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Population Size of the Utila Island Endemic *Ctenosaura bakeri*: Insights From Two Sampling Approaches

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Abstract.—**Accurate population estimates are fundamental for assessing the conservation status of endangered species and guiding management actions. The Utila Spiny-tailed Iguana (*Ctenosaura bakeri*) is a Critically Endangered species on the Red List of the International Union for Conservation of Nature, endemic to Utila, Honduras, and one of the few reptiles specialized for mangrove ecosystems. Despite its conservation importance, reliable population estimates remain limited due to its cryptic behavior and restricted distribution. We evaluated two survey approaches, Mark–recapture and Distance Sampling, across eight mangrove sites between March and October 2024 to estimate population size and describe demographic structure. Observations were strongly adult-biased and revealed an overall balanced sex ratio (0.82 males per one female), with male-biased ratios detected at several urban-associated sites. Of 71 marked adults, only 18 were recaptured (25.35%), preventing robust mark–recapture population estimation. In contrast, distance sampling, based on 448 detections, yielded site-specific density estimates ranging from 6.33 to 32.07 individuals/ha, with lower densities observed in disturbed mangrove areas. Extrapolated across 650 ha of mangrove habitat, we estimated that the island-wide population at 9,945 individuals (95% confidence interval = 7,176–13,812). Our results demonstrate that distance sampling provided a more reliable method for estimating population size in this species. The spatial variation in density highlights the influence of habitat degradation and underscores the urgent need to strengthen mangrove protection, mitigate hunting pressure, and implement continuous, standardized monitoring to ensure the persistence of *C. bakeri* on the island.**

Key Words.— detection probability; distance sampling; Iguanidae; line-transect survey; mark–recapture; population density; reptile conservation

Introduction

Accurate population estimates are essential for evaluating the conservation status of wild species and informing effective management strategies. Because exhaustive counts are rarely feasible, population size must be inferred from limited survey data, making reliable estimation a central challenge in population assessments (Kellner and Swihart 2014; Guillera-Arroita 2017). To improve reliability, analytical approaches must explicitly account for detection probability (MacKenzie et al. 2005; de Infante Anton et al. 2013), which is influenced by both extrinsic factors, such as environmental conditions and survey design, and intrinsic species traits, including morphology and behavior (Bennett et al. 2024). Even when imperfect detection is considered, estimating population size remains particularly challenging for cryptic species, those with restricted ranges, specialized habitat requirements, or inherently low visibility (McDiarmid et al. 2012; Sewell et al. 2012).

One such species is the Utila Spiny-tailed Iguana (*Ctenosaura bakeri*; Fig. 1), a critically endangered iguana endemic to Utila, a small Caribbean Island (41 km2) off the northern coast of Honduras (Zoerner and Köhler 2004; Schulte and Köhler 2010). Unlike other *Ctenosaura* species, *C. bakeri* is a strict mangrove specialist, with females migrating to adjacent beaches only during the nesting season (Gutsche 2005). Over the past decades, rapid tourism-driven development has led to severe habitat loss and fragmentation, posing a significant threat to the survival of species (Pasachnik 2009; Schulte and Köhler 2010; Maryon et al. 2018). Additionally, predation pressure from invasive Northern Raccoons (*Procyon lotor*) has further exacerbated population declines (Maryon et al. 2018). Despite existing legal protections, hunting remains a major concern, with gravid females being

Figure 1. Individual Utila Spiny-tailed Iguanas (*Ctenosaura bakeri*) recorded during sampling surveys at sites across Utila, Bay Islands, Honduras, 2024. (Photographed by Maria F. Flores Bueso).

specifically targeted, contributing to an increasingly male-biased sex ratio (Pasachnik et al. 2012a). These combined threats have resulted in *C. bakeri* being classified as Critically Endangered on the Red List of the International Union for Conservation of Nature (IUCN) since 2004, a status reaffirmed in 2018 (Zoerner and Köhler 2004; Maryon et al. 2018).

Despite the conservation significance of *C. bakeri*, precise data on its population size and demographic structure remain scarce. Early studies, from its initial description by Stejneger (1901), and later field surveys conducted in mangroves on Utila (Köhler 1994), raised concerns about low population numbers, skewed demographics with few juveniles, and a predominance of young females. Subsequent capture-recapture studies (Gutsche 2005; Gutsche and Streich 2009) produced highly variable population estimates, underscoring the difficulties in accurately assessing population size.

