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One small cat and 178 kilometers: longest-known displacement movement by an endangered ocelot (*Leopardus pardalis*)

Un gato pequeño y 178 kilómetros: el desplazamiento más largo de un ocelote (*Leopardus pardalis*) en peligro de extinción

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Successful protection of imperiled species and habitats is often hindered by a lack of current information. Ocelot (*Leopardus pardalis*) is a wide-ranging and elusive species that is federally endangered in Mexico and the United States, where it is facing growing conservation challenges. We maintained non-baited camera-traps at 89 locations in the Sky Islands of Southern Arizona between April 2024 and October 2025. We reviewed photos and videos to identify species and count individuals present and compared unique spot patterns to identify the ocelot individual. We detected a male ocelot in four different mountain ranges across 388 days, with a displacement distance of ≥ 178.4 km. We confirmed the ocelot was the same individual by matching unique spot patterns on the ocelot. These detections represent the longest-known displacement by an ocelot and a range expansion in Arizona. More importantly, these detections contribute to our understanding of ocelot distribution and provide useful information for the conservation of this endangered species. Conservation is often forced to be reactive rather than proactive. Yet, the opportunity exists to proactively protect suitable habitat in Arizona and ensure cross-border connectivity to facilitate protection of this endangered species.

Key words: Endangered species; camera-trap; dispersal; transboundary conservation.

La protección eficaz de las especies y hábitats en peligro comúnmente se ve obstaculizada por la falta de información actualizada. El ocelote (*Leopardus pardalis*) es una especie difícil de observar con amplia distribución, considerada en peligro de extinción a nivel federal en México y Estados Unidos, donde enfrenta desafíos cada vez más graves para su conservación. Mantuvimos 89 cámaras trampa en las Islas del Cielo, en el sur de Arizona, entre abril de 2024 y octubre de 2025. Revisamos las fotos y videos para identificar las especies y contar los individuos presentes, y comparamos patrones de manchas para identificar al ocelote. Detectamos un ocelote macho en cuatro montañas durante 388 días, y la distancia que se desplazó fue ≥ 178,4 km. Confirmamos que se trataba del mismo individuo al identificar hasta cinco manchas distintas en el ocelote. Estas observaciones representan el desplazamiento más largo de un ocelote y una expansión de su distribución en Arizona. Más importante, estas observaciones contribuyen a nuestro entendimiento de la distribución del ocelote y brindan información útil a los para la conservacion de esta especie. La conservación frecuentemente se ve obligada a ser reactiva en lugar de proactiva. Sin embargo, existe la oportunidad de proteger proactivamente el hábitat en Arizona y garantizar la conectividad transfronteriza para facilitar la protección de esta especie en peligro de extinción.

Palabras claves: Conservación transfronteriza; cámara trampa; especies en peligro de extinción; dispersión.

The Endangered Species Act (ESA) of the United States provides for the protection of imperiled species and their habitats. Yet, successful implementation of the ESA is often hindered by a lack of accurate and current data to inform conservation decisions (Bottrill *et al.* 2008). Camera traps are a powerful tool to collect data that can facilitate implementation of the ESA, such as the occurrence and spatial ecology of terrestrial species (Burton *et al.* 2015). Camera-traps can be particularly useful to monitor rare or elusive species because cameras are unobtrusive and can monitor continuously for prolonged periods (Sanderson and Trolle 2005; Lukacs *et al.* 2020). For example, trail cameras have documented the occurrence of jaguar (*Panthera onca*), margay (*Leopardus weidii*), and American black bear (*Ursus americanus*) in Mexico (Ragan *et al.* 2022; Branney *et al.* 2023; Marín and Koprowski 2025).

Ocelots (*Leopardus pardalis*) occur throughout the Americas, reaching the extremes of its range in

northeastern Argentina, southern Brazil, southern Arizona and Texas, United States (USA; US Fish and Wildlife Service 2016). Ocelots are federally endangered in the USA (US Fish and Wildlife Service 2016) and Mexico (SEMARNAT 2010). The northernmost known breeding population in Mexico occurs in Rancho El Aribabi, a private conservation ranch in Sonora, Mexico (Rorabaugh *et al.* 2020). Other northern breeding populations occur in Chihuahua and Tamaulipas, Mexico (Gomez-Ramirez *et al.* 2015; Lombardi *et al.* 2022), whereas the only known breeding population in the USA occurs in coastal South Texas (US Fish and Wildlife Service 2016). The ocelot population in coastal South Texas has been monitored for over 40 years (Schmidt *et al.* 2020; Veals *et al.* 2023; Smith *et al.* 2025), and recent research is elucidating ocelot distribution and ecology in northern Mexico (Amador-Alcala *et al.* 2022; Sternberg *et al.* 2023; VanDevender *et al.* 2023). However, little information exists about the occurrence and distribution of ocelots in Arizona.

