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Municipality socioeconomic characteristics and the probability of occurrence of Wildlife Management Units in Mexico

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ABSTRACT

Wildlife use is a strategy for livelihood diversification, and markets depend on the characteristics of consumers and providers as well as on regional socioeconomic variables, such as the accommodation infrastructure, population density, land use, and economic activities, which are all aspects considered in this study. In Mexico wildlife subsidy is applied with general criteria and economic information related to wildlife uses is scarce. Assessing a municipality's socioeconomic characteristics and the probability of the occurrence of Wildlife Management Units (UMAs) in Mexico provides useful information for identifying the present conditions that have an influence on the location and development of UMAs providing useful information for decision making. Geographical and socioeconomic approaches for describing the distribution of UMAs can lead to better decisions related to focalization and therefore to the improvement of wildlife and environmental policies that have an influence on livelihood quality.

1. Introduction

Wildlife use is a rural livelihood strategy for income diversification. In this context, non-timber forest resources (Shone and Caviglia-Harris, 2006; Arnold and Pérez, 2001; Mutenje et al., 2011), wildlife ranching (Kreuter and Workman, 1994), bush meat consumption (Timah et al., 2008; Morra et al., 2009), sport hunting (Frost and Bond, 2007), wildlife watching, and payment for environmental services are among the most studied topics (Kosoy et al., 2008). In particular, hunting is an important source of revenue in rural areas for many countries, such as Zimbabwe (the Campfire program) (Frost and Bond, 2007), the United States (Wynveen et al., 2005; Munn et al., 2010), and Mexico (Avila-Foucat et al., 2008). In consequence, environmental policies have been built to address wild species conservation for ecological purposes but also for rural livelihoods. However, wildlife policies have been focused on conservation and management strategies, and socioeconomic aspects have been less explored.

1.1. *Problem statement*

The diversity of wildlife uses and socioeconomic aspects associated are one of the challenges to face for building sustainable wildlife markets and policies. Socio-economic information needed is at a micro level, for assessing for example, demand, cost-benefits, and satisfaction, as well as

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regional variables such as population, infrastructure, or international markets.

In that sense, this paper aims to address socioeconomic regional aspects and wildlife use, in order to provide some elements for wildlife policy in Mexico. In the country, there is very limited information on the economics of wildlife use at a micro or regional level. Thus, markets are not sufficiently studied generating limited livelihood income and policy gaps. Moreover, wildlife uses are diverse and depend on many political, social, economic, and biological factors. This heterogeneity makes difficult to generalize wildlife policies. Thus, encouragement Wildlife Management Units (UMAs) policy is not sufficiently focused.

Therefore, this papers aims to analyze pre-existing conditions in terms of socioeconomic and land use characteristics and the probability of the occurrence of UMAs in Mexico. Using a logit model we addressed the importance of some factors in the localization of UMAs in Mexico.

The former is in order to provide useful information for identifying the present conditions that have an influence on the location and development of UMAs. The study is done at a municipality level in order to catch the high Mexican diversity which is important for local or regional policies. In this sense, infrastructure, population density, marginality, land use and economic activities are proxy variables to address the municipality's socioeconomic description.

1.2. *Wildlife economics: brief review*

Human interaction with wildlife can be divided into consumptive and non-consumptive uses. Consumptive implies the extraction of species from the wild for consumption for commercial or subsistence purposes, such as recreation (hunting, fishing), industrial, or food. Meanwhile, non-consumptive uses are mainly for recreation (wildlife watching) or cultural purposes. Most of the literature on economics has been oriented to hunting tourism and fishing especially in developed countries but in the last three decades wildlife tourism demand has also been studied due to the increasing revenues coming from this activity (Duffus and Dearden, 1990; Reynolds and Braithwaite, 2001).

