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Ocelot (*Leopardus pardalis*) density and activity pattern in a biological corridor, northeastern Mexico

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The ocelot (*Leopardus pardalis* Linnaeus, 1758) is one of six felid species found in Mexico, yet its ecology remains poorly understood. In this study, we assessed the ocelot density and activity pattern in the El Cielo-Sierra de Tamalave (EC-ST) biological corridor located in Tamaulipas, northeastern Mexico. We used camera trapping (52 double stations) to identify individuals based on their coat patterns. To estimate population density, we used the random thinning spatial capture-recapture method (rt-SCR), which integrates spatial information from photographs where individual identification is not possible. This approach allows us to retain and utilize data that would otherwise be discarded, thereby maximizing the use of all available data. We analysed ocelot's activity pattern using circular statistics, and temporal overlap was assessed with potential competitors and prey. The estimated ocelot density was 3.73 (95% CRI: 2.84-4.85) individuals per 100 km², similar to estimates in nearby regions such as Sierra del Abra Tanchipa, San Luis Potosí, Mexico. The ocelot showed a nocturnal activity pattern, likely associated with hunting behaviour, and high temporal overlap with prey species such as rodents, rabbits, and deer. Temporal avoidance of apex predators (*Panthera onca*, *Puma concolor*, and *Ursus americanus*) suggests strategies to reduce risk, while overlap with mesocarnivore like *Urocyon cinereoargenteus* may indicate coexistence probably by prey

partitioning. Our findings highlight the importance of combining density and activity analyses, show that rt-SCR provided reliable and precise estimates under our study conditions. This supports more accurate conservation planning in ocelot populations like those in the EC-ST biological corridor.

Key words: activity pattern, camera trapping, density, northeastern Mexico, ocelot, random thinning spatial capture-recapture.

Ocelot (*Leopardus pardalis*) densidad y patrón de actividad en un corredor biológico, noreste de México

El ocelote (*Leopardus pardalis* Linnaeus, 1758) es una de las seis especies de félidos presentes en México, sin embargo, su ecología aún es poco conocida. En este estudio se evaluó densidad y patrón de actividad del ocelote en el corredor biológico El Cielo–Sierra de Tamalave (EC-ST) localizado en Tamaulipas, noreste de México. Se utilizó el fototrampeo (52 estaciones dobles) para identificar individuos mediante sus patrones de pelaje. Para estimar la densidad de población, utilizamos el método de captura-recaptura espacial con aclareo aleatorio (rt-SCR), que integra la información espacial de fotografías en las que no es posible identificar a los individuos. Este enfoque nos permite conservar y utilizar datos que, de otro modo, se descartarían, maximizando así el uso de todos los datos disponibles. Se analizó el patrón de actividad del ocelote mediante estadística circular y se evaluó el solapamiento temporal con competidores y presas potenciales. La densidad estimada fue de 3.73 (95% CRI: 2.84-4.85) individuos por cada 100 km², similar a estimaciones en regiones cercanas como Sierra del Abra Tanchipa, San Luis Potosí, México. El ocelote mostró un patrón de actividad nocturno, probablemente asociado a su comportamiento de caza y un alto solapamiento temporal con presas como roedores, conejos y venados. La evitación temporal de carnívoros tope (*Panthera onca*, *Puma concolor* y *Ursus americanus*) sugiere estrategias para reducir riesgos, mientras que el solapamiento con un mesocarnívoro como *Urocyon cinereoargenteus* podría indicar una coexistencia probablemente por repartición de presas. Los resultados destacan la importancia de combinar análisis de densidad y patrón de actividad, además muestran que el rt-SCR proporcionó estimaciones confiables y precisas bajo nuestras condiciones de estudio. Este resultado respalda una planificación de conservación más precisa en poblaciones de ocelote como las del corredor biológico EC-ST.

Palabras clave: captura-recaptura espacial con aclareo aleatorio, densidad, fototrampeo, noreste de México, ocelote, patrón de actividad.

The presence and ecological role of carnivores within ecosystems are critical factors influencing their structure and function. Predators such as the ocelot (*Leopardus pardalis*) play essential ecological roles, including regulating herbivore populations, maintaining the balance of food webs, and serving as indicators of habitat health (Catalá 2011; Dickman et al. 2014). Despite its ecological importance, ocelot populations have experienced significant declines as a result of habitat loss and fragmentation, road mortality, and reduced genetic diversity (Bauni et al. 2017; Lombardi et al. 2021; Martinez et al. 2024). Estimating population density provides a quantitative baseline for assessing population status, detecting trends over time, and evaluating the effectiveness of management actions (Janečka et al. 2008). Likewise, understanding activity patterns helps identify temporal overlaps with prey, competitors, and human activities, which is essential for mitigating conflict and designing targeted conservation measures. These measures can include the establishment or restoration of biological corridors to maintain connectivity, the regulation of infrastructure development in key activity zones, and the implementation of temporal restrictions on human activities such as hunting or livestock grazing during peak ocelot movement periods (Dickson et al. 2014). Through density estimation and activity pattern analysis, studies have progressively revealed the behaviour of the ocelot across different regions and vegetation types (Gallo-Viracocha and Urgilés-Verdugo 2022; Frohlich and Nanni 2023; Sternberg et al. 2023). Ocelot density varies according to vegetation type or the presence of competitors rather than due to any latitudinal effect (Boas-Goulart et al. 2009; Carrera-Treviño et al. 2018). These factors, along with habitat quality and human disturbance, contribute to the wide variation in reported densities across the species' range. In Mexico, ocelot densities have ranged from as low as 3 individuals per 100 km² in the Huasteca Potosina region (Martínez-Hernández et al. 2015) to as high as 43.24 individuals per 100 km² in coastal habitats of the Gulf of Mexico, specifically in the Laguna Madre and Rio Bravo Delta (Sternberg et al. 2023). Internationally, extreme values include a maximum of 94.7 individuals per 100 km² in protected Peruvian Amazon forests (Kolowski and Alonso 2010), and a minimum of 0.66 individuals per 100 km² in fragmented landscapes of Bolivia (Ayala et al. 2010). On the other hand, although activity patterns have been recorded in different countries, ocelots are predominantly nocturnal, consistent with their natural hunting behaviour (Pérez-Irineo and Santos-Moreno 2014; Martínez-Hernández et al. 2015; de la Torre et al. 2016). Variations in their activity patterns, including activity during other times of the day, may occur due to the presence of anthropogenic factors that influence their routine (Torres-Romero et al. 2017).

Over time, density estimation techniques have evolved significantly, progressing from basic models to more sophisticated approaches that incorporate individual movement simulations and allow a more realistic analysis of how the species uses space (Jiménez et al. 2022). The use of Bayesian spatially capture-recapture (SCR) models has enabled more accurate density estimates, particularly for elusive species (Anile et al. 2024). In this way, management efforts aimed at developing conservation strategies become more effective, as they are informed by reliable estimates of the current population in a given area.

Despite its broad distribution, the ocelot faces significant threats in Mexico, leading to its classification as an endangered species under the Official Mexican Standard NOM-059 and in the United States of America, particularly in southern Texas, which represents the northernmost limit of its distribution (USFWS 1982; SEMARNAT 2018, 2019). Habitat loss, illegal wildlife extraction, and poaching pose major challenges to the survival of ocelots and their prey, highlighting the urgent need to study their populations and assess the impacts of anthropogenic pressures on this emblematic species. Over the past decades, the ocelot's natural habitat has undergone substantial reductions, primarily due to road construction, high-impact tourism developments, human-induced fires, and deforestation (Blackburn et al. 2021a, 2021b). Recent ecological studies have examined the effects of anthropogenic variables on ocelot populations, particularly their impact on density (Gil-Sánchez et al. 2021; Pasa et al. 2021) and activity patterns (Cruz et al. 2018; Pérez-Irineo et al. 2021).

Tamaulipas is one of the few Mexican states hosting all six native felid species and is home to a diverse range of vegetation types, some of which are protected within extensive protected natural areas such as biosphere reserves Sierra de Tamaulipas and El Cielo, and flora and fauna protection area Laguna Madre y Delta del Rio Bravo (Caballero-Rico 2019). The El Cielo biosphere reserve (ECBR), located within the Sierra Madre Oriental (SMO), functions as a critical biological corridor, facilitating genetic flow between ocelot populations in the neighbouring states of San Luis Potosi and Veracruz (Suárez-Mota et al. 2017). On the other hand, the Sierra de Tamalave is part of a recently established protected natural area (PNA) called Monarch Butterfly Natural Landscape (MBNL). This area is of particular interest as it aims to enhance connectivity among several protected areas through a section of the SMO (GET et al. 2022). Although the El Cielo–Sierra de Tamalave (EC-ST) biological corridor provides well-preserved habitats for ocelot survival, it also contains disturbed areas that may compromise connectivity and population viability (Paolino et al. 2018; Thompson et al. 2020).

To address this gap in knowledge, this study aims to leverage the potential of camera traps to assess ocelot populations by estimating their density and analysing their activity pattern within the EC–ST biological corridor. We also examine the activity of potential prey and competitor species to identify temporal overlaps and gain a deeper understanding of the species’ ecological dynamics and behavioural adaptations. By integrating interdisciplinary research approaches, this study will not only contribute to population density and activity pattern knowledge on ocelots but also inform data-driven conservation and management strategies to ensure their long-term persistence.

Methods

2.1. Study area

The study was conducted in the El Cielo–Sierra de Tamalave (EC–ST) biological corridor, located in southern Tamaulipas, Mexico (22°54’ N; 99°10’ W). The EC-ST biological corridor connects two mountainous regions in northeastern Mexico: the El Cielo protected natural area, designated as a biosphere reserve, and the Sierra de Tamalave, a portion of which is included within the recently established protected natural area Monarch Butterfly Natural Landscape. The EC–ST biological corridor spans elevations ranging from 200 to 2,200 meters above sea level and covers a total area of 2,711 km², preserving tropical forest, xerophytic scrubland, temperate forest, and even the northernmost distribution of cloud forest (Ochoa-Espinoza et al. 2023). The rainy season in the region extends from April to October, while the dry season occurs from November to March (Carrera-Treviño et al. 2018). Both protected natural areas are part of the SMO biogeographic region, a corridor of great importance for species migrating from the north. Additionally, their location promotes the coexistence of nearctic and neotropical species (Contreras-Díaz et al. 2021).

2.2. Camera-trapping

A total of 52 paired camera trap stations were deployed from February 01 to July 14, 2023 (Fig. 1), primarily within tropical forest. Infrared-triggered camera traps (Cuddeback H-1453, StealthCam QS20NGK and ScoutGuard SG565 models) were used. Cameras were programmed to capture two photographs per detection event, with medium sensitivity and a minimum delay interval (5 seconds), and were positioned approximately 50 cm above the ground. The distance between stations ranged from 1 to 3 km, based on the movement range of the target felid species (Satter et al. 2019). No bait was used to attract wildlife. Camera traps were placed in locations that favoured the detection of the species, such as trails, natural paths, or areas with signs of presence, in order to maximize detection rates and obtain a robust sample size.