Historical evidence of ocelots in Arizona is sparse with one fossil record and 11 historical records (e.g., carcass, skull, pelt, etc.) between 1887 and 1980. One historical record was confirmed as female, and the rest were male or of unknown sex (US Fish and Wildlife Service 2016). No ocelots were officially confirmed in Arizona between 1980 and 2009 with illegal hunting and habitat loss driving declines throughout their range (US Fish and Wildlife Service 2016). However, due in part to increased use of camera-traps, at least six unique ocelots have been detected in Arizona since 2009 (Culver 2016; Gamillo 2024). All detections since 2009 have been males, presumably dispersing from breeding populations in Sonora, Mexico, the closest of which is roughly 55 km south of the international border (Rorabaugh *et al.* 2020). However, no genetic or telemetry studies have shown definitively the origin of these Arizona detections (US Fish and Wildlife Service 2016).

Given the scarcity of ocelot detections, any new information on the occurrence and spatial ecology of ocelots in Arizona is valuable for state and federal natural resources agencies tasked with protecting this endangered species. Such data will be particularly useful as climate change drives species distributions northward (Chen *et al.* 2011), habitat loss affects the northernmost breeding population of ocelots in Sonora (Rorabaugh *et al.* 2020; Ávalos 2023), and border wall construction expands across the USA-Mexico border (Harrity *et al.* 2024). New data are especially important considering that no critical habitat for ocelots has been designated in Arizona despite the species being listed as endangered at the state and federal level for decades (US Fish and Wildlife Service 2016). Here, we report novel observations of the seventh confirmed ocelot in Arizona since 2009 to further conservation efforts.

We maintained non-baited camera-traps at 89 locations in the Madrean Sky Islands of southern Arizona between April 2024 and October 2025 (Figure 1). The Madrean Sky Islands are a global biodiversity hotspot spanning the USA-Mexico border at the convergence of major biogeographical regions, including Sonoran Desert, Chihuahuan Desert, Rocky Mountains, and Sierra Madre Mountains (VanDevender *et al.* 2013). Camera model, settings, and spatial arrangement varied by organization. Phoenix Zoo maintained 50 Bushnell No-Glow cameras (Bushnell Holdings, LLC., Overland Park, Kansas) at randomized locations in the Atascosa Complex with a minimum distance between camera sites of two km. Cameras were set to capture 10-second videos with a 1-min delay. Sky Island Alliance maintained eight Reconyx UltraFire (Reconyx, Inc., Holmen, Wisconsin) and six Browning Strikeforce (Browning Trail Cameras, Birmingham, Alabama) cameras in the Patagonia Mountains arranged in two systematic grids with 0.5 - 1.0 km spacing between cameras (Jansen *et al. 2014*). All cameras maintained by Sky Island Alliance were programmed to capture 1 - 3 photos with a 1-min delay. University of Arizona Wild Cat Research and Conservation Center maintained 24 cameras in the Santa Rita and Whetstone Mountains as part of a regional spotted cat monitoring effort (Culver 2016). Cameras were placed in drainages or at water sources and set to collect 1 - 3 photos with a 1-min delay following methods described in Culver (2016). A private individual maintained an additional GardePro camera (GardePro, Hong Kong) in the Whetstone Mountains. All cameras, regardless of organization, were programmed to operate continuously, mounted 0.2 - 1.5 m above the ground on sturdy vegetation, and oriented to optimize terrestrial wildlife detection. We reviewed photos and videos to identify species detected and count individuals present. We identified the ocelot individual by matching at least three unique patterns of spots in each detection (Trolle and Kéry 2003). We calculated displacement distances (km) as straight-line distances between detection locations and calculated average daily displacement distances as the straight-line distance between sequential detections divided by days elapsed between the detections. We also characterized vegetation communities for all camera sites following Brown and Lowe (1980). Cameras on public land were permitted under US Forest Service Special Use Permits SUP2349, NOG2405, and SUP2388.