The determinants of hunting demand include microeconomic variables such as: income, price, leisure activities associated (Poudyal et al., 2008), the socioeconomic profile of tourists, and access to the site (Floyd and Gramann, 1997) as well as, non-guided and guided tours (Scrogin and Berrens, 1999). Regional variables associated to hunting demand have also been studied showing that accommodation infrastructure, the proximity of urban areas and roads (Little and Berrens, 2008), and population growth (Poudyal et al., 2008) are significant variables. In developed countries were hunting is an important leisure activity not only specific data on demand has been proved to be important but also the regional infrastructure that provides facilities for hunters and their families to spend time on the region.

For wildlife commerce, such as that of reptiles, the main aspects mentioned in the literature are prices, intermediaries, market access, and international fluctuations (Brooks et al., 2010). These last variables also apply to bush meat markets, in addition to the population density as a proxy for the proximity of urban areas and markets (Dupain et al., 2012). Wildlife international commerce has been documented in terms of the amount of species extracted but economic aspects have been less studied. However, it is recognized that market access and inadequate prices are one of the main issues. In developed countries, information on local bush meat markets and wildlife manufacture is very limited.

On the other hand, the demand for wildlife watching depends on variables such as, price, income, education, previous experience, and environmental knowledge as well on, tour expectations, satisfaction, and the equilibrium between the wilderness, infrastructure and security (Curtin, 2013). In that sense, the determinants of non-consumptive wildlife use is similar to hunting or fishing since both are leisure activities. Users are looking for equilibrium between economics aspects, the wilderness, and satisfaction.

It is also important to mention that wildlife use depends on the household decision regarding the option to supply to the market their wildlife for having an income diversification. That is, when wildlife is located in private lands, wildlife markets are generally a complementary source of income, similar to many other rural activities. Therefore, some literature has been oriented to assess the importance of nature exploitation for rural incomes, which should be part of wildlife and rural policies considerations (Kosoy et al., 2008; Lopez-Feldman et al., 2007).

The literature cited above shows that wildlife markets depend on the characteristics of consumers and providers and also on regional socioeconomic variables such as the accommodation infrastructure, population density, land use, economic activities, and poverty which are aspects considered in this study.

1.3. *Wildlife use and management in Mexico*

Wildlife use and management in Mexico take place in Management Units for Conservation and Sustainable Use of Wildlife (UMAs), which were implemented in 1997 by the Ministry of Environment and Natural Resources (SEMARNAT) in accordance with the Program of Wildlife Conservation and Rural Diversification (Avila-Foucat et al., 2008). The policy aims to generate income for farmers in community and private lands derived from the conservation of species and their habitat. According to Mexican law, UMAs are operated under a management plan approved by SEMARNAT for monitoring species and their habitats as well as for determining harvest rates. Income generation in UMAs is due to both extractive (e.g., sport hunting individuals for ornaments or pets) and non-extractive uses (such as ecotourism), and wildlife management can be carried out in captivity or in the natural habitat, which are also referred to as intensive and extensive management, respectively. The purpose of intensive management is the reproduction and re-introduction of species.

The number of UMAs registered up to 2013 was 12,000, and these units have been increasing at a rate of 5% per year (DGVS, 2014). The integration of UMAs is conducted through the Unit System for the Conservation, Management and Sustainable Use of Wildlife (SUMA). Registration of UMAs can be carried out in the federal or state SEMARNAT offices.

In 2010, the government initiated a subsidy program for the encouragement of UMAs, supporting the new establishment or improvement of these units. The beneficiaries of this policy are landowners living in rural areas, and priority is given to marginalized localities and municipalities listed under the national policy for combating hunger (Cruzada contra el Hambre) (DGVS, 2014).

Infrastructure equipment, specimen acquisition, technical assistance, capacitation, and biological studies are supported by the program and can be applied for conservation, extractive or non-extractive activities. Only native species management is permitted. On average, 37 million dollars per year are dedicated to the program (DGVS, 2014).

The literature on UMAs has been oriented toward discussing the importance of this policy for conservation and economic benefits to landowners.

