ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 14:11 (19 February 2025)
doi:10.15451/ec2025-02-14.11-1-17
ISSN 2238-4782 ethnobioconservation.com

The human-feline relationship from a biocultural perspective: perception, knowledge and traditional use of the six Mexican species, in the state of Hidalgo, Mexico

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ABSTRACT

The human-feline relationship has been evaluated mainly from the perspective of conservation biology. However, it is important to know the established socioecological relationships, unfortunately, little explored, despite the documentation and importance of these predators. In this study, the perceptions and knowledge were documented, as well as the evaluation of the cultural roles of use carried out by the Nahua inhabitants of the north-eastern region of the state of Hidalgo, Mexico, towards the six species of wild cats. 150 semi-structured interviews were applied and photographs were taken of the evidence of felines or their parts in the possession of the informants. Wild felines are identified with a name in Nahuatl and in Spanish. The species that presented the highest frequency of mention, as well as value of cultural importance, was the margay (*Leopardus wiedii*). Nine categories of use were identified, with ornamental use being the most relevant. In addition, we documented the consumption of lion meat (cougar, *Puma concolor*) as a complex socioecological phenomenon, derived from retaliation. As well as the hunt for a tiger cub (jaguar, *Panthera onca*), captured in a playful way. Wild cats, despite their decline due to anthropocentric causes, continue to play a relevant socioecological role and are part of the biocultural diversity of indigenous peoples. Unfortunately, negative perceptions and overvaluation of species indirectly encourage illegal hunting or extraction.

Keywords: Human-carnivore conflict; Human-feline conflict; Index of cultural importance

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SIGNIFICANCE STATEMENT

Felines are top predators with which humans once maintained a relationship of admiration and respect; in recent centuries that relationship has become conflict. Our ethnozoological research on felines helps us understand the complexity of human-feline socioecological relationships. We found that few aspects of the Mesoamerican connotation are still valid, specifically the nomenclature in Nahuatl. The elements related to the forms of knowledge and use have been modified, they play different cultural roles, the most relevant being ornamental, which adds to their overvaluation. Their meat is consumed occasionally, and in many cases hunting is generated by retaliation, as in the case of the puma and the jaguar, and it becomes a celebratory activity; or simply recreational. Overvaluation encourages their illegal exploitation, of which hunters are fully aware, by raising awareness that these are species protected by Mexican legislation. This research is highly significant for the dynamic understanding of socioecological relationships with top predators, umbrella species and key biocultural species, information that should be integrated into conservation programs.

INTRODUCTION

Humans throughout history have established a special relationship with animals, generating a series of links, some of which persist to this day (Alves 2012; Alves and Albuquerque 2017). Wildlife is an important resource, especially from its edible role, currently still, some communities depend in a certain way on hunting wildlife, being one of their main sources of protein, constituting a complementary resource for nutrition of families (Souza-Mazurek et al. 2000; Alves et al. 2009). Wildlife also represents a source of income, raw materials, medicines, tools, ritual and symbolic objects, and is prized as a pet (Ojasti and Dallmeier 2000; Alves 2012).

Subsistence hunting of wild animals is not only carried out by the need to consume '*carne de monte o carne silvestre*' (wild meat), it has a connotation that goes beyond self-consumption, and is considered an important activity to sociocultural level, especially when it comes to hunting species with a high cultural representativeness (Dajczak et al. 2021). In some cases, the hunting of culturally relevant species (Ibarra et al. 2012) has a higher value, because it imprints a high social hierarchy on those who own it and on those who have hunted them (García-Alaniz et al. 2010). Hunting, due to its sociocultural connotation, is considered the cultural heritage of indigenous and rural communities (Dajczak et al. 2021).

Mammals are one of the taxonomic groups that play a preponderant cultural role in perceptual, cognitive and pragmatic issues (Melo et al. 2014). Within this group, felines represent one of the most relevant, since they are appreciated for their aesthetic beauty, symbolize a bond of power, and represent the most conflictive human-carnivorous/human-feline relationship (Viollaz et al. 2021). Felines still maintain a socioecological status, rooted since pre-Hispanic times in different cultures, mainly those of Mesoamerican origin (Gutiérrez-Santillán and Ruíz-Gutiérrez 2019). Derived from this human-feline relationship, this group of mammals have suffered a reduction in their original populations, and many of the species found in Mexico are in danger of extinction or in some other risk category (NOM 059-Ecol-2010; CITES 2019; IUCN 2022). In addition, felines face threats caused by various causes, such as the increase in the agricultural frontier, the destruction of their habitats and the reduction of the populations of wild animals on which they feed (Costa et al. 2005).

The greatest threat that wild cats' populations directly face is determined by the () human-feline conflict (Breitenmoser 1998; Madhusudan and Karanth 2000; Karahth and Madhusudan 2002; Arroyo-Quiroz et al. 2017; Flores-Armillas et al. 2020). This conflict has been accentuated mainly by the belief that some species can cause serious damage to livestock herds and economically affect farmers from different areas (Inskip and Zimmerman 2009; García-Alaniz et al. 2010). The increase in the agricultural frontier is reducing the distribution areas and populations of felines, modifying their areas of activity, forcing them to travel through fragmented habitats, generating a greater number of sightings in rural areas to obtain domestic prey (Ramírez-Álvarez et al. 2021; Hernández-Saint-Martín et al. 2015). For these reasons, the people of many communities perceive felines as a risk to their safety and economy, which causes the rejection of conservation programs, taking drastic measures by hunting them clandestinely (Treves and Karanth 2003; Treves et al. 2006).

In Mexico, studies on felines have focused mainly on two large approaches, the biological-ecological one that deals with issues such as distribution, conservation, reproduction, habitat, feeding, protection status and evaluation of habitat fragmentation (Pérez-Irineo and Santos-Moreno 2010; Ávila-Nájera et al. 2015); and the anthropological-archaeological, mainly highlighting the iconographic (Benson et al. 1970). Therefore, there is a gap from the ethnozoological perspective, which, in theory, offers a detailed socioecological analysis of the relationship between felines and local communities (García-Alaniz et al. 2010).

