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Preliminary assessment of movements and habitat use of the Tabasco Mud Turtle, *Kinosternon acutum* Gray, 1831, in a tropical rainforest in Belize

Collin McAvinchey[1], Eric Munscher[1,2,*], Brian P. Butterfield[3], Tabitha Hootman[1], Barney Hall[4], Rebecca A. Cozad[5], Thomas Pop[4], Joseph J. Pignatelli III[6], Heather Barrett[4], Jacob Marlin[4], Zachary A. Siders[7], and Andrew D. Walde[1]

Abstract. Understanding the movement ecology and habitat use of the Tabasco Mud Turtle (*Kinosternon acutum*) is essential for conservation planning, particularly in dynamic rainforest ecosystems of the Yucatan Peninsula. Despite its broad distribution across Central America, the spatial behaviour of *K. acutum* remains poorly studied. This study examines movement patterns, microhabitat preferences, and the influence of precipitation on *K. acutum* movement in a tropical rainforest setting within the Belize Foundation for Research and Environmental Education reserve. Six adult individuals (two males, four females) were tracked using radio telemetry over a 17-day period, with relocations recorded daily. Results indicate that males exhibited greater movement distances than females, with maximum straight-line movements of 205 m and 103 m, respectively. Microhabitat analysis revealed a strong preference for leaf litter, tree bases, and Cohune Palm (*Attalea cohune*) associations, while use of ephemeral water habitats were lower than expected. Movement was not consistently correlated with rainfall, suggesting that *K. acutum* does not uniformly adjust its movement patterns in response to precipitation events. These findings highlight the species' reliance on specific microhabitats and limited movements, emphasising its vulnerability to habitat fragmentation and environmental change. Conservation efforts should prioritise the protection of terrestrial and aquatic habitat connectivity, particularly in areas with abundant leaf litter and cohune palm.

Keywords. Movement ecology, radio telemetry, Belize, tropical rainforest, freshwater turtles

Introduction

Movement ecology and habitat usage are essential components of understanding the natural history and conservation needs of freshwater turtles. Movement patterns are driven by behaviours such as foraging, mating, and nesting, and vary seasonally in response to environmental factors (Averill-Murray and Riedle, 2004; Riberio et al., 2024). The spatial area used by an individual turtle for routine activities provides critical insights into habitat requirements, how different species have adapted to different environments, and informs the spatial scale at which conservation strategies must be applied (Gibbons et al., 2000; Otten et al., 2021; Lassiter et al. 2023). In semi-aquatic turtles, movement patterns and habitat usage are influenced by factors such as habitat fragmentation, resource distribution, and fluctuating environmental conditions (Pérez-Pérez et al., 2017; Lassiter et al., 2023; Oxenrider and Brown, 2024).

In tropical regions, the distribution and abundance of water across the landscape is a key environmental condition that many tropical turtles are dependent on and responsive to (Legler and Vogt, 2013; Muell et al., 2021). Studies on the behavioural ecology of freshwater turtles in Central America are limited, and most research has focused on larger or more conspicuous species, often overlooking smaller, more cryptic taxa,

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[1] Turtle Survival Alliance, 1030 Jenkins Road, Suite D, Charleston, South Carolina 29407, USA.
[2] SWCA Environmental Consultants, 20 East Thomas Road, Suite 1700, Phoenix, Arizona 85012, USA.
[3] Freed-Hardeman University, 158 East Main Street, Henderson, Tennessee 38340, USA.
[4] Belize Foundation for Research and Environmental Education, PO Box 129, Punta Gorda, Belize.
[5] Nokuse Plantation, 13292 County Highway 3280, Bruce, Florida 32455, USA.
[6] Puget Sound Energy, 6500 Ursula Place South, Seattle, Washington 98108, USA.
[7] Fisheries and Aquatic Sciences Program, School of Forest, Fisheries and Geomatic Sciences,
University of Florida, Gainesville, Florida 32653, USA.
[*] Corresponding author. E-mail: emunscher@swca.com

such as the Tabasco Mud Turtle, *Kinosternon acutum* Gray, 1831 (Pritchard, 1979; Pérez-Pérez et al., 2017). This knowledge gap is particularly significant in the dynamic and seasonally variable ecosystems of Belize's tropical rainforests, where the natural history of cryptic, yet widely distributed taxa have not been thoroughly investigated (Munscher et al., 2023; Skibsted et al., 2023). The Tabasco Mud Turtle is one such small, cryptic semi-aquatic turtle species widely distributed in coastal lowland regions from southern Mexico through Guatemala and into Belize (Iverson, 1986; Legler and Vogt, 2013; Munscher et al., 2023). The species inhabits slow-moving water bodies characteristic of this region, such as swamps, marshes, and forested ponds (Ernst and Barbour, 1989; Lee, 1996), as well as puddles in the jungle after rainfall (Skibsted et al., 2023).

