

Unexpected Alliances:
Biodiversity conservation through Payments for
Ecosystem Services, Protected Areas, and Sustainable
Timber Management in three regions of Mexico

By

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I certify the following:

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Executive Summary

Our research investigated three biodiversity conservation strategies – protected areas (PAs), payments for ecosystem services (PES), and sustainable timber management (STM) – and their interactions with each other within context-specific social conditions in Mexico. Multiple strategies have been implemented to conserve Mexico’s biodiversity-rich communally-owned forests while also meeting economic needs. Federal biosphere reserves incorporate participatory planning and allow limited economic activities within buffer zones. Voluntary protected areas are established by communities that decide to formally conserve land. PES incentivize good forest management through direct payments to forest-owning communities. STM permits require communities to implement biodiversity conservation measures. Though these strategies often interact with each other at the community-level, previous research has often studied them independently. This exploratory comparative case study addresses these complex interactions and provides recommendations for policy design and implementation.

During the summer of 2018 we conducted 56 semi-structured interviews with PES, PA and STM implementers and representatives of participant communities that hold collective land tenure rights. We also conducted five focus groups and attended a number of presentations, meetings and community forestry tours. A total of 123 people participated in some capacity in our qualitative data collection. We conducted our research in three contrasting regions with various combinations of conservation strategies: The Monarch Butterfly Biosphere Reserve (MBBR) in the states of Michoacán and México, the Calakmul Biosphere Reserve (CBR) in the state of Campeche, and four indigenous communities in the state of Oaxaca. In the MBBR, communities have access to up to three different types of PES and varying degrees of access to STM. CBR communities receive mainly one type of PES, some have elected to designate certified Areas Voluntarily Destined for Conservation (AVDCs), and very few have the capacity to carry out STM. Few government-designated PAs exist in Oaxaca, but indigenous communities carry out STM, often designate Community Conservation Areas (CCAs), and can participate in two different PES programs. A geospatial analysis of PES-enrolled communities and land use change complemented our qualitative findings.

We found that the local context at the site of implementation determines the viability of each strategy. Social conditions such as the strength of internal governance and the presence of supporting organizations, and environmental conditions such as ecosystem type and the effects of climate change, may either facilitate or hinder the communities’ enrollment in programs and the capacity to benefit from them. We find that interactions among strategies are generally perceived as positive and complementary. In our three cases, implementation of PES within and around PAs strengthens the latter both by preventing forest loss and by contributing to foster pro-conservation attitudes in local communities. Communities that invest PES funds in sustainable productive projects, including STM, can generate income beyond the lifetime of PES programs and have a financial incentive to conserve their local environment. The potential for receiving PES can incentivize communities to establish AVDCs, which conversion of forests into agricultural or developed land. STM is not allowed within strict conservation zones of PAs but can be implemented in buffer zones, and its ability to both maintain forest cover and generate income may also strengthen PAs. Numerous participants credited the combination of two or more of these strategies with improving attitudes towards forest conservation and management.

1 Introduction

1.1 Payments for Ecosystem Services (PES)

Humans depend on their environment, and their survival and well-being is determined by the quality of natural resources and the ability to benefit from them (Millennium Ecosystem Assessment, 2005). In many areas worldwide, however, rich natural environments have been undervalued, abused, or underused, resulting in less than full benefits for local people. This contributes to poverty, which the World Bank defines as a “pronounced deprivation of wellbeing” due to low income and education, poor health, powerlessness, and high financial and personal vulnerability (The World Bank, 2000). Numerous studies have identified the spatial correlation between high poverty regions and extensively forested areas (Sunderlin et al., 2005; Wunder, 2001), as well as the detrimental environmental effects of unsustainable forest management (Deininger & Minten, 1999; Duraiappah, 1998; Sunderlin et al., 2005).

Growing human populations and consumption rates often create trade-offs between development and conservation, between poor local people and national or global actors, and between the good of present and future generations (McShane et al., 2011; Muñoz-Piña, Guevara, Torres, & Braña, 2008). In an attempt to resolve these seeming conflicts, development and conservation strategies have increasingly aimed to make the conservation of local ecosystems economically feasible for local communities (Barrett, Lee, & McPeak, 2005; Emerton, 2001; McShane et al., 2011; Scherr, 2000; Wunder, 2001). Several researchers have investigated the viability of creating strategies and institutions for socially and environmentally sustainable natural resource management (Corbera, González Soberanis, & Brown, 2009; Moran & Ostrom, 2005; Young & Gunningham, 1996).

One such strategy for joint development and conservation is payments for ecosystem services (PES). The concept of ecosystem services (ES) refers to ecosystem functions that sustain human livelihoods (Heal, 2000), such as providing raw materials, purifying air and water, moderating climatic and flood conditions, creating soil, breaking down wastes, cycling nutrients, capturing carbon, and preserving biodiversity (Balvanera & Cotler, 2009). Local people can benefit from forests’ ES either directly, including through the use of forest products (Millennium Ecosystem Assessment, 2005), or indirectly through market-based mechanisms, such as PES (Sunderlin et al., 2005). In PES, forest owners such as individual land-owners, or, as is more often the case in Mexico, common-property communities, are paid to carry out management activities designed to conserve and enhance ES provided by their land (Muñoz-Piña et al., 2008; Wunder, 2006).

PES programs are policies designed to directly address a typical market failure: the public goods problem for the conservation of biodiversity and other benefits that nature provides human societies (i.e., ES). The PES program responds to the property of markets of under-supplying public goods (Weimer & Vining, 2017) by creating a market for ecosystem services, where the owners of lands that generate these public goods are compensated for the opportunity costs incurred when conserving part of their land and carrying out sustainable management practices. These strategies have delivered mixed results, and doubts remain about their cost-effectiveness and efficacy in meeting social and environmental goals (Alatorre-Troncoso & Knight, 2014; Alix-García, De Janvry, Sadoulet, & Manuel, 2009; Alix-García, Shapiro, & Sims, 2012; Alix-García, Sims, Yanez-Pagans, & Shapiro, 2012; García-Amado, Pérez, Escutia, García, & Mejía, 2011a; Shapiro-Garza, 2013).

1.1.1 PES & Protected areas

Previous studies have looked at PES programs that have been implemented within protected areas (PAs) in several different regions (Alatorre-Troncoso & Knight, 2014; Corbera, Kosoy, & Martínez Tuna, 2007; Figgis, Mackey, Fitzsimons, Irving, & Clarke, 2015; Gross-Camp, Martin, McGuire, Kebede, & Munyarukaza, 2012). However, these studies have not analyzed the interactions between PES and PAs, or how PES within PAs may differ from PES implemented elsewhere. Rather, they have taken advantage of the fact that PES are often implemented within PAs to use PAs as study sites or as a control variable. PES has also been identified as a potential avenue for generating sustainable financing for protected areas, which remains a challenge for many PAs globally (Corbera et al., 2007; FAO, 2014).

A study performed in Costa Rica between 2000 and 2005 analyzed the effectiveness of PES when located within PAs, within PA buffer zones, or away from PAs, and concluded that the latter is more effective (Robalino, Sandoval, Barton, Chacon, & Pfaff, 2015). This is because they found both instruments to be effective in avoiding deterioration, which means it is best to protect one location using a PA and another using PES rather than using both to protect one location. However, it is important to note that PAs in other regions, including Mexico (CONABIO et al., 2007), do not achieve such high levels of avoided deforestation, so this finding may not be applicable in other contexts. In fact, Halffter (2011) considers that more PES should be designated for those living within protected areas, based on the assumption that this integrated conservation policy would increase local peoples' acceptance of protected areas.

In the case of Mexico, the co-occurrence of PES and PAs is not coincidental. In Mexico, proximity to protected areas is one of the graded criteria employed by the National Forestry Commission (CONAFOR) to determine eligibility, with land located within or around PAs receiving higher scores (CONAFOR, 2012). By 2009, more than 30% of Mexico's national PES contracts had been established within protected areas (Halffter, 2011). This may be a positive thing, since PES is an accepted tool for compensating communities, especially those in core areas of PAs, for the restrictions that PAs impose on their livelihood options (Halffter, 2011).

A recent study (Sims & Alix-Garcia, 2017) comparing the impacts of these two strategies between 2000 and 2010 on forest cover and poverty reduction in Mexico found that both policies greatly reduced expected forest cover loss, while only PES resulted in minor poverty alleviation. In fact, strict conservation PAs resulted in a negative rate of poverty alleviation. This suggests that implementing PES within PAs in Mexico can incorporate the poverty alleviation component that PAs alone are not achieving.

1.1.2 PES & Timber management

Studies about the interaction of PES and STM have been few and mostly preliminary. Most of these studies use the term community-based forest management (CBFM), which applies in our context as well, although we have decided to use the term STM in our research to emphasize the internal sustainability components of Mexico's timber harvesting permits. Several of the studies cited here focus on one or the other of the two programs and only mention their possible interaction effects in a hypothetical manner. It is clear that further research is required to empirically demonstrate the range of interactions between these increasingly popular strategies.

Existing literature on a whole supports a positive interaction between PES and CBFM globally. Numerous studies cite the programs' shared activities and outcomes, particularly with regards to carbon sequestration. A study in Mexico concluded that community-based forest management strategies offset atmospheric carbon and protect biodiversity as well as aiding rural development, theoretically making them a good fit for carbon-based PES (Klooster & Masera, 2000). That same study noted that CBFM is often used to fund activities, such as community surveillance and fire control, that overlap with PES requirements (Klooster & Masera, 2000). A study on a PES scheme in Madagascar found further similarities between CBFM and PES (Toillier & Serpantić, n.d.): "Since CBFM regulations aim at protecting forests through forest guards and sanctions, they overlap with ES provisions."

Another study in Madagascar found that community-based forest management did not significantly affect deforestation rates, but concluded that it could nonetheless be a means of implementing PES (Rasolofoson, Ferraro, Jenkins, & Jones, 2015). Further reinforcing the link between the two, a study on the effects of the Kyoto Protocol's effects in Nepal concluded that PES for carbon sequestration may incentivize more communities to practice CBFM (Karky & Banskota., 2006). A review of REDD+ initiatives, a worldwide strategy for PES for carbon sequestration, highlighted the ways in which community forest management produces carbon services, and argues that REDD+ should support community forest management (Angelsen, Brockhaus, & Center for International Forestry Research, 2009).

A smaller number of studies focused on neutral or negative interactions of PES and CBFM. A PES program in Bolivia resulted in the cancelation of three communities' timber concession with an outside company, but researchers ultimately concluded that the communities' net economic gain from PES was positive (Asquith, Vargas Ríos, & Smith, n.d.). A 2006 review of PES' effects on sustainable timber harvesting in the tropics asserted that initial concerns about negative effects of PES may have been exaggerated (Wunder, 2006). That study further stated that there are opportunities for PES to overlap with the certification of productions such as timber, ultimately concluding: "... there can, in fact, be synergies between sustainable forest management and certain types of PES, with options for combining the two in conservation strategies" (Wunder, 2006).

1.2 Mexico background

Mexico is among the world's most biologically diverse countries, both in terms of its ecosystems and species richness (Espinosa Organista, Ocegueda Cruz, Aguilar Zúñiga, Flores Villela, & Llorente-Bousquets, 2008). This is a result of the region's complex geological and cultural histories. Mexico's physiography results from the interaction of five tectonic plates, which has resulted in numerous mountain ranges, plateaus and canyons. Pre-hispanic cultures also influenced biodiversity through the domestication of species such as corn, tomato, vanilla, cotton, and cacao. Wide latitudinal and altitudinal ranges mean that most climate types occur within Mexico.

Mexico has a population of 116 million people, and is classified as an Upper Middle Income country (World Bank, 2018). It is home to an estimated 12% of the world's biodiversity (OECD, 2013). An estimated 30% of Mexico is covered in forests, and the majority of which (approximately 86%) occur in high or very highly socially marginalized regions (Alix-Garcia, Shapiro, et al., 2012; Rico García-Amado, Pérez, Escutia, García, & Mejía, 2011). Approximately 55% of Mexico's forested lands are currently communally owned (Madrid, Núñez, Quiroz, & Rodríguez, 2009). Deforestation driven by

agricultural expansion, both for crops and livestock, is the main environmental challenge (Balvanera & Cotler, 2009; Muñoz-Piña et al., 2008; OECD, 2013). Approximately two-thirds of Mexico's forests are fragmented, which has directly reduced wildlife habitat (OECD, 2013).

Property rights underline the provision of ecosystem services and determine who can (and should) benefit from conservation programs (Corbera et al., 2009). Mexico has two types of land tenure: private property and common-property lands, which are jointly owned and managed by communities (Bonilla-Moheno, Redo, Aide, Clark, & Grau, 2013; Madrid et al., 2009). The latter are further divided into *ejidos* and indigenous communities (Corbera et al., 2009). *Ejidors*, created through the distribution of land to peasant farms, were a core part of Mexico's Agrarian Reform and date back to the early 1900's, while indigenous communities are comprised of indigenous groups with officially recognized ancestral land rights (Corbera et al., 2009). The social structure of these common-property communities creates a unique context for community-based forestry management (Barnes, 2009; Klooster & Masera, 2000).

We will use the term "communities" throughout this document to refer to both *ejidos* and indigenous communities. Both common property systems are legally recognized in Mexico's Agrarian Law (DOF, 2012), which lays out the legal framework for their internal governance structure. Formal community assemblies are at the heart of governance decisions, where titled *ejidatarios* and *comuneros* (holders of legal rights to the community land) express their interests and rights through "voice and vote". Community assemblies make decisions through majority vote and hold ultimate decision-making authority. Communities are required to hold periodic assemblies and must present proof of majority-backing in order to receive approval for many government programs.

The structures of *ejidos* and indigenous communities are such that land rights are inherited in a linear fashion, usually from father to eldest son, meaning that the majority of a community's inhabitants are not official rights holders. Women often only inherit land rights when they are widowed and childless. In some cases, non-titled community members called *avecindados* or *pobladores* may be invited to attend assemblies, but they generally do not have the right to vote or to benefit directly from funding received by the community. *Ejidors* and indigenous communities periodically elect a leadership board known as the *comisariado*. A *comisariado* is composed of a president (who is also referred to as the *comisariado*), a secretary, a treasurer, an oversight committee, and their substitutes. While the secretary and treasurer's roles are fairly self-explanatory, the role of the oversight committee requires more explanation. The oversight committee is in charge both of surveillance of the *ejido* or indigenous community's physical territory and for providing accountability for the *comisariado*'s financial affairs and other dealings. Communities govern themselves according to internal statutes. These statutes, which are generally rooted in customary rules, are legally recognized.

A variety of policy instruments have been implemented in Mexico to promote conservation and sustainable forest and biodiversity use. The main ones have taken the form of poverty subsidies aimed at improving the conditions of *ejidatarios* and indigenous communities living in forests (OECD, 2013). The government has also created a number of large protected areas, which in total account for 10% of Mexico's territory (Bezaury-Creel, Ochoa-Ochoa, & Torres, 2007), and in 2012 it enacted the National Ecological Land Use Plan which developed rules for zoning and land use planning to reduce the effect of development on the environment (OECD, 2013).

In conjunction with the classical conservation and development measures described above, Mexico has also been among the pioneers of implementing economic instruments, including a biodiversity

offsets program for infrastructure projects, paid reforestation programs, fishery buybacks, and a PES program that is one of the world’s largest (OECD, 2013). Voluntary market certification have also been promoted for both eco-tourism and coffee, and approximately 10% of all coffee producers in Mexico have now received green certification (OECD, 2013).

1.2.1 PES models in Mexico

Mexico’s national PES programs are funded by a small percentage of a national water tax (Corbera et al., 2009) and by the Heritage Fund for Biodiversity (Shapiro-Garza, 2013). The National Forestry Commission (CONAFOR)’s Mexican Forestry Fund administers these revenues (CONAFOR, 2011b). The goals of Mexico’s national PES programs are to financially incentivize landowners to avoid deforestation and implement conservation practices (CONAFOR, 2006). The PES program began in 2003, and by 2018 it had been implemented in 6.32 million hectares, with an enrollment of over 9,300 private and common-property lands for a total investment of more than \$12 million Mexican pesos¹ (Table 1).

Table 1. Number of contracts and total area for Mexico’s PES program, 2003-2018. Source: CONAFOR, 2018

Year	Number of contracts	Total area (million ha)
2003	272	0.13
2004	369	0.22
2005	282	0.20
2006	267	0.15
2007	969	0.66
2008	1,111	0.46
2009	691	0.50
2010	688	0.51
2011	558	0.47
2012	739	0.56
2013	635	0.47
2014	584	0.40
2015	550	0.42
2016	1,016	0.72
2017	277	0.24
2018	311	0.23
Total	9,319	6.32

National PES programs focus on two sets of ES, each with their own set of eligibility and implementation requirements (DOF, 2016, p. 201): Payments for Hydrological Services (PES-H) and Payments for Biodiversity Services (PES-B).

CONAFOR has established priority areas for PES enrollment based on a range of social and environmental criteria, including forest type and a deforestation risk index (CONAFOR, 2013, p. 201). In 2011, CONAFOR created a hierarchy of six levels of payments representing general estimations of

¹ 1 USD = 20.29 MXN (December 2018)

the value of six broadly-defined regional ecosystems (Figure 1) (Shapiro-Garza, 2013). Mexico's national PES programs include active land management as a core component of conservation: rather than being a no-strings-attached payment, PES is a results-based contract conditional on the completion of specified management activities. According to the region and PES modality, these practices may include constructing and maintaining firebreaks, building watch towers, removing invasive species, placing water troughs for wildlife (Picture 1) and carrying out monitoring to detect illegal logging (DOF, 2016).



Picture 1. Water capture system and water trough placed to increase availability of water for wildlife during drought, with the goal of preventing animals from approaching human settlements in search for water.

Throughout its history, CONAFOR has modified and adapted the rules of the PES program to better align them to each president's sexennial national forestry plan (María Perevochtchikova & Ochoa Tamayo, 2012). The current government's plan includes the objective of "promoting the generation and consolidation of sustainable *productive projects* [...] to increase the incomes of people living in poverty through the provision of funds for owners of forested lands for the development of conservation, restoration and sustainable use of forest resources" (Gobierno de la República, 2013). The new General Law of Sustainable Forestry Development (enacted on June 5th, 2018) emphasizes productive activities throughout, with text like: "To promote [...] *productive activities* as a means to compensate and conserve ecosystem services derived from forest ecosystems" (DOF, 2018).

CONAFOR's response to this political trend was to publish Strategy 2.1 in their 2018 annual work plan (CONAFOR, 2018): "To strengthen the PES scheme by transitioning to an active conservation model." To achieve this strategy, CONAFOR plans to encourage PES beneficiaries to invest PES funds in sustainable, productive activities that will benefit the entire community in the long term, to counter the common practice of splitting the funds among individual beneficiaries (Rico García-Amado et al., 2011).

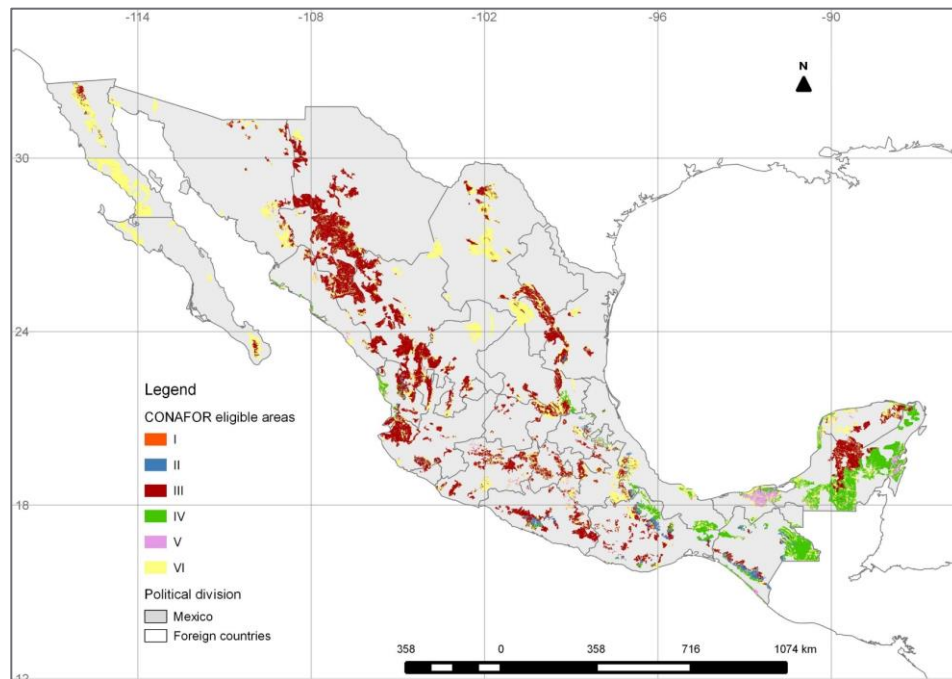


Figure 1. The six categories of lands eligible for Mexico’s national PES programs. Each color category represents a broadly-defined ecosystem type with a certain level of deforestation threat, which are eligible to receive different amounts of PES per hectare per year. Source: edited from (CONAFOR, 2013).

In 2008, CONAFOR created the “Local PES mechanisms through matching funds” program in order to complement the national PES scheme with other sources of funding. In this type of PES, CONAFOR calls on the users of ecosystem services (i.e. local governments, companies or organizations) to directly pay the owners of lands that provide them with services to conserve and restore their lands. CONAFOR then matches the amount that the user agrees to pay, with total contract of 5 to 15 years (CONAFOR, 2011b).

1.2.2 Protected areas in Mexico

Mexico has 528 natural protected areas (PAs) which cover 9.4% of the national territory (Bezaury-Creel et al., 2007). However, most of Mexico’s protected areas were established in an opportunistic manner or for qualities such as their scenic beauty rather than for their ecological biodiversity or connectivity value (CONABIO et al., 2007; Fuller, Munguía, Mayfield, Sánchez-Cordero, & Sarkar, 2006). Because of this, the federal protected area network is insufficient for viably conserving Mexico’s rich biodiversity (CONABIO et al., 2007). Additionally, most protected areas are now surrounded by degraded land (Fuller et al., 2006) and continue to be deforested, making it critical to complement official protected areas with other conservation and development strategies (Balvanera & Cotler, 2009; CONABIO et al., 2007).

The National Protected Area Commission (CONANP), a decentralized agency of the Secretariat of the Environment and Natural Resources (SEMARNAT), designates and manages PAs. There are nine

categories of PAs in Mexico, two of which integrate local participation in their establishment, design and management (DOF, 2014): Biosphere Reserves and Areas Voluntarily Destined for Conservation (AVDCs).

Biosphere Reserves. This type of PA was proposed in 1975 as an alternative to traditional areas where populations were excluded and displaced, recognizing instead the economic and social needs of local people (Bezaury-Creel, Gutiérrez-Carbonell, & Remolina, 2009). They are divided into a core area, a buffer zone, and a transition zone. Core areas are strict conservation areas, whereas buffer and transition zones allow for sustainable productive activities (see Picture 2). There are 39 biosphere reserves in Mexico with a total surface area of 12 million hectares. Most of this surface, including core areas where no economic activities are allowed (including timber management), is owned by indigenous communities, *ejidos*, or private landowners (Halfpeter, 2011).



Picture 2. Posted sign of a community enterprise located within the buffer zone of a Biosphere Reserve. Activities such as apiculture and camping are permitted, while building fires and hunting are forbidden.

Areas Voluntarily Destined for Conservation. This type of PA was formally established by CONANP in 2003 (Bezaury-Creel et al., 2009). AVDCs can be proposed by indigenous communities, social organization, public or private entities and any landowner that wishes to enroll part of their property without losing their property rights (Elizondo & López-Merlín, 2009). They are considered federal-level protected areas once they have been certified by CONANP. In order to be certified, interested parties must present an application which includes a description of the site's physical and biological characteristics, the proposed management strategy, and the amount of time they wish the certificate to last (no less than 15 years). The certification can then be used to apply to national and international incentive programs such as PES or access to green markets (DOF, 2014).

AVDCs have the objectives of improving landscape-level connectivity in priority regions, while acknowledging the needs of landowners (Solís Mecalco & Salvatierra Izaba, 2013). CONANP

establishes three different certification levels: Priority, Intermediate and Basic. This depends on how the proposed areas perform according to a number of indicators which include size, conservation status, proposed management actions, presence of native ecosystems and species, endemism, altitudinal gradient, proposed duration, and the realization of scientific or academic activities, among others (DOF, 2014). By 2015, 689 AVDCs had been certified by CONANP (de la Maza Elvira, Guadarrama Vallin, Rodríguez Ramírez, & Bezaury Creel, 2015).

Community Conservation Areas. Officially-recognized and certified PAs are not the only means through which land is protected in Mexico. Communities have long been interested in preserving their natural resources, and they have been supported by government initiatives and international organizations (Martin et al., 2011). The nationally-recognized power of communities to establish their own natural resource management rules has facilitated the adoption of a variety of community-level conservation strategies (Oviedo, 2002). In particular, community conservation areas (CCAs) are sites that are exclusively recognized by communities and authorized by their assemblies (Picture 3). Reasons for establishing such areas include protecting water bodies and aquifer recharge zones, preserving non-timber forest products, such as resins, gums, fruit, and medicinal plants, or simply maintaining an area as insurance in case of future timber scarcity (Anta Fonseca, 2007).



Picture 3. Posted sign indicating the start of a Community Conservation Area, asking people to avoid littering in order to maintain a clean river.

1.2.3 Timber management in Mexico

Over 50% of Mexico's *ejidos* and indigenous communities are forested, and sustainable timber management (STM) is an important economic activity for communal land tenure communities across Mexico (Merino Pérez, 2018). Community control over timber harvesting has increased dramatically over the past 50 years. The federal government established logging concessions on the majority of

forested land from the 1950's through 1970's, while communities were banned from logging (Merino-Perez 2013). Forestry in concessions typically did not follow best practices and in some cases caused a change in forest species composition, such as the transition from pine-oak forests to oak-dominated forests in Oaxaca (Klooster & Masera, 2000).

In the 1970-80's, community-based forestry was advocated as a way to improve environmental sustainability, return control to communities, and maintain flow of products (Bray & Wexler, 1996; Merino-Perez, 2013). Concessions were outlawed in 1986 (Merino-Perez, 2013). By the late 90's Mexico's community-based forestry sector was one of the world's largest (Bray & Wexler, 1996), and by the early 2000's one report considered it to be "at a scale and level of maturity unmatched anywhere in the world" (Bray et al., 2003). Nonetheless, SEMARNAT (the Ministry of the Environment and Natural Resources) is ultimately responsible for overseeing forest conservation and authorizing community timber management, including establishing harvest volumes, determining pest control responses, and responding to reports of illegal logging (Merino-Perez, 2013).

Approximately 52% of forested communities have timber management authorization and engage to some degree in timber harvesting (Hodgdon, Chapela, & Bray, n.d.). As early as 1996, community-based forestry provided 40% of Mexico's commercial timber production (Bray & Wexler, 1996). Timber management in Mexico is widely recognized as overregulated, which can result in elevated costs for communities (Hodgdon et al., n.d.; Merino Pérez, 2018). All harvesting must follow a forest management plan. Communities work with certified intermediaries, usually forestry technicians, who are consultants responsible for conducting inventories, filing paperwork necessary for the forest management plan, and generally serving as the link between the government and communities (Bray & Wexler, 1996). In most cases, intermediaries come from outside the community, although in some regions, such as Oaxaca, members of communities train as foresters and become intermediaries for their own communities. The relationship between intermediaries and communities is vital for communities.

Forest management for timber production inevitably alters forest ecosystems (Francis E Putz, Blate, Redford, & Robinson, 2001) by modifying species composition, forest structure, and size classes. However, timber harvesting under a well-designed management plan has been recognized as a mechanism for forest conservation (Anta Fonseca, 2007; Bezaury-Creel et al., 2009). Timber can be harvested using a range of methods, from selective logging that removes only specific trees to clear-cutting, which removes all individuals in a stand (Torres-Rojo, Moreno-Sánchez, & Mendoza-Briseño, 2016). Mexico's forestry law currently requires the incorporation of numerous biodiversity conservation measures, including exclusion areas, wildlife corridors, anti-erosion measures, reforestation, and monitoring, into forest management plans (DOF, 2018; Torres-Rojo et al., 2016).

Proper implementation of low-impact forest management can preserve local biodiversity, but only under specific social conditions (Klooster & Masera, 2000). These social conditions include community-based forestry. Well-organized and stable communities have demonstrated that they are capable of following and adapting harvesting rules that encourage sustainability (Klooster & Masera, 2000), and their strong ties to the forest mean they exhibit a low discount rate for future productivity (Johnson & Cabarle, 1993). Under these conditions, timber management can act as an important buffer complementing a protected area strategy (IUCN, 1992). Some studies have even suggested that communal land tenure communities with timber management may have a lower average deforestation rate than national protected areas (Ellis & Porter-Bolland, 2008; Hodgdon et al., n.d.).

