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Perception and uses about mammals in México: a literature review

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ABSTRACT

The negative effects of human activity on wildlife populations in ecosystems must be addressed not only from an ecological perspective but also from a social approach. One way is through studying the perception of human communities that have frequent interactions with wildlife. We conducted a systematic literature review to understand Mexican rural and urban communities' perceptions of wild mammals using web search engines. Of 321 studies found on this topic, only 77 met our criteria and were therefore useful for analysis. We presented data of causes of perception in different states of Mexico where the studies were carried out. We found that positive perception was significantly associated with the use of fauna, mainly in the rural environment, followed by the ecological importance in both urban and rural environments. In negative perception we did not find a significant association between these variables, but we did find a tendency to perceive fauna as dangerous. Mammal species mentioned in the articles reviewed were also classified by size, and their association with negative or positive perception. We found that the species with a positive perception with the highest number of mentions in the literature were the white-tailed deer (*Odocoileus virginianus*), nine-banded armadillo (*Dasypus novemcinctus*), raccoon (*Procyon lotor*), paca (*Cuniculus paca*) and collared peccary (*Dicotyles tajacu*). Species with negative perception were the Coyote (*Canis latrans*), white-nosed coati (*Nasua narica*), Gray fox (*Urocyon cinereoargenteus*) and long-tailed weasel (*Mustela frenata*). In rural environments perception of wild mammals was related to the uses, and in urban areas depends on the information acquired at school. These differences play a fundamental role in forming attitudes and behaviors towards wild mammals. Because perceptions and uses of wildlife can influence conservation efforts, educational programs should highlight the important role of wild mammals within their ecosystems.

Keywords: Fauna; Rural; Urban; Interaction; Social; Environmental.

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SIGNIFICANCE STATEMENT

This study analyzes the causes of the perception of mammals in rural and urban communities. A systematic review of various electronic bibliographic sources was carried out. In total, 321 were retrieved, of which only 77 provided reliable information. The positive perception of wild mammals in urban areas depends to a great extent on the knowledge acquired, especially in the classroom and in rural areas due to the use given to them. Negative perceptions in urban and rural areas are due to their dangerousness, for preying on domestic animals and for transmitting diseases. We observed that species such as white-tailed deer, nine-banded armadillo, raccoon, paca and collared peccary, are the species with positive perceptions and the species with negative perceptions are the coyote, white-nosed coati, gray fox and long-tailed weasel. This research can serve as a basis for a better design of environmental education programs aimed at the conservation of negatively perceived wild mammal species.

INTRODUCTION

Destructive human activities that cause changes in land use (such as massive loss of vegetation or indiscriminate growth of urban areas, among others) have generated an unprecedented environmental crisis at a global level (López-Vázquez et al. 2015), transforming habitats at large scales and thus resulting in defaunation (Dirzo et al. 2014). Therefore, due to the intensification of our activities on the planet, human societies are responsible of generating actions that contribute to mitigating the detrimental effects on wildlife (Dirzo et al. 2014; Rodríguez-Morales et al. 2011). One way is by conducting studies on how people perceive their surrounding environment; that is, what they think, feel, and know about the species that make up the ecosystems. The latter will allow a comprehensive understanding of the origin of environmental problems and thus contribute to the search for alternatives to solve them based on specific social and ecological contexts (Álvarez 2009; Fernández-Tarrio et al. 2010).

Understanding the relationships between people and their surrounding environment, must include knowing the way in which the environment is perceived both individually and collectively (Aguilar Cucurachi et al. 2017). Perception has been addressed by multiple disciplines (e.g. psychology, philosophy, anthropology, among other disciplines) and is considered the basis for all learning (Sánchez-Fuentes et al. 2016). Each discipline approaches this concept in different ways, but in general, perception is defined as a process of interpreting and classifying the information received (Sovero-Lazo 2017). In constructing this perception, the mind elaborates concepts based mainly on the individual's beliefs (Fuenmayor and Villasmil 2008). For sociology, social perception is understood as the beliefs and opinions that individuals and social groups have about their immediate reality and is thus subjective (Rosado Millán et al. 2008). Hence, within the same sociocultural group there is a great variety of perceptions about its natural environment. This is due in part to individual experiences, family stories, memories, and friendships. Other social variables such as age, gender, socioeconomic level, cultural heritage, and ethnic group are part of social perceptions towards the natural environment (Aguilar-Cucurachi et al. 2017). In this way, differences between the perceptions of inhabitants of urban areas and those of rural areas are expected.

A deeper understanding on how people accumulate knowledge about nature is key to realizing biodiversity conservation efforts. For conservation science, social/environmental perception requires generating collective information about environmental problems and their solutions (Espejel-Rodríguez and Flores-Hernández 2012). Mexico stands out for its high diversity with a wide range of ecosystems, which present a unique combination of geographic and climatic conditions that support this diversity (Llorente-Bousquets and Ocegueda 2008). At the same time, Mexico is known for its cosmogony, for its rich cultural diversity reflected in its numerous traditions (e.g., artistic, musical, and culinary); as well as in it religious and spiritual practices where wildlife plays an important role since ancient times (Moreno-Calles et al. 2013). Many indigenous communities have maintained their traditional ways of life, including practices such as hunting, and have made significant contributions to what constitutes Mexico's cultural heritage (Agloglia-Moreno 2010). Despite the importance of wild mammals in Mexico, few studies have been carried out on the perception of people in urban and rural areas. In this context, this study aims to analyze the perception and knowledge about wild mammals by inhabitants of rural and urban areas of Mexico through a systematic review of the scientific literature of the last four decades (1980 – 2023).