Understanding the movement ecology of *K. acutum* is essential for informing effective conservation strategies, as, like many turtles across Central America, the species has been approved to be listed as vulnerable by the IUCN (Munscher et al., in press). Determining how far individuals travel between aquatic and terrestrial habitats and how these movements are affected by seasonal changes can help identify critical areas for protection (Ernst and Lovich, 2009; Pérez-Pérez et al., 2017). Moreover, movement and habitat use data can reveal how habitat alterations, such as deforestation and water pollution, impact the spatial ecology of this species, which is already vulnerable to environmental changes (Todd et al., 2010). Given that freshwater turtles are often slow to mature and have low reproductive rates, the effects of habitat loss on their movement patterns and habitat usage could have significant long-term impacts on population viability (Lovich et al., 2018).

In the context of Belize, tropical rainforests are experiencing rapid environmental changes due to deforestation, agricultural expansion, and climate change, all of which have profound impacts on local biodiversity (Cherrington et al., 2010). As *K. acutum* relies on ephemeral pools within these forests, environmental changes may alter its behaviour, reproduction, movement, and survival. However, few studies have examined how such environmental shifts impact the behaviour and movement of freshwater turtles in this region (Dudgeon et al., 2006; Legler and Vogt, 2013; Pérez-Pérez et al., 2017). In this study, we examine how rainfall and water levels influence movement patterns and habitat use by *K. acutum* in a Belizean tropical rainforest. By exploring the movement and behavioural ecology of *K. acutum* in Belize, this study aims to fill critical knowledge gaps, contributing to both species conservation and a broader ecological understanding of Central American freshwater ecotones.

Materials and Methods

Study Area. The field research portion of this study was undertaken from 30 June to 22 July 2022, on the grounds of the wildlife preserve at the Belize Foundation for Research and Environmental Education (BFREE). BFREE is a 1153-acre privately held nature preserve bordering the Maya Mountains rainforest complex in the Toledo district of Belize (Fig. 1). The preserve is dominated by native tropical broadleaf forest and interspersed with ephemeral wetlands and incursions by the nearby Bladen River. The majority of *K. acutum* captures were made along an ATV and foot track that follows the boundaries of the preserve (see Munscher et al., 2023 for further details).

Capture and Tagging. Six individual *K. acutum* (two males and four females) were captured opportunistically during surveys along the northern and eastern boundaries of BFREE between 4–20 July 2022. All captures occurred during daylight hours in standing ephemeral pools, usually during or immediately following a rainfall event. Iverson and Vogt (2011) claim *K. acutum* is primarily nocturnal, but extensive night-time capture efforts were not undertaken during this study. All *K. acutum* individuals were hand-captured and placed

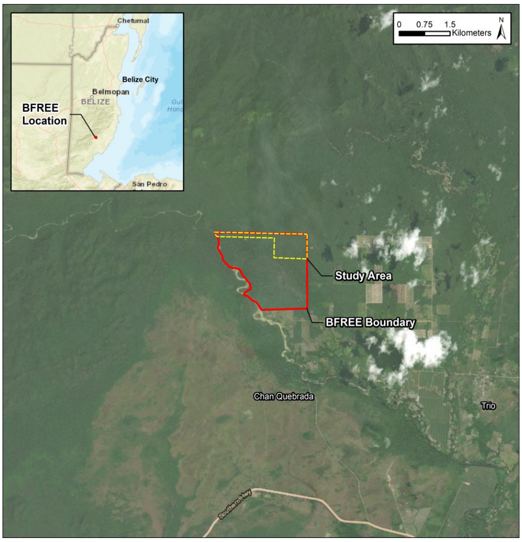

Figure 1. Study site location map, Belize Foundation for Research and Environmental Education.

Figure 2. Adult *K. acutum* found in the BFREE region within a shallow ephemeral pool after release with transmitter attached (A), mud obscuring white colour of adhesive epoxy on adult *K. acutum* (B), typical aquatic habitat, shallow, ephemeral, with vegetation (C), and microhabitat where *K. acutum* can hide (D). Photos by Collin McAvinchey and Jay Ballard.

individually in breathable mesh bags for transport. The location of each capture was noted using a Garmin GPS Map 64s unit. Flagging was affixed to each mesh capture bag and labelled appropriately to ensure each animal was returned to its original capture point. We recorded morphometric data (by millimetre), including carapace length, carapace width, shell height, plastron width, plastron length, and mass (in grams) (Lewis and Iverson, 2018). Numerical shell marking identification numbers were notched into the marginal scutes (adapted from Cagle [1939]). An 8.5 mm Passive Integrated Transponder (PIT) tag (Biomark, Inc., Boise, Idaho) was implanted if the animal was large enough (carapace length greater than 70 mm), as outlined in Munscher et al. (2020).

