# When formal and market-based conservation mechanisms disrupt food sovereignty: impacts of community conservation and payments for environmental services on an indigenous community of Oaxaca, Mexico

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SUMMARY

The impacts of Payments for Environmental Services (PES) and creation of formal Voluntary Conserved Areas (VCAs) on local diets, agricultural practices, subsistence hunting and livelihoods, were assessed in a Chinantec community of southern Mexico. The community has set aside VCAs covering 4 300 ha of its 5 928 ha of communal lands and forests, and has received over $769 245 in PES for protection of 2 822 ha of watersheds roughly overlapping the VCAs. Community members attribute decreased maize and other subsistence crop yields, reduction of area available for agriculture, and shortened fallow cycles to the new conservation policies. Meat consumption has decreased after a hunting ban, accompanied by increases in purchasing meat still consumed. By agreeing to conservation measures that restrict their use of ancestral agricultural land and prohibit hunting, villagers have seen local food security become less stable, leading to greater dependency on external food supplies. Continued strict preservation measures under the guise of community conservation could lead to losses of agrobiodiversity, dietary diversity, hunting skills and associated environmental knowledge. Appropriate application of the precautionary principle is essential to avoid structural displacement of local peoples and to ensure the success of community conservation initiatives.

Keywords: Community conservation areas, nutritional transition, precautionary principle, shifting cultivation, traditional food systems

## Quand les mécanismes de conservation formelle et basée sur le marché dérangent la souveraineté des aliments: impacts sur la conservation de la communauté et les paiements pour services environnementaux dans une communauté d'Oaxaca au Mexique

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Les impacts des paiements pour services environnementaux (PES) et la création de zones de conservation volontaires formalisées (VCAs) sur la nutrition locale, les pratiques de l'agriculture, la chasse de subsistance et les revenus ont été évalués dans une communauté Chinantec du Mexique du sud. La communauté a mis à part des VCAs recouvrant 4300 ha de ses 5928 ha de terres et forêts communautaires et a reçu plus de 769 245$ de PES pour sa protection de 2822 ha de bassins versants dont la superficie coïncide en gros avec celle des VCAs. Les membres de la communauté attribuent une décroissance des récoltes de maïs et d'autres cultures de subsistance, la réduction de la surface disponible pour l'agriculture, et les périodes réduites de jachère aux nouvelles politiques de conservation. La consommation de viande a décru depuis un interdit de chasse, accompagné d'une augmentation de quantité viande qu'il faut maintenant acheter pour consommer. En acceptant des mesures de conservation restreignant l'utilisation des terres arables ancestrales et interdisant la chasse, les villageois ont vu la sécurité de leurs aliments locaux devenir moins stable, les conduisant à une dépendance plus grande sur vis à vis des fournisseurs extérieurs. La continuation de mesures de conservation strictes sous le couvert de conservation de la communauté pourrait conduire à des pertes de l'agrobiodiversité, de la diversité nutritionnelle, de l'habileté à chasser et de la connaissance environnementale associée. Une application appropriée du principe de précaution est essentielle pour éviter un déplacement structurel des populations locales et pour assurer le succès des initiatives de conservation communautaires.

## Cuando mecanismos de conservación formales y de Mercado perturban la soberanía alimentaria: Impactos de la conservación comunitaria y de los pagos por servicios ambientales en una comunidad indígena de Oaxaca, México

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Se evaluaron los impactos de los Pagos por Servicios Ambientales (PSA) y de la creación de Áreas de Conservación Voluntaria (ACVs) formales, sobre la dieta local, prácticas agrícolas, cacería de subsistencia y sustento local de una comunidad chinanteca del sur de México. La comunidad ha asignado 4 300 ha de sus 5 928 de tierras comunitarias y bosques a ACVs, y ha recibido más de $769 245 en PSA por la protección de 2 822 ha de cuencas que se traslapan con las ACVs. Miembros de la comunidad atribuyen disminuciones en la producción de maíz y otros cultivos de subsistencia, una reducción del área disponible para agricultura y un acortamiento del período de descanso de las tierras agrícolas, a las nuevas políticas de conservación. El consumo de carne ha disminuido luego de una prohibición de cacería, acompañado de un aumento en la compra de carne que aún se consume. Estando de acuerdo en estas medidas de conservación que restringen el uso de tierras agrícolas ancestrales y que prohíben la cacería, los pobladores han visto que la seguridad alimentaria local se ha vuelto menos estable, llevando a una mayor dependencia por suministros alimenticios externos. La continuidad de medidas de preservación estrictas, bajo la apariencia de una conservación comunitaria, podrían llevar a pérdidas de agrobiodiversidad, diversidad dietaria, habilidades de caza y el conocimiento ambiental asociado. La aplicación apropiada del principio de precaución es esencial para evitar el desplazamiento estructural de comunidades locales y asegurar el éxito de las iniciativas de conservación comunitaria.

## INTRODUCTION

Payments for Environmental Services (PES) to local communities have been touted nationally and internationally as a market-based mechanism to reward the protection of biodiversity, forests and watersheds on communally owned land. In Mexico, financial subsidies that are part of a national PES programme (McAfee and Shapiro 2010) have been provided to some communities that have Indigenous and Community Conserved Areas (ICCAs), including ones that are certified Voluntary Conserved Areas (Martin *et al*. 2010). Internationally, ICCAs are seen a possible solution to multiple problems associated with conservation practices that exclude local communities (Borrini-Feyerabend and Kothari 2008).

There is a growing interest in exploring the ways in which these financial subsidies and new trends in community conservation are evolving and affecting various aspects of local rights and livelihoods, including food sovereignty.

### Food sovereignty

Food sovereignty is broadly conceived to include the diverse rights that people exercise to protect domestic agricultural production, maintain nutritious diets and regulate market access, all as part of a quest to achieve sustainable development. As Pimbert (2009: 5) notes, food sovereignty is an alternative agricultural and food policy framework that "aims to guarantee and protect people's space, ability and right to define their own models of production, food distribution and consumption patterns." He characterises food sovereignty as a process that seeks to regenerate autonomous food systems that are equitable, socially just and ecologically sustainable.

Key to food sovereignty are traditional food systems (TFS), which incorporate a wealth of acquisition, production, processing, distribution and recycling techniques (Kuhnlein and Receveur 1996, Pimbert 2009). These localised food systems, laden with social meanings and ecological realities, are an integral part of people's cultural identities, knowledge systems, health and economies throughout the world (Johns and Sthapit 2004, Kuhnlein *et al.* 2009). TFS provide edible plants, animal protein and animal micronutrients from traditional agroecosystems, agroforestry and livestock grazing. In addition, they incorporate foods derived from gathering, fishing and hunting as well as exchange with other communities.

Many peoples throughout the world are increasingly distanced from self-sufficiency, as they abandon local dietary traditions and increase their dependence on industrialised foods (Kuhnlein *et al*. 2004, Uauy *et al*. 2001). These changes, part of a complex process referred to as nutritional transition, generally have adverse impacts on local subsistence, food quality and variety, and ultimately public health (Damman *et al*. 2008, Kuhnlein *et al*. 2007, Popkin 2003, 2004). Transitions in various aspects of food sovereignty have occurred with industrialisation, urbanisation, economic development and the globalisation of markets (Damman *et al.* 2008, Pimbert 2009). Dietary changes are a non-directed consequence of other environmental or external forces, and they appear to be accelerating especially in low- and middle-income countries (Kuhnlein and Receveur 1996). These dietary changes are generally promoted by national policies or international programmes that are influenced by global economic and political priorities, rather than responding to local concerns (López and Mariano 2008).

### The emergence of community conservation

International and national laws and policy require the protection of not only the biodiversity that provides sustenance for the entire world's population, but also the traditional systems of knowledge, management and use of this biodiversity that meet the basic needs of local people. In the quest to achieve biodiversity conservation, the global tendency has privileged an approach which excludes people in protected areas (West and Brockington 2006), leading to displacement of communities and restrictions on their access to resources (Agrawal and Redford 2009). By ignoring the role of local cultures in resource management, this trend has promoted a disarticulation between human populations and their environments (López and Mariano 2008). This has resulted in negative impacts such as the disruption of livelihood opportunities, increase in damages to crops by wild animals, and alteration of local economies (Hough 1988, Igoe 2006, Mishra 1982).

The increasing appreciation of the interdependence of diverse environments and local communities and the roles they play in conserving biological diversity and agrobiodiversity has inspired community-based conservation approaches around the world (Gibson and Marks 1995). ICCAs and other modes of community conservation have become important alternatives to government protected areas. In 2004, the IUCN included ICCAs as a distinct category of governance of protected areas (Martin *et al.* 2010), and they have now been recognised in diverse ways throughout the world, including in Africa (Metcalfe 1994, Wainwright and Wehrmeyer 1998), Asia (Bajracharya *et al.* 2005), and Latin America (Camacho *et al.* 2010, Ellis and Porter-Bolland 2008, Toledo 2003).