MATERIAL AND METHODS

Search Methods

We carried out a systematic automated search of published scientific articles, book chapters and unpublished theses carried out in Mexico within a 43 year period (1980-2023) following the PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses;O'Dea et al., 2021). We consid-

ered articles in Spanish and English using the following search criteria and Boolean operators: "mammal" AND "perception" AND "knowledge" AND "Mexico" AND ("wild fauna" OR "native fauna" OR "wildlife"), as well as their Spanish equivalents.

We used the online databases by Scopus, Web of Science, Science Direct and Google Scholar, and publishers such as Elsevier, Wiley, but also local sources that include Latin publications such as REDALYC (Network of Scientific Journals of Latin America and the Caribbean, Spain and Portugal), Dialnet and Scielo. The search was carried out systematically new information was exhausted.

Study selection

Items were excluded if publications: 1) did not have mammals as their central theme; 2) were focused on marine mammals; 3) a specific methodology was not implemented to investigate perception; 4) repeated information in different languages; 5) were published in a different journal under a different title or with altered order of the authors; 6) finally, if an article was derived from a thesis, only the article was considered.

Data extraction

Data was entered into a Microsoft Excel sheet 2016 version using the following fields: study number (ID), last name of the first author, journal, volume, complete bibliography, type of environment (rural or urban), studied species, state of the Mexican Republic where the study was carried out, the use given to the fauna and year of publication. In addition, information on perception regarding mammals was classified as either positive or negative, the causes of the perception were documented, as well as the type of fauna (i.e. wild, domestic), ecosystem type and studied population (i.e. students, adolescents, teachers, public). We categorize positive and negative perception according to Manzano-García and Martínez (2017) criteria. Positive perceptions were divided as follows: 1) ecological importance, 2) use, and 3) conservation. Negative perceptions were divided: 1) danger, 2) disease transmission, and 3) preying on domestic fauna. Another criterion that we considered was the size of the mammals using the classification of Ceballos and Oliva (2009). We filtered the collected articles by year to document the frequency of these studies over the past 43 years.

Data analysis

Subsequently, a data matrix was prepared for descriptive analyses, thus we organized and graphed the frequency of the studies by year, topic, and political division in Mexico. We also generated frequency graphs by the other categories (e.g, type of fauna, ecosystem, perception, and use), and spatial distribution of studies at the national level. To determine the association between positive and negative perceptions with respect to rural and urban areas, we carried out a chi-square test, then we performed Pearson residuals to evaluate the differences between the observed and expected values of the contingency table.

The published literature was analyzed qualitatively, and the results (number and percentage) were reported in a narrative way, focusing on common findings that we identified across the included studies. We also performed a descriptive analysis and coded the content of the final set of 77 articles using the MAXQDA 12 software, which is a tool for the analysis of qualitative and quantitative data (Mayring 2014). We developed the coding scheme according to the research objectives and the variables that help answer the research questions. The main categories of the coding scheme were the general characteristics of the article such as the methodological approach, the location of the case study, the appearance and use of the terms transformations. We also consider indigenous and local knowledge (ILK) and its synonyms, and the connection of ILK and transformations in the literature reviewed. Finally, we continually adapted and refined the coding variables during the iterative process of coding the articles until we reached a consistent level of information.

RESULTS

Temporal and geographical distribution of studies

Initially, 321 articles were selected that provided information according to the topic. However, by means of the inclusion and exclusion criteria, only 77 provided relevant information for this research. The number of documented publications showed a gradual increase until 2014, when excepting the 2019 the frequency seems to decay (Figure 1A). Overall, 84.42 (%) studies were carried out in a rural environment, whereas 5.20 (%) occurred in urban areas, and 10.38 (%) in a mixed environment (rural and urban) (Figure 1B). These 77 studies were carried out in 24 of the 32 states of Mexico. Although 75% of the Mexican territory has addressed the issue of the perception of fauna, most of the studies belong to the states of Veracruz, Jalisco and Oaxaca. There were some studies carried out in multiple states such as, Puebla – Oaxaca, Jalisco – Colima and Yucatán – Quintana Roo. Meanwhile, most states (21) report low number of studies (between one and three) (Figure 1C).

