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Article

Birding for and with People: Integrating Local Participation in Avian Monitoring Programs within High Biodiversity Areas in Southern Mexico

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Abstract: Biological monitoring is a powerful tool for understanding ecological patterns and processes, implementing sound management practices, and determining wildlife conservation strategies. In Mexico, regional long-term bird monitoring has been undertaken only over the last decade. Two comprehensive programs have incorporated bird monitoring as the main tool for assessing the impact of human productive activities on birds and habitats at local and regional levels: the Integrated Ecosystem Management (IEM) and the Mesoamerican Biological Corridor Mexico (CBMM). These programs are implemented in supremely important biodiverse regions in the southern and southeastern states of Mexico. Bird monitoring activities are based on the recruitment and participation of local people linked to sustainable productive projects promoted by the CBMM or IEM. Through a series of training workshops delivered by

specialists, local monitors receive equipment and coordinate to become part of a large monitoring network that facilitates regional covertures. This data currently being obtained by local people will enable the mid- and long-term assessment of the impacts of sustainable human productive activities on birds and biodiversity. Community-based bird monitoring programs are a promising opportunity for enhancing scientific knowledge, improving sustainable practices, and supporting wildlife conservation in areas of high biodiversity.

Keywords: birds; human productive activities; conservation biology; biological corridor; management; citizen science; community-based monitoring; tropics; development

1. Introduction

Biological monitoring is an essential activity for enhancing our understanding of ecological patterns and processes, assessing biodiversity, guiding management activities, and determining wildlife conservation strategies [1,2]. Birds have been widely used in monitoring programs worldwide [3], as they are relatively easy to survey, are present in all habitat types, surveying them over large areas is economically affordable, and information about species with different ecological requirements can be compiled relatively easily [4–6]. Moreover, along with their ecological importance as pollinators, seed dispersers, and predators, birds are valuable for people in local communities as food, commercial, ornamental, medicinal, religious, artistic, and recreational resources [7–9]. Hence, avian monitoring is crucial not only to increase our knowledge on ecosystem dynamics, but also to promote social welfare.

Successful experiences have highlighted the importance of integrating human communities in biodiversity monitoring programs, as local people usually possess a vast knowledge on focal biological groups, a precise understanding of the geography of the region, live near survey sites, and are directly in charge of natural resources management and conservation [10–12]. Incorporating local participation in avian monitoring programs has been particularly useful for determining temporal and spatial patterns on bird distribution [3], promoting local community awareness of environmental issues [6,13], establishing ecotourism programs as additional or alternative productive activities for communities [14], identifying important areas for bird conservation [3], and engaging public policies for wildlife conservation [3,10].