Gonzalez Marín et al. (2003) analyzed UMAs in Yucatan in terms of the wildlife use, species and activities observed in these areas, highlighting that habitat management occurs in 21% of these units, while 29% are dedicated to ecotourism, and sport hunting takes place in 71%. Weber et al. (2006) provided a critique of UMAs located in southeastern Mexico, arguing that UMAs have increased the introduction of exotic species and failed to generate economic benefits for local communities. Similarly, Sisk et al. (2008) and Gallina-Tessaro et al. (2009) have argued that UMAs can achieve conservation aims if the use of exotic species is prohibited and the technical capacity and monitoring programs are improved. Authors highlighted that conservation should be a priority with respect to economic benefits. Thus, the discussion among scholars has been concerned on the introduction of exotic species and capacity building for monitoring and improving harvest rates in UMAs.

Economic benefits derived from UMAs have also been discussed, with different opinions being presented. Some authors argue that economic benefits are not achieved; noting that investment during the first year following the implementation of a UMA is high, especially for landowners in the south of Mexico, where marginalization is greater (Gallina-Tessaro et al., 2009; García-Marmolejo et al., 2008). However, other studies show that UMAs have positive financial effects and that employment is created, generating a source of revenue for families (de la Vega Mena et al., 2012). Modeling can also be performed to determine the optimum harvest rates for the conservation of habitat and economic benefits (Arguelles González Angulo, 2008). The economic revenues from UMAs are between $3000 and (Conabio, 2006) 5000 million pesos (Ramírez and Mondragon, 2010). For other communities, UMAs have represented the first step in income diversification toward ecotourism (Avila-Foucat, 2002, 2012). Other successful case studies have been identified. For example, Castellanos (2010) explains that due to a UMA, a bighorn sheep conservation program was initiated in the Ejido Alfredo Bonfil in the Vizcaino Biosphere Reserve. This species can present a value of approximately $65 thousand dollars in the market, and 40% of the income derived from hunting is used for the bighorn conservation program, which has had successful results as the number of animals increased from 100 in 1995 to 250 in 2010. This program has generated economic benefits of approximately 2.5 million dollars. Successful results can also be observed for the black bear, the ocellated turkey, and the pronghorn (Carabias et al., 2010). Similarly, Mutenje et al., 2011; Ramírez and Mondragon, 2010; Rojo et al. 2010; Rosas-Rosas and Valdez (2010) have demonstrated that white tail deer sport hunting revenues in UMAs have been used for jaguar conservation.

UMA specificities are high depending on the region, habitat, species management measures and uses, as well on the social, economic, natural, financial and physical assets of landowners. This heterogeneity makes it difficult to generalize UMA success or failure.

In response to this issue, an institutional evaluation of UMAs is in process, and the first results show that UMA landowner reports are incomplete, but a general description of species, permits, and employment can be performed (Conabio, 2014). The challenges presented by UMAs noted in the literature include monitoring, administrative and policy planning, financial support (before 2010), market access and creation, and low prices for the extraction and commercialization of some species (Avila-Foucat et al., 2009).

These challenges depend on the characteristics of UMAs and also on the socioeconomic context. For instance, market access is related to the road infrastructure, proximity of accommodations and urban areas, land use, economic activities and poverty conditions, as indicated in the international literature. However, none of these variables have been addressed in UMAs in Mexico. Moreover, the studies in this field are very UMA specific and are not representative at a municipality, state or national level. Therefore, the aim of this study is to take a first step in assessing municipality socioeconomic characteristics and the probability of the occurrence of UMAs in Mexico.

2. Data and methods

Determining the probability of the occurrence of UMAs at the municipality level is our main objective in this study. To achieve this aim, it was necessary to build a logistic model, where the dependent variable was whether a municipality had (1) or not (0) UMAs, and the independent variables were related to poverty, market access, economic activity and land uses. The variables employed to describe the socioeconomic context were consistent with the literature described in the previous section.