Mark-recapture approaches estimate detection probability through repeated encounters of marked individuals but require sufficiently high recapture rates and adherence to population closure assumptions (Lettink and Armstrong 2003). In contrast, Distance Sampling provides a cost-effective framework for addressing imperfect detection by modeling the probability of detection as a function of the distance between the observer and the detected animal, allowing researchers to correct for detection biases and generate more robust abundance estimates (Buckland et al. 2001; Thomas et al. 2010). Distance Sampling, however, depends on assumptions that can be difficult to satisfy for secretive, habitat-specialist reptiles. While both methods are widely used in wildlife research, they pose practical challenges for cryptic reptiles inhabiting structurally complex environments, particularly when encounter or recapture rates are low.

We applied both Distance Sampling and Mark-recapture methods to estimate the population size of *C. bakeri* under field conditions characteristic of its mangrove habitat on Utila. Our primary objective was to obtain updated baseline population estimates while assessing the feasibility and reliability of these commonly used methods for a cryptic island endemic. By identifying methodological constraints encountered during implementation, we aim to inform future monitoring strategies and improve long-term population assessment for this critically endangered species.

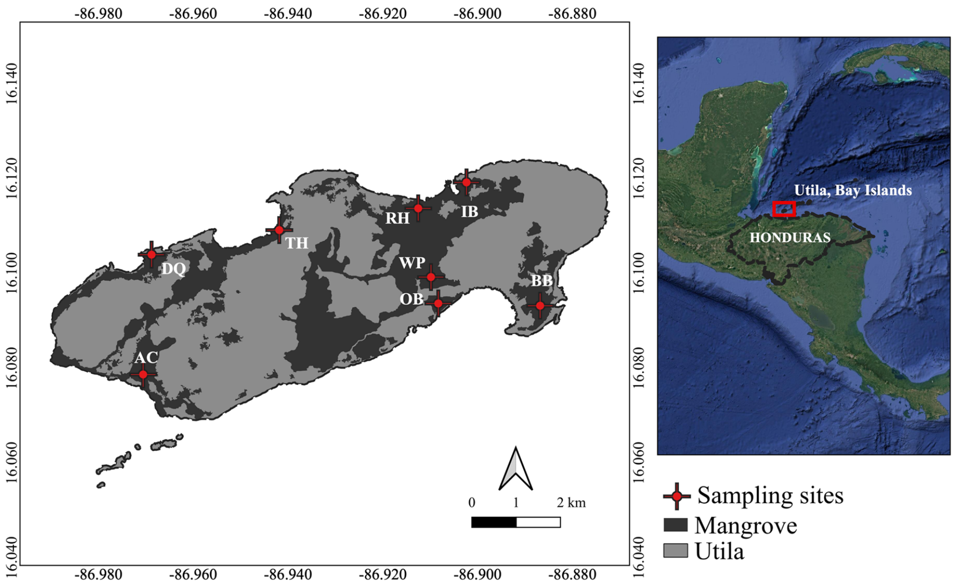

Figure 2. Sampling sites for the monitoring of the Utila Spiny-tailed Iguana (Ctenosaura bakeri) population on Utila, Bay Islands, Honduras. Sites are AC = Aliah's Channel, DQ = Don Quickset, IB = Iron Bound, OB = Oyster Bed Lagoon, RH = Rock Harbour, TH = Turtle Harbor, BB = Big Bight Pond, WP = Western Path.

Materials and Methods

Study site.—We conducted our study on the island of Utila (16°05'50″N, 86°56′14″W), located in the Bay Islands, Honduras. Utila is the smallest and westernmost of the Bay Islands, with a land area of approximately 42 km², situated 32 km north of the mainland city of La Ceiba (McCranie et al. 2005). The topography of the island is flat, with an average elevation of 10 m. The climate is tropical, with an average annual precipitation of 2,500 mm and a mean annual temperature of 26.3° ± 1.9° C (Gutsche 2005). The mangrove forests are distributed in a fragmented pattern, forming three isolated regions in the eastern, central, and western parts of the island (Gutsche 2009). Due to varying tolerances to tidal flooding and salinity, the mangrove ecosystem is heterogeneously composed of four main species: Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*), White Mangrove (*Laguncularia racemosa*), and Buttonwood (*Conocarpus erectus*; Schulte and Köhler 2010).