In addition to preserving biodiversity, community-based timber management has been recognized as source of income and economic development for communities (Bray et al., 2003). This is particularly true for communities with international recognized certifications and/or value-added products. Degrees of community involvement in timber harvesting, processing, and marketing vary widely, however. A 2013 report found that approximately 62% of communities selling timber contracted out the work without direct participation in timber harvesting or processing, and only 21% communities with timber management authorization had processing infrastructure such as a sawmill or participated in marketing their products (Hodgdon et al., n.d.). As of 2003, 12% of Mexico's timber was FSC-certified (Merino-Perez, 2013).

1.3 Research questions and objectives

This project was carried out with in partnership with the World Wildlife Fund (WWF) office in Mexico City. WWF-Mexico's mission is "to protect Mexico's biodiversity, generating local solutions with a global impact and managing national and international resources to promote a prosperous future for the country" (WWF México, 2019). As key actors within Mexico's environmental policy and advocacy, they are interested in learning more about which strategies are more effective for conserving Mexico's unique biodiversity while also promoting sustainable development. Through this research, we sought to explore the following questions:

- A. How do local social and environmental conditions affect the implementation of biodiversity conservation mechanisms through payments for ecosystem services, protected areas, and sustainable timber management?
- B. How do payments for ecosystem services interact with protected areas and sustainable timber management, and what are the effects of these interactions at a community level?
- C. How can PES, PAs, and STM policies take into account local conditions and interaction effects in order to maximize biodiversity conservation and promote sustainable development?

We answered these research questions through a case study approach targeting regions with diverse environmental and social contexts, and where all three strategies have been implemented to varying degrees. Since communal land ownership is the main form of land tenure and governance in Mexico (Madrid et al., 2009), we focused on this type of landowner and their community-based environmental management. Our main data were key informant interviews we conducted encompassing the implementers, intermediaries and promoters of all three strategies, complemented with a geospatial analysis. Our goal is to provide WWF-Mexico with a thorough analysis and recommendations that will facilitate and target their research and policy efforts.

2 Methods

2.1 Methodology

Our research examines communities with different combinations of PES, protected areas, and sustainable timber harvesting across three socially and environmentally distinct regions of Mexico. We employ an exploratory comparative case study approach using semi-structured interviews, focus

groups, and participant observation of communities. We also used a literature review and a geospatial analysis to corroborate our findings and add depth to our analyses.

2.1.1 Theoretical justification

This research project was designed as an exploratory comparative case study, where the units of analysis (cases) are each of the three regions selected (described below). These cases are bounded in place and time (Creswell, 1998). Using a qualitative case study approach is appropriate when studying phenomena within their context through several data sources (Baxter & Jack, 2008) and without manipulating behavior (Yin, 2003). The objective of this study is to identify how the context at each study site influences the interaction effects between biodiversity conservation components of several programs, hence it is exploratory (Yin, 2003). It is in fact a comparative case study because the context will be different for each of the regions and we will be comparing across them (Baxter & Jack, 2008).

The main source of data we will employ are semi-structured interviews. Interviewing is a widely implemented tool for obtaining qualitative data (Denzin & Lincoln, 1994). Unlike the highly-structured interview format that is common in health-related disciplines, semi-structured interviews place the interviewee more as a participant in a guided conversation rather than a source from which information is extracted (DiCicco-Bloom & Crabtree, 2006). According to DiCicco-Bloom and Crabtree (2006), this type of interview is organized around a series of predetermined open-ended questions, with the possibility that more questions will emerge during the dialog. They are usually on a one-on-one format, but it is also possible to interview larger groups.

Unlike a survey, where designing a random and representative sample is crucial for the validity of the data, interviewee selection is based on finding the people able to provide the desired information (Tremblay, 1957). Individuals known as key informants are selected for interviews based on their accessibility, knowledge and social position (DiCicco-Bloom & Crabtree, 2006). In this case, based on the legally-recognized governance structure of *ejidos* and indigenous communities, we identify the members of communities' governing bodies or *comisariados* as key informants. These individuals are vested with the authority to implement the agreements that community members jointly decide through their democratic assemblies, and are thus expected to be knowledgeable regarding the programs that the community participates in.

The second group of individuals who are uniquely positioned to provide perspective on the effects of conservation strategies are the government agency or organization staff who either implement these strategies or act as intermediaries between communities and agencies. These people highly familiarized with the regional context and maintain working relationships with communities, making them ideal key informants. We will refer to these informants as "intermediaries", acknowledging the role they play in liaising between communities and government agencies. We use this term to encompass words like implementor, advisor or consultant.

Multiple studies have recognized that participating communities' perceptions of biodiversity conservation strategies affect the success of programs such as PES in terms of decreasing deforestation and rural poverty. Within Mexico, studies have examined participating communities' perceptions of PES programs in Coatepec, Veracruz, and compared community perceptions of PES success with information on deforestation rates derived from satellite imagery (Scullion, Thomas, Vogt, Pérez-Maqueo, & Logsdon, 2011). Another study compared the perceptions that community

members had of PES programs in an *ejido* in Chiapas, and found that opinions differed by title-holding status, demonstrating how social status and role even within the same community can affect perceptions of program success (García-Amado, Pérez, Escutia, García, & Mejía, 2011b).

Few studies, however, have investigated the perceptions of the intermediaries that implement or promote biodiversity conservation strategies. These individuals' perceptions are likely to differ from those of participating communities, because perception depends on social status and role (García-Amado et al., 2011). Perevochtchikova and Rojo Negrete (2015) noted this difference in their study of perceptions of PES by government officials within CONAFOR and community members in Mexico's Distrito Federal, finding that CONAFOR officials viewed PES programs an overall success but community members perceived PES as ineffective at increasing household income (Maria Perevochtchikova & Rojo Negrete, 2015). Studying the perceptions of program intermediaries is crucial because a less-than-positive perception of the program by either of the key stakeholder groups may negatively affect program outcomes (Bennett, 2016).

2.1.2 Study site selection

Our main criteria for study site selection was the presence of partner organizations that could lend support on the ground and would directly benefit from our research project. Our first site, the Monarch Butterfly Biosphere Reserve in the states of Michoacán and Estado de México, is one of the key focus areas for WWF-Mexico, and their regional office in the city of Zitácuaro served as our base. Secondly we chose to work in the Calakmul Biosphere Reserve in the state of Campeche, whose local CONANP office had previously collaborated with WWF and generously agreed to host us. Our third site was chosen as a contrast to the first two sites' strong presence of a federal protected area. We partnered with the Integrator of Campesino and Indigenous Communities of Oaxaca (ICICO), an organization with a long history of collaboration with Dr. Shapiro-Garza. The communities that ICICO works with in the Sierra Norte and Costa regions of Oaxaca have a strong history of community conservation areas (Figure 2).

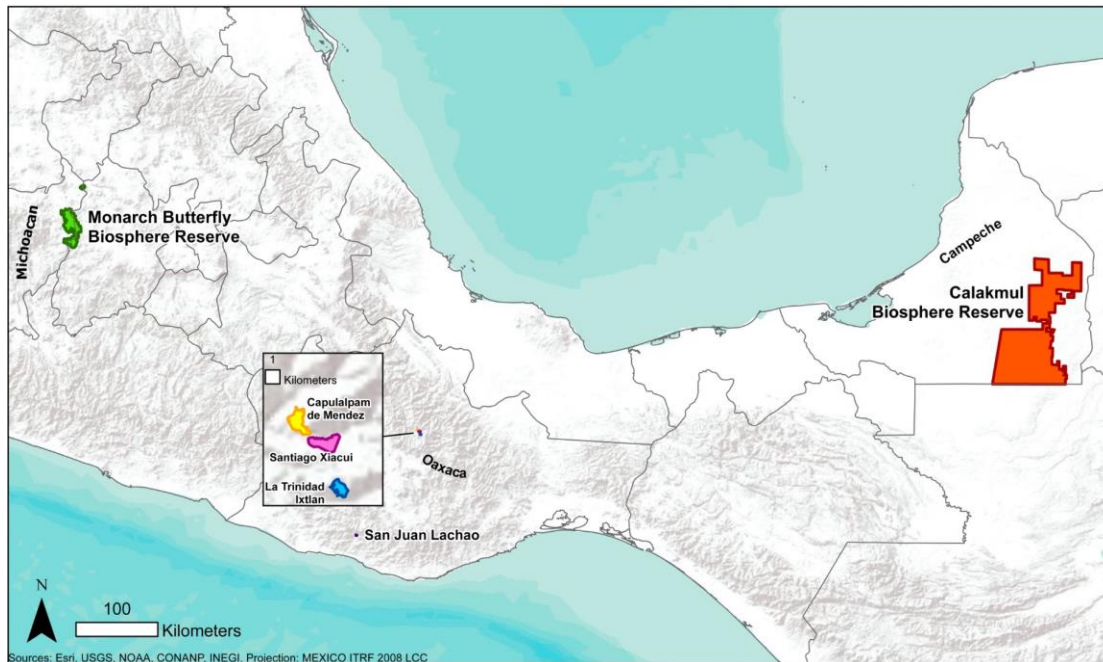


Figure 2. Map showing the three regions included in our research.

These three cases demonstrate a wide range of differences in community size, organization, and ecosystem type, among other factors. We specifically chose to interview representatives of communities with different combinations of PES programs, protected areas, and/or sustainable timber harvesting. PES and sustainable timber harvesting are common among communities across all three regions, so we chose our first two sites based on the presence of Biosphere Reserves and our third based on the presence of community conservation areas. Table 2 summarizes the characteristics of each site.

2.1.3 Qualitative data collection

Interviews. We answered our research questions by conducting two types of semi-structured interviews: one with program intermediaries, and one with community representatives (see interview guides in Appendix I and Appendix II). Intermediary interviews were designed for people such as forestry consultants, who administer both PES and Sustainable Timber Management programs, protected areas staff, and employees of environmental NGOs. In this interview we asked general questions about regional threats, motivation for communities to conserve or degrade their environment, the design of PES and local protected areas, and the effectiveness of PES and protected areas in the region. The second type of interview, designed for community representatives, expanded on the intermediaries' interview to include detailed questions about community-level demographics, history of program participation, and the perceived effects of PES, PAs, and their interactions. While the original interview design did not include questions about the community's Sustainable Timber Management, that information was usually prompted by a question about the community's other economic activities. Participant observation of community forest management and analysis of interview data provided enough content about Sustainable Timber Management to justify including it as a third conservation strategy.

Focus groups. Focus group questions focused on the types of goods and services provided by the community's forest, whether those goods and services had increased or decreased over the past several years, and the types of rules that govern the use of those resources.

Participant observation. Notes were taken throughout the trip on conversations with promoters and observations such as regional land use change, socio-economic factors, and community demographics. These notes were coded and analyzed alongside interview and focus group transcripts.

2.1.4 Qualitative data analysis

We analyzed the data in NVivo, a software program that facilitates qualitative analysis in the form of coding sections of text or other data to themes and querying data by themes. We coded for interview participants' perceptions of different aspects of PES program design (such as community eligibility, required activities, and payments) and social or environmental effects of PES. We did the same for protected areas, which were then further divided into protected area type, and for timber management. We also coded for social and environmental factors that could affect the effectiveness of PES, protected areas, and timber management. We then queried the data for interaction effects between the programs and analyzed query outputs and material coded to each of the different program and factor types to compare key words, themes, and general perceptions.

2.1.5 Geospatial analysis

We used geospatial analysis to corroborate our participant communities' locations relative to the Biosphere Reserves (core area or buffer zone) and participation in the national PES program. This allowed us to triangulate interview data regarding years of enrollment, area enrolled, and funds received from PES. We also performed a forest change analysis for each community in order to obtain a preliminary quantitative measure of the status of forests in each location.

Data for the national PES program from 2003 to 2018, including Matching Funds, were obtained from CONAFOR. The MBBR core area and buffer zone polygons were obtained from WWF-Mexico. CBR core area and buffer zone polygons were obtained from CONANP's Calakmul office. The community polygons, whenever available, were obtained from Mexico's National Agrarian Registry (RAN). In one case, the community polygon was unavailable, so the (roughly equivalent) municipality polygon was used instead. In another case, the use of the municipality would have been inappropriate, so a "locality" polygon was obtained from the National Institute of Statistics, Geography and Informatics (INEGI, 2010). Marginalization data were obtained from CONABIO (CONABIO, 2012). Forest loss and gain data were obtained through the Global Forest Watch (GFW) API (Hansen et al., 2013).

The data were analyzed using Python and maps were created using ArcGISPro (ESRI, 2015) and QGIS (QGIS Development Team, 2014). A program was written to find the polygons corresponding to the communities in this study, match the marginalization and population size data from the marginalization points, connect to the GFW API and find the forest loss and gain (in hectares) from 2010 to 2017 (the last available year). This information was added to a dataset containing all 28 communities in our sample.

There are a number of limitations that must be acknowledged. In particular, the Landsat 7 and 8 satellite imagery used can determine loss of forest for an entire pixel but not necessarily a small but potentially significant decrease in forested area within a pixel (for example, if a tree stand were thinned). More significant is the dataset's limited ability to detect the difference between natural forest and artificial plantations, meaning that areas which have been converted to agroforestry might falsely still be identified as "forest" cover. Furthermore, in this document we refer to "Net forest change" as calculated by subtracting forest loss from forest gain; this is explicitly discouraged by GFW, as the methods used to obtain each metric and the time of year are different for each. However, we are not interested here in obtaining an accurate assessment of forest change to evaluate program effectiveness, but rather to use these measurements in relative terms to infer coarse-level trends or differences among regions.

2.2 Positionality

Our identity as female researchers, one Mexican and one U.S. American, from a foreign university influenced both the data we collected (particularly while conducting interviews) and our analysis and interpretation of the data. During interviews, it was often clear that interview participants considered us as people with advanced knowledge of and/or influence on PES programs due to our status as current Master's students, which likely influenced how they answered certain questions. While Johanna is fluent in Spanish, her fledgling familiarity with Mexican culture and narrative also increased the risk of mis-interpreting transcriptions or of missing implied information. This risk has been somewhat mitigated, however, by extensive discussion about the interviews and interpretation of meaning with Andrea.

Our research was sponsored through an internship with World Wildlife Fund (WWF) International in coordination with WWF Mexico. We described our affiliation as master's students from Duke University in the United States working with WWF during the informed consent statement previous to all interviews. We were visibly affiliated with WWF during our research in Michoacán, as WWF pre-arranged interviews with community representatives and provided transportation and accompanying personnel during visits to communities. Many of our interviews were conducted in WWF Mexico's office in Zitácuaro, and WWF personnel were often present or nearby during interviews with community representatives both within the office and during community visits. All communities were very familiar with WWF, but none were familiar with Duke University.

During our research in Campeche, we were less clearly affiliated with WWF and instead made contact with communities through intermediaries. WWF Mexico coordinated with the CONANP office overseeing the Calakmul Biosphere Reserve to receive authorization for our visit. We conducted two interviews with community representatives at the CONANP office: otherwise, we interviewed community representatives in their communities while visiting independently or while accompanying representatives of environmental NGOs or the community's intermediaries. We also interviewed two community representatives during their trips to town. In a few cases intermediaries pre-arranged interviews for us with community representatives, but on most occasions community representatives were invited to participate in an interview without previous notice. Intermediaries were nearby or present for a few interviews. The majority of the community representatives we interviewed seemed only vaguely familiar with WWF, and were not familiar with Duke University.

While in Oaxaca, we were visibly affiliated with ICICO. We met several of the community representatives during a meeting in ICICO’s office in the city of Oaxaca, but interviewed all of them in their own communities, usually in the community’s authorities’ office. ICICO provided transportation and accompanying personnel during visits to communities, and ICICO personnel were always nearby or present during interviews. Most communities had some familiarity with WWF (some communities had certificates for good forest management from WWF hanging on their office walls). ICICO communities were also familiar with Duke University, since Duke purchased over 1000 tons’ worth of carbon credits from ICICO in 2018.

Our affiliation with the environmental organization WWF may have motivated some interview respondents to emphasize simplified pro-environmental behavior and rhetoric. This may be particularly true in Michoacán, since communities work directly with WWF to receive a variety of funding and training opportunities. In all locations, we would expect that conducting interviews in an organization’s office or within earshot of organizational representatives or intermediaries would heighten interviewees’ likely to emphasize socially acceptable environmental behavior and rhetoric, possibly even leading to self-censoring. Particularly in office settings, some interviewees seemed nervous at the beginning of the interview, although we usually felt that our efforts to build rapport and a sense of interpersonal trust helped reduce interviewees’ nervousness by the midpoint of the interview. In these pre-planned interviews in Michoacán, community representatives usually arrived accompanied by other community representatives, which may have also provided a sense of security. During other interviews, particularly in Campeche, interviewees were in the comfortable setting of their own home, sometimes with family members present, and seemed very relaxed. In Oaxaca, our affiliation with Duke University had a direct stake as a purchaser of communities’ carbon credits, again increasing incentive for interviewees to tell us what they thought we wanted to hear.

2.3 Study sites descriptions

Table 2. General characteristics of each study site.

	Monarch Butterfly Biosphere Reserve	Calakmul Biosphere Reserve	Oaxaca
Protected area type	Biosphere Reserve	Biosphere Reserve; Areas Voluntarily Destined for Conservation	Community Conservation Areas
Total extension	56,520 ha	723,185 ha	N/A
Population	27,000 inhabitants in 93 communities	25,000 inhabitants in 72 communities	12 communities that constitute ICICO
PES programs	PES-Hydrological, Matching Funds, <i>Fondo Monarca</i>	PES-Biodiversity, Matching Funds	PES-Hydrological, Matching Funds, Carbon Credits
Key species	Monarch butterfly	Jaguar	Puma

2.3.1 Monarch Butterfly Biosphere Reserve

The Monarch Butterfly Biosphere Reserve (MBBR) is located on the border between the central states of Michoacán and Estado de México (see Figure 2), on a volcanic mountain range created by the

interaction of tectonic plates (Ferrari, Orozco-Esquivel, Manea, & Manea, 2012). While many of the mountain range's valleys have been converted to urban areas and agriculture, the mountains still host subtropical temperate forests of pine, pine-oak, and even fir forests at higher elevations (Valero, Schipper, Allnutt, & Burdette, n.d.). This region has been the focus of national and international conservation efforts due to the presence of overwintering grounds for migratory Monarch Butterflies (*Danaus plexippus*) (Honey-Rosés, López-García, Rendón-Salinas, Peralta-Higuera, & Galindo-Leal, 2009), whose populations have been declining over the last decade due to numerous threats across their range (Vidal, López-García, & Rendón-Salinas, 2014).

Over the decades, three different protection schemes have been implemented to conserve the monarch's overwintering grounds. In 1980, a reserve and wildlife refuge zone was established, although the protected area was poorly defined and logging was restricted only during winter, when the butterflies were in hibernation. In 1986, five isolated protected areas were established (4,491 ha of core zone and 11,619 ha of buffer zone), which was met by protests from indigenous communities. In 2000, the modern MBBR was established to protect 56,259 ha of temperate forest (Vidal et al., 2014), of which 13,551 were declared as "untouchable" core areas corresponding to the prime habitat for the monarchs (Baylis, Honey-Rosés, & Ramírez, 2012). In 2008, the MBBR became a World Heritage site.

The MBBR's buffer zones have a population of about 27,000 people in 93 *ejidos* and indigenous communities, and the three core zones overlap with the territories of 38 communities. The valleys surrounding the Reserve are also densely populated, with a population of about 1 million. Lack of good employment opportunities drive seasonal migration to Mexico City, neighboring states, and the United States. Many communities in and around the MBBR have a high degree of marginalization, with many people reliant on firewood for cooking and heating and lacking electricity and running water. The MBBR does attract a significant number of tourists, with 72,591 people visited in 2012–2013 (Vidal et al., 2014), which provides some opportunities for employment, particularly during winter months.

The *Fondo Monarca* is an example of a local PES mechanism developed exclusively for communities in the core area of the MBBR (Honey-Rosés et al., 2009). Each of these communities is eligible for a basic annual "conservation" payment, and some communities that previously had approved forest management plans also receive a second payment as compensation for loss of timber harvesting income (Honey-Rosés et al., 2009). The *Fondo Monarca*, which is administered by the Fondo Mexicano para la Conservación de la Naturaleza (and by WWF-Mex, according to Honey-Rosés et al. 2009), was founded in 2000 with a \$5,000,000 USD donation by the David and Lucile Packard Foundation (Honey-Rosés et al., 2009; Reyes & Contreras Franco, 2005). Additional contributions from CONAFOR's Matching Funds and the state governments of México and Michoacán brought the fund's total up to \$7,595,287.75 USD ("El Fondo Monarca," n.d; see Picture 4).



Picture 4. Material used by the *Fondo Monarca* office to explain the sources and allocations of funds to participant communities in the MBBR.

For communities where monitoring demonstrates below a certain threshold of deforestation or forest degradation, payments from interest on the fund are delivered directly to the community's assembly (Honey-Rosés et al., 2009; Reyes & Contreras Franco, 2005). Compliance monitoring is conducted by WWF-Mexico using a combination of aerial photography and field verification visits (Honey-Rosés et al., 2009). Payments have been withheld from communities where forest deforestation or degradation was observed in more than 3% of the community's property in the core area (Honey-Rosés et al., 2009). As of 2004, the majority of communities distributed *Fondo Monarca* payments among their members, while some invested in community surveillance or community projects (Reyes & Contreras Franco, 2005).

Many communities in and around the MBBR have received, essentially, three different sources of PES: Payments for Hydrological Services, *Fondo Monarca* and the corresponding Matching Funds from CONAFOR. Some have also received additional PES funds from the Estado de México government, through the PROBOSQUE program. Most of the communities we interviewed also engage in sustainable timber management (STM) and have a forest management plan and extraction permit.

Numerous studies have assessed the effectiveness of the MBBR and the conservation strategies implemented within it. A recent study by Baylis et al. (2012) employed high resolution geospatial data to compare the effectiveness of three conservation strategies in limiting deforestation and forest degradation in the MBBR: protected areas, PES and forest management (STM). They found little evidence that protected area status alone limited deforestation in the reserve, and concluded that PES helped increase forest conservation but not dense forest cover. Perhaps most promising, there is evidence that STM helped preserve forests, and that those parcels with pre-existing management plans also conserved more forest under PES and logging bans (Baylis et al., 2012).

Vidal et al. (2014) also used aerial photographs and satellite images from 2001 to 2012 to assess changes in forest cover within the MBBR. The authors found that publicly-owned lands uninhabited by communities were heavily affected by illegal logging. A total of 2,179 ha of forest within the core areas was affected by illegal logging. In 2012, for the first time the aerial surveys detected no degradation or deforestation by large-scale illegal logging, while small-scale logging for household use accounted for a quarter of the total affected forest area. They attribute the trend of reduced large-scale illegal logging that began in 2007 to stringent law enforcement by federal authorities, the national PES program, and to economic development opportunities for local communities funded by Mexican and international donors (Vidal et al., 2014).

2.3.2 Calakmul Biosphere Reserve

The Calakmul Biosphere Reserve (CBR) is located on the south-eastern corner of the state of Campeche, in the Yucatan peninsula (see Figure 2). Its eastern boundary is close to the border with the neighboring state of Quintana Roo, while its southern side borders Guatemala. It was established in 1989 on 723,185 hectares of what is known as the “Mayan jungle”, and is now the largest remaining continuous tropical forest in Mexico (Ruiz-Mallén, Schunko, Corbera, Rös, & Reyes-García, 2015). The CBR is home to emblematic endangered species such as jaguar (*Panthera onca*) and tapir (*Tapirus bairdii*) (Ceballos, Chávez, Zarza, & Manterola, 2005). The protected area contains a number of iconic Mayan ruins, including the Calakmul archeological site, one of the most important Mayan cities of its period (INAH, 2015).

A total of 72 *ejidos* have parts of their territory within the CBR’s buffer zone. While some are Mayan communities, the majority are composed of different ethnic groups who came to Campeche from neighboring states as a result of a government colonization program (Boege, 1993). Communities have had to adapt to poor-quality limestone soils, scarce drinking water, seasonal droughts and hurricanes, all of which make agriculture challenging (Chablé, Rosales, & Schmook, 2007; Escamilla, Sanvicente, Sosa, & Galindo-Leal, 2000).

About 25,000 people live within the municipality of Calakmul, which encompasses the CBR, and about 35,000 tourists (foreign and domestic) visit the CBR and its Mayan archaeological sites each year (Cruz, 2014). Calakmul is characterized by high population growth (9.3% annually) and extreme poverty (Escamilla et al., 2000). Since the year 2000, migration to the United States from the municipality of Calakmul has grown exponentially (Chablé et al., 2007; Haenn, 2007).

In 2004, a municipal diagnostic conducted as part of a project funded by the German development agency (GIZ) identified the principle economic activities as subsistence farming, forestry, cattle ranching, bee keeping, cash crop production, tourism, and various subsidy programs. The diagnostic concluded cattle ranching was the most valuable economic activity in the municipality, accounting for 40% of the municipality’s annual GDP. Forestry generated 15%, services 10.7%, cash crops 6%, commerce 5.4%, and honey just 2.5% (Haenn, 2007). By 2013, more than 50 communities in the Calakmul municipality participated in CONAFOR’s PES programs (Ruiz-Mallén, Schunko, et al., 2015; see Picture 5).



Picture 5. Sign indicating participation in PES for Biodiversity conservation. This community has 653.8 hectares enrolled in the program. Forbidden activities include hunting, felling trees and extracting wildlife.

The regional CONANP office has worked to assist the communities around the CBR develop participatory ecological zoning (Negrete & Bocco, 2003). However, recent studies have criticized the CBR for failing to involve local communities in decision-making, leading to a sense of exclusion and resentment from community members (Ruiz-Mallén, Corbera, Calvo-Boyero, Reyes-García, & Brown, 2015; Sosa-Montes, Durán-Ferman, & Hernández-García, 2012).

2.3.3 Oaxaca

Oaxaca is recognized as the most biodiverse state in Mexico. It has high levels of endemism and contains almost half the plant species and vegetation types in the country, as well as 40 percent of Mexico's mammal species (including puma, jaguar, river otter, pygmy skunk and the Mexican anteater) and 63 percent of birds (Oviedo, 2002). Its forests cover 60 percent of the state's 9.5 million hectares (Merino-Pérez, 2004) and it is estimated that nearly 82 percent of forested areas are communally-owned (Velasco Murguía, Duran Medina, Rivera, & Bray, 2015).

The state also boasts an incredible cultural diversity, with 16 different ethnic groups representing about 30 percent of the state's population (Oviedo, 2002), and a rich history of resistance to land appropriations. This is evidenced by the fact that there are relatively few government PAs in Oaxaca, covering a total of 330,000 ha (Martin et al., 2011). Instead, Oaxacan communities have been among the first in the country to establish CCAs within their territories (Anta Fonseca, 2007). As of 2003, Oaxacan communities forming part of UZACHI (Unión de Comunidades Productoras Forestales Zapotecos - Chinantecos de la Sierra Juárez) had established approximately 25,000 ha, slightly over half of their total land, as conserved areas (Bray et al., 2003; see Picture 6).



Picture 6. Sign posted at one of the communities that conform UZACHI, reading “The Earth is not an inheritance from our parents... it is a loan from our children! You must be the change you wish to see in the world. Help us conserve it!” The sign also acknowledges sponsorship from the government of Oaxaca, CONAFOR, SEMARNAT and Oaxaca’s Institute of Ecology.

The history of forest use in Oaxaca has undoubtedly shaped current management practices. Merino-Pérez (2004) provides a detailed explanation of the events that are summarized here. Between 1926 and 1982, forests (including those on communal lands) were concessioned by the government to timber and paper companies, particularly in the North and South mountain ranges. The government charged logging rights to the companies, and distributed 30% of these funds to communities as “rent” for using their lands. In some cases, the federal government then bought out companies: by 1965, the federal government had sole ownership of one such company, FAPATUX, which had a 251,825 ha concession in the Sierra Norte (Bray & Wexler, 1996). Over the decades, anger grew over what many communities perceived as low wages, unjust conditions, and government interference. Communities began organizing themselves into groups to protest against forest concessions. In 1982, when concessions in Oaxaca were about to be extended indefinitely, communities sought an injunction and defeated this order. Many of these communities decided to continue harvesting timber under their own terms by establishing community forest enterprises. Many regions in Oaxaca, most notably the North and South ranges, are currently known for their high levels of internal organization and have achieved certification by the Forest Stewardship Council (FSC). Oaxaca is now regarded as a success story for community-based environmental management worldwide (Martin et al., 2011).

3 Results

We conducted our field research from May through July of 2018. In total, we conducted 23 interviews with program intermediaries and 33 interviews with community representatives. Community representatives came from a total of 28 ejidos and indigenous communities (see Figure 3, Figure 4 and

Figure 5), and in some cases more than one representative was interviewed per community. Community representatives were often but not necessarily current or past elected community authorities. Interview participants who were current or past elected community authorities included *comisariados*, secretaries, treasurers, and heads of community surveillance.

The intermediaries we interviewed were staff or representatives from a total of 15 different organizations or agencies across the three regions. In Michoacán, intermediaries belonged to: WWF, the government of Michoacán's Ministry of the Environment, Climate Change and Territorial Development (SEMACCDET), the government of Estado de México's PROBOSQUE office, the office that administers the *Fondo Monarca*, CONANP's MBBR office, an NGO called ALTERNARE and an independent consultant. In Campeche, intermediaries belonged to: a forestry consultancy called DICOS, another consultancy called Sickingia, an NGO called PRONATURA, the German development agency (GIZ), CONANP's CBR office, a regional association of foresters called ARS and its partner organization called SOSETEC. In Oaxaca, the two organizations we interviewed were ICICO (described above) and UZACHI, a collective of forestry consultants.

