Artículos

Spatial and Economic Assessment of Butterfly-Based Handicrafts as a Tourism Service Provided by Rural Populations*

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Abstract:

Butterfly-based handicraft activities are usually performed around or within natural reserves. Using these insects in a sustainable way by rural communities should address multiple factors, goals and conservation constraints. This study ranks tourist zones in Veracruz, México, to create and market butterfly-based handicrafts by applying a multicriteria analysis. We differentiated top zones where a segment of the rural population

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could benefit from this activity. Roads, butterfly diversity, and tourists emerge as key elements while protected areas and transport costs were considered as constraints. The economic value of the butterfly-based handicraft market was estimated as well.

Keywords: economic diversification, entomotourism, market share assessment, wildlife sustainability.

Evaluación espacial y económica de la artesanía basada en mariposas como servicio turístico prestado por poblaciones rurales

Resumen:

Las actividades de artesanía basadas en mariposas generalmente se realizan alrededor o dentro de las reservas naturales. El uso de estos insectos de manera sostenible por parte de las comunidades rurales debe abordar múltiples factores, metas y limitaciones de la conservación. Este estudio clasifica las zonas turísticas de Veracruz, México, donde se crean y comercializan artesanías basadas en las mariposas, aplicando un análisis multi-criterios. Diferenciamos las zonas más importantes donde un segmento de la población rural podría beneficiarse de esta actividad. Caminos, diversidad de mariposas y turistas surgen como elementos claves mientras que las áreas protegidas y los costos de transporte fueron considerados como limitaciones. También se estimó el valor económico del mercado de artesanías basadas en las mariposas.

Palabras clave: diversificación económica, entomoturismo, evaluación de la participación en el mercado, sostenibilidad de la vida silvestre.

Introduction

Tourism is ranked third as an income source for Mexico, and the country is among the top ten destinations for international tourists. It represents near 8.5% of the Gross Domestic Product and received 32.1 million international tourists and contributed to the economy with US $15.5 billion in 2015 (Sistema Nacional de la Información Estadística del Sector Turismo de México [DATATUR], 2016; Organization for Economic Cooperation and Development [OECD], 2017). The main tourist attractions are related to its richness in natural resources, historic and cultural heritage, and distinctive regional cuisine, along with festivals and custom celebrations (Camarena-Gómez et al., 2014). In México, the value of entomotourism activities is between US $44.2 million to US $88.5 million per year for the monarch butterfly only, while tourists spend near US $913.6 million in souvenirs (Jacinto-Padilla et al., 2017). The state of Veracruz is an important tourist attraction due to the diverse services it provides to the national and international visitors; therefore, it is ranked fifth nationwide (Secretaría de Turismo [Sectur], 2013). Main natural attractions include beaches, rivers, lagoons, thermal springs, mountains, and sand dunes. Other attractions are archaeological sites, colonial towns, museums, local festivals and carnivals. The diversity of services allows having visitants during the whole year and not only on Easter or vacation periods (Secretaría de Turismo y Cultura [Secturv], 2018).

On the other hand, the state of Veracruz is ranked third in biodiversity, and is rich in butterfly species with a potential to make and trade handicrafts, aimed to the visitors (Lopez-Collado et al., 2016). Species like *Morpho helenor* Cramer, *Danaus gilippus* Cramer and *Heliconius erato* L., are currently traded in different ways (Boppré & Vane-Wright, 2012; Mulanovich, 2007). Some countries in Central and South America already benefit from processing insects into souvenirs or handicrafts to generate revenues in rural communities (Fagua et al., 2002; Mulanovich, 2007). Common and widespread butterfly species can be processed to create handicrafts such as earrings, key chains,

framed dry-specimens, necklaces, lamps, among others (Cruz-Salas, 2011). The activities of collecting butterflies, creating and selling butterfly-based handicrafts and souvenirs promote recognizing the importance of biological diversity by the local population within their surrounding geographic area (Saragos-Méndez & Patriganni, 2012). Souvenirs also help to spread cultural values, historic and biological wealth as a part of the essence of people groups (Buenaño-Allauca et al., 2017; De Mello & Ciliane-Ceretta, 2015). Handicrafts are a form of visual communication where the tourist adds a sentimental value to the acquired craft, recreating in his/her memory images of the experiences lived in the place visited. Therefore, a craft represents the bio-cultural heritage of a specific region and becomes a source of identity (López-Reyes & Gómez-Hinojosa, 2016). Thus, the creation and sale of butterfly-based handicrafts, not only serve the purpose of obtaining economic income for the people who can dedicate themselves to this activity, but also as a symbolic acquisition of the visited tourist site identity (Ciliane-Ceretta et al., 2014; López-Reyes & Gómez-Hinojosa, 2016). In addition, producing and selling butterfly-based souvenirs complement the income of people living in rural zones and help to preserve the species diversity by making people recognize the importance of managing these natural resources (Monterrubio et al., 2013; Morgan-Brown et al., 2010). The tourist merchandise sector is diverse and provides a high potential for local people to participate and, more importantly, it is necessary to promote the sustainable use of the biological material (Báez-Lizarazo et al., 2017; López-Serrano et al., 2018; Virapongse et al., 2014).

