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Monitoring of *Mesoclemmys dahli* (Zangerl and Medem 1958) in Sucre, Colombia

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Abstract : *Mesoclemmys dahli* is a critically endangered species that is endemic to the Colombian Caribbean coast, so the Tropical Biodiversity Research Group of the University of Sucre has maintained its monitoring for several years. Their abundance, habitat preferences and proportion of females with oviductal eggs were determined in 42 wells or "jagüeyes", in different localities of Sucre. 83 turtles of this species were captured for an absolute abundance of 7.5 ind/ha, lower than in previous years. It seems to prefer jagüeyes of relatively small area (up to 0.2 ha) and with abundant riparian vegetation in its perimeter. 70% of the females captured presented oviductal eggs. Evidence was obtained that some turtles can remain in the same locality for many years. Possible malformations were detected, but there is no evidence that these could be due to genetic drift. We propose that it would be opportune to create local protected areas in places inhabited by this species.
Key words : *Mesoclemmys dahli*, conservation, endemic, jagüeyes, endangered species.

Introduction

Mesoclemmys dahli (1), known throughout much of the Caribbean coast of Colombia ascarranchina, nape of palm and, side-necked turtle, among other names, is and endemicfreshwater turtle from this region. The speciesappears worldwide, as critically endangered (CR B1 + 2c) (2), due to its rarity, the deterioration of its habitat and its limited distribution.

In the last three decades, research has been undertaken to determine the size of their populations, aspects of their ecology, their distribution and main threats (3-13). Some authors (11,12) have emphasized the existing gaps and the need to take urgent protective measures for thisturtle. In the department of Sucre there are not many such studies about this species, since the work of Zangerl and Medem (1), who placed it for the first time as endemic to Sincelejo. Only a few subsequent publications relate to their habitat, abundance, use given by farmers and the threats affect their populations (3, 4, 11,13). The species does not display a high number of individuals per hectare.Its original habitat has been deteriorated by the advance of agriculture and livestock and it is commonly found in this region in artificial bodies of water, especially in the 'jagüeyes' or artificial ponds that farmers use for agricultural and domestic tasks (3, 9, 11, 13). It is also used for food and craftsmanship. For

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these reasons and because of its status as an endangered species (2, 14) for the Colombian territory, the present study intends to update the state of its populations in Sucre. Monitoring began in 2010 (11), in relation to its abundance, habitat, some reproductive variables of the species, as well as its threats.

Materials and Methods

Field work was carried out between September 2016 and January 2018 in municipalities belonging to the jurisdiction of the Corporación Autónoma Regional Sucre, where the first reported monitoring was carried out (11) and where there seems to be greater probabilities of occurrence of the species in Sucre (15). 42 jagüeyes of less than 7000 m^2 were sampled in different municipalities (Los Palmitos, Morroa, Palmito, Sampues, San Pedro, Sincé, Sincelejo and Toluviejo), all less than 200 m. a. s. l.Area (m^2) and perimeter (m),were determined for each pond, using an Etrex Venture HC (Garmin) navigator.Small areas (P) were considered those measuring between 800 and 1700 m^2; areas of medium size (M) between 1701 and 3500 m^2 and large areas (G) those with more than 3500 m^2.The perimeter sections of the jagüeys that were covered by vegetation (vascular plants) were measured in a linear fashion with a tape measure.Riparian vegetation was classified as abundant (A), if it covered between 70 and 100% of the perimeter of the pond; less abundant (M) if covering between 50 and 69% and scarce (P) if covering less than 50%.The ellipsoidal coordinates of the jagüeyes were taken with the same GPS system and transformed to Gauss Krugger flat coordinates, using the software Magna Sirgas pro 3.0 of the IGAC. Subsequently, the ArcGIS 9.3 (R) software, licensed to the University of Sucre, was used to prepare the corresponding maps.