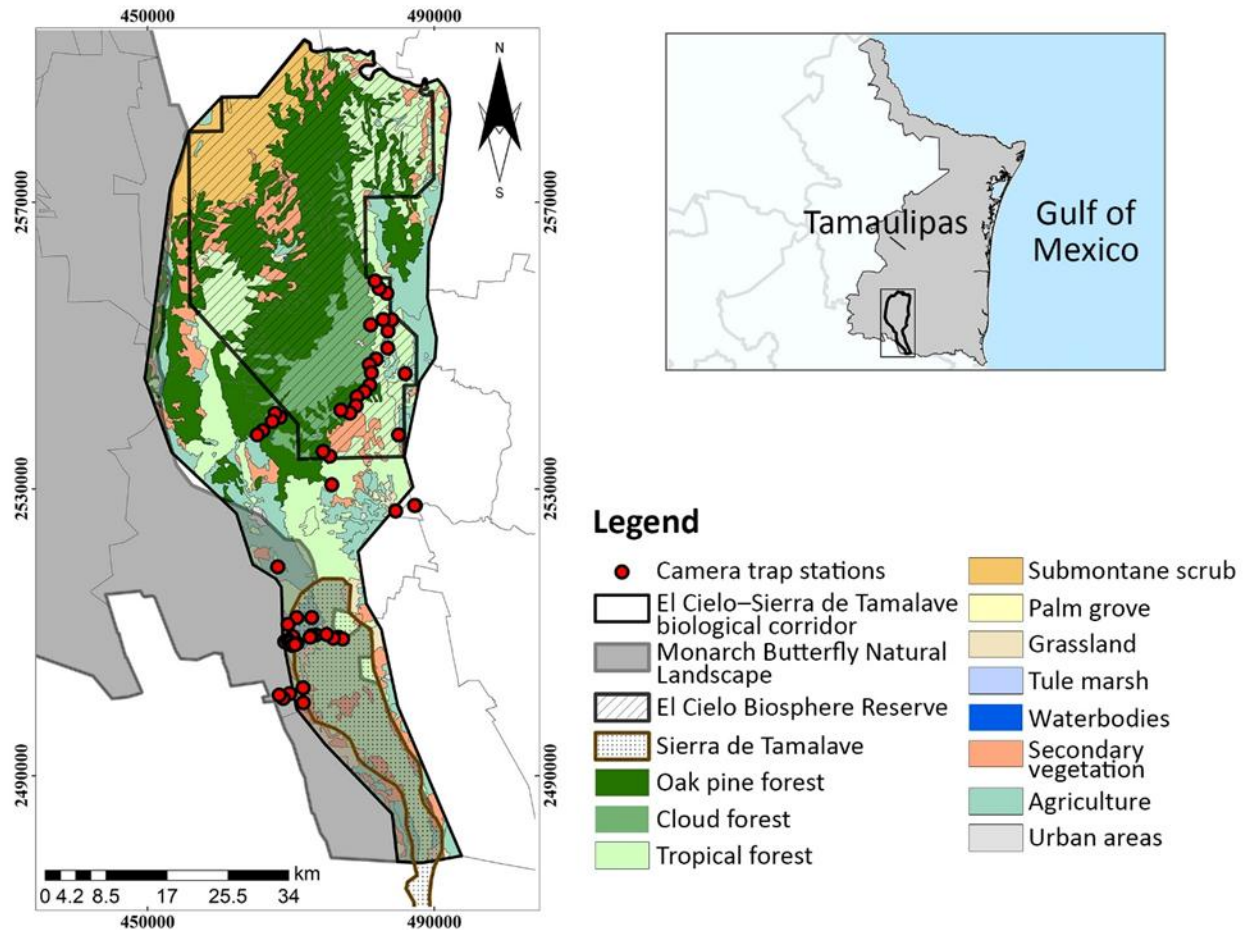


Fig. 1 Monitoring points with paired camera trap stations in the El Cielo–Sierra de Tlalave biological corridor, Tamaulipas, Mexico

2.3. Individual identification

Individual identification of ocelots in the photo captures was performed by one of the authors based on morphological and phenotypic characteristics, primarily the unique spot pattern of each individual (Aranda 2012). Sex determination was conducted by observing the presence of the scrotal sac in males and its absence in females. Image processing and management were carried out using DigiKam® software, which facilitated the tagging and organization of metadata for each photograph. Based on this, unique alphanumeric codes were assigned to each individual and incorporated into their respective captures (Pérez-Solano 2019).

Subsequently, we used R software with the `camtrapR` package (Niedballa et al. 2016) to generate a structured database from the metadata extracted from each photo capture. Using this information, we constructed three-dimensional matrices (individual, trap, and occasion) for ocelots identified by both flanks (see supplementary

material). In this analysis, we included blurry partial photo captures of the left flank that would have been discarded. Excluding them could reduce sample size and compromise the reliability of density estimates for this species (Jiménez et al. 2021). For non-identified detections, two-dimensional matrices (station and occasion) were generated to enable random thinning spatial capture-recapture analysis.

2.4. Density

We estimated ocelot population density within a Bayesian framework using R (R Core Team 2025), applying random thinning spatial capture-recapture approach (Jiménez et al. 2021). This modelling framework incorporates spatial information from individual capture histories to estimate density. To assess the validity of the closed population assumption and determine whether it held, we applied the *closure.test* function from the *secr* package (Efford 2025). For this purpose, we restricted analyses to detections obtained between February 01 and June 10, a time window within the total sampling period that best met the assumption of demographic closure.

In spatial capture-recapture (SCR) models, individual activity centres (ACs), is denoted by $s = (s_x, s_y)$ for each individual $i = 1, 2, \dots, N$, that are distributed within a defined area or state space (S). Detection events are recorded through a network of camera traps systematically deployed across S . In our study, we modelled the spatial distributions of individual ACs using a homogeneous point process, assuming that $s_i \sim \text{Uniform}(S)$. These ACs are treated as latent variables within the model framework and are inferred from detection data collected across a set of camera traps $j = 1, 2, \dots, J$, located at coordinates $x_j = (x_{j1}, x_{j2})$.

Under the standard SCR framework, the probability of detecting an individual declines as the Euclidean distance d_{ij} increases between its activity centre s_i and the location of a camera trap x_j . This spatial relationship was incorporated into the model using the following detection function:

$$\lambda_{ij} = \lambda(s_i, x_j) = \lambda_0 \times \exp\left(-\frac{d_{ij}^2}{2\sigma^2}\right)$$

In this formulation λ_0 represents the baseline detection rate, corresponding to the scenario where the distance $d_{ij} = 0$ and σ functions as the scale parameter of the half normal detection curve. This parameter reflects the spatial extent of individual movements and can be interpreted as a proxy for the mobility characteristics of the target species. In Bayesian SCR frameworks where the true population size N is unknown, data augmentation techniques allow for the estimation of unobserved individuals by introducing latent variables that represent potential but undetected members of the population (Royle et al. 2013).

$$z_i \sim \text{Bern}(\psi)$$

In this framework, z_i represents a partially latent binary indicator that denotes whether individual i is a true member of N , and the parameter ψ of the M data augmentation, and the membership of individual i in the population:

$$y_{ijk}^{full} | z_i \sim \text{Poisson}(\lambda_{ij} \cdot z_i)$$

To account for detection events lacking individual identification, the model was extended using rt-SCR approach (Jiménez et al. 2021). The assignment of individual identities to samples can be modelled as a “random thinning” process, in which each sample retains its identity with probability θ and loses it with probability $1 - \theta$. Thus, the random thinning process yields two distinct data sets: one consisting of detections with confirmed individual identities, and another comprising encounters lacking individual identification. This model incorporates a sub model for model for individual identification y_{ij}^{ID} , conditional on the true encounter frequencies y_{ij}^{full} , assuming:

$$y_{ij}^{ID} \sim \text{Binomial}(y_{ij}^{full}, \theta)$$

The unidentified encounter frequencies y_{ijk}^{noID} remain latent, with $y_{ij}^{noID} = y_{ij}^{true} - y_{ij}^{ID}$. For unidentified samples, only the aggregate counts in each camera trap summed across captured individuals, defined as $nnid_{jk} = \sum_{i=1}^N y_{ijk}^{noID}$, can be observed (Royle et al. 2013; Efford 2019). A single individual may contribute to both encounter histories—identified and unidentified—within the same camera trap.

The rt-SCR model was implemented in R and Nimble, with a Metropolis-Hastings update for y_{ij}^{full} that follows the constraint $y_{ij}^{noID} = y_{ij}^{full} - y_{ij}^{ID}$.

The state space (habitat mask), we implemented the zero’s trick in NIMBLE, buffering the trap array by three times the estimated value of σ (6,276 m, based on a preliminary fit). Beyond this buffered region, individuals are assumed to have and effectively negligible probability of detection and are therefore treated as undetectable within the model framework (Royle et al. 2013). Although density estimates tend to remain stable with buffer sizes exceeding 3σ , this threshold ensures that the model concentrates on individuals with a meaningful probability of exposure to the detection array (Jiménez et al. 2021). Consequently, the zero’s trick confines inference to individuals with a plausible probability of detection, thereby enhancing both the ecological validity of the model and its statistical efficiency.

Given the apparent heterogeneity in detections—where some stations recorded more detections than expected under random conditions, while others recorded none—the null model was compared to a model incorporating a random effect in detection, using the Widely Applicable Bayesian Information Criterion (WAIC: Watanabe 2013).

Bayesian models were implemented using Markov Chain Monte Carlo (MCMC) methods with three chains, each consisting of 60,000 iterations each, including a burn-in of 10,000 iterations and thinning every 5 steps, yielding 30,000 posterior samples per parameter. Model convergence was assessed using the Gelman-Rubin diagnostic ($\hat{R} < 1.1$) and visual inspection of trace plots (Gelman et al. 2013). For point estimates we reported posterior means, except for population size, where we used posterior medians due to skewness. Uncertainty was expressed using 95% Bayesian credible intervals (CRIs). For the goodness-of-fit (GoF) test we generated simulated detection data for all M individuals in rows and J columns for the detectors using the MCMC process. We plotted the observed and posterior predictions for each statistic, and we calculated the Bayesian p -value (used to measure the dissimilarity between observed data and model-predicted data). The GoF was evaluated based on three statistics: total detections, number of detected individuals, and number of visited camera traps (Jiménez et al. 2022). Data and R/NIMBLE code used in the analysis are available in the Zenodo repository: <https://doi.org/10.5281/zenodo.16950785>

2.5. Activity pattern

Independent ocelot records obtained through camera trapping were grouped into 24 hourly categories starting at 00:00 h. Each record was classified into one of four activity categories: diurnal, nocturnal, crepuscular (dawn and dusk), or cathemeral (uniform activity throughout the day) (Bennie et al. 2014; Ikeda et al. 2016). For this classification, the exact date and time of each detection were used, and sunrise and sunset times were determined using the online Time and Date platform (Time and Date 2023).