Diverse studies are required to guide in the sustainable management of wildlife and reduce conflicts between different stakeholders. For example, find the spatial distribution of the target natural resources (Cox et al., 2014; Jacinto-Padilla et al., 2017). However, factors other than biotic and climatic ones affect the potential management of ornamental butterflies. Geographic information systems coupled with multicriteria analysis have been used to select tourism-related sites, such as Convention sites (Chen, 2006) and eco-tourism destinations (Dhami et al., 2017; Çetinkaya et al., 2018; Wong & Fung, 2015). Sustainability is defined by Viso (2005) as "Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" and can be viewed as an approach to study composite systems (Salas-Zapata & Ortiz-Muñoz, 2019). Because analytic hierarchy process is a tool that considers multidimensional components, it is well suited to measure sustainability in diverse fields, like agriculture and forestry, among others (Cinelli et al., 2014; Diaz-Balteiro et al., 2017).

An important component in planning for entomotourism activities is to consider the human capital involved in creating and marketing butterfly-based handicrafts. In Mexico, people in rural areas participate in these activities, for example, in religious festivities, people make and wear ankle rattles made of *Rothschildia cincta* Tepper cocoons, collected from wild plants in the Sonoran Desert (Espinoza-López et al., 2016) and people from Yucatan collect and sell the beetle *Zopherus chilensis* Gray as live pets or souvenirs (Miss & Reyes-Novelo, 2009). As tourists are among the main souvenir consumers, it is necessary to take into account factors such as local population, raw material access, and distance from the origin to the market point (International Trade Centre [ITC], 2014). All of these factors have a spatial variability that needs to be considered to better plan for retail tourism and shopping (Chen, 2007). Therefore, the goal of this study was to explore the potential of the tourist zones in Veracruz as a case study to market butterfly-based handicrafts by people living in the nearby rural areas.

Methodology

Tourist zones and influence factors

The most relevant sites for family-oriented tourism were selected in the state of Veracruz, Mexico (table 1) (Secturv, 2015). Health resorts, thermal springs, colonial towns and magical villages were geo-referenced as points while transects were delineated over the beaches accessed by tourists. In each site, a buffer zone with an 11 km radius was created. The distance is closely equivalent to the minimum one-way ticket cost for public transport, assuming that potential vendors from the rural areas use this mode of transportation. After the tourist zones were delimited, a restriction layer was applied to exclude those areas overlapping with Protected Natural Areas, which by law, have legal restrictions in the use of wildlife. These areas were: *Cofre de Perote* (CP), *Pico de Orizaba* (PO), *Cañón del Río Blanco* (RB) and *Reserva de la Biosfera de Los Tuxtlas* (BT) (Comisión Nacional de Áreas Naturales Protegidas [Conanp], 2015).

TABLE 1.
Tourist sites and code, main attractions and services in the state of Veracruz, Mexico

Tourist site/Code	Tourist Attractions	Services
Tamiahua/Z01	Beaches, lagoon, sport fishing	Hotels, local cuisine, seafood
Costa Esmeralda/Z02	Beaches, fishing, turtle camp	Hotels, local cuisine, seafood
Tajín/Z03	Archaeological site, totonacan crafts, spring festival	Hotels, handicrafts, local cuisine
Lechuguillas/Z04	Beaches	Hotels, local cuisine
Villa Rica/Z05	Beaches	Hotels, local cuisine, seafood
Veracruz-Boca del Río, Cempoala/Z06	Beaches, sand dunes, bird watching, archaeological site, carnival, fishing tournament, museums	Hotels, international airport, handicrafts, local cuisine, seafood
Orizaba/Z07	Cableway, mountain climbing and hiking, cloud forest	Hotels, local cuisine
Tlacotalpan/Z08	Colonial town, virgin of Candelaria festival	Hotels, local cuisine
Tres Zapotes/Z09	Archaeological site	Local cuisine
Costa de Oro, Monte Pio, Roca Partida/Z10	Semivirgin beaches, rappel, ecological reserve, bird watching	Hotels, local cuisine, seafood
Catemaco-Salto de Eyipantla/Z11	Kayak, waterfalls, handmade cigars	Hotels, ecologic cabins, esoterism, local cuisine

Source: own elaboration

TABLE 1.