Many interviews were conducted with multiple people, meaning there was a total of 85 interview participants across the 56 interviews. The vast majority of our interview participants were men in their 40's through 60's. We conducted one-on-one interviews with only three women (one community representative and two intermediaries), although female participants were present and participated to various levels during an additional three interviews.

As mentioned, we actively identified communities we wanted to conduct interviews with in each region based on their participation in PES programs and location relative to protected areas. Interviews with intermediaries occurred more organically and opportunistically. In Michoacán and Oaxaca our host organizations scheduled interviews with local communities, while in Campeche the head of the biosphere reserve introduced us to local intermediaries, who then recommended other intermediaries and communities for interviews.

Interviews ranged from 35 minutes to 104 minutes long, with both types of interviews averaging about 65 minutes. All interviews were conducted in Spanish and audio recorded on our cell phones for transcription at a later date. No one refused to conduct an interview with us, and all participants gave clear verbal consent to the interviews and to being audio recorded.

We conducted a total of five focus groups: two in Michoacán/México, two in Campeche, and one in Oaxaca. All focus groups were conducted in communities where we also interviewed community representatives and were organized with the assistance of community leaders. Given the overwhelmingly male perspective presented in interviews, we specifically recruited women for focus groups (Picture 7). Focus group size ranged from 4 to 15 participants. All in all, 26 women and 12 men participated in the five focus groups.



Picture 7. Focus group with women from a PES-enrolled community.

We had the opportunity to visit 16 of the 28 communities (5 in Michoacán/México state, 7 in Campeche, and 4 in Oaxaca), and drove through another 4 communities in Michoacán. We also had the privilege of attending two community assemblies, one in Michoacán and one in Campeche. In total, we had some form of tour of 7 communities' forests (2 in Michoacán, 1 in Campeche, and 4 in Oaxaca), with extensive multi-hour tours of forest management in the Oaxacan communities. Additionally, we had the opportunity to observe intermediaries' interactions with community members during a mushroom cultivation workshop in Michoacán, a meeting to renew PES contracts in Campeche, and during multiple community visits alongside promoters across all three regions.

All interview recordings were transcribed using a professional transcription service and subsequently coded by both of us. We spent a total of 136 hours coding transcripts from November 2018 to January 2019. We identified a total of 110 themes at several different levels through which we classified the data. Appendix III contains the complete hierarchy of themes we identified, as well as the number of interviews that contained that theme and the number of references we coded to each theme. We also extracted the most relevant basic data regarding interview characteristics and participation in each strategy. This classification table is available in Appendix IV. The coded data was queried to explore and compare the contents of the themes, the interactions between different themes, and the contrasts between regions.

We divided the results into three broad categories in order to answer our research questions. First, we will talk about the factors, both social and environmental, that influence the implementation of biodiversity conservation strategies. Next, we will explore the changes that resulted from the implementation of these strategies, independently or jointly, in order to assess the effects of the strategies and their interactions at the community levels. Finally, we will discuss the interactions we identified between PES and protected areas and PES and sustainable timber management. This

allowed us to analyze the strengths and weaknesses of these interactions and provide recommendations for strategy design and implementation, which are located in the Discussion section.

Finally, our GIS analysis allowed us to calculate a number of indicators for the communities we interviewed, including the percentage of their land enrolled in PES, the amount of PES funds per capita that each community has received, and the number of different programs that they have participated in. We also calculated forest loss, forest gain and mean forest change in two ways: as total hectares and as a percentage of the total territory size. These data can be found in Appendix V.

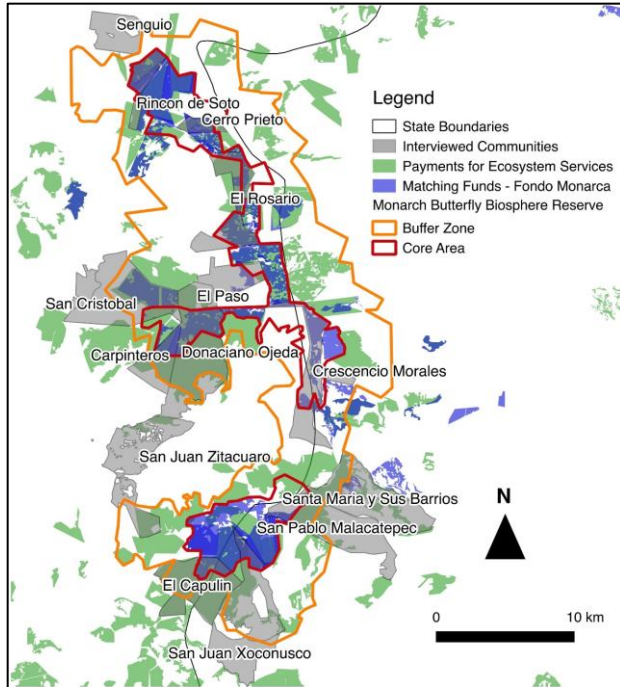


Figure 3. Communities interviewed in and around the Monarch Butterfly Biosphere Reserve. Data sources: WWF, RAN, CONAFOR. Projection: WGS84.

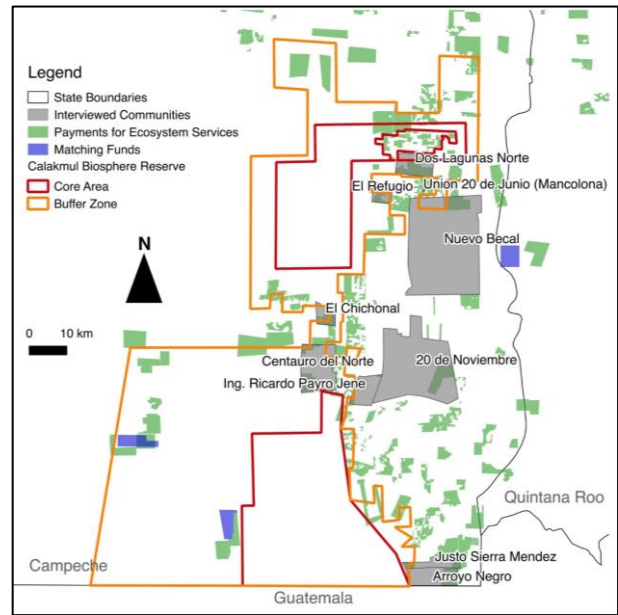


Figure 4. Communities interviewed in and around the Calakmul Biosphere Reserve. Data sources: WWF, RAN, CONAFOR. Projection: WGS84.

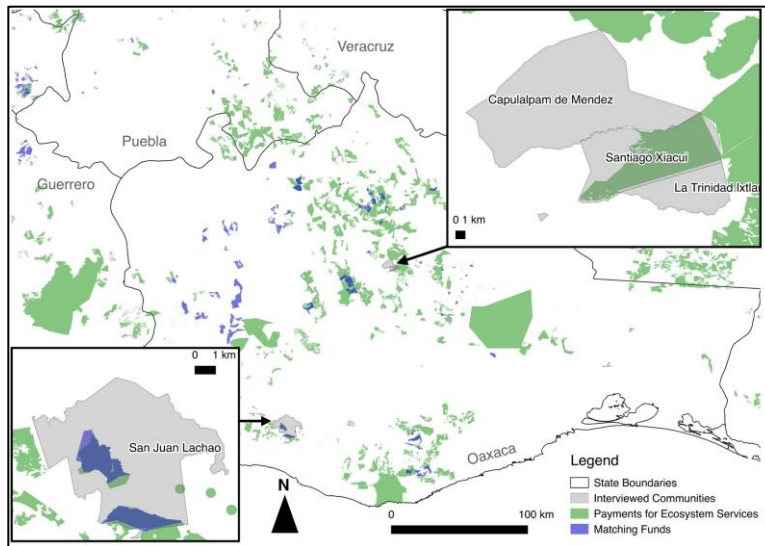


Figure 5. Communities interviewed in Oaxaca. Data sources: WWF, RAN, CONAFOR. Projection: WGS84.

Throughout the following sections we will be presenting and analyzing the statements made by our interviewees. For ethical reasons we will not be disclosing personal names or community membership, but will instead identify communities by their region (Michoacán, Estado de México, Campeche or Oaxaca) and the combination of our focal conservation programs they participate in or belong to in the following way:

of PES types + Type(s) of PA + Timber

1P	One type of PES
2P	Two types of PES
3P	Three types of PES
Ca	Gov. protected area – Core area
Bz	Gov. protected area – Buffer zone
Vpa	Voluntary protected area (AVDC)
CCA	Community conservation area
T	Timber management permit

For example, a community that receives two different types of PES payments, has territory within the core area of a biosphere reserve and does timber harvesting would be referred to as *2PCaT*. A community that receives one type of PES, has land within the buffer zone, has an AVDC and does timber harvesting would be *1PBzVpaT*. A community that receives one type of PES, has a community conservation area and does not engage in timber harvesting would be *1PCCA*. This allows us to represent all the possible combinations of land management approaches and allows the reader to interpret the results with full knowledge of the type of community being discussed.

We will include real quotes from our interviews, focus groups and presentations, which have been translated by us and anonymized when applicable. Whenever we include a quote we will indent it or indicate it by quotation marks.

3.1 Social factors relevant for biodiversity conservation strategies

3.1.1 Government

Mexico's federal government is invested in keeping its international environmental commitments. A development organization representative, an intermediary, and a *3PCCAT* community representative in Oaxaca all saw current ground-level initiatives as the federal government's strategy for meeting its promises at international conferences such as COPs. The development representative saw the COP as motivation for increased coordination between CONAFOR and the federal agricultural agency SAGARPA (Secretaría de Agricultura y Desarrollo Rural, or the Ministry of Agriculture and Rural Development) in Campeche. The intermediary saw Mexico's promise at a recent COP to increase number of protected hectares as the reason behind CONANP's promotion of AVDCs. Meanwhile, the Oaxacan *3PCCAT* community representative was working with an initiative of the UN to develop "biocultural protocols."

From what I understand, these voluntary conservation areas have existed for a long time. What I have understood and interpreted is that on the basis of all these accords and international commitments from the COPs and who knows what else, Mexico has committed itself to increasing its protected areas. It's no longer going to do it through [...] decrees, etc., so then it revises these voluntary conservation areas and assigns them to the natural protected areas that promote them. Do I have that right?

In contrast to the effect of COPs in motivating these various strategies, the same intermediary saw REDD as failing to live up to its promises.

Federal government agencies such as SEMARNAT and CONAFOR make the world go 'round, or not, for communities. They hold the authority to authorize all aspects of timber harvests, grant or withhold PES funds, certify AVDCs, and permit treatment of forest pests. In Estado de México, the state-level agency PROBOSQUE, rather than SEMARNAT, authorizes timber management. Communities that fail to obtain authorization or are not able to contain outbreaks of pests or forest fires may face fines or have funding withheld by these agencies and/or Mexico's environmental protection enforcement agency, PROFEPA (Procuraduría Federal de Protección al Ambiente). Communities' interactions with these agencies are almost always through their intermediary.

As described in more detail below (see 3.2.1 Climate Change), multiple communities in Michoacán and Oaxaca mentioned being frustrated by the delayed responses of these agencies to reports of pest outbreaks. This is likely due to other reports that CONAFOR is understaffed. Intermediaries in Campeche and Oaxaca also commented on the extreme bureaucracy of these agencies. Environmental police, known as the *gendarmería*, were present in and around both the Monarch Butterfly Biosphere Reserve and the Calakmul Biosphere Reserve. Communities' responses to the environmental police varied. Representatives of two communities (*2PCa*, *3PCaT*) in the Monarch Butterfly Reserve had a positive working relationship with the environmental police that they felt helped reduce illegal logging. The *2PCa* community representative initially had to organize a meeting the commandant to clarify the distinction between acceptable and unacceptable firewood cutting (dead trees within the community versus trees that are alive or from outside the community), but overall stated:

Right now I don't have anything to complain about with regards to the Reserve. The truth is that they have helped us as much as they could; I tell you that I've been here

[in this role] almost two years and they've helped us. Afterwards people got into the ejido to cut trees around there and all that, and we talked with the Reserve and they sent us the environmental police to take care of the forest.

Further clarification may be needed, however. Women in the *3PCaT* community mentioned during a focus group that “soldiers” check documents when they go to gather wood. A representative from a *3PCaT* community stated that the environmental police entered his community’s territory without giving him notice. The environmental police are recent arrivals in Calakmul as well, and a development representative said that many *ejidatarios* are uncertain about their firewood gathering rights and are intimidated by the presence of the environmental police.

While communities described a distant and often strained relationship with SEMARNAT, CONAFOR, and PROFEPA, communities in and around the MBBR and CBR had a more personal and positive relationship with CONANP. Representatives of two *3PCaT* communities mentioned the director of the MBBR by his first name, and several communities (*1PBzVpaT*, *1PBz*) and intermediaries in Campeche mentioned the director of Calakmul personally visiting or working with communities.

Other federal government agencies, such as SAGARPA, also played a role in communities’ lives through providing agricultural subsidies (PROCAMPO and PROGRANO), and support for more vulnerable community members (PROSPERA and support for the elderly) in all three regions. While most communities seemed to have a neutral or generally positive view on the school opportunities available to their communities, we heard repeatedly from communities about the lack of proper medical staff and medicines.

3.1.2 Intermediaries, NGOs, and other actors

Intermediaries, NGOs, and other actors played a variety of roles in supporting biodiversity conservation and sustainable development across all regions. Community representatives, NGO staff, and government agency staff persons’ perceptions of their effect seemed strongly positive overall.

Communities we talked with seemed to have a long-term and positive relationship with their intermediaries. Oaxacan communities and Campeche communities both have associations of program intermediaries formed by local people, sons of *ejidatarios*. Intermediaries play a critical role in community well-being by promoting programs to communities, filling out paperwork, explaining program requirements, and coordinating monitoring. As an interviewee in Oaxaca commented:

... it doesn't make a lot of sense for the community and the intermediary to put in a lot of enthusiasm if the people of CONAFOR are going to let it go to waste, or the inverse, for the community and CONAFOR to put in a lot of enthusiasm if the intermediary lets it go to waste. Therefore there has to be an understanding among the three operators of the program for it to have success...

The intermediaries’ role is particularly vital for communities with limited cellular service, internet capabilities, and technological knowledge. One *3PCaT* community representative from Estado de México described some of the challenges of soliciting help from government agencies:

Today we were at PROBOSQUE [...] and when the boss was leaving I told him, “You know what? You’re talking about this and that, and we have those things in hand—support us.” “Send me an email.” We don’t know how to do that, but we’re lacking many things. Among those things, perhaps, for not sending an email—why knows? Perhaps for that reason we can’t [enter the program/receive support] and that’s how it passes us by. But yes, we’re searching—we’re in the struggle of searching for more support for our people.

NGOs also played a strong complementary role in regions with large protected areas. Both biosphere reserves had strong mutualistic relationships with local organizations such as NGOs and intermediaries’ associations that helped increase benefits to communities.

Other actors, such as neighboring communities, corporations and private landowners, and the general public were perceived by interviewees as having mixed positive and negative effects on communities.

Intermediaries and NGOs. As across all regions, communities in Campeche generally expressed a very positive view of their PES and forest management intermediaries. A representative of one *1PB* community emphasized the valuable role of intermediaries in keeping abreast of PES program details released on the internet, carrying the news to the ejidos, and serving as advisors during program enrollment and participation. A remote *1PB* community was especially grateful for the commitment and services of their PES and forestry intermediary:

We have always worked with our intermediary [...], who is the one who always... who doesn’t let us go wrong, who’s always paying attention to us and who helps us with advice, with paperwork, and everything because we as peasant farmers sometimes do not have the capacity to do a project or to send reports, etc. There are various details that have to do with verification as well, and our intermediary has been helping us significantly.

Another *1P* community representative described how their PES intermediary emphasized the community’s ownership over PES funds:

... As he said, “the money is the community’s, the only thing is that you have to know how to take into it, how to re-invest it so that afterwards at the end you have [something]..., at the end of the day the profits are yours”...

Communities’ perceptions of their intermediaries seemed generally positive regardless of whether intermediaries worked with their own small consultancy or were part of a larger intermediaries association such as ARS (Asociación Regional De Silvicultores). In contrast to this general positivity, one community representative did mention two intermediaries who he felt did not actually work on behalf of communities, however, as well describing a former intermediary from another city who was sanctioned for disappearing with communities’ funds.

NGOs, civil societies, and other types of organizations, including TNC, US Fish & Wildlife, WWF, the Carlos Slim Foundation, the Kellogg Foundation, PRONATURA, Consejo Civil (possibly the Consejo Civil Mexico para la Silvicultura Sostenible), Fondo para la Paz, and GiZ, are important actors in Campeche. Many of these organizations, such as TNC, PRONATURA, and GiZ, have biodiversity-focus programs, such as training local community members as wildlife or birding guides

or providing funding for camera-trapping and biodiversity monitoring programs. One organization, Amigos de Sian Ka'an, directly funded matching funds PES in some communities. One NGO staff person, however, criticized the frequent lack of coordination between different organizations and its effects on communities:

... All of them are doing things in the community, for better or for worse, but all are making an effort, a valid one, yes, but it's disjointed, unorganized, with a lack of communication, and a lack of everything, and then we become promoters of this lack of organization within a community...

Several of these organizations, along with intermediaries' associations, partner directly with the CONANP staff at the CBR in formal or informal ways. These types of partnerships extend the Reserve's capacity to benefit communities. A CONANP staff person stated that CBR works directly with communities in capacity-building and promoting conservation, but that it also works with organizations such as ARS. That same staff person described as the "nexus" between the Reserve and the *ejidos*, and stated that the CBR had provided some training to ARS:

They are people who we've trained, I can say that with much pride—we've trained them. They have people, for example, engineers who can measure the volumes of water per hectare, they have forestry engineers, they have tourism technicians, or rather, they have a GIS program that you will see if you go there...

Many of the ARS staff people grew up in the *ejidos* they work with, which they emphasized gave them a special dedication to and relationship with local communities:

What surprises many people is that we are from this same region, we are here and, yes, we are the sons of *ejidatarios*, we actually work with the *ejidos* in which we live, and there really is a good relationship with the *comisariados* [...] we are from there and we continue to work with them.

ARS helps pay the favor forward by training young people in most of the *ejidos* they work with as "community promoters" to help verify program compliance. In addition to timber and PES, these programs include a wide variety of products such as honey, charcoal, and chicle, as ARS is also very focused on working with CONAFOR and CONANP to help communities develop productive activities that create certifiable products for national and international markets.

A GiZ staff person told us that GiZ is working with CONANP to develop a Calakmul-specific certification for social and environmental sustainability. While still in the early stages, this certification is currently being piloted with a few local enterprises, including apiculture, charcoal production, two restaurants, a hotel, a cosmetics business, and a group of wood artisans. In some cases, NGOs even had the staff and resources to offer programs or other forms of support that CONANP could not offer due to its limited budget. A prime example of this is the establishment of fire brigades in the area. According to a CONANP staff person, PRONATURA funded the first fire brigades in the Calakmul area with help from the Fondo Mexicano, while the CBR coordinated the brigades. Within a few years, the brigades were coordinated through partnerships between NGOs PRONATURA and TNC and government agencies such as CONANP, CONAFOR, and Campeche's state government. Even more recently, TNC and GIZ helped make up for CONANP's lack of funds to fight fire in the

Calakmul, Balankín, and Balankú conservation complex by helping with training and donating equipment.

Universities and researchers are also active in the region. A CONANP personnel observed that the area is saturated with researchers: “On your way you will find very capable people from around here that have received thousands of workshops and assisted thousands of researchers.” This creates some immediate benefits, such as free soil sample testing provided by a local university, and a CONANP personnel stated that research by a number of international universities helps inform management decisions in the park. Several other CONANP and NGO staff persons, however, stated that with few exceptions, results of research conducted in the region is not returned to CONANP or participating communities in any way that benefits them.

Some communities also received help from much further afield, such as one *IPBx* community that has received significant funding from World Bank certify their organization of bee-keepers in organic honey production.

Finally, an intermediary and an NGO staff person noted the extra and sometimes unnecessary burdens that program requirements place on communities. The intermediary pointed out that some rules and activities, such as banning subsistence hunting, are unnecessary in a forested area such as Campeche and are only implemented to placate funders concerned about “biodiversity conservation.” The NGO staff person also highlighted the problems with some programs’ rigid budgeting:

Interviewee: “... It’s a question of the ejidos’ organization: ‘Listen, I have to buy a \$5,000 peso camera, but they don’t sell them here and I will have to go to buy it in Chetumal. Going to Chetumal and back will cost me \$2,000, so I will buy a \$3,000 peso camera here and ask them to bill me for \$5,000, because otherwise how will I recuperate the ejido’s costs and my costs?’”

Interviewer: “It generates more problems.”

Interviewee: “It generates more problems, stress and everything [...] and they’re trying to do it will, or in other words, I see that there is good will to comply [with program requirements]...”

The same interviewee also emphasized that some donations or purchases, such as fire brigade equipment, are wasted due to lack of proper storage and maintenance, or are purchased regardless of whether they are actually needed in that community.

Similarly to the CBR, the MBBR also has a close-knit and complementary relationship with NGOs, particularly WWF. WWF’s contribution to the Reserve has been both substantial and long-lasting, as WWF was involved in the early stages of the MBBR’s development and played a role in the Reserve’s redesign in 2000. Currently WWF’s principle functions in Michoacán and the Estado de México are supporting productive activities, including timber milling and mushroom cultivation, and providing monitoring and field verification of forest change for communities in and around the MBBR. WWF also has an important role in partnering with the *Fondo Monarca* and pushing for increased coordination between funding agencies working in the area of the Reserve.

A WWF staff person observed that WWF’s programs have changed community member’s attitudes and made them feel more ownership of their resources. WWF significantly invested in establishing

or developing sawmills in at least four of our participating communities (three *3PCaT* communities and a *2PCaT* community) by providing training, funding land and equipment, and assisting in getting municipal, state, and national licenses. WWF has also helped promote reforestation and has helped at least three of our communities (*2PCaT*, *3PCaT*, and *3PCa*) establish plant nurseries. The representative of a *3PCaT* community also stated that WWF and the MBBR, but mostly WWF, have helped provide funding for reforestation in a community by paying for nursery costs, planting labor, and transport. A WWF staff person said that while the government is willing to provide funding after the first year, WWF and the MBBR can provide start-up funding and continue funding for longer, which enables the survival of projects. Three of our communities (two *3PCaT* communities and *3PBz*) also mentioned receiving funding from WWF, sometimes in partnership with the MBBR, for community surveillance. Despite this, one community representative stated that he believed local government agencies and NGOs, including WWF, were benefiting off funds designated for Monarch Butterfly conservation instead of channeling the money to communities.

WWF monitors forest change in the MBBR via yearly analysis of aerial images and field verifications of suspected deforestation or degradation. According to one WWF staff person, WWF always conducts field verifications with representatives of PROFEPA, CONAFOR, the Reserve, and community leaders. Another WWF staff member observed that the government is often unable to follow up with communities, so WWF's monitoring of community use of PES funds increases government's trust and likelihood of partnering with WWF in providing communities with funding.

In addition to their development programs and monitoring efforts, WWF also plays a variety of other roles, such as interfacing with municipal and state governments and supporting communities' self-governance. A former government official said they held 5 community forums with WWF the previous year. That same official considered WWF a great ally in creating a "biocultural corridor," along with GiZ, Reforestamos México, Grupo BIMBO, and Ecosistémica. Two communities (*3PBz* and *3PCa*) also mentioned WWF's support when petitioning for PES programs or government help in decreasing illegal logging. WWF also invited a lawyer to help a community with the legal aspects of revising and strengthening their community's internal statutes. All in all, a WWF staff person emphasized that working together with communities was crucial to stopping illegal logging in the MBBR's core zone:

How did we manage to eradicate clandestine logging in the core area? My first response, the most important one is that we did not do it alone, a series of institutions got together with *ejidos* and communities; and they, *ejidos* and communities, the owners of the forest, with their ownership, with their presence, they were the ones who eradicated it.

WWF also has a close relationship with the *Fondo Monarca*. WWF has helped promote the *Fondo Monarca* to communities, and also has a seat on the *Fondo Monarca*'s technical committee along with representatives of several communities and government agencies. One WWF staff person described how WWF and the MBBR have pushed for better coordination of funding offered to communities through the *Fondo Monarca*, the different levels of government, other types of PES, and CONAFOR in order increase the funding's effectiveness. Previously, the WWF staff person stated, organizations and agencies often funded unhelpful projects that did not yield long-term benefits for communities:

Many times, for example, they gave them livestock, they gave them poultry, and what did they do with them? They sold them, or many times they ate them and they were

not productive projects because they benefited only private individuals, so we did not see any development, we only saw a lack of follow-through.

That same WWF staff person, however, emphasized that funding, including PES, increased a sense of ownership and helped communities protect their forests:

We have seen it, if it weren't for those [natural] phenomena that have affected [...] the forests, the forest would be there, not the same but more conserved, so we have many experiences already that show that a well-managed forest has many benefits in the economic, environmental, so that's the importance of supporting the ejidos, of them feeling empowered, because they are the owners of the resources, but if they didn't have that type of program they would have to make use of what they have. [...] That's when the misuse and abuse of forests can come about, to be able to subsist.

Descriptions of the *Fondo Monarca* seemed largely positive. Several community representatives (two *3PCaT* communities, others) mentioned *Fondo Monarca* personnel by name while describing how they deliver the community's PES check directly to the community assembly, which helps prevent any conflicts over the payments. Another community (*3PB*) was initially reluctant to accept PES out of fear that their forest would be taken away, but was eventually convinced by *Fondo Monarca* personnel and their *comisariado*.

Other organizations are working in the region as well, such as Alternare, a civil association focused on conservation and sustainable development, which provided camera traps to one of our participating communities (*3PCaT*). The strong presence of these various and cooperating organizations and institutions is recognized by communities: one *3PCaT* *ejido* representative in Michoacán in particular recognized identified the support of WWF, the *Fondo Monarca*, CONAFOR, COFOR, SEMARNAT, and the MBBR in helping them conserve their forest through capacity-building and other types of support. It is worth noting, however, that a former intermediary stated that the strong presence of international funding and strong inter-institutional cooperation makes the MBBR an exception rather than the norm of Biosphere Reserves:

The MBBR has tri-national resources, there are international expectations, many institutions are present, there are many resources, many people, you are coming from Duke University, it is an interesting place, but there are areas where this does not work, [...] where there is little institutional presence, few resources, no management plans, no civil societies to support these processes.

The same former intermediary also strongly critiqued the potential for intermediaries to make decisions on behalf of communities instead of respecting communities' decisions, and also expressed concerns that the role of intermediary can promote a cliental relationship between communities and funding agencies rather than developing a sustainable conservation strategy.

It was often difficult to draw a line between intermediaries and community representatives in the four Oaxacan communities we visited. Each community had community members who served as their forestry and/or PES technicians, and each community also had representatives in UZACHI, ICICO, or both intermediary organizations. Whether or not it is possible to draw a distinction between community representatives and intermediaries, however, it was obvious that intermediaries played a crucial role in community well-being.

A UZACHI intermediary told us that UZACHI was formed in 1989, following communities' victory in gaining rights to their own forests, and has worked with communities to get timber management authorization and FSC certification since the early/mid-90's. UZACHI is composed of 16 delegates from its four constituent communities, and employs a number of biologists and forestry technicians who come from the communities. In addition to the normal paperwork requirements of an intermediary, these UZACHI personnel conduct extensive monitoring to ensure that the forest is being used in a rational manner. UZACHI helped at least one community conduct and implement their territorial zoning. One intermediary we spoke with in one community began working in the forest as a day laborer, but was trained by UZACHI after demonstrating a lot of interest.

According to ICICO personnel, ICICO was formed so that communities would have "voz y voto" (a voice and a vote), which they did not have in ICICO's forerunner, a previous environmental services organization known as SAO:

The communities made de decision to integrate this organization, ICICO, so that the member communities, the partner communities, had more control over the decision-making process, right? Again we come back to the issue of them not feeling part of the effort that SAO was making.

An ICICO staff person said that the organization has always emphasized having communities propose the areas for different uses and the activities so that the relationship between ICICO and communities is a dialogue, not an imposition. In the same spirit, ICICO focuses on organizing learning-exchange visits with other communities and on capacity-building with community intermediaries. The strategy appears to have had good results. Over the course of 10 years of training and education, ICICO brought a *3PCCAT* community from poorly managing their forests to winning CONAFOR's silviculture prize through participation in PES-H, STH, and other programs. That community's representative told us that they replicated the forest management they saw during a learning exchange visit to another community. A different *3PCCAT* community intermediary corroborated the value of ICICO's support for community intermediaries in understanding the technical requirements of carbon credits:

As long as there is support and as long as we have the economic aspect and, mainly, the teamwork, right? If we were to say "well, we already know how to do everything," then we may be mistaken because they, as the technical aspect, they know the whole process of the methodologies, they know the process regarding the ecosystem services and they have built our capacity, they have done workshops for our own people to get involved in this situation.