There is little information about the effectiveness and consequences of this new approach to conservation (Berkes 2009), especially when community protected areas receive external support guided by market mechanisms. Empirical analysis of these arrangements is especially important when ICCAs are linked to new paradigms such as enterprise-based and payments-based conservation (Lele *et al*. 2010). These neo-liberal approaches have spread globally as influential environmental and economic institutions act on the premise that environmental degradation is due to market malfunction or to a lack of financial incentives to protect the services that ecosystems provide (Turner *et al.* 1994). Gómez-Baggethun *et al*. (2010) posit that the shift toward monetisation of ecosystem services marks a conceptual swing from economic recognition of the use value of nature toward a focus on the exchange value of resources.

### Food sovereignty and community conservation in Mexico

The majority of indigenous peoples in Mexico base their food consumption on small-scale agricultural and livestock production, complemented by hunting and gathering of wild foods. The agricultural system is centred on the *milpa*, a traditional Mesoamerican polyculture in which maize and many other food plants are cultivated or available as spontaneous semi-domesticates (Hernández X 1977).

In tropical forested areas, the *milpa* forms part of swidden cultivation in which a section of forest is cut and burned for cultivation as part of the agricultural cycle (Ávila 2010). The parcel is then left fallow for several years enabling regeneration of herbs, shrubs, and later trees. The cultivation of *milpas* in forest ecosystems generates a mosaic of landscapes, biotic communities, species and genetic diversity that are intimately linked to local TFS (Vandeermer and Perfecto 2007) and the maintenance of broader patterns of biological and cultural diversity. For indigenous peoples, biodiversity within and around *milpas* is essential in order to achieve a complete and healthy diet (Johns and Sthapit 2004).

In Mexico, many ICCAs are community initiatives closely related to local systems of management of natural resources, lifestyles, political organisation and land tenure security (Martin *et al.* 2010). Civil society and governmental institutions have supported these local initiatives in recent years. Beginning in 2003, the National Forestry Commission (Conafor; Comisión Nacional Forestal) established PES to support local landowners – if they maintain areas of forest cover – through a series of subsidies (compensatory payments) paid out over periods of five years to avoid changes in land use (Anta 2007). Other governmental programmes, in conjunction with the National Commission of Natural Protected Areas (Conanp, Comisión Nacional de Áreas Naturales Protegidas), have supported the establishment and certification of ICCAs. In May 2008, the General Environmental Law of Mexico (LGEEPA, Ley General del Equilibrio Ecológico y Protección al Medio Ambiente) was modified to allow inclusion of certified ICCAs as a new category of Protected Natural Areas, called Voluntary Conservation Areas (Camacho *et al.* 2010).

Despite these new policies, official state views continue to characterise human disturbance as a threat to forests. For example, in December 2010 during the celebration of World Forest Day, as part of the 16th Conference of the Parties to the UN Framework Convention on Climate Change in Cancun, Mexican President Felipe Calderón blamed traditional forms of agriculture of indigenous peoples and peasants for deforestation in Mexico (Presidencia de la República 2010). In addition, he stated that one of the nation's priorities is to approve and promote financial mechanisms for reducing deforestation, allowing peasants to receive economic compensation instead of continuing to cultivate the land.

The study presented here – conducted in a Chinantec community in Oaxaca, a biologically and culturally diverse state of southeast Mexico – explores the consequences of external support for ICCAs that follow official conservation policies and receive financial subsidies. To better understand the interactive impacts, the study specifically examines the consequences of PES and the creation of certified VCAs for food sovereignty in a broad socio-ecological context, including food acquisition, dietary patterns, domestic economy, and socio-cultural significance.

## STUDY AREA

The Chinantla, defined culturally by the presence of Chinantec indigenous people, is located in northeast portion of the State of Oaxaca, Mexico (Figure 1). It forms part of the Papaloapan hydrological region and the "*Sierras del Norte de Oaxaca-Mixe*" Priority Area for Biodiversity Conservation (Conabio 2008). The zone exhibits one of the highest levels of biodiversity and encompasses the third largest and best conserved tropical humid forest in Mexico (Hernández 2007).

FIGURE 1 *Map of Mexico, showing the State of Oaxaca (in gray). Study area was located in the Chinantla area (black dot; 17°33′N 95°31′W) of Oaxaca*


The study took place in Santiago Tlatepusco, a Chinantec community of 591 residents[1] who have a communal territory of 5 928 ha located between 250 and 2 800 m of elevation in the Municipality of San Felipe Usila. The territory encompasses a mosaic of different habitat types including tropical evergreen, cloud and pine-oak forests, active swidden agricultural areas, coffee plantations, and secondary vegetation (GeoConservación 2006). There are approximately 536 vertebrate species, including jaguar, jaguarondi, margay, tapir, owls, woodpeckers, toucans and other fauna, most of them endemic to Mesoamerica and some rare and endangered (Martin 1996). In addition, there are hundreds of plant species that have not yet been fully inventoried.

Residents combine the *milpa* agricultural system with agroforestry (including shade coffee plantations), extraction of non-timber forest products, subsistence hunting, fishing and, recently, fish production in ponds (Pérez *et al*. 2006). The *milpa* system allows the integration of cultivation of maize, beans, chilli, manioc and squash, among other species, with the collection of other edible plants that complement local diets (Anta and Mondragón 2006). Hunting of birds and mammals in *milpas*, fallow fields and forests, along with fishing, has historically been the main animal protein source in the Chinantla (Weitlaner and Castro 1973).

Santiago Tlatepusco is part of the Regional Committee for Chinantla Alta Natural Resources (CORENCHI), an organisation comprised of six Chinantec communities formed in 2004 by a regional accord with the objective of improving natural resource control, strengthening conservation efforts and obtaining more economic benefits from resource management (Bray *et al.* 2008, Mondragon n.d., Pérez *et al.* 2006).

Between 2003 and 2006, the communities conducted community territorial planning with the help of a non-governmental organisation, which subsequently advocated for a revision of community-level statutes concerning natural resource use and management and the demarcation of different land use zones, including conservation areas to protect biodiversity and ecosystem health (Martin *et al.* 2010).

Large expanses of well-conserved cloud forest and tropical rainforest in the CORENCHI communities are *prima facie* evidence of the adequacy of traditional management practices. As in other parts of the Chinantla (Robson 2009), there has been reduced agriculture and increased fallow forest in Santiago Tlatepusco over the last twenty years (Edward A. Ellis, personal communication, May 16, 2011), a trend not readily attributable to community conservation efforts alone. Because the area is relatively isolated due to limited communication facilities and poor accessibility (Pérez *et al*. 2006), there is no broad commercialisation of bush meat, non-timber forest products or timber species at present (Anta *et al.* 2008), although some small-scale local trade exists. In 2004, Conanp officially certified the communities' conserved areas, promising increased visibility, financial support, and certification of agricultural and non-timber forest products. The certified area included 4 300 ha in Santiago Tlatepusco, putting 72.5% of the communal lands under protection. The community obtained its certification at the same time as three others belonging to CORENCHI, giving a combined area of 22 148 ha certified in 2004 for the four communities.

Processes of community conservation were further supported by Conafor's programme of payment for hydrological environmental services (PES-H), financed by the World Bank (McAfee and Shapiro 2010). The communities were able to access these funds because of the hydrological value of the Chinantla, one of the areas of highest rainfall in the country. Its watersheds benefit many rural and urban areas in the State of Oaxaca, as well as the hydroelectric and other diverse manufacturing industries (Mondragon n.d.).

In 2004, Santiago Tlatepusco submitted 1 969 ha for PES-H, for which Conafor approved 3 938 000 MXN (345 349 USD at the 2004 average exchange rate) for a period of five years (Conafor 2004). In 2007, the community submitted a proposed expansion of the PES-H area that included an additional 853 ha, leading to approval by Conafor of a second payment of 1 401 311 MXN (129 392 USD at the 2007 average exchange rate) for another full five-year period. Finally, in 2009 they recommitted 1 716 ha of the original assigned area to extend the PES-H for an additional five-year period, receiving in exchange 3 786 171 Mexican pesos (294 415 USD at the 2009 average exchange rate). In sum, a total area of 2 822 ha – 47.6% of communal lands – are covered by PES-H payments, totalling $769 245 at the

[1] Demographic statistics from the Centre for Rural Health of Santiago Tlatepusco, belonging to Health Jurisdiction Nº3 of Tuxtepec, Health Services of Oaxaca, Mexico.

summed average exchange rates. To receive these funds, the community – and others in CORENCHI – agreed to maintain vegetation cover, avoid land use change (including conversion to grazing) and pollution in the conserved area, as well as to monitor the territory over time (Conafor 2010, Mondragón n.d.). In Santiago Tlatepusco, these measures were incorporated into a restrictive agreement that prohibits a broad range of activities in the community conserved areas, including: (a) deforestation or damage to vegetation for agricultural, animal husbandry or other purposes; (b) hunting; and (c) extraction of any plants, animals, fruits seeds, or wood.