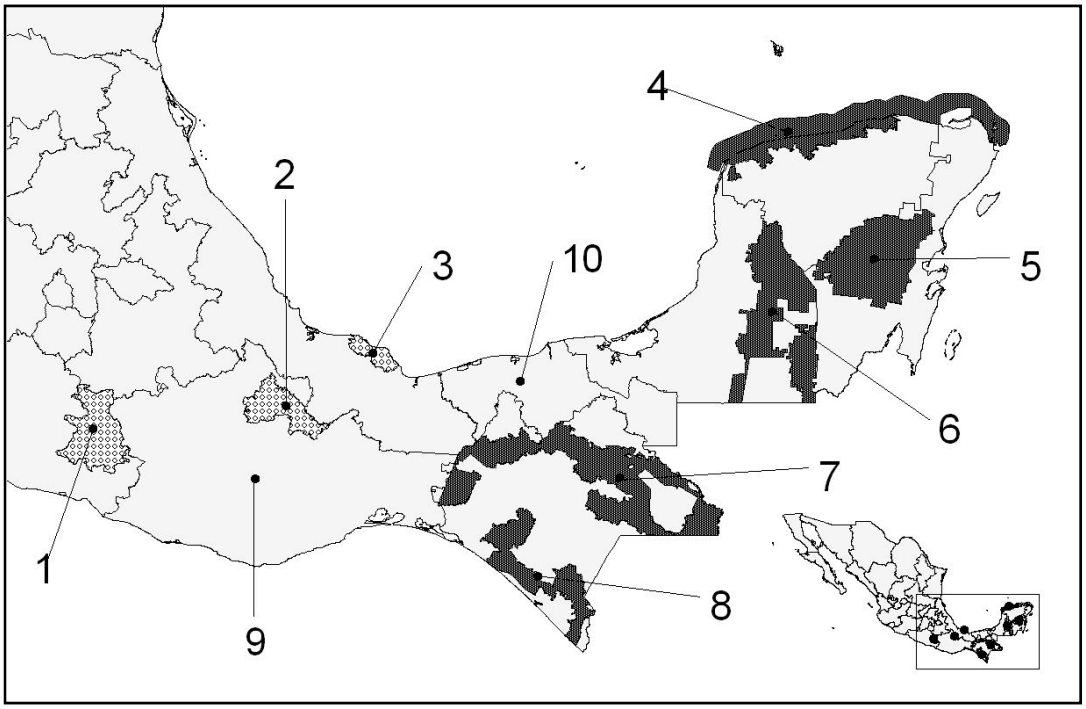
Locally-based avian monitoring programs are quite scarce in Latin American countries [3,15]. In the case of Mexico, such programs have started only in the last few years. In the context of community participative programs, the National Commission for the Knowledge and Use of Biodiversity (CONABIO) through the North American Bird Conservation Initiative—Mexico (NABCI—Mexico), together with local and federal institutions, such as the coordination of the Mexican-Mesoamerican Biological Corridor and the National Commission for Protected Areas (CONANP), have promoted the establishment of community-based bird monitoring programs in several pilot regions in southern Mexico. Here, we highlight the importance of community-based avian monitoring programs for increasing our understanding of the impacts of sustainable productive practices in tropical avifaunas, to analyze how monitoring data can help to evaluate and guide the

management of productive ecosystems, and to enhance human welfare. Moreover, based on our experience, we pinpoint through the discussion section some lessons learned, limitations, and major recommendations to facilitate the development and evaluation of similar programs in other regions. Finally, we encourage integrating local people into bird surveys for species and habitat conservation in sustainable ecosystems as a key component to increase our abilities to close the gap between social, economic, and biological concerns.

2. Community-Based Avian Monitoring Programs Launched in Southern Mexico

Two major programs have promoted community-based bird monitoring in high biodiversity areas in southern Mexico: the Integrated Ecosystem Management Program and the Mesoamerican Biological Corridor Mexico (hereafter referred to as IEM and CBMM, respectively). The IEM was a collective program ratified in 2001 by the Mexican government, through the National Commission for Protected Areas (CONANP in Spanish), the Global Environment Facility (GEF), and the United Nations Development Program (UNDP). Its general objective was to protect biodiversity and maintain vital ecological functions in priority regions, through sustainable management of natural resources at eco-regional scales, by incorporating both local and inter-institutional participation. As a parallel effort from 2010 to 2012, IEM promoted community-based bird monitoring activities to gather information about different avian species within study sites (see Figure 1).

Figure 1. Regions covered by community-based avian monitoring programs launched in southern Mexico. IEM regions include: (1) La Montaña (Guerrero), (2) La Chinantla (Oaxaca), and (3) Los Tuxtlas (Veracruz). CBMM regions include: (4) Yucatán, (5) Quintana Roo, (6) Campeche, (7) northern Chiapas, (8) southern Chiapas, (9) Oaxaca, and (10) Tabasco. As CBMM has extended into Tabasco and Oaxaca until recently, no polygons are currently specified for these states.



The Mesoamerican Biological Corridor was conformed in 1997 by all Mesoamerican countries (*i.e.*, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Mexico). This program promotes the sustainable use of natural resources in the region to enhance human welfare, landscape connectivity, and biodiversity conservation [16]. In Mexico, CBMM activities were initiated in 2002 in the States of Campeche, Yucatán, Quintana Roo, and Chiapas. Currently, the program has been extended to Tabasco and Oaxaca (Figure 1). The CBMM promotes community-based avian monitoring programs to determine the impact of sustainable productive systems on biodiversity, adjust productive processes to mitigate their negative impacts on wildlife, identify and monitor avian indicator species in the region, and establish a regional network of local bird monitors.