In the country, six species of felines are distributed:

Herpailurus yagouaroundi, *Leopardus pardalis*, *Leopardus wiedii*, *Lynx rufus*, *Puma concolor*, and *Panthera onca* (Aranda 2012). The same reported for the state of Hidalgo (Central Mexico), through reports of new records or distribution expansions (Mejenes-López et al. 2010; Valencia-Herverth and Valencia-Herverth 2012; Hernández-Flores et al. 2013; Aguilar-López et al. 2015; Morales et al. 2015), research on maternal care (Rojas-Martínez et al. 2017), dispersal routes (Dueñas-López et al. 2015), and feline-human conflicts (Olivera-Méndez et al. al. 2019).

Despite the advances in knowledge of felines in the Central region of Mexico, it has not been addressed from the socioecological context between wild cats and their relationship with indigenous groups or rural communities that live there within their distribution zone, and who are the ones who interact directly with them. For this reason, the understanding of the human-feline relationship from the ethnozoological perspective, delving into issues such as perception, knowledge and use that local people give to the six species of felines. We assume that the human-feline relationship in this sociocultural region is complex, stemming from the historical and current human-feline interactions. Therefore, many of the beliefs, knowledge and practices are still valid. However, this traditional knowledge is changing, accentuated by the human-feline conflict, derived from livestock extensions and abundance of domestic animals, which puts the conservation of feline populations and the traditional knowledge associated with these mammals at risk.

MATERIAL AND METHODS

Study area

The research was carried out in different communities in northeastern State of Hidalgo, Mexico. The municipalities visited were Calnali, Chapulhuacán, Huautla, Huazalingo, Lolotla, San Felipe Orizatlán, Tepehuacán de Guerrero, Tlahuiltepa, Tlanchinol, Yahualica, and Xochiatipan (Figure 1). The study area presents an altitudinal gradient from sea level to 1,800 m. The average annual temperature is 12°C-18°C, with a rainfall range from 600 to 2,000 mm. The area encompasses a topographic variety, diversity of bioclimates, a high floristic richness, the main vegetation types include pine-oak forests, cloud forest and semi-evergreen tropical forest (Puig 1991). This macroregion is considered as a Priority Terrestrial Region for the Conservation of Biodiversity (Arriaga et al. 2000).

It is socially characterized by its culture, self-styled 'Huasteca', where more than 85% of the population speaks Náhuatl, an indigenous language (INALI 2010). The main economic activities are related to agriculture, where maize, beans, tobacco, and sugar cane are grown. There are vast expanses of coffee and citrus plantations as well as beekeeping and livestock production. Livestock activities require large tracts of forest to be transformed into grasslands, which contribute to the loss of the original vegetation and soil (Puig 1991, Additional File 1).

Field works

For this study, the principles established in the Code of Ethics for research, action research and ethnoscientific collaboration in Latin America (Cano et al. 2016) were taken into account. To respect intellectual property rights, the project was previously presented to the local authorities of each of the communities, who granted their authorization for its development and participation. Also, the prior, free and informed consent of the interviewees was requested to carry out the surveys and take photographs, as well as their authorization for their publication (ISE 2006, `http://ethnobiology.net/codeofethics`; Albuquerque et al. 2014).

To obtain the ethnographic data, various surveys to the different communities were carried out between 2018 and 2020. We applied a snowball technique, which consists of interviewing a random informant and this informant would then recommend another that he considers to have additional knowledge on the subject (Trotter et al. 2001). We also included key informants, such as a local hunter. We applied to 150 semi-structured interviews (55 women and 95 men; Bernard 2006). The approach included: a) what wild cats did they know, b) what was the name in Náhuatl with which they were recognized and in Spanish, c) what uses they gave them, d) what were the parts of the animal that they were used, e) how they were used, and finally f) if they had an anecdote or story about a feline. When key informants (hunters) participated, they were specifically asked if, at some point in their activity, they had caught some type of feline, if they had had a problem with a wild cat (human-feline conflict), or if they were aware of any incident.

Most of the informants were bilingual speakers of Náhuatl and Spanish, with an age range between 20 and 83 years ($n = 150$). The identification of the feline species was carried out with the help of: visual stimuli, where the informants recognized the photographed of the species or drawings from field guides (Aranda 2012), and we also take photographs of stuffed specimens, skins, or parts thereof with the permission of the interviewees (ISE 2006).

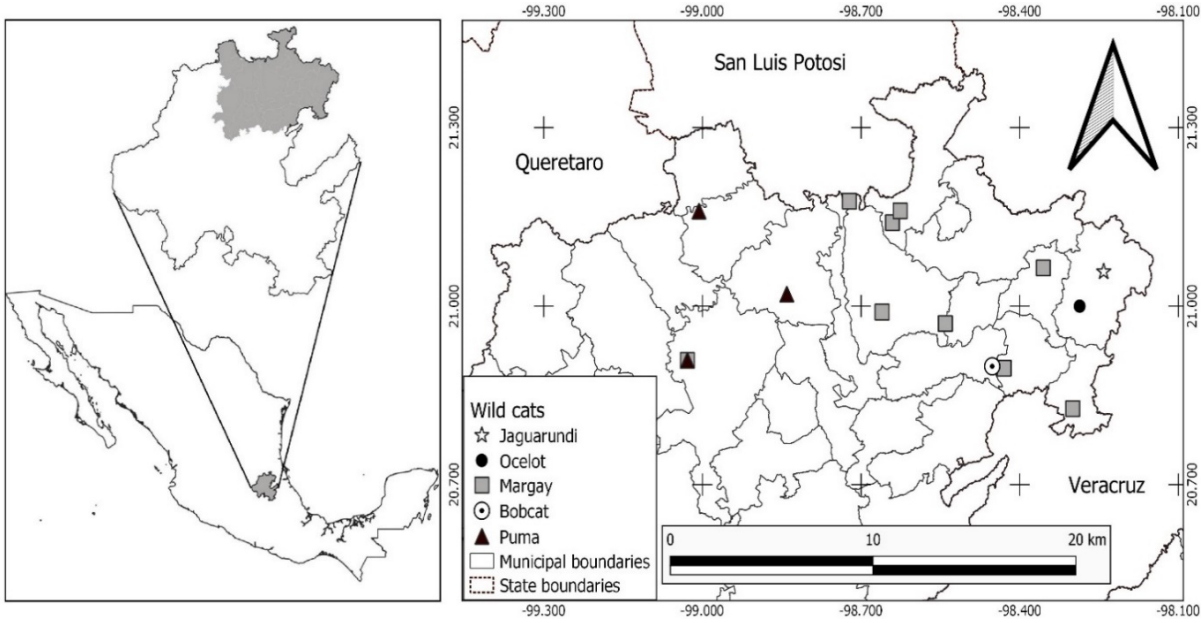

Figure 1. Geographical location of the municipalities in the northeast of the state of Hidalgo, Mexico, as well as mapping of felines records.

