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Knowledge, use and traditional management of wildlife in the community of Zoquital, Morelos, Mexico

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ABSTRACT

Through their traditional productive activities, peasant and indigenous communities have generated knowledge on the use and management of wildlife to satisfy their needs for food, medicine or even to complement their basic food basket through the marketing of the species. The objective of this research was to analyze the knowledge, use and traditional management of wildlife in a rural community in the southwestern part of the state of Morelos, Mexico. The methodology included participant observation, semistructured interviews and guided tours and methods for obtaining and analyzing quantitative data "such as analysis of variance, a Mann–Whitney U test and X^2 test". The interviewees recognized a total of 57 species of wildlife, of which 22 are used as food, medicine, ornament, amulets, furs and agricultural tools in four traditional production units. In addition, eight species were reported in the oral tradition. Four hunting techniques and five weapons were documented, with the shotgun being the most commonly used. Two factors regulate hunting in the community: the closed season and religion. A total of 62,454 kg of useful biomass was recorded, with mammals being the group that contributed the most kilograms, followed by reptiles and birds. There were no significant differences in species consumption, across months or rainy and dry seasons due to factors regulating hunting. Based on the total value index of the species, *Odocoileus virginianus* was the most important for the inhabitants of the community.

Keywords: Subsistence Hunting, Traditional Ecological Knowledge, Ethnozoology, Uses, Odocoileus Virginianus.

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SIGNIFICANCE STATEMENT

Peasant communities possess traditional knowledge of the wildlife of the place where they live, which allows them to complement their basic needs, such as food and medicine, or to obtain a monetary income through the use and management of the species. The present study records the useful species in a rural community in the southwest of the state of Morelos, Mexico, where studies on wildlife are scarce and where in spite of community rules and prohibitions by the religion they profess, they still conserve knowledge about hunting techniques and tools. Family dynamics are related to the search for better income outside the community, and the registry of the species hunted in five family units over one year shows that the number of hunters has decreased; however, the inhabitants recognize the deer *Odocoileus virginianus* as the species with the highest value for food, economic and cultural use.

INTRODUCTION

Wildlife is the main source of food self-sufficiency for the inhabitants of diverse regions of Mesoamerica, including Mexico, and they obtain tangible or intangible benefits from it as medicine, ornament, companion, amulet or climate indicators (Quijano and Calmé 2002; Montiel 2010; Monroy and García 2013; Gotoo 2016; Contreras and Yanguez 2017; Dardón and Retana 2017; Asprilla and Díaz 2020; Zarazúa et al. 2020).

Indigenous and peasant groups, coexisting with wildlife in their immediate environment, have generated multiple dynamic interactions that vary according to each territory, historical period and culture of these societies. As part of these relationships, these traditional groups have accumulated deep traditional ecological knowledge about the animals with which they have interacted over time. This knowledge is characterized by being dynamic, holistic, adaptive and transmitted through spoken language in a generational way. It is derived from the systematic observation of nature, producing detailed and in-depth empirical information on the biological resources with which they are interrelated, such as use values, sexual differentiation, distribution, development and feeding habits of animals, as well as knowledge associated with classification, nomenclature and identification (Boege 2008; Toledo and Barrera 2008; Lira-Torres et al. 2014; Alves and Souto 2015; Velarde and Cruz 2015; Tamburini 2016).

However, territorial fragmentation caused by land use change and the lack of economic resources promote population movements in search of better living conditions, which are the factors that threaten this traditional knowledge (Monroy et al. 2011). Displacements of people from one place of residence to another imply relocation and loss of their territory of origin but encourage the search for identity to act and adapt to the new territory where they arrive (Pries 1999; Arévalo 2016), modifying their strategies and traditional knowledge to achieve their social welfare (UNESCO 2009); an example of this is the peasant community of Zoquital, Amacuzac, Morelos State, Mexico that was created approximately 80 years ago by inhabitants of the state of Guerrero. The traditional knowledge recorded in this research is approached from the perspective of ethnozoology, a branch of ethnobiology that studies traditional zoological knowledge (CZT), i.e., how human groups conceive, classify and relate to animals (Costa-Neto et al. 2009). The objectives were: 1. To characterize the species with the value of use and exchange value recognized by the inhabitants. 2. To document hunting techniques, weapons, and strategies for regulating wildlife, and 3. To quantify the biomass of the species consumed by the local community.

MATERIAL AND METHODS

Study area

The peasant community of El Zoquital, municipality of Amacuzac, Morelos is located at coordinates 18° 32' 08"LN and 99° 21' 53"LO and at an altitude of 1117 masl (Figure 1). The climate is warm subhumid with summer rains, the average annual temperature and precipitation are 23.6°C and 1022.7 mm, respectively (Taboada et al. 2009), and the vegetation type is low deciduous forest and oak forest (Miranda and Hernández-X 2014). The total population is 152 inhabitants, and the degree of marginalization of the community is low (INEGI 2020).

Qualitative research techniques

Initially, an approach was made to the community through previous visits to contact the local authority, who was informed about the objectives of the present work and the activities and techniques to be carried out, as suggested by the Code of Ethics of the Latin American Society of Ethnobiology (Cano-Contreras et al. 2016).

