Food Webs 39 (2024) e00348

Contents lists available at ScienceDirect

Food Webs

journal homepage: www.elsevier.com/locate/fooweb

Short communication

Does the Southern Green Anaconda, *Eunectes murinus*, seek areas of high prey concentration in southeastern Peru?

Patrick S. Champagne[a,b,*], Thomas B. Herman[a], Paul Rosolie[c], Dylan Singer[d], Dan Horton[d], Carter J. Payne[d], Lucy Dablin[e], David Colville[b], Julio Cardenas[f], Miryam Quevedo[g], Trevor Avery[a], Renata Leite Pitman[h]

[a] Biology Department, Acadia University, Wolfville, Nova Scotia, Canada
[b] Centre of Geographic Sciences, Nova Scotia Community College, Lawrencetown, Nova Scotia, Canada
[c] Junglekeepers Peru S.A.C., Puerto Maldonado, Peru
[d] Alliance for Research and Conservation in the Amazon, Puerto Maldonado, Peru
[e] School of Environment, Earth and Ecosystem Sciences, Open University, Milton Keynes, United Kingdom
[f] Clínica Veterinaria Animal Farm, Docente de la Universidad Amazonica de Madre de Dios Perú, Puerto Maldonado, Peru
[g] Universidad Nacional Mayor de San Marcos, Lima, Peru
[h] Nicholas School of the Environment, Duke University, Durham, United States of America

A R T I C L E I N F O

Keywords:
Amazon
Madre de Dios
Boidae
Foraging strategies
Mineral licks
Livestock depredation

A B S T R A C T

Although behavior of *E. murinus* was broadly described over a century ago, observations of predation by *E. murinus* are rare. Some evidence suggests that it may target sites when hunting. We report details of six livestock depredation events at a single locality near Puerto Maldonado, Peru. Additionally, we compare positions of three radio-tagged snakes with known locations of mineral licks in their home ranges and describe the relationship of a single radio-tagged individual with game trails. Our observations of predation at mineral licks, and the association of radio-tagged individuals with them, suggest that *E. murinus* may specifically target mineral licks due to high prey concentration. We believe this is the first report of a reptile actively seeking prey at mineral licks. Our observations indicate that *E. murinus* actively seeks areas with higher prey concentration.

The predatory behavior of *Eunectes murinus* (Southern Green Anaconda) was initially described over a century ago, but understanding of its predation ecology is incomplete (Mole and Urich, 1894; Martins and Oliveira, 1998). Descriptions of diet and predation (Rivas, 2000; Terra, 2018; Thomas and Allain, 2021; Champagne, 2022) portray *E. murinus* as an aquatic ambush predator with a diverse array of wild and domesticated prey, including reptiles, birds, and mammals. *Eunectes murinus* also shows ontogenetic dietary shifts toward larger prey as snakes grow (Rivas, 2000; Rivas et al., 2016). *Eunectes murinus* may target domestic prey, including *Canis familiaris* (Dogs), *Gallus gallus* (Chickens), *Bos taurus* (Cattle), *Felis catus* (Cats), and *Sus scrofa* (Pigs) (Miranda et al., 2016).

Although direct observations of predation by *E. murinus* in the wild are rare, some reports demonstrate that it may target areas with higher prey concentrations, similar to other species of ambush predators. Valderrama and Thorbjarnarson (2001) documented two predation incidents involving separate *E. murinus* individuals at the Caño Caracol inlet in the Venezuelan Llanos. They suggested that snakes deliberately chose the inlet to ambush prey in shallow waters near prey foraging sites, arguing that closer proximity increased hunting opportunities by reducing the strike distances. *Eunectes murinus* may also engage in active pursuit; Martins and Oliveira (1998) described a 3-m-long *E. murinus* in central Brazil chasing a rail at the margin of a flooded area. Additionally, recent observations show that *E. murinus* may climb to the top of trees for prey such as *Bradypus variegatus* (Brown-throated Sloth) and *Iguana iguana* (Green Iguana), demonstrating the willingness to leave their preferred habitat for prey (Lozorio et al., 2023).