Tourist site/Code	Tourist Attractions	Services
San Lorenzo Tenochtitlán /Z12	Archaeological site	Local cuisine
Coatzacoalcos/Z13	Beaches, international fishing tournament	Hotels, international airport, seafood
Zozocolco de Hidalgo/Z14	Colonial town, local festival	Local cuisine
Quiahuiztlán/Z15	Thermal springs, archaeological site	Local cuisine, seafood
Xalapa/Z16	Colonial towns, museums, alpinism	Hotels, national airport, local cuisine, handicrafts
Coscomatepec/Z17	Colonial town, rappel	Local cousine, handmade cigars
Carrizal/Z18	Thermal springs	Hotels, local cuisine, health resort
Córdoba/Z19	Museums, Colonial town, ecologic park	Hotels, local cuisine
El Zapotal/Z20	Archaeological site	Local cousine
Museo Tuxtleco/Z21	Olmeca museum	Hotels, local cuisine

Source: own elaboration

Information sources

At each tourist zone, six information layers or factors were calculated and clipped to estimate a weighted linear grading index (Liaghat et al., 2013). These factors were: (1) Area of the zone A (square km), considered to capture or extract butterfly specimens. (2) Tourist number T (Sistema Integral de Información de Mercados Turísticos [SIIMT], 2013), considered as the potential consumers, near five million tourists visited Veracruz during 2013, from which 3.5 million had a known destination. The remaining tourist number was allocated across the tourist zones based on a double log, linear regression model related to the population size P:

$$\ln(T) = \beta 0 + \beta 1 * \ln(P)$$

(1)

(3) Total population size P (Instituto Nacional de Estadística, Geografía e Informática [INEGI], 2010) as an indicator of tourist services. (4) Federal roads R (km), this layer corresponds to the length of national freeways crossing the area, it is relevant as a way to access the zone and because visitors could stop at local towns and buy souvenirs when traveling in their own vehicles. (5) Raw material sources S, corresponding to locations with population size higher than 8,000; we assumed these locations could be provided with shops and stores to buy the required raw material to make the handicrafts. (6) Butterfly availability B, this is a raster layer that contains the potential diversity distribution of 17 butterflies considered of ornamental importance (Jacinto-Padilla et al., 2017). The layer was clipped per each tourist zone and the mean species diversity was computed. The five most preferred butterfly species were: *M. helenor, D. gilippus, H. erato, Myscelia ethusa* Boisduval, and *Siproeta stelenes* L. These neotropical species are also commercialized in other countries (Boppré & Vane-Wright, 2012; Lopez-Collado et al., 2016). At the next step, values of each factor were normalized between zero and one, and then a weighted sum

was computed. The weight reflects the relative importance of each factor and the sum corresponds to the grading index (Santé-Riveira et al., 2008).

Weight coefficients and grading system

We derived the factor weights from a comparison matrix. By consensus, the authors compared pairs of factors using a 1 to 9 grading scale, 1 meaning both factors are equally important and 9 implies one of the factors is extremely important (Saaty, 1990). The weights were derived from the normalized eigenvalues of the matrix. Once the weights were estimated, a sum of the factors was computed with the equation:

$$I_f = A'_{wa} + T'_{wt} + P'_{wp} + R'_{wr} + S'_{ws} + B'_{wb}$$

(2)

Where I_f is a suitability index, reflecting the potential of the zone to market handicrafts. In this equation, the X' is a normalized factor, ranging from zero to one, and w is its weight obtained from the comparison matrix. Factor normalization was computed with equation 3:

$$X'i = (Xi - min(X)) / (max(X) - min(X))$$

(3)

Equations 2 and 3 were applied to each zone, according to its factor values. The consistency of the comparison matrix was estimated with the Consistency Index (CI), which should be less than 0.10 (Saaty, 1990). We estimated the potential rural population that could benefit from these areas by computing the rural population size in each zone, rural locations have less than 2,500 inhabitants. The bottom and top zones were selected by calculating the quantiles of I_f below 0.20 or above 0.80, respectively.

Economic value of handicrafts in the tourist zones

The economic value (*V*) of the tourist zones was estimated by using a stochastic multiplicative model based on tourist number (*T*), expenditure of tourist per year (*E*), proportion of expenditure in handicrafts (*H*), and the expected market share of butterfly-based handicrafts (*M*) (adapted from Mundy & Bullen, 2008):

$$V = T*E*H*M$$

(4)

We use Monte Carlo simulation (n = 50,000 runs) to obtain the sampling distribution of *V* based on bootstrap sampling or by using distribution models representing the components of equation 4. Model parameters and

constant values were obtained from published data or by expert opinions. The analysis were performed using R v3.5.3 (R Core Team, 2019) and maps were generated using Quantum QGIS v3.6.0 (QGIS Development Team, 2019).