From December 2020 to December 2021, using the "snowball"technique or chain sampling (Taylor and Bogdan 1987; Castillo and Peña 2015), open and semistructured interviews were applied to 33 family units, representing 91.6% of the total households con-

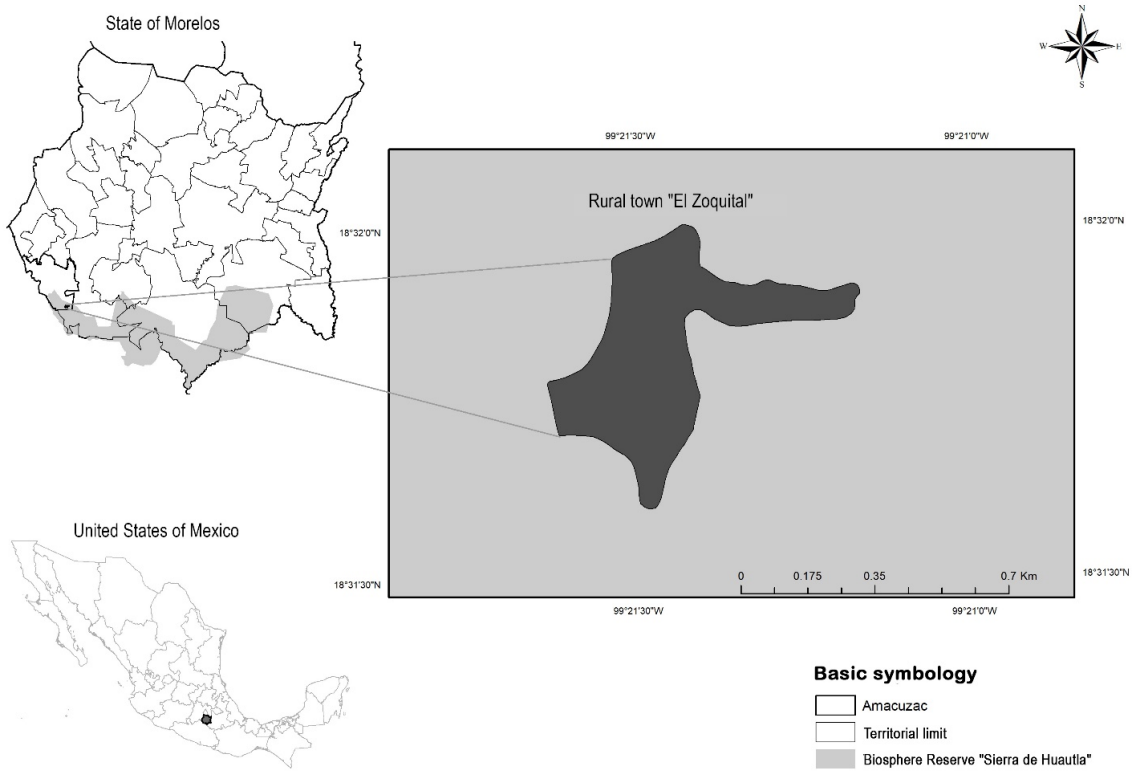

Figura 1. Location of the study area.

sidering the disposition of local collaborators and that they were older than 18 years old. At all times, the health protocols indicated by the municipal assistant were followed for the safety of the families and the interviewer (wearing masks, keeping a distance, not kissing or hugging, conducting the interview in an open-air space, and avoiding the visit if any symptoms such as fever or cough were present). The information was recorded in a field logbook and included the local name of wildlife, its distribution in the territory, categories of use, forms of appropriation, beliefs, stories or legends.

In addition, the wildlife hunting events within the traditional productive units were recognized to obtain the number of individuals and weight of the species. A form was prepared to record the species hunted, the destination of the animals, the productive unit where they were obtained and their weight. To obtain the biomass, a Famsa mechanical scale with a capacity of 5 kg was used, and a Pretul Roman scale with a capacity of 50 kg was used for larger species. This form was completed during each visit to the study area with the information provided by four households that agreed to participate in the research. Wildlife referred to in the interviews was identified through guided walks and the use of field guides for each taxonomic group (Peterson and Chaliff 1989; Urbina and Morales 1994; Aranda 2013; Montalbán and Aréchaga 2014; Gaviño 2015; Pino et al. 2018a; Pino et al. 2018b). Scientific names were corroborated from databases such as The Reptile Database (https://www.reptile-database.org), Avibase- The World Bird Database (https://avibase.bsc-eoc.org) and ASM Mammal Diversity Database (https://www.mammaldiversity-org). The review of the conservation status of the species was carried out based on NOM- 059-SEMARNAT- 2010 (SEMARNAT 2010) and the International Union for Conservation of Nature (IUCN 2021).

Analysis of the information

The information obtained from the interviews was systematized in a Microsoft Excel 360 database and analyzed using descriptive statistics.

To determine if there were significant differences in consumption between wildlife species across the months recorded, an analysis of variance was applied, and between the rainy and dry seasons with respect to biomass consumed, a Mann–Whitney U test was applied for independent samples. The normality and homoscedasticity of the data were previously chec-

ked (Infante and Zárate 2010). Finally, an X^2 test was used to determine whether there were differences between wildlife capture sites. The analyses were processed in the R program (R Core Team 2021).

Finally, with the information provided by the local collaborators and the record of the biomass consumed during the study period, the total value of each wildlife species was calculated, which measures the importance of these species for a given community, using the formula proposed by Reyes-García et al. (2006):

$$\text{Ve}= \text{CVe} + \text{PVe} + \text{EVe}$$

where Ve= total value of species e, CVe= cultural value of the species, PVe= practical value of the species, and EVe= economic value of the species. The CVe of each species was obtained from the following formula:

$$\text{CVe}= \text{Uce} \cdot \text{Ice} \cdot \sum \text{IUce}$$

where CVe= Cultural value of the species; Uce= total reported uses for species e/total uses of the species recorded in the present study; Ice= number of households that listed species e as useful/total households interviewed; UIce= number of households that mentioned each use of species e/total households interviewed.

The PVe of the species was obtained using the formula:

$$\text{PVe}= \text{Upe} \cdot \text{Ipe} \cdot \text{DUpe}$$

where PVe= practical value of the species; Upe= number of different uses observed for species e during field observations/total uses of the species recorded in this study; Ipe= number of times the species was brought to the household/total number of households that participated in the recording; DUpe= duration of each use/total number of field records. Reyes-García et al. (2006) assigned a duration of one day for species with food use and seven days for those used in medicine. In the present study, 15 days were considered for agricultural use and 30 days for ornamental and fur use.

