinaria de los Ríos for providing permission, facilities, and support to conduct this work. They also acknowledge the collaborators in fieldwork, technical advisors, and the Secretariat of Science, Humanities, Technology and Innovation (SECIHTI) for granting the main author a scholarship to pursue a Master's degree (No. 790654).

REFERENCES

Acuña-Mesén RA, Márquez BC. 1993. El dimorfismo sexual de *Kinosternon scorpioides* (Testudines: Kinosternidae) en Palo Verde, Costa Rica. Revista de Biología Tropical 41 (2): 261–265.

Arroyo-Quiroz I, Wyatt T. 2019. Tráfico de vida silvestre entre la Unión Europea y México. Crítica Penal y Poder 16: 32–52.

Beauregard-Solís G, Zenteno-Ruiz CE, Armijo-Torres R, Guzmán-Juárez E. 2010. Las tortugas de agua dulce: patrimonio zoológico y cultural de Tabasco. Kuxulkab' 17 (31): 5–20. https://doi.org/10.19136/kuxulkab.a17n31.394

Cagle FR. 1939. A system of marking turtles for future identification. Copeia 1939 (3): 170–173. https://doi.org/10.2307/1436818

Casas-Andreu G. 1965. Estudio preliminar sobre las tortugas de agua dulce en México. Anales del Instituto Nacional de Investigaciones Biológico-Pesqueras 1: 363–401.

Cassola FM, Henaut Y, Cedeño-Vázquez JR, Méndez-de la Cruz FR, Morales-Vela B. 2020. Temperamento y comportamiento sexual en la tortuga de madera surcada *Rhinoclemmys areolata*. PLoS ONE 15 (12): e0244561. https://doi.org/10.1371/journal.pone.0244561

Cázares-Hernández E. 2015. Guía de las tortugas dulceacuícolas de Veracruz. Industria Gráfica Internacional: Xalapa, México. 65 p.

Chavarría-Pérez I, Melara-Soriano M, Liles MJ, Castro-Menjivar J. 2020. Determinación de la proporción sexual de tortugas Carey (*Eretmochelys imbricata*) inmaduras, mediante la detección de testosterona por medio de la prueba de ELISA. Revista Agrociencia 3 (16): 73–80. https://doi.org/10.5281/zenodo.10912976

Díaz-Gamboa LF, Gallardo A, Alemán MB, Chiappa-Carrara X, Arenas CY. 2022. Guía rápida de identificación tortugas terrestres y dulceacuícolas de la Península Mexicana de Yucatán. Universidad Nacional Autónoma de México. Ciudad de México, México. https://doi.org/10.13140/RG.2.2.29504.40967

DOF (Diario Oficial de la Federación). 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2001. Protección ambiental-Especies nativas de México de flora y fauna silvestres. Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio. Lista de especies en riesgo. Gobierno de México. Secretaría del Medio Ambiente y Recursos Naturales. Ciudad de México, México.

Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M. 2000. Técnicas de investigación y manejo para la conservación de las tortugas marinas. Grupo Especialista en Tortugas Marinas. Unión Internacional para la Conservación de la Naturaleza. Comisión de Supervivencia de Especies. Blanchard, PA, USA. 270 p.

Gallina S, López-González C. 2011. Manual de técnicas para el estudio de la fauna. Volumen I. Universidad Autónoma de Querétaro. Instituto de Ecología A.C. Querétaro, México. 377 p.

Giraldo A, Garces-Restrepo MF, Carr JL, Loaiza J. 2012. Population size and structure of the large-nosed wood turtle (*Rhinoclemmys nasuta*, Testudines: Geoemydidae) in an insular environment of the Colombian pacific region. Caldasia 34 (1): 109–125.

Gómez-Aguilar V, Ramos-Ferrer JA, Mendiola-Campuzano JVH. 2018. Eficacia de la aplicación de la normatividad protectora de las hicoteas (*Trachemys venusta*) en Tabasco. Kuxulkab' 24 (49): 19–30. https://doi.org/10.19136/kuxulkab.a24n49.2623

Guevara-Chumacero M, Pichardo-Fragoso A, Martínez-Cornelio M. 2017. La tortuga en Tabasco: comida, identidad y representación. Estudios de Cultura Maya 49: 97–122. https://doi.org/10.19130/iifl.ecm.2017.49.758

Hernández-Guzmán J, Rimber IJ, Shigueki YG, Arias-Rodríguez L. 2014. Los cromosomas de las tortugas tropicales: *Kinosternon leucostomum*, *Trachemys scripta* y *Staurotypus triporcatus* (Testudines: Kinosternidae/Emydidae). Revista de Biología Tropical 62 (2): 671–688. https://doi.org/10.15517/rbt.v62i2.10843

Hernández-Silva DA, Pulido SMT, Zuria I, Gallina TSA, Sánchez-Rojas G. 2018. El manejo como herramienta para la conservación y aprovechamiento de la fauna silvestre: acceso a la sustentabilidad en México. Acta Universitaria 28 (4): 31–41. https://doi.org/10.15174/au.2018.2171

Ippi S, Flores V. 2001. Las tortugas neotropicales y sus áreas de endemismo. Acta Zoológica Mexicana 84: 49–63.

