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Short Communication

Back to the wild: Post-translocation GPS monitoring of a rehabilitated ocelot (*Leopardus pardalis*) in a forest-agriculture matrix in the Osa Peninsula, Costa Rica

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Abstract

The sparsity of post-translocation monitoring data for rehabilitated felids leaves a pressing gap in our current understanding of their integration into and use of novel landscapes. Remote monitoring tools such as GPS collars can provide crucial insights into animal movement behavior and habitat selection following translocation and assist in the decision-making process for rehabilitation and release sites. In January 2023, a young male ocelot was released on the Osa Peninsula, Costa Rica, after eight months of rehabilitation following a vehicle strike. Six months of post-translocation monitoring using a GPS and VHF-enabled collar revealed distinctive spatial patterns between the ocelot's initial exploratory phase (~75 days) and subsequent residential period, as well as a selection for agricultural-forest matrix habitat over primary forest. We discuss the findings in terms of learning lessons for future post-release monitoring effects and provide insight into an individual's patterns of habitat selection in an anthropogenically modified landscape.

Key words: Costa Rica, GPS tracking, habitat selection, monitoring, ocelot, rehabilitation, telemetry

Introduction

Rehabilitation and reintroduction of injured wildlife can represent crucial conservation approaches to protecting important populations in anthropogenically modified landscapes (Paterson et al. 2021). However, one of the main challenges that rescue and rehabilitation initiatives face is assessing the success of wildlife releases and whether these practices realistically impact conservation outcomes (Guy et al. 2013; Pyke and Szabo 2018; Hernandez 2019). Post-release monitoring is a valuable tool for making assessments of wildlife reintroductions, but it can be challenging to implement in forested landscapes where direct observations of released individuals are rare (Bubac et al. 2019). GPS tracking technology can address the many difficulties of monitoring and characterizing post-release survival and reintegration, particularly as success is typically defined by the survival of specific individuals.

Post-release monitoring is especially challenging for rehabilitated wild felids. There is little information available on their post-release welfare, activity, and success (Houser et al. 2011), likely because they are typically nocturnal and difficult to observe. Range-wide, populations of Neotropical wildcats are in decline due to retaliatory human conflict, habitat loss/fragmentation, and prey defaunation (Sandom et al. 2017). These threats become compounded in mixed-use landscapes, where cats are more likely to encounter human structures and use a variety of human-disturbed habitats.

Costa Rica has the highest wildlife roadkill incidence in Central America, and ocelots (*Leopardus pardalis* Linnaeus, 1758) are the most common feline victims of vehicle strikes (Villalobos-Hoffman et al. 2022). Flexible habitat and diet requirements allow ocelots to take advantage of mixed-use landscapes (Oliveira et al. 2010), and they have been previously documented to select for pasture and agricultural areas at a higher rate than other small Neotropical felids (Sandom et al. 2017). While this flexibility is crucial in sustaining ocelot abundance and population dynamics, it also means an increase in movement around human settlements and roads that bisect their habitat, likely leading to more collisions. In non-fatal cases where animals are taken to rescue centers, there is often little documentation of the post-rehabilitation release process. Previous successful applications of GPS tracking collars on ocelots are generally limited to wild capture and subsequent monitoring (Moreno et al. 2012). Post-release monitoring data for rehabilitated *Leopardus* species with GPS devices is scant, and past post-release monitoring has been short-term due to the death or recapture of the released individual (Montalvo et al. 2022).

To help address the paucity of information on post-release monitoring of rehabilitated felids, we provide the record of an ocelot rescue, rehabilitation, and release. We use data from a satellite and a VHF-enabled collar system to describe a landscape-level approach to post-release movement analysis and individual territory establishment. This work provides rare insight into how small felids may respond to translocations and reintegrate into mixed-use landscapes. We discuss our findings in terms of management and lessons learned for the monitoring of future rehabilitated felids in this area and beyond.

Methods

Study site

The Osa Peninsula is a globally recognized biodiversity hotspot that spans 1,543 km^2 along the southern Pacific coast of Costa Rica. Historically, human density on the Osa Peninsula has been low (<20 inhabitants/km^2), and humans lived in close proximity to wildlife (Lewis 1985; Gutierrez et al. 2019). The region hosts a unique landscape matrix of agricultural areas such as oil palm plantations and cattle farms, along with a stable network of protected areas made up of both primary and secondary lowland rainforests (Sanchez-Azofeifa et al.

2002; Flatt et al. 2022). Mammal populations in this area have been shown to be recovering from past habitat loss and hunting pressures, according to recent region-wide camera trap surveys of terrestrial wildlife (Vargas Soto et al. 2022). Additionally, the region has a singularly dense ocelot population, with estimates of up to 169 individuals per 100 km^2 (Vargas Soto et al. 2023).