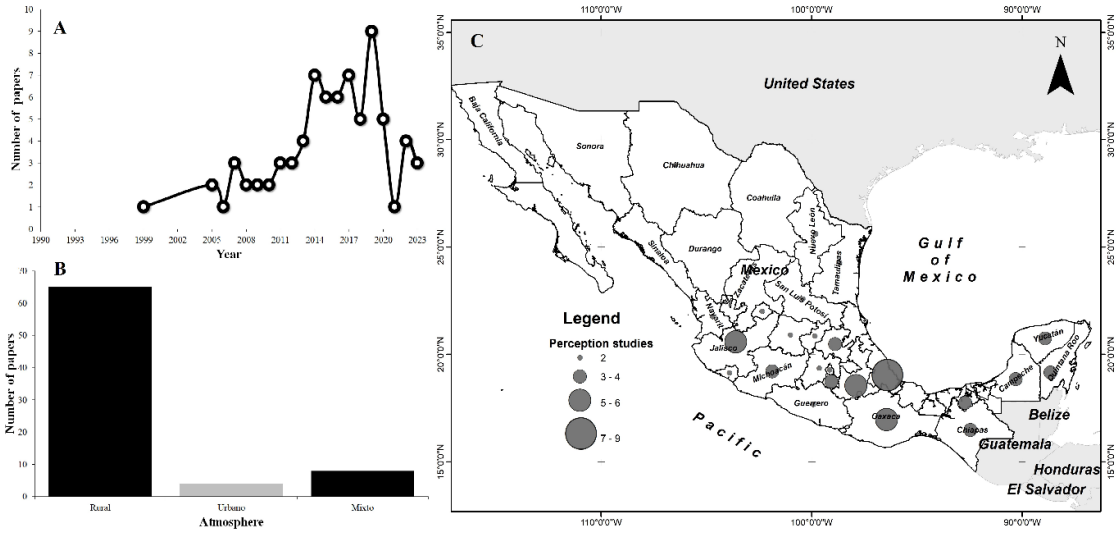

Figure 1. Spatial and temporal trends of studies on perception about mammals in Mexico (Period 1980-2023; $n = 77$). A) Number of publications per year in the period 1980–2023, B) Type of environments where the studies were conducted, and C) Spatial distribution of studies at the national level.

Perception about mammals

Of the 32 states in Mexico, 24 have conducted studies on the perception of mammals. In these studies, the authors mention that in the states of Veracruz, Puebla, Estado de México, Campeche, Oaxaca, Morelos and Michoacán, they surveyed groups of people who say they have a generally positive perception of mammals. The main drivers as described by the authors were classified in ecological importance and utilitarian value (Figure 2).

Of the 77 works reviewed, 30 mention that there is a negative perception and in their special distribution, the states of Puebla, Jalisco and Oaxaca are the ones with the most works that mention this perception (Figure 3).

A significant association was found between the causes of positive perceptions reported and the environments where the studies were conducted (χ^2= 11.634, df = 2, P < 0.001). In this sense, positive perception in rural environment is mainly due to the use of fauna, followed by the ecological importance in both urban and rural environments. In the case of negative perceptions reported, no significant association was found between these variables (χ^2= 1.0131, df = 2, P = 0.6026. Figure 4). However, there is a tendency towards a higher negative perception in the rural environment due to considering mammal's fauna dangerous (Figure 4).

Uses of mammals in rural areas

Of the 77 studies analyzed, only seven reported the use of wildlife in urban areas such as ornament and medicinal use. These articles do not record mammals species but groups of vertebrates such as birds, skunks, reptiles, which people mention come from rural areas.,. Therefore, the following results are based on rural wildlife use reported in 70 articles. Thus, the most mentioned use is food, followed by hunting and medicinal. They are also used for sale, such as decoration, clothing, pets, and, less frequently, in crafts and tools (Figure 5).

The species used for consumption are: paca *(Cuniculus paca)*, nine-banded armadillo *(Dasypus novemcinctus)*, rabbits *(Sylvilagus cunicularius* and *S. floridanus)*. The mammal species used for hunting are: jaguar *(Panthera onca)*, white-tailed deer *(Odocoileus virginianus)*, collared peccary *(Dicotyles tajacu)*, rabbits *(Sylvilagus cunicularius* and *S. floridanus)*. The species that have a medicinal use are: skunks *(Conepatus mesoleucus, Mephitis macroura)*.

Perception associated with mammal species

In the articles of this review, 64 species of mammals are mentioned, represented by 10 orders and 21 families. According to the 77 articles reviewed, 39 species have a positive perception; and medium-sized mammals are the most represented with 58%, followed by large mammals with 27% and, finally, small mammals with 15%. The most represented orders for this perception are Carnivorous (44%), Artidactyla (18%) and Rodentia (12%). The families Procynidae, Felidae, Cervidae and Leporidae have the highest number of species with a positive perception. In terms