Data analysis

To determine the cultural importance of a given species, through the use value, and to know its representativeness, we used the Cultural Importance Index (CI) proposed by Turner (1988) and using the modification made by Figueroa-Solano (2000), who does not give any value to the uses nor distinguish between the used part, as Turner does (Ávila-Nájera et al. 2011), following the formula:

$$IIC_Z = \frac{\sum(luz + fmz + Vutz)}{300} \cdot 100$$

Where:

$$luz = \frac{ni}{N} \cdot 100$$

$$fmz = \frac{mi}{M} \cdot 100$$

$$Vutz = \frac{mij}{M} \cdot 100$$

The sub index is obtained from: $luz = ni$; corresponds to the number of uses reported for species i, N represents the total frequency of uses. For $fmz = m_i$; is the number of mentions of all uses reported for species i, and, M represents the frequency of mentions for all species and for all uses. Finally, *Vutz* is obtained from: mij corresponds to the number of mentions of species i for use j, and M is similar to the previous equation (Estrada et al. 2018).

On the other hand, to describe the association between the reported categories of use and the different species of felines, a correspondence analysis (CA) was performed with the Statistica program (StatSoft 2004). A data matrix was elaborated, where the variables correspond to the six species of wild cats and the cases to categories of use. A chi-square statistic was calculated to find out if the relationship shown was significant. In addition, the percentage of explained variation (inertia) between the first and second dimensions was obtained, to validate the analysis with a contribution of variables and cases above 75%.

RESULTS

Of the 150 people interviewed, 87% (n=130) provided some type of information about the felines, only 34 people indicated they practiced hunting as an alternative subsistence activity or as a recreational activity. The six species recognized as a socioecological entity, identified by a Náhuatl and Spanish name, can be differentiated as well-known ethnospecies (Table 1). Not all informants knew the species names in the indigenous language, 50% of the interviewees handle the nomenclature in Náhuatl and Spanish, while the remaining 50% only use names in Spanish.

In general, regarding the perception of people towards the ethnozoology of these felines, the margay (*L. wiedii*) obtained the highest frequency of mentions ($n = 59$), followed by *L. rufus* with 19 mentions and *P. onca* with 18 (Figure 2). Only 20% of the interviewees mentioned that at least once in their field activities they had an encounter with one of the feline species, but none commented that they had been able to observe the six species in their entire lives.

Table 1. Species and their traditional nomenclature, as well as their categories of use recognized by the inhabitants of the northeast region of the state of Hidalgo, Mexico.

Species of wild cats	Náhuatl Name	Spanish Name	Use category								
			A	B	C	D	E	F	G	H	I
Herpailurus yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)	*Zacamixtle*	Onza	■	■	■	■		■		■	■
Leopardus pardalis Linnaeus, 1758	*Oocelot* / *Ccuametamixto*	Ocelote / Leoncillo		■		■	■	■		■	■
Leopardus wiedii Schinz, 1821	*Cuametamixto*	Tigrillo / Gatillo		■		■	■	■		■	■
Lynx rufus Schreber, 1777	*Mixtle*	Gato montés / Gato de monte	■				■	■		■	■
Puma concolor Linnaeus, 1771	*Mmiztli* / *Mmiztlitecuani*	Lión		■	■				■	■	■
Panthera onca (Linnaeus, 1758)	*Ttecuani* / *Ttecuaquetl*	Tigre			■					■	■

Legend: A=ceremonial, B=Edible, C=Harmful, D=Instrument, E=pet, F=medicinal, G=narrative, H=ornamental, I=trade.

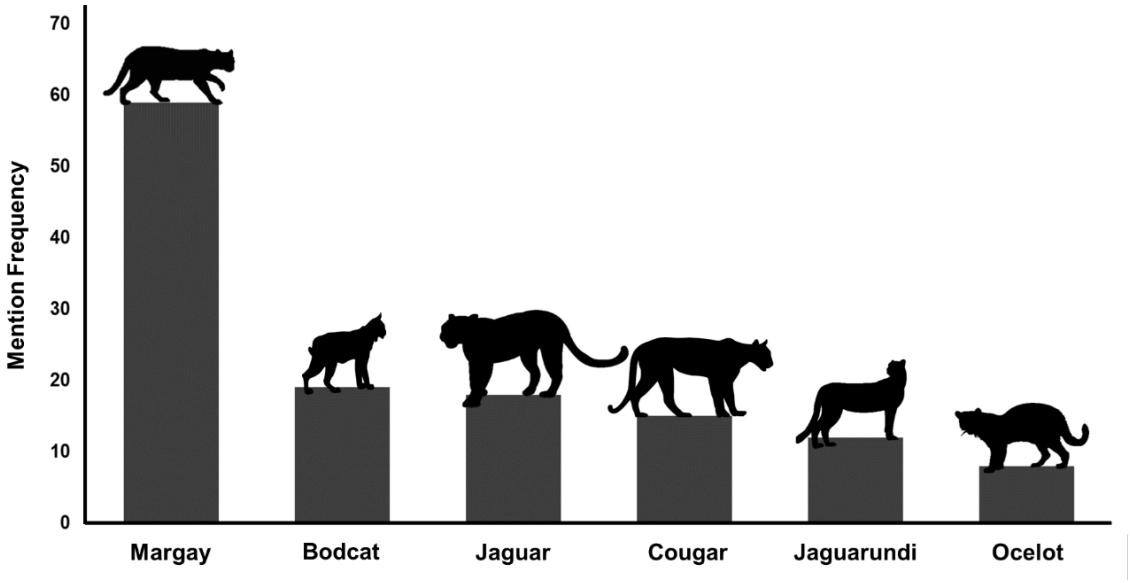

Figure 2. Frequency of mention for felines taxa reported in the north-eastern region of the state of Hidalgo.

Smaller felines are recognized with the unifying principle of '*mixtle*= gato' (cat), plus the prefix '*cua*= monte o cerro' (hill or mountain); that is, '*cuametamixto*'= 'gato de monte' (mountain cat). Approximately 70% of the informants recognized all the feline species, the rest had problems differentiating between *L. wiedii* and *L. pardalis* ('*tigrillo* and *ocelote*'). Of the informants who do differentiate between these species, it is by the pattern of spots and the type coat.