The study combines different sources of data. First, the number (records) of UMAs (both Federal and State) per municipality was obtained from the national SEMARNAT UMA database up to 2010. This database contains information on every registered UMA and some of their characteristics. In this study, we used only the total of records per municipality and reclassified them into two categories: with and without UMAs.

The municipality's marginality index was taken as a proxy of poverty conditions, under the rationale that a minimum amount of assets is needed to implement a UMA (Avila-Foucat, 2012), which is consistent with the literature on rural household income diversification (Weber et al., 2006; Yúnez-Naude and Taylor, 2001). Since 1990, the Mexican Population Council (CONAPO) has published an indicator of social deprivation at the municipality level. Marginality is conceptualized as a multifactorial phenomenon, and income is one of

the variables that can influence deprivation. In this context, variables such as the average education level, access to water and drainage or living in a rural locality exhibit an important weight. In this study, in municipalities showing a high value of this index, marginality was conceived as a factor with a negative influence on the number of UMAs, due the lack of economic, social and cultural capital in these municipalities. For the purpose of this study, the 2010 population census data was used to the construction of the marginalization index.

Similarly, the population density was estimated based on the total population declared in the 2010 population census. This variable is expected to have a positive influence on the presence of UMAs due to the proximity to markets.[1]

Land use is one important factor impacting the presence/absence of UMAs. Land use is a proxy for vegetation coverage, which increases species abundance and richness. A greater amount of rural/forest land is expected to increase the probability of UMA occurrence. Land use data were extracted from the national land use inventory published by the National Institute of Statistics, Geography and Informatics (INEGI). The data correspond to 2007.

One important issue is the spatial distribution of the UMAs. There is a clear difference between the north and the south, as will be noted below. For this reason, a categorical variable was included in the model. This variable had three values: north, central and south.

The number of populations receiving income from the primary, secondary or tertiary sector is also important because it is a proxy relating the economic dynamics of the municipality to the UMA. For instance, a municipality that is dedicated to manufacturing would show a different relationship with a UMA compared with a municipality that is dedicated to services or agriculture. The data used in this analysis come from the 2010 population census.

All of the data were processed using the software ArcMap 9.2©, for map spatial visualization, and IBM-SPSS 20© for statistical analysis.

3. Results

3.1. General description

UMAs are distributed nationally, but there is a clear difference between the north and the south, as has been mentioned above. The northern part of the country includes 2/3 of the total of UMAs (Figs. 1 and 2). Some municipalities in Sonora, Baja California, Tamaulipas and Nuevo Leon exhibit more than 138 UMAs each, whereas the majority of municipalities in Chiapas, Tabasco and Oaxaca present only a few.

The UMAs are located in the municipalities with a lower marginality, as shown in Fig. 3 very low- and low-marginality municipalities account for approximately 2/3 of the total of UMAs. On the other hand, municipalities classified as very high marginality account for only 2.7% of the total UMAs (Fig. 3).

[1] Unfortunately, data on road network in Mexico is not always available and reliable.

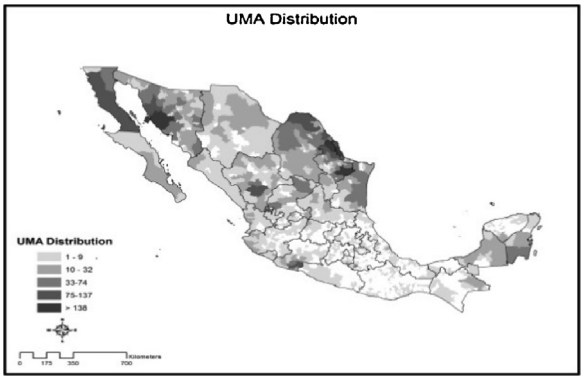

Fig. 1 – UMA distribution.

The municipalities with more than 125 UMAs and their level of marginality are presented in Table 1.