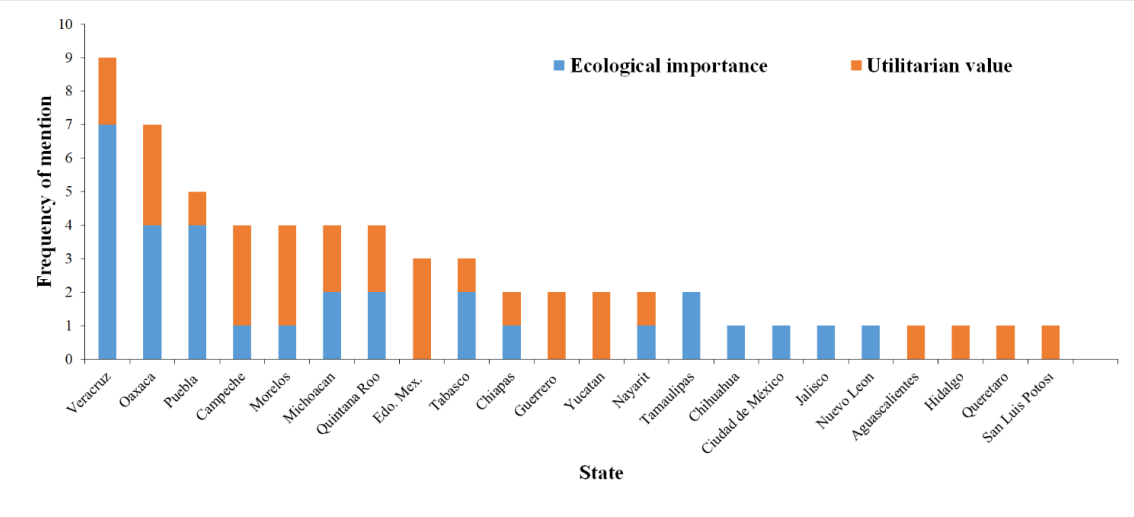

Figure 2. Frequent distribution of the main reasons associated with a positive perception reported in the states of Mexico (Period 1980-2023; $n = 77$).

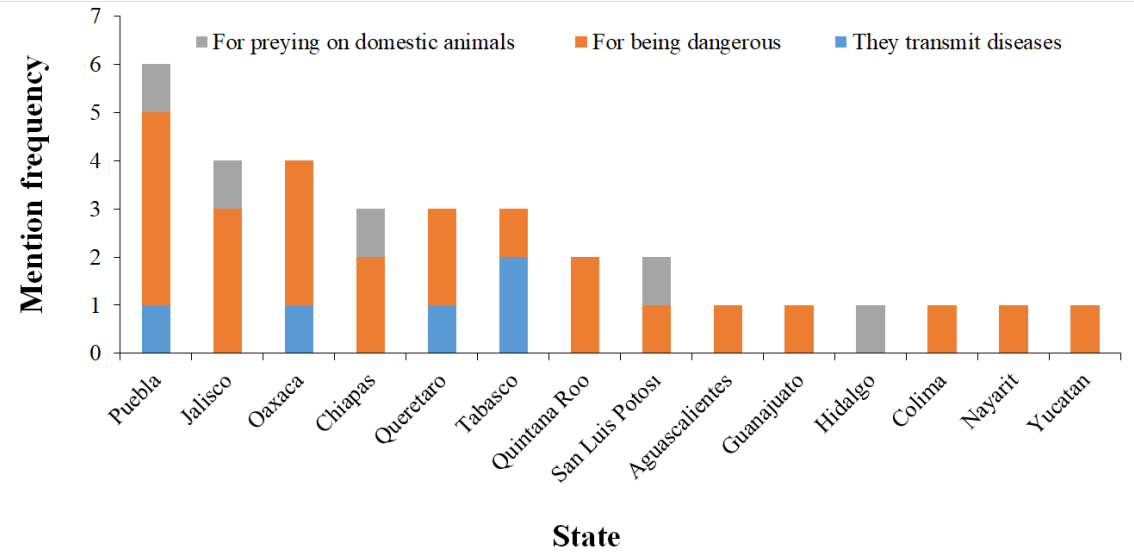

Figure 3. Frequent distribution of the main reasons associated with a negative perception reported in the states of Mexico (Period 1980-2023; $n = 77$)

of species, white-tailed deer (*Odocoileus virginianus*), nine-banded armadillo (*Dasypus novemcinctus*), raccoon (*Procyon lotor*), paca (*Cuniculus paca*) and collared peccary (*Dicotyles tajacu*), are the species with the highest number of mentions (10, 7, 6 and 5% respectively) within the positive perception. These species have medium and large sizes (Figure 6).

In the case of negative perception, 48 species are mentioned. Medium-sized mammals are the most represented with 46%, followed by small mammals 33% and, finally, large mammals 21%. The most represented orders for this perception are Carnivora 51%, Chiroptera 16% and Rodentia 12%. The families Canidae, Procyonidae, Didelphidae, Phyllostomidae and Mormoopidae are those with the greatest number of species of which there is a negative perception. The coyote *(Canis latrans)*, white-nosed coati *(Nasua narica)*, gray fox *(Urocyon cinereoargenteus)* and long-tailed weasel *(Mustela frenata)*, are the species with the highest number of mentions (10, 5 and 4% respectively) within the negative perception, these three species are large sized (Figure 7).

DISCUSSION

In this work 77 articles have been reviewed, which indicate that the main methods for studying perception are interviews and surveys. It was observed that