Sampling sites.—We sampled eight mangrove zones distributed across the island (Fig. 2). Three of these sites, Big Bight Pond (BB), Oyster Bed Lagoon (OB), and Western Path (WP) are inserted in the urban matrix of the island. More isolated and remote sites that we sampled included Iron Bound (IB), Rock Harbour (RH), Don Quickset (DQ), Aliah Canal (AC), and the Turtle Harbour Wildlife Refuge (TH). We selected these sites to ensure spatial coverage across the study area and to encompass the full gradient of mangrove conditions on the island, from relatively intact to highly degraded habitats.

Data collection.—Across all study sites, we established 24 linear transects. Transect lengths varied from 100 to 400 m. Survey effort was broadly comparable among sites but varied according to habitat availability and accessibility constraints. We further based site selection on similarities in mangrove composition, particularly the presence of *R. mangle, A. germinans,* and *L. racemosa*, all of which are ecologically significant for *C. bakeri* (Gutsche 2005; Schulte and Köhler 2010).

We collected field data between March and October 2024. We surveyed each transect over three consecutive days, and surveys were repeated at 3-mo intervals, resulting in a total of six survey occasions per transect. We surveyed for lizards between 0900 and 1400 when iguanas are most active and emerge from their refuge cavities. To minimize biases in detection rates, we did not survey on rainy days or during periods of excessive cloud cover.

At each site, we conducted a systematic search for iguanas through slow walking surveys along pre-established transects. To derive population size estimates, we used both Mark-recapture and Distance Sampling methods. During each survey, the same trained observer recorded the perpendicular distance between each detected individual (or a nearby reference point, e.g., trees) and the transect centerline using a laser rangefinder (model GLM 30, Robert Bosch GmbH, Leinfelden-Echterdingen, Germany) to ensure measurement accuracy. This approach was based on key assumptions, including perfect detection along the transect line, accurate measurement of distances, and minimal movement of individuals during the survey period (Thomas et al. 2010).

Following distance measurements, we approached iguanas and attempted to catch them using pole snares. We primarily conducted individual marking during the first 3-d survey session at each site. We captured additional individuals encountered during subsequent surveys and we measured them opportunistically when required for identification or data collection. We identified previously marked individuals either through recapture or by visual confirmation of external markings when identification could be reliably made without capture or manipulation. We recorded both recaptures and resightings of marked individuals for analyses. We measured snout-vent length (SVL) and tail length (TL) using a measuring tape, and we recorded body mass (BM) with a spring scale. We conducted population structure analyses based on sex and age-class data. We determined age classes using biometric measurements, and we determined sex only for adult individuals based on external morphology, with males distinguished from females by their bigger size, larger dewlap and a more prominent dorsal crest.

To facilitate individual identification, we marked iguanas following the bead-tagging protocol of Rodda et al. (1988). We made a small perforation in the loose skin beneath the dorsal crest of each iguana using a hypodermic syringe needle and inserted a thin wire carrying four colored beads (approximately 4 mm in diameter). We assigned each iguana a unique bead color combination, ensuring visibility from both sides of the perforation for reliable identification. Additionally, we inserted a passive integrated transponder (PIT tag; BioMark® HPT series, Biomark, Boise, Idaho, USA) under the skin of each iguana before release; however, we recorded few subsequent encounters of marked individuals. Upon completing measurements and marking procedures, we released iguanas at their original capture location.

***Data analysis*.**—We estimated density and detection probability of *C. bakeri* using Distance Sampling models implemented using R (R Core Team 2020) via the distance package (Miller et al. 2019). Detection probability was modeled using a detection function [g(x)], which describes the probability of detecting an individual at a given distance (x) from the survey line (Buckland et al. 1993). These detection functions consist of a key function and adjustment terms to refine model fit (Thomas et al. 2010). The models evaluated included Half-normal, Uniform, and Hazard-rate key functions, both with and without adjustment terms (cosine, simple polynomial, and Hermite polynomial). We based model selection on the Akaike Information Criterion (AIC), where lower AIC values indicate a more parsimonious and statistically supported model (Burnham and Anderson 2002). Mark-recapture-surveys provided limited recapture data, restricting analyses to sex ratio determination only. Sex ratios were tested against an expected 1:1 distribution using Chi-square Goodness-of-fit tests with Yates' Continuity Correction. Differences in recapture rates among sites were tested using Chi-square Test of Independence, with Fisher's Exact Test applied when expected cell counts were low.