Animal rehabilitation

A juvenile male ocelot was brought to Alturas Wildlife Sanctuary, Costa Rica, on April 14, 2022. The individual suffered a vehicle strike along a highway in Hatillo, Quepos, Costa Rica, six kilometers north of Dominical (approximate location: 9°17.9939'N, 83°54.2412'W). An initial evaluation by a veterinary and rehabilitation team revealed minor injuries and some central nervous system inflammation and vestibular symptoms as a result of the strike, for which the ocelot was treated for 7 days. See Suppl. material 1: Clinical History for treatment information and details. The ocelot became a candidate for future release due to wild behaviors displayed and was placed under observation and rehabilitation protocols for the following eight months. Four health checks were carried out with the cat under anesthesia to maintain minimal human contact (Fig. 1).

The ocelot's final health check was conducted 24 days prior to release, at which time the animal weighed 9 kg. A complete blood count was conducted, and the ocelot was tested using commercial ELISA kits for the following diseases: panleukopenia, calicivirus, herpesvirus, feline leukemia virus (FeLV), distemper, coronavirus, and *Toxoplasma gondii*. A PCR test was conducted for feline infectious anemia (FIA): *Mycoplasma haemofelis*, and a coprological test was performed to assess the presence of endoparasites. Fecal and blood samples were also retained for future population analysis, in compliance with local permit requirements (SINAC-ACOSA-D-PI-R-071-2022).

During the final months of rehabilitation, a non-functional GPS collar of equivalent size and weight was placed on the ocelot to acclimate the animal to its presence and ensure its normal mobility with a collar (see Suppl. material 4: Ocelot pre-release enclosure). One day before release, the ocelot was chemically immobilized and fitted with a GPS/satellite and VHF-enabled collar (Telonics, Inc., TGW-4177-4; Mesa, AZ, USA). The GPS collar was fitted to the animal before release to minimize stress on the animal during the translocation and release process and to confirm it was functioning before release. The GPS collar was sized to ensure an ideal fit and weighed less than 5% of the ocelot's mass (Cochran 1980). To balance the collar's limited battery life with the need for fine-scale location data, the collar was programmed to collect a GPS fix every 5 hours, transmit data every 5 days, and emit a VHF beacon daily to enable real-time tracking (Lombardi et al. 2022).

Animal release and monitoring

Prior to the ocelot's release, a suitable hard release site was identified near Piro Biological Station, located within a private reserve near the buffer zone of Corcovado National Park, in the Puerto Jiménez district of Puntarenas, southwestern Costa Rica (Fig. 2; 8°24.7842'N, 83°19.3518'W). The habitat around the release site is primarily composed of primary and secondary forest, and

Figure 1. The ocelot during the rehabilitation process **A** shows the ocelot undergoing a health check while under anesthesia **B** shows the ocelot with the GPS collar immediately after release.

the general area had previously been shown to be a "good" habitat for the species through supporting high densities (Vargas Soto et al. 2023). As a release site, the area displayed several desirable features, including access to streams, ample prey presence, a long distance from potential human conflict areas, and ease of access for post-release monitoring activities (Vargas Soto et al. 2022; Whitworth et al. 2023). The ocelot was released on January 4, 2023, at 08:00 local time (GMT-6) (Fig. 1).

We deployed two camera traps (Browning Trail Cameras Strike Force Extreme BTC-5HDX) for 30 days, beginning 105 days post-release, where GPS location data indicated a potential territory had been established to collect opportunistic visual data on the released individual.

Data processing and analysis

Movement data were downloaded from the Movebank study "*Using GPS technology to track a rehabilitated male ocelot*" (Project ID: 2526574641) using the 'move' package (Kranstauber et al. 2018) in the R statistical environment (R Core Team 2021). The raw data were filtered to remove any clear outliers (n = 2) and subset to only include the post-release locations (n = 4), resulting in a final dataset of 693 locations collected between January 4, 2023 and July 1, 2023 (178 days). To characterize general patterns in displacement distances (from the release site and from the previous day's location) and temporal trends in habitat selection, we used a loess smoother within the base 'stats' package of R (v4.2.3). We defined the point of "territory establishment" using a combination of the temporal pattern in displacement distance from the release site (looking for the first clear plateau) and a visual examination of the complete movement track to define when the individual started repeatedly using the same locations. Habitat designations were determined using the open source 'Osa Peninsula Land Cover, 2018 Summer GA. Osa Water Resources OPLC' available on GitHub (https://github.com/NASA-DEVELOP/OPLC). It represents a 10 m habitat classification of eight habitat classes: primary forest, secondary forest, grassland, mangrove, wetland, palm plantations, open water, and exposed soil/urban (Brumberg et al. 2024). To characterize the relative strength of selection for each habitat type (excluding open water bodies), we applied a resource selection function within the animal movement tools ('amt') package (Signer et al. 2019). Initial exploration suggested that habitat selection coefficients stabilized with 50 randomly generated pseudo absences, so we conservatively generated 100 pseudo absences for each GPS location within the MCP of the individual. We then fit a weighted logistic model relating the proportion of true locations to pseudoabsences using the 'glm()' function. We assigned pseudo-absences with a weight of 1,000 and observed locations with a weight of 1 (Fieberg et al. 2021). We used primary forest as our baseline with which to compare the selection strength of different habitats and took any habitat with a Wald test statistic of <0.05, showing strong support for a difference in selection strength (relative to primary forest).