The capture of individuals took place between 07:00 and 16:00. A 100 x 6 m trammel with a 5 cm eye was used for this purpose(13). In each case three sweeps were made, with a 3 hours intervals between them. The total length of the carapace (LC) and the length (LP) and plastron width (AP) were measured for each specimen, by means of an electronic digital caliper (Ubermann± 0.01 mm) and weight (g) was determined using an electronic scale Chinese notebook (WeiHeng ± 5 g).In addition, data about possible malformations and injuries of the individuals were taken. Specimen sex was determined by the difference in pre cloacal length and length of the front nails,both parameters being greater in males than in females (3).According to the same author, individuals with LC> 130 mm were considered adults. While the observations and measurements were made, the specimens were kept in a plastic box with water to reduce possible stress. Once the measurements were completed, the individuals were returned to their habitat.

Turtles of other species captured in the samplings were also identified and counted.

The nocturnal movements of seven carranchinas during the dry season were followed by using Bushnell 4 x 50 mm night vision binoculars with a camera and digital zoom. The individuals were detected in different observation nights and they were followed at a distance of approximately 30 m toassess the distance traveled. To obtain a better observation, three ponds were selected, which were surrounded by paddocks and relatively low vegetation.

In the farms visited, unstructured surveys were conducted through interactive dialogue (16) with 173 adults of both sexes, to determine if they knew about the carranchina turtle, its presence in the area, its abundance and if they are informed that it is a Threatened species.

The presence of oviductal eggs was assessed between September 2017 and January 2018, using a veterinary ultrasound scanner (portable digital ultrasound brand: WELLD, WED-3100V PLUS), and a convex micro probe. For this, individuals were captured using the same technique described above from 15 jagüeys in the municipalities of Sincelejo, Morroa, Sincé, Los Palmitos and Palmito. To perform and interpret the ultrasound recordings, we were directly adviced by zootechnist Camilo Ayud from the Company Embriones, Genética y Equipos SAS.

The normality of the data was determined by a Kolmogorov-Smirnov test and the homogeneity of variance by means of a Bartlet test (17). A Student's t test was used for the comparison of size and weight between males and females. A Spearman rank correlation was used to determine if there is an association between riparian vegetation coverage and the number of animals captured, as well as between the area of the jagüeys and the individuals captured. To determine if there is an association between the size of the females and the presence of eggs, a Simple Classification Contingency Table (X^2) was used, splitting the females into two size groups, from 130 to 170 mm and> 170 mm. The data were processed through the STATISTICA 13.0 program (free version on the internet).

Results

The geographical location area of the jagüeyes, number of specimens captured and percentage of riparian vegetation are shown in Table 1 and Fig. 1.

Table 1. Geographical location (flat coordinates MAGNA-SIRGAS) and area, of the jagüeyes, a number of individuals of *Mesoclemmys dahly* captured between September 2016 and May 2017 and riparian vegetation coverage (A: abundant, M: less abundant, P: scarce).

Municipality	N°	Coordinates Y	Coordinates X	Area (m^2)	Individualscaught	RV
Los palmitos	1	1529775,15	869723,424	6654,12	4	A
	2	1529292,74	872006,051	3073,2	1	P
	3	1529445,65	872323,33	1440	3	A
Morroa	4	1522676,99	860910,28	5022	3*	A
	5	1523901,04	861757,71	2352	6	A
	6	1513642,14	879789,049	2569,08	0	P
	7	1524261,66	863187,454	1692	3	A
Palmito	8	1523324,54	1169366,61	1663,8	2	P
	9	1523608,81	168368,668	1445,3	3	M
Sampués	10	1528578,74	850881,846	2916	0	P
	11	1515032,45	851611,503	2016	0	P
	12	1515069,88	851465,095	1744,84	0	P
San Pedro	13	1531892,28	891266,693	1517	5	A
	14	1531696,87	890932,623	1062	2**	M
	15	1532088,4	890588,012	2449,5	2	M
Sincé	16	1515368,97	881746,29	4055,2	4	M
	17	1515237,42	881246,459	1836	2	M
	18	1514936,95	860882,682	1400	5**	A
Sincelejo	19	1516927,63	857654,325	5232,3	0	P
	20	1517103,34	857505,374	4173,66	0	P
	21	1518881,76	856077,073	1170,4	2	P
	22	1518677,11	855740,513	1182,75	1	P
	23	1521232,67	856085,756	4453,8	1	P
	24	1516262,67	850472,201	6099	2*	M
	25	1515534,53	849699,124	3996,25	6	A
	26	1514839,14	849919,334	3537,2	3**	M
	27	1520627,14	852017,397	1444,5	5	M
Sincelejo, Cgto. Chochó	28	515541,12	859505,497	3399,15	0	P
	29	1515815,19	859347,727	5063	0	P
	30	1515891,47	859500,649	7134,6	0	M
Sincelejo, Cgto. La Arena	31	1529266,47	846425,488	1363	6	M
	32	1529622,31	846436,67	2477,6	1	P
	33	1529061,84	846800,079	1431	8	A
Toluviejo	34	1529406,92	851290,958	1924	0	M
	35	1529440,27	851410,113	3402	0	A
	36	1529056,77	852040,403	3008	0	M
	37	1529713,64	852247,401	2726	0	P
	38	1529451,8	850811,969	895	0	P
	39	1529429,9	850912,6 C	1598	0	P
	40	1529301,12	851632,373	1623,6	3	M
	41	1535310,04	850627,167	3348	0	P
	42	1540696,39	849002,109	3985,26	0	P