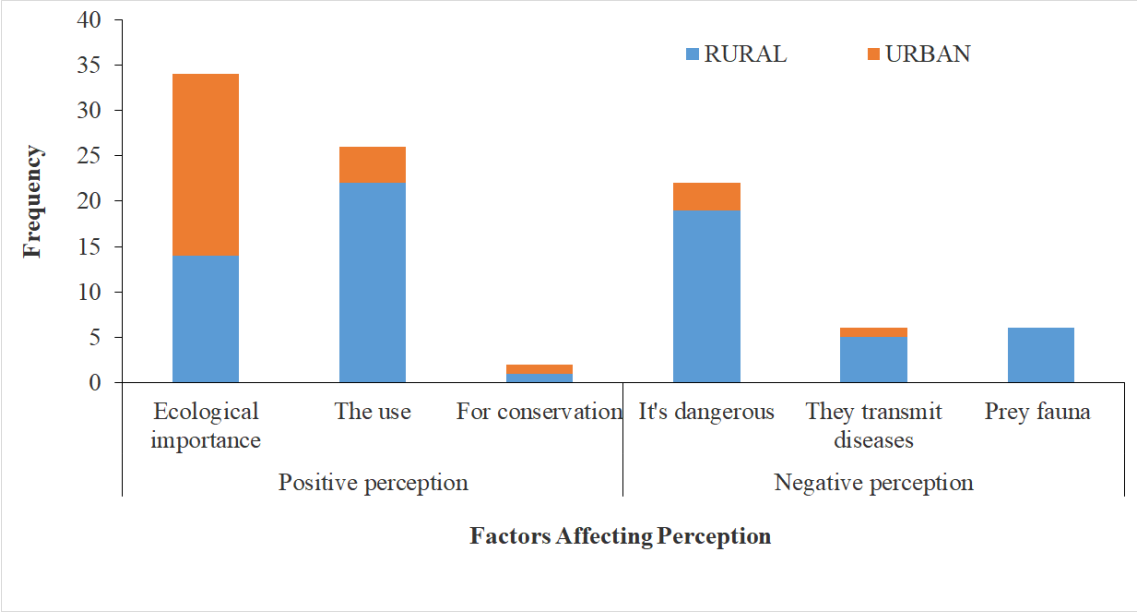

Figure 4. Causes of positive and negative perception about fauna in urban and rural environments in Mexico during the period 1980-2023.

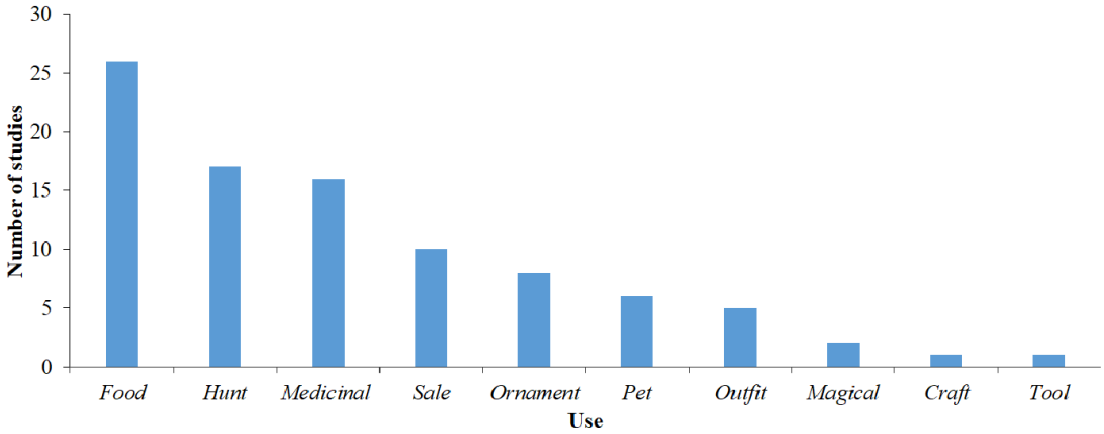

Figure 5. Use of wildlife in rural areas in Mexico.

in the last decade studies on the perception of mammals in Mexico have increased, especially in the central and southwestern part. However, this increase is very slight and, in at least 10 states in the northern part of the country, no studies have been carried out on this topic. Furthermore, the few studies show that in 13 of 14 states of Mexico there is a trend of negative perception, since mammals are considered dangerous. Further studies are needed to understand whether this trend persists, as some studies have found conflicts when wildlife has an adverse effect on human activities (e.g., livestock predation, crop looting) (Can-Hernández et al. 2019, Zarazúa-Carbajal et al. 2022). It is also necessary to know the extent of the intensity of this conflict (frequency of damage and amount of biomass consumed by wildlife) in the negative perception towards mammals in Mexico. In this way, better wildlife conservation measures can be taken that consider the values and cultural history of the affected people. Regarding positive perception, 17 of 22 states in Mexico report studies highlighting the ecological importance of mammals. Future studies are required to know the perception but also the local or traditional knowledge by state, with the aim of emphasizing more actions and practices to mitigate human conflicts with mammals. It is known that local knowledge is adaptive since beliefs and values towards fauna and its interaction with the environment are transmitted from generation to generation (Berkes et al. 2000).