The Vee of the species was obtained from the number of times the species was brought to the household multiplied by the price of the species. The price was referred to by the interviewees. For species for which the cost was not indicated, it was obtained by multiplying the average number of hours of capture by the price of the minimum wage for the community ($172.87 M/N or 9.08 USD).

RESULTS AND DISCUSSION

Description of the reporting group

A total of 81.8% ($n = 27$) of the family units were nuclear (consisting of father, mother and children), and 18.2% ($n = 6$) were extended (consisting of mothers-in-law, daughters-in-law, husbands and children). The average number of members per family unit was 3.7 ± 2.5, with an age range of 1 to 79 years, and the average length of residence in the community was 30.2 years. The distribution of activities within the family units allows them to complement their income and improve their wellbeing; thus, men are dedicated to rainfed agriculture, backyard livestock, commerce, salaried work and hunting as the main activities they carry out. Although hunting was mentioned by 22% of the households, only 16% continue to carry out this activity. Women take care of the household, collect plants for firewood or medicine, help with planting and take care of the livestock when the father of the family leaves the community and participate in the preparation of the hunted species; therefore, the form of family organization in the Zoquital includes the use of the labor force of its members: children, adolescents and adults (Aguado 1993; Solo de Zaldivar 1993; Román-Montes de Oca 2017); therefore, men and women possess and preserve knowledge about the wildlife species of their community. Ayala et al. (2019) call the distribution of these activities peasant specialties, where each member has specific tasks that are taught from the age of seven or eight, an age that coincides with the present research. According to local collaborators, boys participate by accompanying their parents or siblings in field activities, learning and recognizing animal species, while girls are instructed in food preparation by their mothers when the father of the family arrives home with them; in this way and as reported by Ríos (2020), girls and boys are integrated into the knowledge and wisdom of the family unit.

Knowledge of species

The inhabitants of the community recognized 57 species of wildlife corresponding to 2 invertebrates, 1 amphibian, 14 reptiles, 22 birds and 18 mammals, belonging to 19 orders and 37 families (Table 1). The total number of species represents 16.33% of those reported for the Sierra de Huautla Biosphere Reserve (REBIOSH), 8.11% for the state of Morelos and 1.58% nationally (CONANP 2005; Sarukhán et al. 2017; Bustos and Castro 2020; Castro and Bustos 2020; Guerrero et al. 2020; Urbina 2020). According to the IUCN, 85.18% of the species (48.55 species) are in the status of least concern, while NOM-059- SEMARNAT-2010 records 14. 82%, (8 species) in some category of risk (see Table 1).

Tabela 1: Taxonomic relationship of wild animals recognized by the inhabitants of the community of Zoquital, Amacuzac, Morelos State, Mexico.

Order **Family** **Scientific name**	**Common name**	**Use**	**Habitat**	**UICN**	**NOM-059-SEMARNAT-2010**
		Insects			
Hemíptera					
Pentatomidae					
Edessa spp.	"Jumiles"	Al	Mo	LC	
Hymenoptera					
Apidae					
Apis mellifera Linnaeus, 1758	Bees	Al	Mo, Te	LC	
		Amphibians			
Anura					
Hylidae					
Agalychnis dacnicolor (Cope, 1864)	Green frog		Ba	LC	
		Reptiles			
Testudines					
Kinosternidae					
Kinosternon integrum Le Conte, 1854	Tortoise	Me	Ba	LC	Pr
Squamata					
Iguanidae					
Ctenosaura pectinata (Wiegmann, 1834)	Black iguana	Al, Me, Ve	Mo, Ba, Cu	LC	A
Phrynosomatidae					
Phrynosoma taurus Bocourt, 1870	Chameleon		Mo	LC	A
Sceloporus horridus Wiegmann, 1834	"Chintete"		Mo	LC	
Scincidae					
Plestiodon brevirostris (Günter, 1860)	"Eslaboncillo"		Mo	LC	
Teiidae					
Aspidoscelis sp.	Lizard		Mo, Cu		
Helodermatidae					
Heloderma horridum (Wiegmann, 1829)	Scorpión		Mo	LC	A
Serpentes					
Boidae					
Boa constrictor Linnaeus, 1758	"Mazacuata", "malacoa", "coa"		Mo, Ba, Cu		A
Colubridae					
Drymarchon menalunurus (Dúmeril, Bibron & Duméril, 1854)	"Tilcuate"		Ba, Mo	LC	
Leptophis diplotropis (Günter, 1872)	Green snake		Ba, Mo	LC	A
Masticophis mentovarius (Duméril, Bibron & Duméril, 1854)	Ash snake		Mo	LC	
Oxibelis aeneus Wagler, 1824	"Bejuquilla"		Mo	LC	