*Individuals with a label (Sampedro*et al*, 2012); **: individuals with possible malformations andInjuries.

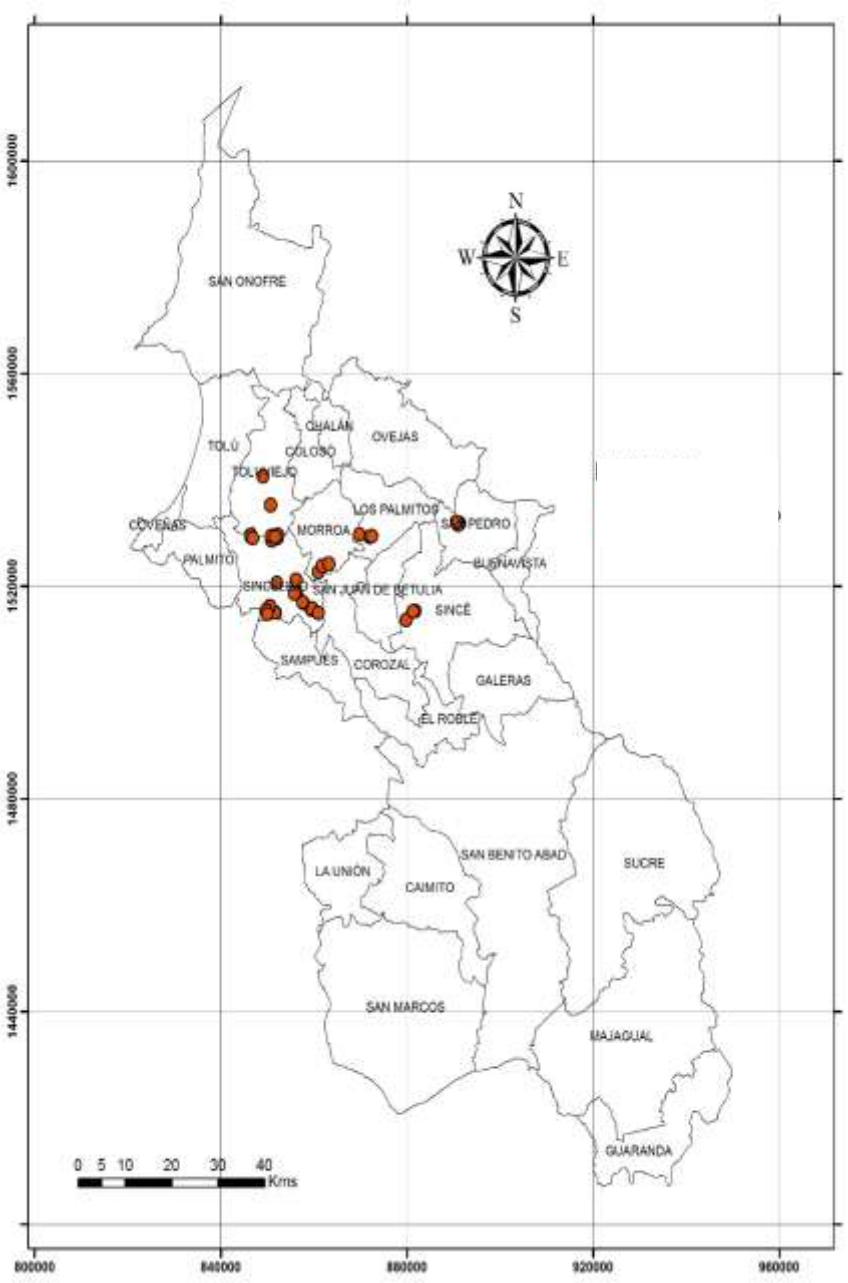

Fig. 1. Geographical location of the jagüeyes sampled in the present study

83 specimens were captured in 60% of the jagüeyes sampled, equivalent to 3.3 individuals per jagüey. Carranchinas did not appear in 17 of them. Absolute abundance is 7.5 ind./ha. The sex ratio was very close to 1:1 (39 males and 44 females). The greatest capture success rates were observed in the municipalities of Sincelejo (42.1%), Morroa (14.4%) and Sincé (13.2%) whilst the largest proportions of jagueyes where no turtles was located was in Toluviejo (47%) and Sincelejo (29%) (Fig. 2).

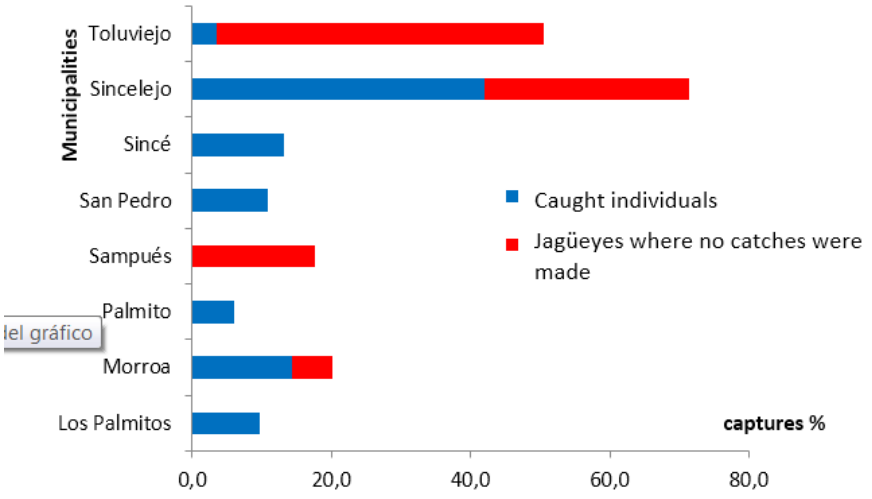

Fig. 2. Proportion of turtles captured by municipalities

A positive and highly significant correlations was observed between the levels of riparian vegetation and the number of individuals captured in the jagüeyes (rs = +0.69), suggesting that there is a greater number of individuals of this species when the wells have a higher proportion of vegetation on their shore.

A similar analysis, but in relation to the number of turtles present in jagüeyes of different area, showed a significant and negative correlation (rs = -0.73) between these parameters, because a significantly greater number of individuals appear in jagüeyes of smaller areas.

Between September 2016 and May 2017, two specimens that had been tagged in the first monitoring of the species 7 years before were captured (11). One is a male (May 6, 2010) captured in a jagüey that is about 1200 m from the site where it was previously captured in Sabanasdel Potrero, Sincelejo. The other marked individual is a female (October 24, 2010) that was captured about 500 m from the site where it was first found, in Las Flores, Morroa. Both jagüeyes were reported by the authors as "permanent" (11). One individual with an apparent malformation and two with severe burn injuries was also caught.

All specimens of *Mesoclemmys dahli* were adult. Females were significantly larger and heavier than males (Table 2).

Table 2. Comparison between adult males and females of *Mesoclemmys dahli* captured during the present work.

Variable	males			females			t
	n	X	S	n	X	S	(Student)
LP	39	137.2	15.1	44	163.6	25.46	3.51***
AP	39	117.5	17.1	44	139.3	21.4	3.65***
LC	39	162.5	18.1	44	220.8	29.35	3.70***
WEIGHT	39	510.6	57.5	44	876.9	63.5	3.81***

During the samplings, two species associated with *Mesoclemmys dahli* were also captured. These were *Trachemys callirostris* (104 individuals) and *Kinosternon scorpiodes* (75 individuals).