Results

Rehabilitation and pre-release health testing

During the rehabilitation process, the ocelot displayed fear and aggression toward humans and was regularly able to hunt small live prey and fish introduced into the rehabilitation enclosure. Along with positive markers of successful rehabilitation, the ocelot showed minimal distress due to captivity, such as pacing behavior (Cope et al. 2022). During the final health check prior to release, test results returned positive for the presence of *Chlamydophila* sp. and *Toxoplasma gondii*, for which ocelots are known hosts, with up to 69% of the wild population carrying *T. gondii* antibodies (Rendón-Franco et al. 2012). As the likelihood of re-infection with these pathogens is high in the wild, no additional actions were taken to address them (Rendón-Franco et al. 2014). The results of the complete blood count were found to be within the expected range for this species (deMaar et al. 2023); see Suppl. material 2: Complete blood count for results.

Post-release monitoring

After release, the collar transmitted a total of 693 locations, at an average of 3.9 (sd = 1.05) locations per day across 178 days of monitoring (81% of attempted GPS fixes were successfully transmitted) (Fig. 2).

Temporal patterns in displacement distance from the release site revealed that the individual moved away from the point of release for the first ~75 days, then appeared to settle and establish a more restricted space use (Fig. 3A). The ocelot's average daily displacement distance (Euclidean distance between the first fixes of successive days) was 1.05 km (sd = 1.00; range = 0.005–5.4 km), with an average daily movement distance (sum of all movement steps in a given day) of 1.7 km (sd = 1.36; range = 0.025–7.5 km). Consistent with these patterns, the average daily displacement distance was reduced by 46% from the day of release (1.82 km per day; 95% confidence interval = 1.4–2.2) to establishing a territory beyond 75 days (0.99 km per day; 95% confidence interval = 0.77–1.19; Fig. 3B). The proportion of locations in which the individual was detected in different habitats also varied through time (Fig. 3C). Initially, the individual was detected in primary forest the majority of the time (consistent with the release site habitat). However, as time went on, the ocelot spent an increasing amount of time

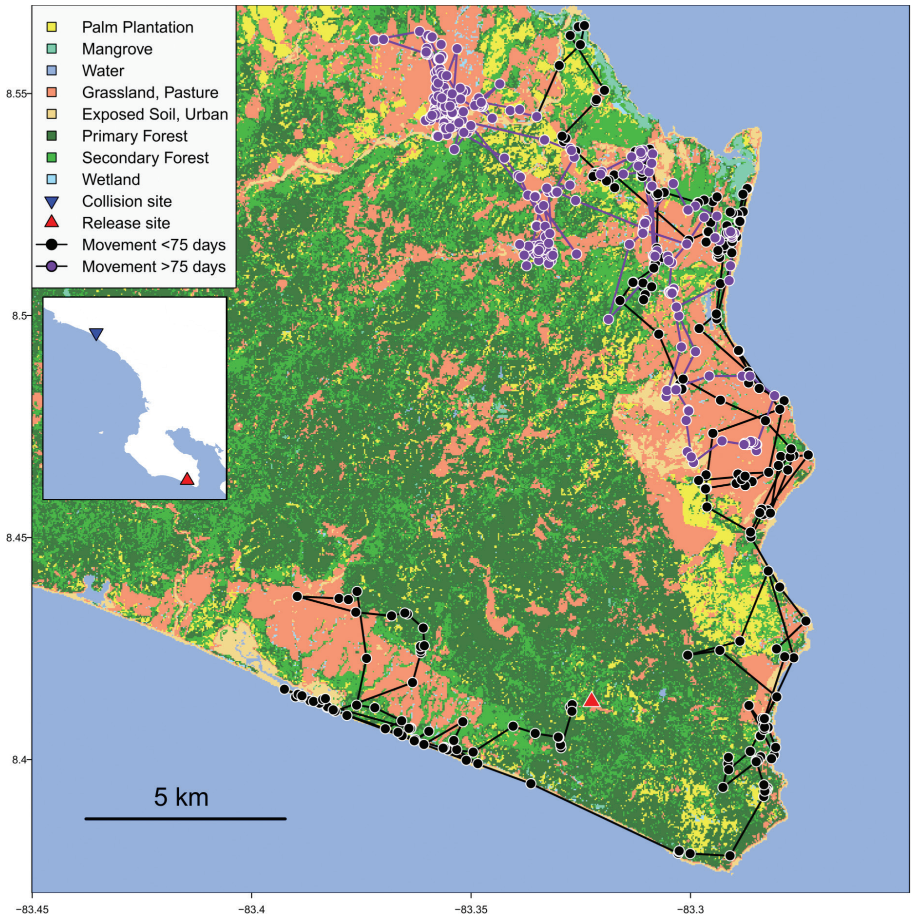

Figure 2. Survey site and post-release monitoring of the rehabilitated ocelot (*Leopardus pardalis*). The inset shows the collision and release locations in the Puntarenas region of Costa Rica; the main figure shows: colored polygons = habitat types derived from the NASA land use layer; blue triangle = approximate collision site; red triangle = the hard release site; points = GPS locations obtained in the first 75 days (black) and in the following period (purple); lines = tracks linking the location points.

in grassland and pasture habitats. The proportion of secondary forest use remained roughly constant throughout the monitoring period. The patterns above are supported by the habitat selection analysis, which showed there was strong statistical support for the ocelot showing a preference for more disturbed habitats (grassland, palm plantations, open/urban areas, and secondary forest) relative to primary forest (Fig. 4A, B; Suppl. material 3). Only mangroves showed a lower relative strength of selection than primary forest, although owing to the small sample size, there was a low degree of confidence in the estimated effect.