3.2. Model results

The model results confirmed the relationship between UMAs, marginality and regions. It also shows the probability of occurrence with regard to the population density, accommodation units (as a proxy for market access), the economically active population per sector (as a proxy for economic dynamics in the region) and land use. Table 2 summarizes the logit β values and significance of each variable.

The logit results show that the probability of finding a UMA in the north or center of Mexico is positive with respect to the southern region, displaying a 2 times or 3 times higher probability of presenting these units.

It was also confirmed that the probability of finding a UMA is higher in less marginalized municipalities. Taking very high marginality as the reference, very low marginality municipalities show a 5 times greater probability of including UMAs and low marginality municipalities an almost 4 times greater probability. Additionally, it was interesting to find that high marginality was not significantly different from very high marginality; i.e., there is little difference in the probability of finding a UMA between these two categories.

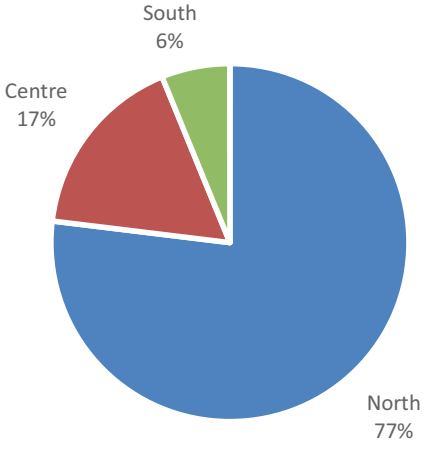

Fig. 2 – Percentages of UMAs in different regions of Mexico.

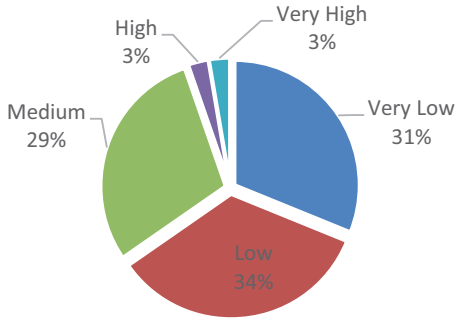

Fig. 3 – Percentage of UMAs at each level of marginality.

The model results show also that UMAs are not related to population that are economically active in the primary, secondary or tertiary sectors, which is an interesting result because UMAs have been shown to be more closely related to economic activities involving agriculture and livestock. Thus, economic dynamics in the region do not contribute greatly to explaining the presence of UMAs.

In contrast, the probability of UMAs occurring in municipalities with forests or agricultural activities is significant and positive. Therefore, UMAs are not necessarily related to only one type of land use or vegetation. This finding is consistent with the fact that UMAs are dispersed across the country as well as with the mega-diversity of Mexico.

This observation is also congruent with the finding that population density has a negative influence on the location of UMAs, meaning that access to markets for UMAs are not necessarily measured in terms of the proximity of a city. Thus, UMAs are located among different land uses, but not close to urban areas. In contrast, accommodation has a positive influence on the probability of finding a UMA, suggesting that minimal infrastructure is necessary to implement a UMA, and this influence might be stronger for sport hunting and wildlife watching.

In summary, a municipality with low or very low marginality and a low population density, but presenting accommodation infrastructure has a major probability of exhibiting UMAs.

4. Discussion

4.1. *Results discussion*

The current regional distribution of UMAs arose because they were initially promoted by northern ranchers looking to diversify their sources of income, following the effects of NAFTA on the agricultural sector. Moreover, the sport hunting demand coming from the United States is much higher (Avila-Foucat et al., 2008) and more organized than that within Mexico, thus decreasing transaction costs for UMAs near the frontier. Additionally, the presence of natural pasture lands increases the possibility of hunting sports in terms of the number of animals per hectare and visibility (Gallina-Tessaro et al. 2009; Gonzalez Marín et al., 2003). Thus, UMA implementation was initiated in the north, where the extent of landowner holdings is much greater compared with the southern states, and economic conditions are less vulnerable, which explains the relationship with marginalization observed in the results. However, it is important to mention that the number of UMAs in the south has been increasing over the years (Conabio, 2006), as demonstrated by the fact that the subsidy created in 2010 has been applied frequently in the south of Mexico (Fig. 4).