Results

Iguana observations were dominated by adults (n = 318, 80.10%), followed by hatchlings (n = 64, 16.12%) and juveniles (n = 15, 3.78%). For adults only, we observed 207 females (66.35%) and 105 males (33.65%), resulting in a significantly female-biased sex ratio of 0.51 males per female ($\chi^2 = 33.35$, df = 1, $P < 0.001$). In contrast, the subset of marked individuals exhibited a sex ratio of 0.82 males per female ($\chi^2 = 0.69$, df = 1, $P > 0.40$), which was not significantly different from 1:1. Of the 71 marked adult iguanas, we recaptured or resighted only 18 individuals, corresponding to a recapture rate of 25.35%. This indicates that a significant proportion of the marked population was not encountered during subsequent surveys. Comparative analysis of recapture rates among sites revealed significant differences (Fisher's Exact Test, $P = 0.013$). We found the highest recapture rates at relatively undisturbed and isolated sites, particularly Turtle Harbour (TH) and Rock Harbour (RH), with recapture probabilities of 0.41 and 0.62, respectively.

We included 448 sightings of *C. bakeri* in the Distance Sampling analysis. The maximum detection

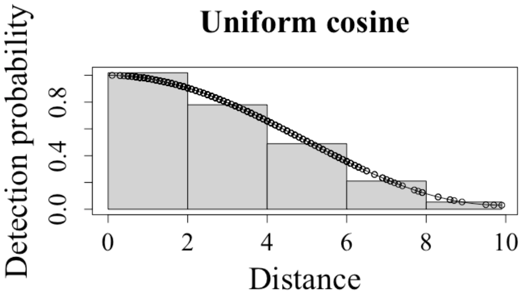

Figure 3. Histogram of perpendicular distance observations for the Utila Spiny-tailed Iguana (*Ctenosaura bakeri*) with the fitted uniform detection function (cosine adjustment).

distance was 9.9 m, with a mean detection distance of 3.11 ± (standard error) 2.04 m. The highest detection frequency occurred within the 0–2 m distance class, followed by a noticeable decline in detectability at distances greater than 4 m. The detection function that best fit the data was the uniform with cosine adjustment model, which yielded the lowest Akaike Information Criterion (AIC) value (1817.425), indicating the best fit between the observed data and the theoretical detection curve (Fig. 3). The model estimated an average detectability of 0.515, indicating that, on average, we detected just over 50% of *C. bakeri* individuals present along the transect.

Density estimates of *C. bakeri* varied across the different sites surveyed on the island (Table 1)). The site Don Quickset, characterized by comparatively high-quality habitat, exhibited the highest estimated density at 32.07 individuals/ha (95% confidence interval [CI] = 14.86–69.20). In contrast, Big Bight, a highly degraded site, showed the lowest estimated density at 6.33 individuals/ha (95% CI = 3.54–11.34). The overall mean density across all sites was 15.31 individuals/ha (95% CI = 11.03–21.25). When extrapolated to the estimated 650 ha of mangrove habitat on the island, this corresponds to a projected total population size of approximately 9,945 individuals (95% CI = 7,176–13,812).

Table 1. Density estimates per hectare of the Utila Spiny-tailed Iguana (*Ctenosaura bakeri*) at sampling sites in Utila, Bay Islands, Honduras, based on distance sampling data collected in 2024. Abbreviations are SE = standard error, lcl = 95% confidence interval lower limit, and ucl = 95% confidence interval upper limit. Sites are AC = Aliah's Channel, DQ = Don Quickset, IB = Iron Bound, OB = Oyster Bed Lagoon, RH = Rock Harbour, TH = Turtle Harbor, BB = Big Bight Pond, WP = Western Path.

Site.	Estimate	SE	lcl	ucl
AC	12.120	6.566	1.370	107.161
DQ	32.068	7.898	14.860	69.200
IB	12.623	7.331	1.244	128.037
OB	15.346	6.844	0.070	3,341.541
RH	17.219	9.001	0.0342	8,665.409
TH	17.033	4.426	8.391	34.573
BB	6.334	0.879	3.540	11.335
WP	9.277	1.887	0.765	112.418
Mean Density	15.311	2.278	11.031	21.251