Two members of the veterinary team visually observed the cat on one occasion 43 days post-release; the ocelot displayed fear and aggression toward the human observers and quickly ran off. Data from two camera traps placed in the ocelot's area of activity around day 105 post-release showed that known ocelot prey species Central American agouti (*Dasyprocta punctata*), White-nosed coati (*Nasua narica*), and raccoon (*Procyon lotor*) were present on multiple occasions in this area. Owners of two properties close to this area indicated to field team members that they had observed a collared ocelot passing through their properties with no overt signs of distress, but no photographic evidence of the cat was collected from either community members or the deployed camera traps.

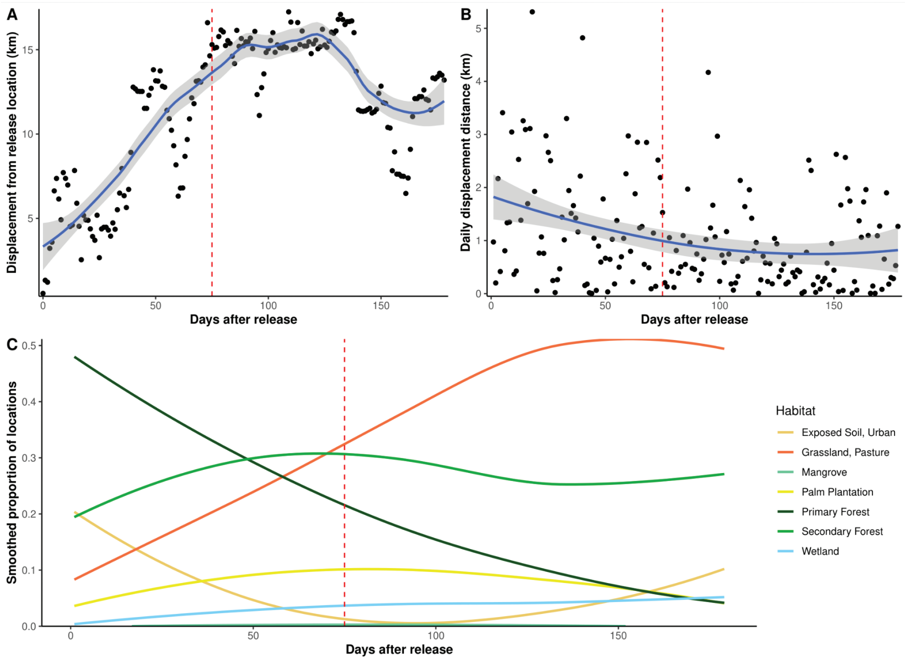

Figure 3. Post-release movement characteristics of the rehabilitated ocelot (*Leopardus pardalis*) **A, B** show the linear distance from the release site for each day after the release and the distance displaced from the previous day, respectively. In **A, B**, the blue lines represent the fitted values, with gray shaded areas representing 95% confidence intervals; black points show the raw data; and the vertical red line marks 75 days post-release **C** shows the smoothed proportion of locations by habitat per day. Colored lines depict a smoothed proportion of locations by habitat, and the vertical red line marks 75 days post-release.