In general, those interviewed do not distinguish between males and females, although some of them mentioned that '*females have been seen with their young, and normally they are not hunted, so that in the future they have more cubs*', and thus be able to continue to further exploit these species. Most admitted that wild cats are scarce in the area due to poaching, poisoning, and road kills.

In addition to the interviews, there are isolated reports of roadkill and poaching. In relation to poaching, a jaguar is reported (Figure 3a. *Panthera onca*, male

Figure 3. **a)** Male Jaguar cub (*Panthera onca*) captured by hunters from the municipality of Tlanchinol, Hidalgo, Mexico. **b)** Male of *Leopardus wiedii* (margay). **c)** Male of *L. pardalis* (ocelot); both found after being run over on the Pachuca-Huejutla highway, in the municipality of Molango de Escamilla, Hidalgo, Mexico; specimen collected by one of the authors (TVGS).

cub), which was captured by poachers using 'perros campeadores' (hunting dogs) from the municipality of Tlanchinol, the approximate date is before October 4, 2023. The one who made the report said he did not want to give details of the incident because it is a species in danger of extinction and protected by Mexican legislation (NOM-059-SEMARNAT-2010); in addition, he mentioned having consumed its meat. The place where the species was captured was not properly located, but there is reference to it being between the municipalities of Tlanchinol and San Felipe Orizatlán. In a second report, it concerns the capture of another adult male jaguar, in August 2023, between the municipalities of Tepehuacán de Guerrero and Chapulhuacán. The informants did not want to provide photographic evidence or give further details.

Regarding feline roadkill, there is evidence for *Leopardus wiedii* and *L. pardallis*, both males. The events were reported on the Pachuca-Huejutla highway, in the municipality of Molango de Escamilla, Hidalgo, Mexico (Figure 3b. *Leopardus wiedii*, Longitude: -98.724863, Latitude: 20.764392, Altitude: 1572; Date: May 12, 2020, Time: 10: 00 pm, near the cruise to Ixmolintla. Figure 3c. *L. pardallis*, Longitude: -98.734375, Latitude: 20.801233, Altitude: 1750, Time: 2:00 am, near the restaurant "El Balcón").

It is mentioned that wild felines are not common to observe in their natural environment, as these events are extremely rare. The main causes mentioned are due to the deforestation of areas with original vegetation for livestock and agricultural activities. On the other hand, few residents (35%) mentioned recognizing the tracks that wild cats leave in the mountains, *e.g.* scat or footprints.

About 80% of the interviewees had knowledge about the feline eating habits. Indicating that *P. concolor* prefers prey such as deer (*Odocoileus virginianus*), collared peccary (*Tayassu tajacu*), pacas (*Cuniculus paca*), white-nosed coatis (*Nasua narica*) and armadillos (*Dasypus novemcinctus*). While the onza (*H. yagouaroundi*), margay (*L. wiedii*), ocelot (*L. pardalis*) and bobcat (*L. rufus*) prefer smaller prey such as tree squirrels (*Sciurus* spp.), rabbits (*Sylvilagus brasiliensis*), gophers (*Orthogeomys hispidus*) and birds, such as '*chachalacas*' (*Ortalis vetula*).

With respect to the different forms of use of taxa, there is a record of a total of nine categories (Figure 4a). The simple correspondence analysis indicates a significant relationship ($\chi^2 = 147.80440gl$, $p = 0.0000$, $p < 0.05$) between the species and the forms of use. The variables that have the greatest contribution to the analysis are: harmful (*P. concolor*) and narratives (*P. onca*). In turn, the '*onza* or *zacamixtle*' are more closely related to ornamental and marketing aspects. While the smaller wild cats (*L. rufus*, *L. wiedii* y *L. pardalis*) are valued as pets, in traditional medicine, for the manufacture of instruments and as ceremonial supplies, as well as ornaments for sale (Figure 4b).

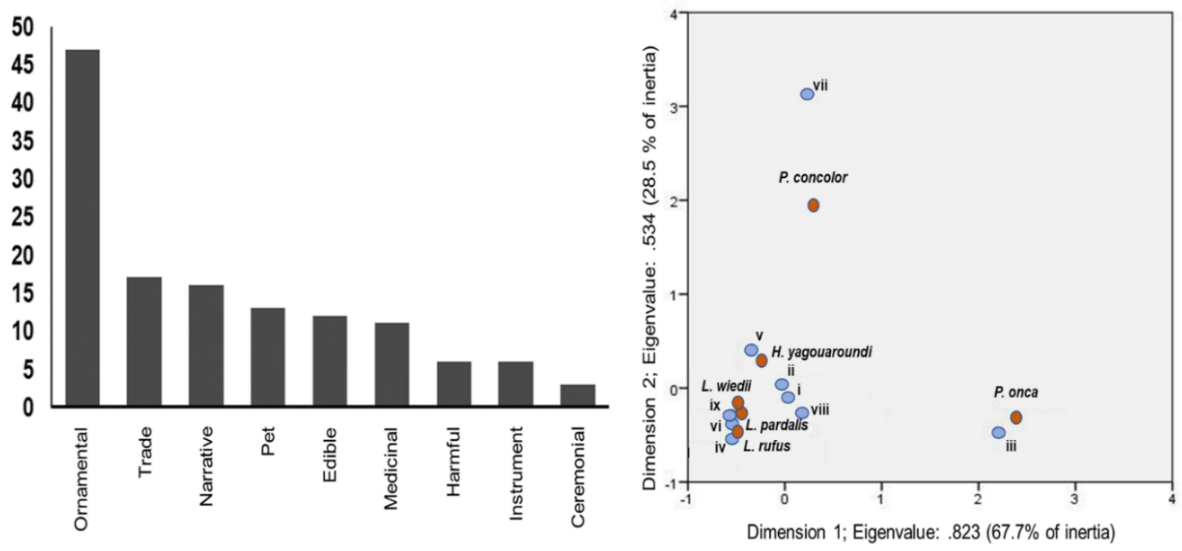

Figure 4. a). Categories of use reported for the different species of felines. **b)** Component Analysis, in which the relationship of the felines with the use categories is shown. The contribution of both dimensions is 96.2%. i. Ornamental, ii. Trade, iii. Narrative, iv. Pet, v. Edible, vi. Medicinal, vii. Harmful, viii. Instrument, ix. Ceremonial.