Discussion

Population size.—Estimating population size in cryptic, habitat-specialist reptiles presents substantial methodological challenges, particularly when detectability is low and heterogeneous across sites. Mark-recapture is often considered advantageous because the method explicitly estimates detection probability rather than assuming perfect detection at the transect line. In our study, however, Mark–recapture approaches were constrained by limited and uneven recapture rates, reducing the precision and reliability of abundance estimates. Low recapture rates may be explained by post-capture avoidance or dispersal of marked individuals. Studies on other herpetofauna have shown that individuals can learn to avoid trap locations after initial experience, which is a form of behavioral avoidance that reduces detectability over time (Hollender and McKnight 2022). Upon initial detection, most *C.bakeri* individuals rely on camouflage to remain undetected, often remaining motionless. A smaller proportion, however, flee to cavities in *A. germinans* trees, seeking immediate refuge. We suspect that individuals previously captured may become more vigilant toward observers, reducing their likelihood of recapture during surveys. Gutsche and Streich (2009) reported low mean individual recapture rates for *C. bakeri*, consistent with the possibility of post-capture behavioral avoidance influencing subsequent detectability.

Good et al. (2020) proposed that reduced resightability of the congeneric Roatán Spiny-tailed Iguana (*C. oedirhina*), may be attributed to hunting activity. For *C. bakeri* , we recorded lower recapture rates in areas adjacent to the urbanized matrix, where anthropogenic pressures are reported to be greater. This pattern suggests that variation in resightability may be negatively influenced by hunting pressure, potentially through increased mortality or heightened behavioral avoidance in disturbed landscapes. Marking failure may have also contributed to this outcome. External tags in our study were prone to loss, likely as a result of prolonged exposure to the saline mangrove environment, which may have accelerated bead deterioration and increased the likelihood of tag failure. Low recapture rates, however, were recorded even with permanent markings.

Distance Sampling, on the other hand, supported by a relatively large number of detections and appropriate model fit, yielded a more stable estimate under the field conditions encountered. Recording of initial locations was facilitated by the species limited flight response, allowing accurate measurement of perpendicular distances. During distance sampling surveys, we detected just over 50% of *C. bakeri* individuals likely to be present along transects. This value reflects a moderate detection probability under the conditions assessed, potentially influenced by factors such as dense vegetation or the cryptic behavior of *C. bakeri*, which perched high in the canopy or hidden in refuges. Burton and Rivera-Milán (2014) studied a translocated population of the Grand Cayman Blue Iguana (*Cyclura lewisi*) and suggested that Distance Sampling, when implemented through carefully designed surveys with representative spatial coverage and sufficient replication, can provide reliable monitoring of wild populations, particularly where individual marking is impractical.

Given substantial site variation in estimated densities associated with differences in habitat condition, the value obtained in this study should be interpreted cautiously as a model-derived range rather than a precise population estimate, with true abundance more appropriately constrained within plausible lower and upper bounds. Beyond providing updated baseline population data for *C. bakeri*, our study underscores the importance of carefully evaluating methodological feasibility when monitoring cryptic species. Although Distance Sampling provided the most stable estimates under the field conditions encountered, future monitoring efforts would benefit from incorporating double-observer protocols, habitat-specific detection covariates, and increased temporal replication. Additionally, future surveys should incorporate habitat stratification and sample representative mangrove types to improve the accuracy of the extrapolation of population estimates.

Despite the limitations of our study, the results provide valuable insights into the population and its trends across the island. The variability in *C. bakeri* density across sites on Utila highlights the heterogeneity of available habitats. The site Don Quickset, located on the western side of the island and distant from urban areas, exhibited the highest estimated density at 32.07 individuals/ha, suggesting a potentially more favorable habitat for the species, likely due to reduced human disturbance and greater habitat quality. In contrast, the site Big Bight, situated within the urban zone and characterized by heavily degraded mangrove, had the lowest density at 6.33 individuals/ha. This stark difference suggests that urban habitat degradation has negatively impacted the *C. bakeri* population in that area.

The population densities of *C. bakeri* in this study were lower than those reported by Gutsche and Streich (2009), who, using Mark–recapture models, estimated adult densities ranging from 44 to 72 and from 78 to 114 adults/ha in areas such as the sites Big Bight Pond and Iron Bound. Based on these mean densities, total population estimates for the mangrove habitat ranged from 57,823 to 93,826 individuals, considering a mangrove area of 1,091 ha. More recently, *C. bakeri* was assessed for the IUCN Red List of Threatened Species in 2018, with a population size between 4,500 and 7,700 individuals, estimated using Distance Sampling models (Daisy Maryon, unpubl. data). This marked variation among estimates underscores the inherent challenges of deriving a precise total population assessment, given methodological constraints and ecological uncertainty. The current estimate of 9,945 individuals of *C. bakeri* in the mangroves of Utila, based on an area of 650 ha, provides a baseline for future research and conservation efforts; however, this figure is alarmingly low for a population facing persistent threats such as habitat destruction, poaching and the presence and expansion of invasive species. These findings underscore the fragility of the species and the urgent need to continue monitoring population trends, especially in the context of increasing urbanization and development that could impact critical habitat.