Between 2012 and 2021, we collected data on activity at mineral licks and predation of livestock by *E. murinus* in the Madre de Dios region of southeastern Peru. Data were aggregated as part of a larger study of *E. murinus* ecology in the western Amazon. Data were also opportunistically acquired during faunal sampling, ecotourism, and forestry activities. The study area encompassed primary lowland rainforests, including floodplain and tierra-firme forests. We used high-frequency

* Corresponding author at: Biology Department, Acadia University, Wolfville, Nova Scotia, Canada.
E-mail address: patrickchampgne@gmail.com (P.S. Champagne).

https://doi.org/10.1016/j.fooweb.2024.e00348
Received 4 December 2023; Received in revised form 19 March 2024; Accepted 9 April 2024
Available online 11 April 2024
2352-2496/

radio tags to track several individual adult *E. murinus* in various systems including a *Mauritia flexuosa* palm swamp, a river, and a stream. Tags, which were implanted using forced ingestion (as described in Rivas, 2001) or sub-epidermally (as described in Holtzman et al., 2002; Raphael et al., 1996), allowed us to monitor movements and behavior for varying periods in 2014 and 2018–2020 (Champagne, 2022).

Our observations of predation at mineral licks, and the association of radio-tagged individuals with them, suggest that *E. murinus* may specifically target mineral licks due to high prey concentration. Mineralized clay salt licks provide essential nutrients for an array of taxa in the Neotropics, influencing their distribution, population dynamics, and densities (Dudley et al., 2012; Powell et al., 2009). Due to higher concentrations and frequencies of occurrence of geophagic prey, felids and other predators are attracted to mineral licks to feed (Griffiths et al., 2020a, 2020b; Montenegro, 2004; Matsuda and Izawa, 2008; Ferrari, 2009).

We mapped locations of active mineral licks within home ranges of three radio-tagged adults; two individuals, A01 (Female, snout to vent length (SVL): 387 cm, tail vent length (TVL): 77 cm, 13.81 kg) and A02 (Male, SVL: 237 cm, TVL: 47 cm, 4.47 kg), occupied a small tributary (Los Amigos River), and a third, A04 (Female, SVL: 401.7, TVL: 51.1, 41.0 kg), occupied a large stream system in the Las Piedras River tributary. Mineral licks located on the Los Amigos River were easily identified from a boat, and several others were found within the nearby forest adjacent to the river. Near the Las Piedras River, intensive surveying of the home range of one radio-tagged adult was done on foot and by inflatable raft. Mineral licks were identified by the presence of exposed clay and heightened faunal activity, indicated by direct observations or recent tooth marks and animal tracks.

We also explored the possible association of game trails with the positions of one radio-tagged individual (A04). At each radio-tracked position, we recorded the presence of game trails within 10 m of the snake and identified faunal presence using tracks or direct observation of live animals. Game trails were identified by observing typical characteristics such as the presence of trampled vegetation, flattened grass, or disturbed soil along a narrow path of least resistance. Radio locations were sampled at approximately 24-h intervals or longer.

All positional data were acquired using a Garmin handheld global positioning system device (1200 East 151st Street Olathe, KS, USA model: 64 s). Polygon shapefiles were generated using minimum bounding geometry of the known ranges of each snake, the point features of radio-tracked positions, and the point features of known mineral lick locations were stored, managed, and visualized within a Geographic Information System (GIS) (ArcGIS Pro-Environmental Systems Research Institute, Redlands, CA, USA).

We used the *Near* tool to calculate the planar distance (in meters) between the radio-tracked positions and the closest mineral lick feature. The output stored the distance of each radio-tracked position as an attribute field within our data table. To test the association between mineral licks and individual snakes, we used the *Create Random Points* tool in ArcGIS Pro to create a series of random positions, while setting the home range polygons of each snake as the input boundaries, and the number of points generated at 500. We repeated the proximity analysis using the Near tool between the three sets of 500 positions and the known positions of the mineral licks.

All distances were stored and exported as a CSV file. Statistical analysis was performed using R (R Core Team, 2021; R version 4.3.3, February 2024). We used a two-sample Kolmogorov-Smirnov test (using the *ks.test* function with the default settings) to evaluate whether the two data sets for each snake (i.e., distances between: mineral licks and radio-positions vs. mineral licks and random points within home range) came from the same distribution.

Graphing was performed using Excel (Microsoft Excel version 16.75, 2023, Microsoft Corporation, Redmond, Washington). We binned both datasets by intervals of fifty meters to visualize the information effectively. We chose a 50-m interval because several of the mineral licks were extensive and ran along a significant length of the rivers and the streams. Although snakes were found within the active zone (area with detectable and recent animal activity) of the mineral lick, the proximity analysis does not capture the true area of influence below a 50-m resolution. As we do not have true size estimations for each of the mapped mineral licks, only a center position was acquired from GPS.

