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Multiple forest use through commercial sport hunting: Lessons from a community-based model from the Petén, Guatemala

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ABSTRACT

The "*Proyecto Pavo*" is a project dedicated to the conservation of the Ocellated Turkey (*Meleagris ocellata*) through sustainable use of the species in multiple-use, community-managed forest concessions of the Maya Biosphere Reserve in Petén, Guatemala. Since 2000, the project has conducted selective turkey harvests, performed related research, and promoted the conservation benefits of managed sport hunting for this species. Field activities of the project feature providing high-quality Ocellated Turkey hunts to sport hunter clients. Participating concessions benefit directly from harvest revenues of a resource that was not previously exploited commercially and indirectly from affiliated project activities. The project began operations in a single concession on an experimental basis and evolved into a commercial enterprise operating in multiple concession units. The project has overcome numerous development and operational challenges, including compatibility issues with timber and NTFP extraction. Under proper circumstances, carefully designed sport hunting programs can offer profitable and sustainable forest product diversification alternatives that are highly compatible with tropical multiple-use management and forest conservation objectives.

1. Introduction

In North America unregulated exploitation and habitat conversion by a growing human population led to precipitous declines of many wildlife species (Mares, 1986; Robinson and Bolen, 1989; Strickland et al., 1994). For many species these trends were reversed during the 20th century when the gradual strengthening of public and private institutions, and economic prosperity permitted the development of a conservation model based on sustainable use through managed sport hunting, habitat protection, and science-based management interventions (Owen, 1971; Mares, 1986; Robinson and Bolen, 1989). One of the most successful recoveries has been of the Wild Turkey (*Meleagris gallopavo*), a species that was approaching extinction a century ago but is once again broadly distributed and abundant in much of the USA today (Schorger, 1966; Aldrich, 1967; Robinson and Bolen, 1989).

In the USA and many other developed countries the integration of recreational activities such as regulated sport hunting with multiple-use forest management is not uncommon (Webb, 1960; Pearse and Holmes, 1993; Stedman et al., 2008). Similar integrated efforts are rare in the American tropics, where rural residents commonly hunt in natural forests under multiple-use management for subsistence or commercial purposes (Ojasti, 1984; Redford, 1992), often with detrimental consequences on wildlife populations (Bodmer et al., 1988; Peres, 1990; Robinson and Redford, 1991; Shaw, 1991; Robinson et al., 1999). Although reduced-impact logging norms (reviewed in Putz et al., 2008) do not adversely affect habitat quality for many animal species (Radachowsky et al., 2004; van Kujik et al., 2009) and may even improve habitat for certain exploited species (Fragoso, 1991; Williams et al., 2010), the improved access to wildlife populations provided by logging infrastructure often facilitates unsustainable exploitation (Auzel and Wilkie, 2000; Frumhoff, 1995; Thiollay, 1997). Initiatives aimed at tapping the conservation, economic, and social benefits of sustainable wildlife exploitation (Freese and Saavedra, 1991; Panayotou and Ashton, 1992; Shaw, 1991; Wang and Wilson, 2007) are in need of further development in the context of multiple forest use in the tropics (but see an example in Elkan et al., 2006).

This paper reviews the design, performance, and compatibility of an integrated conservation and development project that diversifies economic benefits from tropical forests managed primarily

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for timber and botanical non-timber forest products (NTFPs) through commercial sport hunting. The project was specifically designed to support the conservation of the Ocellated Turkey (*Meleagris ocellata*) and to mitigate the negative impacts of subsistence hunting in community-managed forest concession units within the Maya Biosphere Reserve (MBR) in northern Guatemala (Baur et al., 2008). The primary activity of the project, locally known as the "*Proyecto Pavo*" (hereafter PP), is conducting community-operated, selective harvests of the Ocellated Turkey with sport hunter clients.