The wild cat species with the highest number of use categories was *H. yagouaroundi* with seven, followed by *L. pardalis* and *L. wiedii* both with six, *L. rufus* and *P. concolor* with five categories, and *P. onca* with three (Table 1).

The most important anthropocentric category was ornamental (n = 47, Figure 5a, c-f), represented mostly by *L. wiedii*, *H. yagouaroundi* and *L. pardalis*. The second category of importance was sale or trade (n=17), with *L. wiedii* being the most traded species. The data from the interviews provide an estimate of the economic remuneration of the commercialization of the species, for example, a margay skin costs between $1,500 and $2,000 Mexican pesos (70-100 USD), the legs cost $500 Mexican pesos (25 USD) each, while the sale of a complete recently hunted specimen can reach $4,000 and $5,000 Mexican pesos M.N. (200-250 USD). On the other hand, the meat of wild cats is generally consumed by hunters' families. In general, it can be said that the most commercialized feline is *L. wiedii* valued for its skin, which is considered a decorative object (Figure 5a, c, f).

For other wild cats such as *H. yagouaroundi* and *L. pardalis*, the greatest use was for tanned skins that are normally displayed in the houses of those who hunted them (Figure 5d). The species *L. pardalis* and *L. wiedii* are prepared by full-body taxidermy for trophy decoration (Figure 5c, f). Teeth, especially fangs, are also valued and can be purchased for an average of $500 to $1000 Mexican pesos M.N. (25-50 USD) each, documented only for *L. wiedii* and *P. concolor* (Figure 5b), and are considered '*buena suerte*' (good luck) amulets.

In the pet category, small species were the most used: the margay (*L. wiedii*, n=9, Figure 5g) and the ocelot (*L. pardalis*, n = 3; Figure 5j). Regarding medicinal use, *L. wiedii*, *L. rufus* and *H. yagouaroundi* are used. It is said that the fat of felines helps cure muscle pain in the legs, in addition, that their dexterity properties are acquired in the bush. For the instrumental category, the skin is used to make drums. In ceremonial use, reference is made to the bobcat and the jaguarundi, using the entire specimen, the skin or the legs to cure diseases of cultural affiliation, 'remove evil or do it'.

Stories were also obtained, some of the most relevant are: "One day, I was working in the milling of the cane. I had made wooden roof in a tree, I looked over towards the river, I saw the '*tecuani*' (jaguar) slowly passing by, I had never seen that animal (story made by people form the town of Huazalingo)". "Between 2012 or 2014, in one of the neighboring communities, it was said they had hunted a *'tigre*' (jaguar), so we went to see it. It was big, had shiny, smooth skin and full of spots. The people of the community mentioned that it was eating the cattle and that is why neighbors have hunted it with rifles and dogs (story made by people form the town of Huazalingo)". "My dad went hunting with other men from the community, he said there was a '*lion*' (cougar) that was eating the cattle, they had been looking for it for about two years. With '*perros campeadores*' (hunting dogs) they went out looking for

the puma and, in the bush, far away, they found him and hunted him down. My dad brought him home, dismembered him and made his meat in a *barbcacboa*, all the members of the community came to celebrate (story made by people form the town of Tlahuiltepa)".

Derived from the testimony of the informant who refers to the hunting of *P. concolor* and its consumption as 'carne de monte' (meat) and with hints of celebration. In this study, we document the use of puma meat for feeding purposes for the first time for the state of Hidalgo, and for the central region of the country.

Puma hunting was recorded in the community of Santiago in the Tlahuiltepa municipality (Figure 6a), which was hunted in retaliation for having preyed on cattle and other domestic animals, implying a connotation that goes beyond hunting or self-consumption, and be considered a triumph by the members of the community. The meat was prepared as a typical dish of the region, which is considered a party meal, due to its elaborate preparation; which is known by the name of '*barbacoa*'. For this, it is necessary to have a hole in the ground (oven), lined with bricks; which is heated with burning wood for approximately six hours. Once the oven is hot, a metal container is placed in the bottom ('*cazo*') with water and spices; and on this, a metal rack where the raw meat is placed, it is covered with previously roasted maguey (*Agave* spp.) stalks; it is covered again, with '*costales*' (a type of plastic cloth) and dirt. Its cooking time is approximately four hours.

As evidence of this event, a skull was collected in a sanitary waste dump, it was taken to the department of Man and his Environment of the Universidad Autónoma Metropolitana for review by a specialist, who indicated it corresponded to an old female cougar (*P. concolor*, Figure 6b, c).

The species with the highest mention in hunting events were *L. wiedii*, *H. yagouaroundi* and *L. pardalis* (Figure 5i). In the case of *P. concolor*, there was information gathered from three hunters related to livestock conflict in the municipality of Chapulhuacán, Tepehuacán de Guerrero and Tlahuiltepa (Figure 5b, h). In addition, 25% of the hunters admitted hunting these wild cats for harming their livestock, because they are left without food resources and that is when wild cats attack domestic animals.

Regarding the cultural importance of the six species of wild cats used in the northeast region of Hidalgo, the '*tigrillo* or *gatillo*' (*L. wiedii*) presented the highest value for the index ($CI = 36.48$), followed by the '*gato montés*' (bobcat, *L. rufus*; $CI = 15.05$) and the onza (*H. yagouaroundi*; $CI = 13.63$). The other species presented relatively low values (Table 2).

These results are a function of three subindices and the role of each species within them: a) intensity of use, b) frequency of mention and c) value of use (Table 2). For example, with respect to the intensity of use, the '*onza*' (*H. yagouaroundi*, $UI = 22.58$) presented the highest value, which means that the ounce is the species on which the greatest pressure is exerted in exploitation. For the frequency of mention and the value of use, it was the margay, both with the same values (*L. wiedii*, $MF = 45.04$), this species is the best known, and its relationship between the frequency of mention, the role that it plays within. The anthropocentric categories give it the most significant value in use.

DISCUSSION

The current relationship between humans and felines has been approached mainly from the context of conservation, mainly determined by the risk they represent for local communities (Madhusudan and Karanth 2002; Lucherini and Merino 2008; Treves 2009; Loveridge et al. 2010; Viollaz et al. 2021). There are few studies that explore the human-feline relationship from an ethnozoological perspective (García-Alaniz et al. 2010; Arroyo-Quiroz et al. 2017; Schulz et al. 2017; Olivera-Méndez et al. 2019),. Our results provide an overview of this complex relationship by all of the six species of Mexican felines and the socioecological role they play within Nahua and mestizo communities, in central Mexico (Figure 1).