A database was created in Microsoft Excel (version 2308), incorporating the camera ID, date, and time of each detection. Time was converted into decimal format, and the database was exported as a .csv file for analysis in R (R Core Team 2023) using RStudio. The activity pattern was analysed through circular statistics, using the `circular` package (Agostinelli and Lund 2017; López-Tello 2019).

To assess activity directionality, Rayleigh's test of uniformity (z) was applied for unimodal distributions, and Rao's spacing test (U) was used for bimodal or multimodal distributions. These tests allowed us to determine whether activity was significantly oriented (e.g., diurnal, nocturnal, or crepuscular), or randomly distributed, suggesting a cathemeral pattern (Sánchez-Reyes et al. 2009; Zar-Jerrold 2010; Oliveira-Santos et al. 2012).

Based on a literature review, we identified key prey species and potential spatial and trophic competitors of the ocelot across its distribution, with emphasis on records from Mexico (de Villa-Meza et al. 2002; Abreu et al. 2008; Booth-Binczik et al. 2013; Dias et al. 2018; Contreras-Díaz et al. 2021; Branney et al. 2023; Ruiz-Gutiérrez et al. 2023). Only species that were actually detected within the EC–ST biological corridor through camera traps were included in the analysis.

Temporal overlap between the ocelot and these species was estimated using the area under the minimum of two kernel density curves, based on the hourly times of independent photographic events. This method assumes that the detections represent random samples from an underlying continuous temporal activity distribution (Sánchez-Reyes et al. 2009). Only species with more than 30 independent records were included (Fonseca-Prada et al. 2023).

To quantify these patterns more precisely, we calculated the overlap coefficient (Δ Dhat), choosing the estimator based on the smallest sample size between each species pair: Δ_1 for sample sizes <50 , Δ_4 for sizes >75 , and Δ_1 for intermediate sizes (50-75), following a conservative approach (Ridout and Linkie 2009; López-Tello 2019). Overlap values ranged from 0 (no overlap) to 1 (complete overlap), and were interpreted as follows: low ($\Delta < 0.50$), moderate ($0.50 < \Delta < 0.70$), and high ($\Delta > 0.70$), as proposed by Monterroso et al. (2014), Massara et al. (2018), and Contreras-Díaz et al. (2021).

All analyses were conducted using the `overlap` package in R (Meredith and Ridout 2020), and comparative plots were generated to visualize the temporal overlap between the ocelot and its potential competitors or prey. Data and R code used in the analysis are available in the Zenodo repository: <https://doi.org/10.5281/zenodo.16970591>

Results

Between February and June 2023, a total sampling effort of 4,732 trap-days was achieved. During this period, we recorded 165 ocelot detections. From 147 events, 33 individuals were identified, resulting in a total of 60 recaptures. Most detections ($n = 22$) occurred at a camera located near a fenced area containing remnants of tropical forest and secondary vegetation, within a private land in the municipality of Ocampo, on the Sierra de Tamalave. In addition to the identified records, 18 unidentified records were included in the analysis to enable the use of random thinning-SCR.

Two males, OM36 and OM43, accounted for the highest number of detections ($n = 21$ and $n = 19$, respectively). In terms of sex identification, 6 females, 18 males, and 9 unsexed individuals were recorded.

The model including a random effect by site in detection was selected (WAIC = 148.56) over the null model (WAIC = 149.87). Results from the closure test indicated that the closure assumption was not violated ($Z = -1.28$, $p = 0.099$). The estimated population size was $N = 50$ individuals (95% CRI: 38–65), with a density of 3.73 individuals/100 km² (95% CRI: 2.84–4.85). The spatial scale parameter, σ —descriptive of movement—was estimated at 2.10 km (95% CRI: 1.75–2.45). The coefficient of variation (CV) for the population size estimate was 0.14.

The GoF was satisfactory across the three evaluated statistics, with Bayesian p -values of 0.82 for total detections, 0.35 for detected individuals, and 0.37 for camera traps visited (Fig. 2). Predicted activity centres (Fig. 3) indicated a higher concentration of ocelot in the northern sector of the study area.

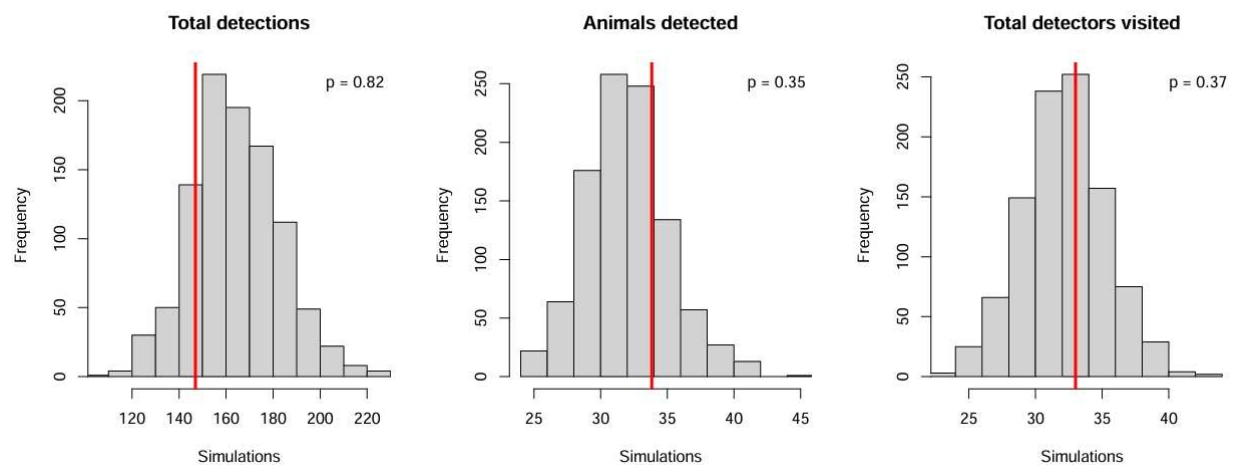


Fig. 2 Comparison of observed values (red lines) with posterior predictive distributions generated by the random thinning spatial capture-recapture model. The corresponding Bayesian p -values appear in the top right of each histogram

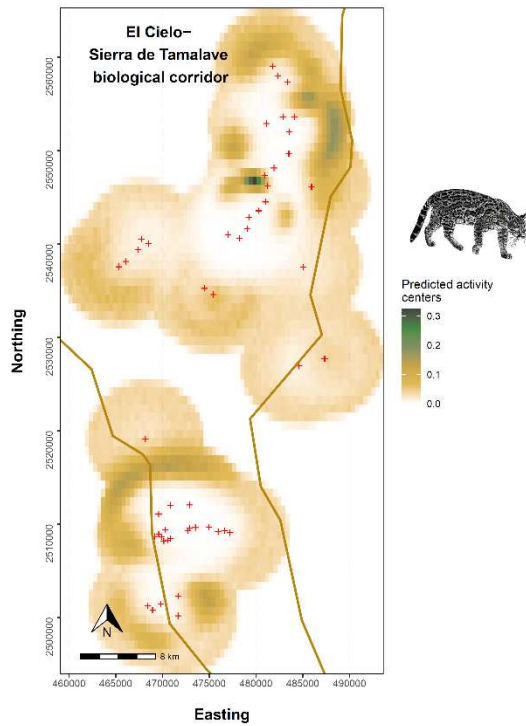


Fig. 3 Predicted distribution of ocelot activity centres in the El Cielo–Sierra de Tamalave biological corridor, Tamaulipas, Mexico, derived from random thinning spatial capture-recapture modelling of spatial detection histories. Camera trap locations are shown as red crosses

Regarding activity patterns, based on data from the entire sampling period with a total of 8,528 trap-days, the ocelot exhibited a nocturnal activity distribution (Rayleigh's $z = 0.58$, $p < 0.05$), with two distinct activity peaks: one between 04:00 and 05:00 h ($n = 26$ detections) and another between 23:00 and 00:00 h ($n = 22$ detections) (Fig. 4). Minimal activity was observed during daylight hours.

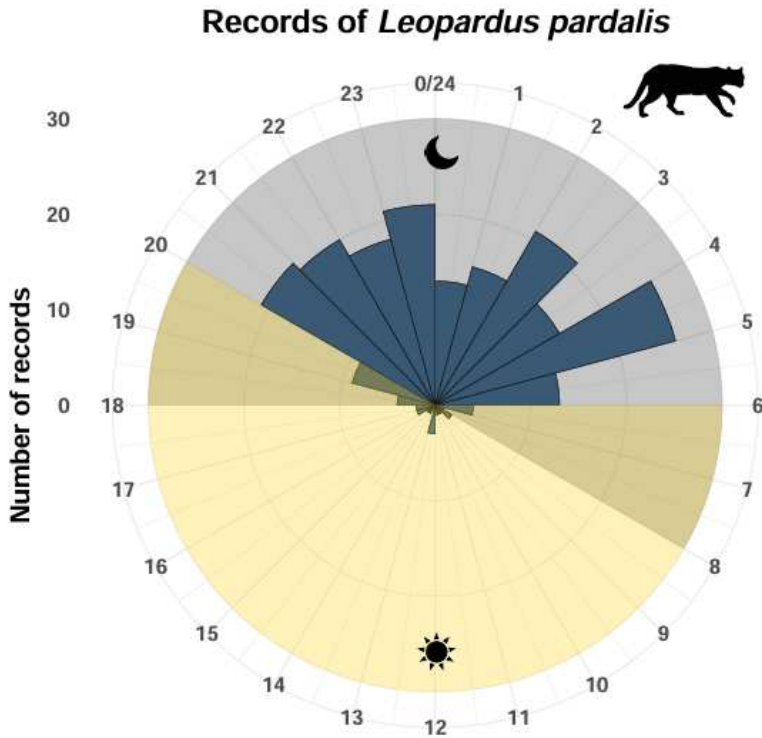


Fig. 4 Activity pattern of ocelot in the El Cielo–Sierra de Tamalave biological corridor, Tamaulipas, Mexico. The figure shows a circular histogram in which the numbers around the perimeter represent the 24 hours of the day. Yellow areas indicate daylight hours, grey areas represent nighttime hours, and the blue bars correspond to the number of photographic records per hour

Based on the minimum number of records required for overlap analysis, jaguar (*Panthera onca*), cougar (*Puma concolor*), grey fox (*Urocyon cinereoargenteus*), and black bear (*Ursus americanus*) were identified as potential competitors. Jaguarundi (*Herpailurus yagouaroundi*), margay (*Leopardus wiedii*), and bobcat (*Lynx rufus*) were excluded due to having fewer than 30 independent records. As for potential prey species, lowland paca (*Cuniculus paca*), central american red brocket (*Mazama temama*), white-nosed coati (*Nasua narica*), white-tailed deer (*Odocoileus virginianus*), and eastern cottontail (*Sylvilagus floridanus*) were included in the analysis, while nine-banded armadillo (*Dasypus novemcinctus*), common opossum (*Didelphis marsupialis*), and virginia opossum (*D. virginiana*), was excluded for not meeting the minimum record threshold.