Holohil PD-2 transmitter units weighing 3.8 grams were attached to each captured turtle. A combined mass of the transmitter unit and epoxy of no more than 8% of the total body mass of the turtle was considered ideal (Hootman et al., 2025). Transmitters could only be affixed to individuals weighing more than approximately 90 grams due to the combined weight of the transmitter and epoxy. Each animal was placed on its side after transmitter affixation to ensure that their righting response remained available despite the added weight of the transmitter. Animals were released at their original capture location.

Relocation Data. Radio telemetry observations began the day following each animal's release. We walked to the last known location before beginning to radio track the animal, and each animal was located to within 1 m. A flashlight was used for visual verification of each animal if they were present on the surface or visible in the substrate, but substrate was not disturbed if animals were not visible. We recorded the date, time, turtle ID number, GPS location, and notes about microhabitat use for each animal radio tracked. Relocations were collected daily between 4–20 July 2022, except for July 5 and 18, when staffing or storms prevented data collection. Distances between relocations were rounded to the nearest meter based on the resolution of the GPS locations.

Weather Data. We recorded ambient weather data, including precipitation, temperature, relative humidity, atmospheric pressure, and wind speed and direction, using two HOBO (Onset Computer Corp., Bourne, Massachusetts) units present within the wildlife reserve near the study area. A reading was collected every 5 minutes over the duration of the study period. Two variants of precipitation were calculated to be measured against turtle straight-line movement: rain coincident, which was a sum of measured rainfall in between observations from one day to the next; and accumulated rain, which was a measure of the total amount of precipitation that had fallen since the start of the study period on 4 July.

Data Analysis Methods.

Microhabitat Usage.—Microhabitat classes were designated to capture the full extent of utilised structure variation and are defined as follows:

- Woody Debris–animal was observed in and/or under small woody debris like sticks and logs.
- Water–animal was observed at least partially submerged in a body of water like a stream or puddle.
- At Tree Base–animal was observed at the base of a tree.
- Leaf Litter–animal was observed in and/or under fallen leaf litter.
- Cohune Associated–animal was observed in association with a cohune palm.

As our microhabitat classes were not mutually exclusive (Table 1), we first tabulated the instances of all possible combinations of a turtle occurring in one or more microhabitats upon relocation. This resulted in 31 possible categories, which we visualised using the VennDiagram package in *R* (Chen, 2022). We then calculated the observed proportion of relocations in each category by dividing the number of instances by the number of relocations. We calculated the expected proportion as an equal chance of each microhabitat class and the chance of occurring in one of the 31 categories as a product of those equal chances. For example, a *K. acutum* occurring in woody debris and in associated with cohune palm would have a 1 in 5 chance of occurring in either microhabitat or a 1 in 25 chance of occurring in both. We then divided the probability of each category by the sum of the probabilities across all 31 categories. Next, we calculated the multinomial likelihood ratio statistic to test whether our observed instances (X_i) across the 31 categories (k) were significantly different than the expected proportions ($\tilde{p}_i$) given our number of relocations (n) and assuming a likelihood ratio of χ^2 distributed with $k-1$ degrees of freedom (Equation 1).

$$-2\log\left(\prod_{i=1}^{k}\left(\frac{n\tilde{p}_i}{X_i}\right)^{X_i}\right)\sim\chi^2_{k-1}$$

(Equation 1)

Table 1. Frequency of each individual *Kinosternon acutum* in the 17 observed microhabitats out of the 31 possible microhabitat combinations. Possible microhabitat classes were leaf litter (LL), woody debris (WD), at tree base (TB), cohune fronds (CF), or in water (WT).