Our analysis of game trail association is purely descriptive. We attempted to map game trail frequency and trail crossing areas but could not produce positions that realistically reflected the spatial influence of game trails beyond their immediate estimated area of influence. In particular, game trails that followed the stream and provided a greater range and time that a prey item would be within the preferred strike range were difficult to define and classify. We chose a 10-m buffer because we recognize that the area of occurrence or influence of fauna at many of the trail crossing locations extends beyond the immediate crossing area. At some of the areas where we observed *E. murinus*, we also observed species such as deer and peccary along a length of the stream at a trail crossing, but not necessarily crossing the stream or at the immediate crossing point where the snake was positioned. We believe that using high-grade GPS devices and deploying unmanned aerial vehicles could be used to resolve this in the future.

We documented three instances of *E. murinus* depredating at mineral licks. All three mineral licks were near or at springs serving as sources of streams and >900 m from the nearest permanent water body. The first event (1134 h on January 23, 2010) was recorded at the head of a small stream flowing into the Tambopata River, where we found a large female *E. murinus* (4.2 m TL) constricting an adult *Tayassu pecari* (White-lipped Peccary) in shallow water below a mineral lick (Fig. 1A). The *E. murinus* had bitten the lower jaw of the *T. pecari* and then folded the prey in half using its coils. The second event (September 2017) was recorded by a forestry worker who provided a video and description of an adult (TL >400 cm- presumably female) *E. murinus* waiting in an ambush position at a mineral lick near the source of a stream, 1.5 km from its confluence with the Pariamanu River. The *E. murinus* was slightly out of the water and facing the wall of the mineral lick where prey items could ingest clay (Fig. 1B). The snake was described as searching the area with its head and neck slightly off the ground. The third event (morning of June 14, 2018) was recorded at a mineral lick near the trail system of Refugio Amazonico on the Tambopata River, where we found an *E. murinus* consuming a *Dasyprocta variegata* (Brown Agouti).

Although only three snakes were fitted with radio tags, all were significantly associated with mineral licks (two-sample Kolmogorov–Smirnov test (A01: $D = 0.714$, p-value $= 0.002$; A02: $D = 0.492$, p-value $= 0.017$; A04: $D = 0.516$, p-value <0.001) and were directly observed at them (Fig. 2A, B). While tracking one of the individuals on the Loboyoc (A04), we found 13 mineral licks within its home range; six were in the interior of the forest and were strictly associated with A04 during the wet season when water levels inundated the forest. A04 was within 50 m of a mineral lick >50% of the time. On some occasions, A04 remained at a mineral lick location for numerous days and was located in the water directly in front (within 2 m) of active animal use as indicated by recent tracks and trampled ground.

Game trails were present at 32 of 64 recorded A04 locations. At most locations, game trails were notable, and most were distinct crossing points of the primary stream used by several species (Fig. 3A). A04 revisited several of these locations throughout the study, remaining at some for multiple days. South American Tapir (*Tapirus terrestris*) was the most frequently recorded species to use or create game trails (86.3%, $n = 19$). Several additional species used the same trails, and most potential prey items were documented using areas within immediate striking proximity of the water (Fig. 3B). These included *Dicotyles tajacu* (Collared Peccary) (37%, $n = 12$) and *Cuniculus paca* (Paca) (18%, $n = 4$). *Mazama* sp. (Brocket), *D. variegata*, *Ardea cocoi* (Cocoi Heron), *Lontra longicaudis* (Neotropical River Otter), *Tupinambis teguixin* (Golden Tegu), *Caiman crocodilus* (Spectacled Caiman), and *Pteronura brasiliensis* (Giant

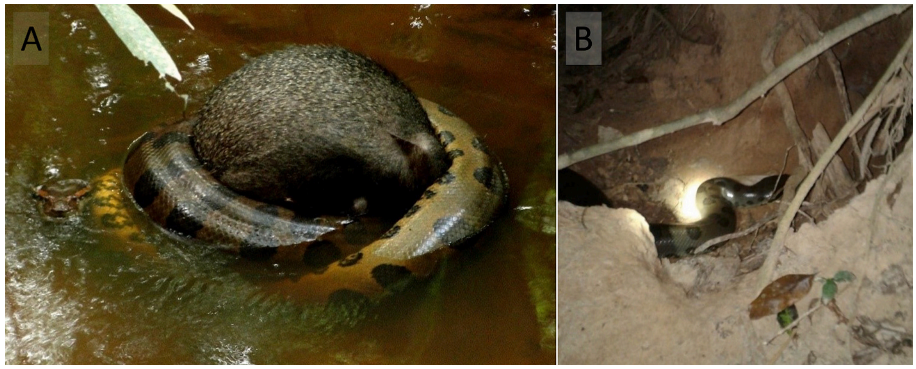

Fig. 1. (**A)** Adult female *E. murinus* constricting a *T. pecari* (White-lipped Peccary) at a mineral lick in Tambopata (Photograph by Paul Rosolie). **(B)** Adult *E. murinus* partially out of the water and facing a mineral lick near the Pariamanu River (Photograph by Silver Inuma).