3. Regions and Habitats Covered by Monitoring Programs

3.1. Integrated Ecosystem Management Program

IEM activities were focused on three globally important eco-regions [17]: the Tehuantepec Moist Forests (including Los Tuxtlas in Veracruz and La Chinantla in Oaxaca), the Pacific Dry Tropical Forests, and the Sierra Madre del Sur Pine-Oak Forests, the latter two found in La Montaña, Guerrero (Figure 1). These eco-regions contain different forest types, ranging from cloud and pine forests to dry and mangrove forests. All these regions exhibit relevant cultural, climatic, and topographic characteristics, which determine high biodiversity levels and considerable beta-diversity values, as well as some species listed under different levels of threat, according to the Mexican Red List of Species at Risk [18].

3.1.1. Los Tuxtlas

This region encompasses an isolated volcanic mass located in the coastal plain of southern Veracruz [19]. As the mountain range is facing directly to the coast, it is one of the rainiest regions in the country [20], which has resulted in complex geological, climatic, and topographic characteristics. Major natural habitats include tropical, subtropical, dry, cloud, oak, and mangrove forests, all of them included in the Tehuantepec Moist Forest Eco-region. Anthropogenic habitats comprise secondary forests, crop and cattle grazing lands, as well as urban settlements [21,22]. Biotic diversity is represented by a high number of species, including an important number of endemics (Table 1) [23,24]. Human pressure in the region is very high, as a significant proportion of the population depends heavily on agriculture and livestock production [25].

Table 1. Eco-regions, surface (ha) and species numbers for the three selected IEM working areas. Number of species is shown as follows: Total (endemics/Mexican Red List).

	Los Tuxtlas	**La Chinantla**	**La Montaña**
Eco-region	Tehuantepec Moist Forest	Tehuantepec Moist Forest	Pacific Dry Tropical Forest Sierra Madre del Sur Pine-Oak Forest
Surface (ha)	165,000	461,000	692,000
Plants	1300 (2/15)	1847 (35/169)	Unknown
Amphibians	42 (35/25)	93 (62/49)	40 (10/16)
Reptiles	113 (82/63)	200 (114/107)	112 (10/52)
Birds	561 (27/24)	530 (31/169)	561 (7/85)
Mammals	63 (6/6)	260 (41/52)	98 (2/25)

3.1.2. La Chinantla

Immersed within one of the largest watersheds in southern Mexico, La Chinantla is situated between two mountain ranges: the Sierra Madre Oriental and the Sierra de Juarez, in Oaxaca (Figure 1). Its topographic complexity has caused a high biological and cultural heterogeneity in the area. In fact, La Chinantla occurs in the region with the highest biodiversity values for the country (Table 1) [26,27], and is included in the Tehuantepec Moist Forest Eco-region. An important altitudinal gradient occurs in the area, which promotes the presence of different habitats in a relatively small area [28]. Major habitat types include tropical, cloud, and coniferous forests [29]. La Chinantla also maintains a large number of indigenous populations, which magnifies the cultural importance of the region. Approximately 70.5% of the total economically active population depends on agriculture and forestry [30].

3.1.3. La Montaña

Located in Guerrero state (see Figure 1), southwestern Mexico, the area comprises two different ecological regions as a result of an important altitudinal gradient, which resulted in a complex topography and an important climatic variability. Thus, the region encompasses different ecosystems included in the Pacific Dry Tropical Forest and Sierra Madre del Sur Pine-Oak Forest eco-regions. Major habitats include dry, cloud, and conifer forests, all with high numbers of species (Table 1). An 84% of the economically active population relies on agricultural activities [31], while 90% of households in the region depend on firewood [32].