***Population structure*.**—The predominance of adults over juveniles and hatchlings across all sampling sites in this study aligns with previous findings for *C. bakeri* (Gutsche and Streich 2009; Pasachnik et al. 2012a; Cabrera 2017). Low juvenile and hatchling detections may reflect their small size, cryptic behavior, and habitat use. Hatchlings often remain near the ground, camouflaged among red mangrove roots to avoid predation (Schulte and Köhler 2010), while juveniles frequently shelter in holes and crevices in mangrove trees (Gutsche and Streich 2009). Predation pressure, particularly from raccoons, may also shape population structure. We recorded raccoon tracks and feces at all sites, and these introduced predators are known to target nests and juveniles (Maryon et al. 2018). Island species like *C. bakeri* are particularly vulnerable due to their limited anti-predator defenses (Medina et al. 2011; Doherty et al. 2016; Slavenko et al. 2016; Senior et al. 2021), making the uncontrolled spread of raccoons on Utila a potential threat to the population.

The population sex structure and female-biased observations that we found at most sites align with patterns reported for other stable iguanid populations, including the congener *C. oedirhina* (0.61 male:1.00 female; Pasachnik 2013). For *C. bakeri*, previous studies reported a slight female bias in 2000 (1.00 male:1.30 female) and 2009 (1.00 male:1.20 female; Kuttler 2000; Gutsche and Streich 2009), indicating relative stability, but Pasachnik et al. (2012a) documented a decline in female proportion from 2011 onwards, with a male-biased shift between 2006 (1.04 male:1.00 female) and 2011 (1.67 male:1.00 female), potentially linked to overharvesting of females, as observed in *C. melanosterna* (1.00 male:0.56 female; Pasachnik et al. 2012b). Despite legal protections in the island, hunting continues to exert significant pressure on the *C. bakeri* population (Pasachnik et al. 2012a; pers. obs.). Gravid females are particularly targeted due to high demand for iguana meat and eggs, especially during Easter time (Maryon et al. 2018), and poaching is most concentrated in the eastern part of the island (Gutsche and Streich 2009). In our study, sites located in the urban matrix of the island, such as Oyster Bed Lagoon (1.30 male:1.00 female) and Western Path (1.33 male:1.00 female), exhibited a slight male-biased sex ratio compared to more isolated areas. These patterns underscore the need for strengthened enforcement of hunting regulations and complementary community-based education programs, particularly aimed at protecting reproductive females to maintain population stability.

Management suggestions and conclusion.—The data we report provide a scientific basis for evaluating anthropogenic impacts on *C. bakeri* and its mangrove habitat, thereby informing strengthened legislation and targeted conservation actions. Mangrove loss on Utila has been documented since the early 2000s, coinciding with rapid expansion of real estate development and tourism (Clauss and Wild 2002; Currin 2002; Gutsche and Streich 2009; Fickert and Grüninger 2010; Pasachnik et al. 2012a). The eastern region of the island has been particularly affected, experiencing intense urbanization pressure. In addition to deforestation, mangroves are further degraded by urban waste accumulation near or within these ecosystems, including the main landfill of the island (Canty and Svensson 2007; Maryon et al. 2018).

Given this context, habitat protection should be prioritized. In the heavily impacted eastern region, urgent measures include strengthening land-use planning, relocating the landfill away from mangroves, improving waste management, and increasing awareness among residents and tourists to reduce pressure on critical habitats. In western areas, where populations of *C. bakeri* are more stable, establishing conservation zones and promoting sustainable land stewardship in collaboration with landowners are recommended. On the other hand, effective enforcement of hunting regulations, combined with preventative measures such as regular patrolling of mangroves and nesting beaches, especially during the breeding season, is essential to mitigate poaching impacts on population structure and long-term viability. Lastly, it is crucial to continue the raccoon control program and implement preventive biosecurity measures to avoid the introduction of new invasive species, which could have similarly detrimental impacts on the ecosystem and *C. bakeri* populations.