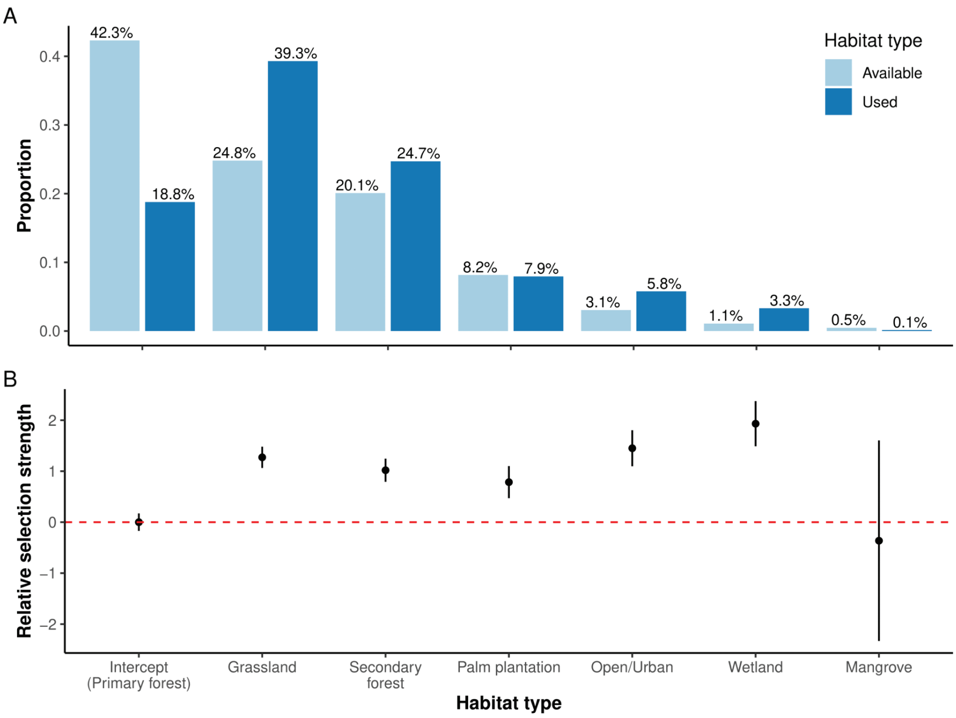

Figure 4. Post-release habitat selection summary of the rehabilitated ocelot (*Leopardus pardalis*) **A** shows the proportion of the habitats in the landscape that are available (light blue) and used (dark blue), and **B** shows the relative selection strengths for each habitat derived from a resource selection function relative to the use of primary forest, where points = estimated coefficients and lines = 95% confidence intervals. For the full model output, including statistical tests of coefficients, see Suppl. material 3.

Discussion

Published accounts of post-release monitoring of rehabilitated felids in Neotropical landscapes are rare, and long-term success benchmarks can be difficult to measure (Pyke and Szabo 2018; Cope et al. 2022). In the first phases of release, when translocated animals are especially vulnerable, GPS devices provide insight into territory establishment and survival that is nearly impossible with other monitoring methods. Long-term monitoring of this individual with camera traps could possibly have been accomplished with higher camera trap density and effort in the area. The scarcity of data on the focal individual from the two deployed camera traps and visual reports both underscores the limitations of these techniques and further highlights the importance of satellite tracking technology when attempting to establish reliable evidence of translocation success or failure (Recio et al. 2011).

Here we present six months of GPS location data that show distinctive patterns of early displacement and later territory establishment of this translocated ocelot. Movement patterns established distinct periods post-release: exploratory (days 1–75) and residential phases (>75 days). After the initial exploratory period, habitat selection patterns skewed toward disturbed habitat, despite the availability of high-quality habitat such as primary and secondary forest near the release site (Fig. 3C). We believe that these patterns could occur for two, non-mutually exclusive reasons. Firstly, prior camera trap surveys in the surrounding area recorded high densities of resident ocelots (Sergeyev et al. 2023; Vargas Soto et al. 2023). This young male likely encountered high competition for available territory, contributing to early displacement and increased distance moved per day during the exploratory phase. Competition with more mature individuals or other sympatric carnivores could have pushed the ocelot out of occupied territory and into less favorable habitat, such as grasslands, until the territory of the more established individuals became available (Mares et al. 2008; Sergeyev et al. 2023). Secondly, though we have little information on the ocelot's habitat before its injury and rehabilitation, a high proportion of the area close to the collision site is dominated by agricultural or human activities. The ocelot may have had a learned preference for disturbed habitats or was accustomed to feeding on domesticated animals such as chickens and so sought out a familiar environment after its release. Movement patterns from the later residential period, when the ocelot favored pasture/grassland habitat and secondary forest/forest edge areas, could also indicate natal habitat preference induction (Stamps and Swaisgood 2007). Camera traps in this area showed prey species that are known to be present in disturbed habitats and could constitute familiar wild prey items for this individual prior to its rescue and rehabilitation (Vargas Soto et al. 2022).

Future ocelot or small felid post-release monitoring efforts may consider the existing density of ocelots and sympatric carnivores when evaluating a potential release site, along with the suitability of the surrounding available habitat and other factors that will impact success (Montalvo et al. 2022). Although potential intraspecific competition faced after release is difficult to predict, the density of conspecifics can play a role in long-term success (Cope et al. 2022). Due to their flexible habitat and diet requirements, ocelots and other generalist species could be well-suited to release in mixed-use landscape matrices, where they have access to a variety of prey and habitat types to compensate for the effects of competition with resident individuals (Oliveira et al. 2010).

While the overall movement patterns of this individual do indicate a period of reduced space use (after day 75), with a relatively short post-release monitoring period of six months, it is unclear if this ocelot established a true territory or home range. For the purposes of this analysis, we assume that six months was sufficient for this individual to establish a territory, but longer-term monitoring could have revealed further home range shifts or altered patterns of habitat selection. Previous observations of postnatal dispersal and later home range establishment by subadult ocelots showed the process can take up to 18 months, even where familial competition rates were low (Mares et al. 2008). Ideally, post-release tracking could last the full duration of a translocated individual's integration into the new landscape, although this post-translocation vulnerability period has been suggested to last up to four years (Bubac et al. 2019). However, monitoring for a longer period involves trade-offs against limitations on GPS collar weight for smaller-bodied species such as ocelots. Longer monitoring periods require either longer battery life and therefore a heavier collar or less frequent data collection, possibly limiting the conclusions surrounding habitat selection or movement patterns (Recio et al. 2011). Lighter-weight or higher-functionality collars may also be cost-prohibitive for post-rehabilitation release projects (Foley and Sillero-Zubiri 2020). Recapture of a released individual to change a collar or collar battery would significantly extend post-release monitoring time; however, recapture can be difficult to guarantee in a wild setting.