Microhabitats	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6
LL	4	4	0	4	1	1
LL, WD	2	0	2	1	1	4
LL, WD, TB	0	1	0	1	1	1
LL, WD, TB, CF	0	0	0	0	0	1
LL, WD, WT	1	0	0	0	0	0
LL, TB	2	1	2	1	2	2
LL, TB, CF	0	1	0	1	1	0
LL, CF	1	2	3	0	0	0
LL, WT	1	0	0	0	0	0
WD	0	0	1	2	0	0
WD, TB	0	0	0	0	0	1
WD, TB, CF	0	0	0	0	0	2
WD, CF	0	1	1	1	1	0
WD, WT	1	0	0	0	0	0
TB	2	1	6	0	3	1
TB, CF	0	2	0	3	5	2
WT	1	1	0	1	0	0

We tested whether the observed proportion ($\hat{p}_i$) in each category was significantly different than the expected proportion by calculating the binomial likelihood ratio for each category and assuming a test statistic of χ^2 distributed with 1 degree of freedom (Equation 2).

$$2\left(X_i\log\left(\frac{\hat{p}_i}{\tilde{p}_i}\right)+(n-X_i)\log\left(\frac{1-\hat{p}_i}{1-\tilde{p}_i}\right)\right)\sim\chi^2_1$$

(Equation 2)

We corrected the *p*-values using the Holm method given the multiple testing across the 31 categories.

Movement.— The weighted mean movement between near-daily observations, the maximum straight-line movement observed between individual consecutive observations (displacement), and the maximum straight-line distance across all relocations of individual turtles were calculated separately for males and females. We used a lognormal regression to check whether the movement distance was a function of tracking days to assess whether the tagging process caused individuals to significantly displace more or less using glmmTMB (Brooks et al., 2017).

Rainfall influence on movement.—We fit lognormal regressions to the displacement in meters and the displacement rate in meters per day between relocations of each individual (Equation 3).

$$D_i \sim \text{logNormal}(\mu_i, \sigma_i)$$

(Equation 3)

Where D_i is the measured displacement or displacement rate, μ_i is the expected value, and σ_i is the variability. We did not have an *a priori* expectation regarding the influence of repeated sampling of individuals or how rainfall would affect the expected value, μ, or the variability, σ, of displacement and displacement rate. As such, we trialed several model formulations and used leave-one-out model selection (Vehtari et al., 2020) to identify the top model (Table 2). We chose the model with the lowest leave-one-out information criterion to present. We fit the lognormal regressions using the Bayesian Regression Modelling in STAN (brms) package (Bürkner, 2017) in R (R Core Team, 2024). We ran each model over four chains with 3,000 samples in the warmup block and 1,000 posterior samples from each chain, with a max tree depth of 15 and an adapt delta of 0.95. We ensured the $\hat{R} > 1.1$, Gelman-Rubin statistic (Gelman and Rubin, 1992), and estimated the R^2 value of each model. From the top models, we predicted the displacement or displacement rate across the range of observed rainfall accumulation. We then calculated the median and 90% credible interval of this posterior (Table 2).

Results

We relocated each individual 15 times over the 17 days, with no relocations on 2 and 18 July 2022. We found that the observed proportion of relocations in the 31 categories (Fig. 3) derived from the combinations of the five microhabitat classes was significantly different than the expected proportions given a multinomial probability distribution ($\chi^2 = 135.7$, df = 30, $p < 0.001$). Six of the 31 categories had significantly different observed than expected proportions given a binomial likelihood ratio test (Fig. 3). The observed proportion was lower than the expected proportion for two of these categories: relocations in only woody debris ($p = 0.016$) and relocations in only water ($p = 0.016$) (Fig. 3). Higher proportions than expected were observed for the

Table 2. The six model formulations of the expected value, μ, and variability, σ, trialed for modeling displacement and displacement rate of *K. acutum* captured during turtle surveys within the BFREE ecoregion. For each model formulation, β_0 indicates intercepts, β_1 indicates slopes, and $\varepsilon_{0,i}$ indicates random intercepts, and $\varepsilon_{1,i}$ indicates random slopes. Random intercepts and slopes were assumed to be normally distributed with a standard deviation of σ_{ε_X}. For each model, the leave-one-out information criterion (LOOIC) is provided for displacement (D) and displacement rate (DR) model comparisons. The lowest LOOIC is bolded, and the corresponding model was chosen as the top model and presented.