An intermediary from another *3PCCAT* community also stated that the carbon credit requirements are not too complicated because the ICICO personnel are from the communities and know what community needs are. This positive relationship between ICICO and community intermediaries is the result of significant investment in capacity-building and education. ICICO personnel noted that ICICO's relationship with communities has improved over the years as the communities have come to understand PES for carbon and other environmental services better:

I can tell you that all the communities in the Sierra Norte and El Rincón [regions] did not believe in the project, because they said: "How can we possibly sell an intangible service?"

Community representatives and intermediaries at least two of the *3PCCAT* communities described the environmental education work that community intermediaries now carry out with schoolchildren in their own community.

Neighboring communities. Next, an ejido or communities' relationship with its surrounding communities is significant. Numerous participants mentioned conflicts between communities in Michoacán, while almost no conflicts between communities were mentioned by community representatives or intermediaries in Campeche. In Oaxaca, we heard of examples of both conflicts and general collaboration between communities. Conflicts generally consisted of boundary conflicts or illegal timber extraction, and in fewer cases, trespassing and hunting. Boundary conflicts can contribute to environmental degradation in the contested area. This is because government agencies do not authorize funding for contested areas, and because lack of clear responsibility for the area can allow for pest proliferation and unchecked illegal logging. While conflicts between communities seemed common in Michoacán and Estado de México, and were mentioned for a few communities in Oaxaca, interview respondents did not perceive inter-community conflicts to be a significant factor in Calakmul. While some communities had conflicts, communities in Oaxaca also showed greater collaboration between communities. A community representative told us about inter-community collaboration in Michoacán among a group of four communities that coordinate a joint surveillance group.

Corporations and private landowners. Corporations and private landowners were generally seen as a threat by our interviewees, either purchasing land for large-scale agriculture in Campeche or taking control of land through concessions in Oaxaca. While the paper company concessions that led Oaxacan communities to band together, organize themselves, and win government approval to manage their own forests are a thing of the past, many Oaxacan communities still deal with mining concessions. This leads communities in Oaxaca to have a strong distrust of outside corporations, something that the carbon credits organization had to work to overcome. Still, signs of that distrust linger even among carbon-credit participating communities: the representative of a *3PCCAT* community described how they rotate their carbon credit areas regularly to ensure that no corporation pays for the same land for many years in a row.

The general public. Finally, the public at large also affected communities. Respondents in Michoacán and Oaxaca in particular stated how they were affected by population growth's contribution to water scarcity and the general public's negative perception of timber harvesting.

3.1.3 Internal organization and governance

Both intermediaries and community representatives across all three regions recognized high levels of internal organization and governance as crucial for good forest management. Traditional community governance structures were also similar in *ejidos* and indigenous communities across all regions. Interview participants in Oaxaca, however, emphasized the mandatory nature of community leadership roles and community service much more strongly than in other regions.

Three intermediaries in Oaxaca repeatedly stated that community organization is fundamental for the success of projects. As one intermediary in Campeche put it:

... You can bring in a super great project that you've spent a month painstakingly figuring out the math and engineering for, but without a strong base of social organization, it doesn't work...

Respondents in Campeche and Oaxaca both noted that communities are able to organize more easily when they are smaller, of a single ethnic group and linguistic group, or closely related. One intermediary who works with both Mayan *ejidos* and *ejidos* composed of immigrants from other states did comment, however, that he was incredulous of the common belief that Mayan communities inherently managed their land better.

The community assembly. *Ejidos* and indigenous communities have similar structures of governance across all three regions, and both depend on the same three main components: the community assembly, their internal statutes, and the territorial zoning. As one *3PCaT* community representative in Michoacán put it: “what the majority of the assembly tells me is what I do.” The power of the community assembly is recognized by both community representatives and intermediaries. In Campeche, a *1PBzT* community representative stated, “the supreme authority is the assembly,” which was echoed almost word for word by two intermediaries:

The assembly is the supreme authority. In all the *ejidos*, it's the supreme authority. And it's the assembly that decides if one can or one cannot, or whether or not to authorize. That's how it is.

Multiple communities in Campeche (two *1PBz* communities, an *1PBzT* community, and a *1PBzVpaT* community) and Oaxaca (three *3PCCAT* communities) affirmed that the community's involvement in PES or the creation of an AVDC had not changed the level of community participation. In at least one case, a community assembly decided to act more conservatively with regards to natural resource use than permitted or encouraged by government agencies. A *3PCaT* community in Michoacán made the decision to harvest less than their authorized timber harvesting volume in order to protect community springs. Logging below the authorized harvest volume in an effort to ensure sustainability has been noted in other Mexican regions as well, such as Oaxaca (Bray et al., 2003). Through community assemblies, communities learn about and decide whether to participate in PES programs, STM, and community conservation areas such as AVDCs and ACCs. More specifically, *ejidos* and indigenous communities use community assemblies to approve PES program details, chose from the list of required PES activities, and organize fulfill meeting PES requirements. Two government officials, a PROBOSQUE official, and a CONANP staff person favored investment of PES funds over equal division between community members, but one of these and another former PES promoter strongly emphasized the need to respect communities' decisions over use of funds.

Participation of women varies widely from community to community within each region. Some communities did not have any title-holding *ejidatarías* or *comuneras* (including three of the four Oaxacan communities we visited), while in several others there were only a handful of *ejidatarías*, generally widows who had inherited their title from their husbands. Still other communities had active *ejidatarías* or *comuneras* with full rights and obligations including the responsibility to participate in mandatory community service and to take leadership positions. One *3PCa* community in Michoacán mentioned having 12 people total in their *comisariado*, while another *1PBzT* community representative stated they had an 8-person *comisariado*.

The *comisariado*. *Comisariados* are seen first and foremost as a community representative, subject to the authority of the community assembly. As one community representative in Oaxaca put it, “More than anything else, we have to obey the voice of the people.” One intermediary from a *3PCCAT* community mentioned that the assembly has the power to sanction *comisariados*. The role of *comisariado*, as well as the other roles on the governing bodies, are generally honorific (i.e., unpaid), although an NGO staff person in Michoacán said that some *comisariados* receive 10% of forest management income as payment. Community representatives and intermediaries in Oaxaca emphasized that leadership roles (also known as “cargos,” or charges) are mandatory and that community members are obligated to take on the “cargos” they are elected to. A community member elected to a cargo while living abroad, say in the United States, must either return to take up the role or pay a substitute (up to US\$8000 to be a *comisariado*) to take on the responsibility. Oaxacan interviewees from *3PCCAT* and UZACHI communities also emphasized *comisariados*’ commitment to transparency and public service, which is particularly motivated by the knowledge that they will continue to live in the community once they complete their term of service. Managing the communities natural and financial resources is a core element of the *comisariado*’s role as described by a *3PCa* community representative in Michoacán:

The *comisariado*’s responsibility is first, to protect the land, a very important responsibility, second, to generate resources, and third, to do work sufficient to maintain the forest at 100%.

Three communities in Michoacán (*3PCa*, *1PBzT2*, *3PCaT*) also described “knocking on doors” to seek government programs and funding as a significant part of the *comisariado*’s role.

The oversight committee’s responsibility for overseeing the *comisariado* extended to interviews with us as outside researchers. Oversight committees frequently accompanied *comisariados* to pre-scheduled interviews in Michoacán and Oaxaca, though not in Campeche.

We met four women who currently or previously held community representative roles such as secretaries or treasurers, but did not meet any *comisariadas*. An intermediary and a *3PCCAT* community representative in Oaxaca referenced a 2015 change in the agrarian law governing ejidos and indigenous communities that would require 40% of titled members to be women. The intermediary described the requirement as a challenge for communities that currently have no female titleholders, while the community representative described as an imposition on 430 years of community customary rules.

Comisariados were generally elected for three-year terms in Michoacán and Campeche, while an intermediary in Oaxaca stated that terms range from one to three years in different communities, with one-year terms being common in the Sierra Norte. The frequent changing of community representatives can cause challenges for communities and intermediaries’ organizations. Two intermediaries, one from within the community and one from an outside organization, highlighted that new leaders often want to change things or have a new mindset. As an NGO staff person in Michoacán commented: “those three years can be very good, or those three years can be lost.” Nonetheless, leaders of one *3PCCAT* community in Oaxaca felt that the demonstrated success of their forestry management program over nearly thirty years meant it would be difficult for a new community representative to change it. Even if new *comisariados* are supportive of participating in a PES or forest management program, an intermediary emphasized that the learning curve can be steep and require significant investment in education by intermediaries’ organizations. This is especially challenging in communities where *comisariados*’ terms are shorter, resulting in more frequent turnover.

A *1PBzVpaT* community in Campeche and two *3PCCAT* communities in Oaxaca appointed leaders or committees to direct community projects such as charcoal production and timber management. At least two communities, one in Michoacán (*3PCa*) and one in Oaxaca (*3PCCAT*), organized themselves by sub-groups (known as “manzanas” in Michoacán).

Internal statutes. Natural resource management rules that we discussed with participating communities included rules about firewood collection, fire management, and land sale. Firewood collection is recognized by all communities as a necessity, since many homes still depend on woodfire for cooking. While some communities had upheld the right to firewood collection for domestic use with few or only general regulations (*3PCaT*, *3PCaT*, *1PBzVpaT*, *3PCCAT*), other communities, particularly in Campeche, expect firewood extraction to be limited to agricultural plots (*1P*, *1PBzT*). Several communities in Michoacán (*3PBz*, *3PCaT*, *1PBzT*) issued authorizations for firewood extraction, and some (*3PCaT*, *3PCCAT*) prohibited the cutting of green trees or firewood extraction outside of the community.

Fires were a frequently mentioned threat in all regions. A representative from a *1P* community described his community’s guidelines for agricultural fire management, such as acceptable times of day to set fires. While some communities have designated fire-fighting brigades (often funded by PES), community representatives commonly said that the entire community is expected to help fight fires. To prevent illegal woodcutting and fires, permission required to visit the forests in Oaxaca. Sale of community land, while legalized by PROCEDE, is tightly controlled by most communities. All four communities in Oaxaca prohibited sale of communal land to outsiders. This was also mentioned by communities in Michoacán and Campeche (*3PBz*, *3PCaT*, *1PBz*), while in Campeche two communities (*1PBz*, *1P*) said that purchasers of land have to be approved by the community assembly. Community rules, including mandatory community service requirements, are enforced with fines or sanctions (which may include more mandatory community service). Communities must report environmental crimes committed by outsiders to PROFEPA in order to avoid legal responsibility.

Mandatory community service. Communities in all three regions use mandatory community service or paid day labor by community members to complete activities required for PES and timber management. The mandatory community service, known as the “*faena*” in Michoacán, “*fajina*” in Campeche, and “*tequio*” in Oaxaca, is a concept common across ejidos and indigenous communities in all three regions.

A *3PCCAT* community representative in Oaxaca spoke of the *tequio* with near-religious fervor:

...The *tequio* is communal work [...] it’s obligatory, it isn’t compensated, it’s fellowship, it’s sharing, it’s communality.

Mandatory community service is commonly used to provide labor for community surveillance and for clearing firebreaks. This is done as part of PES-requirements, but many communities across all three regions have used mandatory community service to support surveillance programs and land management, such as clearing boundary tracks between communities, for decades.

Territorial zoning. Territorial zoning manifests as community maps designating which activities are permissible in which areas. At a minimum, zones generally include urban areas, agricultural plots assigned to individual *ejidatarios* or *comuneros*, and a forested area that for communal use. Enrollment in PES requires an official territorial zoning. Several communities (*1PT*, *3PCCAT*) we visited had an

official territorial zoning which pre-dated their enrollment in PES, while other communities (*1PBz*, *3PCa*) completed an official territorial zoning as a PES-requirement. While an intermediary in Campeche pointed out that territorial zonings can be nothing more a formality, zonings that do not reflect community land use can cause activity to be seen as illegal, with negative environmental consequences:

What is the threat? Not having permission. Doing it illegally. Why? Because you have to do it. If you cut down one tree, you have to cut down three tree in order to pay everyone off. Therefore, bad planning and doing things in an illegal manner. If you do things legally, everyone arrives and you're doing it well.

More generally, the issue of overregulation, the prohibition of extractive land use, and its link with corruption was also identified by a former PES promoter in Michoacán: "...in a repressive and over-regulated state, illegality and corruption are the result." In essence, these promoters saw timber extraction as an activity which can benefit communities, but which has been criminalized through unrealistic zoning and over-regulation.

Nonetheless, other intermediaries and community representatives (*1PT*, *3PCCAT*) affirmed that some communities respect the territorial zoning and use it for community planning and requesting other government programs. An intermediary in Campeche also pointed out that completing territorial zonings for PES also provide communities with an opportunity to designate community protected areas in forested areas, creating an interaction effect between PES and protected areas. This was true in several communities we visited.

3.1.4 Pre-existing conservation practices

Understanding pre-existing conservation practices within communities is crucial to understanding to what extent programs such as PES and timber management or the presence of protected areas changed behaviors. Pre-existing conservation practices are also a determining factor of additionality, an important component of PES that determines whether the payments are actually increasing conservation and, hence, the provision of ecosystem services. We heard examples of previous conservation practices, such as traditionally conserved forest areas or voluntarily community surveillance groups, from some communities in each of our regions. Representatives in Campeche and Oaxaca in particular frequently mentioned previously-recognized "conservation" areas in their communities.

Campeche. At least five of our ten communities in Campeche (a *1P* community, *1PBzVpa* community, and three *1PBz* communities) recognized part of their land as permanently forested areas, or "reserves" prior to the advent of PES or AVDCs. Representatives of four of those communities (an *1PBzVpa* community and three *1PBz* communities) further stated the lands designated for PES or AVDCs were previously recognized permanently forested areas. In two communities (*1PBz*, *1PBzT*), community representatives emphasized that the forested areas were traditionally unused, while in a *1PBzVpa* community they were former timber management zones that were no longer economically viable to harvest. A representative of another *1PBzT* community said that no one was working on their PES-designated land previously. This phenomenon was corroborated by an NGO staff person and three intermediaries. These intermediaries emphasized that communities decreed permanent forested areas on their own initiative:

... all of the ejidos take into account their forested area, even though there are very small ejidos, [there are] many forested areas, many areas that are like this, conservation areas, that have already been decreed as such by the community itself.

An intermediary explained that in some communities these permanent forest areas had been officially recognized as community “reserves” during community zoning processes (see “3.2.3 Internal Organization and Governance, “Territorial zoning”). The intermediaries described how these communities care for their reserves with something like affection:

... for example, [an ejido], which I’ll tell you is where there’s a lot of land use change, where yes, they sell a lot of [land] rights, but for the past twenty years they’ve had a reserve, and they care for it and they respect it, and they know that it’s already internally divided up. But they take a lot of care for that area where they’ve had a plantation for twenty years, and of their reserve area, and of their archeological site and their hill, they have these as their areas of value. They give these areas value, and they take care of them.

In contrast, the NGO staff person emphasized that communities tend to put PES in areas that are not economically profitable:

... many of these lands that are given for environmental services [...] are permanently forested areas, in other words, they are locations where traditionally the people have always left them there because they did forest harvesting of some sort, of chicle or whatever other thing [...] and this piece of land they never touched [...]. Usually the permanently forested area is relegated to a space that doesn’t have a lot of function, as an area that’s less suitable for things, because of the type of vegetation, [...] so, that’s why these lands are maintained [in a forested state] because they don’t produce anything.

While recognizing the biological richness of some of the permanent forested areas, particularly in shorter tropical forests (“selvas bajas”), the NGO staff person also emphasized that land use change surrounding the area can result in a loss of connectivity which reduces its biodiversity value.

A representative of one *1PBz* community who emphasized that no one had worked their PES area previously stated that the area would likely be conserved even without the AVDC: “from my point of view, I would leave that area as it is, let it continue conserving, because, well, it’s an area that has never been touched, and there it stays.” This is likely due to a low perception of threat to forests in the area. One representative from an *1PBzT* community stated that the level of illegal logging in his community had not changed as a result of PES because there was no illegal logging previously. Two intermediaries also corroborated that there was not much deforestation going on in ejidos. Nonetheless, three communities (*1PT*, *1PBz*, *1PBzT*) stated that they had taken care of their forest previous to PES through surveillance or the construction of firebreaks. Another *1P* community representative detailed how the community prevented illegal logging in its “reserve” before PES, in contrast to the illegal extraction from the Calakmul Biosphere Reserve:

In what is our reserve that we have there, there isn’t illegal logging, we’ve always guarded it, [...] for this reason I tell you that we have this reserve area because no one can cut a tree or do anything there. The person who is caught cutting a tree there is

called to attention and told, “You know what? This is a restricted area which is everyone’s and no one’s, but no one can make use of this wood, we have to care for it between all of us [...]” It’s that it is all of ours, not just one person’s, it belongs to all of the 96 *ejidatarios*, we have the obligation to take care of this area. And yes, some understand, they understand and don’t enter there anymore. Where they have really made disasters is over there by the Reserve...

That same representative stated that PES had not changed community mindsets about the forest or their “reserve”: while some *ejidatarios* wanted to divide it up, they ultimately decided to keep it in hopes of attracting government projects and programs. Other community representatives, such as one from an *1PBz ejido*, also expressed their hope that reserves certified as AVDCs would generate some income for the community.

Michoacán. Pre-PES and protected area conservation practices in Michoacán mostly took the form of surveillance patrols. At least three communities (*2PCa*, *3PCaT*, *1PBzT*) had pre-existing monitoring groups; one of them *3PCaT* dating back over 30 years. Surveillance was funded either by the community or by other government programs. Women at a focus group in a *3PCaT* community with a long-standing surveillance program particularly emphasized how the community finances surveillance. They stated that in addition to providing meals and transportation such as horses or cars, community members have to pay for substitutes if they do not personally go to serve their turn for surveillance. A *3PCaT* community representative, however, stated that he felt the community’s investment in surveillance has restored streams and resulted in a beautiful forest. In fact, the community’s recent authorization for timber management has come as a shock and has received pushback from community members: “now that they’ve given us the timber management program, it’s as if a weight has fallen on us to say “put a chainsaw to this garden and cut it down,” the people have been affected...” In response, the community decided to harvest less than their authorized volume of timber:

And it’s good, because the people say, “It’s good, we have the timber management program, but I’m more interested in protecting than in cutting down.” [...] It’s respectable, because [it’s] the priority of the people of the assembly, which says “It’s that we have trees, we have a forest, we have water, and we’re going to cut down trees for the few pesos that they will give us, that we will divide up [...] And the water? If the water runs out on us, from where [will we get it]? With the pesos that we have we won’t have water, so then, it’s better to see that we go extracting only a little of the wood in each year, and we prefer to conserve in order to have water.” And well, I told them in the last meeting, “Congratulations,” because as representatives we can’t require or say, “it’s that it’s for us,” no. It’s in the authorized timber management plan, but if you want to do it, you do it, you harvest—if not, well, it’s not obligatory.

Other communities (a *2PCaT* community and two *3PCaT* communities) have a long history of reforestation, either by their own means or supported by government programs. Representatives of three different communities (*2PCa*, *3PCaT*, and *3PCa*) described their forests as “precious”. The *2PCa* community has not had timber management for 15 years, while the other *3PCaT* community is the afore-mentioned community that only recently started a timber program. The *3PCa* community also described having an area that has been traditionally untouched for decades and contains very large-diameter trees. In one *3PCaT* community, the forest expanded after *comisariados* decided to remove

some agricultural fields and ban unauthorized firewood extraction in the 1980's. A *3PCa* community framed PES as logical compensation for the forest protection they were already doing:

I'm going to do this kind of management because we're protecting the land, so then, I'm going to manage this part so that the payment arrives, and these payments will serve us to give the forest maintenance...

Similarly, a *3PCaT* community representative strongly emphasized that the MBBR has had positive effects because it supports the community's pre-existing conservation mindset by helping strengthen community agreements and promoting artisanry:

It's strengthened our community because the intention to care [for the forest] came out of the community, it wasn't born out of any government institution [...] it was already in existence when the Monarch Butterfly [Biosphere Reserve] was decreed, so there that's served us, it helped us to strengthen. Rather than harming us, the Reserve has also helped us because it's strengthened us in the agreements that we live out in the community because the community is in agreement to protect and the Reserve, WWF, and the *Fondo Monarca*, what they ask is protection, so we're speaking the same language, the same thoughts, what they think there, we've thought, but before it came from there. We already said to close cutting down of trees in the forest, so therefore it's strengthened us, yes. The MBBR has also been supporting the pine-needle artisans, it's helped them, they already took groups to expositions in other states, etc.

That community and a *3PBx* community emphasized that they would continue taking care of the forest with or without PES and other types of support due to their sense of ownership of the forest: "we're going to continue caring because the forest is ours... it's very clear to us that the forest is ours, and that we live here." A good illustration of that commitment is the fact that the *3PCaT* community pays about five times as much support to community surveillance as the government does.

Oaxaca Communities in Oaxaca, more so than in either of the other two regions, emphasized a holistic management of their territory through the designation of different use-zones in their territorial zoning. One *3PCCAT* community representative described the 9 different zones established by their territorial zoning, and proudly stated that their forest is equally conserved regardless of its use-category:

... if we walk in the forest, the only difference that you'll find is in the sign, "Area for Matching funds and Carbon Services, Indigenous Carbon," and in the other area, if you walk, you'll see it looks the same. Well, the difference is that it doesn't have a sign, but it's equally conserved.

This is the result of a long process: an intermediary emphasized that communities have been improving in their management over the past 40 - 50 years. The previously mentioned *3PCCAT* community first received an award from WWF for good timber management in the mid 1990's. That same community's representative stated the holistic land management and economic diversification (now including a bottled water company, ecotourism, restaurants, interpretive trails, and sale of gravel and sand) the community has achieved evolved over the past 30 years:

... Before, the only thing that interested us was 100% timber management, lately what's interested us is the mushrooms, the deer UMA, the orchids, the bromeliads, the diversification of the everything that the forest can give us. Yes, since 30 or 40 years ago until today it's now very clear to us that the forest doesn't give us nothing more than wood...

Because of their diverse economy, the community representative stated that the *3PCCAT* community no longer depends on the forest, which means the forest would continue without PES. Additionally, PROCYMAF, a SEMARNAT forest use and conservation project in Oaxaca, also noted that diverse economic activities in forestry communities can allow for increased women's participation and empowerment (Bray et al., 2003). Another *3PCCAT* community also explained how the territorial zoning establishes zones for different management and changed their perspective on the forest:

... the zoning here tells us the area that you have destined for timber management, the area that you have for agriculture, we have an area of conserved forests [...] Therefore, based in this I tell you that one begins to turn towards the forest with a different mentality.

Community conservation areas (CCAs) are now formally designated through territorial zoning. An intermediary and a *3PCCAT* community representative affirmed that many CCAs were previously recognized by communities as ritual areas, which are often established at spring heads or water recharge areas. One *3PCCAT* community stated that their CCA was established 15-20 years ago as part of their timber management plan. An intermediary shared that although some communities' ACCs had become degraded and are now restored, communities generally cared for and managed their community conservation areas:

the communities in and of themselves give them maintenance, protect their areas, they care for them, there's a program perhaps unwritten, but traditional, of what they do year after year in those conservation areas [...]

A community representative described the ecological richness of their CCA, which is located at a springhead:

... where the springs of water are there are some huge trees, large pines, and we know that there they're going to die by themselves, but we're not going to cut them down—we know how much they're worth, but we also know the value that they have for water and we also know [their value] in what is conservation. We have identified conservation areas because that's where the animals and birds take refuge...

Several communities now have PES in their CCAs, although an intermediary stated that the frequent overlap between the two programs is purely coincidental. A *3PCCAT* community representative stated that the community's CCAs are monitored against pests and disease outbreaks but are otherwise considered untouchable.

Representatives of three of the four *3PCCAT* communities described tightly controlling access to their forests and have detailed sets of rules controlling hunting and the extraction of plants, animals, mushrooms, and firewood. Several *3PCCAT* communities have established UMAs: two communities we visited had UMAs for white-tailed deer, and one of those also had an UMA for mushrooms.

Despite regulations to protect the plants, members of one community stated that medicinal plant populations were being negatively affected by timber clear cuts. Members of one *3PCCAT* community also described additional rules regarding lighting fires, littering, and safety equipment (particularly hardhats) for timber management workers during a focus group. As one community member stated: “For everything that exists in the forest, from the very first thing, for everything there are rules. For everything, there are rules.”

Several participants (two from *3PCCAT* communities and one from UZACHI) particularly emphasized that many PES-land management practices were already typical for communities, either as community tradition or part of timber management practices. Respondents also highlighted that land management activities were carried out through mandatory communal work in the form of tequios. As one *3PCCAT* community representative stated:

I insisted a lot that we’re not waiting until the payments for ecosystem services arrive or that the payments for matching funds arrive and now we’re going to do the work. No, from the start we do it as a custom, no? to have the territory protected, we do it through the tequio [...] nothing more than that, only all of our forest has importance, it requires a very punctual care from us...

An intermediary from another *3PCCAT* community also emphasized that communities do the work customarily:

We and the communities, the communities of [an intermediaries’ association] already bring it because of culture, and practically began to work together. They do the jobs because of culture, it’s not because it’s an obligation; in other words, what comes as an obligation comes, but because of our culture we already do it...

Another group of intermediaries stated that PES doesn’t benefit communities because it only gives them a resource for work that they customarily did:

Interviewer: “And do you see that [PES in general] has in some ways contributed in some way to stopping or mitigating the threats that we talk about it? Do you think PES is in some ways effective in achieving its objectives?”

Interviewee: “No, none, to the contrary, they [PES] don’t come to benefit them [communities]. They don’t come to benefit them because it gives them a resource, well, for the work that they’re doing. [...] They’ve always done this work, they reforest, clear underbrush, do pruning, do thinning—first, second, third thinning—so, it’s a work that the communities have always been doing. They clear their [boundary] firebreaks and all of this benefits, [...] and they do it through the tequio or however they do it, it’s a custom to do the tequio, and you see, you see that they are doing it.”

Another *3PCCAT* community representative echoed the group of intermediaries, stating that clearings of boundary lines between communities, a traditional practice, also serve as firebreaks. Representatives of two *3PCCAT* communities stated that their communities have always reforested, and one sells pine seedlings from their nurseries to other communities. Representatives of one *3PCCAT* community that has traditionally reforested said that their timber management plan currently requires reforestations, but voluntary reforestation may have been preferable. That same community also described how they started community surveillance against illegal logging over 30 years ago, even

before starting their timer management program. The community representative linked the community's forest conservation to a protection of community resources: "Yes, it's been respected—as I tell you, we all have the culture of protecting what is our own," concluding that the community would continue working in their forests in the same way if the different PES programs ended.

3.1.5 Community agricultural practices

Agricultural expansion has been identified as a major driver of deforestation in Mexico and worldwide (Ferretti-Gallon & Busch, 2014; Roy Chowdhury, 2006). This makes an understanding of community agricultural practices important for understanding communities' decision to conserve their forests or engage in STM. While subsistence agriculture was a common practice in all of our regions, agricultural practices differed significantly by region.

Calakmul. Interview participants in Campeche discussed agriculture at much greater length than in other regions: in total, references from Campeche accounted for 49 of the 80 total pages of interview content coded to agricultural practices. In Calakmul, agricultural production is limited by erratic rainfall (see also section 3.2.3 "Water access"), chalky soil (see also section 3.2.4 "Soil"), and the prohibitive cost of clearing and preparing land. Increasingly undependable rainfall patterns, mentioned by representatives of two *1PBz* communities, two intermediaries, and a protected areas staff person, is particularly critical because most families depend on a traditional form of rain-irrigated agriculture known as the *milpa*. *Milpa* is a form of shifting rotational subsistence agriculture using the intercropping of corn, beans, and pumpkin, generally in small fields. A festival is held annually to celebrate different local corn varieties. Peppers were also mentioned as an important crop in five communities (four *1PBz* communities and an *1PBzVpa* community), while other communities mentioned growing rice (*1PT*), yucca and camote (*1PBz*), and watermelon (two *1PBz* communities). A community representative described a 5 ha corn field, while two intermediaries and stated that people are now clearing less land for agriculture than before due to unpredictable rainfall. This was further emphasized by a protected areas staff person:

My father is a peasant farmer, and I remember how before peasant farmers would make 5, 10, 20 hectares of milpa. Not any more, now it's difficult to see a peasant farmer working that much area, now they practically produce for their daily needs—2 hectares, 3 hectares—if it's a lot, in some places 5 hectares, but that's when it's a lot. It used to be that the peasant farmer would clear a lot of land, but not anymore.

Another intermediary emphasized the traditional, subsistence nature of corn cultivation: "... corn doesn't even pay your expenses—corn is cultural." Another representative from a large *1PBzVpaT* community mentioned that each *ejidatario* has been allotted 300 hectares for agriculture and livestock, but that in any given year the *ejido* has about 150 has of agriculture in all. Jalapeño production was important and a major cause of deforestation in Calakmul (average extension 20-30 ha), but crashed recently, with interviewees blaming the downturn on the increased cost of agricultural inputs and low prices offered by buyers' associations.