Results and Discussion

The relative importance of each factor affecting the potential marketing of butterfly-based handicrafts is presented in table 2. The numbers in the cells represent the relative importance of the row factor related to the column factor. Fractions indicate the contrary, that is, the row factor is less important than the column factor. The computed weights were: wa = 0.029, wr = 0.425, ws = 0.088, wb = 0.2002, wp = 0.056 and wt = 0.2002, thus, the most important factors were roads R, butterfly species diversity B, and tourist number T. The CI was 0.09. Therefore, the comparisons were consistent. On the other hand, based on the tourist number reported by Sectur (2013) (table 3), we adjusted the model: $\ln(T) = -0.0549 + 1.0375*\ln(P)$, ($r^2 = 0.88$; $F_{1, 8} = 7.8$, $p < 0.01$) and estimated the number of visitors for the tourist zones without official data. Population size was obtained from the 2010 national census (INEGI, 2010).

TABLE 2.
MATRIX OF THE RELATIVE IMPORTANCE OF FACTORS RELATED TO THE PRODUCTION AND MARKETING OF BUTTERFLY-BASED HANDICRAFTS

Factor	A	T	P	R	S	B
A	1	1/6	1/4	1/7	1/5	1/6
T	6	1	4	1/3	4	1
P	4	1/4	1	1/7	1/3	¼
R	7	3	7	1	6	3
S	5	1/4	3	1/6	1	1/4
B	6	1	4	1/3	4	1

Source: own elaboration
Note: Tourist zone area A, Tourist number T, population size P, roads length R, Services S, Butterfly diversity B

Once the weights were estimated, equation 2 was applied to grade the tourist zones and were ordered and ranked in table 3, which also presents the non-transformed factor values. The column rP is the rural population living in the respective zone that could benefit from marketing butterflies. The top zones were: Z06, Z13, Z02, Z16, and Z11 while those in the bottom were: Z09, Z12, Z20, Z01 and Z15. Zone Z06 presented the highest score in most of the factors.

TABLE 3.

Non-transformed factor values for each tourist zone used to compute the suitability index If

Zone	A	T	P	R	S	B	If	O	rP
Z06	1088	2578823	1243740	83	10	14	0.898	1	449
Z13	512	319039	349816	26	7	17	0.448	2	91
Z02	619	*17364	46047	68	1	13	0.443	3	105
Z16	674	719100	676477	16	7	16	0.414	4	427
Z11	479	82624	171154	28	2	17	0.387	5	374
Z21	362	34897	55595	30	2	16	0.351	6	161
Z19	331	*366768	287464	9	6	17	0.348	7	347
Z17	346	*36527	99867	25	2	16	0.327	8	281
Z03	364	423601	80521	40	1	12	0.292	9	87
Z05	195	*9352	6694	46	0	12	0.273	10	38
Z08	365	*17739	10418	24	0	15	0.266	11	16
Z04	173	*17860	16528	30	0	14	0.259	12	18
Z18	360	*10221	30133	28	1	13	0.229	13	93
Z07	234	*312765	103143	0	5	15	0.211	14	198
Z14	187	*7277	38485	0	0	17	0.206	15	169
Z10	63	*155896	4173	0	0	16	0.179	16	24
Z09	366	3270	21178	0	0	16	0.176	17	86
Z12	367	3608	8512	0	0	16	0.176	18	49
Z20	361	2346	23135	0	0	15	0.143	19	106
Z01	910	*237863	127456	0	1	13	0.123	20	203
Z15	163	*13998	828	2	0	11	0.014	21	4

Source: own elaboration
* Estimated with a regression mode l
Note: Zones are ranked (O) by this index and *rP* is the potential rural population
that could benefit from this activity. See text for a description of the factors.

Geographic distribution and ranking of the tourist zones

The map presented in figure 1 shows the tourist zones and their suitability to produce and market handicrafts. The zone with the highest grade was Z06; it covers from Chalchihuecan to Anton Lizardo beaches, including the cities of Veracruz and Boca del Rio. The second place was Coatzacoalcos (Z13). The third was Costa Esmeralda (Z02). Next was Xalapa (Z16), and the fifth zone was Catemaco-Salto de Eyipantla (Z11). Three zones are located in the central part of the state while Catemaco-Salto de Eyipantla and Coatzacoalcos are located in the south. The less ranked areas correspond to Tres Zapotes (Z09), San Lorenzo Tenochitlán (Z12), El Zapotal (Z20), Tamiahua (Z01), and Quiahuixtla#n (Z15). Tourist zones with beaches, waterfalls and a colonial city were the best graded,