Most of the payments (97.5%) received are divided among community members and their families, and the other portion (2.5%) has been used for CORENCHI activities and infrastructure (Anta *et al.* 2008). Each family receives an average PES contribution of US $1.48/day, or US $44.40/month, equivalent to 27.2% of the basket of consumer goods per year across the four communities (Mondragon n.d.).

## METHODS

**Methodological considerations**: The ideal way to determine the presence of cultural changes is through diachronic analysis in which socio-ecological phenomena from two different time periods – such as before and after a particular intervention – are directly compared (Balée 1994). As no systematic data on food sovereignty are available from before the advent of the establishment of PES and certification of VCAs, research relied on asking informants to recall the time prior to the PES and VCA programmes, an indirect means for documenting changes in the recent past.

By maximising the number of people interviewed and triangulating information collected through diverse methods, substantial data were collected on how these initiatives have affected the community. Methods included participant observation, informal interviews and semi-structured interviews, which are among the best ways to learn about common and divergent perspectives held by community members (Bernard 2005). In addition to these approaches, formal elicitation techniques such as freelist exercises and structured interviews were used to examine patterning of environmental knowledge (Puri 2011a) and then interpret if these patterns are attributable to the aforementioned conservation initiatives.

**Free Prior informed consent (FPIC):** Following best practice as defined by professional codes of ethics and international conventions – including the United Nations Declaration on the Rights of Indigenous Peoples – FPIC was obtained from local authorities and the General Assembly of the community after explaining the scope of the project, and clearly stating the potential benefits and risks of our presence and proposed study. This built on community research agreements established with the Global Diversity Foundation, an international non-governmental organisation which has been active in the communities since 2008. Additional consent, rapport and willingness to participate in the study were gained after participating in diverse community events and work activities.

**Participant observation:** Participant observation (Puri 2011b) was conducted in the community between 2008 and 2011. Participation in community events and agricultural activities included firewood gathering, sowing, weeding, measuring agricultural productivity, identification of pest damage, participatory mapping, and community labour (*tequio*). Informal interviews were carried out during these activities with individuals or groups of people, with a total interaction of over 150 individuals (Table 1). Notes relevant to the research were made during these conversations and later developed in field notes recorded daily (Bernard 2005).

While the researchers were working in the community, local authorities arranged for them to have three meals per day with different families on a rotating basis. Families were encouraged to serve foods eaten daily and not to prepare special dishes, as is customary when receiving visitors. In order to assess household dietary patterns, the ingredients of every dish given to researchers were recorded during two months. These data were compared with statements by community members about dietary patterns at the household level (White *et al.* 2005).

**Freelists:** Women (n=30) were asked (in Spanish or Chinantec) to freelist the most common foods available in the household (Atran *et al*. 2002) in order to elicit information about household diets. Later, *Smith's index of saliency* (Smith's S), which is based on order and frequency of mention of items on a freelist, was used to measure the relative importance of the foods (Smith 1993). The index predicts that foods mentioned first and most frequently are more salient and, therefore, more important to individual women, as compared to foods mentioned last and least often (Smith 1993, Smith and Borgatti 1997).

**Semi-structured and structured interviews:** An interview question set was designed and piloted with a subsample of

TABLE 1 *Breakdown of informants according to major subsistence occupation, age, and gender*

| Method used | Number of participants | Major subsistence occupation | Age range | Gender |
|---|---|---|---|---|
| Informal interviews | ± 150 | Farmers, hunters or ex-hunters and local authorities | 16–55 | ± 100 male<br>± 50 female |
| Freelists | 30 | Farmers and housewives | 20–46 | All female |
| Semi-structured and structured interviews | 76 | Farmers, hunters or ex-hunters, local authorities and traditional healers | 18–59 | 21 female<br>55 male |

people from the villages (n=20) allowing researchers to minimise the possibility of errors in the data in later interviews (Bernard 2005, White *et al.* 2005). Afterwards, the interview was applied at the household level with married women and men (n=76; Table 1). Interviews consisted in a first semi-structured part of open-ended questions, and a second structured part of pre-determined questions. Together they revealed socio-economic information, dietary patterns, meat consumption, agricultural practices, productivity and pest species, foraging knowledge and attitudes towards conservation initiatives (Ibarra 2010).

## RESULTS

**Diet overview:** Women mentioned a total of sixty-two common foods in the freelist exercises. Ranked by Smith's S, black beans, rice, noodles and chicken were the most salient foods currently consumed. Among mentioned meat resources, game animals such as the collared peccary, nine-banded armadillo, red brocket deer, and white-nosed coati were mentioned, but rarely. Meat from domestic animals, such as chicken, steak and pork, showed greater saliency than game (Appendix 1).

The most salient items were regularly consumed by families, as noted during participant observation. Based on meals actually consumed by local families, hand-made tortillas of maize were present in 99% of meals, including breakfast, lunch and dinner. As noted in Figure 2, black beans (39%) were the second most consumed, followed by onions (37%), hen's eggs (33%), tomatoes (29%), noodles (25%), and rice (18%). The main animal protein sources consumed were hen's eggs (33%), chicken (15%), ray-finned fish (0.07%) and canned tuna fish (0.02%). Armadillo, pork and canned herring occurred at a frequency of only 0.01% (Figure 2).

Purchased items were slightly more commonly consumed than foods locally obtained (Figure 3). As confirmed during participant observation, less than half of the most salient food items (such as black beans, squash vine, chayote fruits, nightshade and chayote vine) are still gathered or produced – including in small home-gardens – by local farmers. Of the animal protein sources consumed during participant observation, only chicken and ray-finned fish are locally produced, and armadillo is hunted. Several villagers have stopped raising poultry because of increased frequency of disease, especially during the dry season. Buying of hen's eggs and chicken – and almost all other meat sources – has increased.

Both men and women reported a change in the consumption of meat. Men stated that meat consumption has decreased from 1.75 ± 0.89 times/week before the hunting ban, to 0.83 ± 0.41 after the ban. Women reported a change from 1.50 ± 0.71 to 1.10 ± 0.32 times/week. Aggregated figures showed a perceived change from 1.61 ± 0.78 to 1.00 ± 0.37 times/week (Figure 4). In order to improve animal protein consumption, ray-finned fish production is increasing. Several families engage in this complementary activity, although the high cost of pellet fish food limits further expansion of fish farming.

During interviews, 90% of informants noted that the consumption of previously common food items has decreased after the implementation of the PES and VCA programmes. Although these changes were attributed the new conservation initiatives and financial subsidies, many respondents noted

FIGURE 2 *Frequency of food items present in meals (n=87) consumed during two months with different families one Chinantec community. Black bars show the four most salient foods, according to the* Smith's Index of Saliency *(Smith'S), currently used among Chinantecs (based on freelists). Black arrows show the animal protein sources consumed (note that hen eggs were the most important animal protein source consumed, and the others were never present in more than 15% of meals). Dashed arrow shows the only game meat (nine-banded armadillo), consumed once, among the meals documented*