Model	Formulation	LOOIC-D	LOOIC-DR
Full model	$\mu_i = \beta_{0,\mu} + \varepsilon_{0.i} + \beta_{1,\mu}X_{\text{rainfall}} + \varepsilon_{1,i}$ $\sigma_i = \beta_{0,\sigma} + \beta_{1,\sigma}X_{\text{rainfall}}$ $\varepsilon_i \sim \text{Normal}(0, \sigma_\varepsilon)$	575.1	557.1
Random intercepts	$\mu_i = \beta_{0,\mu} + \varepsilon_{0,i} + \beta_{1,\mu}X_{\text{rainfall}}$ $\sigma_i = \beta_{0,\sigma} + \beta_{1,\sigma}X_{\text{rainfall}}$ $\varepsilon_i \sim \text{Normal}(0, \sigma_\varepsilon)$	575.0	558.7
Random effects, shared sigma	$\mu_i = \beta_{0,\mu} + \varepsilon_{0.i} + \beta_{1,\mu}X_{\text{rainfall}} + \varepsilon_{1,i}$ σ	572.9	**554.8**
No random effects	$\mu_i = \beta_{0,\mu} + \beta_{1,\mu}X_{\text{rainfall}}$ $\sigma_i = \beta_{0,\sigma} + \beta_{1,\sigma}X_{\text{rainfall}}$	582.3	564.5
Shared sigma	$\mu_i = \beta_{0,\mu} + \varepsilon_i + \beta_{1,\mu}X_{\text{rainfall}}$ σ	**572.4**	556.5
Base model	$\mu_i = \beta_{0,\mu} + \beta_{1,\mu}X_{\text{rainfall}}$ σ	581.0	564.3

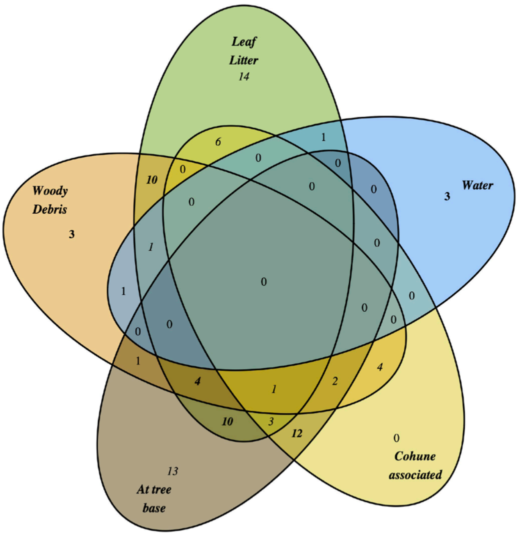

Figure 3. Venn diagram of the five microhabitat classes where *K. acutum* were captured within the BFREE region, with the number of relocations occurring in one or more of the non-mutually exclusive classes. Bold numbers indicated significant departure from expected proportions in a given category using a binomial likelihood ratio test. Italic numbers indicated greater observed proportions than expected.

remaining four categories: leaf litter and woody debris ($p = 0.003$), leaf litter and at tree base ($p = 0.003$), at tree base and cohune associated ($p < 0.001$), leaf litter with woody debris, and at tree base ($p = 0.018$) (Fig. 3).

Movement. The weighted mean movement between near-daily observations was 34 m for male turtles, and 22.1 m for female turtles (Table 3). The maximum straight-line movement observed between individual consecutive observations was 205 m for males and 103 m for females (Fig. 4). The maximum straight-line distance across all relocations of individual turtles (Table 3) across the entire study period was 275 m for males, and 196 m for females. The distribution of all individual observations is depicted in (Fig. 4). We did not find any significant effects of time since tagging on the observed displacement values (slope = -0.013 [-0.044 – 0.018], mean and 95% confidence interval).

Rainfall influence on movement. A total of 78 observations of paired movements and rainfall data were available to model the displacement and displacement rate. There was a weak positive correlation between displacement and rainfall accumulation ($R = 0.137$) and a very weak negative correlation with displacement ($R = -0.035$). The top model for displacement had random intercepts, shared slope and shared σ while the top model for displacement rate had random intercepts and slopes for each turtle and a shared σ. In these top models, rainfall accumulation only influenced the expected value of the displacement or displacement rate and did not influence the variability (Table 2). There was still considerable noise in the individual displacement and displacement, even with random intercepts and slopes, which was reflected in the posterior parameter estimates (Fig. 5) and in the model R^2, 0.14 for displacement and 0.12 for displacement rate. Neither displacement ($\beta_1 = 0.02$ [-0.01,0.04], median and 95% confidence interval) nor displacement rate ($\beta_1 = -0.009$ [-0.06,0.05]) had significant rainfall accumulation slopes. However, the median slope was positive for displacement and negative for displacement rate indicating that displacement tends to increase as a function of rainfall accumulation, but the displacement rate tends to slightly decreased as rainfall accumulation increased (Figs. 5A and 5B). Half of the random slopes in the displacement rate model had negative medians indicating that displacement rate decreased as a function of rainfall while two individuals (ID 4 and 6) had positive median slopes (Fig. 5B).