Several conservation efforts are already underway. Organizations such as the Bay Island Foundation (FIB) and Kanahau Conservation Facility conduct field monitoring of wild populations, while FIB also operates captive breeding and reintroduction programs. Kanahau is implementing an invasive species management plan for raccoons on Utila, including a strategic eradication program. Education and outreach initiatives, such as the Save the Swamper campaign, have further strengthened local engagement and support for *C. bakeri* conservation. Building on the findings of this study, it is essential not only to continue long-term monitoring of wild populations but also to refine and standardize population assessment methodologies to improve accuracy and comparability over time. The integrated efforts combining rigorous scientific monitoring, adaptive management, invasive species control, and community outreach are critical to ensure the long-term persistence of *C. bakeri* on Utila.

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Literature Cited

Bennett, J.R., B.P. Edwards, J.N. Bergman, A.D. Binley, R.T. Buxton, D.E. Hanna, J.O. Hanson, E.J. Hudgins, S. Karimi, C.V. Raymond, et al. 2024. How ignoring detection probability hurts biodiversity conservation. Frontiers in Ecology and the Environment 22: e2782. https://doi.org/10.1002/fee.2782.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press, Oxford, UK.

Burnham, K., and D. Anderson. 2002. Model Selection and Multi-model Inference. 2nd Edition. Springer-Verlag, New York, New York, USA.

Burton, F. J., and F. F. Rivera-Milán. 2014. Monitoring a population of translocated Grand Cayman Blue Iguanas: assessing the accuracy and precision of distance sampling and repeated counts. Animal Conservation 17:40–47.

Cabrera, A.A. 2017. Estado poblacional de *Ctenosaura bakeri* en Utila, Honduras. Tesis de pregrado, Escuela Agrícola Panamericana, El Zamorano, Honduras.

Canty, S.W., and M. Svensson. 2007. Positive and negative impacts of dive tourism: the case study of Utila, Honduras. M.Sc. Thesis, Lund University, Lund, Sweden. 41 p.

Clauss, S., and C. Wild. 2002. Planning of land area use and protected areas as means for sustainable development on the island of Utila, Honduras and possibilities and bounds of sustainable tourism on the island of Utila, Honduras. Combined Diploma Thesis, Technical University of Munich-Weihenstephan, Germany. 173 p.

Currin, F.H. 2002. Transformation of paradise: geographical perspectives on tourism development on a small Caribbean island (Utila, Honduras). M.Sc. Thesis, Louisiana State University, Baton Rouge, Louisiana, USA. 125 p.

de Infante Anton, J.R., A. Rotger, J.M. Igual, and G. Tavecchia. 2013. Estimating lizard population density: an empirical comparison between line-transect and capture–recapture methods. Wildlife Research 40:552–560.

Doherty, T.S., A.S. Glen, D.G. Nimmo, E.G. Ritchie, and C.R. Dickman. 2016. Invasive predators and global biodiversity loss. Proceedings of the National Academy of Sciences 113:11261–11265.

Fickert, T., and F. Grüninger. 2010. Floristic zonation, vegetation structure, and plant diversity patterns within a Caribbean mangrove and swamp forest on the Bay Island of Utila (Honduras). Ecotropica 16:73–92.

Goode, A.B.C., S.A. Pasachnik, and T.L. Maple. 2020. Assessing the status of a threatened island endemic, *Ctenosaura oedirhina,* on Roatán, Honduras. Wildlife Research 47:137–145.

Guillera-Arroita, G. 2017. Modelling of species distributions, range dynamics and communities under imperfect detection: advances, challenges and opportunities. Ecography 40:281–295.

Gutsche, A. 2005. Distribution and habitat utilization of *Ctenosaura bakeri* on Utila. Iguana 12:143–151.

Gutsche, A., and W.J. Streich. 2009. Demography and endangerment of the Utila Island Spiny-tailed Iguana, *Ctenosaura bakeri*. Journal of Herpetology 43:105–113.

Hollender, E.C., Ligon, D.B., and D.T. McKnight. 2022. Learned avoidance of trap locations in freshwater turtles. Wildlife Research 50:465–474.

Kellner, K.F., and R.K. Swihart. 2014. Accounting for imperfect detection in ecology: a quantitative review. PLoS ONE 9: e111436. https://doi.org/10.1371/journal.pone.0111436.

Köhler, G. 1994. Ecology, status and conservation of the Utila Spiny-tailed Iguana *Ctenosaura bakeri.* Iguana Times: 3:12–13.

Kuttler, H.P. 2000. Untersuchungen zur Populationsökologie und zum Ortsverhalten des Utila-Leguans (*Ctenosaura bakeri*). Diploma thesis, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany. 119 p.