because they have better infrastructure and high butterfly diversity. Regarding the protected zones, there were two non-overlapping zones, CP and PO that locate in the cold, high dry mountain region of Veracruz and relatively far from the tourist sites. Therefore, because of the harsh climatic conditions, they also present low butterfly diversity. On the other hand, the protected area RB was excluded from zones Z07 and Z19 while the protected area BT was excluded from zones Z10, Z11, and Z21. The former is considered to have semi-virgin beaches, Z21 is between Z10 and Z11, this is one of the richest diversity region in Mexico (Koleff & Soberón, 2008).
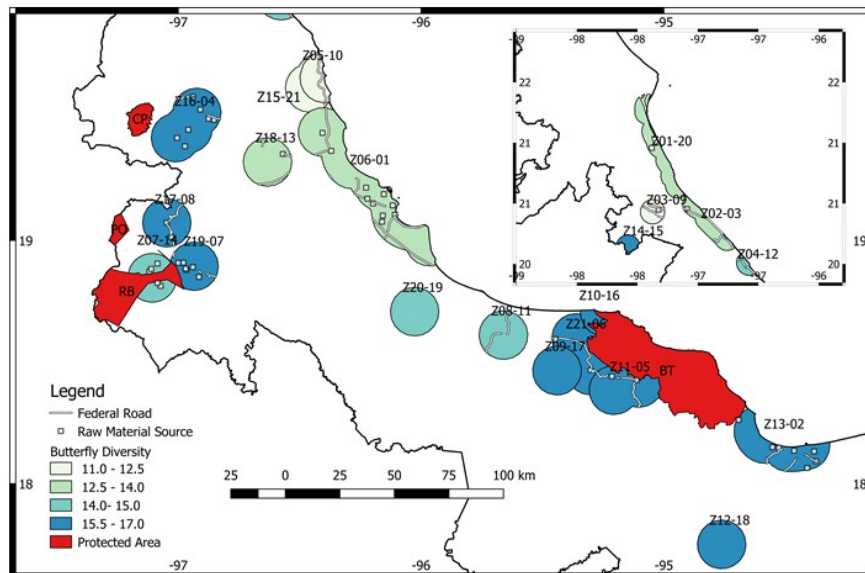

FIGURE 1.

Tourist zones and their suitability rank (Z-O) related to production and marketing of handicrafts based on butterflies in Veracruz, México. Inset map corresponds to the tourist zones in the northern part of the state
Source: own elaboration

The grading scale was able to breakdown tourist zones based on their favorability to market butterflies as crafts. For example, zone Z06 had the highest rank due to its commercial, maritime, and tourist activities that translate into high values for the selected factors (table 3). This zone attracts tourists that like to spend time in the beaches or enjoy other tourist attractions (table 1). In this zone, Cruz-Salas (2011) interviewed visitors and local people and found that they are willing to spend from MX $100 to MX $130 to buy butterfly-based handicrafts. Similar conditions were found in Coatzacoalcos (Z13). On the contrary, the colonial city of Xalapa (Z16) had a high butterfly diversity and was ranked fourth despite being far from the beaches. These zones contrast with some of the less favorable, like Z09, Z12, and Z20, which lack roads and services, even though they have high butterfly diversity (table 3). Therefore, in these sites, transportation and services are less abundant and limit the willingness of tourists to visit them. The least ranked zones have no roads, have few services, small areas and receive few tourists, except for zone Z01 that was expected to receive a high number of tourists, according to the regression model (table 3).

These results suggest that, in general, roads and services limit the potential to market handicrafts. The restrictions on transportation have been recognized in other studies. For example, places like Michapan, Paso de Ovejas and Tepexilotla, have ecotourism potential, but the lack of roads limit their access (Díaz et al., 2008; Quitano-Díaz et al., 2017). The same happens in other places in the country, where the tourist potential is hampered by difficult access, for example, San Miguel Topilejo, in the valley of Mexico (Carpinteyro-Urbán & Espinosa-Castillo, 2014). As in other countries, it is suggested that government develop the infrastructure and promote cooperation between tourism actors (Budiarta et al., 2017). A distinguished feature of our work is that, unlike previous research addressing entomotourism activities around and within natural parks and conservation sites

(Goodwin, 2002; Putri, 2016; Tran et al., 2015), we took into account the different constraints and legal restrictions on the management of natural resources within these kinds of place (Esquivel-Rios et al., 2014). Thus, we adopted a conservative approach by excluding protected sites rich in biodiversity and minimizing the risk of degrading the natural resources as it has been documented in other places like the Bantimurung Nature Recreation Park in Indonesia (Putri, 2016). In the case of the monarch butterfly in Mexico, socio-economic conflicts have been reported between local inhabitants because some of them have rights to develop entomotourism activities while others are not allowed to (Mendoza-Ontiveros et al., 2015). In addition, in the protected areas, it is necessary to have a conservation management plan to perform eco-tourism activities. However, in most cases, there is no such plan, thus leading to a negative balance in protecting the natural resources as it was reported in the Lacandona Selva in Chiapas (Calleros-Rodríguez & Guevara-Romero, 2016). Therefore, our approach minimized these type of conflicts by excluding protected areas.