While this work has revealed important patterns and insights into post-release monitoring, given that the results presented here relate to a single individual, the degree to which we can generalize these findings to other ocelot rehabilitation and release initiatives remains to be determined. If we want to tease apart if competition or an existing preference for more disturbed habitats caused the focal animal to select degraded landscapes far from the release site, we would have to monitor multiple ocelot individuals raised and released in a variety of different landscape contexts. Despite the limitations of analysis for single individuals released after rehabilitation, future releases with consistent, long-term post-release monitoring can contribute to this expanding dataset. This type of analysis would only be possible with long-term, close collaboration between wildlife rehabilitation centers and wildlife researchers, existing examples of which are rare at broad scales (Guy et al. 2014; Paterson et al. 2021).

Rehabilitated and rescued animals can be suitable candidates for relocations, but release outcomes often remain unclear due to a lack of consistent data-driven post-release monitoring and movement analysis. Here we have provided one of the first fine-scale GPS assessments of an ocelot's distinctive movement patterns and habitat selection during six months of post-release monitoring. To fully determine the utility of wildlife release as a species conservation and biodiversity reconstruction tool, longer-term assessments of post-release behavior are needed (Houser et al. 2011; Guy et al. 2013; Paterson et al. 2021). With the growing popularity of both wildlife rehabilitation and conservation translocations as a rewilding tactic, increased collaboration between wildlife rescue centers and conservation organizations will help us understand the value of rescue and translocation for improving the health and viability of wildlife populations.

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Additional information

Conflict of interest

Christopher Beirne, Eleanor Flatt, Andrew Whitworth, and Sarah Wicks were employees of Osa Conservation and executing this study constituted part of their salaried work. Sandy Quirós Beita, Rigoberto Pereira Rocha, and Cristina Azzopardi Schellmann were employees of Alturas Wildlife Sanctuary and executing this study constituted part of their salaried work.

Ethical statement

This study involves the rescue, rehabilitation, and release of an ocelot (Leopardus pardalis) under permit number SINAC-ACOSA-D-PI-R-071-2022. All wildlife rescue and rehabilitation procedures were conducted in accordance with ethical guidelines and legal regulations in Costa Rica, and all necessary local permits were obtained.

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Author contributions

Conceptualization: CAS, AW. Data curation: CB. Formal analysis: CB. Funding acquisition: AW, CAS. Investigation: EF, SW, SQB, RPR, CAS. Methodology: RPR, CAS, CB, SQB, EF. Project administration: SQB, CAS, EF. Software: CB. Supervision: CAS, AW. Visualization: CB. Writing - original draft: CB, SW. Writing - review and editing: EF, AW, CB, SW.

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Data availability

The data underpinning the analysis reported in this paper are available in the Movebank Data Repository, https://doi.org/10.5441/001/1.348 (Wicks et al. 2024).

References

Brumberg H, Furey S, Bouffard MG, Mata Quirós MJ, Murayama H, Neyestani S, Pauline E, Whitworth A, Madden M (2024) Increasing Forest Cover and Connectivity Both Inside and Outside of Protected Areas in Southwestern Costa Rica. Remote Sensing 16: 1088. https://doi.org/10.3390/rs16061088

Bubac CM, Johnson AC, Fox JA, Cullingham CI (2019) Conservation translocations and post-release monitoring: Identifying trends in failures, biases, and challenges from around the world. Biological Conservation 238: 108239. https://doi.org/10.1016/j.biocon.2019.108239

Cochran WW (1980) Wildlife tracking. In: Schemnitz SD, Wildlife Society (Eds) Wildlife management techniques manual. Wildlife Society, Washington, D.C, 507–520.

Cope HR, McArthur C, Dickman CR, Newsome TM, Gray R, Herbert CA (2022) A systematic review of factors affecting wildlife survival during rehabilitation and release. PLoS ONE 17: e0265514. https://doi.org/10.1371/journal.pone.0265514

deMaar TW, Laack LL, Mays JL, Sternberg MA, Swarts HM, Korchia J (2023) Free-ranging ocelots (*Leopardus pardalis*): Hematology and serum chemistry reference values. Journal of Zoo and Wildlife Medicine 54. https://doi.org/10.1638/2022-0112

Fieberg J, Signer J, Smith B, Avgar T (2021) A 'How to' guide for interpreting parameters in habitat-selection analyses. Journal of Animal Ecology 90: 1027–1043. https://doi.org/10.1111/1365-2656.13441

Flatt E, Basto A, Pinto C, Ortiz J, Navarro K, Reed N, Brumberg H, Chaverri MH, Whitworth A (2022) Arboreal wildlife bridges in the tropical rainforest of Costa Rica's Osa Peninsula. Folia Primatologica, 1–17. https://doi.org/10.1163/14219980-20211109