The relationship between marginalized municipalities and UMAs is consistent with results at a state level. That is, the probability of finding a UMA in a municipality with low marginalization is not due to UMA characteristics or needs. Instead, it arises because northern municipalities exhibit

Table 1 – Municipalities with more than 125 UMAs and their marginality.

State	Municipality	UMA	Marginality
Nuevo León	Anáhuac	281	Low
	China	224	Very low
	Gral. Terán	173	Low
	Lampazos de Naranjo	137	Very low
Tamaulipas	Guerrero	260	Low
Sonora	Hermosillo	206	Very low
	Pitiquito	133	Very low
Baja California	Ensenada	133	Very low
Michoacán	Arteaga	126	Intermediate

Table 2 – Logit results indicating the probability of the occurrence of UMAs with regard to socioeconomic characteristics at the municipality level.

Municipality socioeconomic variables	β values (significance at gl 1)	Exp (β)
Constant	−6.337 (.147)	
Categorical variables		
Region. Reference: South		
North	1.191 (.000)	3.290
Central	.838 (.000)	2.311
Reference: very high marginality		
Very low marginality	1.629 (.000)	5.097
Low marginality	1.375 (.000)	3.954
Intermediate marginality	1.050 (.000)	2.856
High marginality	.451 (.061)	1.569
Continuous variables		
Accommodation units	.008 (.013)	1.008
Population density	−.059 (.000)	.943
% PEA primary sector[a]	.037 (.407)	1.037
% PEA secondary sector[b]	.021 (.639)	1.021
% PEA commerce	−.004 (.928)	.996
% PEA services[c]	.058 (.202)	1.060
Agriculture	.002 (.000)	1.002
Pastizal	.002 (.000)	1.002
Temperate forest	.003 (.000)	1.003
Tropical forest	.003 (.000)	1.003
Dry forest	.003 (.000)	1.003

[a] Population economically active in agriculture, livestock, hunting and fishing.
[b] Population economically active in mining, petroleum and gas extraction, manufacturing industry, electricity, water and construction.
[c] Population economically active in transport, government and other services.

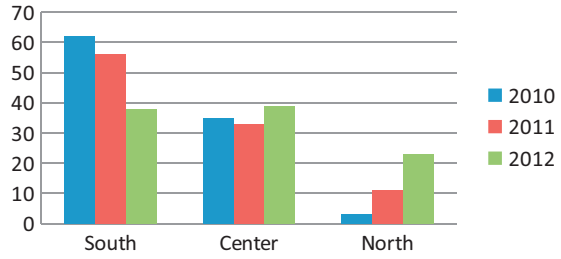

Fig. 4 – UMA subsidies per region. Based on DGVS reports.

better socioeconomic conditions (Fig. 5). This finding is interesting because it has been noted that diversification is initiated by households with a certain level of income, as a minimum level of assets is needed (Yúnez-Naude and Taylor, 2001). Therefore, our findings are relevant for policy, suggesting that a subsidy is crucial for establishing new UMAs in the poorest regions because a minimum amount of assets is required.

On the other hand, the economically active population by sector is not significant for the probability of UMA occurrence. UMAs are not exclusively related to the agricultural or service sector. This situation is most likely due to the diversity of wildlife uses, some of which are linked to the tourism sector, while others are associated with wildlife commerce or livestock markets, making it difficult to establish a structural relationship. A second interpretation is that UMAs are independent of a municipality's economy, showing no link with local markets or economic activities, as indicated previously (García-Marmolejo et al., 2008). It is also possible that the population economic activity by sector is not an adequate indicator and that further research is desirable to explore other economic variables and household livelihoods. Finally, it is possible that landowners are dedicated to different sectors being UMAs a diversified source of income. Thus, landowners are dedicated to one sector or another and wildlife will be used anyway.