On the other hand, the total area of the 21 tourist zones accounts for 11% of the state area, in which 579,104 inhabitants live in the rural areas. We assume that high diversity correlates with abundance, thus, we expect that extracting butterflies in the best ranked zones would not affect natural populations. In addition, previous estimates consider that near 6% of the economically active population work in tourism, and only 9.6% of them focus on the handicrafts and souvenirs (INEGI, 2015). Therefore, we estimate that 3,326 persons in the rural areas of these tourist zones could directly work in marketing butterfly-based handicrafts. This total is disaggregated by zones in table 3, but as people already work in this market segment, it should be considered as the best-case scenario. In addition, because of the differences in the marketing potential, we would expect that people living in the top zones (1,446) have the best opportunities to develop this activity and because there is an already established handicraft marketing sector, people will need to compete and develop marketing strategies to attract the consumers. Also, our objective was to address people living in the rural areas near these tourist zones because they are best located to collect or capture ornamental butterflies (Lopez-Collado et al., 2016), but it does not exclude inhabitants of urban areas because some of the target Neotropical butterflies also thrive in those areas as well (Jacinto-Padilla, 2016). Anecdotal evidence indicates that in zone 16 a single person sells butterfly-based handicrafts, thus highlighting both the potential of this activity and the lack of people dedicated to it. A previous research estimated that most visitors (74%) have the intention to buy this type of merchandise (Lopez-Collado et al., 2016).

The favorability index of the assessment system integrates the three pillars of sustainability. Tourist area, number of tourists and row material sources are part of the economic sphere. Socially speaking, the size of the rural population and roads are included. Also, in the environmental component, protected natural areas and the availability of non-threatened butterfly resources were included. Thus, our model conciliates the economic development and the conservation of the biological resources. However, much work is needed and some challenges are expected to be overcome in order to establish a butterfly-based handicraft market. First, the need of training because this a new activity (Abisuga-Oyekunle & Fillis, 2017). Another challenge is to evaluate the preferences of visitors to buy different handicraft articles like earrings, frames or key chains. However, some knowledge has been generated on this issue because a previous work focused on the willingness to pay for different handicraft models and preferences. It was found that butterfly frames, pendants, lamps, picture frames and key chains were preferred (Cruz-Salas, 2011). Other countries, like Costa Rica and Papua New Guinea are examples of success in the sustainable use of the butterfly resource by rural communities. In part due to public policies and legislation that regulate the value chain, from the rearing of butterflies, their commercialization, diversification in products and by-products from the wings of butterflies (Montero, 2007; Hutton, 1985; New, 1994). Therefore, in Mexico is essential to regulate the management and use of the butterfly resource, because there are no restrictions on the capture of rare species when their populations are low, which may lead to be placed on the Red List index. Currently, the Official Mexican Standard NOM-059 (Secretaría de Medio Ambienté y Recursos Naturales [Semarnat], 2010) only protects the monarch and the Esperanza butterflies.

Finally, an important future step is to gain market share because there is an established handicraft component within the tourism activities (Jiménez-Castañeda et al., 2009). Therefore, as people in the rural locations usually have low income, it is highly advisable that government policies and activities support the initial stage in introducing new products or services (ITC, 2014; López-Delfín et al., 2018). Though some challenges have been outlined, it is difficult to generalize because artisans face different obstacles depending on their activity (Harris, 2014). For example, "Needle and Thread" artisans in India lack education, have low economic resources, and the institutional framework is weak (Shah & Patel, 2017). Pro poor tourism strategies aim to benefit marginalized urban and rural populations by increasing their opportunities in the tourism sector. However, it should be integrated into mainstream research (Harrison, 2008). Thus, while our study focused on populations in the rural communities, it also considers how they "fit" within the current tourism activities and recognizes its limitations.

Economic value of handicrafts in the tourist zones

The value of the handicraft market was estimated based on the model parameters and constants presented in table 4. Random variability was generated by bootstrap sampling of historic values, like numbers of tourirsts visiting the state of Veracruz and the proportion of expenditure allocated to buy handicrafts and souvenirs. The percentage of expenditure in handicrafts is close to the 5.5% value reported in tourism-related handicraft in Ethiopia (ITC, 2014). We estimated the variability of market share by consensus and used the Pert distribution to model such variable while we obtained a single value for the expenditure per tourist from a national survey (table 4). The sampling distribution of the potential annual value of butterfly-based handicrafts is shown in figure 2(A). The distribution is right-skewed (skewness = 0.031) and has a median value of US $259,482 with a 95% confidence interval between US $122,273 and US $438,971. The economic value for each tourist zone is presented in figure 2(B), the top 20% zones accounted for 69% of the total economic value. It is interesting to note that zone 03, Tajin, accounts for 7.8% of the potential economic value but due to the relatively low contribution of the other factors, it is ranked halfway in the grading scale. However, as mentioned before, to promote rural inhabitants into the souvenir market requires additional planning and training efforts, like identifying the value chain components and their challenges, for example, by promoting innovation and new designs or by overcoming the lack of suitable market outlets (ITC, 2014). Training programs are also required to enhance the competitiveness of the involved people in the established handicraft and souvenir market (ITC, 2014; Saragos-Méndez & Patriganni, 2012). In particular, training and certification by the government to achieve primary production and value addition is recommended, as occurs in Costa Rica where around 400 families produce butterflies (Montero, 2007; Umaña, 2019). Some of these issues have been addressed in Veracruz, like assessing the value and preference of different butterfly-based handicrafts as mentioned before (Cruz-Salas, 2011). Another example of the economic assessment is the use of pine needles to make handicrafts in Perote, Veracruz, where it was reported that the profit was similar to the national minimum wage (López-Serrano et al., 2018). Though we emphasize the economic aspect of handicraft trading, other non-mensurable values are associated to souvenirs, that is, they have sign, spiritual, cultural and use values (Paraskevaidis & Andriotis, 2015). For example, souvenirs are part of the cultural heritage of the Yoreme people in Sonora; they use the cocoons of *R. cinta*, a saturniid moth, to make ankle rattles used in ceremonial dances in religion tourism (Espinoza-López et al., 2016; Peigler & Maldonado, 2005).