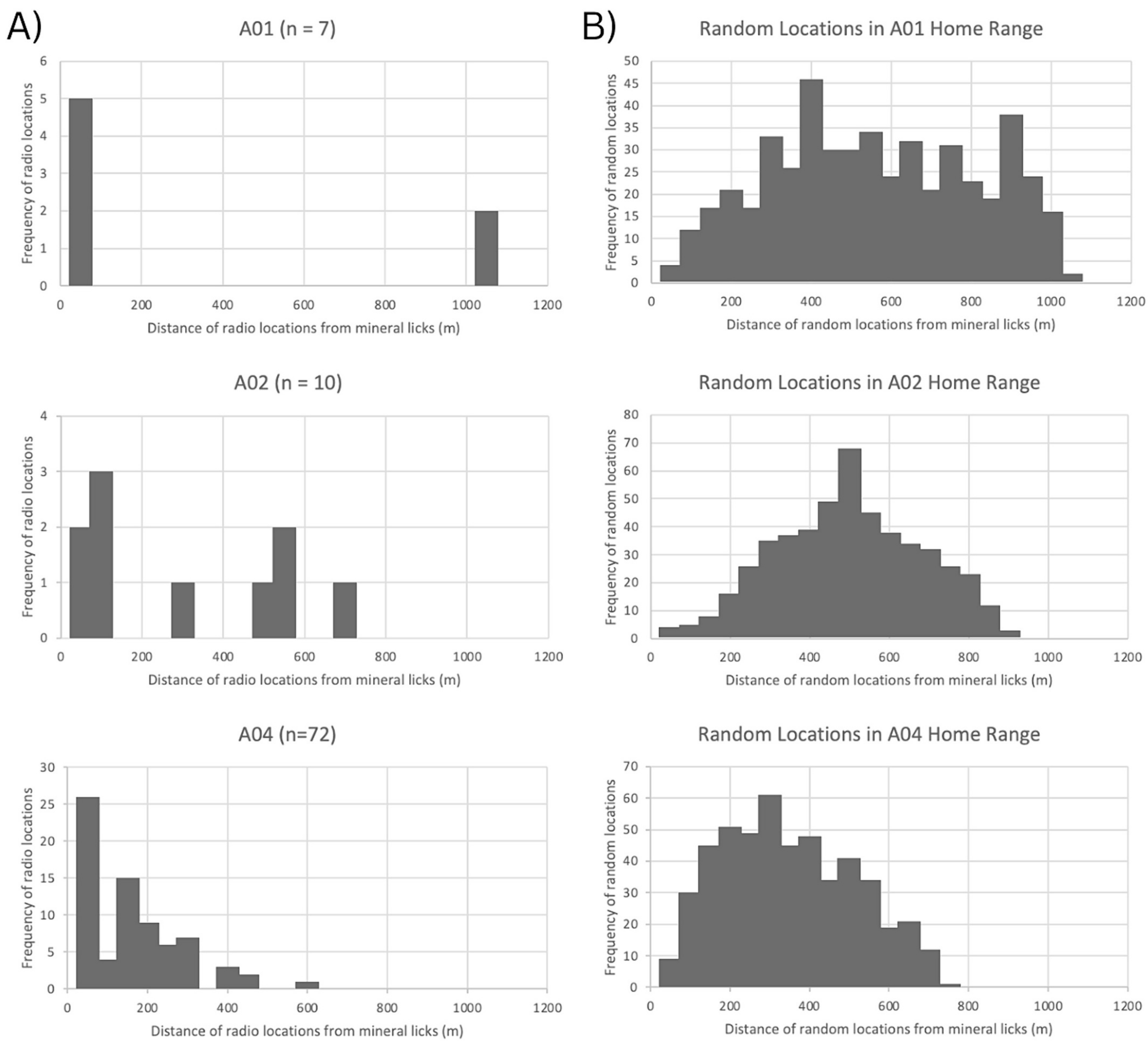

Fig. 2. A) Frequency of confirmed radio-tracked locations of three adult *Eunectes murinus* and their distances from mineral licks. **B)** Frequency of distances of randomly generated positions from mineral licks within *E. murinus* home ranges. All distances are binned by 50 m intervals.