The results show that UMAs can be located in different types of vegetation, which is most likely explained by Mexico's

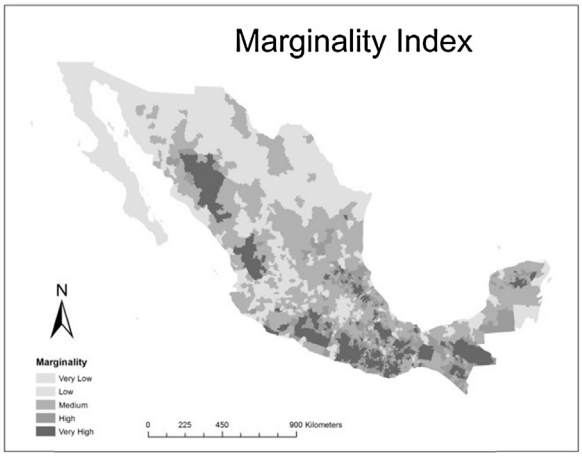

Fig. 5 – Municipality marginality.

diversity of species and their uses. In the north, sport hunting is dominant, while in the south, other uses are more important, such as fauna-related commerce (Santos-Fita et al., 2012).

Moreover, access to markets must also be analyzed in greater detail because cities do not seem to play an important role in the distribution of UMA products or as a link to tourism demand or attraction. However, the accommodation infrastructure has a positive effect on the probability of finding an UMA. Therefore, wildlife demand must be assessed in more detail at the scale of municipalities.

The aim of this study did not take into consideration important aspects that will need to be assessed in further studies, such as the impacts of UMAs on the household economy and conservation, or other determinants of demand, such as consumer characteristics, or different types of infrastructure. However, policy recommendations can be drawn from this study.

4.2. *Policy recommendations*

The problem addressed in this paper is the lack of a specific wildlife policy in Mexico, since the subsidy criteria are too general, and the inexistence of a wildlife markets strategy. In that sense, the results showing that probability to find UMAs is higher in municipalities with less marginality, guides us to recommend that subsidy is well focused for UMA creation in those areas. Moreover, UMA can be consolidated in regions where accommodation is available but not necessarily close to important cities.

On the other, hand our findings show that UMAs can be located in many vegetation types, therefore, policies need to be oriented to species and their relationship with their habitats. Finally, the probability to find UMAs is not related to economic population activities. Therefore, the relationship between UMAs and economic activities in the regions need to stressed, but at the same time other variables trying to assess this relationship need to be explored, as well as, the income proportion on livelihood derived from UMAs. Specific market studies conducted by region or municipality are important for consolidating existing UMAs. These studies will allow the identification of possible links with regional or international markets and different economic sectors, considering the diversity of species and their uses. This topic must be considered a high priority in policy development. It is also important to analyze the complementary incomes of ranchers to create synergies that can help to develop UMAs. Wildlife demand has been assessed principally in developed countries. However, it is important to increase scientific knowledge of the determinants of wildlife demand in developing countries because biodiversity is an important source of revenue for many rural households. Therefore, the results derived from our study are relevant to international policies related to wildlife uses.

5. Conclusions

Assessing municipality socioeconomic characteristics and the probability of the occurrence of UMAs in Mexico provides

useful information for identifying the present conditions that have an influence on the location and development of UMAs. A strict cause–effect relationship was not delineated in this study. Instead, this work resulted in a description of pre-existing conditions regarding marginality, population density, land use, and accommodation infrastructure that exhibit a greater influence on the occurrence of UMAs compared with other variables. Geographical approaches to evaluating the distribution of UMAs can lead to better decisions related to focalization and therefore to the improvement of wildlife and environmental policies that have an influence on livelihood quality.

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