The six species of wild cats are part of the socioecological heritage. Regarding the traditional nomenclature, the names in Náhuatl and also the names in Spanish are preserved. In Nahuatl the names are similar to those documented by naturalists in the colonial period (Hernández 1959) and used since pre-Hispanic times (Sahagún 1985; Seler 2004). In the pre-Hispanic times, the most emblematic name was '*tecuani*' (*Panthera onca*), which literally translates as '*fiera* or *bestia*' (fierce wild, beast), with a deeper cultural connotation, its linguistic interpretation is '*el señor de la noche / el devorador de hombres*' ('lord of the night or the one that devours man'; Seler 2004). This term is still in force in the Náhuatl oral tradition and among the mestizo communities to recognize the '*tigre*' (jaguar). Even among the mestizo communities in this region its name continues to be '*tecuani'*. The maintenance of the traditional name of *Pantera onca* is indicative of its cultural importance, despite being documented as an occasional record in the northeast of the state of Hidalgo (Aguilar-López et al. 2015; Morales et al. 2015) and in central Mexico (Villordo-Galván et al. 2010; Charre-Medellín et al. 2014; Arroyo-Quiroz et al. 2017). However, as shown in Figure 3a the species is affected mainly by poaching, prompting researchers to assess the phenomenon in more detail and local authorities to establish environmental education workshop. The names used for other species refer to

Figure 5. Photographic records of five of the six feline species for the northeast of the state of Hidalgo. **a)** mammalian skins, including ocelot (*Leopardus wiedii*), **b)** hunted specimen of *Puma concolor*, **c)** Child with dissected a margay taxidermy, **d)** skin of *Herpailurus yagouaroundi ´zacamixtle´*, **e)** skull of ´gato montés´ (*Lynx rufus*), **f)** stuffed margay, **g)** offspring breeding of *L. wiedii*, **h)** specimen of ´puma/lion´ hunted by local residents, **i)** hunted specimen of *L. pardalis ´ocelot´*, and j) specimen as pet of *´ocelot´*.

their status as '*gato* or *felino*' (cat or feline; '*miztli*' or '*mixto*', Table 1). For example, the term '*miztlitecuani*' (*Puma concolor*) translates as '*gato que devora*' (the cat that devours), which maintains its nomenclatural connotation of big cat (Seler 2004). However, its situation is similar to the jaguar, it is hunted for retaliation and even this action is a cause for celebration (Figure 6a). For the rest of the smaller felines, the Nahuatl word '*cuametamixto*' is used, which means '*gato de monte*' (mountain cat), as well as the use of specific names, for example, the word '*ocelotl*' (*L. pardalis*) which differentiates it from *L. wiedii* (margay). The linguistic documentation of felines suggests that their socioecological role has maintained to some extent until today (Hernández 1959; Sahagún 1985).

In general, felines have a cultural contribution in different cultural domains, which gives them the status of cultural or highly relevant species (Ibarra et al.

Figure 6. a) Informant from the community of Santiago in the municipality of Tlahuiltepa, Hidalgo; México holding a *Puma concolor* (*´lión´*= cougar) skull. The same that was hunted and eaten by the inhabitants of the community. **b)** Dorsal view of the skull, where a burn caused by the cooking process to which the specimen was subjected can be observed. **c)** Ventral view of the puma skull, note the absence of fangs.
Photograph by: Gutiérrez-Santillán T.V.
NOTE: For the taking of photographs, the prior and informed consent of the interviewees was obtained, as well as their authorization for their publication (ISE 2006).

Table 2. Values for the Cultural Importance Index (CI) applied to the six feline species that converge in the study area.

Specie	Usage intensity	Mention frequency	Use value	Cultural Importance Index
Herpailurus yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)	22.58	9.16	9.16	13.63
Leopardus pardalis Linnaeus, 1758	16.13	6.11	6.11	9.45
Leopardus wiedii Schinz, 1821	19.35	45.04	45.04	36.48
Lynx rufus Schreber, 1777	16.13	14.50	14.50	15.05
Puma concolor Linnaeus, 1771	16.13	11.45	11.45	13.01
Panthera onca (Linnaeus, 1758)	9.68	13.74	13.74	12.39
Total	**100**	**100**	**100**	**100**

2012), and they are important because they are top predators in the trophic chain, as an umbrella or emblematic species (Roberge and Angelstam 2004).

Regarding the anthropocentric categories or the forms of use of these species, defined patterns are observed, the largest species (jaguar and cougar) are related to the conceptualization of harmful and in the narrative, this is surely associated with occa-

sional records (*P. onca* and *P. concolor*; Aguilar-López et al.; Figure 4b). Small species cover another series of categories, the most relevant being ornamental (Figure 4b). However, to cover any of the use categories it is necessary to hunt or capture the animal. From this perspective, the hunting of wild cats is an activity that directly impacts the populations of the different species that converge in this region and in general in the country (Lira-Torres and Naranjo 2003; Carvalho and Desbiez 2013; Horn et al. 2020). It should be considered that felines are species with low population densities and that require wide ranges of distribution (Nowell and Kackson 1996).It is evident that the cultural roles that felines have encourage their hunting or extraction, which is illegal (Ramírez-Álvarez et al. 2021; Neumann et al. 2022; (Figure 3a; 5h, i; 6a), if we consider that the different species of felines are found in categories of risk and threat in Mexican legislation (NOM 059-Ecol-2010), and by international organizations (CITES 2019, IUCN 2022). Unfortunately, as in other states of the Mexican Republic and the world, felines products or by-products have a wide demand in the market or cultural appreciation (Aranda 1997; García-Alaniz et al. 2010; Olvera-Méndez et al. 2019; Flores-Armillas et al. 2020), these mammals have an overvalued commercial value and are highly valued (Aranda 1997; Lira 2006), which encourages their hunting or illegal extraction (Balaguera-Reina and González-Maya 2007; Aya- Cuero et al. 2021; Chacón and González-Maya 2013; Dickman and Hazzah 2016). This activity turns out to be one of the main causes of risk and threat faced by different feline populations (Carvalho and Desbiez 2013). Therefore, the promotion of conservation under the biocultural status and environmental education for its protection is essential (Neumann et al. 2022).