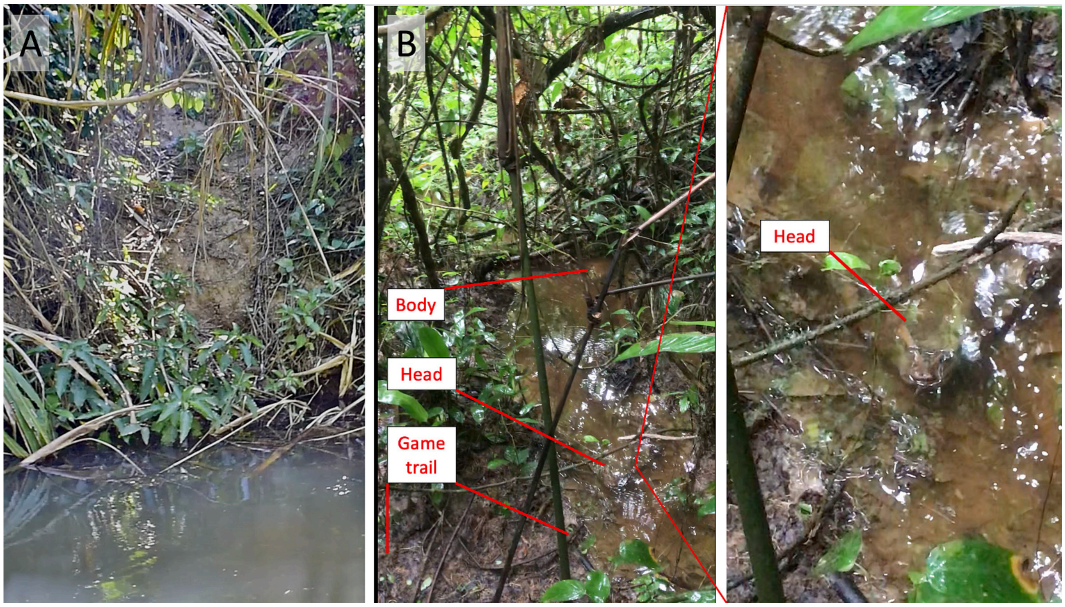

Fig. 3. A) A typical game trail and crossing point for potential prey items of *E. murinus* on the Loboyoc stream system. **B)** An adult *E. murinus* (A04) positioned in front of a game trail within a temporarily flooded interior forest.

River Otter) were also observed. A04 was never observed with a large prey item; we speculate that this individual regularly consumed smaller prey such as *C. paca* and *A. cocoi*.

We documented four livestock and two domestic dog predation events at a single locality, a farm near the Madre de Dios River, six km from Puerto Maldonado, on February 27, 28, and March 22, 2018, and between December and February 2019. The property consisted of a field on the edge of a darkly colored tannin-rich lake, approximately 800 m from the Madre de Dios River, and 2 km from a wetland dominated by aguaje palms (*Mauritia flexuosa*) and peaty soils. During February and March, the lakeshore extended to the edge of the field, and at times the entire field was inundated and contiguous with the lake. The first two predation events involved a juvenile female and an adult male *Canis familiaris* (Rottweiler). The female disappeared at ~1600 h on February 27, near a shallow pool connected with the blackwater lake. The male was found by its owner at 0730 h on February 28 at the edge of the field (12°32′2"S, 69° 10'27"W, WGS84), being constricted by an adult female *E. murinus* in a shallow (5–10 cm) pool connected to the lake that served as a daily bathing area for the property's three dogs. A colleague who lived nearby reported the event to us and measured the snake's total length before it was skinned (5.32 m). We arrived shortly after and measured the length of the skin without the head (6.24 m). The prey item, an adult male *Canis familiaris* (Rottweiler) (Fig. 4A), measured 109 cm in body length, 50 cm tall at the shoulder, 61 cm chest girth, and weighed approximately 70 kg. The dog was bleeding from its eyes, nose, mouth, ears, and genitals. Heavy bleeding from the mouth post-mortem also suggested severe internal bleeding. Ribs were palpated, but no breakage was detected. A 10-cm laceration was present on the lower front left leg (Fig. 4B). Two puncture wounds were present on the left shoulder, presumably where the snake struck.