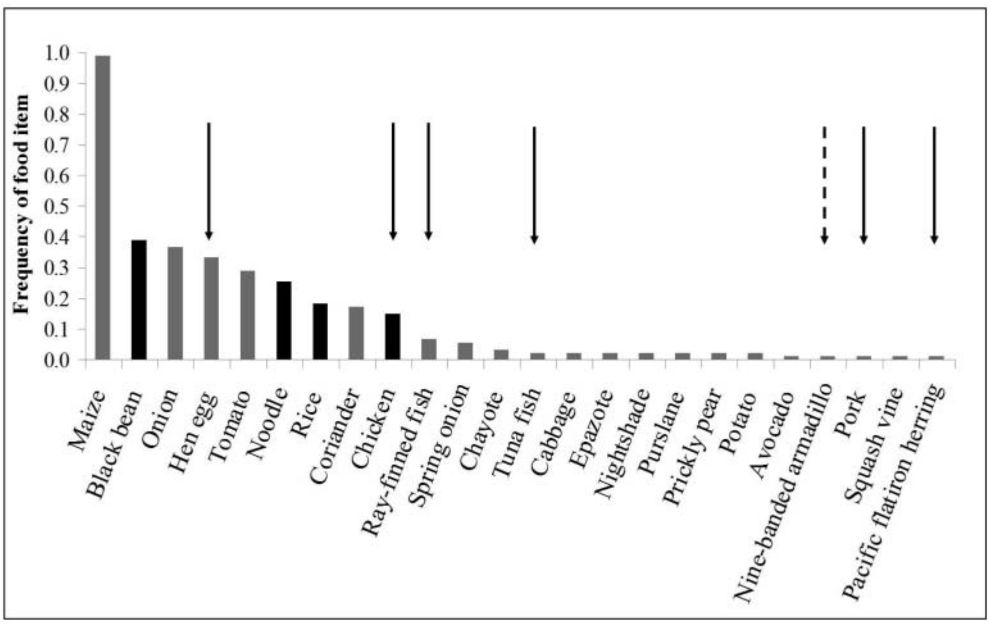
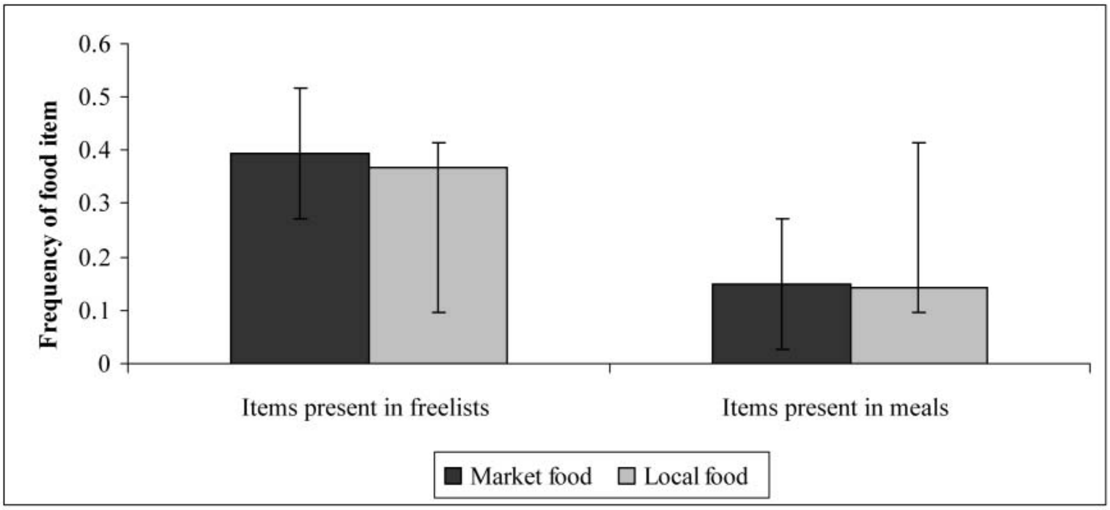


FIGURE 3 *Mean market purchased food item frequencies and mean locally obtained (through cultivation, gathering or hunting) food item frequencies in freelist exercises and in meals consumed by local Chinantec families (and researchers). According to* t*-tests, frequencies of market food items and local food items were not significantly different in both freelist exercises (*$t = 0.178$, $df = 58$, $P = 0.859$*) and in meals actually consumed by families (*$t = 0.042$, $df = 20$, $P = 0.967$*). Error bars (95% CI) are shown*

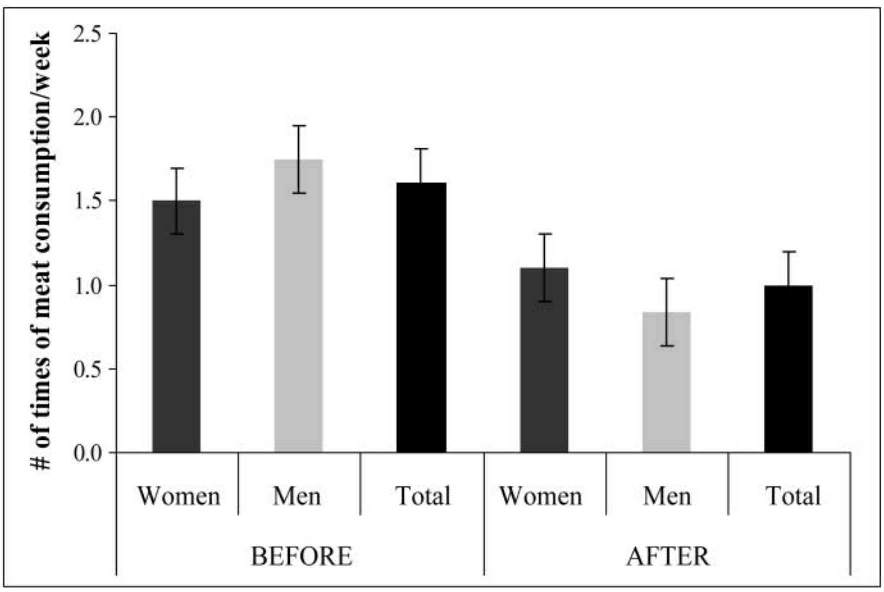



that the availability of local freshwater food (e.g. prawn, crayfish and trout) obtained from the river declined beginning in the 1980s, after the construction of the Miguel Alemán-Cerro de Oro dam on the Usila River during the 1970s.

Sixty-five per cent of informants said that they have incorporated new food items since the implementation of the PES and VCA programmes. The most common recently incorporated food items in local diets were rice, noodles, canned beans, steak, canned sardines, canned tuna fish, and soft drinks. According to informants, consumption of these foods increased after implementation of the PES because villagers were able to purchase these new goods with their annual income from this programme.

**Agricultural production, meat consumption and domestic economy:** Maize production has reportedly dropped from 31.08 ± 10.17 *zontles*[2] of maize/year before, to 20.63 ± 7.41 *zontles* of maize/year after the advent of the PES and VCA

FIGURE 4 *Reported incidence of meat consumption/week, before and after the implementation of hunting prohibitions in the Community Conservation Area. Error bars (95% CI) are shown*




[2] Area maize yields are measured in zontles: one zontle contains 400 well-formed ears, equivalent to 35 kg grain, equivalent to 87.5 g per ear (Van der Wal *et al*. 2006).

initiatives. Similarly, farmers reported that the production of black beans, which are typically cultivated in higher elevation fields that are now in the community conservation area, has almost disappeared.

In addition, harvest of semi-cultivated edible greens is diminished. A local farmer[3] attributed this in part to shortened fallow cycles and the use of agricultural chemicals: "*Ahora la tierra descansa sólo dos años, cuando antes descansaba 15 años. Ahora se usa más líquido químico, y eso acaba con las semillas de los quelites… Imagínate cuánta semilla de quelites hay en los acahuales viejos…*". [Now the land is left to fallow only for two years, whereas before a fallow was left for 15 years. Now more chemicals are used, and they eliminate seeds of leafy greens (quelites)… Imagine how much quelite seed there is in the old fallows…].

Seventy-six per cent of interviewees associated the diminishing productivity in the area with the PES and VCAs programmes, and they evoked three main reasons. First, informants pointed out that since a large proportion of the territory is currently under conservation designation, areas for agriculture have been reduced and, as a consequence, fallowing is diminished to only two to three years, which potentially lowers productivity in the long term. Preceding the PES and VCAs programmes, respondents reported that fallows used to rest for 15–20 years before they were again slashed and burned to reinitiate the agricultural cycle. Second, interviewees indicated that because of the hunting prohibition, pest animals are currently multiplying and adversely affecting agricultural production (Table 2). Finally, there is an impression that the annual payment had reduced the incentive to cultivate, because they no longer needed to produce enough food to last the entire year as was necessary prior to the establishment of the payments.

Villagers interviewed reportedly spent US $268.75 ± 220.87 dollars/year in order to complement the shortfall of maize and black bean production. In addition, there has been a change in patterns of purchasing meat. Sixty-five per cent of respondents noted they did not purchase meat before the hunting prohibition (because meat could be obtained by hunting), while 35% had occasionally purchased meat. Currently only 10% of respondents do not purchase market meat whereas the other 90% of respondents spend an average of US $30.97 ± 24.48 dollars/month to purchase meat.

Although villagers receive an annual payment from the PES programme, most interviewees (80%) stated that they now have to spend a greater proportion of their income purchasing food, since both agricultural productivity and meat procurement have decreased locally. Seventy-nine per cent of households stated that their families could not now survive without buying external goods. Respondents reported that the approximately US$ 500/year that households currently receive from the PES programme is less than the amount spent annually purchasing maize and meat alone.