Discussion

Our research indicates that *K. acutum* exhibits relatively limited daily movement, with males demonstrating greater movement distances than females. Specifically, we found that the maximum straight-line movement observed for males (205 m) was almost double that of females (103 m). This sexual difference in the ecology of movement may be attributed to mate-searching behaviours commonly observed in male freshwater turtles; it must be noted that some of these

Table 3. Total, mean, and maximum movements by sex of *Kinosternon acutum* captured during turtle surveys within the BFREE ecoregion. The mean is the average of the total observed straight-line movements. Max straight-line is the maximum distance observed between two adjacent movement observations. Total max is the maximum distance travelled between any two observations, whether subsequent or not.

ID #	Sex	Mean (m)	SD	Max Straight-line (m)	Total Max (m)	Total Cumulative Movement (m)
1	F	14	7	71	105	142.43
2	M	16	11	67	92	174.98
3	F	29	29	29	196	286.54
4	M	52	13	205	275	292.12
5	F	18	6	103	151	108.62
6	F	28	22	93	174	337.55

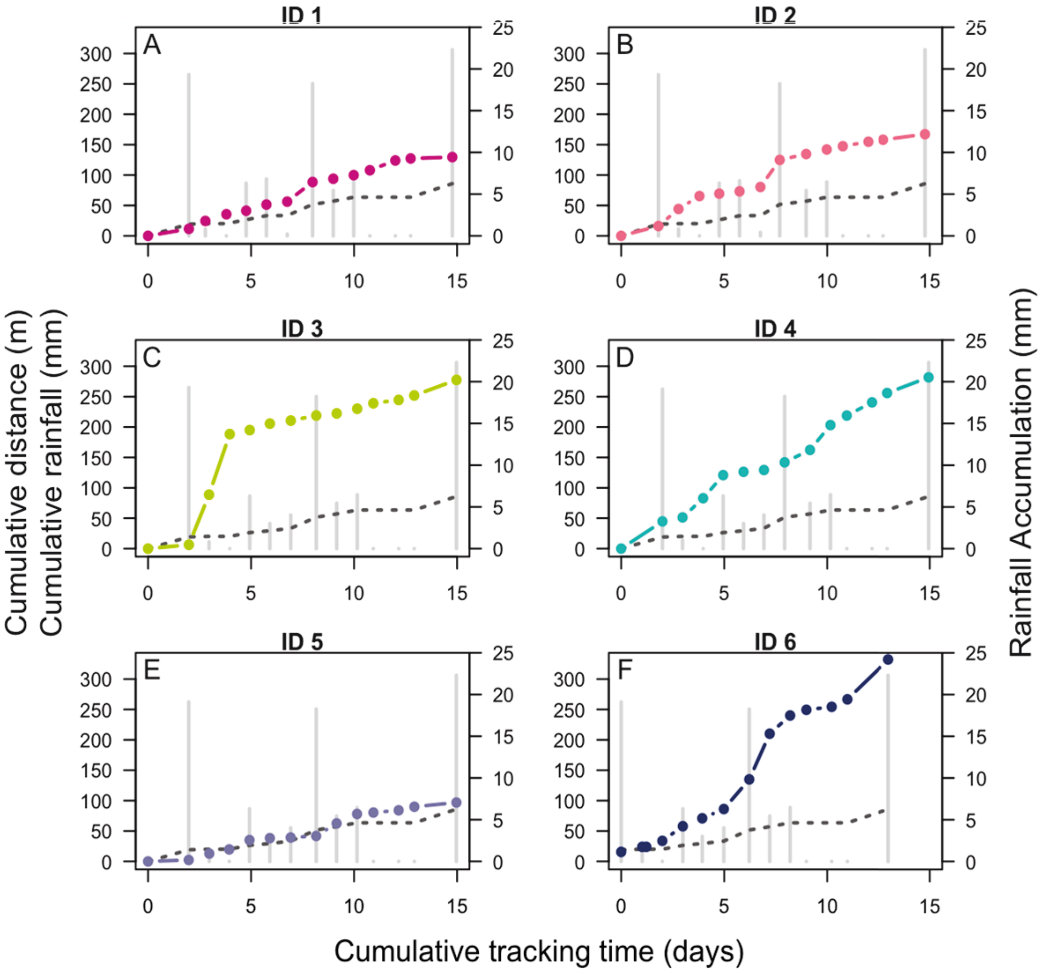

Figure 4. Cumulative distance as a function of cumulative tracking days of *Kinosternon acutum* at the BFREE preserve for the six tracked turtles. Individual rainfall accumulation is indicated in light grey vertical bars while cumulative rainfall is indicated in the dark grey dashed line.

movements could be an effect of removing the turtles from their habitat and putting radio transmitters on them (Ernst and Lovich, 2009). The overall restricted movement patterns suggest that *K. acutum* relies heavily on localised resources. A similar study of the Mexican Mud Turtle (*Kinosternon integrum*) showed similarly restricted movements, with 87.3% of recorded movements being less than 100 m (Pérez-Pérez et al., 2017). This study provides important insights into the spatial behaviour and environmental interactions of *K. acutum*, contributing to the limited body of knowledge on this species.