Regarding the overlap analysis results, among the competitors, jaguar ($\Delta_4 = 0.77$) and grey fox ($\Delta_1 = 0.74$) showed high temporal overlap with the ocelot, followed by cougar ($\Delta_1 = 0.57$) with moderate overlap, and black bear ($\Delta_1 = 0.41$) with low overlap (Fig. 5).

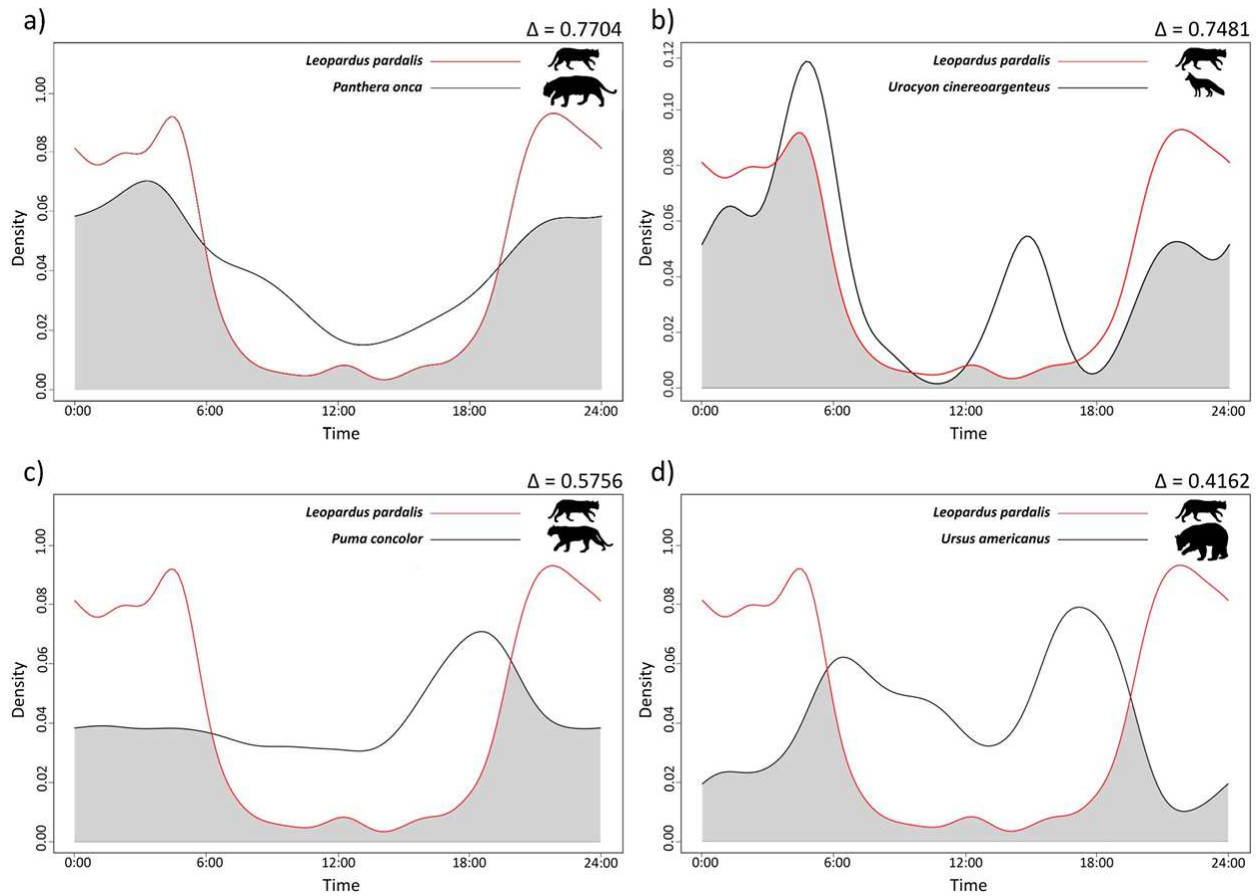


Fig. 5 Activity patterns of the ocelot and its competitors in the El Cielo–Sierra de Tamalave biological corridor, Tamaulipas, Mexico. The red line represents ocelot activity; the black line represents the activity of the competitor species. The grey area indicates the time period during which both species' activities overlap. a) jaguar (*Panthera onca*), b) grey fox (*Urocyon cinereoargenteus*), c) cougar (*Puma concolor*), and d) black bear (*Ursus americanus*)

Among the potential prey species, lowland paca ($\Delta_4 = 0.82$) exhibited high temporal overlap with the ocelot. Moderate overlap was found with eastern cottontail ($\Delta_4 = 0.67$) and central american red brocket ($\Delta_4 = 0.53$), while white-tailed deer ($\Delta_4 = 0.34$) and white-nosed coati ($\Delta_4 = 0.34$) showed low overlap values (Fig. 6).

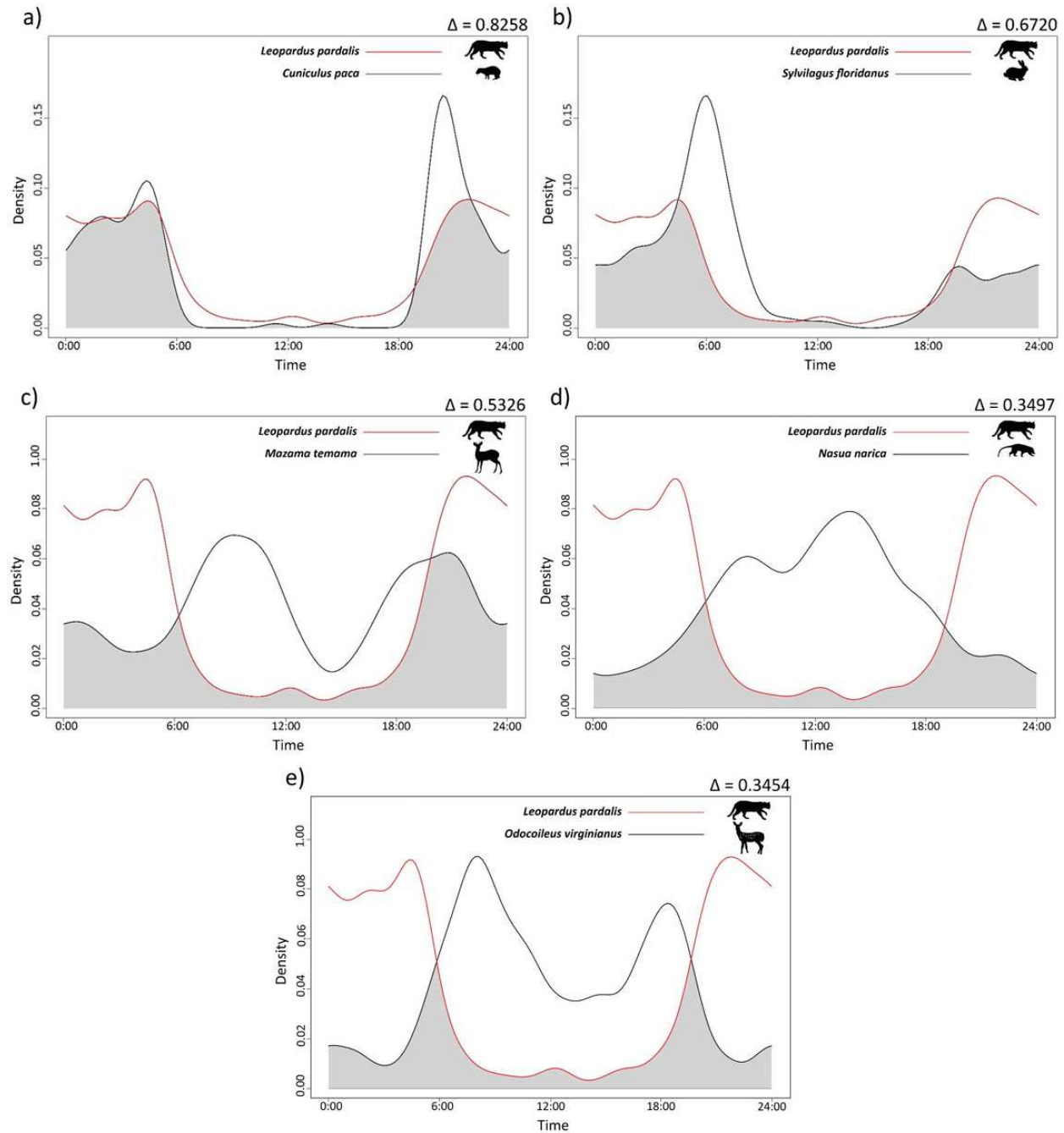


Fig. 6 Activity patterns of the ocelot and its potential prey species in the El Cielo–Sierra de Tamalave biological corridor, Tamaulipas, Mexico. The red line represents ocelot activity; the black line represents the activity of the prey species. The grey area indicates the time period during which both species' activities overlap. a) lowland paca (*Cuniculus paca*), b) eastern cottontail (*Sylvilagus floridanus*), c) central american red brocket (*Mazama temama*), d) white-nosed coati (*Nasua narica*), and e) white-tailed deer (*Odocoileus virginianus*)

Discussion

Estimating population density is a critical step for understanding the conservation status of the ocelot (*L. pardalis*) in Mexico, particularly in the northeastern portion of its range where the species reaches its distributional limit. Reliable density estimates provide essential information for evaluating population viability, identifying priority areas for conservation, and guiding management actions in landscapes increasingly affected by habitat loss and human activity. In the country, studies on ocelot density remain scarce and geographically biased toward southern regions, leaving a significant knowledge gap for populations in the north.

To partially fill this gap, the results of our study indicate that the density of ocelot was 3.73 individuals/100 km² (95% CRI: 2.84–4.85) and is within the lower range of values previously reported for the species in northeastern Mexico. For example, in the Sierra del Abra Tanchipa, a mountainous region adjacent to our study site, densities between 3 and 18 individuals/100 km² were reported (Martínez-Hernández et al. 2015). Similarly, telemetry studies conducted in the Lower Rio Grande Valley, Texas, found densities around 3 individuals/100 km² (Haines et al. 2006). In contrast, substantially higher values have been documented in nearby areas such as Laguna Madre (43.24 individuals/100 km²) and the Sierra de Tamaulipas (28.19 individuals/100 km²) (Sternberg et al. 2023).

Beyond Mexico, comparisons at the international scale provide further context. Internationally, ocelots have been recorded at higher densities, from 22.34 individuals/100 km² in the Pantanal (Trolle and Kéry 2005) to over 90 individuals/100 km² in the Peruvian Amazon (Kolowski and Alonso 2010), reflecting differences in prey availability, human impact, and landscape connectivity (Table 1).