In the words of one community member[4], "*Trabajo ahora en Santa Teresa pero antes trabajaba arriba de Arroyo Colmena. Ahora tengo problemas con la tuza y muy baja producción. Compro 700 kg de maíz este año a 4 200 pesos más 104 kg de frijol a 1 976 pesos. Recibo 4 000 pesos de pago por PSA. No alcanza ni para comprar todo lo que necesito*". [I work now in Santa Teresa (outside the conservation area) but before I worked above Arroyo Colmena (now inside the conservation area). Now I have problems with

TABLE 2 *Most significant vertebrate pests as reported by Chinantec farmers, Oaxaca, Mexico*

| English name (Scientific name) | Milpa (maize) | Manioc | Pineapple | Sugar cane | Bananas | Coffee | Black bean |
|---|---|---|---|---|---|---|---|
| MAMMALS | | | | | | | |
| Lowland paca *(Agouti paca)* | # | | | | # (Ø) | | |
| Mexican agouti *(Dasyprocta mexicana)* | # | # | | | | | |
| Squirrel *(Sciurus* spp.*)* | ○ | # | | | | | |
| Pocket gopher *(Orthogeomys hispidus)* | • | • | Δ | Δ | # | Δ | |
| Rats (more than one species) | Δ | | | | | | |
| White-nosed coati *(Nasua narica)* | • | • | | | # | | |
| Raccoon *(Procyon lotor)* | # | # | | | Δ | | |
| Tayra *(Eira barbara)* | | | | | | | |
| Collared peccary *(Pecari tajacu)* | • | ○ | | | Δ (Ø) | | |
| Red brocket deer *(Mazama americana)* | | | | | | | Δ |
| BIRDS | | | | | | | |
| Parakeet *(Aratinga* sp.*)* | # | | | | | | |
| Yellow-billed cacique *(Amblycercus holosericeus)* | # | | | | | | |
| Montezuma oropendula *(Psarocolius montezuma)* | Δ | | | | | | |

[3] S.M.A., 58 years old (The initials of key informants quoted in the text have been changed to protect their anonymity).
[4] B.S.P., 38 years old.

TABLE 2 *Continued*

| English name (Scientific name) | Squash | Jicama | Sweet potato | Cacao | Mamey sapote | Chayote |
|---|---|---|---|---|---|---|
| MAMMALS | | | | | | |
| Lowland paca *(Agouti paca)* | Δ | | | | | Δ (Ø) |
| Squirrel *(Sciurus* spp.*)* | | | | # | | |
| White-nosed coati *(Nasua narica)* | Δ | # | # | | | |
| Tayra *(Eira barbara)* | | | | | Δ (Ø) | |
| Collared peccary *(Pecari tajacu)* | Δ | | | | | |

• = primary pest (i.e. those reported by 80–100% of respondents); ○ = secondary pest (i.e. those reported by 50–79% of respondents); # = tertiary (i.e. those reported by 20–49% of respondents); Δ = marginal (i.e. those reported by at least 10–19% of respondents); Ø = eats fallen fruit.
Note 1: This list does not consider one bat species (*Desmodus rotundus*), which was reported as a pest by 40% of respondents because it would attack mules, chickens and donkeys.

pocket gophers and a very low production. I am buying 700 kg of maize this year for 4 200 pesos plus 104 kg of beans for 1 976 pesos. I receive 4 000 pesos from PES. It isn't enough to buy all that I need].

**Subsistence hunting and culture:** According to interviewees, at least 32 vertebrate species were used prior to the implementation of the hunting prohibition (Table 3). Species mentioned were used primarily as a source of food (84.4% of mentioned species), medicines (15.6%), handcrafts (12.5%), ornamentation (9.4%), pets (6.3%), or tools (3.1%). Formerly, 75% of the birds and mammals used by Chinantec villagers were hunted in the forest, 62.5% in fallows, 34.4% in *milpas*, and 18.8% within or near the community (Table 3). For local hunters, the main reasons for hunting before the prohibition were to control pest species (52.6%), and obtain meat for families and kin (47.4%). From the total, only 26.3% of hunters noted that, on rare occasions, they sold meat to neighbours or friends. Hunters who reported gathering useful plants and mushrooms while hunting said this was mainly a complementary activity to the hunt, and not worthwhile as a separate endeavour.

Permission is still granted to hunt 10 species (31.3% of those formerly hunted) exclusively in *milpas*, as they are considered harmful to agriculture. Nevertheless, even this practice is disappearing, since hunters are afraid that sanctions – especially withholding annual PES annual allocations – could be imposed by local or national authorities because of unsubstantiated concerns that any hunting could be considered harmful to wildlife. As one farmer and hunter[5] from Santiago Tlatepusco stated "*Hoy en día nadie va armado a la milpa. . . No es bien visto que andes con un arma*". [Today no one goes to the milpa armed . . . it is not well accepted that you carry a gun].

Furthermore, a prohibition on keeping hunting dogs has further reduced hunting success. Before the prohibition, the principal strategies were stationary hunting from blinds or bushy vegetation (recognised by 57.9% of informants as their main practice), followed by hunting with dogs (36.8%) and opportunistic hunting (5.3%). As one hunter[6] stated: "*Antes ibas a la milpa con tus perros y ellos empezaban a ladrar hacia el bosque. Después salían ladrando, persiguiendo al animal. Tú solo tenías que seguirlo hasta alcanzarlo. . . A veces lo encontrabas ladrando bajo un árbol hacia un tejón en sus ramas o a la entrada de una guarida de armadillo*". [Before you would go to the *milpa* with your dogs and they would start to bark towards the forest. Then they venture out barking, following the animal. You would only have to follow to capture it . . . sometimes you would find your dog barking beneath a tree at a white-nosed coati on its branches or at the entrance of an armadillo den].

The hunting prohibition is also leading to a progressive deskilling among hunters. The people who demonstrated the greatest knowledge about animals were the hunters who would go accompanied by their dogs on hunting expeditions that could last for days, now a practice of the past. As one community member expressed[7], "*Un cazador es nada sin su perro. . . Ya no hay cazadores en Santiago porque los perros están prohibidos. Con la pérdida de los perros, los cazadores también nos estamos perdiendo*". [A hunter is nothing without his dog . . . Now there are no more hunters in Santiago because dogs are prohibited. With the loss of the dogs, we hunters are also disappearing].

Hunting was also one means by which socio-cultural ties, such as friendship and kinship, were maintained in the community before the ban was implemented. Villagers used to go hunting with their relatives, sharing what they obtained from a hunting trip and thereby maintaining relationships. Hunting

[5] S.T.J., 38 years old.
[6] R.N.L., 49 years old.
[7] M.I.S. 39 years old.

TABLE 3 *Reported terrestrial vertebrates used by Chinantec villagers, before the implementation of a hunting prohibition in the area (Note: * indicates those species for which permission is still granted for hunting)*

| Family | Scientific name | English name | Uses[1] | Part used[2] | Site[3] |
|---|---|---|---|---|---|
| MAMMALS | | | | | |
| Didelphidae | *Didelphis marsupialis* | Common opossum | M, F (-) | T, M | V |
| | *Didelphis virginiana* | Virginia opossum | M, F (-) | T, M | V |
| Dasypodidae | *Dasypus novemcinctus* | Nine-banded armadillo | F, O (-) | M, Ar | F, Fa, B |
| Myrmecophagidae | *Tamandua Mexicana* | Northern tamandua | F (-), M (-) | M | F, Fa |
| Eretizonthidae | *Coendu Mexicana* | Mexican porcupine | M | S | V, F, Fa |
| Dasyproctidae | *Cuniculus paca** | Lowland paca | F, P, Pe (-) | M, C | F, Fa, M, R, C |
| | *Dasyprocta Mexicana* | Mexican agouti | F, P | M | M, F, Fa |
| Sciuridae | *Sciurus* spp.* | Gray squirrel | F, P | M | M, F, Fa |
| Geomydae | *Orthogeomys hispidus** | Pocket gopher | P | - | M |
| Echimyidae, Muridae | - * | Rats | P | - | M, V |
| Procyonidae | *Nasua narica** | White-nosed coati | F, P | M | M, F, Fa |
| | *Procyon lotor** | Raccoon | F, P | M | M, F, Fa |
| Mephitidae | *Conepatus mesoleucus* | Skunk | M (-), F (-) | M | F, Fa |
| Mustelidae | *Eira Barbara* | Tayra | F (-), P (-) | M | F, Fa |
| Felidae | *Panthera onca* | Jaguar | F (-), H (-) | M, S, C | F |
| | *Leopardus wiedii* | Margay | F (-), H (-) | M, S, C | F, Fa |
| | *Leopardus pardalis* | Ocelot | F (-), H (-) | M, S, C | F, Fa |
| Tayassuidae | *Pecari tajacu** | Collared peccary | F, P, H (-) | M, C | M, F, Fa, C |
| Cervidae | *Mazama Americana* | Red brocket deer | F, P (-), T (-) | M, A | F, Fa, R |
| BIRDS | | | | | |
| Tinamidae | *Tinamus major* | Great tinamou | F | M | F, Fa |
| Cracidae | *Ortalis* sp. | Chachalaca | F | M | F, Fa |
| | Crax rubra | Great curassow | F | M | F |
| Columbidae | *Columba* spp. | Pigeons (several species) | F, Pe (-) | M | F, Fa, V |
| Psittacidae | *Aratinga* sp.* | Parakeet | P, F(-) | M | M |
| Ramphastidae | *Pteroglossus torquatus* | Collared aracari | F (-), O (-) | M, B | F, Fa |
| | *Ramphastos sulfuratus* | Keel-billed toucan | F (-), O (-) | M, B | F, Fa |
| Picidae | *Melanerpes aurifrons* | Golden-fronted woodpecker | F (-) | M | F, Fa |
| | Campephilus guatemalensis | Pale-billed woodpecker | F (-) | M | F |
| | *Dryocopus lineatus* | Lineated woodpecker | F (-) | M | F |
| Icteridae | *Quiscalus quiscula* | Common grackle | P (-) | - | V |
| | *Amblycercus holosericeus** | Yellow-billed cacique | P | - | M |
| | *Psarocolius montezuma** | Montezuma oropendula | P (-) | - | M |

On the basis of interviews with informants, (-) means that use is marginal or not practiced anymore.
[1] F = food, H = handcraft, M = medicinal, T = tool, Pe = pet. This column includes "P", which refers to those species considered agricultural pests.
[2] M = meat, S = skin, C = canines, A = antlers, T = tail, B = bill, Ar = armour, S = spines.
[3] Preferred site where species is hunted: V = village (in the case of Opossum species they are caught close to poultry), F = forests, Fa = fallows, M = *milpa* or other crop fields, R = river, C = cave, B = burrow.

was an avenue for adolescent Chinantecs to gain environmental skills, including hunting *per se* as well as identification of wildlife and useful plants. Hunting was also a means of enjoying free time and forgetting daily preoccupations and problems.