TABLE 4.

Variables, constants, and parameters of the distribution models related to the estimation of the economic value of butterfly-based handicrafts in Veracruz, Mexico

Variables (units)	Constants and distribution model (parameters)	Data Source
T (tourist year[1])	Sample(4682443, 5151131, 5361578, 5699743, 5440578)†	Datatur (2017)
E (US\$ tourist[1] year[1])	23.97‡	Sectur (2013)
H (proportion)	Sample(0.046,0.045,0.042,0.043, 0.042)†	Inegi (2016)
S (proportion)	Pert (0.015, 0.045, 0.095)	Authors' consensus

Source: own elaboration
† Statistics for years 2011-2015
‡ Estimate for year 2013 and are adjusted by inflation to year 2015
Note: T is the number of tourists visiting the state of Veracruz, E is the total expenditure by national tourists per year, H is the proportion of expenditures allocated to buy handicrafts, and S is the proportion of butterfly-based handicraft market share.
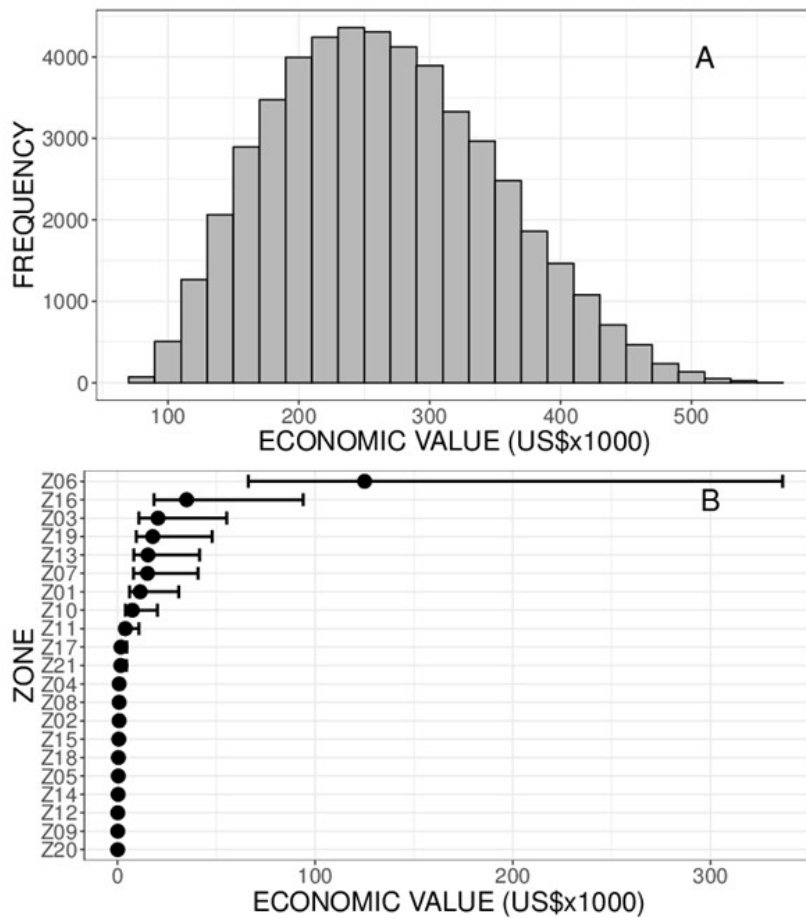
FIGURE 2.