The majority of survey respondents (61%) said that they knew the carranchina and that it can be seen commonly in the jagüeyes and walking on its banks. They differentiate it perfectly from the ‘‘‘white turtle’’’ (*Trachemys callirostris*), and the ‘‘‘tapaculo’’’ (*Kinosternon scorpiodes*). The peasants use it for their consumption eventually (35%), because “they smell bad and prefer the meat of the white turtle” (75%). When detected, carranchina turtle arekilled because they are considered a harmful species that eats fish from the pond (45%). Only three people (2%), said they know that it is an endangered species.

Between September 2017 and January 2018, 56 specimens of carranchina were captured, of which 35 were females and 21 males. Table 3 shows the individuals captured in the 15 selected ponds.

Table 3. Individuals caught between September and December 2017 in 10 ponds selected for their high frequency of *Mesoclemmys dahli*.

Municipality	N°	Coordinates Y	Coordinates X	Area (m^2)	Individuals caught
Morroa	4	1522676,99	860910,28	5022	5
	5	1523901,04	861757,71	2352	3
	7	1524261,66	863187,454	1692	5
Sincé	16	1515368,97	881746,29	4055,2	7
	17	1515237,42	881246,459	1836	2
	18	1514936,95	860882,682	1400	4
Sincelejo	24	1516262,67	850472,201	6099	7
	25	1515534,53	849699,124	3996,25	5*
	26	1514839,14	849919,334	3537,2	3
	27	1520627,14	852017,397	1444,5	5
Los palmitos	1	1529775,15	869723,424	6654,12	3
	2	1529292,74	872006,051	3073,2	1
	3	1529445,65	872323,33	1440	2
Palmito	8	1523324,54	1169366,61	1663,8	2
	9	1523608,81	168368,668	1445,3	2

*Individual with label(Sampedro*et al*, 2012)

One of these individuals was labelled and corresponds to a juvenile female captured for the first time 6 years previously(March 27, 2011) in the same well in the village of Las Flores.

The 35 females captured were all adults, 23 with oviductal eggs (65%). Larger females presented oviductal eggs more frequently ($X2 = 5.3$, $p < 0.05$, 1 gl).

It was not possible to determine the number of oviductal eggs in each female because they overlap in the images. Table 4 shows the statistics of 21 eggs observed using the digital ultrasound system. Standard deviation was very small for both diameters.

Table 4. Statistics of 21 eggs observed by ultrasound scan in 12 turtles collected in jagueyes from the department of Sucre.

Parameter	n	Average value(mm)	S	CV
Largerdiameter	21	32.72	0.41	1.25
Minordiameter	21	27.83	0.28	1.01

One of the females captured in December expelled eight eggs in the plastic box where it was placed to be measured at a later stage, before the ultrasound was performed. The measurements of such eggs, are part of the 21 whose measurements were shown previously. An ultrasound scan was performed on this specimen and the rest of the females and it was detected that some of them had ovules with different degrees of development, some of them very evident and others not so much.

The seven individuals followed during nocturnal monitoring were adult females. The distance traveled by three of these turtles was determined to be 850 m, 974 m and 1350m, before they were lost from sight in the vegetation. Two others traveled less than 130 m and returned to the pond. The remaining individuals walked for 550 m to get to a nearby well. During the day, it was often possible to find individuals prowling in the surroundings of their respective ponds.

Discussion

The abundance of *Mesoclemmys dahlia* appears to have remained low over the last few years. In comparison to the value of 13.6 turtles/ha reported by Sampedro *et al*. just seven years ago(11), across several municipalities of the jurisdiction of CARSUCRE, or an abundance of 8 turtles/ha registered in SanOnofre and Tolú,two years later(13), the present work indicates an abundance of 7.5 ind/ha in several municipalities of Sucre.