Representatives of seven of the ten communities (*1PT*, *1P*, three *1PBz* communities, *1PBzT*, *1PBzVpa*) mentioned some limited cattle and/or sheep ranching in their community, generally for commercial sale. Another *1PBz* community mentioned that they had sheep previously but had to sell them due to predation by jaguars. One intermediary and an *1P* community representative emphasized that while

many settlers from Veracruz and Tabasco were used to large-scale ranching, which is incompatible with Campeche's lack of water. Because they come from other regions, the same intermediary said that many settlers, "in reality don't even know what forest management is." While fewer families seem to own livestock than to engage in subsistence farming, ranching has a relatively larger impact. Representatives of two communities (*1PT*, *1PBz*) stated that ranchers are assigned 50 hectare parcels for their livestock, although in the *1PT* community ranchers typically only use 10 – 30 hectares of the land. As described by representatives of two communities (*1PT*, *1PBz*), this is partially due to the prohibitive cost of clearing forest to prepare pasture, which is also a restricting factor agricultural fields. Nonetheless, representatives from two communities (*1PT*, *1PBz*) and a CONANP staff member affirmed that agricultural production is a motive for deforestation:

Interviewer: "What reasons might people have for deforesting or doing other activities that damage the forest?"

Interviewee: "Well, one reason that one would do it is because one wants to produce better. [...] Because the change of soil use [from forest] gives you more production."

Another *1PT* community member summarized the tradeoffs between government-financed conservation and agriculture facing communities:

It's good to conserve, the people put a lot of care into it, but as my friends and I say, if the government takes away the support [PES], with all sincerity we have to look at survival, that is to say, at the wellbeing of our families and of ourselves. [...] We have to see what to do. We will cut down the forest [...] in order to plant, because the land does produce fertile soil, and if not, as the representative says, well, we will have to see what to sell. But we're going to do something--we're not going to stay seated, waiting, if the government doesn't have us any more. Then we will have to see what we are going to do. [...] That's how it is. Up until now, we're conserving—we're conserving.

Though representatives of one *1PT* community disagreed, members of other communities (*1PBzT*, *1P*) and two intermediaries saw mechanized agriculture as a way to improve production and reduce deforestation. Four intermediaries and an NGO staff person emphasized that the true deforestation threats are through large-scale agriculture by outside companies or groups such as Mennonites with financial capacity to develop land.

Seven of the 10 communities (*1P*, *1PT*, *1PBzVpa*, *1PBzVpaT*, and three *1PBz* communities) affirmed that bee-keeping is the major, promising, or financially viable activity for the community. One representative stated that 70% of the members of his *1PBzVpa* community were bee-keepers. A community representative from one *1PBz* community also stated that bee-keeping does not require clearing the forest, and that hives can be placed within the Reserve. That same community received significant funding for bee-keeping from the World Bank.

Three community representatives mentioned that fire is a common method of clearing agricultural or pasture land (*1PBzVpaT*, *1P*, *1PBz*), which was corroborated by two intermediaries and two protected areas staff. While communities work together to respond to escaped fires (*1PBz*), there are also fire brigades established by CONANP or funded by outside organizations in a number of communities.

Michoacán and Estado de México. Compared to in Campeche, interview participants talked about agriculture significantly less in Michoacán, Estado de México, and Oaxaca, resulting in much shorter

summaries of agricultural practices. Representatives of six communities (*2PCa*, *2PBzT*, *3PCaT*, *3PCaT*, *1PBzT*, *3PCa*) in Michoacán and the Estado de México said that most community members have some agriculture, including corn, beans, wheat, oats, lima beans, green beans, barley, and livestock forage. Representatives of five communities (*2PCa*, *2PBzT*, and three *3PCaT* communities) also stated that community members also typically have a few livestock, generally a cow or two and a few sheep, for personal consumption, while two communities (*2PBzT*, *3PCa*) said that the livestock could be for commercial sale. One *1PBzT* community said that they used to have livestock, but they were stolen due to insecurity, while an *3PCaT* community representative said his community did not have livestock due to lack of pastureland.

At least four communities (three *3PCaT* communities and an *1PBzT* community) also produce fruit, including peaches and manzano peppers, but primarily avocados. In at least two of these communities, both *3PCaT* communities, the production of avocados has resulted in the exclusion of other crops. Representatives of one *3PCaT* community, which just recently received sustainable timber management authorization, described how people had been producing peaches and manzano peppers but switched to avocado as price for avocados increased. The community has planted many of the avocado trees in former cornfields. Some of the avocado trees up to 15 years old, but the majority of the groves were planted 5-6 years ago. In another *3PCaT* community, avocado production the major activity and resulted in the deforestation of forests in the *ejido*'s non-Reserve areas. While that community still produces a limited amount of peaches and manzano peppers, the ratio of hectares in avocado versus peach cultivation is 18:1 and only 2 people still grow corn. One *2PBzT* community representative stated that avocados do not bear fruit in his community. While we did not verify this, it is possible that the avocados do not grow in the community because it is at a higher elevation. If avocados are in fact non-viable in much of the MBBR due to higher elevation, this would be an important factor to take into consideration when considering how effective the MBBR has been in preventing conversion to avocado plantations. Representatives of two communities (*2PBzT*, *3PCaT*) also said that there are bee-keepers in their community.

Particularly in comparison with Campeche, it seemed that communities in Michoacán and the Estado de México dedicate a significantly larger percentage of their land to agriculture: in at least two cases, a *2PCa* community and a *3PCaT* community, about 50% of the *ejido*'s total land was dedicated to agriculture. Nonetheless, four communities (two *3PCaT* communities and two *1PBzT* communities) mentioned that agriculture is frequently financially unviable due to cost of inputs such as fertilizer, which also reduces the profitability of avocados. Another *1PBzT* community also mentioned that irregular rainfall was affecting agricultural production.

Oaxaca. Agriculture, mostly corn, beans, peas, fava beans, potatoes, garbanzo beans, and wheat, is common among the Sierra Norte communities in Oaxaca, although one *3PCCAT* community stated that they have very little agriculture due to younger generations seeking different kinds of employment. A representative of another *3PCCAT* community stated that 90% of the agriculture production in his community was for personal consumption. Representatives of two *3PCCAT* communities stated that there is little livestock, including cows, goats, pigs, and chicken, some of which is for sale in one of the communities. One *3PCCAT* community mentioned that they have little to no livestock except for oxen used to plough fields.

One of the four *3PCCAT* communities has about 200 bee-keepers, coffee cultivation, and cattle ranching. Coffee production was recently reduced by an outbreak of “la roya,” or coffee leaf rust fungus, requiring coffee farmers there to plant a new variety of coffee tree. Deforestation by ranchers

clearing pastureland caused decline in water in rivers which motivated forest conservation through PES and sustainable timber management in that community:

Interviewee: "... Many people were already beginning to deforest up towards the mountain and beginning to put in pasture. That's already a land use change that in the long run is going to affect us significantly, beginning with the water because you could already see streams in some areas that had water and dried up when they began to deforest."

Interviewer: "You noticed the change."

Interviewee: "Yes, that's where this was explained, and there were a few community members that even with it all deforested trees up until the stream banks. As time passed they didn't even have [water] for their animals, then they saw that it wasn't advisable, and that's the reason why."

Two *3PCCAT* communities described fires that resulted from escaped agricultural fires. Agricultural land abandoned in one *3PCCAT* community 40-50 years ago naturally regenerated into forest, but is still considered an agricultural zone.

3.2 Environmental factors relevant for biodiversity conservation strategies

3.2.1 Climate change

Climate change directly and indirectly creates some opportunities for communities by motivating pro-forest conservation on a national and international level. Several communities mentioned the ways in which international funding or meetings were motivating national-level forest conservation in Mexico. A CONANP staff member saw this as motivation for promoting AVDCs in local communities as locations for carbon offset credits in order to help the Mexican government meet their emissions reductions promises in the 2016 Paris Agreement. An intermediary in Campeche saw the Calakmul Biosphere's promotion of AVDCs as a direct result of Mexico's promise to increase protected areas during the climate-change oriented COP meetings. The same intermediary, however, believed that the REDD initiative did not produce effects. A representative of a development organization in Campeche also saw the COP meetings as motivating attempts to align the goals of and eliminate conflicts between Mexico's national forestry and agricultural agencies, CONAFOR and SAGARPA. A *3PCCAT* community representative in Oaxaca described how his community was chosen as part of the pilot study in association with the U.N.'s PNUD initiative to develop "protocolos comunitarios bioculturales," in fulfillment of Mexico's promises with regards to biodiversity in COP meetings:

June 22nd—July, excuse me—I have it now here, is already set aside as the day when the formal presentation of the community protocol will be made to the Consejo de Caracterizados to be validated. On that day people are coming from PNUD Mexico, people are coming from SEMARNAT, and from a Japanese association that wants to know that we're really fulfilling, or that, international organizations that are watching the follow-through, to make sure that Mexico is fulfilling what it said...

On the other hand, climate change has a number of direct environmental effects, such as exacerbating the incidence of pest and disease outbreaks in forests and enabling the spread of new insect species, particularly in Michoacán and Oaxaca. While six communities (*2PCaT*, *2PBzT*, *1PBzT*, *3PBz*, and two

3PCaT communities) felt forest pests were at reasonable or controllable levels, half of the 14 communities in Michoacán and the state of México (2PCa, 1PBzT, and five 3PCaT communities) named forest pests as a major threat to their forests. As a 3PCaT community representative said,

...the other [major threat] are the forest pests, for this reason we're trying to combat them each year, because if we don't combat them, they're going to extend more and the forest will be more sick every time.

A WWF employee linked forest pest outbreaks to increased pine tree vulnerability as a result of climate change-induced water stress, as did a 2PCaT community representative. In 2017, communities in Oaxaca started dealing with a new and expanding threat, the gusano defoliador (*Zadiprion falsus*, aka “mosca-sierra”), in addition to the previously forest pest, the gusano descortezador (*Dendroctonus* spp.). One 3PCCAT community's territory conflicts with neighboring communities meant that no one had responsibility for treating an outbreak in the contested area, which then spread and cost the community over 23,000 m³ of wood. Authorization from CONAFOR and SEMARNAT is required to deal with affected trees, typically by removing and burning or burying the trees. In both Michoacán/Estado de México and Oaxaca, communities described frustration with several month delays by institutions such as CONAFOR and SEMARNAT, which allows forest pests to spread further. An official from PROBOSQUE, the state of México's forestry office, also recognized the issue of delays in verifying forest pest outbreaks:

It's a problem in that CONAFOR creates the report, we send it to SEMARNAT to be authorized, but in order for CONAFOR to go [out and visit the site] one has to go to the owner and tell him, ‘Schedule this visit,’ after the visit where they verify the forest pests they go to SEMARNAT, send the report, and afterwards send out the notification—by the time they arrive there are already more forest pests.

While dealing with forest pest outbreaks without authorization causes conflicts with government agencies, a group of intermediaries in Oaxaca also stated that failure to report or address forest pests can result in the cancellation of a community's timber management authorization. Mistletoe is also considered a forest pest in Michoacán, México state, and Oaxaca. When asked about pests in their forests, interview respondents in Campeche only brought up parrots.

Respondents in all regions also linked climate change with extreme weather events. In Michoacán respondents described *ventarrones*, storms with unusually strong strong wind and rains, in 2008, 2010, and 2016, some of which caused mudslides. 32 people died as a result of the 2010 *ventarrones*, and the 2016 event knocked down an estimated 20,000 trees in the RMM. A community 3PCaT representative made a connection between deforestation and mudslides, a link supported by a study on the 2010 event supported the fact that the landslides began in deforested areas (Alcántara-Ayala, López-García, & Garnica, 2012). Communities in Oaxaca also described storms with strong winds and mudslides. Even more importantly, respondents across all regions but especially in Campeche highlighted climate change's affect on rainfall patterns, causing drought and water scarcity, which are further detailed in below (see 3.2.3 “Water access”).

3.2.2 Forest type

Density of merchantable trees. Michoacán communities' forests generally contains four main timber species: pine, fir, oak, and cedar. In Oaxaca's Sierra Norte, forests are generally not pure pine, oak, or pine-oak, but rather a mix of pine, oak, and hardwoods. Campeche's tropical forests contain a much greater assortment of species, meaning that there may be only a few individuals of merchantable species per hectare (Merino-Perez, 2013).

Value of species. In Michoacán, prices are high for pine and low for oak, as oak is mostly used for oak flooring. In Campeche, commonly mentioned tree species included *cedro* and *caoba*.

Effects of forest type on PES payments. PES amounts also differ by forest type, which affects eligibility. There are several different tropical forest types in Campeche, including *acabual*, *selva alta*, *selva baja*, and others. Communities in Michoacán, Estado de México, and Oaxaca generally have pine, pine-oak, and pine-fir forests, although a few communities in Oaxaca also have cloud forests, which receive the highest amount of PES.

3.2.3 Water access

Climate change also exacerbates water scarcity via changing rainfall patterns. Communities in Michoacán, Campeche, and Oaxaca observed changing rainfall patterns due to climate change; furthermore, respondents in Michoacán and Campeche reported that increasingly unpredictable rainfall is interfering with traditional crop-planting cycles. A CONANP official in Campeche told us the story of trying to cultivate a traditional *milpa* with his father, who is a *campesino*, but failing because of the erratic rainfall:

We invested three times in that season and nothing—not one peso did we get out of that investment. And I took that as an example for the whole region: if that was what I lost, then that's what everyone lost in that season [...] And later, now that it rains even less, my father's told me already, "I'm not going to plant milpa in this season any more.

While some respondents in Michoacán mentioned water stress in trees, respondents in Campeche described drought as having much more severe effects. Droughts in 2011 and 2017, among other years, caused wildlife to go searching for water and caused some wildlife deaths. Droughts also increase risk of dangerous fires, which are often caused unintentionally by farmers trying to clear land. As a development organization staff member pointed out, droughts also decrease flowering, causing decreased honey production and negatively affecting beekeepers.

The effects of the drought were likely exacerbated because Campeche has so little surface water to begin with. According to community representatives, water is scarce and often chalky, limiting the potential for large-scale agriculture or livestock ranching. Several intermediaries pointed out that this increased attractiveness of forest-based initiatives by contrast. One environmental NGO representative went so far as to say that Calakmul has been protected not because of conservation efforts, but by the lack of water.

Water scarcity can also result from rising demand from a growing population, as mentioned by several participants in Michoacán and Oaxaca. Being the source of water that others depend on gives communities political power, and water scarcity, whether as a result of drought or population growth, may increase that power. None of the communities we interacted with in Campeche were a significant water source. Water from communities in Michoacán, however, goes to the Ciudad de México via the Sistema Cutzamala, and water from a *3PCCAT* community in the Sierra Norte of Oaxaca supplies the city of Oaxaca, Papaloapan, and Tuxtepec via the Río Papaloapan. Communities in Oaxaca and Michoacán repeatedly talked about where the water produced in their communities went to. A *3PCaT* community representative in Michoacán used the language of being able to “cerrar las llaves” (closing the faucet) of the water in order to force Mexico City to provide more compensation to communities in the Reserve for the water they produce. A development organization staff person used the same expression when talking about how two communities with control over water on the border between Campeche and Quintana Roo negotiate for programs from the state governments:

The day that they're discontent, they can shut off the faucet [...] And if you realize when you go, well they have everything looking very nice, I mean they have a little more paving in their streets and everything looks nice because the municipality has to keep them happy so that they don't shut off the faucet.

3.2.4 Soil

Poor soil limits agricultural productivity in Campeche. Representatives from a *1PT* community observed that the soil is chalky and low in nutrients, so many crops don't grow well in the area. Women in a focus group in a *1PBzT* community further remarked that the soil becomes infertile when farmed for multiple years, driving many farmers to clear forested land for agricultural fields and livestock pasture. Because of the soil, mechanization of agriculture is less effective. An agronomist working with CONANP said, “Here there's nothing that's mechanized. And why? Because here the soils aren't suitable for agriculture.” These poor soils and limited water availability, conditions shared by the neighboring state of Quintana Roo, are the cause of Campeche's slow-growing, medium height forest (Ellis et al., 2015). This slow, stunted growth explains why individuals of many species never reach the minimum diameter size necessary for harvesting in other regions, as commented on by two intermediaries. In contrast to Campeche's poor soils, a community intermediary in Oaxaca commented that their forest has a faster growth rate than other communities due to its high quality soil, which has positive implications for their timber management. In Michoacán a *3PCaT* community representative commented on how the soil led to high natural regeneration rates, and also seemed to be more productive following fires.

3.2.5 Charismatic fauna characteristics

The presence of charismatic fauna can provide both opportunities and restrictions for communities. In large part, the characteristics of the species determines the distribution and magnitude of opportunities and restrictions. The establishment of the MBBR to protect Monarch hibernation colonies caused communities in the core zone of the Reserve to lose their timber harvesting rights, whether or not they actually had a colony in their territory. The Monarch Butterfly's migratory lifecycle takes it through three countries: Mexico, the United States, and Canada, meaning many individuals in the United States and Canada also felt a sense of ownership of the Monarch Butterfly and a vested interest in the species' survival. As mentioned by an intermediary in Michoacán,

international pressure due to the Monarch's tri-national migration was an important factor in the creation of both the reserve and the *Fondo Monarca*.

Still, the establishment of the reserve increased opportunities for income-generation through tourism. Because the Monarch Butterfly hibernates in densely packed colonies located in specific sites (generally in fir tree stands in higher-altitude forests, within a certain distance of water), tourism benefits are concentrated in communities that have a colony on their territory. Two of these communities, both *3PCaT*, have developed extensive tourist infrastructure close to the colony, including food and merchandise shops, horseback rides, and guided hikes to the colony. A representative of one of these communities stated that 80% of his community is employed by tourist activities during the four months of the butterfly season. Other communities, which may be in the core zone but lack a colony, have more limited opportunities to attract tourists to highway rest stops or allegedly profit indirectly by charging tourists a fee to pass on the highway to communities with colonies.

3.3 Social changes resulting from biodiversity conservation strategies

Table 3. Number of coded references for each combination of conservation mechanisms and social changes.

Social change	Effects of timber management	Effects of protected areas	Effects of PES
Community Capacity	7	24	13
Conflict	0	3	6
Learning	15	27	29
Extraction of Species	0	2	0
Firewood Extraction	1	3	2
Hunting	3	7	11
Illegal Logging	5	10	27
Biodiversity Monitoring	8	13	10
Certification	3	2	3
Firebreaks and Fire	3	12	22
Reforestation	8	9	19
Surveillance	5	6	34
Agricultural Practices	2	11	13
Employment	21	11	47
Productive Activities	14	19	26
Timber Management	25	5	12
Tourism	2	20	5
Territorial Zoning	2	4	18
Internal Statutes	4	6	4

3.3.1 Culture or value changes

Several interviewees in Campeche shared the belief that participating in PES has changed people's attitudes towards conservation. A member of a *1PT* and one from a *1PBz* community mentioned that receiving PES or even the knowledge that these programs exist can motivate people to take care of their land, because they can earn money from an intact forest. Another representative of a *1PBz* community said that even those that were not interested in conservation at all changed their minds when they learned of the PES program. According to a forestry technician, communities come to see their PES plots as their own community protected areas, and they protect them fiercely. A *1PBz* community member further noted that having the CONAFOR office “nearby” is a constant reminder that they have a commitment to conserve. The importance of this “commitment” was echoed by a *1PBzT* and a *1PBz* community.

Communities in Michoacán and Estado de México also shared this perspective, with one *2PCa* community representative explaining that people used to beat Monarch butterflies with sticks, but when WWF and CONANP explained the PES program to them, they realized they should conserve butterflies in order to benefit from tourism. This was echoed by a focus group of women from a *3PCaT* community.

A common answer to the question of what would happen if or when PES is over was that nothing would change, because people had already adopted a conservationist mentality and they are committed to continue to care for their forests. We heard this from three communities in Campeche (*1PBzVpaT*, *1PBz*, *1PBz*), three communities in Michoacán (*3PCaT*, *2PCa*, *3PCa*) and two *3PCCAT* communities in Oaxaca. This was often tied to the fact that forests provide communities with “benefits”, including income sources such as sustainable timber management, beekeeping, or ecotourism:

Now we're working with the butterfly for temporary employment, it helps us a lot [...] and our obligation is to take care of the environment and protect the butterfly. So now we no longer feel obligated, we no longer see it as an imposition, rather we know that we have to care for our forest and with or without payments we have to protect it.

This valuation of ecosystem services was clearly laid out by a member of a *1PBzVpaT* community in Campeche, who believes that the long-term economic benefits of conservation will outweigh any short-term gains from extraction. It is interesting to reflect about this realization of the provision of ecosystem services. In particular, several communities in all three regions mentioned that they were motivated to continue to conserve their forests because they increase the availability of water. Whether this value became entrenched in communities due to participation in PES for hydrological services, or whether it was part of the community's traditional ecological knowledge, was unclear.

A very relevant change in values, which is discussed in depth in the PES-PA interaction section, regards local people's perception of government protected areas. A CONANP official in Campeche stated that:

In [X community], for example, they used to say “I did not ask to be part of the Reserve, if you put it there, that's your problem, I will continue to work as I have always done”, but this has changed, it has changed so much that [...] 10 years ago they decided to form a fire brigade, all by themselves.

In Campeche, the recent push towards certification of AVDCs also seems to have affected how some communities value the CBR, as stated by a *1PBzVpaT* community representative:

Right now we are 10 ejidos that have joined the voluntary protected areas, and those 10 ejidos are now thinking long-term. If the protected area hadn't been created, we would not have that vision now to conserve what we have."

In Michoacán, an MBBR official said that he perceived a change in the way some communities take ownership of their land; he says that there used to be a very paternalistic relationship with the government, with communities waiting for handouts before carrying out any activity within their lands, but now they realize that they must invest and care for their home territories without waiting for subsidies. However, he emphasized that this is not the case for all communities, and their capacity to be self-sufficient greatly depends on their level of organization. As a positive example, a member of a *3PCa* community in this region described how their new focus on conservation has meant convincing community members of changing their agricultural practices, which they have mostly done successfully. This was also the case in a *1PBzVpaT* community in Campeche.

A social change we were not setting out to explore, but which we did hear about, was the increased participation of women within communities. A *1PBzVpaT* community representative in Campeche told us that women were participating in decision making, including regarding the PES program. On the other hand, with one significant exception, we observed an almost total lack of active participation from women in the three assemblies we had the privilege of attending (one in Michoacán and two in Campeche). In one case, at a meeting where *ejidatarios* were making decisions about the use of PES funds, no women were present even though we were told there were at least two *ejidatarías*. In the other two meetings, a significant number of women with land rights were present (composing about 50% and 28% percent of attendees), but women did not actively engage in discussions about natural resource management at all, with sole exception of the *ejidataria* mentioned below. This was the case even though women were repeatedly prompted to contribute by an outside intermediary in one meeting, and despite the fact that a female intermediary was leading the other assembly. The sole woman who actively participated, a former treasurer of the *comisariado*, had a dominant voice in the community's discussion about use of PES funds.

We also heard that PES may cause negative changes in culture or values. A *1PBzVpaT* community in Campeche said that the negative thing about PES is that people become accustomed to that income, and there will be problems when the program ends. An ARS member described how PES made some communities in a neighboring region worse-off by removing incentives for additional employment:

People there are poorer. Why? Because they made them stop working. If each year they give you eighty or a hundred thousand pesos, well, you just sit there. [...] Why would I work if they're giving me a lot of money? Then, well, they get disaccustomed [to working].

Another change in perceptions about conservation came from a surprising source. Many communities were involved and actively engaged in biodiversity monitoring programs with camera traps in all three regions. In the MBBR, the regional CONANP office is promoting a community-based monitoring program where they are training and incentivizing young men and women to use camera traps and identify species. It was inspiring to learn from several communities who have used this technology

that knowing and seeing the animals that live in their forest has changed peoples' perceptions about the importance of conserving their forests, as described by a representative of a *3PCaT* community:

[The Reserve] made us realize what we have within the community, within our forests, because we don't know anything about that, what type of animals live there. When we went to receive training [...], when we started doing monitoring, working, well it's very lovely to know what we have in our forests.

3.3.2 Organization and governance changes

Both PES and AVDCs have led to the creation of second-level organizations among communities with common goals. A *1PBzVpaT* community in Campeche says that the AVDC program led communities in the area to form a committee dedicated to attracting funding: "The more organized we are, the broader our reach will be." This same community also formed a second level organization with a neighboring ejido to produce and sell sustainable charcoal after receiving AVDC certification. A forestry technician in the same region mentioned an example of a group of isolated neighboring communities that receive PES that decided to work together and form an association, which meant she only had to make a single trip to advise all three of them.

These programs have also increased organization and participation in governance activities within communities. A *1PBzVpa* in Campeche described how PES brought changes in community organization: they received training through the program to form a fire brigade, and now have an effective system for alerting the community and the CONANP officials of any fires. A CONANP official corroborated that this community is in fact one of their first points of contact for handling fires in the CBR. In this region, the requirements of the PES and AVDC programs were described by a member of a *1PBzVpaT* community as activities that require cooperation and a shared understanding, and they have had to organize a number of meetings to achieve these goals. A member of a *3PCaT* community in Michoacán pointed out that CONANP holds annual meetings to provide training before each tourism season, and most community members attend. Several communities in this region also mentioned that the annual meetings where they receive the matching funds from *Fondo Monarca* have high attendance, as people are interested in understanding how the money they receive is allocated and where it comes from.

An ex-PES practitioner in Michoacán described the effects of the strong combination of actors on the governance decisions made by communities in the MBBR through their assemblies:

The work of the Reserve, the work of WWF, of *Fondo Monarca*, the protected area officials, have allowed for the integration of processes so that, as you just saw in the assembly, the decision-making revolves around how to manage natural resource within the core area, so conserving resources has become an important baseline to be able to continue to benefit and increase incomes under important poverty levels and lack of opportunities.

The PES program was also credited with leading to conservation-minded changes in communities' internal rules. A *1PBz* community representative in Campeche explained that people now need to ask for permission from the *ejido's* authorities before felling a tree.

3.3.3 Community agricultural practices

In general, PES and PAs seemed to have little effect on communities' agricultural practices across the three regions. In Campeche, two communities stated that livestock has not been restricted by the PES program (*1PT*, *1PBz*), and two *1PBz* communities stated that their agricultural practices have not been affected by PES either. This is due to the fact that these activities are conducted in individual *ejidatarios*' agricultural plots (*1PT*, *1PBz*). There may, however, be some potential for PES in abandoned agricultural lands, given the rate of forest regeneration in this region. An intermediary described some reforestation or PES programs in former agricultural plots, while representatives from two communities (*1P*, *1PBz*) described natural regeneration in old agricultural plots, with one emphasizing that the rate of natural regeneration decreases if the land was farmed for multiple years.

In the Michoacán and Estado de México, representatives of two communities emphasized that PES and the MBBR did not cause a change in their use of lands for agriculture or livestock, for one *2PBzT* *ejido* because their agricultural plots were already outside of the Reserve. In contrast, representatives of two other communities (*3PBz*, *1PBzT*) fenced in their livestock to protect reforestations, which in at least one of the communities was funded by PES.

For one *3PCCAT* community in Oaxaca, clearing pastureland continues to be a motivator for deforestation. This is guarded against, however, by the community's monitoring, which are funded by PES and sustainable timber management. The representative of that community also noted that forest conservation has reduced planting of corn and beans. In contrast, a representative from another *3PCCAT* community stated that PES has not caused a change in agricultural areas.

3.3.4 Capacity building and learning

The role of organizations and agencies in providing training and other resources was often highlighted in all three regions. A CONANP official in Campeche pointed out the role that GIZ has had in promoted regional cooperation with neighboring state protected areas. In Campeche, a *1PBz* community specifically pointed out that the organizations they've worked with bring laptop computers and projectors that allow them to show educational videos to local children. A *1PBz* community member spoke of the importance of capacity building for the development of productive projects:

When we started with the beekeeping, well we had no knowledge, and one by one the trainers started to come, the technicians, and they started to build our capacity, that was when we finally learned about that beekeeping business.

A *1PBzVpaT* community representative in Campeche specifically highlighted the role of a CONANP official in helping his community re-draw their territorial zoning and design an Ejido Development Strategy, which included the creation of an AVDC. In Michoacán, CONANP was also perceived as an essential actor that provided capacity building for sustainable tourism and biodiversity monitoring, and several communities highlighted the role of WWF in providing capacity for taking timber management to the next level of the production chain by providing sawmills. A WWF employee confirmed that both WWF and CONANP provide financial and training support for a variety of projects such as nurseries, aquaculture and cultivation of edible mushrooms (Picture 8). A CONANP official further explained that they have supported several productive projects such as artisanal products, even helping communities get their business registered and start accepting credit cards.



Picture 8. Edible mushrooms being commercially cultivated by a community member in Michoacán, with the financial and technical support of WWF.