Taken together, these contrasting estimates highlight the influence of multiple ecological and methodological factors, these variations in ocelot density may be attributed to multiple ecological and methodological factors. Differences in habitat continuity, human disturbance, and prey availability likely play a key role (Boas-Concone et al. 2025). Moreover, the EC-ST biological corridor lies within a biogeographic convergence zone between the Neotropical and Nearctic realms, which supports a unique assemblage of carnivores. The confirmed presence of three apex predators jaguar, cougar, and black bear may be exerting top-down regulatory pressure on ocelot populations via competition or intraguild predation (Soria-Díaz et al. 2017; Contreras-Díaz et al. 2021). These interactions can suppress mesocarnivore densities and influence their spatial behaviour, as observed in other carnivore guilds (Allen et al. 2024). Given the location of the jaguar's activity centres in the area (Manuel-de la Rosa,

pers. comm.), it cannot be ruled out that the heterogeneity detected in the ocelot model may be a consequence of interaction with the jaguar.

In addition to ecological interactions, another major contribution of this study lies in its use of Bayesian spatial capture–recapture models incorporating random thinning, representing the first application of this method for ocelots in Mexico. Traditional SCR models rely exclusively on high-confidence individual identifications, which leads to the exclusion of a substantial number of photographic records particularly those that are blurry, obscured, or taken at suboptimal angles. By contrast, random thinning allows for the inclusion of partial records by probabilistically integrating them into the model structure, thus minimizing data loss (Jiménez et al. 2021) although in this case, with numerous identified detections, the expected improvement from using random thinning-SCR would likely be limited.

This methodological advance is especially valuable for cryptic and low-density species, where detection rates and recapture probabilities are inherently low. In recent years, random thinning has gained attention for its ability to enhance parameter estimates and reduce bias in spatial models (Anile et al. 2024). Comparative studies in other carnivores have demonstrated its efficacy in retaining ecological signal while managing uncertainty in individual recognition.

Table 1. Ocelot density estimates across its geographical distribution.

Country	Study area	Method	Density	Year	Reference
EE. UU.	Rio Grande Valley	CR	30	2003–2004	Haines et al. 2006
Mexico	Sierra de Tamaulipas		28.19		
	Laguna Madre y Delta del Rio Bravo	SCR	43.24	2017	Sternberg et al. 2023
	El Cielo-Sierra de Tamalave biological corridor	rt-SCR	3.80	2023	This study
	Nacori Chico	SCR	4.33	2009	Greenspan et al. 2020
	Northern Jaguar Reserve	CR	0.24	2010–2012	Gómez-Ramírez et al. 2017
	Sierra Abra-Tanchipa	CR	4	2011–2012	Martínez-Hernández et al. 2015
	Los Chimalapas	CR	22–38	2011–2013	Pérez-Irineo and Santos-Moreno 2014
	Selva Lacandona	CR	12.9	2007–2008	de la Torre et al. 2016
	El Eden Ecological Reserve	CR	14	2008	Torres-Romero et al. 2017
Belize	Chiquibul	CR	12.61	2003–2004	Dillon and Kelly 2008
	Broadleaf forest sites	Open-SCR	6.5 – 14.7	2004–2016	Satter et al. 2019
Guatemala	El Burral Central biological corridor	SCR	13.06	2008	Contreras et al. 2016

Costa Rica	Talamanca-Caribbean Biological Corridor	CR	6.4	2009	González-Maya and Cardenal-Porras 2011
Panama	Cana	CR	62.7	2005	Moreno and Bustamante 2009
	Barro Colorado Island	SCR	15.87	2012	Rodgers et al. 2014
Colombia	Valle del Cerrejon	CR	24	2013–2014	Padilla-Rivera et al. 2020
	Palmarito	CR	23	2009	Díaz-Pulido and Payán-Garrido 2011
	Bojonawi Nature Reserve	SCR	1.8	2018	Garrote et al. 2019
Ecuador	Tiputini Biodiversity Station	CR	41.5	2010–2011	Mosquera et al. 2016
	Lorocachi (Yasuni)	CR	34.8	2008–2009	Salvador and Espinosa 2016
Peru	Peruvian Amazon	CR	94.7	2008	Kolowski and Alonso 2010
	Las Piedras River	CR	70	2012–2013	Castagnino-Vera 2017
Bolivia	Hondo River	SCR	0.66	2005	Ayala et al. 2010
	Gran Chaco	SCR	19	2002–2004	Maffei and Noss 2008
Brazil	Pantanal	CR	22.34	2004	Trolle and Kéry 2005
	Caraguata Ecological Reserve	CR	4	2006	Boas-Goulart et al. 2009
Argentina	San Pablo Reserve	CR	15.2	2021	Frohlich and Nanni 2023
	Urugua-i Provincial Park	CR	7.7	2004	Di Bitetti et al. 2006

Method: CR = non-spatial capture-recapture; rt-SCR = random thinning spatial capture-recapture; SCR = spatial capture-recapture

For species like the ocelot, with complex coat patterns and variable camera conditions in the field, this method can be crucial to extract maximum information from datasets that would otherwise be partially discarded.

Complementing these density estimates, our behavioural analyses revealed that the ocelot exhibited a nocturnal activity pattern, with two distinct peaks between 04:00–05:00 and 23:00–0:00 h. This pattern is consistent with observations in other Mexican regions, where ocelots have been shown to be predominantly nocturnal (Ayala et al. 2010; Pérez-Irineo and Santos-Moreno 2014; Martínez-Hernández et al. 2015; de la Torre et al. 2016). Studies conducted in or near the EC-ST region have also reported similar nocturnal and bimodal patterns (Carrera-Treviño et al. 2018).

To interpret these activity patterns, several hypotheses have been proposed to explain this behaviour. One suggests that ocelots follow the temporal activity of their main prey, many of which are also nocturnal (Salvador and Espinosa 2016; Penido et al. 2017). Another proposes that nocturnality may reduce the risk of encounters with humans or larger predators, particularly in areas with moderate disturbance (Santos et al. 2019). Interestingly, some studies have

shown that even under conditions of high human presence, ocelots retain their nocturnal activity patterns, suggesting limited behavioural plasticity in response to anthropogenic factors (Sandoval-Serés et al. 2022). In our study area, the relatively low human density and habitat buffering may allow ocelots to maintain their natural temporal rhythms without the need to shift activity to avoid disturbance.

When examining overlap with sympatric carnivores, the highest temporal overlap of the ocelot was observed with jaguar. The high overlap with jaguar may reflect temporal coincidence rather than spatial coexistence. Several studies have shown that smaller carnivores, such as the ocelot, often adjust their activity patterns to avoid encounters with larger intraguild competitors (de Oliveira et al. 2010; Oliveira-Santos et al. 2012). This strategy could explain the moderate overlap observed with cougar, suggesting that the ocelot may be shifting its activity to reduce the likelihood of direct interactions. Such behavioural adjustments may represent an adaptive response to the risk of predation or competitive exclusion, especially considering that both jaguars and cougars have been reported to occasionally prey on ocelots (Emmons 1988; Murray and Gardner 1997; Perera-Romero et al. 2021).

In contrast to these interactions between felids, the low overlap with black bear may be related to this species' more flexible and variable activity patterns, which are largely influenced by the seasonal availability of plant-based foods. Given that up to 70% of its diet consists of plant material, the black bear tends to be active during daylight and crepuscular hours (Bridges et al. 2004; Martínez-González et al. 2025), resulting in reduced temporal overlap with the primarily nocturnal ocelot.

Shifting from interspecific interactions to prey dynamics, our results are consistent with previous studies indicating that some felids, such as the ocelot, adjust their activity patterns in response to those of their prey, showing a “mirror effect” (Weckel et al. 2006; Harmsen et al. 2011; Hernández-SaintMartín et al. 2013). In fact, the ocelot’s nocturnal-crepuscular activity coincides with that of pacas, which are mostly nocturnal (Dias et al. 2018; Sandoval-Serés et al. 2022).

The moderate overlap observed with eastern cottontail also supports previous findings that identify it as one of the ocelot’s main prey species in other regions (Sánchez et al. 2008; Booth-Binczik et al. 2013). Outside the survey period but within the study area, we obtained photographic evidence of an ocelot carrying an eastern cottontail in its mouth, confirming active predation of this species (see supplementary material).

Both red brocket deer and white-tailed deer have also been reported in the ocelot’s diet (de Villa-Meza et al. 2002; Abreu et al. 2008; Booth-Binczik et al. 2013), although predation likely focuses on juveniles or subadults due to their

smaller size and reduced ability to defend themselves. This is particularly relevant for white-tailed deer, which can reach up to 150 kg in adult males (Ceballos 2014). Their low to moderate temporal overlap with the ocelot in our study may be explained by their primarily diurnal activity, a strategy that likely reduces predation risk from nocturnal carnivores and helps avoid apex predators (Martínez-González et al. 2025).

The white-nosed coati showed one of the lowest overlap values with the ocelot. This could be due to several ecological or behavioural factors, such as its diurnal activity pattern, group-living behaviour, and potential use of open areas, which may reduce the likelihood of temporal and spatial encounters with the ocelot (Pérez-Irineo and Santos-Moreno 2016). Additionally, the white-nosed coati's foraging strategies and group vigilance may make it a less accessible or less preferred prey for solitary predators such as the ocelot (Reid and Gómez-Zamora 2022).

Overall, these results underscore the importance of understanding both the spatial and temporal ecology of ocelot is crucial for its conservation. The species is currently listed as Endangered in both Mexico and the United States (USFWS 1982; SEMARNAT 2019), and its persistence depends heavily on the availability of prey (Martins-Wolff et al. 2019), habitat connectivity, and low levels of human-induced mortality. Overhunting of prey species could further disrupt trophic dynamics and intensify intraguild competition (Palomares and Caro 1999; Tlapaya and Gallina 2010), emphasizing the importance of protecting large, contiguous areas of forest with minimal disturbance.

This study demonstrates that ocelot density within the EC-ST biological corridor is at the lower end of values reported for the species across its range. Such reduced densities are likely shaped by a combination of ecological factors, including prey availability, habitat continuity, and potential interactions with larger predators. In other hand, the application of Bayesian rt-SCR models provided reliable and precise density estimates, demonstrating their suitability for monitoring elusive carnivores in heterogeneous landscapes. Complementarily, activity pattern analyses revealed the predominantly nocturnal behaviour of ocelots, consistent with an efficient hunting strategy and temporal coexistence with apex predators such as jaguar, cougar, and black bear provides the first evidence of their co-occurrence with ocelots in this region, emphasizing its role as a key area for the coexistence of multiple carnivore species and other mammals. These behavioural insights underscore the value of activity patterns as a tool to evaluate species responses to ecological and anthropogenic pressures. In this context, the construction of a highway crossing parts of the EC-ST biological corridor represents a critical threat to wildlife populations, and monitoring activity patterns may help assess the potential impacts of such infrastructure.

Collectively, these findings emphasize the ecological importance of the EC-ST biological corridor as a key refuge for ocelots in northeastern Mexico and reinforce the urgency of conserving both habitat integrity and prey resources to support the long-term persistence of the species in this distributional frontier.