In other departments similar results have been produced, such as in the department of Cesar (18) where 10 turtles/ha were observed in Córdoba, however, higher densities have been found (20-60 turtles/ha). It is possible that this is related to the hydrographic characteristics of each region, considering that it is an eminently aquatic species. In the municipalities of the jurisdiction of CARSUCRE only 22 streams and about 2540 bodies of water occur. The latter includes jagüeyes, dams and lakes (19).Considering the place occupied by the species on the trophic scale, these low values do not seem strange (20). In any case, the effective size of the population is very low, as it has been found for other locations in the Colombian Caribbean, including Sucre (21).

The number of municipalities sampled was higher than in 2010 (11) and also the number of jagüeyes; however, the proportion of jagüeyes in which caranchina specimens appeared in this work(approximately 59%) is similar to the proportion observed in the first investigation, although the number of jagüeyes sampled and the area they occupy is almost double. In both investigations the average number of *Mesoclemmys dahli* per jagüey is approximately 2 individuals. In the municipalities of Tolú and San Onofre (13) the figure found was 6 individuals of this species per jaguey. In this case the ponds were not randomly sampled but selected from among a larger group of jagüeyes, attending to certain requirements such as having an area greater than 1000 m^2 and not communicating with anther pond.

Several authors have suggested that there is a tendency for turtles to be more frequent in ponds with vegetation on their banks (11, 18, 22). The results obtained here show that there is a marked preference for jagüeyes with medium to abundant shore vegetation which perhaps enables them to hide better during summer and provides a perfect place nesting (22). The problem in the region lies in the fact that a large number of jagüeyes are not perennial or have no vegetation on their banks. On the other hand, it was also shown here that the size of the jagüeyes is important for the turtles, since they are more frequent in ponds that are not excessively large. It is possible that the lack of coincidence of these two factors (jagüey size and enhanced shore vegetation), explains that in 40% of the jagüeyes sampled turtles were not captured.

The reproductive potential of marine fish (23) was calculated from some reproductive variables, such as the relative partial frequency (eggs released in a laying session), the frequency of laying, the size at sexual maturity and the proportion of sexes. In the present work a new variable was included for the case of carranchina, which is the proportion of females in the sample that presents oviductal eggs. The results indicate that *M. dahli* has a good reproductive potential since one female had 8 oviductal eggs and other authors have indicated a maximun of 6 (3), or 12 (24). Some females had ovules with a different degree of development, which suggests more than one oviposition in the year, as other authors have also suggested (3, 24). The sex ratio remains close to 1:1. The slight unfavorable difference to the males could be due to the fact that aestivate longer in summer than the females, which have greater activity because they carry out the laying during that season (25). Another result confirming the reproductive potential of *M. dahli* is the high proportion of females with oviductal eggs found in the samplings, although, as stated before, the effective size of the population is very small.

In Sucre the nocturnal displacement of the carranchina has not been corroborated nor have the data on its home range, but finding two turtles marked in jagüeyes relatively close to the places where they were marked 7 years ago (11) seems to indicate that individuals find what is necessary for their survival in these places or that they have not been able to abandon them. There is a possibility that turtles, both juveniles and adults, will be washed away by currents during the rainy season to other locations (22), but the results show that some of them remain in those places. This fact raises the question of whether the genetic variability of the species would be affected, since the genetic flow between populations would decrease. Evidence of moderate to high genetic diversity has been found in populations of Sucre, Atlántico and Cesar (21). The researchers defined 4 subpopulations of the species, however, suggest that the effective population sizes are very small and have no genetic flow between them, which has led to the high degree of inbreeding in these subpopulations. One result

from this work supporting this hypothesis is that two turtles presented possible malformations in the carapace, which had already been reported before for turtles of *M. dahli* in the region (11). From these elements it would be important to study the possibility of implementing the artificial gene flow between these subpopulations.

In the different localities sampled the threats detected several years ago are still maintained (11), since, according to the majority of the peasants consulted, the turtles are used for consumption and handicrafts, although they report that carranchina is the least used, as has also been raised by other researchers(13). These authors also mention that many turtles die or are physically affected as a result of the burning of vegetationin order to plant different crops, something that could be evidenced in several turtlespecimens. Another significant aspect is that mostof the respondents were not aware that this species is in critical danger.