Lettink, M., and D.P. Armstrong. 2003. An introduction to using mark-recapture analysis for monitoring threatened species. New Zealand Department of Conservation, Technical Series 28A:5–32.

MacKenzie, D.I., J.D. Nichols, N. Sutton, K. Kawanishi, and L.L. Bailey. 2005. Improving inferences in population studies of rare species that are detected imperfectly. Ecology 86: 1101–1113.

Maryon, D., D. Ardon, A. Martinez, S. Clayson, and S.A. Pasachnik. 2018. *Ctenosaura bakeri.* The IUCN Red List of Threatened Species 2018. International Union for Conservation of Nature. http://www.iucnredlist.org.

McCranie, J.R., L.D. Wilson, and G. Köhler. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah, USA.

McDiarmid, R.W., M.S. Foster, C. Guyer, J.W. Gibbons, and N. Chernoff (Eds.). 2012. Reptile Biodiversity: Standard Methods for Inventory and Monitoring. University of California Press, Berkeley, California, USA.

Medina, F.M., E. Bonnaud, E. Vidal, B.R. Tershy, E.S. Zavaleta, C.J. Donlan, and M. Nogales. 2011. A global review of the impacts of invasive cats on island endangered vertebrates. Global Change Biology 17:3503–3510.

Miller, D.L., E. Rexstad, L. Thomas, L. Marshall, and J.L. Laake. 2019. Distance sampling in R. Journal of Statistical Software 89:1–28. https://doi.org/10.18637/jss.v089.i01.

Pasachnik, S.A., B.M. Fitzpatrick, T.J. Near, and A.C. Echternacht. 2009. Gene flow between an endangered endemic iguana and its widespread relative on the island of Utila, Honduras: when is hybridization a threat? Conservation Genetics 10:1247–1254.

Pasachnik, S.A., C.E. Montgomery, A. Martinez, N. Belal, S. Clayson, and S. Faulkner. 2012a. Body size, demography, and body condition in Utila Spiny-tailed Iguanas, *Ctenosaura bakeri.* Herpetological Conservation and Biology 7:391–398.

Pasachnik, S.A., C.E. Montgomery, L.E. Ruyle, J.P. Corneal, and E.E. Antunez. 2012b. Morphological and demographic analyses of *Ctenosaura melanosterna* across its range: implications for population level management. Herpetological Conservation and Biology 7:399–406.

Pasachnik, S.A. 2013. Growth, reproduction and diet of Roatán Spiny-tailed Iguanas, *Ctenosaura oedirhina,* with notes on the status of the species. Herpetological Conservation and Biology 8:191–198.

R Development Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org.

Rodda, G.H., B.C. Bock, G.M. Burghardt, and A.S. Rand. 1988. Techniques for identifying individual lizards at a distance reveal influence of handling. Copeia 1988:905–913.

Schulte, U., and G. Köhler. 2010. Microhabitat selection in the Spiny-tailed Iguana *Ctenosaura bakeri* on Utila Island, Honduras. Salamandra 46:141–146.

Senior, A.F., M. Böhm, C.P. Johnstone, M.D. McGee, S. Meiri, D.G. Chapple, and R. Tingley. 2021. Correlates of extinction risk in Australian squamate reptiles. Journal of Biogeography 48:2144–2152.

Sewell, D., G. Guillera-Arroita, R.A. Griffiths, and T.J. Beebee. 2012. When is a species declining? Optimizing survey effort to detect population changes in reptiles. PLoS ONE 7:e42357. https://doi.org/10.1371/journal.pone.0043387.

Slavenko, A., O.J. Tallowin, Y. Itescu, P. Raia, and S. Meiri. 2016. Late Quaternary reptile extinctions: size matters, insularity dominates. Global Ecology and Biogeography 25:1308–1320.

Stejneger, L. 1901. On a new species of spiny-tailed iguana from Utila Island, Honduras. Proceedings of the United States National Museum 23:467–468.

Thomas, L., S.T. Buckland, E.A. Rexstad, J.L. Laake, S. Strindberg, S.L. Hedley, J.R.B. Bishop, T.A. Marques, and K.P. Burnham. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5–14.

Zoerner, S., and G. Köhler. 2004. *Ctenosaura bakeri*. The IUCN Red List of Threatened Species 2004. International Union for Conservation of Nature. http://www.iucnredlist.org.

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