ANNUAL SAMPLING DISTRIBUTION OF THE ECONOMIC VALUE OF BUTTERFLY-BASED HANDICRAFT MARKET IN VERACRUZ, MÉXICO AT STATE LEVEL (A) AND 95% CONFIDENCE INTERVAL OF THE ECONOMIC VALUE PER TOURIST ZONE, POINT IS THE MEDIAN VALUE (B)

SOURCE: OWN ELABORATION

Regarding the extraction of butterflies to make souvenirs, the information about the risks involved in marketing butterflies is scarce. Some guidelines have been proposed to mitigate risks related to the Butterfly House Industry, which is a network of stakeholders centered on butterfly exhibition centers, usually located in temperate places like the United States and Europe, and populated with species obtained from breeding and farming activities in tropical countries (Boppré & Vane-Wright, 2012; Veltman, 2009). In the case of butterfly-based souvenirs, it is a market segment that demands less management because it uses preserved or dissected specimens, which can be collected in different ways. Then, rearing and farming are not essential (Gómez-S, 2006). This research also considers species that have a wide distribution in the country (Jacinto-Padilla et al., 2017) and not listed as protected species, like the monarch butterfly and the Esperanza

butterfly (Semarnat, 2010). By excluding reserves, protected zones, and threatened species, this approach diminishes some issues found in other regions, like restricted access to tourists and potential reduction of butterfly populations (Goodwin, 2002; Putri, 2016).

As in other countries where butterflies are processed to create handicrafts, there is also a broad range of souvenirs that do not necessarily involve using actual butterflies. By tradition, people in Veracruz make souvenirs using the sea ecosystem as inspiration. Therefore, people can create t-shirts, mugs, and key rings with butterfly and insect

themes (Lopez-Collado et al., 2016). This is occurring in the states of Puebla, Sinaloa and Sonora, where artisans are organized to use local natural resources to diversify the supply of souvenirs in rural areas and to increase their income (Hernández-Soto, 2014; Jouault & Pulido-Madariaga, 2014; Romero-García, 2014). Likewise, artisanship activities are considered as a cultural heritage that can support the economy in rural communities, for example, through religious tourism (Rivera-Cruz et al., 2008). The sustainability of butterfly-based handicraft marketing will depend upon the awareness of potential vendors to abide by the conservation practices aimed to protect the native butterfly populations and the willingness of tourist to accept management regulations (Bach & Burton, 2017).

Although this research addresses the tourism sector, there are other potential markets to expand the sales of butterfly-based handicrafts. For example, regional festivals and shows, public places like parks or gastronomic routes where people gather for eating, leisure and resting. Another option is by including butterflies in landscape management to create spaces for visitors to attend and enjoy these insects (Lemelin, 2009; Monterrubio et al., 2013). This activity requires a different spatial analysis to take into account the natural habitat and factors that enhance the potential of the butterflies to thrive in their natural conditions, that is, to diversify ecotourism activities (Çetinkaya et al., 2018; Wong & Fung, 2015). Rearing and selling live butterflies is a current, popular activity, which uses newer media for advertising like the internet. Thus, additional research is needed to address issues related to the economic value of these activities, the effect of specimen extraction on conservation and the competitiveness of this new activity within the established market. However, we consider this research as a first approach where specific factors were quantified and combined to better assess the opportunities of people to use these local natural resources in a planned way.

Conclusion

This research provides an exploratory, empirical analysis framework to model different factors that affect the butterfly-based handicraft marketing potential, using tourist zones of the state of Veracruz, Mexico, as a case study. Current practices of producing and marketing butterfly-based handicrafts and entomotourism activities have been developed to take advantage of local biodiversity and tourist demand, usually in biosphere reserves like the "sanctuaries" of the monarch butterfly or tropical reserves like those in Southeast Asia. However, marketing and protecting natural resources lead to conflicts and opposing goals. This study considered spatial, economic, social, legal and biotic factors to grade the tourist zones aimed to enhance the opportunities of rural communities in this activity. The results indicated that roads, butterfly species diversity, and visitors increased the ranking of tourist zones while excluding protected areas enhance the sustainability of these natural resources by constraining the target zones and minimizing the risk of overexploitation. The best areas were beach zones and colonial towns that have most of the resources and services required. The analysis allowed estimating the number of persons from rural communities that could engage in this activity with a minimum transport cost. Also, a stochastic economic value of butterfly-based handicrafts across all the tourist zones was derived based on the probability theory and assuming a varying market share. We are aware that this study is dependent on the local, particular data collected and processed, and, if applied to other places, the results would differ, but we expect the differences reflect inherent potential conditions for marketing butterfly-based handicrafts at a strategic level. In addition, this study could serve as a starting point to help discriminate and guide in selecting the tourist zones with the highest likelihood to succeed. However, we also recognize the additional challenges to overcome in order to establish this tourist market segment. It includes to train people in collecting, rearing and processing butterflies, explore the offer of handicrafts in festivals, fairs, and carnivals within the favored zones, determine the market chain components and promote public policies intended to ensure the rational use of this resource. Future research should also address environmental

aspects such as the effect of climate change on the distribution of butterfly species and their plant hosts, and assess the management of butterflies within their natural habitat as recreational components of ecotourism.

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Notes

* Research article