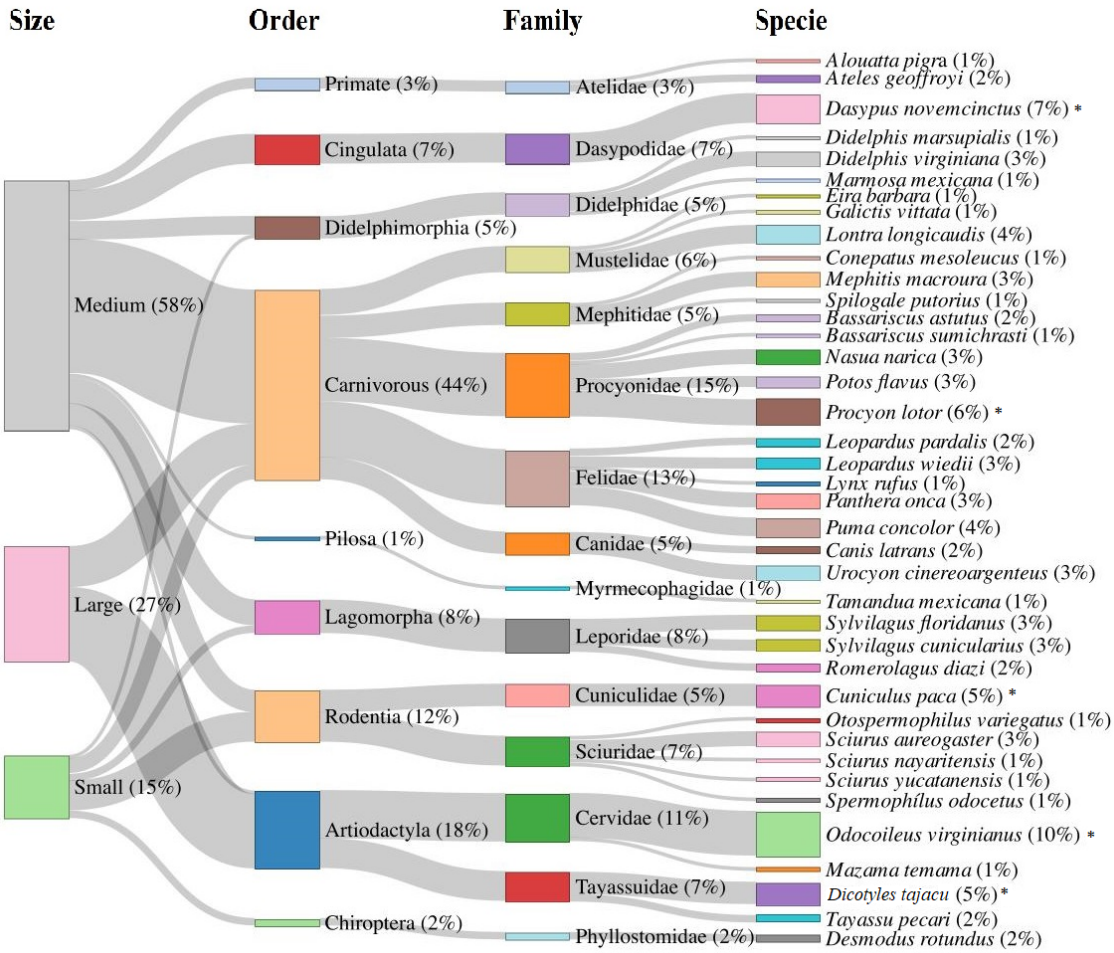

Figure 6. Species with positive perception classified by size, gender, family and species. The height of the rectangle represents the percentage of mention of each species, within the 77 articles reviewed.

Positive perception

In studies carried out in urban areas, it is generally mentioned that there is a positive perception of mammal species, but they do not specify the species found in these areas (García-Feria and Gallina-Tessaro 2020). On the contrary, studies carried out in rural areas have more information since they know the fauna that lives in those areas (Gómez Jiménez 2014). For this reason, to obtain perception data, only the results of studies in rural areas were taken into account.

When we analyzed the causes of the perceptions, we found through chi square test that positive perception in rural environment is mainly due to the use of fauna. People in rural environments use fauna mainly for consumption, medicine, pets, ornament, among others. The mammal species of which there is a positive perception due to their use or utility are: for consumption: paca (*Cuniculus paca*), nine-banded armadillo (*Dasypus novemcinctus*), rabbits (*Sylvilagus cunicularius, Sylvilagus floridanus*). For hunting they are: jaguar (*Panthera onca*), white-tailed deer (*Odocoileus virginianus*), collared peccary (*Dicotyles tajacu*), rabbits (*Sylvilagus cunicularius, Sylvilagus floridanus*). Medicinal: Skunks (*Conepatus mesoleucus, Mephitis macroura*). The mammal species that have a positive perception due to their ecological importance are: white-tailed deer (*Odocoileus virginianus*), jaguar (*Panthera onca*), raccoon (*Procyon lotor*) and neotropical otter (*Lontra longicaudis*). The species with a positive perception due to their importance for conservation are: jaguar (Panthera onca), white-tailed deer (*Odocoileus virginianus*) and neotropical otter (*Lontra longicaudis*).