Wildlife hunting fauna in indigenous and rural communities is considered a subsistence activity (Souza-Mazurck et al. 2000; Alves et al. 2009; Melo et al. 2014), and has even been designated as heritage culture of humanity (Dajczak et al. 2021). However, with the documentation in this work, we realize that its cultural connotation is changing, generating a more complex psycho-social pattern, where hunting is simply carried out by the fact of showing preponderance over the wild fauna or as a recreational phenomenon (Figure 3a; 5h, i; 6a). In this regard, Herrmann and collaborators (2013) mention that the perception of felines has a long historical and current coexistence, which is often based on religious and symbolic beliefs, combining ancestral roots that go beyond being considered a threat. The worldview towards felines reflects the fascination with large species (jaguar and puma) or those that are similar (margay, ocelot, jaguarundi and wild cat). This fascination can be framed by the symbolism of fear, a human attitude since ancient times, derived from the survival behaviours that these evoke (Trout 2011). This is the driving force behind the generation of myths, observed in the detailed narratives documented in this work. However, the creation of the myth as a form of survival or care indirectly threatens wild populations (Trout 2011). Attention must be paid to the fact that human-animal relationships are social and subjective constructions, which depend on the sociocultural context and this directly affects how animals are treated, so these worldviews benefit or harm wild populations according to the vision developed by people in a given space and time (Echeverri et al. 2018). This proposal must be evaluated in depth, where the effects of globalizing thought and changes in perception towards nature are manifested. These changes are a reflection of colonialist pressure that traditional peoples or societies have suffered (Vertovec and Posey 2020)In the case of felines meat consumption, it is a phenomenon little described, with some reports in Argentina (Altrichter et al. 2006; Lucherini and Merino 2008), Brazil (Schulz et al. 2017), Colombia (Payán and Trujillo 2006; Balaguera-Reina and González-Maya 2007; González-Maya et al. 2010; Chacón and González-Maya 2013; González-Maya et al. 2013; Pacheco and González-Maya 2013; Aya-Cuero et al. 2021), Venezuela y Mexico (Contreras-Díaz and Pérez-Lustre 2008; García-Alaniz et al. 2010; Estrada et al. 2018). In Mexico, the consumption of felines meat has been documented in mestizo communities in the Lacandon jungle in Chiapas (García-Alaniz et al. 2010), in the Mixteca Poblana Region (Estrada et al. 2018), and in Zapotec communities in the Sierra Madre de Oaxaca (Contreras-Díaz and Pérez-Lustre 2008). Our testimonies confirm that in the center of the country and in this particular region, feline meat is consumed as food, when they are hunted occasionally, that is, the meat is not wasted, it is consumed by hunters and their families (Figure 6a). Furthermore, some informants reported that: '*wild cats meat is consumed, it is visual, olfactory or agility qualities; they are acquired by people, including skills as a good hunter*'. This connotation prevails to this day, originating from the Mesoamerican peoples, where the figure of felines was highly relevant, which is why they were worshiped for their biological qualities and ways of life, where warriors fought dressed in jaguar skins; as a symbol of strength and bravery (Benson et al. 1970; Saunders 1994; Loveridge et al. 2010). It is not surprising that, in some way, these perceptions are still valid in the collective thought of those who inhabit territories of high biological diversity and where species are distributed.

In particular case, the edible use of cougar is little mentioned in the literature, but eventual cases have recently been reported for different South Amer-

ican countries such as Venezuela, Colombia and Argentina. In Mexico, there is little information on the use of *Puma concolor* meat as food; this event has only been documented in Zapotec communities in the Sierra Madre of Oaxaca (Contreras-Díaz and Pérez-Lustre 2008). Therefore, in this contribution we detail the meat consumption of this species, as a direct reflection of the human-feline conflict (Breitenmoser 1998; Karanth and Madhusudan 2002; Treves and Karanth 2003; Treves et al. 2006; Lucherini and Merino 2008; Inskip and Zimmerman 2009; Almazán-Catalán et al. 2013; Arroyo-Quiroz et al. 2017; Flores-Armillas et al. 2020, Figure 5h; 6a), and particularly cougar-humans (Lira-Torres and Naranjo 2013; Olvera-Méndez 2019, Ramírez-Álvarez et al. 2021). We also report the consumption of jaguar (*P. onca*), cougar (*P. concolor*) and ocelot (*L. pardalis*) meat is part of the human-feline socioecological relationships in this region, in some way satisfying needs such as food, the acquisition of mystical properties and as a manifestation of the supremacy of hunters over feline species (Figure 3a, c, 6 a).

However, there are various sociocultural processes and connotations of the consumption of feline meat, especially cougar, as: a) The reasons for hunting, which correspond to the predation of livestock and domestic animals (Monroy-Vilchis et al. 2009), which is why it is feared that it attack humans (Beier 1991). b) The way of hunting, which was not casual, but rather in retaliation for predation (Peebles et al. 2013). c) The very peculiar way of preparing the meat in a traditional food from central Mexico known as '*barbacoa*' (barbecue), which denotes a celebration (CONACULTA 2004). d) Victory over the hunted specimen. e) Finally, the disposal of evidence (skull) in a sanitary landfill, which demonstrates the collective awareness that it is illegal to kill or hunt wildlife without the corresponding legal permits, especially feline. To this point we add the observation that the skull did not have the fangs, which indicates that someone kept them as a sign of triumph (García-Alaniz et al. 2010; Almazán-Catalán et al. 2013), and that these are valued as amulets, as well as representing an economic income. In general, in this isolated event, the specimen was hunted, as it was identified as a risk to the safety of the locals and their economy, so there should be greater promotion of livestock recovery programs due to predation by local authorities, as is done in other parts of the world, where conflicts of this kind are common (Neumman et al. 2022). On the other hand, regarding the isolated case of the hunting of the cub jaguar (Figure 3a), it was indirectly documented that the meat of the specimen was also consumed by the locals as a sign of supremacy, changing the connotation of the hunting phenomenon of subsistence. Both cases may be supported by unconscious collective memory determined by fear (Trout 2011) and historical relationships (Herrmann 2013), as well as the effects of globalization manifested in changes in perception (Vertovec and Posey 2020).