Agricultural activities and hunting were also mechanisms for transmission of traditional beliefs, environmental knowledge and skills. Interviewees pointed out that young boys and men, by the ages of 12–20 years old, should be able to perform most subsistence related tasks competently, including hunting at least to protect their *milpas*. Hunters reported that they learned to hunt at age 17.4 ± 5.1 years (n=19); 58.2% of hunters were taught by their parents or grandparents, while the others were taught by an older sibling or a friend.

Informants expressed concern that the younger generation is losing the knowledge and skills of their fathers and grandfathers. As one farmer noted[8], "*Ahora, mi hijo más chico (10 años) no conoce los acahuales de Arroyo Quelite, y mi hijo del medio (14 años) ni quiere caminar hasta allá cuando lo invito. Los jóvenes se están acostumbrando a no caminar y a trabajar menos*". [Now, my youngest son (10 years old) doesn't know the fallows of Arroyo Quelite, and my middle son (14 years old) doesn't even want to walk there when I ask him. The youngsters are getting used to non-walking and working less].

## DISCUSSION

Payments for Environmental Services (PES) and the formalisation of community conservation efforts may entail unintended consequences, including alterations of traditional resource management and declines in the health and nutrition of relatively isolated indigenous communities. By providing financial subsidies linked to environmental services, the Mexican government has initiated an exchange mechanism based on agreements concerning the bundle of rights inherent in community governance of the forest. In these agreements, a large subset of the services the forest provides to the communities (including long-fallow agricultural sites, hunting and gathering grounds, and related opportunities for locally sourcing nutritional foods) are abrogated or diminished in exchange for cash payments. These changes may be initiated or exacerbated by the designation of Voluntary Conserved Areas (VCAs) if the community members are not fully in control of the process of delimiting and monitoring these local protected areas.

Several scholars have called for rigorous empirical studies on the impact of the market economy on the well-being of indigenous peoples and their use of natural resources (Godoy *et al*. 2005, Gómez-Baggethun *et al.* 2010, Lu 2007, Reyes-García *et al.* 2005). While noting that deficiencies and discrepancies in methodology limit the general conclusions that can be drawn from available case studies, they generally conclude that current evidence suggests market exposure has mixed effects on the subsistence, health, nutritional status, social capital, and traditional ecological knowledge of indigenous peoples.

The preliminary results of research on PES, community conservation and food sovereignty in the Chinantla contribute additional insights into these issues. Chinantec communities are facing a transition in (a) dietary patterns and food acquisition, (b) household economies and food security, and (c) socio-cultural significance of subsistence activities. This study has considered if these changes are partially driven by preservationist approaches inherent in the establishment of PES and VCAs.

### Dietary patterns and food acquisition

Many indigenous groups around the globe are going through a transition of lifestyles and diets (Damman *et al.* 2008, Creed-Kanashiro *et al.* 2009, Huamán-Espino and Valladares 2006), which often poses a threat to their health and nutrition. This decline usually goes hand in hand with processes of acculturation – particularly the degradation of local knowledge of, and pride in, traditional agricultural practices – and of increasing consumption of Western foods of low nutritional quality, especially soft drinks and refined flour (Correal *et al.* 2009). This new dietary pattern, which includes dependence on nutrient-deficient market items such as noodles, rice and fried foods, can contribute to insufficient intake of vitamins and minerals.

The results of this study suggest that Chinantec traditional food systems have been altered by limitations on shifting agriculture, a hunting ban, the construction of a river dam, and new income received by villagers from PES and other sources, which allows them economic access to new industrialised food items. Purchased foods (rice, noodles, steak, canned beans, sardines and tuna fish and bottled soft drinks) are becoming more frequent in the local diets. The important proportion of external market foods in meals, together with the loss of traditional foods, attests to changes in Chinantec food sovereignty.

Among Mesoamerican indigenous peoples, the *milpa* is the most critical element of a diversified traditional food system (Alcorn and Toledo 1998), and is the key agricultural and economic component of local livelihoods in the Chinantla. Shifting cultivation associated with the *milpa* is only one component of a much larger agroecosystem that includes agriculture, hunting, and gathering (Warner 1991).

As revealed by this study, decreases in *milpa* productivity are associated with the implementation of the PES and VCAs programmes, mainly via three avenues. First, land-use change is now prohibited in approximately three quarters of the territory, which reduces the availability of agricultural land, shortens cycles of sowing and fallowing, affects soil quality, and decreases productivity. Second, since villagers receive annual payments through the PES-H scheme and other government subsidies, they are working their fields less and are harvesting

[8] J.P.B., 38 years old.

reduced food stocks that do not last the entire year. Finally, nuisance animals are reportedly multiplying and there is a constant escalation of pest attacks affecting agricultural fields. Increasing negative effects of nuisance animals have been associated with the implementation of conservation initiatives elsewhere (Mishra 1982, Chhangani *et al.* 2008), and could become a major source of conflict between local communities and VCA management if not properly addressed (Bajracharya *et al.* 2005).

Swidden cultivation has long proven a flashpoint for development scholars and practitioners, including those who characterise it as a backward and destructive practice linked to deforestation and poverty (FAO Staff 1957 in Mertz *et al.* 2009). Conklin (1957, 1963) contested this assessment, and recent empirical work substantiates his assertion that swidden agriculture is adaptive, economically rational, and sustainable. For example, Diemont and Martin (2009) found high indices of sustainability and low environmental impact in Lacandon Maya swidden agroforestry systems. Mertz *et al.* (2009) have argued that a deeper understanding of agroecosystem dynamics is needed before declaring that shifting cultivation is unsustainable and proposing alternative land uses. Despite these new insights, there were no efforts on the part of the governmental and civil society proponents of conservation efforts in Santiago Tlatepusco to conduct baseline studies or implement monitoring of the impact of preservationist measures on swidden agriculture, dietary diversity and other aspects of food sovereignty.

Villagers frequently pointed out that meat consumption patterns changed after the hunting prohibition. Similar to other shifting cultivators in Mexico (Naranjo *et al.* 2004, Quijano-Hernández and Calmé 2002, Ramírez and Naranjo 2007) and elsewhere in the Neotropics (Smith 2005), Chinantec community members used to obtain animal protein partly by hunting in adjacent forests, fallows and fields while they protected their *milpas*. According to Neusius (1996), hunting of animals that frequent fields and fallows provides high-quality protein and effective reduction of competition for crops.

Robinson and Bennett (2004) have argued that the sustainability of subsistence hunting, which is critical to the livelihoods of people around the world, depends in part on the ecological conditions that affect wildlife supply and demand. They provide empirical evidence that the supply of game is greater in secondary forests and forest–farm–fallow mosaics than in undisturbed forests. They recommend that empirical studies of the impact of hunting in various ecosystem types and degrees of human disturbance be conducted before land is zoned for protected areas or resource management. Unfortunately, there has been no such analysis of the viability of wildlife populations in the Chinantec communities before and after the implementation of hunting prohibitions. In addition, there was little consideration of customary forms of governing and managing the territory and sustaining hunting yields, elements that are closely linked to the institutions and cosmology of Chinantec communities (Ibarra 2010, Oliveras de Ita 2005).

Decreases in the proportion of game versus livestock meat in the diet reflect changes in traditional livelihoods and lifeways among indigenous peoples (Hawkes *et al.* 2001, Spielmann and Eder 1994, Vázquez and Godínez 2005). This tendency, currently experienced by Chinantecs, is common among indigenous groups in Mexico. Furthermore, local efforts to establish poultry to compensate for diminished animal protein have been limited by diseases, preventing year-round consumption, and an increase in grazing livestock raises concerns about erosion and landslides near settlements. These changes in local procurement of protein exacerbate the impact of the Miguel Alemán-Cerro de Oro dam, which decreased local access to aquatic resources in favour of regional hydropower development (cf. Arthur and Friend 2011).