3.2. Mesoamerican Biological Corridor Program

Areas covered by the CBMM aim to connect natural ecosystems from Mexico through Central America to Colombia. Focal areas in Mexico include high priority conservation eco-regions, such as dry forests from Yucatán, wetlands and mangrove forests from Quintana Roo, tropical forests from Campeche, and cloud forests from Chiapas [16]. Recently, the CBMM has extended activities to tropical forests in Tabasco and cloud forests in Oaxaca (see Figure 1). Bird monitoring activities in CBMM regions have been initiated since February 2012, including areas in southern Tabasco, and south and southeastern Chiapas, including areas north of the Triunfo and the Tacaná Volcano

Biosphere Reserves. These regions are located in core corridor areas of major conservation concern for northern Mesoamerica, as they exhibit both an enormous biological and cultural importance. Different indigenous communities inhabit the area and many of their lands are adjacent to protected areas [16]. Hence, efforts directed to preserve biodiversity in the region also contemplate the enhancement of local community welfare, through poverty reduction programs and training for sustainability.

4. Training Local People to Conduct Bird Surveys

With the support of both governmental institutions and non-governmental organizations, NABCI—Mexico has conducted several activities to train local people in bird monitoring activities in IEM and CBMM focal areas. Implementing community-based avian monitoring programs in these areas should facilitate the establishment of a bird monitoring national network at key sites for biodiversity conservation. As stated in other studies, surveying birds also may have benefits for local communities, including the opportunity to determine bird species present in their properties, sensitize community members on environmental issues, initiate bird-watching ecotouristic activities as an additional or alternative economical input, and obtain information about the probable impacts that their productive activities have on bird populations [33–36].

Three-day training workshops are performed in regional strategic locations, where people can lodge overnight, have meals, and follow bird-watching trails. Workshop funding is provided by community-based bird monitoring programs. Locations also must contain adequate facilities for indoor and outdoor activities, which are equally distributed along workshops. Indoor activities include theoretical training in which community members are provided with basic information on bird biology, visual and aural identification of local birds, and bird surveying through standardized methods. For bird surveying, local people are equipped with binoculars (8 × 32) and with specialized bird identification guides. In order to enhance visual and aural identification of bird species, monitors are provided with a local bird checklist and bird songs recordings from the region, which also help in reducing bird misidentifications. As there is not a standardized nomenclature for Spanish bird names, monitors are encouraged to learn the bird's scientific name. This warrants a uniform communication between monitors with different cultural origin, given the multicultural nature of Mexico [37]. A language-accessible (*i.e.*, with no technical wording) bird monitoring manual is also provided [36], as a reference guide that includes all the information given during the training workshop. In outdoor activities, theory sessions are reinforced through field practices on bird identification and surveying protocols (see Section 4.1). Three months after receiving the initial training, a second workshop is provided to monitors in order to reinforce bird-surveying skills. As one of the main objectives of bird monitoring programs is to broaden the network of local monitors, trained monitors are encouraged to replicate workshops within their own communities and with their own capabilities. This ensures that more local members may be included in monitoring activities by trained individuals from their own communities.

4.1. Bird Surveys Protocol

Monitors are trained to gather information about all bird species present in their focal regions. With this information, specialists may select potential bird indicator species from each particular surveyed

habitat or region in order to analyze population trends. Two complementary bird survey methods are performed by local monitors: point counts and area search [38,39]. Point counts consist of counting all bird individuals seen and heard from a spot (radius of 25 m) in a fixed count period (5 min) during bird peak activity [38]. As counting secretive species and large flocks might impose a problem for this method, area search is also implemented as a complementary survey method. During area searches, the observer moves within a fixed area (survey plot ~ 2 ha) counting all birds over a 20 min period [38]. To acquire representative data at each surveyed site, monitors are encouraged to establish a minimum number of point counts and survey plots at each focal habitat (*i.e.*, at least 10 point counts and 3 survey plots per habitat). Bird surveys are performed monthly at the same point counts and surveys plots throughout the whole year for detection of seasonal variations in avian community parameters. Focal habitats include a vast array of sustainable productive systems (e.g., coffee and cacao plantations, agro-pastoral and silvo-pastoral systems, ecotouristic lands, forestry and honey production plots), as well as disturbed and conserved habitats. Surveying disturbed sites (e.g., extensive cattle grazing lands, mono-specific crop fields, secondary forests) is promoted as they represent undesired reference states, while conserved habitats (*i.e.*, primary forests) are considered to be desired reference states. Data gathered by monitors through both survey methods includes number of individuals seen or heard, surveyed habitat type, and other personal observations (e.g., breeding, flocking, foraging data).