We detected a male ocelot four times in four different mountain ranges over 388 days (Figure 1; Table 1). We confirmed the ocelot was the same individual by matching up to five unique spot patterns on the back, flank, and inner leg (Figure 2) and determined sex by the presence of a scrotum. The minimum displacement distance was ≥ 178.4 km with step-lengths between subsequent detections of 78.9 km, 68.0 km, and 31.5 respectively (Table 1). The minimum convex polygon of the detection locations was 1,085 km^2. Only seven days elapsed between the third and fourth detection, giving an average daily displacement distance of 4.5 km. All detections occurred at night during

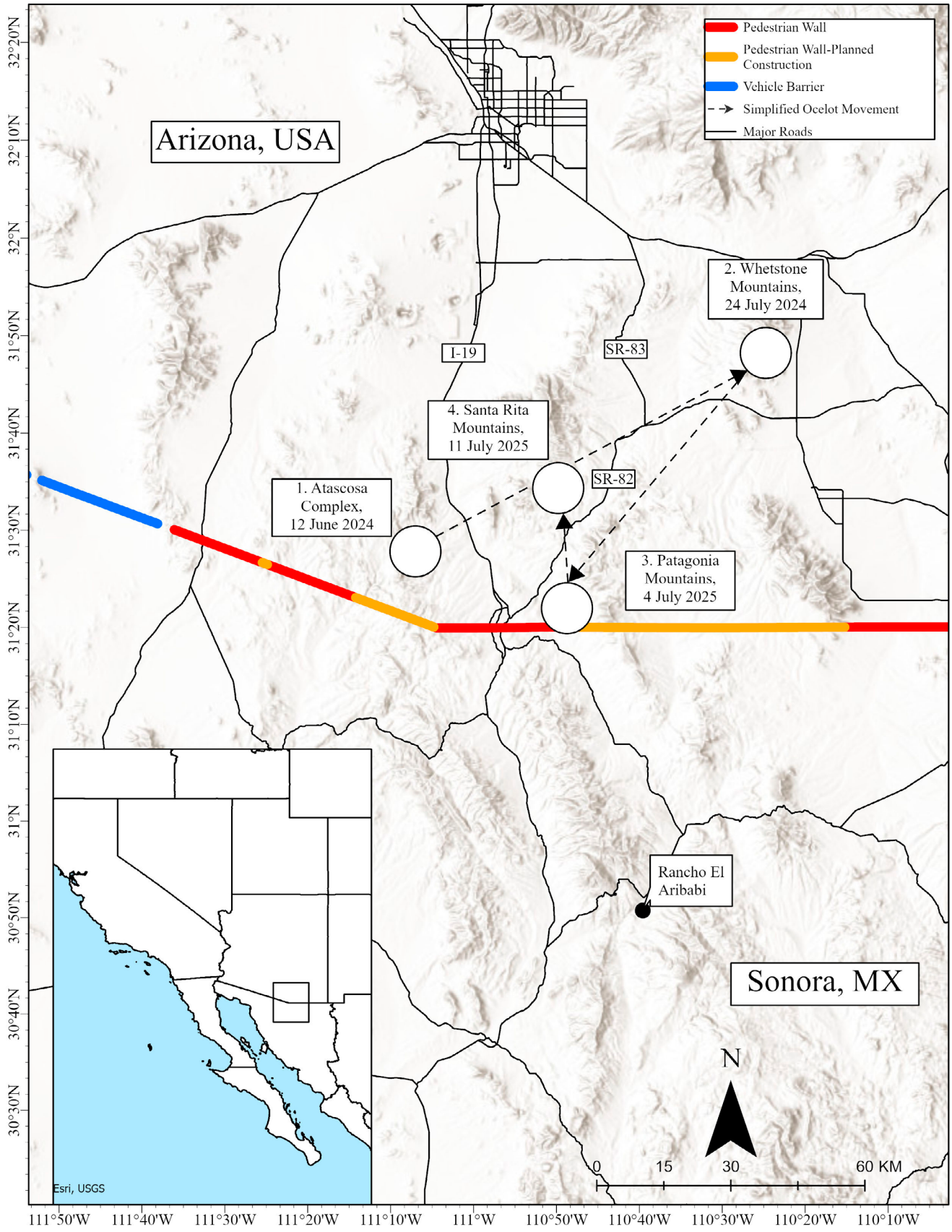

Figure 1. Four detections of the same male ocelot (*Leopardus pardalis)* in four different mountain ranges in Arizona, USA during 2024 and 2025.White dots represent detection locations and dashed lines represent simplified movements between detections. Rancho El Aribabi (black dot) is home to the northernmost breeding population of ocelots in Sonora, MX. Pedestrian walls (shown in red) are steel bollard-type walls between 5.5 - 9.1 m tall and with interstitial spaces averaging ≤ 10 cm. Yellow indicates where construction of pedestrian walls was announced or initiated in 2025. Vehicle barriers (shown in blue) are variable structures designed to stop vehicle but not pedestrian traffic.

Table 1. Camera-trap detection details of a male ocelot (*Leopardus pardalis)* in Arizona, USA in 2024 and 2025. Vegetation communities follow Brown and Lowe (1980). Step distances are the straight-line distance between sequential points.

Detection	Date and time	Mountain range	Minimum step distance (km)	Elevation (m)	Vegetation community
1	12 June 2024 04:47	Atascosa	NA	1,155	Encinal Oak
2	24 July 2024 04:32	Whetstone	78.9	1,568	Chihuahuan Desert Scrub
3	04 July 2025 01:58	Patagonia	68.0	1,152	Desert Scrub Grassland
4	11 July 2025 02:47	Santa Rita	31.5	1,569	Encinal Oak

summer months (June and July) and occurred in drainages. Dominant vegetation community of each detection location included, Encinal Oak, Chihuahuan Desert Scrub, and Desert Scrub Grassland, and elevation ranged from 1,152 - 1,569 m (Table 1).