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Contributions

Conceptualized: L-SD, GR-MG, JJ-GH; Methodology: L-SD, C-BV, JJ-GH; Field investigation and data collection: L-SD, GR-MG, ZA-MDR, N-MG; Data curation: ZA-MDR, GR-MG, N-MG, CC-AS; Formal analysis: JJ-GH, ZA-MDR; Visualization: GR-MG, ZA-MDR; Writing – original draft: GR-MG, L-SD, JJ-GH, ZA-MDR, N-MG; Writing – review and editing: GR-MG, L-SD, JJ-GH, ZA-MDR, N-MG, CC-AS, C-BV; Resources: L-SD, C-BV, CC-AS; Supervision: L-SD, JJ-GH; and Funding acquisition: C-BV. All authors read and approved the final version of the manuscript and take responsibility for its content.

Ethics declarations

Conflict of interest

The authors declare that they have no competing interests.

Ethical approval

This study was purely observational and did not involve any manipulation of humans or animals; therefore, ethical approval was not required.

Electronic supplementary material

ESM 1.—Identification of an individual ocelot (*Leopardus pardalis*) based on camera trap photographs showing both left and right flanks, obtained in El Cielo-Sierra de Tamalave biological corridor, Tamaulipas, Mexico.

ESM 2. —Camera trap photograph of an ocelot (*Leopardus pardalis*) carrying an eastern cottontail (*Sylvilagus floridanus*) in its mouth, taken in the El Cielo–Sierra de Tamalave biological corridor, Tamaulipas, Mexico. This record, obtained outside the established sampling period, nevertheless provides evidence of predation and contributes to the understanding of the species' trophic ecology.

References

- Abreu KC, Moro-Rios RF, Silva-Pereira JE, Miranda JM, Jablonski EF, Passos FC (2008) Feeding habits of ocelot (*Leopardus pardalis*) in Southern Brazil. *Mammalian Biology* 73:407–411.
<https://doi.org/10.1016/j.mambio.2007.07.004>
- Agostinelli C, Lund U (2017) Circular: Circular statistics. Version 0.4-93. Vienna (Austria): R Foundation for Statistical Computing. <https://cran.r-project.org/web/packages/circular/index.html>
- Allen ML, Avrin AC, Wittmer HU, Wang Y, Wilmers CC (2024) Mesocarnivores vary in their spatiotemporal avoidance strategies at communications hubs of an apex carnivore. *Oecologia* 204:805–813.
<https://doi.org/10.1007/s00442-024-05541-y>
- Anile S, Augugliaro C, Nasanbat B, Ravchig S, Tserendorj U, Bombieri G, Fabio D, Jiménez J (2024) Population density and activity of the Gobi bear. *Mammal Res* 69:345–354. <https://doi.org/10.1007/s13364-024-00756-z>
- Aranda M (2012) Manual para el rastreo de mamíferos silvestres de México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Ciudad de México
- Ayala G, Viscarra ME, Wallace R (2010) Densidad y patrones de actividad de ocelotes (*Leopardus pardalis*) en Río Hondo, Parque Nacional y Área Natural de Manejo Integrado Madidi, La Paz, Bolivia. *Rev Bol Ecol Conserv Ambient* 28:119–129
- Bauni V, Anfuso J, Schivo F (2017) Mortalidad de fauna silvestre por atropellamientos en el bosque atlántico del Alto Paraná, Argentina. *Ecosistemas* 26:54–66. <https://doi.org/10.7818/ECOS.2017.26-3.08>
- Bennie JJ, Duffy JP, Inger R, Gaston KJ (2014) Biogeography of time partitioning in mammals. *Proc Natl Acad Sci USA* 111:13727–13732. <https://doi.org/10.1073/pnas.1216063110>
- Blackburn A, Anderson CJ, Veals AM, Tewes ME, Wester DB, Young JH, DeYoung RW, Perotto-Baldivieso HL (2021a) Landscape patterns of ocelot–vehicle collision sites. *Landsc Ecol* 36:497–511.
<https://doi.org/10.1007/s10980-020-01153-y>
- Blackburn A, Heffelfinger LJ, Veals AM, Tewes ME, Young Jr JH (2021b) Cats, cars, and crossings: The consequences of road networks for the conservation of an endangered felid. *Glob Ecol Conserv* 27:e01582.
<https://doi.org/10.1016/j.gecco.2021.e01582>

479 Boas-Concone HV, Bogoni JA, Alberici V, Giordano AJ, Oliveira-Santos LGR, Ferraz KMPMB (2025) Exploring
 480 the drivers of ocelot population density: A systematic review and meta-analysis of methodological and ecological
 481 influences. *Mammal Rev* e70002. <https://doi.org/10.1111/mam.70002>

482 Boas-Goulart FV, Graipel ME, Tortato MA, Ghizoni-Jr IR, Oliveira-Santos LG, Cáceres NC (2009) Ecology of the
 483 ocelot (*Leopardus pardalis*) in the Atlantic Forest of Southern Brazil. *Neotrop Biol Conserv* 4:137–143.
 484 <http://dx.doi.org/10.4013/nbc.2009.43.03>

485 Booth-Binczik SD, Bradley RD, Thompson CW, Bender LC, Huntley JW, Harvey JA, Laack LL, Mays JL (2013)
 486 Food habits of ocelots and potential for competition with bobcats in southern Texas. *Southw Naturalist* 58:403–
 487 410. <https://doi.org/10.1894/0038-4909-58.4.403>

488 Branney AB, Carvajal S, Lombardi JV, Stasey WC, Tewes ME, Caso A (2023) Jaguars, ocelots, coatimundis...oh
 489 my: Species composition and temporal overlap of a diverse carnivore guild in the Sierra of Tamaulipas, México.
 490 *Glob Ecol Conserv* 44:e02493. <https://doi.org/10.1016/j.gecco.2023.e02493>

491 Bridges AS, Vaughan MR, Klenzendorf S (2004) Seasonal variation in american black bear *Ursus americanus*
 492 activity patterns: Quantification via remote photography. *Wildl Biol* 10:277–284.
 493 <https://doi.org/10.2981/wlb.2004.033>

494 Caballero-Rico FC (2019) Estado del conocimiento generado sobre las Áreas Naturales Protegidas de Tamaulipas.
 495 Colofón, Ciudad de México

496 Carrera-Treviño R, Astudillo-Sánchez CC, Garza-Torres HA, Martínez-García L, Soria-Díaz L (2018) Interacciones
 497 temporales y espaciales de mesocarnívoros simpátricos en una Reserva de la Biosfera: ¿coexistencia o
 498 competencia?. *Rev Biol Trop* 66:996–1008. <https://doi.org/10.15517/rbt.v66i3.30418>

499 Castagnino-Vera R (2017) Estudio ecológico del ocelote (*Leopardus pardalis*) utilizando el método de cámaras
 500 trampa en el distrito de Las Piedras, Madre de Dios, Perú. *Espac Desarro* 153–178.
 501 <https://doi.org/10.18800/espacioydesarrollo.201701.007>

502 Catalá EI (2011) Los conceptos de especies indicadoras, paraguas, banderas y claves: su uso y abuso en ecología de
 503 la conservación. *Interciencia* 36:31–38

504 Ceballos G (2014) *Mammals of Mexico*. Johns Hopkins University Press, Baltimore

505 Contreras MI, Guerra CD, Gracia R, Moreira J (2016) Densidad de ocelotes (*Leopardus pardalis*) en el Bural,
 506 Petén, Guatemala. *REDVET* 17:1–15.

507 Contreras-Díaz CA, Soria-Díaz L, Gómez-Ortiz Y, Carrera-Treviño R, Astudillo-Sánchez CC, Chacón-Hernández
 508 JC, Martínez-García L (2021) Temporal and spatial segregation of top predators (Felidae) in a Mexican tropical
 509 Biosphere Reserve. *Zoologia (Curitiba)* 38:e63231. <https://doi.org/10.3897/zoologia.38.e63231>
 510 Cruz P, Iezzi ME, De Angelo C, Varela D, Di Bitetti MS, Paviolo A (2018) Effects of human impacts on habitat use,
 511 activity patterns and ecological relationships among medium and small felids of the Atlantic Forest. *PLoS ONE*
 512 13:e0200806. <https://doi.org/10.1371/journal.pone.0200806>
 513 de la Torre JA, Arroyo-Gerala P, Torres-Knoop L (2016) Density and activity patterns of ocelots in the Greater
 514 Lacandona Ecosystem. *Therya* 7:257–269. <https://doi.org/10.12933/therya-16-372>
 515 de Oliveira TG, Tortato MA, Silveira L, Kasper CB, Mazim FD, Lucherini M, Jácomo AT, Soares JB, Márquez RV,
 516 Sunquist M (2010) Ocelot ecology and its effect on the small-felid guild in the Lowland Neotropics. In: Macdonald
 517 D, Loveridge A (eds) *Biology and conservation of wild felid*. Oxford University Press, Oxford, pp 559–580
 518 de Villa-Meza A, Martinez-Meyer E, López-González CA (2002) Ocelot (*Leopardus pardalis*) food habits in a
 519 tropical deciduous forest of Jalisco, Mexico. *Amer Midl Naturalist* 148:146–154. [https://doi.org/10.1674/0003-](https://doi.org/10.1674/0003-0031(2002)148[0146:OLPFHI]2.0.CO;2)
 520 [0031\(2002\)148\[0146:OLPFHI\]2.0.CO;2](https://doi.org/10.1674/0003-0031(2002)148[0146:OLPFHI]2.0.CO;2)
 521 Dias DM, Campos CB, Rodrigues FHG (2018) Behavioural ecology in a predator-prey system. *Mammalian Biology*
 522 92:30–36. <https://doi.org/10.1016/j.mambio.2018.04.005>
 523 Diaz-Pulido A, Payán-Garrido E (2011) Densidad de ocelotes (*Leopardus pardalis*) en los Llanos Colombianos.
 524 *Mastozool Neotrop* 18:63–71.
 525 Dickman CR, Glen AS, Jones ME, Soulé ME, Ritchie EG, Wallach AD (2014) Strongly interactive carnivore
 526 species: Maintaining and restoring ecosystem function. In: Glen AS, Dickman CR (eds) *Carnivores of Australia:*
 527 *Past, present, and future*. CSIRO Publishing, Collingwood, pp 301–322
 528 Dickson BG, Roemer GW, McRae BH, Rundall JM (2014) Correction: Models of regional habitat quality and
 529 connectivity for pumas (*Puma concolor*) in the Southwestern United States. *PLoS ONE* 9:e81898.
 530 <https://doi.org/10.1371/annotation/3e4cab4a-23b1-4912-b943-9119cb2401aa>
 531 Dillon A, Kelly MJ (2008) Ocelot home range, overlap and density: comparing radio telemetry with camera trapping.
 532 *J Zool* 275:391–398. <https://doi.org/10.1111/j.1469-7998.2008.00452.x>