Order **Family** **Scientific name**	**Common name**	**Use**	**Habitat**	**UICN**	**NOM-059-SEMARNAT-2010**
Elapidae					
Micrurus sp.	"Coralillo"		Mo		
Viperidae					
Crotalus culminatus Klauber, 1952	Rattlesnake	Me, Pe, Ve	Mo, Ba, Cu	NE	
		Birds			
Galliformes					
Cracidae					
Ortalis poliocephala (Wagler, 1830)	"Chachalaca", "paita"	Al	Mo	LC	
Odontophoridae					
Philortyx phasiatus (Gould, 1844)	"Codorniz, churrunda"	Al	Mo, Cu	LC	
Columbiformes					
Columbidae					
Columbina inca (Lesson, 1847)	Turtle doves	Al	Mo, Cu, Ba, Pa	LC	
Leptotila verreauxi Bonaparte, 1855	Pigeon	Al	Mo, Cu, Ba, Pa	LC	
Zenaida macroura (Linnaeus, 1758)	"Huilota"	Al	Mo, Cu, Ba, Pa	LC	
Zenaida asiatica (Linnaeus, 1758)	White wing dove	Al	Mo, Cu, Ba, Pa	LC	
Cuculiformes					
Cuculidae					
Crotophaga sulcirostris Swainson, 1827	"Garrapatero", "tíjolo"		Mo, Cu, Ba, Pa	LC	
Geococcyx velox (Wagner, 1836)	"Correcaminos"		Mo	LC	
Accipitriformes					
Cathartidae					
Coragyps atratus (Bechstein, 1793)	Buzzard	Am	Mo, Cu	LC	
Cathartes aura (Linnaeus, 1758)	"Aura"		Mo, Cu	LC	
Accipitridae					
Accipiter striatus Viellot, 1808	Hawk		Mo, Cu, Pa	LC	
Buteo jamaicensis (Gmelin, JF, 1788)	Eagle		Mo, Cu, Pa	LC	
Strigiformes					
Strigidae					
Glaucidium brasilianum (Gmelin, 1788)	"Cuacuana"		Mo	LC	
Coraciiformes					
Momotidae					
Momotus mexicanus (Swainson, 1827)	"Pájaro bobo"		Mo	LC	

Order **Family** **Scientific name**	**Common name**	**Use**	**Habitat**	**UICN**	**NOM-059-SEMARNAT-2010**
Piciformes					
Picidae					
Melanerpes chrysogenys (Vigors, 1839)	"La chica", "carpintero"		Mo	LC	
Falconiformes					
Falconidae					
Herpetotheres cachinans (Linnaeus, 1758)	"Guaco"		Mo	LC	
Caracara cheriway (von Jacquin, 1784)	"Quebranta-huesos"		Mo	LC	
Passeriformes					
Corvidae				LC	
Corvus corax Linnaeus, 1758	Raven		Mo, Cu		
Turdidae					
Turdus rufopalliatus Lafresnaye, 1840	"Primavera"		Mo	LC	
Icteridae					
Icterus pustulatus (Wagler, 1829)	"Calandrias"		Mo	LC	
Quiscalus mexicanus (Gmelin, JF, 1788)	"Imes", "zanate"		Mo	LC	
Tyrannidae					
Pitangus sulfuratus (Linnaeus, 1766)	"Luis"		Mo	LC	
	Mammals				
Artiodactyla					
Cervidae					
Odocoileus virginianus (Zimmerman, 1780)	Whitetail deer,deer "cuernicabra"	Al, Me, Or, Esa, Pe, Ve	Mo	LC	
Tayassuidae					
Pecari tajacu (Linnaeus, 1758)	Wild pig		Mo	LC	
Carnivora					
Canidae					
Canis latrans Say, 1823	Coyote	Me, Am	Mo	LC	
Urocyon cinereoargenteus (Schreber, 1775)	Fox		Mo	LC	
Felidae					
Herpailurus yagouaroundi (Geoffroy	"Onza"		Mo	LC	A
Saint-Hilaire, 1803)					
Leopardus wiedii (Schinz, 1821)	Margay		Mo	NT	P
Lynx rufus (von Schreber, 1777)	Wild cat		Mo	LC	
Mephitidae					
Conepatus leuconotus (Liechtenstein, 1832)	White-bandedskunk o "cadena"	Me, Ve	Mo	LC	
Spilogale gracilis (Linnaeus, 1758)	Spottedskunk	Me, Ve	Mo	LC	
Procyonidae					
Nasua narica (Linnaeus, 1775)	Badger	Al, Me, Ve	Mo	LC	
Procyon lotor (Linnaeus, 1758)	Raccoon	Al	Mo	LC	

Order **Family** **Scientific name**	**Common name**	**Use**	**Habitat**	**UICN**	**NOM-059-SEMARNAT-2010**
Cingulata					
Dasypodidae					
Dasypus novemcinctus Linnaeus, 1758	Armadillo	Al, Me, Or	Mo, Cu	LC	
Didelphimorphia					
Didelphidae					
Didelphis virginiana Kerr, 1792	Opossum	Me	Mo, Pa	LC	
Lagomorpha					
Leporidae					
Lepus sp.	Hare		Mo, Cu		
Silvylagus cunicularius (Waterhouse, 1848)	Rabbit	Al, Or, Am	Mo, Cu	LC	
Rodentia					
Muridae					
Peromyscus sp.	Field rats		Mo		
Sciuridae					
Sciurus aureogaster Cuvier, 1829	Squirrel	Al	Mo, Cu	LC	
Otospermophilus variegatus (Erxlebem, 1777)	"Cuinique"		Mo, Cu	LC	

Use: Al= food, Me= medicinal, Or= ornamental, Am= amulet, Pe= fur, EsA= agricultural tool, Ve= sale; Ba= ravine, Mo= bush, Cu= crops, Pa= yard; IUCN (International Union for Conservation of Nature): LC= least concern, NE= not evaluated, NT= near threatened: NOM- 059- SEMARNAT- 2010: A= threatened, P= endangered, Pr= protected.

Use of fauna

The community harvests 22 species of wildlife for different uses, which in order of importance are food (68%), medicine (45%), ornaments (18%), amulets (9%), furs (9%) and agricultural tools (4.5%). The number of species with use and sale is low when compared to other localities in the country such as Aguascalientes (Amador and De la Riva 2016), Campeche (Méndez and Montiel 2007) Chiapas (Gotoo 2016), Guerrero (Zavala et al. 2018), Morelos (García 2008; Monroy et al. 2008; Monroy and García 2013; García et al. 2020), Quintana Roo (Quijano and Calmé 2002) and the Tehuacán-Cuicatlán valley (Zarazúa et al. 2020), this may be due to two reasons: 1) 74% of the interviewees are neighborhood and when facing new conditions in their environment they have had to appropriate their territory (Arévalo 2016) by obtaining species through learning acquired locally or transmitted by parents and/or grandparents; and 2) the lack of economic resources within the community propitiates the father of the family to seek better job opportunities such as salaried work in the municipal capital or abroad, leaving the housewife in charge of the family and who does not go hunting, modifying the temporary or permanent organization of the family unit, a characteristic habit for Morelos farmers (Guzmán and León 2014).

