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Impact of the roadkill of a jaguar cub (*Panthera onca*) on social networks and the inhabitants of Sinaloa, México

Impacto del atropellamiento de una cría de jaguar (*Panthera onca*) en las redes sociales y las comunidades de Sinaloa, México

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Vehicle traffic on roads is a risk factor for wildlife; the death of wild animals by collision involves direct adverse effects at the population level, especially for endangered species such as the jaguar (*Panthera onca*). This note reports the first roadkill record of a jaguar cub and its impact on the inhabitants of southern Sinaloa, México. The collision occurred in November 2020 on the road running adjacent to the Meseta de Cacaxtla Ecological Reserve. Information on the jaguar cub roadkill was distributed by the people that rescued the corpse and media awareness. About 50 thousand people were reached or informed through social networks. Environmental education workshops, conferences, and webinars were conducted in several villages across the region to raise awareness and for drivers to take precautions to prevent accidents threatening the well-being of wild fauna and road users.

Key words: Conservation; feline; mortality; roads; rural communities; social networks.

El tráfico vehicular en carreteras se ha evidenciado como un factor de riesgo más para la fauna silvestre; las muertes por atropellamiento de individuos pueden tener impactos negativos directos a nivel poblacional, sobre todo para aquellas especies en peligro de extinción, como es el jaguar (*Panthera onca*). El objetivo de este documento es dar a conocer el primer registro de atropellamiento de una cría de jaguar y el impacto que generó en comunidades del sur de Sinaloa, México. El accidente ocurrió en noviembre de 2020 en una carretera colindante a la reserva ecológica Meseta de Cacaxtla. Las personas involucradas en el rescate del cuerpo y los medios de comunicación dieron a conocer la muerte de la cría. Cerca de 50 mil personas fueron alcanzadas / informadas en redes sociales; en los pueblos de la región se llevaron a cabo talleres de educación ambiental, conferencias y webinarios, dirigidos a sensibilizar y tomar precauciones para evitar accidentes que comprometan el bienestar de la fauna y los transeúntes en carretera.

Palabras clave: Carreteras; comunidades rurales; conservación; felino; mortalidad; redes sociales.

The jaguar (*Panthera onca*) is the most admired feline throughout the history of humankind in America (Saunders 2005; Olivier 2016). It plays a key role in the structure of the ecosystems where they thrive (Miller and Rabinowitz 2002; Ripple *et al.* 2014; Cruz *et al.* 2021) and is the focus of research and conservation efforts at continental and national levels (Medellín *et al.* 2016; Paviolo *et al.* 2016; Ceballos *et al.* 2021a).

In México, the original distribution range of the jaguar used to comprise a vegetation continuum ranging from dry forests in Sonora to tropical rainforests in the southeast (Ceballos *et al.* 2016). However, this area has been reduced, and jaguar populations are currently threatened by multiple factors such as poaching, habitat destruction by changes in land use, cattle-jaguar conflicts, and the construction of infrastructure (de la Torre *et al.* 2017; Peña-Mondragón *et al.* 2017; Quigley *et al.* 2017; SEMARNAT 2019). The latter includes the opening of roads that impairs the connectivity and fragments natural landscapes, creating barriers that reduce the ability of wild animals to move in the habitat to meet their needs (food, shelter), ultimately leading to their death. Several feline

species involved in roadkills have been recorded, including the ounce (*Herpailurus yagouaroundi*) and lynx (*Lynx rufus*; González-Gallina and Hidalgo-Mihart 2018). The anthropization of nature alters essential habitats for wildlife (Ceballos *et al.* 2021b), including the construction of infrastructure for the production and transportation of goods and people (González-Gallina and Hidalgo-Mihart 2018; Filius et al. 2020).

Wildlife death from road accidents can have direct impacts on their populations. Road mortality has been reported as one of the most serious hazards for many threatened species, such as ocelots (*Leopardus pardalis*) and Florida panthers (*Puma concolor coryi*) in the United States, whose mortality is as high as 32 % (Clevenger *et al.* 2008). In Latin America, research addressing this issue is at a very early stage (Abra *et al.* 2021); in México, knowledge is being generated regarding the impacts of vehicles (González-Gallina and Hidalgo-Mihart 2018; Cupul-Magaña 2019; Canales-Delgadillo *et al.* 2020; Preciado and Romero 2020) and actions are being taken to prevent wildlife losses on roads (González-Gallina *et al.* 2013; Pacheco *et al.* 2016; Manteca-Rodríguez *et al.* 2021).