Lesher-Gordillo JM. 2019. Establecimiento de un programa de manejo genético para las especies *Dermatemys mawii* (tortuga blanca) y *Trachemys venusta* (tortuga hicotea) en Unidades de Manejo de Vida Silvestre (UMA) para favorecer el flujo genético y la conectividad del Corredor Biológico Mesoamericano en Tabasco. Universidad Juárez Autónoma de Tabasco. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Ciudad de México, México. 34 p.

Mandujano-Rodríguez S. 2011. Conceptos generales de ecología poblacional en el manejo de fauna silvestre. *In* Manual de Técnicas para el Estudio de la Fauna, Volumen I. Instituto de Ecología A.C. Universidad Autónoma de Querétaro. Querétaro, México, pp: 37–60.

Patiño-Martínez J, Marco A. 2005. Potencial invasor de los galápagos exóticos en el País Vasco. Munibe Ciencias Naturales 56: 97–112.

Quevans N, Falcón N, Elías R. 2013. Fauna silvestre y productos derivados decomisados durante el período 2000-2007, Lima–Perú. Salud y Tecnología Veterinaria 1 (1): 14–18. https://doi.org/10.20453/stv.v1i1.105

Rangel-Mendoza JA, Weber M. 2015. Evaluation of the physical condition of the white turtle, *Dermatemys mawii*, under captivity conditions in Tabasco, Mexico. Agrociencia 49 (5): 499–511.

Rengifo-Palacios MY, Cetré-Mosquera Z, Rengifo-Mosquera JT, Halaby-Guerrero JC. 2022. Estructura poblacional y estado de conservación de *Rhinoclemmys melanosterna* Gray, J.E, 1861 (Orden: Rhinoclemmys familia Geoemydidae) en ecosistemas perturbados por minería en el Pacífico colombiano. Boletín Científico Centro de Museos, Museo de Historia Natural 26 (1): 99–110. https://doi.org/10.17151/bccm.2022.26.1.7

Ricker WE. 1975. Cálculo e interpretación de estadísticas biológicas de poblaciones de peces. Boletín de la Junta de Investigación Pesquera de Canadá 191: 1–38.

Rodríguez-Murcia JD, Giraldo A, Garcés-Restrepo M, Sánchez F. 2014. Estructura poblacional y dimorfismo sexual de *Kinosternon leucostomum* (Testudines: Kinosternidae) en un sistema de charcas asociadas con el río Purnió, Caldas, Colombia. Investigación, Biodiversidad y Desarrollo 33 (2): 86–95.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2009. Taller de capacitación para la conservación y aprovechamiento sustentable de tortugas dulceacuícolas del Sursureste de México. Secretaría de Medio Ambiente y Recursos Naturales. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Comisión Natural de Áreas Naturales Protegidas. Procuraduría Federal de Protección al Ambiente. Catemaco, México. https://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/libros2009/SF408T352009.pdf (Retrieved: June 2021).

SEMARNAT (Secretaría del Medio Ambiente y Recursos Naturales). 2018. México biodiversidad que asombra. Gobierno de México. Secretaría del Medio Ambiente y Recursos Naturales. Ciudad de México, México. https://www.gob.mx/semarnat/es/articulos/mexico-biodiversidad-que-asombra (Retrieved: May 2021).

Tellería JL. 2013. Loss of biodiversity: Causes and consequences of the species loss. Memorias de la Real Sociedad Española de Historia Natural 10: 13–25.

van Uhm DP. 2016. Monkey business. *In* The Illegal Wildlife Trade. Studies of Organized Crime (Volume 15). Springer: Cham, Switzerland. https://doi.org/10.1007/978-3-319-42129-2_8

Venter O, Sanderson EW, Magrach A, Allan JR, Beher J, Jones KR, Possingham HP, Laurance WF, Wood P, Fekete BM, *et al*. 2016. Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. Nature Communications 7 (1). https://doi.org/10.1038/ncomms12558

Vogt RC, Platt SG, Rainwater TR. 2009. *Rhinoclemmys areolata* (Duméril and Bibron 1851): Furrowed wood turtle, black-bellied turtle, mojena. *In* Rhodin AGJ, Pritchard PCH, van Dijk PP, Saumure RA, Buhlmann KA, Iverson JB, Mittermeier RA. (eds.), Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Foundation: Arlington, VT, USA. https://doi.org/10.3854/crm.5.022.areolata.v1.2009

Yvan L, Charette R, Leyva GFA. 1999. CITES identification guide – Turtles and tortoises. Guide to the identification of turtles and tortoises species controlled under the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Ottawa, Canada. 232 p.