These four detections contribute to our understanding of ocelot occurrence in Arizona and the spatial ecology of the species. Indeed, these observations represent the longest-known displacement by an ocelot anywhere within its range (US Fish and Wildlife Service 2016). Notably, this was the first confirmed ocelot in the Atascosa Complex, the second confirmed ocelot in the Whetstone Mountains (first since 2009; Avila-Villegas and Lamberton-Moreno 2013) and Santa Rita Mountains (first since 2015; Culver 2016), and the seventh ocelot in Arizona since 2009. Finally, these detections in four mountain ranges by four camera networks underscore the importance of maintaining connectivity throughout the region as well as the need for collaboration and data sharing to achieve conservation goals.

Our observations demonstrate the remarkable movement capacity of this species. For example, the ocelot covered ≥ 31.5 km between the Patagonia Mountains (detection three) and the Santa Rita Mountains (detection four) in seven days. This gives an average daily displacement of 4.5 km, greater than distances observed in telemetry studies (2.5 km; Gonzalez-Borrajo *et al.* 2017) and camera-trapping studies (e.g., 2.3 - 2.4 km; Lombardi *et al.* 2022). The minimum displacement distance of this ocelot was 178.4 km — more than two times greater than the next longest reported displacement (an 84-km round-trip movement in Arizona; Culver 2016). As no known breeding populations exist in Arizona, this ocelot presumably dispersed from the northernmost breeding population in Rancho El Aribabi, Sonora, which lies roughly 80 km south of our first detection (Rorabaugh, *et al.* 2020). Ocelots exhibit sex-based dispersal with males moving greater distances than females (Gonzalez-Borrajo *et al.* 2017), and this behavior probably explains why all ocelots confirmed in Arizona since 2009 (including our recent detections) have been male.

We detected the ocelot in Encinal Oak, desert grassland, and desert scrub vegetation communities, which is consistent with ocelot habitat preferences in Sonora (VanDevender *et al.* 2023). Moreover, the detections occurred in drainages, emphasizing the importance of riparian corridors for wildlife connectivity and access to water in arid regions (Ragan *et al.* 2023). Recent research from Sonora also documented ocelot use of riparian corridors (Rorabaugh *et al.* 2020). Importantly, whereas the detection locations conformed with known ocelot habitat preferences, much of the landscape between the detection locations is predicted as low suitability for ocelots (NatureServe and Heritage Network Partners 2021). This highlights the need to protect suitable habitat and the movement corridors between habitat patches to successfully conserve mobile species.