Mammals were the taxonomic group that contributed the most species with use, followed by birds and reptiles. Similar results are reported by Asprilla and Díaz (2020) in Colombia, Tamburini (2016) in Argentina, García et al. (2020) in Morelos, Mexico and Contreras and Yánguez (2017) in Panama.

Food use was the most important, as it was highly mentioned by the inhabitants of the community, as in other regions of the country (Guerra et al. 2004; Monroy et al. 2008; Monroy-Vilchis et al. 2011; Barrasa 2012; Estrada et al. 2018). The part used for consumption is the meat, and the most common forms of preparation are roasted, fried or prepared in marinade, sauce and barbecue depending on family tastes. The insects Edessa spp. are consumed roasted or in sauce, and the honey of the bee *A. mellifera* is used for honey.

In addition, several authors report the current use of wildlife by indigenous and peasant communities to counter ailments and diseases related to the digestive, circulatory, respiratory, integumentary and cultural affiliation systems (Monroy and García 2013; Ramírez-Mella et al. 2016; Zavala 2018; García et al. 2019a; Valle et al. 2021). In the study area, reptiles are reported to use *Kinosternon integrum* to remove the "chipil"from children; the meat and blood of *Ctenosaura pectinata* to cure eyesight and anemia, as well as the skin of *Crotalus culminatus* that is placed on the affected part to counteract the effect of the scorpion bite or stop nosebleeds, regarding mammals, the use of the burnt tail of *Didelphis virginiana* combined with other plants to cure empacho and its meat consumed together with that of *Spilogale gracilis* to cure asthma; the ground carapace of *Dasypus novemcinctus* mixed with fat relieves sores caused by saddles in horses and the fat of *Nasua narica*, *D. novemcinctus*, *Canis latrans* and *Odocoileus virginianus* is used to relieve muscular pains while the consumption of meat of *S. gracilis* and *Conepatus leuconotus* prevents the appearance of pimples on the skin.

The paws of *Sylvilagus cunicularius* and the tusks of C. latrans were considered an amulet because they grant "good luck"to people; this protection is also mentioned by Monroy and Garcia (2013) and Estrada et al. (2018). In addition, the head of *Coragyps atratus* is smeared on the nose of dogs to "make them crawl"and help in the capture of prey.

The skin of *C. culminatus*, the tail of *S. cunicularius*, the carapace of *D. novemcinctus* and the skin and antlers of *O. virginianus* have ornamental uses, while the bones of *O. virginianus* are used to trample the cob.

Forty-five percent of the species presented multiple uses; of these, *O. virginianus* had 6 uses, followed by *C. culminatus*, *C. pectinata*, *D. novemcinctus*, *S. cunicularius* and *N. narica*, with three uses each, as has also been reported for the community of Bonifacio Garcia (Garcia et al. 2020).

Species sold in the community or outside with family or friends were *Edessa* spp, *C. pectinata*, *C. culminatus*, *S. cunicularius*, *N. narica*, *M. macroura*, *S. gracilis*, *O. virginianus* and *A. mellifera* honey. Prices are assigned by the hunter and depend on the size of the organism; for example, *S. gracilis* is priced at $100.00 per whole individual, while *O. virginianus* ranges from $450.00 to $600.00 per kilo or up to $5,000.00 per whole animal. The price of *O. virginianus* meat is high compared to other places such as Campeche, Puebla or Tabasco, where the price ranges from $85.00 to $300.00 per kilo (Hernández-López et al. 2013; Estrada et al. 2018; Retana and Padilla 2018); however, as reported by Monroy-Vilchis et al. (2011), the flavor and quality of the meat and the time invested to capture the species are characteristics that families take into consideration when selling individuals or parts of individuals.

Species reported in oral tradition

Species that due to their characteristics, habits, song or behavior were included in anecdotes transmitted from grandparents to parents or among the inhabitants and that are part of the intangible zoological heritage of indigenous and peasant communities

(Vargas 2009) are the following:

(a) **Reptiles**

Drymarchon melanurus "'chicotea' (hits people with its tail) if it is found nearby"; this story is also reported for the Sierra de Montenegro, Morelos (Reyna 2013). *Phrynosoma taurus* is considered "the king of all animals because it carries a little crown on its head", while *Plestiodon brevirostris* "can cause death if grabbed". *C. culminatus* is referred to in the Bible, and interviewees report that "it will only bite from the heel down".

(b) **Ominous birds**

The song of *Crotophaga sulcirostris* announces rain, while the song of *Glaucidium brasilianum* and *Herpetotheres cachinans* portends misfortune or death for someone in the community, a belief documented in other regions of Morelos (Monroy and García 2013; García et al. 2019b; García-Flores et al. 2022), Guerrero (Zavala et al. 2018) and Aguascalientes, where nocturnal raptors are considered witches and to scare them away, one must shout profanities (Amador and De la Riva 2016).

(c) **Mammals**

"La piedra del venado"tells the story of a deer named "chalchihue"that was difficult to hunt because the hunters' shotguns would not shoot in front of it. It is said that one day they "cured"one of the guns and with it they managed to kill it. Later, when they cut up this animal, they found in the stomach a ball of hair, also known as "stone", which was put in a glass with water or blood and took with him to the hunt, and thanks to her, they caught deer easily. In southeastern Mexico, the "piedra"is called "Tunich Kéej"and serves as an amulet to hunt deer, but in the course of the day, it must be returned to the bush because otherwise it can be harmful to whoever possesses it (Quijano and Calmé 2002; Retana and Padilla 2018; Ríos 2020).