Within the genus *Kinosternon*, it has been documented that some species exhibit high site fidelity, where individuals tend to have small home ranges and make small movements because they eat, mate, and nest around the core habitat they inhabit (Reyes-Grajales and Macip-Rios, 2023). The small movements we report could be related to the sample size (6 turtles) and the fact that we tracked the turtles at a time of year when they were highly associated with seasonal ephemeral pools within the landscape. The ephemeral pools did not wane during the study. During the beginning of the rainy season, turtles may restrict movement to stay near large, recently filled, ephemeral pools for food and mating resources.

Microhabitat analysis revealed a predominant association with leaf litter, tree bases, and cohune palms,

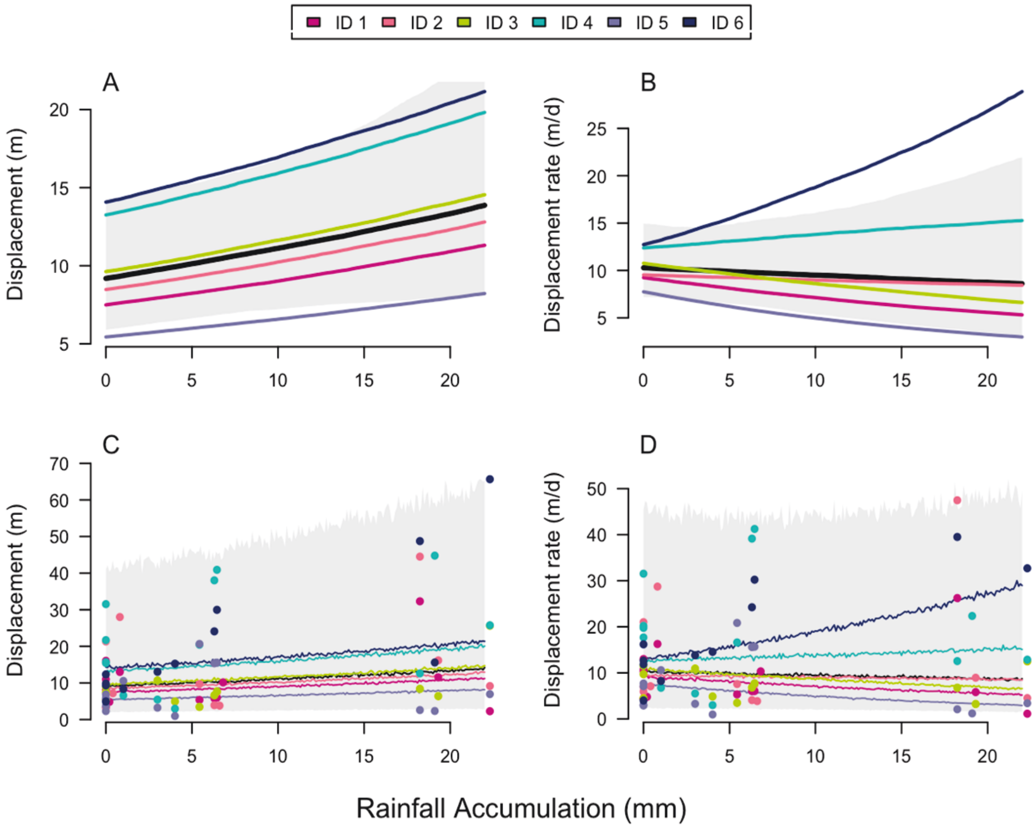

Figure 5. Rainfall accumulation as it pertained to *Kinosternon acutum* movement within the BFREE region. Marginal effect of rainfall accumulation on displacement in meters (A) and displacement rate in meters per day (B). Model prediction of displacement in meters (C) and displacement rate in meters per day (D) as a function of rainfall accumulation. Solid black line are model average, shaded region is the 90% credible interval, the coloured lines are the turtle-specific average effect, and the coloured points are the raw observations.

while utilisation of woody debris and open water was less frequent. Despite being classified as semi-aquatic, *K. acutum* shows significant terrestrial activity, which may be influenced by foraging needs, predator avoidance, or thermoregulation. Similar terrestrial tendencies have been documented in other kinosternid species, such as the Red-Cheeked Mud Turtle (*Kinosternon scorpioides cruentatum*), which exhibits terrestrial nesting and foraging behaviours in southeastern Mexico and Belize (Iverson, 2010). A movement study on Creaser's Mud Turtle (*Kinosternon creaseri*) showed similar preference for microhabitat, with the turtle predominately being found associated with rock shelters (Enriquez-Mercado et al., 2024).