Other smaller feline species such as the ocelot and the margay were also mentioned as edible and with various forms of cooking. As in other regions of America, the hunting of felines with edible uses is intermittent (Chacón and González-Maya 2013, Pacheco and González-Maya 2013, Aya-Cuero et al. 2021), they are events generated by considering the species of felines as harmful, which represent a risk to the livestock and the economy of local families (Neumann et al. 2022).

In general, wild cats are killed due to reprisals originating from the conflict that humans have with these mammals, or during casual encounters with hunters (Lucherini and Merino 2008, Almazán-Catalán et al. 2013, Flores-Armillas et al. 2020). These conflicts have arisen with other large Mexican carnivores, considering them detrimental to livestock (Treves and Karath 2003; Arroyo-Quiroz et al. 2017, Vázquez and Gaston 2006). In particular, wild cats in Mexico and worldwide are strongly threatened by retaliatory hunting, run over, fragmentation and habitat loss that negatively affects their populations (Lucherini and Merino 2008; Inskip and Zimmermann 2009; García-Alaniz et al. 2010; Flores-Armillas et al. 2020; Aya-Cuero et al. 2021).

Other factors that are affecting felines are the rapid growth and expansion of human populations, leading to habitat fragmentation, degradation and destruction (Cincotta et al. 2000; Fairbanks et al. 2002; Vázquez and Gaston 2006). This has led to carnivores coming into contact with people and eventually breaking into human spaces, causing problems for both parties (Treves 2009; Almazán-Catalán et al. 2013; Peebles et al. 2013; Neumann et al. 2022). Despite representing a risk to domestic fauna, the probability of encounters with felines is minimal or almost nil (Dickman and Hazzah 2016).

In general, our results show that the socioecological relationship between humans and felines has changed, although some ethnohistorical connotations are maintained in the Nahua collective of the Huastec in this particular region. The thinking has been drastically modified and with it the perceptions and attitudes towards this group of vertebrates (Trout 2011, Herrmann 2013). The phenomenon of subsistence hunting is profoundly modified, and is now a recreational event, which deeply devalues the role of these species in the ecosystems of this region and shows cultural degradation. Strongly promoting negative attitudes and a greater appreciation for a dead feline than for a live one, generating a phenomenon that directly impacts the populations of these species; and strongly encourages the illegal extraction or death of these species

(Loveridge et al. 2010).

CONCLUSION

In this central region of Mexico, the six species of felines are recognized as socioecological entities; the traditional nomenclature used by the Mesoamerican Nahuas is maintained. The species were corroborated through literature, sightings reported by informants, as well as by photographs and parts of specimens in the possession of the residents themselves.

Nine anthropocentric categories were documented, the most relevant being ornamental use. Skins, fangs, the complete specimen in taxidermy or alive as a pet are appreciated. Wild felines represent a high economic value for hunters, an action that affects wild populations.

One of our main contributions is the consumption of feline meat as an extra benefit. In particular, the consumption of cougar meat is an unusual fact, associated with attitudes of retaliation. On the other hand, we also documented the hunting of a jaguar cub, which was captured simply for the fact of being hunted (playful act), its meat was also consumed; furthermore, this act is recognized by the inhabitants themselves as illegal. In both of these particular cases, it is necessary to evaluate these socioecological phenomena in greater detail, since changes in perception with negative effects on nature are common in indigenous and rural communities, unfortunately generated by globalizing pressure.

The inhabitants and especially the local hunters are fully aware that wild feline species are protected by Mexican legislation, that their population densities low or almost reduced, that phenomena such as deforestation, the expansion of agriculture, livestock, among other; directly affect wild populations; forcing them to live closer to rural communities, increasing the possibility of generating human-feline conflicts.

It is suggested that environmental education workshops be held from a biocultural approach, so that local residents know the ecological importance of wild felines. Residents should be guided on how to avoid unjustified conflicts, especially by revaluing the Mesoamerican historical, sociocultural and socioecological status. Fortunately, the permanence of felines in collective memory can help the relationship between human-feline, and promote the long-term conservation of these species.

ACKNOWLEDGMENTS

To the people who kindly agreed to answer the interviews and provide relevant information about felines. To Dr. Jorge Servin of the Department of Man and his Environment, of the Universidad Autónoma Metropolitana for corroborating the identification of the skull of a cougar (*Puma concolor*). To María Lizeth Olguín and Nadia Cano Valdez for their support in integrating the database.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: JVH, TVGS, RVH, EEC Ethnographic work: JVH, TVGS
Carried out the data analysis: TVGS, JVH, EEC
Wrote the first draft of the manuscript: TVGS, JVH
Review and final write of the manuscript: TVGS, JVH, EEC, RVH
Supervision: EEC, JVH

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Received: 09 September 2024
Accepted: 28 January 2025
Published: 24 February 2025

Editor: Rômulo Alves

Additional Files

Add File 1. Photographs of the sites where the interviews were conducted and some of their general cultural manifestations. Sites: A) Calnali, B) Chapulhuacán, C) Huautla, D) Huazalingo, E) Lolotla, F) San Felipe Orizatlán, G) Tepehuacán de Guerrero, H) Tlahuiltepa, I) Tlanchinol, J) Yahualica, and K) Xochiatipan. Culture: L) traditional dances 'huapango', M) gastronomy 'zacahuil', and, N) day of the dead 'xantolo'.

Add File 2. Interview applied (Semi-structured interview applied in Spanish)

Confidentiality clause: This interview is based on and respects the guidelines established in the "Code of ethics for research, action-participation research and ethnoscientific collaboration in Latin America".

1. Nombre del entrevistado:
2. Edad:
3. Género: M ( ) F ( );
4. Escolaridad:
5. Ocupación:
6. Localidad:
7. Município:
8. Estado:
9. Hablante de lengua indígena: Si ( ) No ( )
10. Cuál?

1. ¿Cuáles son los gatos del monte qué conoce y qué nombre les da en español y en lengua materna?
2. ¿Qué conoce de los gatos de monte? (alimentación, hábitos, reproducción)
3. ¿Cuáles son los usos qué se les da? (categorías antropocéntricas)
4. ¿Cuáles son las historias que se cuentan de estos animalitos? (percepción)
5. ¿Qué tan frecuentes son en el monte?
6. ¿Cómo se consiguen? (formas de cacería, compra-venta)
7. En caso de adquirirlos mediante la compra, ¿cuál es su costo aproximado?