Fig. 4. (A) An adult male Rottweiler was killed by an adult *E. murinus* and examined 4 h postmortem. **(B)** A deep laceration 10 cm in length was found on the dog's left leg where the snake struck. **(C)** A 250 cm *E. murinus* constricting and killing a domestic chicken (Photograph by Paul Blau).

On March 22, a second individual *E. murinus* (TBL: 250 cm, SVL: 210 cm, 10 kg) constricted and killed an adult chicken (Fig. 4C). At 0740 h, the farmer heard chicken distress calls and found a sub-adult *E. murinus* constricting a 2.5-kg chicken, which had been foraging outside a coop in an inundated vegetated field (12°32′7"S, 69°10′13"6 W; WGS84). The location, on the other side of the field approximately 400 m from the first event, was temporarily contiguous with the blackwater lake following heavy rains. The *E. murinus* was assumed to be female based on its girth but this was unconfirmed. On three occasions between December 2018 and February 2019 a 3-m individual *E. murinus* preyed on domesticated ducks in the same area of the field as the chicken. However, since no captures were made, we cannot confirm if all incidents involved the same snake.

Our sampling was limited to opportunistic records and a small sample of three intensively radio-tracked snakes. However, our observations provide empirical evidence about the species predatory modes, and particularly its relationship to areas with higher prey frequency. The few studies that have addressed predation ecology of *E. murinus* broadly describe its habits as an ambush predator that typically strikes from the water. Our observations suggest that *E. murinus* seeks areas with higher prey concentration, such as mineral licks, and sometimes at a distance from primary water bodies, even if that increases its own vulnerability to predation.

Reports on livestock and domestic animal loss from the Madre de Dios region have focused primarily on predation by mammalian and avian carnivores. Although predation of domestic animals by *E. murinus* appears to be less frequent than by other predators such as *Leopardus pardalis* (Ocelot), *Panthera onca* (Jaguar), and birds of prey (Naughton-Treves et al., 2003) it can be consequential for individual *E. murinus* (Miranda et al., 2016). Immediately after the fatal attack on the dog described above, the snake was killed.

Adult female *E. murinus* have large home ranges and large body sizes. As such, adult females are more likely to prey on livestock and domestic animals, and also be killed by people for presenting a threat to their livelihoods. Differential killing of adult female *E. murinus* by humans, particularly in light of the relatively long generation time of *E. murinus*, may therefore have both individual and population consequences. Without human intervention, female *E. murinus* already have higher mortality and injury rates attacking prey (Rivas et al., 2007; Rivas, 2020). If predation of livestock occurs frequently in Madre de Dios, with a high mortality risk for the snake, then understanding the predation ecology of this species is vital to its conservation and management in the region.

Eunectes murinus appears to be the first reptile confirmed to seek prey at mineral licks in the Amazon. Although previously unreported, such predation should not be surprising, as mineral licks are important hunting sites for other large vertebrate predators in the Amazon rainforest, including *L. pardalis* (Griffiths et al., 2020a, 2020b), *P. onca*, and *Puma concolor* (Puma) (Montenegro, 2004; Matsuda and Izawa, 2008; Ferrari, 2009). However, we were surprised by the distance of some mineral licks from a primary water source, in habitats otherwise unfavorable for *E. murinus*. Although adjacent streams contained water, they had minimal cover or depth; thus, large snakes would have traversed terrain with high mortality risk from terrestrial predators such as *P. onca* and *P. concolor*. *Eunectes murinus* appears to be more susceptible to predation on land, which is especially evident in migrating males in the Llanos during breeding season (Rivas, 2000). Large females, which already have increased mortality rates and problems with injuries during attacks (Rivas et al., 2007; Rivas, 2020) may also be exposed to heightened predation risk as they migrate to and through foraging areas in the southwestern rainforests.

Our results indicate a positive non-random association between known positions of radio-tracked snakes and mineral licks, suggesting that *E. murinus* may specifically target mineral licks due to high prey concentration. Mineral licks themselves are clumped in the Amazon; erosion from rivers and proximity to historical oceans influence their concentration and expression within the landscape (González et al., 2021). Given this non-randomness, the chance of a snake randomly encountering one is low, providing further support for the selection of mineral licks by *E. murinus*. The more dispersed distribution of proximity of random vs. known positions within home ranges relative to known mineral licks (Fig. 2A, B) further supports the active selection of mineral licks by these individuals.