In some regions of México, scientific research has been supplemented by cultural activities and actions to promote the dissemination of information and environmental education (Briones-Salas *et al.* 2011; Peña-Mondragón *et al.* 2017; Castillo *et al.* 2020; Zamudio *et al.* 2020). These measures have raised awareness among individuals and social groups, who have recognized the jaguar as an important species in the contemporary natural and cultural landscapes of México (Morales and Morales 2018). This note describes the effect of a roadkill event involving a jaguar cub on a number of actions to conserve this species in Sinaloa (DCS 2020).

The present research was conducted in the San Ignacio municipality, in the southern region of the state of Sinaloa, México (Figure 1). This area comprises 4,651 km^2 with landscapes of the Pacific coastal plains and high mountains in the Sierra Madre Occidental. The prevailing climate in the study area is warm sub-humid, being semi-dry on foothills and coastal plains and temperate in mountainous areas. The mean annual temperature ranges between 22 ºC and 26 °C, and the mean annual precipitation is between 700 and 1,000 mm. There are two clearly defined seasons: rainy in summer and part of autumn and dry the rest of the year. Dry forests are the dominant vegetation, and pine-oak forests are distributed in high-mountain temperate areas (Rzedowski 2006). The towns with the largest number of inhabitants are Estación Dimas, Piaxtla, Coyotitán, and San Ignacio (the municipal capital); the total population in the San Ignacio municipality is 23,355 inhabitants (INEGI 2010).

The jaguar cub was road-killed in the early morning hours of 5 November 2020. A. Loaiza, a local inhabitant, found it at 6:30 hr lying on the road at km 64 of the México 015 federal highway, Coyotitán-Mazatlán section, Sinaloa (23° 47′ 18.86″ N, 106° 36′ 42.02″ W; Figures 1 and 2). This