533 Di Bitetti MS, Paviolo A, De Angelo C (2006) Density, habitat use and activity patterns of ocelots (*Leopardus*
 534 *pardalis*) in the Atlantic Forest of Misiones, Argentina. J Zool 270:153–163. [https://doi.org/10.1111/j.1469-](https://doi.org/10.1111/j.1469-7998.2006.00102.x)
 535 [7998.2006.00102.x](https://doi.org/10.1111/j.1469-7998.2006.00102.x)
 536 Efford MG (2019) Non-circular home ranges and the estimation of population density. Ecology 100:e02580.
 537 <https://doi.org/10.1002/ecy.2580>
 538 Efford MG (2025) secr: Spatially explicit capture-recapture models. Version 5.2.1. Vienna (Austria): R Foundation
 539 for Statistical Computing. <https://CRAN.R-project.org/package=secr>
 540 Emmons LH (1988) A field study of ocelots (*Felis pardalis*) in Peru. Revue d'Écologie 43:133–157
 541 Fonseca-Prada KA, Botero-Henao N, Mendoza-Mora A, Tunarrosa-Echeverría EM (2023) Patrones de actividad de
 542 mamíferos medianos en fragmentos de bosque de Marquetalia (Caldas, Colombia). Rev Mutis 13:1–13.
 543 <https://doi.org/10.21789/22561498.1852>
 544 Frohlich FV, Nanni AS (2023) Densidad, abundancia relativa y patrones de actividad de *Leopardus pardalis*
 545 (Carnivora: Felidae) en la Reserva natural y de usos múltiples San Pablo, Yungas de Tucumán. Acta Zool Lilloana
 546 67:195–215. <https://doi.org/10.30550/j.azl/2023.67.1/2023-04-24>
 547 Gallo-Viracocha F, Urgilés-Verdugo C (2022) Patrón de actividad y relaciones ecológicas del paujil nocturno en la
 548 Amazonía norte ecuatoriana. Rev Mex Biodiv 93:e933991–e933991.
 549 <https://doi.org/10.22201/ib.20078706e.2022.93.3991>
 550 Garrote G, Castañeda B, Escobar JM, Pérez L, Trujillo F (2019) Estima de densidad de ocelotes (*Leopardus*
 551 *pardalis*) en los Llanos Orientales de Colombia. Galemys 31:78–82. <https://doi.org/10.7325/Galemys.2019.N2>
 552 Gelman A, Carlin JB, Stern HS, Dunson DB, Vehtari A, Rubin DB (2013) Bayesian data analysis. 3rd ed. Chapman
 553 and Hall/CRC, New York City
 554 Gil-Sánchez JM, Jiménez J, Salvador J, Sánchez-Cerdá M, Espinosa S (2021) Structure and inter-specific
 555 relationships of a felid community of the upper Amazonian basin under different scenarios of human impact.
 556 Mammalian Biology 101:639–652. <https://doi.org/10.1007/s42991-021-00149-8>
 557 Gobierno del Estado de Tamaulipas (GET), Pronatura Noreste, Universidad Autónoma de Tamaulipas, Centro
 558 Internacional Cabo de Hornos (2022) Programa de Manejo del Área Natural Protegida Paisaje Natural “de la
 559 Mariposa Monarca”. Periódico Oficial del Estado, Ciudad Victoria. [https://po.tamaulipas.gob.mx/wp-](https://po.tamaulipas.gob.mx/wp-content/uploads/2022/09/cxlvii-117-290922F-ANEXO.pdf)
 560 [content/uploads/2022/09/cxlvii-117-290922F-ANEXO.pdf](https://po.tamaulipas.gob.mx/wp-content/uploads/2022/09/cxlvii-117-290922F-ANEXO.pdf).

561 Gómez-Ramírez MÁ, Gutiérrez-González CE, López-González CA (2017) Ocelots thrive in a non-typical habitat of
562 northwestern Mexico. *Endanger Species Res* 32:471–478. <http://dx.doi.org/10.3354/esr00828>

563 González-Maya JF, Cardenal-Porras J (2011) Ocelot density in the caribbean slope of the Talamanca region, Costa
564 Rica. *Hystrix It J Mamm (N. S.)* 22:355–360. <https://doi.org/10.4404/hystrix-22.2-4675>

565 Greenspan E, Anile S, Nielsen CK (2020) Density of wild felids in Sonora, Mexico: a comparison of spatially
566 explicit capture-recapture methods. *Eur J Wildl Res* 66:60. <https://doi.org/10.1007/s10344-020-01401-1>

567 Haines AM, Janečka JE, Tewes ME, Grassman Jr. LI, Morton P (2006) The importance of private lands for ocelot
568 *Leopardus pardalis* conservation in the United States. *Oryx* 40:90–94.
569 <https://doi.org/10.1017/S0030605306000044>

570 Harmsen BJ, Foster RJ, Silver SC, Ostro LET, Doncaster C (2011) Jaguar and puma activity patterns in relation to
571 their main prey. *Mammalian Biology* 76:320–324. <https://doi.org/10.1016/j.mambio.2010.08.007>

572 Hernández-SaintMartín AD, Rosas-Rosas OC, Palacio-Núñez J, Tarango-Arámbula LA, Clemente-Sánchez F,
573 Hoogesteijn AL (2013) Activity patterns of jaguar, puma and their potential prey in San Luis Potosí, Mexico. *Acta*
574 *Zool Mex (N. S.)* 29:520–533. <https://doi.org/10.21829/azm.2013.2931595>

575 Ikeda T, Uchida K, Matsuura Y, Takahashi H, Yoshida T, Kaji K, Koizumi I (2016) Seasonal and diel activity
576 patterns of eight sympatric mammals in northern Japan revealed by an intensive camera-trap survey. *PLoS ONE*
577 11:e0163602. <https://doi.org/10.1371/journal.pone.0163602>

578 Janečka JE, Tewes ME, Laack LL, Grassman-Jr LI, Haines AM, Honeycutt RL (2008) Small effective population
579 sizes of two remnant ocelot populations (*Leopardus pardalis albescens*) in the United States. *Conserv Genet*
580 9:869–878. <https://doi.org/10.1007/s10592-007-9412-1>

581 Jiménez J, Augustine B, Linden DW, Chandler R, Royle JA (2021) Spatial capture–recapture with random thinning
582 for unidentified encounters. *Ecol Evol* 11:1187–1198. <https://doi.org/10.1002/ece3.7091>

583 Jiménez J, Díaz-Ruiz F, Monterroso P, Tobajas J, Ferreras P (2022) Occupancy data improves parameter precision in
584 spatial capture–recapture models. *Ecol Evol* 12:e9250. <https://doi.org/10.1002/ece3.9250>

585 Kolowski JM, Alonso A (2010) Density and activity patterns of ocelots (*Leopardus pardalis*) in northern Peru and
586 the impact of oil exploration activities. *Biol Conserv* 143:917–925. <https://doi.org/10.1016/j.biocon.2009.12.039>

587 Lombardi JV, Perotto-Baldivieso HL, Sergeyev M, Veals AM, Schofield L, Young JH, Tewes ME (2021) Landscape
 588 structure of woody cover patches for endangered ocelots in southern Texas. *Remote Sensing* 13:4001.
 589 <https://doi.org/10.3390/rs13194001>
 590 López-Tello E (2019) Análisis de actividad y traslape: Overlap. In: Mandujano-Rodríguez S, Pérez-Solano LA (eds)
 591 Fototrampeo en R. Vol. 1, Organización y análisis de datos. Instituto de Ecología A.C., Xalapa, pp 155–166
 592 Maffei L, Noss AJ (2008) How small is too small? Camera trap survey areas and density estimates for ocelots in the
 593 Bolivian Chaco. *Biotropica* 40:71–75. <https://doi.org/10.1111/j.1744-7429.2007.00341.x>
 594 Martínez LA, Lombardi JV, Parker ID, East F, Campbell TA, Lopez RR (2024) Long live the cat: Ocelot population
 595 viability in a planned reintroduced population in Texas, USA. *Ecosphere* 15:e70044.
 596 <https://doi.org/10.1002/ecs2.70044>
 597 Martínez-González N, Soria-Díaz L, Astudillo-Sánchez CC, Barriga-Vallejo C, Mendoza-Gutiérrez GR, Manuel-de
 598 la Rosa ZA, Vanoye-Eligio V (2025) Activity patterns and predator–prey interactions of mammals in the cloud
 599 forest of Tamaulipas, Mexico. *Ecologies* 6:51. <https://doi.org/10.3390/ecologies6030051>
 600 Martínez-Hernández A, Rosas-Rosas OC, Clemente-Sánchez F, Tarango-Arámbula LA, Palacio-Núñez J, Bender
 601 LC, Herrera-Haro JG (2015) Density of threatened ocelot *Leopardus pardalis* in the Sierra Abra-Tanchipa
 602 Biosphere Reserve, San Luis Potosí, Mexico. *Oryx* 49:619–625. <https://doi.org/10.1017/S0030605313001452>
 603 Martins-Wolff N, Ferregueti AC, Tomas-Moraes W, Bergallo HG (2019) Population density, activity pattern and
 604 habitat use of the ocelot *Leopardus pardalis* in an Atlantic Forest protected area, Southeastern Brazil. *Hystrix*
 605 30:120–125. <https://doi.org/10.4404/hystrix-00214-2019>
 606 Massara RL, de Oliveira-Paschoal AM, Bailey LL, Doherty-Jr. PF, de Frias-Barreto M, Chiarello AG (2018) Effect
 607 of humans and pumas on the temporal activity of ocelots in protected areas of Atlantic Forest. *Mammalian*
 608 *Biology* 92:86–93. <https://doi.org/10.1016/j.mambio.2018.04.009>
 609 Meredith MS, Ridout M (2020) Overlap: Estimates of coefficient of overlapping for animal activity patterns. Version
 610 0.3.9. Vienna (Austria): R Foundation for Statistical Computing. [https://cran.r-](https://cran.r-project.org/web/packages/overlap/overlap.pdf)
 611 [project.org/web/packages/overlap/overlap.pdf](https://cran.r-project.org/web/packages/overlap/overlap.pdf)
 612 Monterroso P, Alves PC, Ferreras P (2014) Plasticity in circadian activity patterns of mesocarnivores in
 613 Southwestern Europe: implications for species coexistence. *Behav Ecol Sociobiol* 68:1403–1417.
 614 <https://doi.org/10.1007/s00265-014-1748-1>

615 Moreno R, Bustamante A (2009) Datos ecológicos del ocelote (*Leopardus pardalis*) en Cana, Parque Nacional
616 Darién, Panamá; utilizando el método de cámaras trampa. *Tecnociencia* 11:91–102.