Our study highlights the need for a deeper understanding of the feeding ecology of *E. murinus*. Despite past descriptions of feeding behavior, many aspects remain unexplored. Our observations suggest that *E. murinus* may engage in more active predation than previously believed, targeting areas with high prey concentrations. The association of three radio-tagged snakes with mineral licks suggests that these sites play a crucial role in hunting behavior within certain Amazon systems, potentially making it the first reptile reported to use mineral licks as ambush sites. Future conservation of this species requires a better understanding of variation in feeding dynamics across multiple spatial scales within the Amazon rainforest.

CRediT authorship contribution statement

Patrick S. Champagne: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Thomas B. Herman:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Paul Rosolie:** Writing – review & editing, Resources, Project administration, Funding acquisition, Data curation, Conceptualization. **Dylan Singer:** Writing – original draft, Project administration, Data curation. **Dan Horton:** Investigation, Data curation. **Carter J. Payne:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Lucy Dablin:** Writing – review & editing, Investigation, Data curation. **David Colville:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition. **Julio Cardenas:** Resources, Methodology, Investigation. **Miryam Quevedo:** Writing – review & editing, Supervision, Resources, Investigation, Conceptualization. **Trevor Avery:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Renata Leite Pitman:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation.

Declaration of competing interest

The authors have no declarations of interest or conflicts to submit.

Data availability

The data that support the findings of this study are part of ongoing research initiatives, and thus subject to embargo restrictions. When these studies are complete, data will be available in a public database. In the interim, data are available on request from the corresponding author.

Acknowledgments

We extend our gratitude to all those who contributed to the successful completion of our research. Without their invaluable support, this endeavor would not have been possible. First, we express our sincere appreciation to the staff at Refugio Amazonico and Silver Inuma for generously providing us with observational data relating to predation events. Their cooperation and willingness to share their knowledge have been instrumental in enriching our research. We would also like to acknowledge the exceptional service and logistical support provided by the staff at Saona Lodge, the Las Piedras Amazon Center, the Las Piedras Biological Station, and the Estación Biológica Los Amigos. Their unwavering dedication ensured the smooth execution of our research activities in the Madre de Dios region. Grateful thanks are extended to the concession stewards of the Los Amigos Conservation Concession on the Los Amigos River and the concession stewards of Junglekeepers on the Las Piedras River. Both groups played roles in our research, offering their assistance in various aspects, including assistance with radio locating snakes, logistical support, and even medical services when needed. Our research was also enriched by the contributions of volunteers from the Alliance for Research and Conservation in the Amazon and the staff and guides of Tamandua Expeditions. Their passion for environmental conservation and commitment to research in the Amazon influenced the success of our endeavors. Furthermore, we express our deep appreciation to the Environmental Systems Research Institute (Esri), the Amazon Rainforest Conservancy, and MITACS International for their financial and logistical support of research and analysis.

References

Champagne, P.S., 2022. Conservation ecology of Eunectes Murinus (Green Anaconda). In: In the Madre de Dios Region of Southeastern Peru Using Remote Sensing Techniques and Machine Learning Driven Geospatial Modeling. Acadia University (MSc dissertation,.

Dudley, R., Kaspari, M., Yanoviak, S.P., 2012. Lust for salt in the Western Amazon. Biotropica 44 (1), 6–9. https://doi.org/10.1111/j.1744-7429.2011.00818.x.

Ferrari, F.F., 2009. Predation risk and antipredator strategies. In: Garber, P.A., Estrada, A., Bicca Marques, J.C., Heymann, E.W., Strier, K.B. (Eds.), South American Primates: Comparative Perspectives in the Study of Behavior, Ecology, and Conservation. Springer, New York, pp. 211–250. https://doi.org/10.1007/978-0-387-78705-3.

González, E.M., Henríquez, W.A., Armenteras-Pascual, D., 2021. Mineral lick distribution modeling and NW Amazon conservation planning alternatives. Biodivers. Conserv. 30, 3409–3432.

Griffiths, B.M., Bowler, M., Gilmore, M.P., Luther, D., 2020a. Temporal patterns of visitation of birds and mammals at mineral licks in the Peruvian Amazon. Ecol. Evol. 10 (24), 14152–14164. https://doi.org/10.1002/ece3.7006.

Griffiths, B., Gilmore, M., Bowler, M., 2020b. Predation of a Brazilian porcupine (*Coendou prehensilis*) by an ocelot (*Leopardus pardalis*) at a mineral lick in the Peruvian Amazon. Food Webs e00148. https://doi.org/10.1016/j.fooweb.2020.e00148.