The diversity of uses of fauna can probably be due to high demand pressure, which increases its value, especially when resources are relatively scarce. A global analysis of the use of mammals in traditional medicine shows that vertebrates are the most used animals in folk medicine, perhaps due to their large body size. Larger animals tend to provide more products that are used as ingredients in traditional remedies than

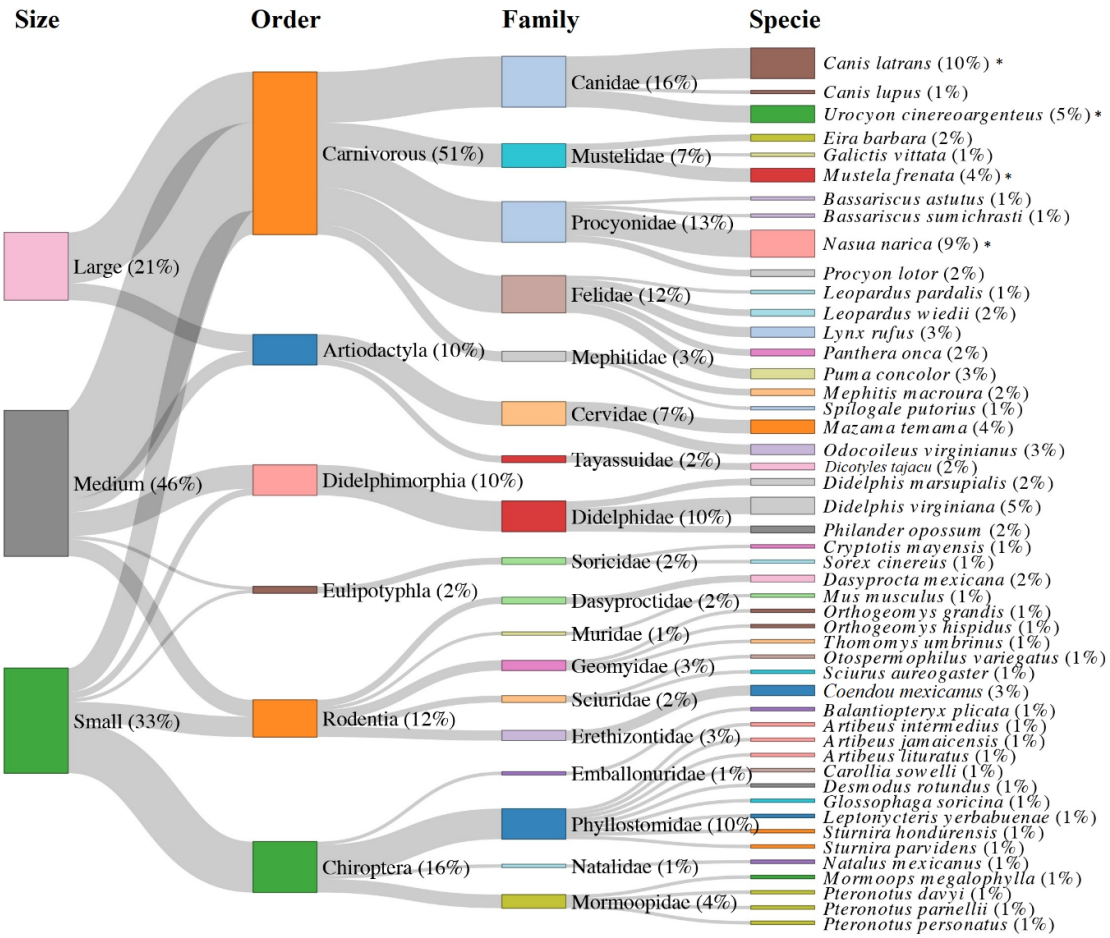

Figure 7. Species with negative perception classified by size, gender, family, and species. The height of the rectangle represents the percentage of mention of each species, within the 77 articles reviewed.

smaller ones (Alves et al. 2021). For example, the hooded skunk (*Mephitis macroura*) in Mexico have reported 21 different uses (Alonso-Castro 2014). Other factors that were found to influence positive perception were the ecological importance, which is defined by the ecological functions that they contribute to ecosystems as pollinators, seed dispersers or food for other species. The importance for conservation was also mentioned (Manzano-García and Martínez 2017). These last two uses mentioned in the articles suggest that people in rural environments known the importance of mammals in the conservation of their environments, because they recognize some of the functions that they have.

As shown in figure 6, mammals were classified according to their size (Ceballos and Oliva 2009). For the positive perception, medium mammals weighing between 1 and 20 kilos were the most represented with 58%, followed by large mammals weighing more than 20 kilos with 27% and small mammals weighing less than one kilo with 15%. Of the medium-sized mammals, the orders with the greatest representation were Carnivorous and Cingulata. In the large ones, the most represented orders are Artiodactyla and Carnivorous. And for those of small size, the orders with the greatest representation are Rodentia and Carnivorous. There are species such as the jaguar, the white-tailed deer and the otter, which have been widely disseminated through formal education or environmental conservation programs, which has generated a positive perception in the residents of certain rural communities in the country (Alvarez et al. 2009).

Negative perception

In the case of negative perception, the literature mentions that there are three factors that cause it: a) because they are dangerous. They can attack people. b) they transmit diseases c) they can prey on domestic fauna. The species that have a negative perception due to their danger are: coyote (*Canis latrans*), puma (*Puma concolor*), white-nosed coati (*Nasua narica*) and bobcat (*Lynx rufus*) (Gómez-Jiménez 2014). Among species that have a negative perception for transmitting diseases there were bats (*Glos-*

sophaga soricina, Sturnira parvidens, Sturnira hondurensis, Leptonycteris yerbabuenae, Pteronotus parnellii, Mormoops megalophylla, Pteronotus davyi and *Pteronotus personatus*) mouse (Mus musculus), opossums (*Philander opossum, Didelphis marsupialis and D. virginiana*) (Leal 2012). The results of this review suggest that bats are the group of mammals with the greatest negative perception because people mention eight species more than other groups. However, more studies are needed to understand the reasons why people perceive bats negatively given that although bats harbor viruses that transmit diseases, rodents harbor an even greater total number of zoonotic viruses (Banerjee et al. 2019). Negative perception on bat can be a threat as associating bats only with zoonoses can hinder efforts to conserve declining species (Meli et al. 2024). Species with negative perception for preying on domestic fauna: coyote (*Canis latrans*), opossum (*Didelphis virginiana*), gray fox (*Urocyon cinereoargenteus*), margay (*Leopardus wiedii*) and long-tailed weasel (*Mustela frenata*) (Zepeda Hernández 2018).