The strong association with cohune palms is particularly noteworthy. The structural complexity provided by fallen cohune palm fronds and seeds may offer essential cover and foraging opportunities, emphasising the importance of this microhabitat feature within *K. acutum*'s habitat. Conservation efforts should prioritise the preservation of areas with abundant leaf litter and cohune palm presence to support the species' ecological requirements. The Sonoran Mud Turtle (*Kinosternon sonoriense*) utilises terrestrial habitats for aestivation during periods of drought and heat, without necessarily suffering negative population impacts (Stone, 2001). Creaser's Mud Turtle was found to utilise specialised rock shelters and sartenejas (Enriquez-Mercado et al., 2024). Our observations, made during the hottest part of the day, suggest that *K. acutum* may engage in similar behaviour. The high use rate of leaf litter and tree cover (over two-thirds of our microhabitat use observations) supports this assertion. Aparicio et al. (2018) also note the use of heat-sheltering microhabitats among Mexican

Mud Turtles (*Kinosternon integrum*) during aestivation periods lasting up to six months. If species are trying to minimise the mortality to growth ratio, habitats that can offer foraging with minimum increases in predation risk are optimal.

Our movement results contrast sharply with those described by Aparicio et al. (2018), who reported movement ranges of up to 27,000 m for Mexican Mud Turtles, and by what Stone (2001) reported observing in Sonoran Mud Turtles, of which 13 travelled distances greater than 1 km. The maximum straight-line movement observed in this study was only 275 m. This discrepancy may be due to differences in study design or environmental conditions. The limited distance travelled by our turtles may corroborate findings by Slavenko et al. (2016), which suggest that a turtle's range size is closely linked to its body size. Iverson and Vogt (2011) report that *K. acutum* is largely nocturnal, which may explain the lack of observations in water bodies during our daytime surveys. It is possible that the turtles were using aquatic habitats at night and returning to terrestrial resting locations during the day. Most of our observations were of stationary animals hiding in vegetative material; it is unknown if this is a normal behaviour or if it indicates an awareness of the research team's presence. Except for one turtle (ID 3), there is little observable evidence from the accumulated displacement that tagging individuals affected their movement. Modelling the expected movement as a function of time since capture also did not reveal any significant effects. Our exceptional turtle moved over two days the two largest displacements we observed (82.4 m then 99.6 m) three days after capture.

There was no consistent relationship between individual movement distances and precipitation levels, with only one individual showing a significant positive relationship. While rainfall may create favourable conditions for movement by increasing the availability of ephemeral pools, *K. acutum* does not uniformly adjust its movement patterns in direct response to precipitation. We measured 91 mm of rain during the first weeks of July, which was below average for this time of year in southern Belize (Heyman, 1999; Bridgewater, 2012). This finding aligns with observations in other freshwater turtle species, where individual responses to environmental variables can vary widely (Gibbons et al., 2000).

While this study provides preliminary insights, its scope is inherently limited by the short duration of the observation period and the relatively small number of individuals sampled. These constraints may reduce the generalisability of the findings, as emphasised by Small (2009) and Maxwell (2013), who highlight the susceptibility of short-term, small-scale studies to sampling bias and contextual variability. Despite these limitations, considerable effort was made to ensure methodological rigor and careful documentation throughout the project. Nonetheless, future work should aim to expand the temporal and demographic breadth of the study to enhance its robustness and ecological validity.

The limited movement range and specific microhabitat preferences of *K. acutum* underscore the species' vulnerability to habitat alteration and fragmentation. In southern Belize, ongoing deforestation and agricultural expansion pose significant threats to the integrity of both aquatic and terrestrial habitats (Cherrington et al., 2010). The reliance on specific microhabitats suggests that *K. acutum* will be sensitive to environmental changes that alter these features. Understanding the movement ecology and habitat utilisation of the Tabasco Mud Turtle (*Kinosternon acutum*) is crucial for developing effective conservation strategies, particularly within the dynamic tropical rainforest ecosystems of Belize. Monitoring programs should be established to track habitat changes and population responses, facilitating adaptive management approaches to conservation.

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