Foley CJ, Sillero-Zubiri C (2020) Open-source, low-cost modular GPS collars for monitoring and tracking wildlife. Methods in Ecology and Evolution 11: 553–558. https://doi.org/10.1111/2041-210X.13369

Gutierrez BL, Almeyda Zambrano AM, Almeyda Zambrano SL, Quispe Gil CA, Bohlman S, Avellan Arias E, Mulder G, Ols C, Dirzo R, DeLuycker AM, Lewis K, Broadbent EN (2019) An island of wildlife in a human-dominated landscape: The last fragment of primary forest on the Osa Peninsula's Golfo Dulce coastline, Costa Rica. PLoS ONE 14: e0214390. https://doi.org/10.1371/journal.pone.0214390

Guy AJ, Curnoe D, Banks PB (2013) A survey of current mammal rehabilitation and release practices. Biodiversity and Conservation 22: 825–837. https://doi.org/10.1007/s10531-013-0452-1

Guy AJ, Curnoe D, Banks PB (2014) Welfare based primate rehabilitation as a potential conservation strategy: does it measure up? Primates 55: 139–147. https://doi.org/10.1007/s10329-013-0386-y

Hernandez SM (2019) Postrehabilitation Release Monitoring of Wildlife. In: Hernandez SM, Barron HW, Miller EA, Aguilar RF, Yabsley MJ (Eds) Medical Management of Wildlife Species. Wiley, 123–127. https://doi.org/10.1002/9781119036708.ch10

Houser A, Gusset M, Bragg CJ, Boast LK, Somers MJ (2011) Pre-Release Hunting Training and Post-Release Monitoring are Key Components in the Rehabilitation of Orphaned Large Felids. South African Journal of Wildlife Research 41: 11–20. https://doi.org/10.3957/056.041.0111

Kranstauber B, Smolla M, Scharf A (2018) move: Visualizing and analyzing animal track data. R package version 3.1.0. https://www.semanticscholar.org/paper/move%3A-Visualizing-and-analyzing-animal-track-data.-Kranstauber-Smolla/f325b3791182590ca4469cdf58645bf7b090ce21 [February 4, 2024]

Lewis BE (1985) Reseña historica de la poblacion y los recursos naturales de la Peninsula de Osa, Pacifico Sur. 1848-1981. Revista Geográfica de América Central 2: 123–130. https://www.revistas.una.ac.cr/index.php/geografica/article/view/3028 [March 6, 2024]

Lombardi JV, Perotto-Baldivieso HL, Hewitt DG, Scognamillo DG, Campbell TA, Tewes ME (2022) Assessment of appropriate species-specific time intervals to integrate GPS telemetry data in ecological niche models. Ecological Informatics 70: 101701. https://doi.org/10.1016/j.ecoinf.2022.101701

Mares R, Moreno RS, Kays RW, Wikelski M (2008) Predispersal home range shift of an ocelot *Leopardus pardalis* (Carnivora: Felidae) on Barro Colorado Island, Panama. Revista de Biología Tropical 56: 1–9. https://doi.org/10.15517/rbt.v56i2.5623

Montalvo VH, Hagnauer I, Cruz-Díaz JC, Morera B, Lloyd K, Sáenz-Bolaños C, Fuller TK, Carrillo E (2022) Experimental Release of Orphaned Wild Felids into a Tropical Rainforest in Southwestern Costa Rica. Veterinary Sciences 9: 468. https://doi.org/10.3390/vetsci9090468

Moreno R, Kays R, Giacalone J, Aliaga- Rossel E, Mares R, Bustamante A (2012) Home range and circadian activity of ocelots (*Leopardus pardalis*) in Barro Colorado Island, Panama. Mesoamericana 16: 30–39.

Oliveira T, Tortato M, Silveira L, Kasper C, Mazim F, Lucherini M, Jácomo A, Soares J, Marques R, Sunquist M (2010) Ocelot ecology and its effect on the small-felid guild in the lowland neotropics. In: Macdonald D, Loveridge A (Eds) Biology and Conservation of Wild Felids, 559–580.

Paterson JE, Carstairs S, Davy CM (2021) Population-level effects of wildlife rehabilitation and release vary with life-history strategy. Journal for Nature Conservation 61: 125983. https://doi.org/10.1016/j.jnc.2021.125983

Pyke GH, Szabo JK (2018) Conservation and the 4 Rs, which are rescue, rehabilitation, release, and research. Conservation Biology 32: 50–59. https://doi.org/10.1111/cobi.12937

R Core Team (2021) R: A language and environment for statistical computing. https://www.R-project.org/

Recio MR, Mathieu R, Denys P, Sirguey P, Seddon PJ (2011) Lightweight GPS-Tags, One Giant Leap for Wildlife Tracking? An Assessment Approach. PLoS ONE 6: e28225. https://doi.org/10.1371/journal.pone.0028225

Rendón-Franco E, Caso-Aguilar A, Jimenéz-Sánchez NG, Hernandez-Jauregui DMB, Sandoval-Sánchez AL, Zepeda-López HM (2012) Prevalence of Anti-Toxoplasma gondii Antibody in Free-ranging Ocelots (*Leopardus pardalis*) from Tamaulipas, Mexico. Journal of Wildlife Diseases 48: 829–831. https://doi.org/10.7589/0090-3558-48.3.829