5. General Program Structure

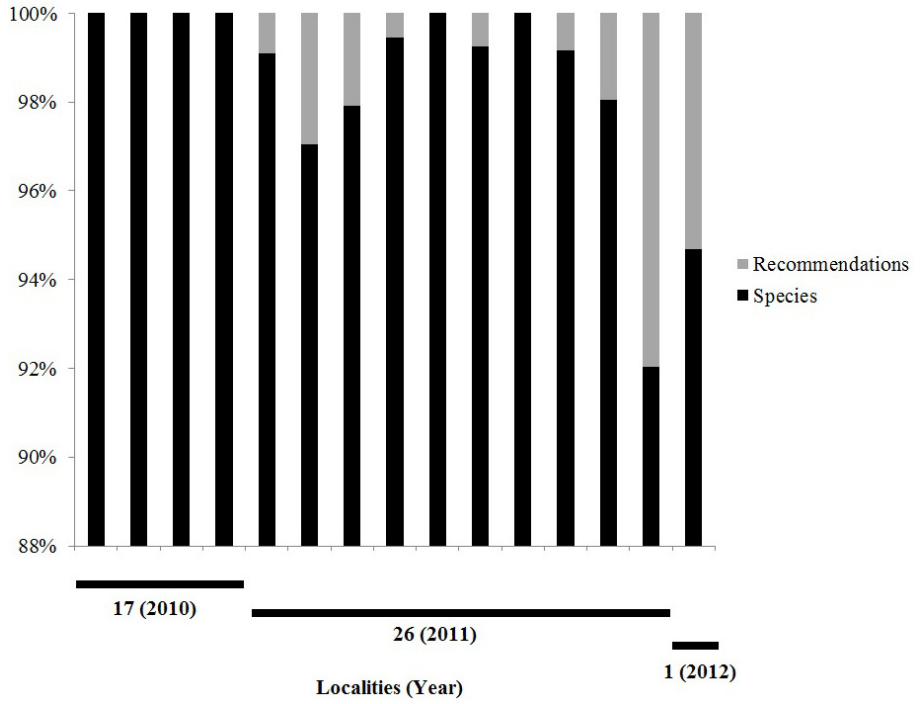
Three main parties are involved in monitoring programs: local monitors, regional coordinators, and avian specialists. Local monitors are active and committed community members in charge of performing avian surveys within their lands. They are usually involved in other sustainable activities promoted by the CBMM and IEM programs. Local monitors are not paid for carrying out bird surveys, as avian monitoring activities are promoted to be part of their own sustainable practices. In this way, avian monitoring is not conditioned to the presence of institutional funding.

Regional coordinators are a crucial component of monitoring programs as they are directly in charge of motivating local monitors, compiling and organizing avian survey data, and communicating advances and emergent problems to avian specialists. Coordinators might be community members, protected area employees, and/or members of non-governmental organizations. Finally, avian specialists are professionals working for CONABIO who are in charge of training local monitors, validating bird survey data, analyzing monitoring results, and broadcasting monitoring advances to funding and scientific organizations.