Considering the importance of jagüeyes for the conservation of biological diversity in Sucre (26) and in particular for *Mesoclemmys dahli* (11), as demonstrated in this investigation, it seems obligatory to resort to basic measures to conserve and improve this important ecosystem, as suggested by Forero-Medina et al. (12) when raising the need to establish regional or local protected areas to safeguard this species.

Conclusions

Mesoclemmys dahli has managed to survive the extensive drought periods of the Colombian Caribbean, lives in a fragmented habitat with a strong anthropic impact, relatively small and not always perennial bodies of water. It seems to have good potential to reproduce, however it maintains avery low effective population with little exchange with other neighbors. The species already shows signs of the effects of genetic drift, which could represent a serious threat to its survival in the future.

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References

1. Zangerl, R. and F. Medem.A new species of chelid turtle, *Phrynops* (Batrachemys) *dahli*, from Colombia. Bulletin Museum of Comparative Zoology,1958,119: 373-390.
2. Turtle Taxonomy Working Group (van Dijk, P. P., Iverson, J. B., Rhodin, A. G. J., Shaffer, H. B. andBour, R.). Turtles of the World, 7th edition: annotated checklist of taxonomy, synonymy, distribution with maps, and conservation status. In: Rhodin, A. G. J., Pritchard, P. C. H., van Dijk, P. P., Saunmere, R. A. Buhlmann, K. A., Iverson, J. B. and Mittermeier, R. A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Proyect of the IUCN/SSC Tortoise and Freshwater Turtle specialist Group. ChelonianResearchMonographs,20145 (7): 000329-479, doi: 103854/crm.5.000.checklist.v.7.2014.
3. Medem, F. Contribuciones al conocimiento sobre la ecología y distribución geográfica de *Phrynops* (Mesoclemmys) *dahli*; (Testudinata, Pleurodira, Chelidae). Caldasia, 1966, 9 (3): 467-482.
4. De la Ossa-Velásquez, J. and A. Fajardo. Introducción al conocimiento de algunas especies de fauna silvestre del Departamento de Sucre-Colombia. Sincelejo: Carsucre - Fundación George Dahl, 1998, 1-15.
5. Ceballos–Fonseca, C. P. Tortugas (Testudinata) Marinas y Continentales de Colombia. Biota Colombiana,2000, 1(002), 187-194.
6. Gallego, N., Rueda, J., López, C. and Negrete, A. Diagnóstico y acciones de conservación de especies acuáticas amenazadas en la eco-región del bajo Sinú. Corporación autónoma de los valles del Sinú y San Jorge-CVS, 2004.
7. Castaño, O., Cárdenas, G., Gallego, N. and Rivera, O. Protección y conservación de los quelonios continentales en el departamento de Córdoba. Corporación autónoma de los valles del Sinú y San Jorge-CVS, 2005.
8. Dueñas, P., Quiroz, J. and Linares, J. Movimiento y uso del espacio de la tortuga carranchina (*Batrachemys dahli*) en la Vereda Ceiba Pareja, del Municipio de Santa Cruz de Lorica, Departamento de Córdoba Colombia. Tesis de grado, 2005.