Conservation of wide-ranging species is challenging because their movements may bring them into regular contact with human development and other stressors (Nandintsetseg *et al.* 2019). Indeed, vehicle collisions are a leading cause of mortality of ocelots in Texas (Schmidt *et al.* 2020; Veals *et al.* 2023). The ocelot we observed must have crossed busy roadways multiple times when moving between the mountain ranges, including Interstate-19 (I-19), a multi-lane highway with abundant commercial traffic between Sonora and Arizona (Figure 1). Annual average daily traffic volumes in 2024 were 39,072.5 ± 24,806.2 vehicles/day (ADOT 2025), well above the threshold for avoidance by ocelots (5,000 vehicles/day) observed in Texas (Veals *et al.* 2023). In addition to I-19, this ocelot likely crossed State Routes 82 or 83 at least three times when moving between mountain ranges (Figure 1). Traffic volumes on these state routes are lower than I-19 (2,333.9 ± 1,229.6 vs 39,072.5 ± 24,806.2 vehicles/day) and they are typically only two lanes, but maximum speed limits are high (90 km/h). The potential crossings by this ocelot emphasize the need for wildlife crossing structures to facilitate safe wildlife movement across transportation infrastructure.

Limitations of camera-traps are highlighted by our observations as we cannot know how this ocelot moved between camera locations, nor whence it came. The origin of this ocelot is particularly relevant because a railroad was constructed through Rancho El Aribabi in 2023 to connect with railroads near Nogales, Arizona (Ávalos 2023). The habitat loss and fragmentation from this development could negatively impact local ocelot populations (Kotze *et al.* 2021; Kuipers *et al.* 2021) and may lead to increased ocelot dispersal away from the area (i.e., frustrated dispersal). Loss of ocelot habitat in Rancho El Aribabi, coupled with our detections in Arizona, reinforce the need for telemetry and genetic studies to elucidate movement corridors and connectivity between countries.

Beyond these threats, ocelots face multiple conservation challenges in the region. For example, ≥ 1000 km of border walls measuring 5.5 - 9.1 m tall and with interstitial spaces