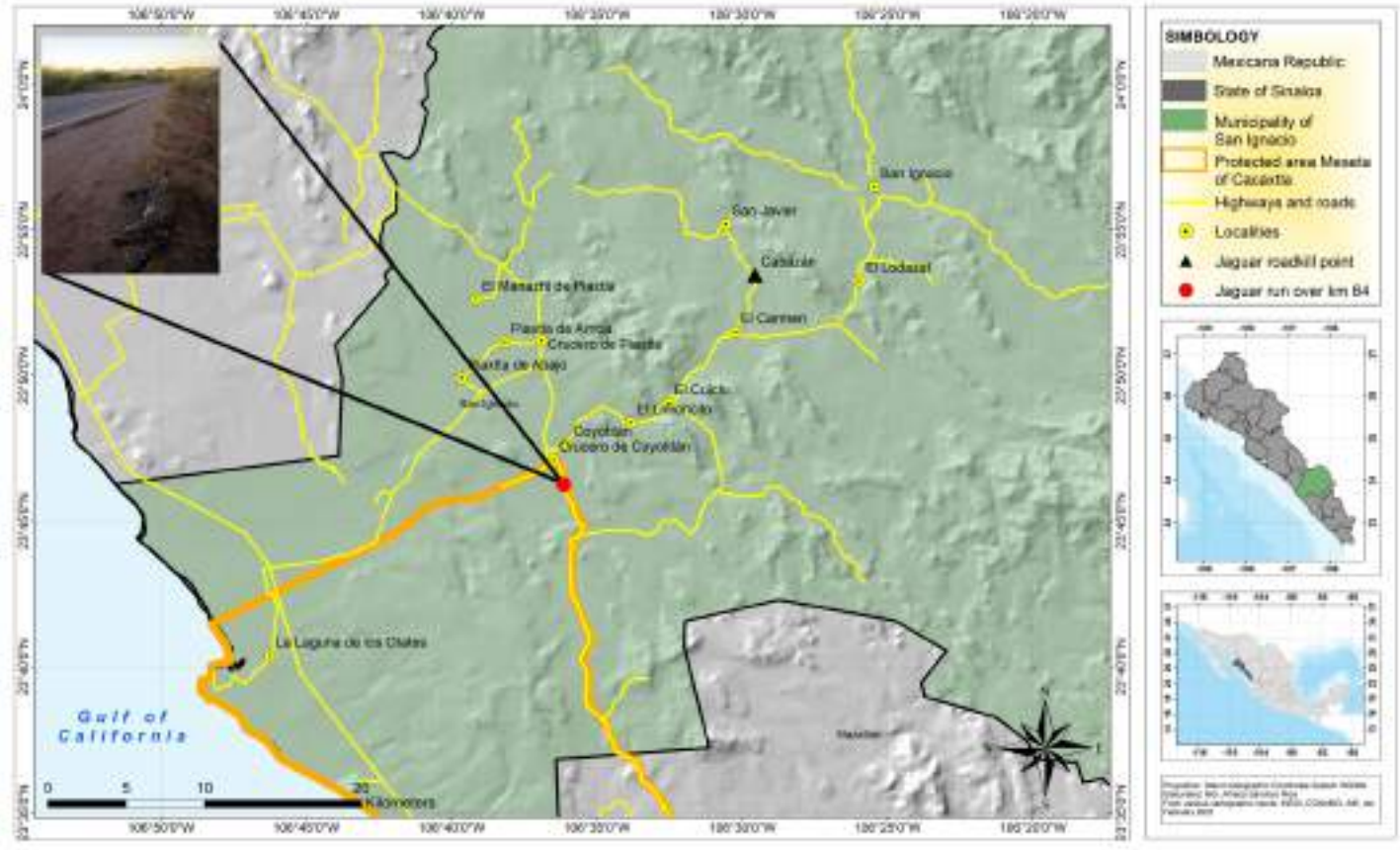

Figure 1. Location map of the San Ignacio municipality, Sinaloa, México, and site of the jaguar cub roadkill event. Prepared by A. Sánchez.

work is the first to record in detail the roadkill of a jaguar cub on a highway in México. The specimen was a male of approximately 100 days of age, with a weight of 8.5 kg and a body length of 1.5 m from the nose to the tip of the tail. This event was informed to the staff of the Museo del Jaguar (Jaguar Museum), the Procuraduría Federal de Protección al Ambiente (Federal Attorney's Office for Environmental Protection; PROFEPA, in Spanish), and the Comisión Nacional de Áreas Naturales Protegidas (National Commission of Natural Protected Areas; CONANP, in Spanish), particularly the direction of the Meseta de Cacaxtla Flora and Fauna Protection Area (APFFMC, in Spanish). The road section where the roadkill occurred is part of the border delimiting the polygon of the APFFMC protected area, which comprises 50,000 ha of tropical deciduous forest and is a key habitat for the conservation of populations of jaguar and other felines at risk, such as the ocelot, margay (*Leopardus wiedii*), and jaguarundi (*H. yagouaroundi*; Rubio-Rocha *et al.* 2010).

In years prior to the jaguar cub roadkill (Armenta 2020; Redacción/Sin Embargo 2020), anecdotal evidence of the roadkills of 4 adult jaguars and 2 cubs was found. These 6 specimens include one adult that was road-killed in 2014 at kilometer 59 of the México 015 highway, at the periphery of the APFFMC (G. Corrales-Herrera, com. pers.). On 25 July 2016, a CONANP staff recorded the roadkill of 1 female jaguar with 2 cubs at kilometer 36 of the Mazatlan-Culiacán highway (México 15D) and 1 male jaguar at kilometer 32 of the same road on 19 September of the same year (M. Amador-Medina, webinar of the third Road Ecology Workshop). In 2017, the death of 1 adult male in the Concordia municipality was reported (Entreveredas 2017; Rasnoticias 2017).

Sinaloa has a road network of 16,837 km, of which 4,866 km are paved roads plus 11,971 km of gravel rural and dirt roads (INEGI 2017). The México 015 highway comprises 656 km and runs throughout the state, from the north in the Ahome municipality to the south in Escuinapa; the length of the section that crosses the San Ignacio municipality is 41 km (INEGI 2017). This information gives an idea of the extent of the paved road network and the potential risk for the conservation of the jaguar and the wildlife that crosses it (Canales-Delgadillo *et al.* 2020). Some animals are attracted to roadsides where grass and food resources consumed by deer and other herbivores grow, posing the risk of being hit and killed by vehicles (Gottdenker *et al.* 2001; Toro-Garay *et al.* 2021). Certain species, such as the jaguar, are rarely observed after a collision event. Sometimes, corpses are removed (legally or illegally) before the road maintenance crew finds them (Abra *et al.* 2021) for the economic value of the skin and fangs; in other cases, the animal affected does not die immediately and seeks shelter in the surrounding vegetation. Abra *et al.* (2021) conducted thorough research on the roads of Sao Paulo, Brazil, over 10 years of monitoring and did not record jaguar roadkills. However, these authors found one report of 2 dead jaguar cubs in the databases of the company in charge of managing the roads and estimated more than 37 thousand road-killed mammals in 27 10-km sections out of a total of 199,371 km of road.