617 Mosquera D, Blake JG, Swing K, Romo D (2016) Ocelot (*Leopardus pardalis*) density in Eastern Ecuador based on
618 capture–recapture analyses of camera trap data. *Neotrop Biodivers* 2:51–58.
619 <http://dx.doi.org/10.1080/23766808.2016.1168593>

620 Murray JL, Gardner GL (1997) Mammalian Species. *Leopardus pardalis*. *Mamm Spec* 1–10.
621 <https://doi.org/10.2307/3504082>

622 Niedballa J, Sollmann R, Courtiol A, Wilting A (2016) camtrapR: an R package for efficient camera trap data
623 management. *Methods Ecol Evol* 7:1457–1462. <https://doi.org/10.1111/2041-210X.12600>

624 Ochoa-Espinoza JM, Soria-Díaz L, Astudillo-Sánchez CC, Treviño-Carreón J, Barriga-Vallejo C, Maldonado-
625 Camacho E (2023) Diversidad y abundancia de mamíferos del bosque mesófilo de montaña del noreste de México.
626 *Acta Zool Mex (N. S.)* 39:1–18. <https://doi.org/10.21829/azm.2023.3912591>

627 Oliveira-Santos LGR, Graipel ME, Tortato MA, Zucco CA, Cáceres NC, Goulart FV (2012) Abundance changes and
628 activity flexibility of the oncilla, *Leopardus tigrinus* (Carnivora: Felidae), appear to reflect avoidance of conflict.
629 *Zoologia (Curitiba)* 29:115–120. <https://doi.org/10.1590/S1984-46702012000200003>

630 Padilla-Rivera O, Madariaga E, Arciniegas H (2020) Densidad poblacional del tigrillo (*Leopardus pardalis*) en el
631 Valle del Cerrejón, La Guajira, Colombia. *MaNo* 5:10–15. <https://doi.org/10.47603/manovol5n2.10-15>

632 Palomares F, Caro TM (1999) Interspecific killing among mammalian carnivores. *Amer Naturalist* 153:492–508.
633 <https://doi.org/10.1086/303189>

634 Paolino RM, Royle JA, Versiani NF, Rodrigues TF, Pasqualotto N, Krepschi VG, Chiarello AG (2018) Importance
635 of riparian forest corridors for the ocelot in agricultural landscapes. *J Mammal* 99:874–884.
636 <https://doi.org/10.1093/jmammal/gyy075>

637 Pasa JB, Arrais RC, Massara RL, Pereira G, de Azevedo FCC (2021) Factors influencing the habitat use by ocelots
638 in one of the last large Atlantic Forest remnants in southeastern Brazil. *Ecol Evol* 11:4631–4643.
639 <https://doi.org/10.1002/ece3.7363>

640 Penido G, Astete S, Jácomo ATA, Sollmann R, Tôrres N, Silveira L, Marinho-Filho J (2017) Mesocarnivore activity
641 patterns in the semiarid Caatinga: limited by the harsh environment or affected by interspecific interactions?. *J*
642 *Mammal* 98:1732–1740. <https://doi.org/10.1093/jmammal/gyx119>

643 Perera-Romero L, Garcia-Anleu R, McNab RB, Thornton DH (2021) When waterholes get busy, rare interactions
 644 thrive: Photographic evidence of a jaguar (*Panthera onca*) killing an ocelot (*Leopardus pardalis*). Biotropica
 645 53:367–371. <https://doi.org/10.1111/btp.12916>
 646 Pérez-Irineo G, Santos-Moreno A (2014) Density, distribution, and activity of the ocelot *Leopardus pardalis*
 647 (Carnivora: Felidae) in Southeast Mexican rainforests. Rev Biol Trop 62:1421–1432.
 648 <https://doi.org/10.15517/rbt.v62i4.12941>
 649 Pérez-Irineo G, Santos-Moreno A (2016) Abundance and activity patterns of medium-sized felids (Felidae,
 650 Carnivora) in Southeastern Mexico. Southw Naturalist 61:33–39. <https://doi.org/10.1894/0038-4909-61.1.33>
 651 Pérez-Irineo G, Hernández-Sánchez A, Santos-Moreno A (2021) Effect of anthropogenic activity on mammal
 652 activity patterns in two ecosystems. Mammalia 85:336–344. <https://doi.org/10.1515/mammalia-2020-0084>
 653 Pérez-Solano LA (2019) Etiquetado y organización de fotos: DigiKam. In: Mandujano S, Pérez-Solano LA (eds)
 654 Fototrampeo en R. Vol. 1, Organización y análisis de datos. Instituto de Ecología A.C., Xalapa, pp 53–65
 655 R Core Team. (2023). R: A language and environment for statistical computing (Version 4.3.1). R Foundation for
 656 Statistical Computing, Vienna, Austria. <https://www.R-project.org>
 657 R Core Team (2025). R: A language and environment for statistical computing. R Foundation for Statistical
 658 Computing, Vienna, Austria. <http://www.r-project.org/>
 659 Reid F, Gómez-Zamora G (2022) Pocket guide to the mammals of Costa Rica. Comstock Publishing Associates,
 660 Ithaca
 661 Ridout MS, Linkie M (2009) Estimating overlap of daily activity patterns from camera trap data. JABES 14:322–
 662 337. <https://doi.org/10.1198/jabes.2009.08038>
 663 Rodgers TW, Giacalone J, Heske EJ, Janečka JE, Phillips CA, Schooley RL (2014) Comparison of noninvasive
 664 genetics and camera trapping for estimating population density of ocelots (*Leopardus pardalis*) on Barro Colorado
 665 Island, Panama. Trop Conserv Sci 7:690–705. <https://doi.org/10.1177/194008291400700408>
 666 Royle JA, Chandler RB, Gazenski KD, Graves TA (2013) Spatial capture–recapture models for jointly estimating
 667 population density and landscape connectivity. Ecology 94:287–294. <https://doi.org/10.1890/12-0413.1>
 668 Ruiz-Gutiérrez F, Ávila-Nájera DM, Chávez C, Sánchez-Rojas G (2023) Spatial and temporal coexistence of
 669 medium-sized felines and their potential preys in Sierra Madre del Sur of Guerrero, México. Therya 14:319–328.
 670 <https://doi.org/10.12933/therya-23-1220>

671 Salvador J, Espinosa S (2016) Density and activity patterns of ocelot populations in Yasuní National Park, Ecuador.
672 Mammalia 80:395–403. <https://doi.org/10.1515/mammalia-2014-0172>

673 Sánchez F, Gómez-Valencia B, Álvarez SJ, Gómez-Laverde M (2008) Primeros datos sobre los hábitos alimentarios
674 del tigrillo, *Leopardus pardalis*, en un bosque andino de Colombia. Rev U.D.C.A Act & Div Cient 11:101–107.
675 <https://doi.org/10.31910/rudca.v11.n2.2008.627>

676 Sánchez-Reyes E, Rivera-García P, Marques-Dos Santos MJ (2009) Estadística circular: Herramienta para analizar
677 datos angulares en Biología. Universidad Nacional Autónoma de México-Facultad de Estudios Superiores
678 Zaragoza, Ciudad de México

679 Sandoval-Serés ME, Sánchez-Pinzón K, Reyna-Hurtado R (2022) Waterhole use and diel activity pattern of ocelots
680 in Calakmul rainforest, Mexico. Rev Mex Biodiv 93:e933930.
681 <https://doi.org/10.22201/ib.20078706e.2022.93.3930>

682 Santos F, Carbone C, Wearn OR, Rowcliffe JM, Espinosa S, Moreira-Lima MG, Ahumada JA, Sousa-Gonçalves
683 AL, Trevelin LC, Alvarez-Loayza P et al (2019) Prey availability and temporal partitioning modulate felid
684 coexistence in Neotropical forests. PLoS ONE 14:e0213671. <https://doi.org/10.1371/journal.pone.0213671>

685 Satter CB, Augustine BC, Harmsen BJ, Foster RJ, Kelly MJ (2019) Sex-specific population dynamics of ocelots in
686 Belize using open population spatial capture–recapture. Ecosphere 10:e02792. <https://doi.org/10.1002/ecs2.2792>

687 Secretary of Natural Resources of Mexico (SEMARNAT) (2018) Programa de acción para la conservación del
688 ocelote (*Leopardus pardalis*), margay (*Leopardus wiedii*) y jaguarundi (*Puma yagouaroundi*). Delegación Miguel
689 Hidalgo (CDMX, Mexico): SEMARNAT/CONANP. <https://www.gob.mx/conanp/>. Accessed 27 Jun 2025

690 Secretary of Natural Resources of Mexico (SEMARNAT) (2019) Modificación del Anexo Normativo III, Lista de
691 especies en riesgo de la Norma Oficial Mexicana NOM-059-SEMARNAT-2010 Diario Oficial de la Federación

692 Soria-Díaz L, Fowler MS, Monroy-Vilchis O (2017) Top-down and bottom-up control on cougar and its prey in a
693 central Mexican natural reserve. Eur J Wildl Res 63:73. <https://doi.org/10.1007/s10344-017-1129-y>

694 Sternberg MA, Schmidt GM, Carrera-Treviño R, Ocañas-García OA, Illescas-Martínez F, deMaar T, Peña LJ (2023)
695 Characteristics of ocelot populations in Tamaulipas, Mexico, using capture recapture techniques. Endanger Species
696 Res 52:113–127. <https://doi.org/10.3354/esr01271>

697 Suárez-Mota ME, Villaseñor JL, López-Mata L (2017) Dominios climáticos de la Sierra Madre Oriental y su
698 relación con la diversidad florística. Rev Mex Biodiv 88:224–233. <https://doi.org/10.1016/j.rmb.2017.01.020>

699 Thompson JJ, Martí CM, Quigley H (2020) Anthropogenic factors disproportionately affect the occurrence and
 700 potential population connectivity of the Neotropic's apex predator: The jaguar at the southwestern extent of its
 701 distribution. *Glob Ecol Conserv* 24:e01356. <https://doi.org/10.1016/j.gecco.2020.e01356>
 702 Time and Date AS (2023) World Clock – Time Zone Differences. Time and Date.
 703 <https://www.timeanddate.com/worldclock/>. Accessed 27 Jun 2025
 704 Tlapaya L, Gallina S (2010) Cacería de mamíferos medianos en cafetales del centro de Veracruz, México. *Acta Zool*
 705 *Mex* 26:259–277. <https://doi.org/10.21829/azm.2010.262698>
 706 Torres-Romero EJ, Espinoza-Medinilla E, Lazcano-Barrero MA, Maffei L (2017) Ecology and conservation of
 707 ocelot (*Leopardus pardalis*) in Northern Quintana Roo, Mexico. *Therya* 8:11–18. [https://doi.org/10.12933/therya-](https://doi.org/10.12933/therya-17-439)
 708 [17-439](https://doi.org/10.12933/therya-17-439)
 709 Trolle M, Kéry M (2005) Camera-trap study of ocelot and other secretive mammals in the northern Pantanal.
 710 *Mammalia* 69:409–416. <https://doi.org/10.1515/mamm.2005.032>
 711 U.S. Fish and Wildlife Service (USFWS) (1982) Endangered and threatened wildlife and plants; endangered status
 712 for U.S. population of the ocelot. Arlington, Federal Register
 713 Watanabe, S (2013) A widely applicable Bayesian information criterion. *J Mach Learn Res* 14:867–897.
 714 <https://dl.acm.org/doi/10.5555/2567709.2502609>
 715 Weckel M, Giuliano W, Silver S (2006) Jaguar (*Panthera onca*) feeding ecology: distribution of predator and prey
 716 through time and space. *J Zool* 270:25–30. <https://doi.org/10.1111/j.1469-7998.2006.00106.x>
 717 Zar-Jerrold H (2010) Biostatistical-Analysis 5th ed. Pearson Prentice Hall, Upper Saddle River

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