9. Rueda-Almonacid, J.V., J.L. Carr, R.A. Mittermeier, J.V. Rodríguez-Mahecha, R.B. Mast; R.C. Vogt, A.G.J. Rhodin, J. De La Ossa-Velásquez, J.N. Rueda and C.G. Mittermeier. Las tortugas y cocodrilos de los países andinos del trópico. Serie de guías tropicales de campo N°6. Conservación Internacional. Editorial Panamericana, Formas e Impresos. Bogotá, Colombia,2007, 53 pp.
10. Forero-Medina, G. and Cárdenas, G. Movement patterns and toad-headed Turtle *Mesoclemmysdahli* in Cesar, Colombia,2009, 28 pp.
11. Sampedro-Marín, A., P. Tobíos-Atencioand T. Trespalacio-Solana. Estado de conservación de la tortuga "carranchina" (*Batrachemys dali*) en localidades del departamento de sucre, Colombia. Revista Colombiana de Ciencia Animal,2012, 4 (1): 69-88.
12. Forero–Medina, G., Castaño–Mora, O. V, Cárdenas–Arévalo, G, Medina–Rangel GF. *Mesoclemmys dahli* (Zangerl and Medem 1958). Dahl's toad-headed turtle. Carranchina, Tortuga Montañera. Chelon Res Monogr., 2013, 5:069.1-069.8. DOI:10.3854/crm.5.069.dahli.v1.
13. Ardila-Marulanda, M., J. De La Ossa V. and A. De Laossa-Lacayo. Uso de quelonios continentales en el Golfo de Morrosquillo, Sucre, Colombia. Rev. Colombiana Cienc. Anim. 2014, 6; 8 (Supl):361-367.
14. MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE. Listado de especies silvestres amenazadas de la diversidad biológica colombiana. Resolución 0192, 2014, 36 pps.
15. Forero-Medina et al 2012. Forero-Medina G., G. Cárdenas Arévalo, O. V. Castaño-Mora. 2012. Habitat Modeling of Dahl's Toad-Headed Turtle (*Mesoclemmys dahli*) in Colombia. Herpetological Conservation and Biologgy, 7(2):313-332.
16. De La Ossa, J., G. Cárdenas-Arévalo and V. Páez. Métodos de campo para estudios demográficos. Capítulo 13. Pp. 171-178. *En*: Páez, V. P., M. A. Morales- Betancourt, C. A. Lasso, O. V. Castaño-Mora y B. C. Bock (Editores). 2012. V. Biología y conservación de las tortugas continentales de Colombia. Serie Editorial Recursos Hidrobiológicos y Pesqueros Continentales de Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH). Bogotá, D. C., Colombia. Anabel Rial Bouzas (Fundación La Salle de Ciencias Naturales, Venezuela), AnielloBarbarino (Instituto Nacional de Investigaciones Agropecuarias-INIA, Venezuela).
17. Zar, J. H. BiostatisticalAnalysis. Prentice Hall, 2010, ISBN: 0131008463, 9780131008465, 944 páginas
18. Forero-Medina, G., G. Cárdenas-Arévalo and O. V. Castaño-Mora. Abundance, home range and movement patterns of the endemic species Dahl's toad-headed turtle (*Mesoclemmys dahli)* in Cesar, Colombia. ChelonianConservation and Biology, 2011, 10 (2): 228-236.
19. Corporación Autónoma Regional Sucre (CARSUCRE). Plan de Acción Institucional, 2016-2019, 2016.
20. PrimacK, R. B. 2002. Essentials of Conservation Biology (3a ed.). SinauerAssoc., Inc., Sunderland, USA.
21. Gallego‐García, N., M. Vargas‐Ramírez, G. Forero‐Medina and S. Caballero. Genetic evidence of fragmented populations and inbreeding in the Colombian endemic Dahl's toad-headed turtle (*Mesoclemmys dahli*). Conserv. Genet., 2017, https://doi.org/10.1007/s10592-017-1021-z
22. Rueda-Almonacid, J. V., P. A. Galvis, C. López and G. Y. Lozano. Estudio sobre la distribución geográfica y el estatus ecológico de la tortuga carranchina (*Batrachemys dali*) en el bajo Sinú, Departamento de Córdoba. Diagnóstico y acciones de conservación de especies acuáticas amenazadas en la ecoregión del bajo Sinú. Conservación Internacional Colombia-Corporación Autónoma Regional de los Valles del Sinú y San Jorge. Informeinterno, 2004, 53 pp.
23. Trippel E.A. Estimation of stock reproductive potencial. History and challenges for Canadian Atlantic gadoid stock assessments. J. Northw. Atl. FishSci. 1999, 25: 61-81.
24. Gallego, N., Rueda, J., López, C. and Negrete, A. Diagnóstico y acciones de conservación de especies acuáticas amenazadas en la eco-región del bajo Sinú. Conservación Internacional, Corporación Autónoma Regional de los Valles del Sinú y del San Jorge (CVS),2004.
25. Lozano, G. Formulación e implementación de una estrategia para la conservación de la biota Cordobesa. Informe Final, Conservación Internacional, CVS Córdoba, 2006.
26. Botero, A. L., J. V. De La Ossa, A. Espitia and A. De La Ossa-Lacayo. Importancia de los jagüeyes en las sabanas del caribe colombiano. Rev. Colombiana cienc. Anim. 2009, 1(1): 71-84.

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