PES was often perceived as a precursor for community capacity and learning. Apart from learning to do firebreaks and brigades, as mentioned above, a forestry technician in Campeche said that communities learned from PES how to monitor and defend their forests. A member of *1PBzVpaT* community in Campeche stated that, after they were awarded PES for the first time:

With that, we began to operate, well, many of the things that [our community] can now brag about, and in 2016 we got a chance to see about the voluntary [protected] areas, we got a chance to go to Mexico [City] to enroll them and two years later we received the certificate.

Information exchange was often mentioned as an important source of learning. When it comes to holistic forest management, Oaxaca has long been recognized as an international standard for what communities can achieve. An intermediary in Campeche told us about organizing visits to Oaxacan communities, and how Campeche communities were inspired to make the most of their natural resources. Other researchers have affirmed the value of this type of community-to-community learning transfers for Mexican communities engaged in CBFM (Klooster & Masera, 2000). A *1PBz* community representative in Campeche also described a trip he organized for local schoolchildren. They visited regions in Chiapas where forests had given way to pastures, and stressed that this is what could happen to their land if they fail to value what they have. A *3PCaT* community in Michoacán also described visiting an ejido in the state of Puebla where they were doing sustainable timber management, and feeling inspired to have a better and more productive forest through their management plan. This type of educational visits was also described by an Estado de México government official.

Participants also described traveling as changing perceptions in another important way. A community representative from Estado de México and one from Michoacán talked about how living and working in the United States taught them different strategies for land management which they are interested in replicating. A *3PCaT* community representative in this region said that he does not have to go far to learn from people with other backgrounds and experiences because they come to visit the community. The representative saw this as one of the advantages of receiving tourists in their community.

Learning was also mentioned often in terms of environmental education of children. All three regions had examples of how children were now aware of the importance of conservation, and rejected actions perceived to have a negative environmental impact. A relevant comment from two members of a *1PBz* community in Campeche was that they used the money they received from PES to pay for their children's transport to and from school, which allowed them to continue or finish their high school education. A community representative from a *2PBzT* ejido in Estado de México also mentioned that they, as adults, learned (and were impressed) about the Monarch butterfly's life cycle and migration from CONANP officials.

It is also important to note that participating in a PES program necessarily involves learning about the definition of ecosystem services. This can be a complicated concept to grasp. It was interesting to observe how interviewees appropriated the concept of ecosystem services, and how there were often misinterpretations. In particular, the idea of payments for carbon capture was sometimes mixed-up with payments for oxygen production. However, the concept of payments for hydrological service seemed to be a clear and powerful concept for people to understand, which sometimes translated into threats to cut-off the supply of water for downstream communities (see 3.2.3, "Water Access" for more details).

In all three regions we heard about the importance of forestry technicians that come from the communities themselves. In Campeche, a CONANP official detailed the origins of the ARS and SOCETEC, which are made up of young ejido members who have trained as foresters and now assist their communities directly. This was confirmed by a SOCETEC employee. In Michoacán, another CONANP official further clarified that the advantage of having forestry technicians who are community members is that they receive a large percentage of the PES or STM funds as payment for their work, so this way more of the money stays within the communities themselves and has a trickle-down effect.

3.3.5 Conflict

A *3PCaT* community representative in Michoacán said that the presence of both the MBBR and PES has reduced conflict between the community and government agencies, because they now understand they share a common goal.

In Michoacán and Estado de México, politics have caused conflicts between PES beneficiaries. Unlike Michoacán, Estado de México has its own state-level PES scheme, so communities within the MBBR located within Estado de México receive more PES funds than their Michoacán neighbors. This has led some Michoacán communities to protest by blocking highways and threatening to shut-off the water supply to the Cutzamala system. Also within the MBBR, the distinction between core areas (which receive much larger PES through *Fondo Monarca*) and buffer zones has led to conflict, which CONAFOR has tried to remedy by increasing PES to communities in the buffer zone.

3.4 Environmental changes resulting from biodiversity conservation strategies

Table 4. Number of coded references for each combination of conservation mechanisms and environmental changes.

	Environmental changes		
	Biodiversity	Forest Cover	Water quantity or quality
Effects of timber management	5	15	0
Effects of protected areas	14	23	8
Effects of PES	7	33	4

3.4.1 Biodiversity

Biodiversity monitoring has been successfully employed by several of our interviewed communities. A *1PBzVpaT* community in Campeche proudly exhibited camera trap pictures in their community meeting house (see Picture 9). Several *3PCCAT* communities in Oaxaca were afraid that the noise from harvesting timber was going to drive animals away, so they implemented camera traps and have shown that animals only flee temporarily and then return to clear-cut sites. This biodiversity monitoring has revealed the presence of animals, including endangered species. After decades of STM, their medicinal plants and other biodiversity has remained intact. One *3PCCAT* community used to only grow and harvest pine trees, but they have learned from the PES program that each species has a value, and they leave some individuals standing to maintain the species mix. They follow SEMARNAT timber harvesting rules that require building burrows, leaving snags for birds to perch on and leaving biological corridors connecting around clear-cut sites.

Technicians from UZACHI in Oaxaca have observed high levels of native species reproduction including pumas, wild boars and deer. They attribute this to local conservation practices in Oaxacan communities. An ICICO interviewee said that PES benefits biodiversity because when you protect water or sequester carbon you are automatically protecting biodiversity.

A *3PCCAT* community in Oaxaca and a *1PBzT* in Campeche stated that since they started participating in PES they changed their internal rules and now prohibit hunting. In a *2PCa* community in Estado de México they talk about how PES has taught them to respect the Monarch butterfly and not harm them. They and two more *3PCaT* communities in neighboring Michoacán also mention that since the establishment of the MBBR hunting is now prohibited, and they have seen animal populations recover since then. One of these *3PCaT* mentioned an abundance of birds, and explained they are motivated to care for the animals because tourists enjoy seeing them:

We are conscious that we should not destroy [the animals] because this is something that attracts people here, if people come from the city, well, they have to be able to see something different.



Picture 9. Camera trap pictures displayed on a Campeche community's meeting room (*casa ejidal*).

On the other hand, a *1PBzVpaT* community in Campeche that has a wildlife management unit (hunting permits), says that the fact they can “sell” their animals makes it profitable for them to conserve them.

In Oaxaca, a *3PCCaT* community observed that wild animals use the CCA to “hide”, as it is a quiet area where people do not disturb them. Likewise, interviewees from a *1PBz* and a *1PBzT* community in Campeche expressed a theory that animals move to where they are most comfortable, but in this case they believe they have left their community and migrated to neighboring Guatemala, which is better conserved. A *1PBzVpaT* in Campeche stated that there have been numerous attacks on their cattle, which proves there is a healthy jaguar population that he thinks has benefited from their conservation practices.

Not everything is good news for biodiversity. In a *3PCaT* community in Estado de México interviewees mentioned that dust and dirt from nearby mining activities have affected the Monarch butterfly and reduced the number of butterflies that visit their land. A focus group of women from a *3PCaT* community in Michoacán perceive a decrease in availability of medicinal plants, firewood, birds, deer and Monarch butterflies. A WWF staff member in Michoacán corroborated that deer populations have decreased as a result of overharvesting in the past. He claims that now, people still hunt but mainly predators who they fear can attack their livestock. Another WWF employee stated that, although there is no robust biodiversity monitoring mechanism for species other than the Monarch butterfly, he believes there are still high levels of extraction within the reserve.

A focus group of women from a *1PBzT* community in Campeche indicated that several animal and species have been dwindling because of population growth and the fact that people hunt them and dogs chase them away.

3.4.2 Water quantity or quality

An ICICO interviewee said that after a community started doing restoration for a carbon capture PES project in the highlands, water started flowing where it hadn't before. UZACHI technicians agree that forest conservation in Oaxaca has guaranteed the provision of water for local communities. Two *3PCCAT* communities in Oaxaca perceive that their ACCs have guaranteed water provision. This was echoed in a *3PCaT* community in Michoacán, whose representative stated that PES has helped them increase surveillance in their forests, which in turn has led to an increase in forest cover and water provision.

A member of a *3PCCAT* community in Oaxaca acknowledged that some communities, themselves included, have experienced firsthand the loss of water because of deforestation. A *3PBz* and a *3PCaT* community in Michoacán noticed that when they deforested their lands, the springs dried out, and when the forest recovered after the establishment of the reserve, they started getting water again.

Several communities in Michoacán recognize the fact that an increasing population has put pressure on water supplies (*1PBzT*, *3PCaT*, *2PBzT*). A *2PCa* in Estado de México has experienced a “water crisis” that they associate with a loss of forest cover:

The children now go to school and they talk openly, they make us understand that we have water because of the forest, if we lose the forest, automatically we run out of water.

Avocado plantations are growing threat for water availability in Michoacán. A government official explained that many people in the region have sold their lands to avocado producers, a very water-intensive crop, which has exhausted water supply:

We visit indigenous communities and ejidos and everyone complains, “There used to be a river here and now only a drizzle, we used to be able to take water directly from here, but now they have exhausted our reserves”, and we ask, “why are those people here?”, “because we sold them our lands...”

In one *3PCaT* ejido they told us that a neighboring avocado plantation not only caused a reduction in water flow, but the water they did receive was found to be contaminated with carcinogenic chemical compounds.

3.4.3 Forest cover

Our interviewees reported significant and complex changes in forest cover trends across the three regions. Communities in Oaxaca have mastered forest management practices and use them to maintain or increase the health of their forests. Michoacán communities have mostly seen a decrease in illegal logging favored by a strong protected area and PES.

Timber management played an important role in maintaining forest cover in all regions. In Campeche, a *1PBzVpaT* community representative found that designating timber management areas helps

prevent agricultural encroachment on the forest and makes caring for the community's forests profitable. Two *3PCCAT* communities in Oaxaca observed that trees grow faster under timber management than naturally, because clearing allows the sun to reach them. A *3PCaT* community in Michoacán also noticed an increase in natural regeneration in timber management areas. Another *1PBzT* Michoacán community has carried out reforestation as part of their forest management plan, but they perceived natural regeneration to be much more effective. However, a WWF staff member said that the forest management plans in the MBBR region are developed by the timber buyers, who have a big influence on the ultimate composition of community forests. This has led to forest degradation in some cases.

There was strong support for the belief that the MBBR has been successful in halting reducing logging. A *3PCaT* community perceived that the reserve has been a positive thing for them because it helps fight illegal logging and conserve the forest. One interviewee from another *3PCaT* recalled that he used to watch truckloads of huge diameter trees that had been cut down, which no longer happens since the reserve was established. Representatives from a *2PCaT* and a *2PBzT* community in Estado de México stated that they experienced devastating illegal logging, but their forests have now recovered thanks to CONAFOR's reforestation programs. They feared that the presence good quality timber in now healthy forests may attract more illegal logging. A *Fondo Monarca* official corroborated that previously logged forests have recovered in some locations.

In Campeche, a member of PRONATURA indicated that the CBR has also been greatly effective in maintaining forest cover within its borders, as have all protected areas in the Yucatán Peninsula. A *1p* community member in Campeche believed that the communities that lie within the CBR have better-conserved forests because the reserve does not allow them to deforest. An ARS member indicated that AVDCs are also helping reduce deforestation in Campeche, citing a *1PBzVpaT* community that organized to obtain a timber harvest permit and FSC certification and went from managing their forest on an individual basis to enrolling most of their territory in sustainable forest management for the benefit of the entire community. This was corroborated by two members of that same community, who added that trees have grown in the zones designated as AVDC core areas:

The positive impacts [of the AVDC] are, for example, that after I'm gone, after you're gone, after my grandchildren are gone, [our community] will still be conserved.

On the other hand, two *3PCaT* communities in Michoacán stated that the whole approach of leaving forests "untouched" is detrimental to the health of forests because there is no natural regeneration. They advocated for active, data-based management to promote healthy forests:

No one wants to use up all the forest, it's not in our best interest, but what we are interested in is having a good management plan for the entire reserve to identify where some activities are required.

Several WWF staff members and an Estado de México government official also supported this view, claiming that the best alternative for conserving forests is through active management by local people:

If local people go into the forests, put out fires, stop illegal loggers and produce timber and furniture, well, we will then have more and more forests.

In contrast, a former PES intermediary questioned the effectiveness of all the conservation mechanisms that coexist in this region:

In Michoacán the PES and the Monarch Butterfly Biosphere Reserve have been around for many years, yet we have lost 300,000 hectares to illegal land use change, PES has not contained it, the Forestry Law has not contained it, the protected area has not contained it, and the Environmental Management Unit biodiversity conservation strategy has not contained it, the policies are not working.

A WWF staff member, however, perceived that PES has indeed helped conserve forests, and that forest loss within the reserve has been mostly due to natural disasters. In a *3PCCAT* community in Oaxaca they have noticed a reduction in forest plague infestations due to PES support for forest monitoring. A *2PCa* community in Estado de México and a *1P* in Campeche were also grateful that PES is helping them do firebreaks, which have been successful in preventing forest fires in recent years. They have also noticed that natural regeneration and reforestation have resulted in an increased forest cover. A *3PBx* member went as far as to say that:

If they hadn't given us those funds [PES], the forest probably wouldn't exist anymore, there would probably be only avocado plantations and this spring wouldn't exist either.

This community was been awarded a distinction for their good forest management (Picture 10), which the representative perceived as one of the positive outcomes of the PES programs, in that it allows them to demonstrate they can get things done when they receive support.

A PES intermediary in Campeche believes that PES has been highly effective preventing land use change in this region because people understand that if they fail to conserve, they will not get paid, and the payments are extremely attractive (“there is nothing that compares to it”). It also prevents land use change because lands that are enrolled in the program cannot be sold, so it is safe from people who want to buy lands to exploit them. However, she admits that PES is not additional in many communities, as they mostly enrolled areas that would not have been used anyway. A PRONATURA staff member cautions that, while PES does in fact help maintain forest cover, it does so:

[...] for five years, between that and nothing there is no difference, that is, it does achieve its function, yes, for five years and not a day longer.

This view was echoed by an ARS intermediary, who acknowledged that nothing prevents PES recipients from converting the land to agriculture once the program is over. A member of a *1PBx* community in the same region supports the notion that PES payments can represent an important source of income for some people, and predicts that necessity will lead them to deforest once they stop receiving payments.



Picture 10. Community representative in Michoacán showing the community’s awards for good forest management.

3.5 Interaction Effects

3.5.1 PES & Protected areas

Respondents in each of our regions described significant interactions between Payments for Ecosystem Services and Protected Areas, whether federally decreed Biosphere Reserves or the community-level AVDCs, ACCs, or UMAs. There seemed to be the widest complexity of interactions in Calakmul, although this may be partially because of the diversity of opinion among our interview participants there, which included CONANP staff, members of environmental and development organizations, and several different associations of community intermediaries.

Both the Monarch Butterfly Biosphere Reserve and the Calakmul Biosphere Reserve have clear interactions with PES in ways that can benefit both communities and the Reserve. Communities near the Reserves seeking PES benefit because CONAFOR authorizes PES for communities based on a number of criteria, including proximity to national protected areas. This is based on the theory that PES in nearby communities may lead to increased ecological buffering and improved pro-conservation sentiment and behavior in nearby communities. While a positive relationship between PES and pro-conservation attitudes and/or protected areas has been challenged by a number of studies (Rico García-Amado, Ruiz Pérez, & Barrasa García, 2013; Rode, Gómez-Baggethun, & Krause, 2015), both are supported by our research, as detailed further below. While a former PES intermediary pointed out that communities within protected areas were initially excluded from state-level PES in Michoacán, a government official in Michoacán stated that Michoacán also now prioritizes communities with higher proximity to the reserve. As two intermediaries in Campeche explained it, PES is a perk of being near a Reserve:

CONAFOR has considered us as priority areas for the selection of environmental services. This is what we have told the ejidos. Yes, there are benefits in being close to a protected area, and one of those benefits is payments for ecosystem services.

In addition to being favored by CONAFOR, protected areas may directly promote PES or provide other types of support to neighboring communities. Leaders of two communities in Campeche (*1PT* and *1P*) further from the reserve, however, saw this negatively, as they believed it caused them to be less favored for PES or other programs. A representative of an environmental organization in Campeche also pointed out that privileging reserve-proximity for PES may have negative implications of not placing conservation mechanisms in areas further from the reserve that may not have any conservation mechanisms.

Reserves also benefit from PES. A pair of intermediaries saw PES as part of Calakmul's strategy to increase connectivity with the reserve, while a CONANP representative described the value of PES as providing an ecological buffer:

Interviewer: "How do you see [the PES] program with respect to the Reserve?"

Interviewee: "Well, yes it helps us because every ejido that enters, they plan out, they have to delimit the area that they're going to conserve, that they propose to CONAFOR. If they say 2,000 hectares, then in these 2,000 hectares they're not going to touch a single tree, they're going to create their firebreak, they're going to do their rounds so that no one, no foreign person enters to cut wood and all that. And what I'm telling you is, the resources for this—for the maintenance of the firebreaks, for taking care of the fauna... I heard of an ejido that put artificial drinking troughs, they take them water so that the animals wouldn't leave. In times of drought you see that there isn't water, and the animals have to come close to the urban zones [...] And yes, payments for ecosystem services to an ejido helps us a lot in conserving the region."

As the CONANP representative mentioned above, PES can also be a way to improve communities' attitudes towards the Reserve. The connection between PES, the often-accompanying community conservation areas, and pro-conservation or pro-Reserve sentiment was corroborated by another intermediary:

There has been a lot of support on this side in order to not generate as much pressure on the Reserve and so that the people don't see the Reserve as something foreign, but rather like one of the community's reserves.

A CONANP official in Campeche saw PES as directly causing a pro-conservation mindset:

If you go to an ejido that has never participated in PES, in and of itself the ejido doesn't know what conservation is. [...] It's not important to them. However, an ejido that participates in PES already has the knowledge that the Reserve is almost similar. And this has resulted in that many people respect it.

A member of a intermediaries' association even saw PES affecting conservation mindset intergenerationally:

And with this PES program, including AVDCs and all of those things, the people have begun understanding more and more. Even in the school they tell them, “One has to conserve, one can’t fell trees,” etc. Before the people were very closed off and when one came and told them, “You know what? Here you’re not going to fell trees anymore.” [They would respond] “Why not? Where is my food going to come from? Where are my children going to eat from?” but that was many years ago already, not anymore.

A *1PBz* community member in Campeche also vividly described PES’s effect on opinions about the Reserve:

Interviewer: “Do you believe that specifically PES has changed peoples’ opinions about the reserve, creating a connection with the reserve?”

Interviewee: “Look, for me it has a connection, for me it has a connection because what the Reserve does is conserve, and PES searches for [conservation], only that now it’s like what they say, how in a single plate there is both meat and beans, but in the end they’re almost the same.”

Intermediaries from a *3PCCAT* community in Oaxaca echoed the Campeche community member’s statement about PES’s shared goals of conservation with a protected area, although they were describing a community conservation area rather than a biosphere reserve. Two community representatives in the MBBR said that the *Fondo Monarca* has changed opinions about conservation and the Reserve as well.

For most respondents in Michoacán and the state of México, however, the interaction between PES and the Monarch Butterfly Biosphere Reserve had even higher stakes. PES may provide added benefits for reserves such as Calakmul where the majority of communities are outside of the park, but for the Monarch Butterfly Biosphere Reserve PES are the critical mechanism that makes the Reserve financially and socially viable for its constituent communities. A CONANP Reserve official emphasized the crucial role of PES—in the form of the *Fondo Monarca*—in allowing communities to coexist with the reserve.

Definitely this type of mechanism and strategy has contributed in a very, very important manner to the conservation of the Reserve, for a better management of its resources and overall, for the social and economic development of the communities that live within it.

Staff people in *Fondo Monarca* and WWF emphasized the importance of compensating communities for lost timber rights through PES, as timber management was the communities principle economic activity. Leaders of communities within the Reserve (*2PCa*, *3PCaT*, *3PCa*) were in agreement with the CONANP official. One *2PCa* community representative stated that the community sees itself as obligated to care for the forest because of PES, while a *3PCaT* community representative said that his community would have to push for forestry management rights in the Reserve if it were not for the *Fondo Monarca*. A third community’s leader perhaps put the connection between PES and the viability of the Monarch Butterfly Biosphere Reserve most succinctly:

Interviewer: “Do you believe that the fact of receiving PES has changed how people perceive being within the protected area?”

Interviewee: “Well yes, yes it’s changed. It’s changed a lot, because on the basis of one, the other is protected.”

As both a *2PCaT* community representative and an NGO staff person told us, PES and the Reserve also jointly provides funds for some activities, such as community surveillance groups and firebreaks.

PES’ relationship with other types of protected areas, such as AVDCs, UMAs, and ACCs was more nuanced, although in general terms PES often led to community-level protected areas. Numerous respondents in Campeche described PES as leading to AVDCs, a transition which was actively promoted both by Calakmul CONANP staff and by a prominent local intermediaries’ association. This finding is in accordance with research by Bezuary-Creel, Gutiérrez-Carbonell, and Remolina (2009), who found that PES is an important factor for motivating communities to establish voluntary conservation areas (Bezuary-Creel et al., 2009). As one intermediary told us, territorial zoning conducted to fulfill PES requirements led to the delineation of a community conservation area, which in some cases then certified with CONANP as an AVDC:

When they begin with PES, they already know their territory, they already have an area destined for conservation and they’re already in the process of [updating] their internal laws...

Two representatives from a *1PBzVpaT* community corroborated this by mentioning they established their conservation area as part of their Ejidal Development Plan, which was a PES requirement. In other cases, community conservation areas or formerly PES-enrolled areas may be certified as AVDCs once the PES program ends, as described by an intermediary:

The organization here in the zone where I work is called that, the Network of Silviculturists with Community Conservation Areas, it’s a silviculturists’ association. All of them are going to have their reserves, because all of them that finish PES are left with their conservation area. [...] The ejidos that I work with come to see their PES plots as community reserves because people adopt them, take care of them, they respect them and nobody goes in because they know it’s their reserve and they know its limits....

Although he agreed that AVDCs may help communities seek other types of programs, a representative of an environmental NGO was concerned that communities may mistakenly believe that AVDCs will have direct economic benefit:

Lately they [AVDCs and PES] have interacted more, because the AVDCs have been mutating... the PES areas are being converted into AVDCs. It’s changing the name, but the problems carry over. I believe it’s a good strategy, but at the same time, the people enter thinking that it’s continuing to be environmental services, that they’re going to receive an economic benefit in the short-term.

Three different CONANP representatives and leaders of the local intermediaries’ association told us that they promote AVDCs in hope that communities will be able to sell carbon credits from AVDCs in the near future. Two communities (*1PBzVpaT*, *1P*) also mentioned hoping to use their AVDC for

selling carbon credits or attracting some other type of project. Ironically, the very fact of certifying the AVDCs may limit opportunities for carbon credit sales. A carbon credit specialist in Oaxaca pointed out that while carbon offsetting in protected areas would be possible under the ISO certification standard, it would not be under the CARP certification that his organization promotes:

Interviewer: “If the community conservation areas are already registered with CONANP and become AVDCs, then would they be eligible for [CARP]?”

Interviewee: “Well, you would have to exclude them from within the activity area of the project for carbon capture, because since harvesting is already prohibited in these areas, you don’t have the additionality part, right? So they wouldn’t be capturing carbon, but if they had, for example, threats because of external factors, such as deforestation, fires, or land use change and you proposed management activities, they might be able to enter into a second stage. But you would have to justify the additionality.”

This additionality may be justifiable, if the intermediaries’ association leadership’s particular vision for AVDCs is acceptable to CONANP. A intermediaries’ association representative described to us AVDCs that allow for different management activities, including timber activities, and one of their communities (*1PBzVpaT*) has their AVDC structured to include a core and buffer zone.

Our respondents in Michoacán did not emphasize any particular interactions between PES and AVDCs or UMAs. In both Campeche and Oaxaca, however, PES has helped promote ecotourism activities in some communities (*1PBzVpaT* and two *3PCCAT* communities), which resulted in the creation of UMAs. A forestry technician and an environmental organization staff person described how these UMAs, one for the conservation of the Royal Vulture in Campeche, and the other two for white-tailed deer in Oaxaca, served as part of a bundle of community offerings and activities intended to help attract tourists.

PES had a more ambiguous link with CCAs in Oaxaca. A carbon credits organization representative stated that there is not an intentional link. Preferably, he said ACCs would be outside of PES areas, but that CCAs often overlap with PES-H by accident. A *3PCCAT* community representative confirmed that there was an overlap between PES-H and the CCA in his community. This is likely because several communities have traditionally considered the water sources prioritized by PES-H to be sacred sites, which they then protected with CCAs. The community representative did note that they were able to use PES funds to put a firebreak around the CCA. Highlighting one of distinctions between federal water-based and market-based carbon credit PES, another *3PCCAT* community representative pointed out that CCAs are ineligible for carbon credit PES because CCAs are exclusively for conservation.

PES and PAs do not always work together harmoniously in this variety of interactions. One intermediary in Campeche said that he did not see any interaction between PES and the Reserve. A CONANP representative pointed out the lack of coordination between PES-participant communities, which are required to organize fire-fighting brigades, and Calakmul Reserve, which has trained and equipped several independent brigades.

The Monarch Butterfly Biosphere Reserve has its own set of challenges. According to a *Fondo Monarca* representative, the Monarch Butterfly Biosphere Reserve does not allow some PES-required activities,

such as digging trenches, in the core zone, which has required meetings between CONANP and CONAFOR. A CONANP official at the Reserve pointed out that the distinctions caused by the structure of the *Fondo Monarca* payments caused some conflicts:

... but it's also true that this mechanism, because it didn't encompass those localities that don't have anything except the buffer zone, generated certain annoyances. To put it another way, at the end of the day the core zone is as important as the buffer zone. So then, suddenly existed this situation of dissent where [people said], "Why, because of not being in the buffer zone, do we not benefit? Or are you saying that in the Reserve there are first, second, and third class ejidos?" suddenly it gave rise to that situation.

According to the same official, the availability of Matching funds starting in 2009 helped fortify *Fondo Monarca* by providing a source of PES to communities in the buffer zone. The *Fondo Monarca* representative emphasized, however, that disparities between communities in the Reserve are still exacerbated by the fact that ejidos in México state receive more PES funds than communities in Michoacán.

3.5.2 PES & Timber management

At first glance there would appear to be little opportunity for positive interactions between timber management and PES. Timber harvesting is prohibited on lands enrolled in national PES programs such as Matching funds, PES for water, and PES for biodiversity, as well as in the *Fondo Monarca*. Only carbon credits-based PES may be somewhat amenable to concurrent timber management, depending on the regulations of the standard certifying the credits. In reality, however, we encountered a wide spectrum of interactions between PES and timber management, ranging from mutual exclusion to communities where the two programs strengthen and reinforce each other.

At one extreme, PES and timber management are described as mutually exclusive. This either-or view was most often expressed to us in the MBBR. As one *3PCaT* community representative stated: "if you have a timber management program, you don't have PES." Similar statements were made by representatives of two *1PBzT* communities. It makes sense that this view was expressed by communities in the Monarch Butterfly Biosphere Reserve, since the *Fondo Monarca* was designed explicitly to compensate communities which lost their timber management rights when the Monarch Butterfly Reserve was established. One NGO staff person in Campeche expressed concerns that PES' prohibition on timber management created a harmful conceptualization of "conservation":

... Their forest is well conserved because they do timber management, and that's where we tie this in with the topic of PES, which is a shame, but they manage it as if it were a glass cabinet—it's as if they put a fence around a portion of the forest and one can't do anything there, one can't touch anything there, and that's not conservation...

The design of PES programs that strictly prohibit timber management, however, was still influenced by timber management. According to a *Fondo Monarca* representative, *Fondo Monarca* pays communities in the core zone of the Reserve according to the number many cubic meters of timber they were authorized to harvest. A government official in the Estado de México's PROBOSQUE office

explained that PROBOSQUE originally proposed a PES amount equivalent to communities' specific timber profits. Due to government funding restrictions, however, the payments were significantly lowered to an amount that was considered competitive with alternative land uses such as renting it out for agriculture. Even at the reduced amount, PES amounts paid by PROBOSQUE for communities in the Estado de México are significantly larger than what communities in Michoacán receive for PES. Despite attempts to use timber harvesting as a reference point, several communities (including a *3PCa* and a *3PCaT* community) in the Monarch Butterfly Biosphere Reserve pointed out that they receive significantly less income through PES than they would through harvesting timber on the same amount of land. One *3PCa* community stated that their income with PES was 38-50% of what it could have been with timber harvesting in the same area. Another *1PBχT* community was interested in PES but unwilling to enroll in the programs if it required giving up timber harvesting. The *Fondo Monarca* representative corroborated what communities said about the comparison between PES and timber management income while reflecting on the *Fondo Monarca*:

... the [*Fondo Monarca*] support was minimal, it was 18 per cubic meter of wood and 12 dollars [per hectare] for conservation [...] in reality very little money for the enormous effort made by the ejidos and communities to conserve their resources.

Despite the prohibitions on concurrent timber management and PES in the same stand, timber management and PES have a complex variety of positive interactions at the community level. Of the 28 communities we spoke with, at least seven communities in Michoacán, three communities in Estado de México, three communities in Campeche, and all four communities in Oaxaca concurrently managed for timber and PES in different areas of their land. A representative of a *1PT* community in Campeche with both timber management and PES drew a clear link between the community's dependence on timber and the continued survival of the forest:

In the three years we weren't harvesting timber, the ecologists come and ask me: "Listen, comi, how is the ejido?" I tell them: "It's being kicked, because the economy is the ejido's timber. And if they don't authorize us [to harvest timber], what are they going to do?" I say, "Take down the forest, there's no other option left to us."