The inhabitants of Zoquital further related that when the cry of the fox *Urocyon cinereoargenteus* is heard, it is because "they announce that a girl from the community is going to leave with her boyfriend". The situation is different in the state of Guerrero, where the appearance of this species in front of deer hunters portends a bad hunt (Zavala et al. 2018).

Hunting techniques

Hunting techniques in order of importance by frequency of mention were muzzleloading, champering, spying, and lamping. To obtain O. virginianus, the "arriada" is used, by which friends and/or family members gather and head toward the bush and once they arrive at the selected place, the work is divided: those who carry guns are located in a specific place while the rest of the hunters advance in the opposite direction and with the support of dogs, they begin to make noise to direct the deer to where those who carry guns are waiting and once the animal is identified, they proceed to hunt it. This method allows the division of labor, coexistence and participation of all members of the family unit from the organization of the tools to the preparation of the species. This technique is also known as "acorralar" (García 2008), "búsqueda" (Bardales et al. 2017) or batida (Plata 2017; Retana and Padilla 2018). In addition, it has been reported in other states of Mexico, such as Guerrero, Morelos and Yucatán (Montiel 2010; Velarde and Cruz 2015; López et al. 2018).

The "campeada"refers to the direct encounter with wildlife while performing activities such as planting, grazing or collecting firewood, mushrooms or edible and/or medicinal plants; it is also known as opportunistic (Lira-Torres et al. 2014), surprise or excursion (Retana and Padilla 2018), chance encounter (Bardales et al. 2017) or diurnal routes (Gotoo 2016). This is common for hunting *C. pectinata*, *S. cunicularius*, *C. culminatus* and/or *C. leuconotus*.

The spying technique consists of identifying places where it is known that animals will arrive for food or water; they then place themselves in nearby trees (e.g., *Ficus* sp. amates) and wait for the animal to approach the site. This is mainly used for hunting *O. virgninianus* and *N. narica* and is also reported in central Morelos (García 2008), southeastern Mexico (Quijano and Calmé 2002; Gotoo 2016; Retana and Padilla 2018) and Peru (Bardales et al. 2017). This suggests that the inhabitants of the communities possess knowledge about the feeding habits of local wildlife, which gives them an advantage in gaining easier access to prey by recognizing the spaces used by the species to meet their biological needs.

The "lampareada"is recognized by the inhabitants as "campeada de noche"(night hunting), and species such as *D. novemcinctus*, *O. virginianus* and *N. narica* are sought. The "lampareo"starts at dusk and can last until the following day depending on the species and has also been reported for communities in Chiapas (Gotoo 2016), Guerrero (López et al. 2018) and Tabasco (Hernández-López et al. 2013).

The average time spent capturing animals depends on the number of participants, distance and accessibi-

lity. For Edessa spp. For example, an average of nine hours is needed, from 8 to 18 hours for *O. virginianus* and from approximately 10 minutes to 3 hours for the rest of the animals.

Hunting weapons

The weapons used are shotguns, "dogs,"slingshots, machetes, and "cuaxtlera"; the latter is a type of handmade shotgun that uses gunpowder and ixtle blocks. Although the use of the shotgun implies the purchase of ammunition and/or cartridges, it allows for obtaining species easily and quickly, and such characteristics make this instrument widely used in communities in the state of Morelos (García 2008; Velarde and Cruz 2015), Campeche, Chiapas, Guerrero, Oaxaca, Puebla and Veracruz, (Lira-Torres et al. 2014; Gotoo 2016; Estrada et al. 2018; López et al. 2018; Retana and Padilla 2018) and Argentina, Panama and Peru (Tamburini 2016; Bardales et al. 2017; Contreras and Yanguez 2017).

Dogs accompany hunters during the development of their activities when they go alone or in groups, and their function is to follow the trail of the species and chase wounded prey until they are located; therefore, they provide benefit not only by guarding the home but also by obtaining wildlife meat useful for the inhabitants of the community. In Campeche, depending on their performance, they can be considered leader or master dogs or else, support or secretary dogs (Plata 2017).

Regulation of species harvesting

The hunting season is from December 21 to February 21. However, when species such as *N. narica*, *D. virginiana* or *C. latrans* threaten crops or backyard animals, they are hunted regardless of the closed season. The rest of the animals are captured when they are accidentally encountered while tending crops, tending livestock or collecting firewood. In the municipality of Pasto, Colombia (Martínez-Ceballos 2014), the productive activities carried out by the inhabitants allow them to cover their food needs, so the consumption of wildlife is null; however, in the Zoquital, despite being dedicated to agricultural activities, if a species is obtained, the family decides whether to consume it, give it to another family or sell it to complement their basic food basket, which indicates the importance of this resource in food and the economy.

In addition, 40% of the interviewees belong to the Israelite religion, who follow the "law of food"reported and explained in the Bible in the book Leviticus 1, 11; it indicates the type of animals they are allowed to consume according to certain characteristics, for example, "the animal with a split hoof, cleft in two nails and that a ruminating. You will eat those who have fins and scales either live well in the sea or in the rivers, in the case of four-legged insects, will you be able to eat those that, in addition to their four legs, have legs to jump on the ground. Animals that do not have these characteristics are considered "unclean" according to their beliefs and therefore are not hunted in the community. Howeber use them and about hunting techniques; in this way, the traditional knowledge about the species with use continues to be maintained in the Zoquital in comparison to the Chenes region in Campeche, where religion prohibits the use of wildlife as a means of healing and therefore there is a loss of traditional medicinal knowledge (Dardón and Retana 2017).