As shown in figure 7, according to classification we made of the size of mammals (Ceballos and Oliva 2009), we found for negative perception that large - sized mammals were the most represented with 46%, followed by small mammals with 33% and large mammals with 21%. Of the medium-sized mammals, the orders with the greatest representation were Carnivorous and Didelphimorphia. In the small ones, the most represented orders are Chiroptera and Rodentia. Those of large size, the orders with the greatest representation are Carnivorous and Artiodactyla. Many of the species that have a negative perception, such as the coyote, opossums and white-nosed coatis, are the result of their ferocious appearance, that they are predators and above all due to the lack of knowledge that the residents of the communities have about the species (Riojas-López et al. 2019).

Among the mammal species reported in the articles reviewed, we found species with both positive and negative perceptions (see Figure 6 and 7), such as puma (*Puma concolor*), jaguar (*Panthera onca*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), collared peccary (*Dicotyles tajacu*), bobcat (*Lynx rufus*), central american red brocket (*Mazama temama*), ocelot (*Leopardus pardalis*), raccoon (*Procyon lotor*), Tlacuache (*Didelphis virginiana*), Tayra (*Eira barbara*), white-nosed coati (*Nasua narica*), gray fox (*Urocyon cinereoargenteus*), margay (*Leopardus wiedii*), greater grison (*Galictis vittata*), hooded skunk (*Mephitis macroura*), opossum (*Didelphis marsupialis*), ringtail (*Bassariscus astutus*), cacomistle (*Bassariscus sumichrasti*), rock squirrel (*Otospermophilus variegatus*), eastern spotted skunk (*Spilogale putorius*), gray squirrel (*Sciurus aureogaster*) and vampire bat (*Desmodus rotundus*).

According to the discussions in the articles, this double perception could be generated due to the outreach and conservation work carried out in different areas of the country, generating knowledge and information about the species, which has made it possible to change the perception of the local population. Such is the case of the jaguar, a friendly species that has been venerated since pre-Hispanic times and at the same time very feared for its ferocity and dangerousness to humans and domestic or farm animals. For this reason, they were hunted to near extinction. However, conservation efforts for this species are changing perceptions and allowing people to recognize the importance of the jaguar in their environment (Ávila-Nájera et al. 2011).

Another example of species that have both positive and negative perceptions is the white-tailed deer. The positive perception is due to it is used as food (Ebergenyi and Cruz León 2015), and the negative perception is due to the fact that it feeds on plants planted by farmers. There are species that have a negative perception, and this can cause people to hunt them or generate behaviors that are not beneficial for the conservation of the species (Gómez Jiménez 2014). Therefore, it is important to generate a change of perception about these species, through the generation of knowledge and its correct dissemination mainly in the communities where these species and humans cohabit.

CONCLUSION

Perception is a process involving both direct information from the environment (through the senses of taste, touch, sight, hearing and smell), and the direct and indirect experience of people from different social groups, determined by a specific economy and cultural context. The integration of physical, ecological, and social elements in the analysis can help establish links between citizens and academia with the common goal of contributing to a better quality of life for both wildlife and human populations. Studies on environmental perceptions in Mexico are scarce. Work from anthropological approaches prevails in rural landscapes, and few are carried out in urban environments.

The perception of rural inhabitants towards wild mammals is generally positive, due to their usefulness. The main reported uses were: food, medicinal, hunting, decorative, sale, clothing and as a pet. On the contrary, the negative perception towards fauna depends on its appearance, its danger, its ability to transmit diseases. The perception of wild mammals in urban areas depends on the knowledge acquired mainly in schools, so their perception is overall positive. However, by not being in direct contact with wild mammals, one of the most effective ways to generate changes in environmental perception in urban children

is through environmental education programs.

Future studies can focus on how positive perception can contribute to decision-making for wildlife conservation in rural and urban settings. Therefore, it is necessary to increase scientific knowledge about species in both environments, to improve perceptions, leaving behind beliefs and myths that lead to a negative perception.

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DATA AVAILABILITY

Data used to support the findings of this study are available from the corresponding author, upon reasonable request (mbaena@uv.mx, cdelfin@uv.mx).

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: C. A. D. A., I. F. S and M. L. B. Carried out the experiment: I. F. S. and C. A. D. A.
Wrote the first draft of the manuscript: E. S. R., I. F. S. and M. L. B.
Review and final write of the manuscript: J. L. P. C., E. S. R., M. L. B., C. A. D. A. and I. F. S.
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