A government official, an NGO staff person, and three intermediaries in Estado de México and Campeche strongly advocated for the direct incorporation of timber management as a PES activity during their interviews. As a PROBOSQUE official stated:

... many of the country's forests—all those that are in national level-PES—aren't being productive. They need to be.

Intermediaries highlighted two principle benefits of timber management: healthier forests, and economic self-sufficiency for communities. Several intermediaries and community representatives also strongly expressed the belief that forests benefit from active management because it reduces risk of fire and severe pest and disease outbreaks. One intermediary in Campeche stated that PES increases risk to forests because the forests are not being managed the way they would be for timber harvesting.

The primary focus, however, was on the social benefits of timber harvesting. One former PES intermediary emphasizes strongly that communities that own resources should be able to benefit from them directly rather than receiving "compensation" for them. As a PROBOSQUE government official put it:

They have the hen with the golden eggs. [...] We're just giving out an egg, but they have the hen—set her to producing!

Several communities in both Campeche (*1PBzVpaT*, *1PBzVpa*) and Oaxaca (*3PCCAT*) used PES to fund the applications for timber management permits and/or certifications such as FSC (Forest Stewardship Council). Intermediaries in Campeche described the use of PES as seed money for timber management:

... many of the ejidos are already linking the PES funds with productive activities [...]. They receive their benefit upon the authorization of the timber management program—if they invest, say, MX \$10,000 in the study, the timber management program will triple that amount because it will generate an economy...

An influential intermediary in Campeche strongly emphasized the potential of PES to fund certifications, either through FSC or the Calakmul Reserve. The intermediary was enthusiastic about the potential for certifications of items such as honey, charcoal, and furniture to fetch higher prices in domestic and international markets, establish credibility for consumers, and ultimately reduce community dependence on outside funds:

I don't need to go searching for the Norwegian fund, I don't need to go looking for the fund of who-knows-who [...]. This fund is in Florida. It's in the market. And what are we going to sell to the market? Products.

In addition to direct market benefits, a *1PBzVpaT* community representative in Campeche articulated that an FSC certification would improve their chances of having PES program renewed: "Since we're an FSC-certified ejido, perhaps they'll automatically give us this honor." The positive correlation between a community's existing productive activities or certifications and their likelihood of being authorized for PES was corroborated by an intermediary in Campeche and a government official in the Estado de México.

The synergistic interaction of PES and timber management seemed to have had positive results in many of the communities we visited. One NGO staff person in Campeche emphasized how a community values an endangered vulture species differently now that they receive the tangible benefits from the UMA, STM, and PES, as well as national and international recognition. That same *1PBzVpaT* community proudly displayed banners with the details of their timber management, non-timber productive activities, and wildlife monitoring camera-trapping programs in their casa ejidal. A *3PCCAT* community representative in Oaxaca also described how their community had also used PES to fund forest management, biodiversity monitoring, and ecotourism:

First it started out with hydrological PES, with Matching funds, and from there the rest of the programs and the other projects began to arrive, and now there are several. [...] I always say that [PES] is the parent of the other projects, and that's why we are where we are today.

We also heard more about timber management preceding PES, either recently or in the more distant past. A *1PT* community in Campeche told us that their intermediary advised them to place PES in recently-harvested areas (presumably harvested through selective harvesting) to ensure that they did not enroll any areas that they would like to harvest in the near future. In Oaxaca, communities harvest

timber, reforest, and enroll the area in PES for carbon capture. An intermediary in Campeche told us that the areas many communities currently have enrolled in PES were areas that they had managed for timber about twenty years previously.

Of all the regions we visited, PES and timber management were most inextricably linked in Oaxaca. Oaxacan communities manage their land holistically, incorporating both PES and timber management in a mosaic of plots. One *3PCCAT* community intermediary beautifully expressed the prevailing view among communities that PES and timber management should go hand in hand:

... I believe that there should be an affinity between the services, between the goods and services such as carbon, water, and biodiversity, the payments for all of those, and timber management. I believe there should be a great succession, they're not rivals, not at all...

Forest management activities are very similar for PES and timber management, and we heard multiple examples of communities using income from one program to cover costs for the other. Intermediaries told us that in most communities, money from CONAFOR does not cover costs of forest management activities. Corroborating this, one of the *3PCCAT* communities' intermediaries told us that money from timber sales is used to fund intermediaries' salaries for monitoring, reforestations, and pests and disease monitoring when funds from PES and matching funds run short. In contrast, two *3PCCAT* communities we visited used PES funds to fund labor for forest management activities. Two *3PCCAT* communities also used their PES-funded camera-trap biodiversity monitoring program to demonstrate that timber management does not permanently scare away wildlife. One *3PCCAT* community also noted that they used their PES experience to start planting or allowing for the regeneration of a mixture of species, instead of just pine, in clearings after harvesting for timber. It was also the only region in which we encountered an exception to the rule that national PES programs prohibit cutting down trees. One *3PCCAT* Oaxacan community annually deforested a small area designated for hydrological PES in order to restore the ecosystem by replanting *Pinus chiapensis*, an endangered pine species.

Carbon capture credits interact with timber management differently from other types of PES. The value of forests' biological and hydrologic services generally increases with forest age, meaning that most types of PES privilege older, established forests. In contrast, carbon accumulation rates are highest in younger forests. Communities in Oaxaca have taken advantage of this phenomenon by harvesting timber and then designating reforested clear-cuts as carbon capture plots. The Carbon Action Reserve Protocol, one of the two certification standards used by communities working with ICICO, also allows for thinning of carbon plots, meaning that some trees can be removed (and potentially sold) to allow for increased growth in remaining trees. While carbon credits themselves can be sold from stands with young trees, a carbon credits specialist told us that community management of forests for water capture and biodiversity protection, such as through PES or community conservation areas, can be seen as co-benefits that may bring a higher price for carbon credits. He went on to state that prices including co-benefits can be twice as high as on the international market as in the national market.

Carbon credit sale contracts with the CAR protocol occur on a thirty-year basis, with an option for renewal ("Mexico Forest Protocol: Climate Action Reserve," n.d.). While this was not emphasized by our interviewees, the intensive management given to forests used as carbon credit plots would also

result in a higher-quality timber, should the communities choose to harvest them after the carbon credit contract expires.

4 Discussion

4.1 Relevant local social and environmental conditions

A number of variables were found to influence the implementation of payments for ecosystem services, protected areas and sustainable timber management. Based on the frequency and strength of the qualitative data we coded, the main local conditions that affect strategy implementation are:

Recognition of environmental vulnerability. Environmental vulnerability in our context has two components: the vulnerability of forests to natural and anthropogenic effects, and the dependence of communities on their national environment. We found that communities that directly experienced the devastation of their forests mentioned this as a strong motivation for conservation. This was particularly in Michoacán and Oaxaca, with their respective histories of illegal logging and forest concessions. Witnessing degradation in other places was also identified as a similar motivating factor. Communities across all three regions clearly recognized that a degraded environment would negatively affect local quality of life, mainly through lack of water or shade. The link between forest health and human wellbeing is a critical motivating factor for conservation through PAs, PES, or STM.

Level of internal organization and local governance. Both community representatives and intermediaries across all three regions emphasized the importance of strong internal organization and governance. Communities must have a certain level of internal organization to access programs such as PES, STM or AVDCs. Once enrolled, several implementers described how well-organized communities have the capacity invest program funds in productive activities or community projects rather than splitting them between *ejidatarios*, which can have a larger impact. Those communities that can sustain successful community enterprises can generate income into the future, leading to more sustainable livelihoods. As demonstrated in Oaxaca, communities with high degrees of internal organization and governance can also maintain better control of their forests by tightly regulating resource extraction, such as the collection of firewood, by community members and by preventing illegal logging by outsiders.

The role of intermediaries and organizations. These actors are extremely important, both for facilitating the establishment of PES, STM or voluntary protected areas, and also for capacity building within communities. This is in agreement with previous findings by Klooster and Masera (2000), who found that NGOs and government extension services played a key role in teaching communities the techniques, skills, and expertise necessary for success (Klooster, 1999; Klooster & Masera, 2000; Merino Pérez, 1996). Organizations such as NGOs and civil associations also played a crucial role for communities. A few NGOs, such as PRONATURA, directly provide PES opportunities for communities. In general, however, NGOs and civil associations provide a wide variety of opportunities for economic development and biodiversity conservation, which complement the programs and incentives offered by local governments and federal protected areas. In both the MBBR and the CBR, NGOs and civil associations had strongly mutualistic relationships with the biosphere reserves.

Land-to-*ejidatario* ratio. The effect of PES and STM is largely dependent on the ratio of forested community land to *ejidatarios*. While communities use and distribute funds in a variety of ways, the larger and less populated an ejido is, the more each person stands to “earn” from PES and STM. Because of this, PES can range from representing a large proportion of someone’s income to representing an almost imperceptible bonus. In the most extreme examples from our research, one community in Calakmul will receive the equivalent of MXN \$47,469 per capita in total (approximately USD \$2517 as of April 2019) from the PES contracts on their land, while a community in Michoacán receives the equivalent of MXN \$401 per capita (the equivalent of USD \$21) (Appendix V, Table 7). Forest size similarly determines potential timber management profits. Communities must have a large enough territory to sustainably rotate harvest areas, and small communities are especially burdened by high costs of receiving harvesting authorization (Klooster, 1999; Klooster & Masera, 2000; Merino Pérez, 1996).

Ecosystem and species characteristics. Combined with the size of their territory, a community’s forest type determines their potential maximum income from PES and STM. The amount of national PES per hectare that PES beneficiaries receive varies according to the type of ecosystem: communities with rarer ecosystems, such as cloud forests, receive higher payments. Second, the type of forest will influence whether STM is even a viable option for a community. Communities in the states of Michoacán, México, and Oaxaca have largely pine, pine and oak, or pine and fir forests, which can be efficiently harvested via clear-cutting or other methods. Communities in Campeche with tropical forests, however, have a high diversity of tree species. While these tropical forests may contain high-value hardwoods, the high diversity of species means that the abundance of any given species is low, requiring significantly more effort in locating and extracting valuable trees. Compared to other communities in temperate areas of Mexico, *ejidos* in the tropical states such as Campeche face extra challenges for economically viable community-based timber management (Klooster & Masera, 2000).

Wildlife species characteristics can also generate different challenges and opportunities for communities, particularly with regards to ecotourism. Colonies of hibernating Monarch butterflies, with their stunning visuals and high annual site fidelity, create a very different type of tourist opportunity for communities than, say, jaguars, the emblematic species of the Calakmul Biosphere Reserve. While international support for big cat conservation is also high, interview participants in Campeche did not mention international pressure as a motivation for the establishment of the park. Jaguars are solitary, secretive, and have large home ranges, meaning that visitors drawn to the park with the hopes of seeing a jaguar will almost certainly be disappointed. Still, the jaguar population’s wide distribution allows almost any *ejido* in the mostly-forested region of Calakmul to promote tourism on the hopes of seeing a jaguar or other charismatic tropical fauna, such as tapirs.

Availability of income-generating opportunities. Socioeconomic conditions and opportunities determine the extent to which PAs, PES, or STM are beneficial or detrimental to communities. Communities that have the potential to receive income from other forest-dependent sources, such as ecotourism or extraction of non-timber forest products, do not rely as heavily on PES income. This increases financial incentive to continue conserving the forest after PES programs come to an end. On the other hand, poorer communities that rely directly on their land are more likely to see PES as a significant source of income. In this context, STM can be seen as an alternative income source to PES, and the much larger potential gains from STM mean that PES is merely a complement to this income. In the case of protected areas, alternative income sources can increase communities’ acceptance of the PA and their relationship to its regulatory structure. In particular, communities that used to conduct STM may resent the prohibitions imposed by the PA, while communities that rely on

ecotourism or other activities that require a healthy forest may appreciate the PA for its power to prevent forest loss.

Climate change. This overarching factor can affect communities in many ways, and programs should be designed to cope with this. In Michoacán, many respondents identified climate change as one of the main threats to forested areas. In Oaxaca, respondents acknowledged that climate change can exacerbate the incidence of forest pests and diseases, which greatly threatens their main livelihood. In all three regions, respondents described witnessing the effects of climate change, mostly with regards to changes in rain patterns. The effects of climate change on PES-enrolled lands must also be considered. For example, if climate change causes forests within a community to disappear (through water scarcity, increased risk of natural disasters or increased incidence of pests and diseases), is it fair for PES payments to be reduced or discontinued?

4.2 Interaction between PES, PAs and STM at the community level

The interactions between these three programs are multiple and complex, but mostly complementary and positive. We summarize the main interactions and direction of effects in Figure 6. Some of the main ways in which these interactions occur at a community level are:

Shared biodiversity conservation rules. Although their approaches are vastly different and, all three strategies contain rules designed to protect biodiversity. The overwhelmingly positive perception of community-based biodiversity monitoring in all three regions hints at the openness of communities to participate in biodiversity conservation within their lands. Some form of biodiversity monitoring has been carried out in all three regions, and while we did not corroborate this through ecological studies, we heard positive anecdotes of biodiversity recovery in all three regions. In Oaxaca we were shown pictures and videos gathered and proudly displayed by community members, and we observed that at least some animals do return to harvested and reforested sites. Each strategy may have advantages and disadvantages for biodiversity conservation, although the income generating properties of PES and STM and the further potential for STM to lead to sustainable livelihoods make these attractive complementary strategies to the strict conservation premise of PAs. Since PAs cannot realistically be established everywhere, and each government agency (CONANP and CONAFOR) has limited resources and capacity, it is reasonable to conclude that implementing all three strategies in a given region may increase the probability that biodiversity is conserved.

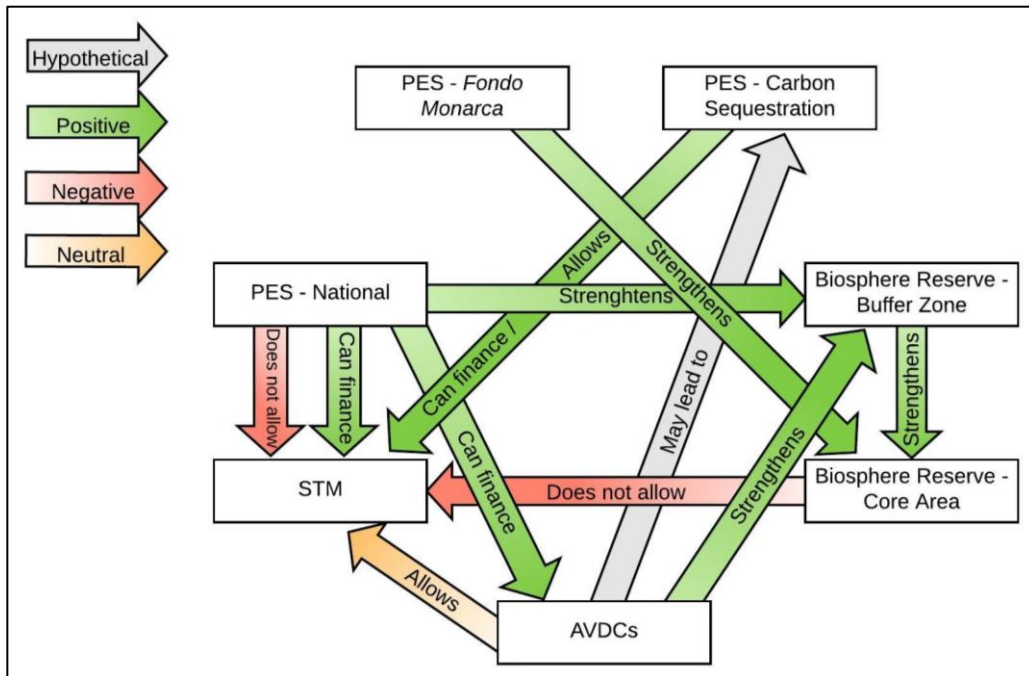


Figure 6. Interactions between the three different types of PES we studied, biosphere reserves, areas voluntarily destined for conservation (AVDCs) and sustainable timber management (STM). The color of the arrows corresponds to the type of interaction.

PES as compensation for opportunities lost from PAs. When government protected areas prohibit the extraction of forest products within their core areas, PES can be provided to mitigate this negative impact on affected communities. In the MBBR, the *Fondo Monarca* and matching funds programs that provide payments to communities whose lands lie within the core area of the reserve were perceived as a success by both community representatives and intermediaries. Language such as “working together” or “because of one, the other is conserved” shows that these PES programs are providing adequate compensation to incentivize local communities to cooperate towards the goals of the PA. In the CBR, on the other hand, the resettlements that occurred after its designation mean that hardly any communities overlap with the core area. It is an interesting hypothetical question to consider whether, if PES programs had existed back in 1989, the resettlements could have been avoided in favor of a more conciliatory approach.

PES can change opinions about PAs. When the above is true, or when there is some initial opposition to the establishment of a government PA, receiving PES can reduce negative perceptions of PAs. Beneficiaries understand that communities within or around PAs are given priority as part of PES eligibility rules, and that PAs more generally can help attract funds for environmentally-friendly productive activities within their territory. Our interviewees made it clear that PES promotes a friendlier perspective towards conservation, but it is not clear why this is the case. We propose two hypotheses: Either the process of describing PES to communities leads to an understanding and appreciation of the benefits provided by the environment, or the activities associated with PES (monitoring boundaries, clearing firebreaks, placing water troughs for wildlife) make people get into closer contact with their forest, which in turn leads to increased ownership and appreciation. This finding contrasts with the conclusion of researchers studying PES in another Mexican biosphere, who found that PES increased communities’ utilitarian valuation of the environment at the expense of

intrinsic motivations and negatively affected perception of the PA (Rico García-Amado et al., 2013). Nonetheless, our research strongly supports the conclusion that PES promotes pro-conservation attitudes and perceptions of the PA in both the MBBR and CBR.

PES strengthens PAs. CONANP staff in both the MBBR and the CBR said that PES helps them in fulfilling their goals of conserving these ecologically important regions. Because of the conditionality of PES payments on maintenance of forest cover, PES-enrolled lands are likely to be well-protected from forest fires and illegal logging. In Oaxaca we heard that the surveillance and fire-prevention activities required by PES also benefitted their community conservation areas. Additionally, as mentioned above, participating in PES leads communities to have a more positive perception towards conservation, thus no longer feeling that the PA is going against their best interests. Having local communities on your side is essential for PA staff, as they rely on them to receive reports of fires or any illegal extraction activity. All in all, prioritizing PES allocation to communities within PAs does seem to have a positive effect on PAs.

PES funds can be used to establish PAs or for STM. One interaction we were definitely not expecting to encounter is the use of PES funds for the establishment of PAs, but that was the case for some communities in Campeche. The CBR's CONANP office is promoting the establishment of Areas Voluntarily Destined for Conservation within communities that surround the CBR as part of an ambitious strategy to increase connectivity, certify local products and attract carbon sequestration payments. Although obtaining an AVDC certificate provides no immediate benefits to communities, those that have established them did so with the expectation that it will bring future opportunities and were particularly interested in gaining access to the carbon market. The process of establishing an AVDC requires a considerable investment from communities, as they must hire a technician to conduct the proper studies, revise the territorial zoning and formally apply for CONANP certification. And, interestingly, an appropriate source of these funds can be PES, as they can definitely justify this expense as an environmentally-friendly community project. We witnessed a meeting between community members and their PES intermediaries where the community decided to spend part of their PES funds in this way.

In Oaxaca we heard that PES funds were often used to cover the costs of STM. As community members explained (and as was easy to imagine from our visits to the forestry plots), STM is an incredibly labor- and cost-intensive activity that communities are barely able to afford. PES funds can provide some relief. It is also convenient for communities that engage in both strategies that the PES requirements of clearing firebreaks, pruning, thinning and regularly monitoring the forest are the same activities they must engage in for timber management, so they just do these practices across their entire territory.

STM may strengthen PAs. The income that STM provides communities is a financial incentive for forest conservation. In fact, it has been suggested that communities that participate in STM maintain more and more continuous forest cover than protected areas in Mexico (FAO, 2016a), and during our participant observations of forestry plots in Oaxaca we definitely saw some healthy and robust-looking forests. We also heard from intermediaries across all three regions that the classical perception of timber harvesting as going against forest conservation is outdated and incorrect, and some strongly emphasized that STM should be allowed even within core areas of PAs (with some exceptions such as prohibiting it during the monarch butterfly hibernation months). These perceptions point towards a great potential for STM to also strengthen PAs by maintaining forest cover and connectivity in surrounding areas. When we consider that this strategy is also the one that can potentially bring the

biggest revenue for participating communities, it becomes hard to argue against the promotion of this practice wherever possible.

4.3 Recommendations for PES, PA and STM design and implementation

Our recommendations for policy advocates and implementers are outlined in this section. We will address specific recommendations to the relevant groups of actors.

4.3.1 Policy recommendations

This section contains recommendations addressed to decision-makers in the environmental policy sector. It highlights the main ways in which we believe rules and regulations can be created or modified to maximize the positive biodiversity conservation and sustainable development goals of PAs, PES and STM.

Continue to implement PES within protected areas: It compensates for lost opportunities and changes people's perspectives on conservation. PES was overwhelmingly perceived as a strategy that strengthens protected areas. It may seem redundant to implement a biodiversity conservation strategy within another, however, our findings suggest that each addresses a different but equally fundamental aspect of environmental protection. Protected areas by themselves are perceived as working against local communities, and often their establishment leads to forced resettlements within the core area (as was the case in the CBR). Providing PES to local communities whose territories are affected by a protected area can change the way people perceive the reserve and biodiversity in general. The program teaches people about the value of their forested land not only for their own livelihood but for society in general. PES seemed to have a positive effect on intrinsic environmental values, as multiple communities acknowledged this change in attitudes and even stated they would continue to conserve in the absence of PES. In our cases, PES increased the sense that communities and protected area staff were all working towards the same goal and helping each other achieve it. The compensation that PES provides for the loss of resource extraction opportunities also increases the social fairness of protected areas. It is possible that, if PES is implemented jointly with the designation of a protected area (as was the case in the latest designation of the MBBR), then there would be no need to displace communities.

Design PES rules and requirements to enhance compatibility with sustainable, productive activities. We heard both in Campeche and Oaxaca that investing PES funds into community-wide productive projects, such as ecotourism or sustainable timber harvesting, can be a game changer compared to the usual practice of splitting funds among beneficiaries. Successful and sustainable productive activities would incentivize conservation even after PES is over, which would represent long-term savings for CONAFOR, and provide communities with a reliable source of income. However, it is important to note that this solution may broaden the income gap between beneficiaries and non-beneficiaries by making beneficiaries even better off. This negative impact on equity could be ameliorated by requiring that projects intentionally incorporate all sectors of communities, including non-legal right holders like *avecindados* and women.

Provide training to forestry technicians to successfully implement productive projects by building inter-institutional alliances and designating funding. If use of PES funds for

productive activities is to be promoted, participating communities must have the capacity to successfully undertake a collective business venture. Intermediaries, who are usually foresters by training, are currently not prepared to assist communities in this process. By requiring that PES intermediaries demonstrate the skills necessary to develop productive activities, it is possible to maintain and strengthen their role within communities. Beneficiaries of the PES program already rely on their intermediaries to advise them on all other aspects of enrollment and compliance, so it makes sense for them to receive this additional training from the service providers they are accustomed to working with.

The Ministry of Social Development (SEDESOL) manages a variety of programs and subsidies to “contribute to improve the income of people living in extreme poverty, through productive and financial inclusion into the social sector of the economy (DOF, 2017).” In particular, its General Directorate of Productive Options (DGOP) administers a public fund for both in-kind and cash supports for the development of productive projects. Cash supports are provided for groups looking to start a productive project, for example, up to \$200,000 can be provided for apiculture projects. In-kind supports provide training and technical assistance for groups of people living below the poverty line. They do so through “strategic partners,” which are national or state-level institutions of higher education. These educational institutions design the workplans and provide direct training to beneficiaries. They are hired by the DGOP to plan and implement productive activities with poor communities. They have the experience that PES intermediaries lack. Presumably, these institutions would be interested in being part of the PES program, as this would increase their client base without requiring much additional training or resources.

CONAFOR could contact DGOP and obtain from them a list of the higher-education institutions they use as productive activity training providers throughout the country. These training providers can then be directly contacted and asked whether they are interested in being included in the final list to be provided to PES intermediaries.

Provide funding for information exchange visits. Throughout our interviews we received highly positive remarks regarding the experience of traveling to other communities and learning from the ways in which they manage their forests. An intermediary in Campeche reported that there used to be funding available for them to organize visits where they would take members of the communities they work with to learn from other communities, but that this funding source was recently discontinued. They were probably referring to the “Intercambio de Experiencias” (experience exchange) program that CONAFOR used to promote within its Community Forestry Development category (CONAFOR, 2011a), which indeed seems to have vanished after 2011. Programs such as this one should be funded and incentivized, as everyone who participated in some sort of information exchange experience described learning from it and being incentivized to apply the knowledge gained to their context.

The collaboration between NGOs and government agencies amplifies the capacity of protected areas to achieve social development and conservation. We heard ample evidence of the involvement of CONANP staff with local communities, both in the MBBR and the CBR. They spearhead and promote a range of projects aimed at benefitting and improving the livelihoods of local people, such as the elaboration and marketing of pine-leaf crafts and the creation of a youth biodiversity monitoring team in the MBBR, or the promotion of indigenous species of corn and the creation of a certification for sustainably and ethically produced goods in the CBR. In many cases, CONANP works closely with both local, national and international NGOs to implement and

promote these projects. This type of partnership should be incentivized, particularly given the budgetary constraints that CONANP is currently dealing with.

Design a community-targeting strategy for sustainable timber management. A recent FAO report found that sustainable timber management can reduce social inequality, but only when it explicitly targets the poor (FAO, 2016b). Unlike PES, no national-level targeting scheme exists in Mexico for sustainable timber management permitting, but rather communities must either seek out forestry technicians to develop and submit a management plan or NGOs must work with them to guide them through the process. In either case, there may be a bias in the sense that communities that already have the capacity to engage in STM are more likely to do so, and these may not necessarily be the poorest possible subset. There should be a national targeting strategy for STM rather than continuing to implement it in an opportunistic fashion. A national registry should be created which captures the status of each forest-owning community in Mexico with regards to how they fulfill certain preconditions such as strength of local governance, previous experience with forest management, and liaisons with local NGOs or cooperatives. NGOs and other stakeholders should assist the government in establishing this list, as they have knowledge about the conditions of the communities they work with. Targeting should prioritize the poorest communities, and implementation should incorporate marginalized sectors within communities.

4.3.2 Management recommendations

This section is aimed at implementers, promoters and managers of PAs, PES and STM. It contains our recommendations for on-the-ground interventions that are based on existing rules and regulations and can potentially increase implementer's abilities to assist communities.

Promote using PES funds for sustainable, productive activities, such as STM. The 10-year limit on national PES programs means that PES is not a sustainable long-term income source or forest management strategy for communities. PES can be used, however, as seed money for other productive activities that will continue to generate sustainable development and conservation benefits into the future. Depending on the community's context, these activities may include sustainable timber management (particularly with timber certifications), ecotourism, woodworking and furniture-making, water bottling, and extraction of non-timber forest products such as resin and chicle. PES intermediaries in Campeche actively promoted using PES to fund productive activities, and the communities we visited in Oaxaca have already established community enterprises using PES funds. STM incorporates active management activities that also reduce risk damage from wildfires and pests and diseases. We believe that this model is one of the most effective ways to ensure sustainable forest use after PES programs end.

Reduce agency response time for forest pest and disease management. Communities in the MBBR and Oaxaca frequently voiced concern and frustration over government agencies' delays in authorizing management of forest pest and disease outbreaks. Communities that tackle infestations without a permit—usually by cutting down and destroying infested trees—can be penalized. Significant delays in receiving management permits, however, can significantly increase the size and severity of outbreaks. Particularly given the expected increase in outbreak severity with climate change, we believe it is crucial for this bureaucratic problem to be addressed if STM is to be promoted as a reliable and sustainable option for communities. Reducing agency response time would likely also improve relationships between communities and the federal government.

Monitor community biodiversity with camera traps. It is hard to overstate the level of enthusiasm and passion exhibited by community members when talking about or showing camera trap pictures taken on their land. Most wildlife species are notoriously cryptic, and camera traps often reveal the presence of species that community members knew existed but never or only rarely saw previously. We believe that investing in such a relatively simple project can lead to great gains in community engagement and motivation for conservation.

Organize information exchange visits to other communities. Interview participants in each of our three regions shared stories of organized visits to other communities and emphasized the value of sharing natural resource management experiences for learning and capacity-building. Past research on community-based forestry in Mexico has also affirmed the value of these sorts of exchanges (Klooster & Masera, 2000). The value of these sorts of exchanges have also been Government agencies, NGOs, and intermediaries can play a key role in these trips by facilitating the experience, organizing logistics, and accompanying community members in their process of learning. We recommend that, wherever possible, organizations or agencies invest in scheduling visits by community members to other communities that manage their forests successfully and sustainably. Local trips within regions may be especially cost-effective, as there seems to be little exchange even between many neighboring communities. Long-distance trips to other regions may also be worthwhile, however, if the visiting community could gain significantly by learning from the host community.