The principal income of participating concession units is derived from Forest Stewardship Council (FSC) certified timber in reduced-impact logging operations (Carrera et al., 2006). The most economically important NTFP from the participating concessions are the fronds of understory *xate* palms (*Chamaedorea* spp.) which are exported for use in floral arrangements, the harvest of which is included in the FSC certification (Pinelo, 2009). Other traditional NTFPs of economic importance include allspice, the fruit of the dioecious tree *Pimenta dioica*, and *chicle*, the latex of *Manilkara zapota* trees used formerly as the principal ingredient in chewing gum (Schwartz, 1990; ProPetén-Conservation International, 1996; OMYC-NPV, 1999). Timber and NTFP harvesters typically operate out of temporary forest camps although in concessions with resident communities NTFP harvesters often operate out of their homes. Most local residents cultivate corn and other crops using a rotational, swidden production system (Baur et al., 2008). A large proportion of the dietary protein in local communities is derived from subsistence hunting of several species of birds and mammals (Roling, 1995; Morales and Morales, 1998; Baur, 1999).

Currently there are 10 active community forest concessions ranging from 12,200 to 83,000 ha in the Multiple-use Zone (MUZ) of the MBR (Radachowsky et al., 2004; the MUZ encompasses about 0.8 million ha of closed-canopy forest, the entire MBR is approximately 2 million ha). Each concession has a management organization recognized by the National Protected Areas Council (*Consejo Nacional de Áreas Protegidas* – hereafter CONAP) composed of a local membership and operated by elected officers. The concessionaires are entitled to natural resource extraction rights for a 25-year period. The forest is described as Subtropical Moist (Holdridge et al., 1971). Mean annual precipitation is 1250 mm with peaks in May–June and September, and a 4-month dry season from January through April (Baur, 2008). Over twenty species may be harvested for timber, but extraction efforts concentrate on four: *Swietenia macrophylla*, *Cedrela mexicana*, *Calophyllum brasiliense*, and *Lonchocarpus castilloi*, at intensities that range from 0.8 to 2.4 trees per ha (Radachowsky et al., 2004). Annual logging compartments range from 300 to 1200 ha with planned rotation cycles ranging from 25 to 40 years (Radachowsky et al., 2004).

2. Background

2.1. Sport hunting and the Ocellated Turkey

The Wild Turkey of North America has five recognized subspecies; the Ocellated Turkey is the only other turkey species (Aldrich, 1967). The popularity of sport hunting for the Wild Turkey has increased steadily in pace with the species' recovery (Schorger, 1966; Kennamer et al., 1992). Successful turkey hunters require years to develop an intimate understanding of turkey behavior and the ability to imitate various turkey calls, and often develop a high level of enthusiasm for the activity in the process (Latham, 1967; Williams, 1989). One of the largest sportsmen-based conservation organizations in North America is the National Wild Turkey Federation (NWTF), with over 350,000 members and local chapters in the USA, Canada, and Mexico (Poole and Allard, 2007; NWTF, 2010). The NWTF promotes turkey conservation based on managed sport hunting via public education, political activism, and support for research and management efforts. A component of the NWTF membership participates in an internal achievement system that recognizes individuals who have successfully hunted specific combinations of the distinct turkey varieties (NWTF, 2010).

Fig. 1. A breeding male Ocellated Turkey displaying behind a female turkey. Photograph by Lovett E. Williams Jr.

The Ocellated Turkey (Fig. 1) is endemic to the Yucatan Peninsula. The current geographic distribution of the species (Fig. 2) includes the Mexican states of Yucatán, Campeche, and Quintana Roo, and the northern parts of Guatemala and Belize (American Ornithologists' Union, 1998; Williams et al., 2010). Interest in the

Fig. 2. Approximate geographic distribution of the Ocellated Turkey (shaded area).

Ocellated Turkey among North American turkey hunters has grown substantially since the 1990s (NWTF, 2010). Most NWTF members who hunt the Ocellated Turkey travel to Mexico, which has greater infrastructural access to turkey populations and a relatively long and stable history of state-administrated hunting (NWTF, 2010) compared to its southern neighbors. In contrast, Belize has not had an established system for administrating sport hunting in recent decades, and until 2005 there was no mechanism for obtaining hunting licenses in Guatemala (Baur et al., 2008).