## Domestic economy: food for health and security

Increased income in rural areas does not translate directly into increased or higher quality food consumption (Dewey 1981, DeWalt 1983). Poor and market-dependent individuals tend to purchase cheap and filling industrially processed foods and drinks, high in refined carbohydrates and saturated fats rather than good quality food (Kuhnlein *et al.* 2004), due to affordability, which in turn affects the amount of time and energy committed to harvesting and preparing traditional foods (Kuhnlein and Receveur 1996). When alternative foods are available at low cost in local markets, local farmers tend to reduce the time spent working in traditional agroecosystems when they can afford to buy processed products.

The current challenges of food acquisition in Chinantec communities could arguably be ameliorated by the PES income each family receives annually. However, villagers currently spend a high proportion of these revenues to purchase externally produced, lower-quality food. Following the implementation of PES and VCAs, they are increasingly dependent on external markets for industrialised foods, meat, black beans and maize, historically the pivotal element of their diversified subsistence system strategy. With greater distance from regional markets, PES cash payments buy relatively fewer goods and services for members of remote communities because food prices are augmented by transport costs. For these reasons, economic benefits of the transition in food sovereignty are unlikely to accrue locally.

A diet based on processed food can result in health problems, especially for indigenous communities who are predisposed to certain health conditions. This has been demonstrated in Mexico where a decrease in food quality has increased the prevalence of chronic degenerative diseases like diabetes mellitus, cancer, and arterial hypertension (Chávez *et al.* 2003). In South America, Uauy *et al.* (2001) documented the extent of obesity and metabolic complications among rural and urban Mapuche and Aymara indigenous people in Chile after they became dependent on external markets and increasing incomes. A wide range of literature, summarised by Fleuret and Fleuret (1980), consistently documents nutritional declines, called transitional malnutrition, associated with new income strategies. Further studies in the Chinantla are necessary to test whether current changes in food sovereignty are yielding measurable changes in nutritional status and health.

For indigenous peoples, global economic drivers have contributed to redirecting land and resources away from traditional modes of securing household subsistence and toward cash cropping, conservation, or industrial development (Kuhnlein and Receveur 1996). While making greater numbers of people secure in terms of caloric energy, industrialised food also drives the nutritional transition and can undermine the self-sufficiency and economic viability of local systems (Kuhnlein and Receveur 1996, Diaz-Bonilla and Robinson 2001).

In the Chinantla, by agreeing to restrict use of their ancestral agricultural land and prohibit hunting as conservation measures, food security has become less stable, leading to greater community dependency on external supplies for food. If market food of sufficient quality (meat, low-fat dairy items, vegetables, whole grains) is not available to replace essential nutrients from traditional meat, fish and produce, the nutrition of the entire community is at risk (Kuhnlein *et al.* 2004). Compromising food security is questionable at best: "food is so fundamental to human well-being that it is hard to envisage a situation in which it could be traded-off for some other good" (Arthur and Friend 2011: 219).

### Socio-cultural significance of Chinantec food acquisition

Swidden agriculture and hunting represent more than a food quest for Chinantecs. The *milpa* has an essential function as a major food source (DeWalt 1983), but also a socio-cultural role in defining land tenure and various social interactions (Alcorn and Toledo 1998). Garden hunting in *milpas*, fallows, and forests links natural and social environments, agricultural practices, custom and cosmology (Ibarra 2010). Chinantec hunting is related to eliminating nuisance animals, but also to providing protein, medicine and tools. Traditional environmental knowledge related to farming, hunting and gathering is both vertically and horizontally transmitted. Hunting previously provided an opportunity to learn about the environment, reaffirm traditional beliefs, gather plants and socialise. The socialisation involved processes by which individuals became hunters, embodying in their own experience and acting out in their learned behaviour part of Chinantec swidden maintenance and hunting culture (Oliveras de Ita 2005).

With the prohibition of hunting, not only meat consumption, but also other traditional uses of wildlife and socio-cultural meanings of hunting and gathering have been disrupted (Ibarra 2010). PES appear to have created new forms of self- and community policing (Foucault 1977): community members relate that they avoid shooting animals in agricultural areas for fear other community members will report them, leading to loss of their PES allocation. If this is the case, then the influence of the PES over certain spaces in the community has been extended beyond the officially protected areas. A formalised commons has rules governing membership and access to resources. By monetising and effectively closing the Chinantec communities' commons, PES and VCA certification have generated a new set of rules about resource management on community land, including areas not set aside to provide environmental services or conserve biodiversity.

## CONCLUSIONS

Programmes to protect food sovereignty can provide strategies to combat malnutrition while ensuring sustainable development (Murcott 1992). With the current focus on advocating and assessing the impact of policy shifts that seek to directly foster food sovereignty (Pimbert 2009), much less attention has been paid to the influence of a broader web of policy, law and regulations, especially related to nature conservation (Martin *et al*. 2010). A central concern is that new uses of land, ranging from large-scale agriculture to biodiversity conservation, and financial subsidies, including market-based mechanisms such as PES, may disrupt the resource access, production, consumption and distribution that are at the heart of localised food systems. This is part of a gradual structural displacement of indigenous peoples and local communities, a process of restricting access to and use of communal lands that eventually limits the ability of community members to meet their basic needs.

Traditional food systems, once lost, are hard to recreate, underlining the imperative for documentation, compilation, and dissemination of knowledge of biodiversity and its uses, especially when it is eroding in the face of acculturation and globalisation (Johns and Sthapit 2004). For indigenous peoples and local communities, it is not just a loss of food items *per se* that matters, but also deskilling, such as the loss of fishing and hunting practices, and the impoverishment of the knowledge related to recognising, harvesting, preparing, and consuming traditional foods that contribute to maintaining healthy diets and social relations.

Agrawal and Redford (2009) have summarised contemporary critiques of biodiversity conservation programmes, noting they have been faulted for distressing ". . .human populations, especially those who are less powerful, politically marginalised, and poor" (2009:1). They highlight in particular the impact of physical dispossession of peoples from their lands, restrictions on access to resources, loss of livelihoods and diminished opportunities for future income that often accompanies the establishment of protected areas. Lele *et al*. (2010) explore alternative forms of biodiversity conservation that are intended to rectify these difficulties, with a focus on inclusive approaches such as community-based conservation, enterprise-based conservation and PES. Indigenous and Community Conserved Areas (ICCAs) are considered to show particular promise (Borrini-Feyerabend and Kothari 2008), although there are concerns about assessing their conservation benefits, ensuring they integrate traditional ecological knowledge and finding appropriate governance regimes, among other challenges (Berkes 2009).

In order to be successful, ICCAs will have to avoid the pitfalls of previous approaches to biodiversity conservation. Lele *et al*. (2010: 1) have already raised a red flag on enterprise-based conservation, noting that it "offers some potential if design flaws, poor implementation, assumptions about homogeneous communities, and inattention to tenurial change and security are addressed". They equally urge caution on payments-based programmes, suggesting the need for more insightful and detailed studies of their "economic efficiency, and simplified assumptions regarding the nature of rights, biological information, monitoring costs, and state interventions" (Lele *et al*. 2010: 1).

## The precautionary principle applied to community conservation

The caveats detailed in this paper highlight the importance of applying a precautionary principle when implementing the increasingly diverse set of measures and practices that are currently included under the broad rubric of community conservation.

Since the early 1990s, environmental scientists have recognised the importance of the precautionary principle as an essential guideline in environmental policy and practice (Kriebel *et al*. 2001). A consensus definition from Raffensperger and Tickner (1998), cited in Kriebel *et al*. (2001: 871), summarizes the principle: "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." Four specific components of the principle, all specifically relevant to community conservation, have been proposed: (1) preventive action should be taken in the face of uncertainty; (2) the burden of proof should be shifted to the proponents of an intervention; (3) a wide range of alternatives to possibly harmful actions should be explored; and (4) public participation in decision making should be increased (Kriebel *et al*. 2001: 871).

Cooney (2004) notes that the precautionary principle should not be used to support protectionist approaches to conservation, without considering the potential impacts of these policies. Furthermore, she argues that scientific assessments should incorporate indigenous, traditional and local resource user knowledge, and should examine the broader socio-economic and political contexts which affect the impact of conservation decisions. The precautionary principle is particularly relevant to ICCAs, many of which have been managed by local peoples over long periods of time.

Conservationists should shoulder the responsibility of proving that changes in landscape or resource use are needed, and they should actively engage community researchers in their environmental assessments. Absence of evidence of environmental degradation on a landscape scale should be a strong incentive to block preservationist measures whose impacts are uncertain. Above all, a wide range of alternatives – many of them based on the knowledge, innovations and practices of indigenous and local communities – should be explored before implementing extensive protected areas, hunting bans and other restrictions on customary resource use. Articles 8(j) and 10(c) of the Convention on Biological Diversity, and well as Article 8.2(b) and Article 26 of the United Nations Declaration on the Rights of Indigenous Peoples, support this approach.