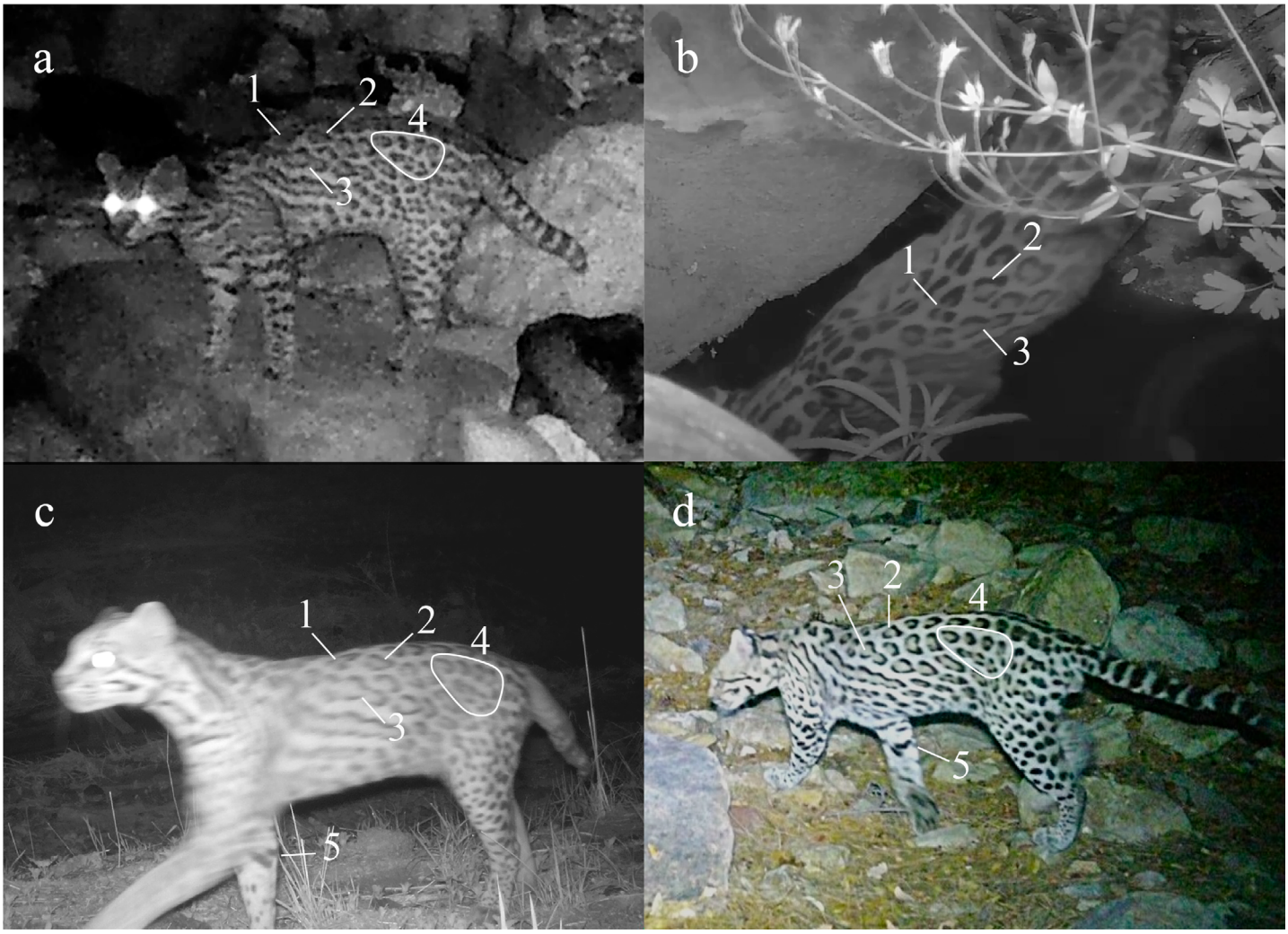

Figure 2. The identity of the ocelot (*Leopardus pardalis*) was confirmed in the four different mountain ranges in southern Arizona, USA during 2024 and 2025 by matching up to five distinguishing spot patterns. Spots 1 - 3 are unique single spots on the back, spot 4 is a cluster of spots on the flank, and spot 5 is a unique linear spot on the right inner-leg. At least three of the five spot patterns were matched in each detection. Note, image a and b are screenshots selected from the original videos and additional spot patterns were visible in other frames (a = Atascosa Complex, b = Whetstone Mountains, c = Patagonia Mountains, d = Santa Rita Mountains).

averaging ≤ 10 cm exist along the USA-Mexico border. Importantly, at least 450 km of new border wall projects were initiated in 2025 (US Customs and Border Protection 2025) that will dramatically reduce wildlife connectivity along the entire USA-Mexico border (Flesch *et al.* 2010; Peters *et al.* 2018; Harrity *et al.* 2024). Existing wildlife crossing structures improve crossing rates for some species but should be made larger and installed more frequently in existing and future walls to provide for some cross-border connectivity (Harrity *et al.* 2024). Mining operations are also expanding that will degrade or destroy potentially suitable ocelot habitat (e.g., Hermosa Mine in Arizona, Buenavista Copper Mine in Sonora, etc.). Additionally, southern Arizona has several inventoried roadless areas that support potentially suitable habitat for ocelot and many other imperiled species (NatureServe and Heritage Network Partners 2021). Recent efforts to rescind the Roadless Area Conservation Rule in the USA (US Department of Agriculture 2025) may have strong negative impacts to habitat quality of these areas by increasing anthropogenic disturbance and activity (Selva *et al.* 2015). Finally, climate change may drive ocelot distribution northward (Chen *et al.* 2011) and into an increasingly fragmented and densely populated landscape in southern Arizona (US Census Bureau 2024). Rather than reacting to these conservation challenges if ocelots recolonize Arizona, the opportunity exists to proactively ensure suitable habitat and adequate connectivity exist within the region and across the USA-Mexico border. Additionally, the mounting evidence of ocelot occurrence and movement throughout the Madrean Sky Islands of southeastern Arizona could justify the designation of critical ocelot habitat in the region. Such actions would facilitate conservation of ocelots under the US ESA and would be an important step towards the successful recovery of this endangered species.

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