A crucial point of all monitoring programs is data validation [11]. To achieve this, data provided by local monitors during the first semester after receiving bird survey training are not included in bird population trend analyses, as it is expected that during this period the ability of monitors to correctly discriminate among species is still incipient. Nevertheless, these data are useful for avian specialists to detect possible mistakes in bird identification and thus "calibrate" the identification skills of monitors (Figure 2). When survey data is revised, avian specialists highlight potential bird misidentifications and other rare records (e.g., an unexpected number of individuals for a species, rare species records for particular regions or habitats), and communicate recommendations for local monitors to verify such records with the assistance of regional coordinators. For example, in

Los Tuxtlas region, the maximum number of species recorded in 2010 was 103 (100% in Figure 2) and no recommendations by avian specialists were emitted. However, in 2011, the number of recorded species was 181, while 27 recommendations were emitted. Several factors could have been involved with the increased number of recommendations in 2011, such as: (1) surveying a larger number of localities, where different species might be recorded; (2) an increment of new trained local monitors, who may increase the number of misidentifications; (3) the record of more avian species by monitors, which suggests that their abilities to discriminate among different species were improving; and (4) an increase in the detection of migrant species, as recommendations during this period increased for this group of birds, suggesting that local monitors might be more familiar with local resident species when they started to perform bird surveys. Recommendations are also addressed in a second workshop, which is provided to local monitors to enhance their surveying skills and resolve particular identification problems.

Figure 2. Percentage of total species recorded from a number of localities (vertical bars) by local monitors in Los Tuxtlas since 2010. Recommendations (misidentifications detected during the validation process) are shown in light grey.



After validation, survey data is made accessible to local communities through an online checklist open-access platform called *aVerAves* [40]. This program is the Mexican version of *eBird*, which was developed by the Cornell Lab of Ornithology and the National Audubon Society [41]. *aVerAves* is maintained by avian specialists from CONABIO, and gathers information about bird sightings and bird surveys throughout Mexico [42]. Records in this program nurture a global avian database, useful for compiling bird records and analyzing bird distribution and population trends [43]. For each community engaged in avian monitoring programs, avian specialists create local *aVerAves* accounts to provide bird survey data for communities and to analyze bird community and population trends in focal monitoring sites.

6. Current Results of Avian Monitoring Programs

A total of 30 monitors have been trained in regions covered by the IEM program, while within CBMM regions, 40 different local monitors have received bird-monitoring instruction. However, in Los Tuxtlas region (IEM program), monitors embraced bird monitoring activities so enthusiastically that they have trained 19 additional community members on their own initiative, broadening the regional avian monitoring network, an expected outcome of the whole program. In this way, a total of 89 bird monitors are present in both IEM and CBMM regions.

As may be expected, the progress of community-based bird monitoring programs in southern Mexico has varied among focal regions (Table 2). Bird monitoring has been especially successful in Los Tuxtlas region, where the program started with 10 monitors, who have trained other community members, attaining a total of 29 monitors currently involved in survey activities. Up to January 2012, the number of records and checklists uploaded in *aVerAves* from Los Tuxtlas surpasses those from the rest of IEM regions: a total of 292 species (52%) of the overall total of 561 species present in the eco-region have been recorded; and a total of 205 checklists from 58 localities have been entered in *aVerAves* (Table 2). The other IEM regions (*i.e.*, La Chinantla, La Montaña) have had limited success in the implementation of the program, as suggested by broad differences regarding current results in Los Tuxtlas (see Table 2). As workshops for bird monitoring activities in the CBMM regions are quite recent (*i.e.*, February 2012), it may be too early to conclude the ongoing situation of the program in these sites.

Table 2. Number of monitors and percentage (in parentheses) of recorded species in each eco-region, number of checklists uploaded, and surveying localities in each Integrated Ecosystem Management region.

		La Montaña	La Chinantla	Los Tuxtlas
Monitors	2010			10
	2011	10	10	10
	2012			9
Total monitors		10	10	29
Total species in the region		561	530	561
Species recorded	2010	74	108	175
	2011	-	-	285
	2012	-	-	10
Total Species recorded		74 (13.1%)	143 (26.9%)	292 (52%)
Check-lists	2010	6	10	28
	2011	-	-	175
	2012	-	-	2
Total Check-lists		6	10	205
Localities	2010	4	7	34
	2011	-	-	22
	2012	-	-	2
Total Localities		4	7	58

7. Discussion

Diverse activities have been suggested for sustainable development in high biodiversity areas throughout tropical countries [37,44]. However, there is still a need to determine their degree of effectiveness in promoting biological conservation, economic productivity, and human welfare [45,46]. Under such a scenario, bird monitoring is an adequate tool to determine goal achievement of sustainable practices. Due to a lack of financial resources, professionals are limited to conduct bird monitoring, hence, training and promoting bird monitoring by local people could overcome this barrier.