Rendón-Franco E, Xicoténcatl-García L, Rico-Torres CP, Muñoz-García CI, Caso-Aguilar A, Suzán G, Correa D, Caballero-Ortega H (2014) Toxoplasmosis seroprevalence in wild small rodents, potentially preys of ocelots in north-eastern Mexico. Parasite 21: 57. https://doi.org/10.1051/parasite/2014058

Sanchez-Azofeifa GA, Rivard B, Calvo J, Moorthy I (2002) Dynamics of Tropical Deforestation Around National Parks: Remote Sensing of Forest Change on the Osa Peninsula of Costa Rica. Mountain Research and Development 22: 352–358. https://doi.org/10.1659/0276-4741(2002)022[0352:DOTDAN]2.0.CO;2

Sandom CJ, Williams J, Burnham D, Dickman AJ, Hinks AE, Macdonald EA, Macdonald DW (2017) Deconstructed cat communities: Quantifying the threat to felids from prey defaunation. Diversity and Distributions 23: 667–679. https://doi.org/10.1111/ddi.12558

Sergeyev M, Cherry MJ, Tanner EP, Lombardi JV, Tewes ME, Campbell TA (2023) Multiscale assessment of habitat selection and avoidance of sympatric carnivores by the endangered ocelot. Scientific Reports 13: 8882. https://doi.org/10.1038/s41598-023-35271-9

Signer J, Fieberg J, Avgar T (2019) Animal movement tools (amt): R package for managing tracking data and conducting habitat selection analyses. Ecology and Evolution 9: 880–890. https://doi.org/10.1002/ece3.4823

Stamps JA, Swaisgood RR (2007) Someplace like home: Experience, habitat selection and conservation biology. Applied Animal Behaviour Science 102: 392–409. https://doi.org/10.1016/j.applanim.2006.05.038

Vargas Soto JS, Beirne C, Whitworth A, Cruz Diaz JC, Flatt E, Pillco-Huarcaya R, Olson ER, Azofeifa A, Saborío-R G, Salom-Pérez R, Espinoza-Muñoz D, Hay L, Whittaker L, Roldán C, Bedoya-Arrieta R, Broadbent EN, Molnár PK (2022) Human disturbance and shifts in vertebrate community composition in a biodiversity hotspot. Conservation Biology 36: e13813. https://doi.org/10.1111/cobi.13813

Vargas Soto JS, Flatt EJ, Whitworth A, Salom-Pérez R, Espinoza-Muñoz D, Molnár PK (2023) More than one way to count a cat: estimation of ocelot population density using frameworks for marked and unmarked species. Biodiversity and Conservation 32: 1821–1838. https://doi.org/10.1007/s10531-023-02579-x

Villalobos-Hoffman R, Ewing JE, Mooring MS (2022) Do Wildlife Crossings Mitigate the Roadkill Mortality of Tropical Mammals? A Case Study from Costa Rica. Diversity 14: 665. https://doi.org/10.3390/d14080665

Whitworth A, Basto A, Vinueza-Hidalgo G, Pinto C, Kleiner L, Soto-Navarro C (2023) Osa Biological Station: Protecting Central America's greatest Pacific lowland rainforest. Ecotropica 25: 1. https://doi.org/10.30427/ecotrop202306

Wicks S, Beirne C, Schellmann CA, Flatt E, Beita SQ, Rocha RP, Whitworth A (2024) Data from: Back to the wild: Post-translocation GPS monitoring of a rehabilitated ocelot (*Leopardus pardalis*) in a high competition, forest-agriculture matrix. Movebank Data Repository.

Supplementary material 1

Clinical history of rehabilitated ocelot

Authors: Sandy Quirós Beita

Data type: docx

Explanation note: Veterinary clinical history of the rehabilitated ocelot (*Leopardus pardalis*) treated for eight months following a vehicle strike and subsequently released in the Osa Peninsula, Costa Rica.

Link: https://doi.org/10.3897/neotropical.19.e124324.suppl1

Supplementary material 2

Complete blood count results

Authors: Sandy Quirós Beita

Data type: pdf

Explanation note: Clinical test results of the complete blood count of the rehabilitated ocelot (*Leopardus pardalis*) prior to release in the Osa Peninsula, Costa Rica.

Link: https://doi.org/10.3897/neotropical.19.e124324.suppl2

Supplementary material 3

appendix S1

Authors: Christopher Beirne

Data type: docx

Explanation note: Full model output from the habitat selection analysis.

Link: https://doi.org/10.3897/neotropical.19.e124324.suppl3

Supplementary material 4

Ocelot pre-release enclosure video

Authors: Cristina Azzopardi Schellmann

Data type: mp4

Explanation note: Camera trap video from the pre-release enclosure of a rehabilitated ocelot (*Leopardus pardalis*) prior to release in the Osa Peninsula, Costa Rica.

Link: https://doi.org/10.3897/neotropical.19.e124324.suppl4