The road-killed jaguar cub caught the attention of society, even though it occurred during the SARS-CoV-2 pandemic (DCS 2020; Ortiz 2020), triggering the launch of the #IBrakeForTheJaguar campaign. The people of the communities of San Ignacio municipality, following the health protocols and with the collaboration of several institutions, organized educational activities to raise awareness about wildlife-vehicle collisions. On November 12, 2020, within the framework of the International Jaguar Day, the campaign # IBrakeForTheJaguar (Museo del Jaguar 2020a) was launched on the media and digital platforms, with the support of the Alianza Nacional para la Conservación del Jaguar (National Alliance for Jaguar Conservation) and Biofutura organization. During this event, with the collaboration of local inhabitants, 150 posters were affixed at various road crossings, starting in the Crucero de Piaxtla community (Figure 3). As a result, more than 150 drivers were informed about the jaguar cub roadkill, the importance of slowing down when traveling through signposted wildlife passages, and being alert to spot the crossing of any animal.

Additionally, 6 exhibitions were held, including environmental education workshops, in the communities of Ajoya, La Labor, El Carmen, Cabazán, San Javier, and San

Figure 2. Road-killed jaguar cub on the México 015 federal highway at km 64 of the Coyotitán-Mazatlan section, Sinaloa, México. Photograph by A. Loaiza.

Ignacio municipal capital, with the participation of around 400 children and adults (Leyva 2020; Tenorio 2020). With the appropriate permits, taxidermy was performed on the specimen, which was exhibited in the Jaguar Museum of Cabazán (Museo del Jaguar) to attract attention and raise awareness about the impacts of road accidents.

Informative videos were produced on the ecological and cultural importance of the jaguar, the threats that put it at risk, and the actions to support the conservation of its populations. Online meetings were promoted on digital platforms (Facebook and Zoom). On the Museo del Jaguar Facebook page, news of the road-killed cub was posted, reaching a large number of people. The digital administrator statistics show that the news was seen by 48,884 users and shared 272 times; 2,198 comments were also posted, and 7,531 clicks were recorded in digital posts (Museo del Jaguar 2020b).

As a result of the jaguar cub roadkill event, the Direction of the APFFMC Reserve monitored 107 km of roads on 12 occasions and recorded 92 roadkill events of 31 species, including 11 raccoons, 8 boas, and 5 rattlesnakes (S. González-Palacios, webinar of the third Road Ecology Workshop). These findings reflect the extent of the issue for wild mammals and other vertebrate species (Leyva 2021).

Roads in Sinaloa pose a hazard for jaguar and other wildlife populations; the vast majority of roads do not include wildlife passages and signaling to guide and inform about the possibility of animals crossing the road. An additional risk factor is the poaching facing these natural predators because they are considered potential threats to livestock, even without actual evidence (Inskip and Zimmermann 2009; Puc-Sánchez *et al.* 2013). Therefore, it is necessary to promote new forms of human-jaguar coexistence. Socio-environmental assessments should be performed to define participatory strategies that consider the needs of people and wildlife to mitigate wildlife species loss, including America's big cat — the jaguar (Castillo *et al.* 2020; Ceballos *et al.* 2020; PNUMA 2021). Jaguar roadkills are seemingly sporadic events in the study region. Nonetheless, the adverse effect of the loss of even a single specimen is serious enough for the local jaguar population, which is extremely small, from 0.75 to 3.3 individuals per 100 km^2 (Chávez *et al.* 2016). Therefore, measures for its long-term conservation are of paramount importance and urgent.

The use of digital strategies and communication actions is an instrument that allows sharing information quickly over large distances to a large number of people, objectively and assertively in the best case (Larena 2010). The dissemination of socio-environmental news, such as the jaguar cub roadkill, can foster changes in social perception and behavior (Peña-Mondragón *et al.* 2017; Whitehouse-Tedd *et al.* 2021) to avoid or reduce road-related risks, which claim lives of wildlife and road users (Ament *et al.* 2021).

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Figure 3. Informative poster about the sites identified as wildlife crossings and participants in the #IBrakeForTheJaguar campaign in the San Ignacio municipality, Sinaloa, México. Photograph by A. Pérez.

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