The varying success of community-based bird monitoring programs among focal regions in southern Mexico may be due to a variety of factors: (1) the commitment and hard work of regional coordinators, who are expected to constantly supervise the needs of bird monitors, as well as the improvement in their birding skills; (2) participation of governmental and non-governmental institutions associated with protected areas in coordinating bird monitoring activities; (3) training preferably young people as bird monitors, as they are very enthusiastic in learning, performing, and teaching monitoring activities; and (4) promoting the participation in training workshops of local members with high decision power within the community (e.g., community or cooperative leaders), as they may ensure the establishment and continuity of the program in the region.

As an important strategy to broaden the impact of bird monitoring programs, we believe that it is essential to encourage trainees to replicate workshops within their own communities. This has been partially successful in the IEM regions, particularly in Los Tuxtlas (see Section 6). Bird monitoring programs are more easily accepted by local communities when workshops are carried out by native monitors, facilitating the recruitment of new and more members from the region. Moreover, this strategy promotes social cohesion, motivates bird monitors, and reduces the time and economic resources needed to train more people within the same region.

At some of our focal regions, training local people to perform bird-monitoring activities has gone beyond assessing the state of local bird populations. In fact, monitors have taken the initiative to employ their new birding skills to perform other types of productive activities by becoming bird guides in archaeological sites, sponsors of bird conservation by giving conferences at local schools, and integrating themselves into ecotourism projects. In this way, training local people to perform bird monitoring activities could be implemented not only for the assessment of productive activities or for gathering scientific information, but also to aid in social cohesion and provide local communities with alternate means to generate additional economic inputs [35,47,48].

In our experience, integrating institutions responsible for the management of protected areas as coordinators of local bird monitors could result in several short-term benefits. For instance, institutions obtain basic knowledge on the state of the avifauna within and around their reserves, enhance communication with local people to reduce conflicts and solve common problems, and broaden their conservation impact by integrating local communities. On the other hand, local communities could be directly benefited by working together with institutions in charge of natural reserves, as this could facilitate communication of their urgent needs associated with natural resources management, the acquisition of professional instruction to perform biological monitoring activities, and obtaining economic support from environmentally related programs.

Based on our results, we suggest the following criteria which might be useful for evaluating the effectiveness of locally-based bird monitoring programs: (1) maintenance of bird monitoring activities since the start of the program; (2) an increment in the number of local monitors trained by local capacities (*i.e.*, initial trainees); and (3) constant flowing of bird monitoring data, reflected as an increase of both recorded species and checklist number. Although such criteria might be adequate as an initial baseline, we suggest considering particular local factors that may be important for different regions.

Finally, bird monitoring in southern Mexico has been designated as a tool for answering problems associated with human productive systems, which could place pressure on natural resources, habitats, and communities [49–52]. Avian monitoring could provide answers to biodiversity problems in the mid- and long-term, given that birds are conspicuous organisms which, according to their ecological requirements, could encompass species with different sensitivities to habitat modification (*i.e.*, indicator species) [5,38,53].

8. Conclusions

Community-based bird monitoring programs are a promising opportunity for enhancing scientific knowledge, human welfare, and conservation in high biodiversity countries. As southern Mexico is a culturally rich region [37], integrating local communities into bird monitoring programs could also enhance the preservation of traditional knowledge about biodiversity and natural resources throughout the region. Natural, protected areas within the country are usually low in both human and economic resources, which impede the achievement of their environmental and social goals (authors' personal observations). Integrating local people into bird monitoring programs could enhance their impact in biodiversity conservation by promoting biological investigation and incorporating communities into conservation issues. Moreover, local people could benefit from bird monitoring programs by utilizing their birding skills in other productive and social activities.

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Conflicts of Interests

The authors declare no conflict of interest for the publication of this manuscript.

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