Species captured

Seventy captured individuals corresponding to 11 species were recorded. The total biomass extracted was 116.34 kg, and the biomass consumed was 62.454 kg. Of the reptiles, 11,525 kg were consumed, while birds and mammals contributed 1,804 kg and 49,125 kg, respectively. The total biomass consumed during one year was lower compared to the Chaco Seco in Argentina, where species consumption was 1,483 kg (Tamburini 2016). This difference may be because in that region, only mammals were hunted, whose biomass is higher compared to other vertebrate groups, while in the Zoquital, the number of species consumed was five mammals, four birds and two reptiles. Lira-Torres et al. (2014) reported 1 900 kg of biomass extracted from mammals in a community in the Zoque jungle, while Montiel (2010) reported 4.8 tons in localities of the Yucatan Peninsula from the same group of wild vertebrates, which reflects that communities consider other taxonomic groups according to the region and habitat where they are located to supplement their basic needs. According to the statistical analysis, there were no significant differences in consumption between species ($H = 3.12$, $p = 0.7539$). The species that contributed the most biomass was N. narica at 24.575 kg, followed by *O. virginianus* (19.5 kg) and *C. pectinata* (7.925 kg) (Figure 2). Mammals by size and weight were the taxonomic group that contributed the most biomass in the Zoquital, which has also been reported in Tabasco (Hernández-López et al. 2013), Colombia (Martínez-Ceballos 2014) and Peru (Bardales et al. 2017; Costa et al. 2018). Although there were no significant differences in species consumption across months ($H = 5.86$, $p = 0.4012$), March was the month in which the most biomass was obtained (16.925 kg), of which 88% came from *N. narica*; on the other hand, no species were caught in April (Figure 3). Likewise, there were no significant differences in consumption between the rainy and dry

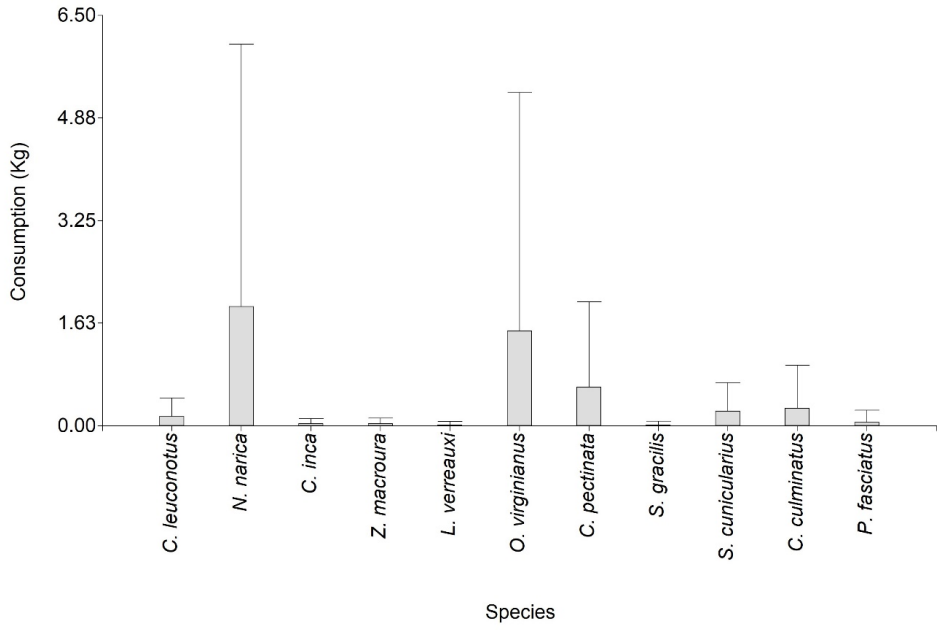

Figura 2. Wildlife biomass consumed by species for the inhabitants of the community of Zoquital, Amacuzac, Morelos State, Mexico.

seasons ($W = 4658.00$, $p = 0.4012$) characteristic of the low deciduous forest, which suggests that the capture of organisms occurs occasionally while activities are carried out in the traditional productive units regardless of the months or times of the year or because they caused some damage to the crops. According to Tamburini (2016), hunting is practiced for three main objectives: obtaining meat for food, for causing damage and to obtain income from them, which coincides in the Zoquital community, since 40% of the

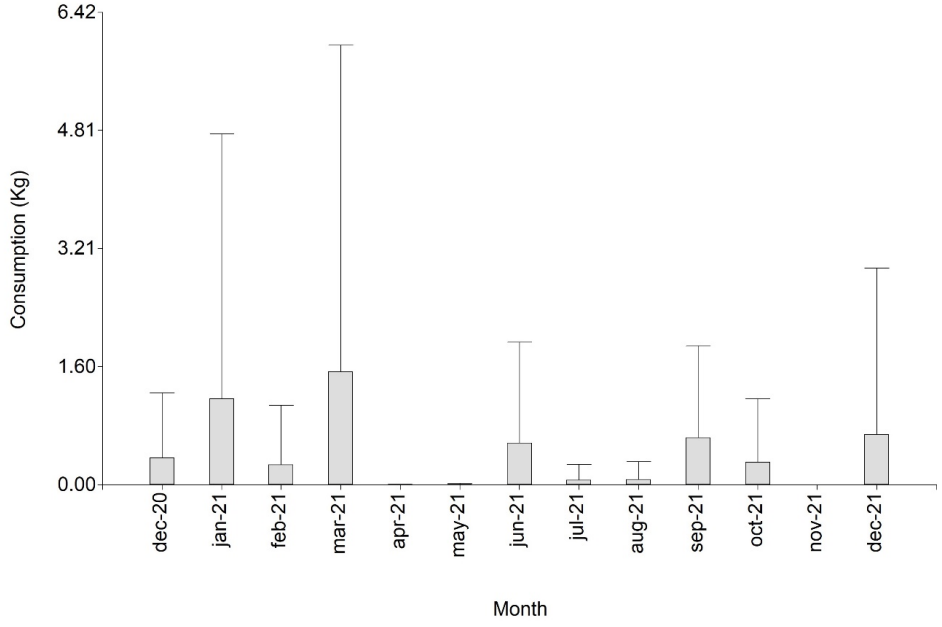

Figura 3. Wildlife biomass consumed per month for the inhabitants of the community of Zoquital, Amacuzac, Morelos State, Mexico.

species captured were obtained for food while 60% had an exchange value through sale (54%) or as a gift (6%).