4.3.3 Research recommendations

These recommendations acknowledge the value of research-informed environmental management and policy. They are addressed at universities or NGOs that work with PAs, PES or STM within communities.

Research forest pests and diseases to improve management options for communities. Severe outbreaks of forest pests and diseases pose a significant threat to the economic wellbeing of communities that depend on PES funds and Sustainable Timber Management. We saw evidence of this in communities affected by pine beetles in the MBBR and by pine beetles and defoliating sawflies in Oaxaca. Pests and diseases are complex and often-understudied. Insects and fungal lifecycles that may play out differently depending on weather, host species availability, and geographic location. Climate change is largely predicted to increase pest population and to drive range expansion into new areas. We strongly recommend further research on forests pest and disease lifecycles, geographic ranges, and dispersal mechanisms and pathways. In addition to establish valuable baseline information, we also recommend experiments testing different detection and management strategies that can reap practical benefits at the community level.

Study the effect of different conservation strategies on migration. Migration from rural communities to urban centers in search of employment opportunities is common across México. Participation in PES, Protected Areas, and Sustainable Timber Management all have economic implications for communities. While each of these options can create income opportunities for communities, they also regulate and restrict certain types of extractive activities. Benefits and burdens of conservation strategies are also likely to be unevenly distributed. Non legal title-holders (*avecindados*), for example, do not have the right to receive direct distribution of PES funds, although depending on the community they may have the opportunity to participate in paid day-labor or community enterprises. Given that young, better educated community members are more likely to migrate,

understanding the effect of different conservation strategies on migration is vital for understanding long-term community sustainability.

Involve local communities in biodiversity monitoring efforts and other research. Communities in all three of our case studies expressed a strong interest in knowing more about the biodiversity on their territory. Beyond simply receiving permission to conduct research on community land, inviting community members to join as active participants can help build community capacity, provide employment, and strengthen pro-conservation attitudes. Several organizations and institutions we interacted with already have citizen science initiatives and may serve as helpful resources.

Return information to communities, organizations, and institutions. Whether or not the research itself involves community members, research results should be returned to participating communities and partnering organizations and institutions. Interview participants, particularly in Campeche and Oaxaca, emphasized that researchers often received the benefits of cooperation from communities without returning any benefits beyond compensation for basic services. Interview participants valued researchers who took the time to build lasting relationships with communities and to present their results in-person. While re-visiting research sites is often challenging, research results should be returned in an accessible and practical format. We recommend tailoring research results and recommendations for each different audience, perhaps by preparing flyers or pamphlets for participating communities, and powerpoints, recorded short presentations (sent on USB flash drives), or short summaries to organizations and institutions. Consideration should also be given to the recipients' technological capabilities and technical understanding of the research topic.

5 Conclusions

While not the original focus of our study, sustainable timber management emerged as a source of key interactions with payments for ecosystem services and protected areas. Investing PES funds in STM within buffer zones of PAs has allowed communities to improve their livelihoods while conserving biodiversity in all three regions. Interactions between PES, PAs and STM are complex but largely synergistic, with the exception of the prohibition of STM within core areas of biosphere reserves. All interactions we observed are conditional on the social and environmental context of the sites of implementation, with certain key variables determining the viability of strategies. A wide variety of government agencies, NGOs and forestry and PES intermediaries play a vital role in supporting communities and maximizing the beneficial interactions of these strategies. These have resulted in an overall positive attitude towards conservation perceived from local communities. Further policy, research and management improvements could further align the implementation and outcomes of these strategies.

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8 Appendix I

INTERVIEW GUIDE FOR IMPLEMENTERS, INTERMEDIARIES OR PROMOTERS INTERACTIONS BETWEEN PROTECTED AREAS, PAYMENTS FOR ECOSYSTEM SERVICES AND TIMBER MANAGEMENT IN MEXICO

INTERVIEWEE NAME: _____

POSITION OR JOB TITLE: _____

YEARS IN CURRENT POSITION OR JOB TITLE: _____

ADDITIONAL PEOPLE: _____

NAME OF THE RECORDING FILE: _____

1. What are the main threats you perceive towards the protected area/region?
2. Which factors affect the capacity of local communities to protect or manage their natural resources
3. In your opinion, what are the primary motivations of community members for carrying out activities that harm the environment?
4. In your opinion, what are the primary motivations of community members for carrying out activities that conserve the environment?
5. How do you perceive the differences between communities that are part of the protected area/region? Are there any socio-economic or environmental factors that particularly influence the experiences of these communities regarding the protected area and PES?
6. Are there conflicts within and between communities in this region?
7. How do protected areas interact with PES programs? In your opinion, does this interaction influence the capacity of communities to protect or degrade their environment?
8. In your opinion, have PES programs contributed to eliminate or mitigate the threats to the protected area/region mentioned above?
9. In your opinion, how has the protected area and/or the PES programs affected biodiversity in this region?
10. How would changes at a regional/national/international level influence your organization/agency?
11. What is your opinion regarding the requirements (mandatory activities) of PES programs?
12. How do you observe compliance with PES requirements?
13. How would you characterize local communities' involvement with the protected area?
14. How would you characterize local communities' involvement with PES programs?
15. If you were tasked with re-designing the PES program, what would you change?
16. If you were tasked with re-designing the protected area, what would you change?

9 Appendix II

INTERVIEW GUIDE FOR COMMUNITY REPRESENTATIVES

INTERACTIONS BETWEEN PROTECTED AREAS, PAYMENTS FOR ECOSYSTEM SERVICES AND TIMBER MANAGEMENT IN MEXICO

INTERVIEWEE NAME: _____

COMMUNITY NAME: _____

POSITION OR JOB TITLE: _____

YEARS IN CURRENT POSITION OR JOB TITLE: _____

ADDITIONAL PEOPLE: _____

DATE: _____

START TIME: _____

FINISH TIME: _____

	Name	Type
Protected area		Core Area Buffer Zone
Voluntary PA		
Wildlife management unit		
PES		
Other		

GEOGRAPHIC LOCATION

State: _____

Municipality: _____

INTERVIEWER/S: Andrea Johanna Elizabeth

PERSON WHO REFERRED THEM: _____

NAME OF THE RECORDING FILE: _____

CONDICIONES SOCIOECONÓMICAS GENERALES

1.

Número de habitantes del ejido/comunidad	Número de ejidatarios	Número de habitantes que viven dentro del territorio
--	-----------------------	--

2. Número de hectáreas del ejido/comunidad: _____
3. ¿Ha habido personas que han decidido vender sus tierras? ¿Cuántas? _____
4. Número de asambleas por año: _____
5. Personas que participan en las asambleas
6. Nivel de escuela en el ejido/comunidad
7. Nivel de educación de la mayoría de los adultos del ejido/comunidad:
8. Formas de atención a la salud en la comunidad/ejido:
9. ¿Qué tan lejos está la ciudad más cercana que cuenta con un hospital/mercado/universidad?
- 10.

Porcentaje que hablan una lengua indígena	Porcentaje que no hablan español
---	----------------------------------

11. Actividades de subsistencia

a	Agricultura para autoconsumo		
	¿Qué cultivan?		
b	Agricultura para venta		
	¿Qué cultivan?		
c	Ganadería para autoconsumo		
	¿Qué tipo de animales?		
d	Ganadería para venta		
	¿Qué tipo de animales?		
e	Actividades forestales		
f	Trabajos formales		
g	Jornaleros		
h	Turismo		
i	Remesas de familiares que viven fuera		
j	Apoyos de gobierno		
k	Pagos por servicios ambientales		
l	Otra		

12. ¿Hay familias que no tienen suficiente comida en ciertas épocas? ¿Cuántas?

13. Hectáreas destinadas para:

	Total	Área protegida			PSA	Notas
		ZA	ZN	ADVC		
a	Bosque					
b	Cultivos					

14. ¿Cómo es su bosque?
15. ¿Cuáles son las principales amenazas hacia su bosque?
16. En su opinión, ¿Cuáles son los motivos principales que tienen los miembros de esta comunidad/ejido para realizar actividades que dañan el medio ambiente?
17. En su opinión, ¿Cuáles son los motivos principales que tienen los miembros de esta comunidad/ejido para realizar actividades que mejoran el medio ambiente?
18. Factores que afectan la capacidad del ejido/comunidad de proteger o manejar sus recursos naturales

ÁREAS NATURALES PROTEGIDAS

19. Actividades prohibidas en la ZN / ZA / ADVC / UMA
20. Actividades de manejo requeridas en la ZN / ZA / ADVC / UMA
21. ¿Quién o quiénes realizan las actividades de manejo requeridas? ¿Se les paga?
22. ¿Reciben pagos o apoyos por ser parte del ANP?
23. ¿Cuáles han sido los impactos positivos o negativos sobre el bienestar de la comunidad/ejido de pertenecer a un área protegida?

Impactos positivos	Impactos negativos	¿Balance positivo o negativo?
--------------------	--------------------	-------------------------------

ÁREAS DESTINADAS VOLUNTARIAMENTE A LA CONSERVACIÓN O UNIDADES DE MANEJO AMBIENTAL

24. ¿Cuándo se estableció la ADVC o UMA? _____
25. En su opinión, ¿por qué se decidió establecer el ADVC o UMA?
26. Actividades de manejo requeridas en la ADVC/UMA
27. ¿Quién o quiénes estuvieron involucrados en la decisión de establecer un ADVC o UMA?
 - a. ¿Quiénes decidieron qué zonas iban a designar?
 - b. ¿Quiénes decidieron qué tipo de actividades de manejo se iban a realizar?
 - c. Si la ADVC o UMA genera algún tipo de ingreso ¿Quiénes deciden cómo se utilizan estos ingresos?
28. ¿Quién o quiénes realizan las actividades de manejo requeridas? ¿Se les paga?
29. ¿Hicieron un ordenamiento territorial durante el desarrollo del ADVC o UMA?
 - a. El ordenamiento territorial ¿ha afectado la forma en que la comunidad/ejido hace uso de su territorio?
30. ¿Tener un ADVC/UMA ha llevado a que tengan que hacer cambios en su reglamento interno?
31. Después del establecimiento del ADVC/UMA, ¿los miembros de la comunidad/ejido estén más o menos involucrados en las actividades de gobierno local (i.e. asistir a asambleas, participar en comités o proyectos comunitarios)? ¿Por qué?
32. En su opinión, el hecho de tener un ADVC/UMA ¿ha ocasionado conflictos dentro de la comunidad/ejido? Si sí, ¿de qué se trataron estos conflictos? ¿Se lograron resolver? Si sí, ¿cómo?
33. Tener un ADVC/UMA ¿ha ocasionado conflictos con otros grupos o comunidades?

PAGO POR SERVICIOS AMBIENTALES (PSA)

34. ¿En qué año se inscribieron por primera vez?
35. ¿Quién pone los fondos para los pagos?
36. ¿Alguna organización o persona externa a la comunidad/ejido los ayudó a implementar el programa de PSA?
37. En su opinión, ¿por qué se decidió en esta comunidad/ejido inscribirse en el programa de PSA?
38. ¿Qué actividades de manejo se requieren específicamente para el programa de PSA?
39. ¿Quién o quiénes realizan las actividades de manejo que son requeridas como parte del programa de PSA? ¿Se les paga?
40. ¿Qué tipo de actividades se prohíbe realizar en los predios inscritos en PSA?
41. ¿Cuáles han sido los impactos positivos y negativos sobre el bienestar de la comunidad/ejido de estar inscritos en un programa de PSA?

Impactos positivos	Impactos negativos	¿Balance positivo o negativo?
--------------------	--------------------	-------------------------------

42. ¿Quién o quiénes estuvieron involucrados en la decisión de inscribirse en el programa de PSA?
 - a. ¿Quiénes decidieron qué zonas iban a inscribir?
 - b. ¿Quiénes decidieron qué tipo de actividades de manejo se iban a realizar?
 - c. ¿Quiénes deciden cómo se reparten los pagos?
43. ¿La comunidad/ejido llevó a cabo un ordenamiento territorial al decidir inscribirse en el programa de PSA?
 - a. El ordenamiento territorial ¿ha afectado la forma en que la comunidad/ejido hace uso de su territorio?
44. En su opinión, el hecho de participar en el programa de PSA ¿ha llevado a que los miembros de la comunidad/ejido estén más o menos involucrados en las actividades de gobierno (i.e. asistir a asambleas, participar en comités o proyectos comunitarios)? ¿Por qué?
45. ¿Estar inscritos en PSA ha llevado a que tengan que hacer cambios en su reglamento interno?
46. En su opinión, el hecho de participar en el programa de PSA ¿ha ocasionado conflictos dentro de la comunidad/ejido? Si sí, ¿de qué se trataron estos conflictos? ¿Se lograron resolver? Si sí, ¿cómo?
47. Contar con PSA ¿ha ocasionado conflictos con otros grupos o comunidades?
48. Aproximadamente, ¿cuánto les paga anualmente el programa de PSA? \$ _____
49. Aproximadamente, ¿qué porcentaje del pago total se destina a cada categoría?

a	Costos administrativos internos
b	Salario del técnico forestal
c	Proyectos comunitarios
	¿Qué tipo de proyectos?
d	Salarios de las personas que realizan las actividades de manejo
e	Se distribuye a cada familia
	¿A todas las familias o sólo algunas? Si sólo algunas, ¿cuáles?
	¿Aproximadamente cuánto recibe cada familia anualmente?

	En su opinión, ¿este ingreso tiene un impacto grande, mediano o chico sobre los ingresos totales de estas familias?
f	Otro

COMBINACIÓN DE PSA Y ÁREAS PROTEGIDAS

50. ¿Ha observado cambios en los siguientes aspectos? ¿Se deben al ANP o al PSA?

a	Tala de madera		
b	Reforestación		
c	Regeneración natural del bosque		
d	Presencia de animales		
e	Prácticas agrícolas		
f	Pastoreo de ganado		
g	Extracción de leña		
h	Construcción de caminos		
i	Incendios y construcción de brechas forestales		
j	Plagas, especies invasoras o enfermedades		
k	Cantidad o calidad del agua		
l	Cacería		
m	Extracción y venta de especies		
n	Extracción de alimentos o plantas medicinales		
o	Vigilancia		
p	Monitoreo de biodiversidad		
q	Uso espiritual, cultural o recreativo		
r	Turismo		

51. ¿Recibir PSA ha cambiado opiniones sobre el ANP?

52. ¿Tener ADVC/UMA ha cambiado las opiniones sobre el ANP o PSA?

53. Hipotéticamente, si se quitara el PSA pero se quedara el ADVC, ¿cambiaría la forma en que esta comunidad/ejido hace uso de su territorio? ¿cómo y por qué?

54. Hipotéticamente, si se quitará el ADVC pero se quedara el PSA, ¿cambiaría la forma en que esta comunidad/ejido hace uso de su territorio? ¿cómo y por qué?

55. Hipotéticamente, si se quitara tanto el ADVC como el PSA, ¿cambiaría la forma en que esta comunidad/ejido hace uso de su territorio? ¿cómo y por qué?

56. El futuro del bosque.

10 Appendix III

HIERARCHY OF THEMES USED FOR CODING INTERVIEW DATA

Table 5. Names and hierarchy of the themes we identified and used to code our interview data, as well as the coding frequency for each theme.

Name of Theme	Number of Interviews	Number of References
Changes - Environmental	5	6
Biodiversity (Change)	22	42
Forest Cover (Change)	42	83
Pests and Disease (Change)	7	8
Water Quantity or Quality (Change)	17	26
Changes - Social Outside	3	3
Changes - Social Within	1	1
Cultural, Social, and Values (Change)	30	89
Community Capacity (Change)	27	50
Conflict (Change)	8	13
Learning (Change)	32	98
Use of Funds (Change)	52	149
Extraction (Change)	8	12
Extraction of Species (Change)	4	9
Firewood Extraction (Change)	11	11
Hunting (Change)	21	34
Illegal Logging (Change)	25	53

Name of Theme	Number of Interviews	Number of References
Land Management (Change)	36	59
Biodiversity Monitoring (Change)	30	48
Certification (Change)	6	9
Firebreaks and Fire (Change)	28	62
Reforestation (Change)	38	78
Surveillance (Change)	31	73
Livelihoods (Change)	27	49
Agricultural Practices (Change)	26	45
Employment (Change)	39	106
Productive Activities (Change)	26	56
Timber Management (Change)	19	38
Tourism (Change)	22	54
Organization and Governance (Change)	30	64
Territorial Zoning (Change)	15	25
Internal Statutes (Change)	22	33
Factor - Environmental	2	2
Climate Change (Factor)	28	43

Name of Theme	Number of Interviews	Number of References
Ecological Characteristics (Factor)	64	319
Extreme Weather Events (Factor)	22	36
Pests and Disease (Factor)	31	58
Factor - Social Outside	5	5
Collaboration Outside (Factor)	19	47
Conflict Outside (Factor)	47	119
Fires Outside (Factor)	23	34
Government (Factor)	45	126
Govt Negative	58	309
Govt Positive	50	142
Insecurity (Factor)	12	22
Land Rights (Factor)	28	58
Land Use Change Outside (Factor)	13	32
Public Perception (Factor)	22	43
Regional Agriculture Practices (Factor)	28	75
Regional Socioeconomic Conditions (Factor)	56	258
Remoteness (Factor)	11	16
Intermediaries, NGOs etc (Factor)	48	138
Intermediaries and NGOs Negative	21	35

Name of Theme	Number of Interviews	Number of References
Intermediaries and NGOs Positive	48	162
Factor - Social Within	0	0
Agricultural Practices Within (Factor)	45	165
Collaboration Within (Factor)	17	25
Community Background (Factor)	63	469
Conflict Within (Factor)	37	80
Conservation Practices Within (Factor)	37	121
Culture (Factor)	27	41
Connection to the Land	19	30
Indigenous Groups	15	18
Languages	24	28
Values	18	28
Education and Knowledge (Factor)	57	154
Extraction (Factor)	45	163
Fires Within (Factor)	31	48
Land Use Change Within (Factor)	25	42
Organization and Governance (Factor)	65	396
Asambleas	39	92
Reglamento Interno	32	81

Name of Theme	Number of Interviews	Number of References
Sale of Land Within (Factor)	19	25
Identifiers table	60	466
STM Description	52	292
STM Effects	42	179
Negative STM	22	30
Positive STM	37	143
Motives to Conserve	11	12
Cultural or Values (Motive to Conserve)	47	137
Environmental (Motive to Conserve)	40	123
Financial (Motive to Conserve)	50	126
Motives to Degrade	3	5
Conflict (Motive to Degrade)	6	9
Cultural or Values (Motive to Degrade)	19	29
Financial (Motive to Degrade)	24	36
Greed-based Motive	9	11
Need-based Motive	28	48
Lack of Knowledge or Capacity (Motive to Degrade)	10	11
Other	21	34

Name of Theme	Number of Interviews	Number of References
PA Description	11	18
ACC	25	74
ADVC	18	77
Reserve	46	206
UMA	18	42
PA Effects	55	329
Negative PA	35	93
Positive PA	51	223
PES Description	63	405
PES Eligibility	18	25
PES Requirements	50	181
PES Effects	64	568
Negative PES	53	199
Positive PES	62	355
PES PA Interaction	18	35
Beneficial Ecological Interaction	22	36
Beneficial Social Interaction	24	51
Detrimental Ecological Interaction	2	2
Detrimental Social Interaction	4	6
Quotes	57	246

11 Appendix IV

INTERVIEW DATA CLASSIFICATION SHEET

Table 6. Basic information extracted from the interview files. EdoMex = Estado de México state, CR = Community representative, Discipline = The schooling or background of intermediaries, WMU = Wildlife management unit; PA = Protected area, AVDC = Area voluntarily destined for conservation, CCA = Community conservation area, PES-H = PES for hydrological services, PES-B = PES for biodiversity services, MF = Matching funds, FM = “*Fondo Monarca*”, STM = Sustainable timber management.

State	File type	Years experience	Discipline	WMU	PA	AVDC	CCA	PES-H	PES-B	MF	FM	Carbon Credits	STM
Campeche	CR Interview	2	N/A	No	Yes	Yes	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	3	N/A	Yes	Yes	Yes	No	No	Yes	No	N/A	No	Yes
Campeche	CR Interview	N/A	N/A	Yes	Yes	Yes	No	No	Yes	No	N/A	No	Yes
Campeche	CR Interview	2	N/A	No	Yes	No	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	4.5	N/A	Yes	Yes	Yes	No	No	Yes	No	N/A	No	Yes
Campeche	CR Interview	9	N/A	No	Yes	No	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	1	N/A	Yes	Yes	No	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	0.1	N/A	Yes	No	No	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	2	N/A	No	Yes	No	No	No	Yes	No	N/A	No	Yes
Campeche	CR Interview	1	N/A	Yes	No	No	No	No	Yes	No	N/A	No	Yes
Campeche	CR Interview	3.5	N/A	No	Yes	No	No	No	Yes	No	N/A	No	No
Campeche	CR Interview	N/A	N/A	No	Yes	No	No	No	Yes	No	N/A	No	UA
Campeche	CR Interview	2	N/A	Yes	Yes	No	No	No	Yes	No	N/A	No	No
Campeche	Focus Group	N/A	N/A	Yes	Yes	Yes	No	No	Yes	No	N/A	No	Yes
Campeche	Focus Group	N/A	N/A	No	Yes	No	No	No	Yes	No	N/A	No	Yes
Campeche	I Interview	3	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	8	Agronomist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	13	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	2	Environ. Scientist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	10	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Campeche	I Interview	20	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	11	Biologist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	I Interview	30	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	Presentation	N/A	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Campeche	Presentation	N/A	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EdoMex	CR Interview	2.5	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
EdoMex	CR Interview	1	N/A	No	Yes	No	No	Yes	No	Yes	No	No	Yes
EdoMex	CR Interview	1.5	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	No
EdoMex	CR Interview	2.5	N/A	No	Yes	No	No	Yes	No	UA	Yes	No	Yes
EdoMex	I Interview	23	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	CR Interview	4	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	CR Interview	2.5	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	CR Interview	3	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	CR Interview	2	N/A	No	Yes	No	No	Yes	No	No	No	No	Yes
Michoacán	CR Interview	1	N/A	No	Yes	No	No	Yes	No	Yes	Yes	N/A	Yes
Michoacán	CR Interview	6	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	CR Interview	4.5	N/A	No	Yes	No	No	No	No	Yes	Yes	No	Yes
Michoacán	CR Interview	2.5	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	CR Interview	1.5	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	No
Michoacán	CR Interview	6	N/A	No	Yes	No	No	Yes	No	No	No	No	Yes
Michoacán	CR Interview	0.3	N/A	No	Yes	No	No	Yes	No	No	No	No	Yes
Michoacán	Focus Group	N/A	N/A	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes
Michoacán	Focus Group	N/A	N/A	No	Yes	No	No	No	No	Yes	Yes	No	Yes
Michoacán	I Interview	8	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	16	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	6	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	UA	Biologist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	UA	Lawyer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	11	UA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Michoacán	I Interview	18	Biologist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	10	Biologist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Michoacán	I Interview	UA	Politician	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	CR Interview	2	N/A	Yes	No	No	Yes	Yes	No	Yes	N/A	Yes	Yes
Oaxaca	CR Interview	2	N/A	Yes	No	No	Yes	Yes	No	Yes	N/A	Yes	Yes
Oaxaca	CR Interview	2.5	N/A	No	No	No	Yes	Yes	No	Yes	N/A	Yes	Yes
Oaxaca	CR Interview	0,5	N/A	No	No	No	Yes	Yes	No	Yes	N/A	Yes	Yes
Oaxaca	Focus Group	N/A	N/A	No	No	No	Yes	Yes	No	Yes	N/A	Yes	Yes
Oaxaca	I Interview	30	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	7	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	15	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	6	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	5	Forester	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	4	Environ. Scientist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	I Interview	13	Agronomist	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	Presentation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oaxaca	Presentation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

12 Appendix V

GEOSPATIAL COMMUNITY DATA

Table 7. Demographic, PES, and forest change data for interviewed communities in Michoacán. Mean PES area (%) was calculated by dividing the total area enrolled in PES by the number of contracts (years), to account for the fact that many communities enroll the same or similar zones in different years. \$PES per capita corresponds to the total amount of money that each community member has or will receive from all PES contracts within their land. Net forest change was calculated between 2010 and 2017. The last column shows net forest change as a percentage of the community's total area. FM = *Fondo Monarca*.

Type	Area (ha)	Population size	Marginalization Index	PES Year(s)	PES Type/s	Mean PES area (%)	\$PES p/c (MXN)	Net forest change (ha)	Net forest change (%)
Ejido	2,691	1,158	High	2005, 2007, 2008, 2012	PES-H, FM	13.4	9,695	0.1	0.0
Indigenous community	2,692	4,541	High	2003, 2007, 2013, 2012, 2008	PES-H, FM	8.4	779	1.2	0.0
Indigenous community	1,373	2,575	High	2010, 2015, 2012, 2008	PES-H, FM	16.4	1,233	-2.3	-0.2
Indigenous community	2,637	3,091	High	2006, 2012, 2017, 2018	PES-H, FM	21.8	1,757	4.5	0.2
Indigenous community	325	860	High	2016, 2011, 2008, 2012	PES-H, FM	59.6	3,256	0.0	0.0
Ejido	321	627	High	2008, 2012	PES-H, FM	69.9	5,070	0.0	0.0
Ejido	6,805	1,113	Very High	2008, 2010, 2013, 2014, 2018	PES-H, FM	7.9	5,963	-1.3	0.0
Indigenous community	2,280	2,264	High	2007, 2010, 2015, 2008, 2012	PES-H, FM	24.0	5,755	-1.7	-0.1
Ejido	482	749	High	2005	PES-H	41.5	401	0.8	0.2
Ejido	2,865	5,963	High	2008, 2013, 2018	PES-H, PES-B, FM	20.1	1,281	0.1	0.0
Ejido	209	370	High	2008, 2012	PES-H, FM	50.7	2,454	-0.2	-0.1
Indigenous community	2,775	3,826	High	2008, 2011, 2013, 2018, 2012	PES-H, FM	16.4	2,643	12.9	0.5
Ejido	862	4,076	High	2009, 2012, 2017	PES-H	61.8	941	-0.6	-0.1
Ejido	765	3,089	Medium	2003, 2007, 2008, 2012	PES-H, FM	18.5	1,796	3.6	0.5

Table 8. Demographic, PES, and forest change data for interviewed communities in Campeche. Mean PES area (%) was calculated by dividing the total area enrolled in PES by the number of contracts (years), to account for the fact that many communities enroll the same or similar zones in different years. \$PES per capita corresponds to the total amount of money that each community member has or will receive from all PES contracts within their land. Net forest change was calculated between 2010 and 2017. The last column shows net forest change as a percentage of the community's total area.

Type	Area (ha)	Population size	Marginalization	PES Year(s)	PES Type/s	Mean PES area (%)	\$PES p/c (MXN)	Net forest change (ha)	Net forest change (%)
Ejido	37,205	418	High	2009, 2015	PES-B	5.2	23,623	-21.1	-0.1
Ejido	6,976	240	High	2015	PES-B	26.8	13,942	-17.0	-0.2
Ejido	12,404	236	High	2012	PES-B	22.9	33,837	-206.9	-1.7
Ejido	6,035	209	Very High	2010, 2015	PES-B, PES-H	28.9	47,469	64.3	1.1
Ejido	2,787	156	Very High	2013, 2018	PES-B	33.4	29,347	-45.2	-1.6
Ejido	2,964	131	High	2013, 2018	PES-B	39.4	46,551	-21.0	-0.7
Ejido	5,303	648	High	2010, 2018	PES-B, PES-H	4.5	2,079	-54.3	-1.0
Ejido	3,560	184	High	2013, 2018	PES-B	26.7	24,560	-87.0	-2.4
Ejido	54,264	393	High	2014	PES-B	4.2	16,539	39.6	0.1
Private properties	N/A	449	High	2010, 2016	PES-B, PES-H	N/A	12,494	-1.1	-3.2

Table 9. Demographic, PES, and forest change data for interviewed communities in Michoacán. Mean PES area (%) was calculated by dividing the total area enrolled in PES by the number of contracts (years), to account for the fact that many communities enroll the same or similar zones in different years. \$PES per capita corresponds to the total amount of money that each community member has or will receive from all PES contracts within their land. Net forest change was calculated between 2010 and 2017. The last column shows net forest change as a percentage of the community's total area. MF = Matching Funds.

Type	Area (ha)	Population size	Marginalization	PES Year(s)	PES Type(s)	Mean PES area (%)	\$PES p/c (MXN)	Net forest change (ha)	Net forest change (%)
Indigenous community	3,974	1,467	N/A					-50.7	-1.3
Indigenous community	831	783	Low					-0.1	0.0
Indigenous community	21,940	4,494	High	2008, 2012	PES-H, MF	12.9	5,702	19.0	0.1
Indigenous community	1,971	460	Low	2016	PES-H	57.8	3,849	-9.2	-0.5