Holtzman, D.A., Stosic, C.D., Wyatt, J., 2002. Field use of a local anesthetic, lidocaine hydrochloride, for radiotransmitter implantation in Boa constrictor imperator. Herpetological Review 33 (3), 189.

Lozorio, A., Silva-Soares, T., Gomes, J., Leite, A., 2023. Giants above us: two field observations of anacondas hunting on trees. Herpetol. Brasil. 12 (1), 49–53. https://doi.org/10.5281/zenodo.7828889.

Martins, M., Oliveira, M.E., 1998. Natural history of snakes in forests of the Manaus region, Central Amazonia, Brazil. Herpetol. Nat. Hist. 6 (2), 78–150.

Matsuda, I., Izawa, K., 2008. Predation of wild spider monkeys at La Macarena, Colombia. Primates 49, 65–68. https://doi.org/10.1007/s10329-007-0042-5.

Miranda, E.B., Ribeiro Jr., R.P., Strüssmann, C., 2016. The ecology of human-anaconda conflict: a study using internet videos. Trop. Conserv. Sci. 9 (1), 43–77.

Mole, R.R., Urich, F.W., 1894. Biological notes upon some of the Ophidia of Trinidad, BWI, with a preliminary list of the species recorded from the island. In: Proceedings of the Zoological Society of London, pp. 499–518.

Montenegro, O.L., 2004. Natural Licks as Keystone Resources for Wildlife and People in Amazonia. (Doctoral dissertation). University of Florida ProQuest Dissertations Publishing, p. 3158841.

Naughton-Treves, L., Mena, J.L., Treves, A., Alvarez, N., Radeloff, V.C., 2003. Wildlife survival beyond park boundaries: the impact of slash-and-burn agriculture and hunting on mammals in Tambopata, Peru. Conserv. Biol. 17 (4), 1106–1117. https://doi.org/10.1046/j.1523-1739.2003.02045.x.

Powell, L.L., Powell, T.U., Powell, G.V., Brightsmith, D.J., 2009. Parrots take it with a grain of salt: available sodium content may drive collpa (clay lick) selection in southeastern Peru. Biotropica 41 (3), 279–282. https://doi.org/10.1111/j.1744-7429.2009.00514.x.

R Core Team, 2021. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Raphael, B.L., Calle, P.P., Karesh, W., Rivas, J.A., Lawson, D., 1996. Technique for surgical implantation of transmitters in snakes. Proc. Wildlife Disease Assoc. 1996, 82.

Rivas, J.A., 2000. The life history of the green anaconda (Eunectes murinus), with emphasis on its reproductive biology (doctoral dissertation). Univ. Tenness. ProQuest Dissert. Pub. 1999, 9973496.

Rivas, J.A., 2001. Feasibility and efficiency of transmitter force-feeding in studying the reproductive biology of large snakes. Herpetol. Nat. Hist. 8 (1), 95–97.

Rivas, J.A., 2020. Anaconda: The Secret Life of the world's Largest Snake. Oxford University Press.

Rivas, J.A., Muñoz, M.D.C., Thorbjarnarson, J.B., Burghardt, G.M., Holmstrom, W., Calle, P., 2007. Natural history of the green anacondas (Eunectes murinus) in the Venezuelan llanos. In: Henderson, R.W., Powell, R. (Eds.), Biology of Boas, Pythons, and Related Taxa. Eagle Mountain Publishing Company, Eagle Mountain, pp. 128–138.

Rivas, J.A., Molina, C.R., Corey, S.J., Burghardt, G.M., 2016. Natural history of neonatal green anacondas (Eunectes murinus): a chip off the old block. Copeia 104 (2), 402–410. https://doi.org/10.1643/CE-15-238.

Terra, J.D.S., 2018. Ecologia, nicho climático e efeito das mudanças climáticas sobre a distribuição potencial das espécies do gênero Eunectes (Squamata, Serpente) (Doctoral dissertation,. Universidade de São Paulo.

Thomas, O., Allain, S., 2021. Review of prey taken by anacondas (Squamata, Boidae: Eunectes). Reptiles Amphibians 28 (2), 329–334. https://doi.org/10.17161/randa.v28i2.15504.

Valderrama, X., Thorbjarnarson, J.B., 2001. *Eunectes murinus* (Green Anaconda). Diet. Herpetol. Rev. 32 (1), 46–47.