Hunting areas

Informants identified four traditional productive units where wildlife species are distributed: the forest, the ravine, crops or plots of land, and backyards or family gardens. Species can be found in more than one site (see Table 1) because of their ability to move in search of food, perch or to reproduce; these characteristics are considered by hunters when looking for a particular species.

Of the sites identified, during the field work, the capture of the species was recorded in the bush, which contributed 50.924 kg of biomass, followed by the cornfield with 10.8 kg and the pasture with 0.7 kg. The bush is the main space where appropriation takes place, as it is the natural environment inhabited by the species. López et al. (2018) identified 11 hunting spaces in Guerrero, which indicates that the inhabitants travel long distances and possess knowledge of their environment that allows them to obtain bush meat (Aldana et al. 2016; Tamburini et al. 2016; Estrada et al. 2018; López et al. 2018; García et al. 2020).

Total value of species

Of the 22 species harvested by the community, *O. virginianus* is the most important (see Table 2). According to Martínez-Ceballos (2014), conservation processes, environmental education and income derived from productive activities influence the low values of species use, which coincides with the present work because those in charge of hunting animals and seeking income to meet family expenses are men who migrate, and therefore, hunting decreases. For example, the price referred to by the interviewees for *O. virginianus* was approximately $5,000.00 per animal, compared to $32.41 for the birds, which was calculated based on the average time invested in capturing them. The practical and economic value was obtained from the species that were recorded during the study period, and only the animals referred to by the participating families were taken into account; however, *O. virginianus* was the most culturally, practically and economically important species for the inhabitants of Zoquital, as has been documented for communities in central, southern and southeastern Mexico (Velarde and Cruz 2015; Ramírez-Mella et al. 2016; Estrada et al. 2018; López et al. 2018; Retana and Padilla 2018; García et al. 2020; Montiel 2010).

CONCLUSION

The relationship that the inhabitants of the Zoquital community have with wildlife has allowed them to meet their basic needs through direct use or by generating income from the sale of animals. Although the use of the species is regulated by community and religious rules, the inhabitants of the community still maintain their traditional knowledge about hunting techniques and weapons as well as the recognition of spaces where the animals carry out their activities, allowing them to obtain the species in diverse productive units such as the bush, yard, pasture or cornfield, the latter being the space where the wild fauna that competes for the crops is hunted. In addition to the information provided by the local collaborators, studies of the species used in the community should be carried out, which will allow us to know the current situation of the populations in use, as well as to generate strategies for their management, conservation and exploitation without losing the traditional knowledge of the species in the Zoquital.

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DATA AVAILABILITY

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

CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTION STATEMENT

Conception of the idea presented: MBR, AGF.
Conduct of field work: MBR.
Conducting data analysis: MBR, AGF.
Drafting of the manuscript: MBR, AGF, JMPM.
Review and final drafting of the manuscript: MBR, AGF, JMPM.
Supervision: AGF.

Tabela 2. Value of wildlife species in the community of Zoquital, Amacuzac, Morelos, Mexico.

Scientific name	Common name	CVe	PVe	EVe	Ve
Odocoileus virginianus	Whitetail deer,deer "cuernicabra"	0.781	0.465	1000	10001.245
Crotalus culminatus	Rattlesnake	0.004	0.167	2400	2400.170
Conepatus leuconotus	White-bandedskunk o "cadena"	0.001	0.000	1500	1500.001
Nasua narica	Badger	0.006	0.032	1250	1250.038
Ctenosaura pectinata	Black iguana	0.004	0.000	750	750.004
Spilogale gracilis	SpottedSkunk	0.001	0.009	500	500.010
Silvylagus cunicularius	Rabbit	0.006	0.235	200	200.240
Columbina inca	Turtle doves	0.074	0.032	162.05	162.156
Zenaida macroura	"Huilota"	0.061	0.011	97.23	97.303
Philortyx fasciatus	"Codorniz, churrunda"	0.006	0.001	32.41	32.417
Leptotila verreauxi	Pigeon	0.004	0.001	32.41	32.415
Dasypus novemcinctus	Armadillo	0.019	0.000	0.000	0.019
Canis latrans	Coyote	0.004	0.000	0.000	0.004
Edessa spp.	"Jumiles"	0.001	0.000	0.000	0.001
Apis mellifera	Bees	0.001	0.000	0.000	0.001
Zenaida asiatica	White wing Dove	0.001	0.000	0.000	0.001
Kinosternon integrum	Tortoise	0.0006	0.000	0.000	0.0006
Ortalis poliocephala	"Chachalaca", "paita"	0.0006	0.000	0.000	0.0006
Coragyps atratus	Buzzard	0.0002	0.000	0.000	0.0002
Didelphis virginiana	Opossum	0.0002	0.000	0.000	0.0002
Sciurus aureogaster	Squirrel	0.0002	0.000	0.000	0.0002
Procyon lotor	Raccoon	0.0002	0.000	0.000	0.0002

CVe= Cultural value of the species; PVe= Practical value of the species; EVe= Economic value of the species; Ve= Total value of species e.

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