The preliminary results presented here provide initial evidence that dietary diversity, agricultural practices, household economies and livelihoods may be negatively affected by strict preservation measures imposed under the guise of community conservation, especially when subsidised through financial incentives. Although PES and VCAs schemes in the Chinantla maintain community ownership of lands and resources and are putatively community-led, they still represent avenues for government and civil society policies to permeate local institutions and customary governance of commons, and to drive changes in food acquisition and consumption. This results in a *de facto* structural displacement of Chinantec people from their communal lands.

These drivers of change are intertwined with other factors – such as migration, large scale development projects and various other trends associated with the market economy – that affect local livelihoods and modes of social reproduction. Although it can be conceptually and empirically difficult to distinguish the impact of one driver from the others, this study has identified some consequences that local people attribute to the prohibition of hunting, the reduction of swidden agriculture and the effects of financial subsidies linked to conservation initiatives.

The people of Santiago Tlatepusco are not alone in questioning the impact of preservationist measures implemented in the name of community conservation (Schmidt 2010). Concerned about the impact of conservation measures on subsistence production, the General Assembly of Santiago Lachiguiri, a Zapotec community in the Isthmus of Oaxaca, voted in May 2010 to cancel the certification of its VCA, originally delimited in 2003 as the first indigenous VCA in Mexico. In addition, the community opted unanimously to reject any further PES. Instead, it decided to rewrite the municipal statutes to explicitly recognise the responsibility of all inhabitants to manage and protect the natural resources of Santiago Lachiguiri in an equitable way (Schmidt 2010: 23). The new statues recognise that swidden farming is "un sistema de agricultura tradicional milenario que mantiene el equilibrio entre la producción de alimentos y el cuidado de la montaña, bosque y selva" [an ancient traditional agricultural system that maintains the equilibrium between food production and caring for the mountain, woods and tropical forests].

An important question is whether market-based mechanisms like PES can ever be made compatible with food sovereignty. Answers are urgently needed, as these mechanisms already form part of national and international biodiversity conservation policies, and some indigenous and local communities see them as a viable source of income even as others reject them. This study suggests that taking socio-cultural context and ecological parameters into account is essential in any analysis of the impact of nature conservation and financial incentives on food sovereignty. This requires a detailed understanding of local production systems and wild food harvesting that can inform any restrictions on resource access or use, ensuring they are sensitive to local livelihood needs. This is consistent with international recognition of the importance of reviving and rebuilding food sovereignty in developing countries to reap health and environmental benefits (Johns and Sthapit 2004).

In order to achieve a deeper analysis of these complex issues, the tentative results and preliminary methodology of this study will need to be expanded in more comprehensive and comparative socio-ecological studies (Lele *et al*. 2010) which heed calls for more rigorous methodology (Godoy *et al*. 2005). Danielsen *et al*. (2009) have demonstrated the diverse ways in which local peoples can be involved in monitoring of trends in the conservation status of species or habitats. A community-based participatory approach will be an essential element of any deeper analysis of conservation, market mechanisms and food sovereignty.

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APPENDIX 1 *Food items mentioned by Chinantec women during freelists exercises. Items are shown in descending order according to the* Smith's Index of Saliency. ** shows the rarely mentioned game resources*

| English name | Spanish name | Scientific name | Response frequency | Smith's S Index |
|---|---|---|---|---|
| Black bean | Frijoles | *Phaseolus vulgaris* | 1 | 0.93 |
| Rice | Arroz | *Oryza sativa* | 0.9 | 0.73 |
| Noodle | Sopa | - | 0.9 | 0.62 |
| Chicken | Pollo | *Gallus domesticus* | 1 | 0.60 |
| Squash vine | Guía de calabaza | *Cucurbita moschata* | 0.8 | 0.56 |
| Chayote vine | Guía de chayote | *Sechium edule* | 0.7 | 0.50 |
| Chayote | Chayote | *Sechium edule* | 0.9 | 0.49 |
| Mint | Hierbabuena | *Mentha viridis* | 0.3 | 0.48 |
| Hen egg | Huevo de gallina | *Gallus domesticus* | 0.8 | 0.46 |
| Steak | Res | *Bos taurus* | 0.8 | 0.45 |
| Manioc | Yuca | *Manihot esculenta* | 1 | 0.43 |
| Squash | Calabaza | *Cucurbita moschata* | 0.8 | 0.39 |
| Maize | Maíz | *Zea mays* | 0.7 | 0.35 |
| Banana | Plátano | *Musa cuminata* | 0.9 | 0.34 |
| Ray-finned fish | Mojarra | *Aequidens latifrons* | 0.6 | 0.27 |
| Tomato | Tomate | *Solanum lycopersicon* | 0.6 | 0.26 |
| Night-blooming jasmine | Huele de noche | *Cestrum nocturnum* | 0.3 | 0.25 |
| Potato | Papa | *Solanum tuberosum* | 0.4 | 0.24 |
| Pacific flatiron herring | Sardina | *Harengula thrissina* | 0.4 | 0.23 |
| Prickly pear | Nopal | *Opuntia cochenillifera* | 0.7 | 0.21 |
| Sweet potato | Camote | *Ipomoea batatas* | 0.5 | 0.19 |
| Early beans | Ejote | *Phaseolus vulgaris* | 0.3 | 0.18 |
| Apple | Manzana | *Malus domesticus* | 0.3 | 0.17 |
| Carrot | Zanahoria | *Daucus carota* | 0.3 | 0.16 |
| Nightshade | Hierba mora | *Solanum nigrescens* | 0.8 | 0.16 |
| Freshwater prawn | Camarón | - | 0.3 | 0.15 |
| Papaya | Papaya | *Carica papaya* | 0.3 | 0.14 |
| Orange | Naranja | *Citrus x aurantium* | 0.4 | 0.12 |
| Pork | Cerdo | *Sus scrofa* | 0.2 | 0.12 |
| Corn | Elote | *Zea mays* | 0.3 | 0.10 |
| Lime | Lima | *Citrus aurantifolia* | 0.2 | 0.09 |
| Pineapple | Piña | *Ananas cosmosus* | 0.3 | 0.09 |
| Onion | Cebolla | *Allium cepa* | 0.2 | 0.09 |
| Pacaya | Tepejilote | *Chameadora tepijilote* | 0.2 | 0.09 |
| Watermelon | Sandía | *Citrullis vulgaris* | 0.2 | 0.09 |
| Chilli | Chile | *Capsicum annuum* | 0.4 | 0.08 |
| Coral tree | Hoja de corazón | *Erythrina* sp. | 0.1 | 0.07 |
| Mango | Mango | *Mangifera indica* | 0.3 | 0.07 |
| Coriander | Cilantro | *Coriandrum sativum* | 0.2 | 0.07 |
| Cheese | Queso | - | 0.3 | 0.06 |
| Lemon | Limón | *Citrus limon* | 0.2 | 0.06 |
| Melon | Melón | *Cucumis melo* | 0.1 | 0.05 |

APPENDIX 1 *Continued*

| English name | Spanish name | Scientific name | Response frequency | Smith's S Index |
|---|---|---|---|---|
| Coconut | Coco | *Cocos nucifera* | 0.2 | 0.05 |
| Avocado | Aguacate | *Persea americana* | 0.2 | 0.04 |
| Ice cream bean | Jinicuil | *Inga jinicuil* | 0.1 | 0.04 |
| Grape | Uva | *Vitis vinifera* | 0.1 | 0.04 |
| Plum | Ciruela | *Spondias purpurea* | 0.2 | 0.04 |
| Spring onion | Cebollín | *Allium cepa* | 0.2 | 0.03 |
| Collared peccary * | Jabalí | *Tayassu tajacu* | 0.1 | 0.02 |
| Mushroom | Hongo | ? | 0.1 | 0.02 |
| Turkey | Guajolote | *Meleagris gallopavo* | 0.1 | 0.02 |
| Cacao | Cacao | *Theobroma cacao* | 0.1 | 0.02 |
| Nance | Nanche | *Byrsonima crassifolia* | 0.1 | 0.02 |
| Mamey sapote | Sapote mamey | *Pouteria sapota* | 0.1 | 0.02 |
| Red brocket deer * | Mazate | *Mazama americana* | 0.1 | 0.01 |
| Guava | Guayaba | *Psidium guajava* | 0.1 | 0.01 |
| Yam bean | Jícama | *Pachyrhizus erosus* | 0.1 | 0.01 |
| Nine-banded armadillo * | Armadillo | *Dasypus novemcinctus* | 0.1 | 0.01 |
| Sugar cane | Caña de azúcar | *Saccharum officinarum* | 0.1 | 0.01 |
| White-nosed coati * | Tejón | *Nasua narica* | 0.1 | 0.01 |
| Guachipilin | Huachepil | *Diphysa robinioides* | 0.1 | 0.00 |
| Garlic | Ajo | *Allium sativum* | 0.1 | 0.00 |