In Mexico and Guatemala, like much of Latin America, subsistence hunting commonly occurs in rural areas where law enforcement is limited (Baur, 1999; Escamilla et al., 2000; Jorgenson, 2000). Because wildlife and law enforcement agencies are usually centralized in urban areas and the relevant regulations and licensing protocols are not straightforward, legal compliance by rural residents is inaccessible and unenforceable, contributing to a tendency among subsistence hunters to operate without regard for legal hunting restrictions (Leopold, 1959; Ojasti, 1984; Jorgenson, 2000). Rural residents who rely on subsistence hunting must meet their needs year-round, often harvesting wildlife opportunistically during the course of other activities (Baur, 1999; Jorgenson, 2000). Continuous harvest pressure without regard for breeding status, age, or gender has deleterious effects on wildlife populations when exerted above extremely low-levels (i.e. when hunting pressure exceeds or becomes additive to natural predation pressure) (Robinson and Redford, 1991; Bennett and Robinson, 2000; Carrillo et al., 2000). Ocellated Turkey populations are subject to subsistence hunting pressure throughout their distribution, except for in a handful of sites where hunting is effectively limited by authorities or lack of access. Even in many areas where suitable habitat persists, Ocellated Turkeys have been extirpated or severely reduced due to unsustainable hunting pressure (McNab et al., 2004; Kampichler et al., 2010).

In the late 1990s the Mexican federal government began the Wildlife Conservation and Production Diversification in the Rural Sector Program (*Programa de Conservación de la Vida Silvestre y Diversificación Productiva en el Sector Rural*) to integrate diverse wildlife conservation strategies featuring stakeholder participation (INE – Instituto Nacional de Ecología, 2000; Valdez et al., 2006). This program established wildlife conservation units (called *Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre*, hereafter UMAs) to integrate sustainable wildlife resource use, including commercial sport hunting, into multiple-use management (Valdez et al., 2006). Despite successes in some regions and considerable growth of the program (Valdez et al., 2006), critics argue that due to administrative and technical deficiencies of the UMA system, commercial sport hunting pressure often compounds existing problems associated with uncontrolled subsistence hunting, particularly in southern Mexico where most remaining forest is community-managed (Bray and Wexler, 1996; Weber et al., 2006; García-Marmolejo et al., 2008).

In Mexico most sport hunting by foreigners is organized by commercial hunt outfitters (Weber et al., 2006). Many outfitters offer Ocellated Turkey hunts with a range of service options and often other species are available to sport hunters. Many of the UMAs where turkey hunting is permitted are communally managed *ejidos* with resident populations that engage in subsistence hunting (Escamilla et al., 2000; García-Marmolejo et al., 2008). Commercial outfitters provide their own personnel and equipment and bring their clients to hunt at UMAs where local management authorities typically receive only a minor fraction of total hunt revenues (Weber et al., 2006). UMA income derived from sport hunting is limited and irregular in many cases, offering little incentive for local subsistence hunters to adopt sustainable extraction practices (García-Marmolejo et al., 2008).

In the late 1990s Guatemala began implementing community forest concessions as part of the conservation strategy for the MBR, and in 2004 created legislation for the administration of hunting (CONAP, 2001; Congreso de la República de Guatemala, 2004; Nittler and Tschinkel, 2005; Bray et al., 2008). Although natural resources such as timber and traditional NTFPs were included in the management framework of the forest concession system, wildlife resource use by MBR residents was given only superficial treatment (i.e. ProPetén-Conservation International, 1996). Although the national hunting legislation and corresponding regulations include content specific to subsistence hunting, they do not reconcile subsistence needs with sustainable wildlife use or offer meaningful mechanisms for improving legal compliance by rural subsistence hunters (CONAP, 2001).

2.2. Factors that contribute to harvest sustainability

Harvesting a limited number of male turkeys late in the breeding season has negligible impacts on population size for a number of reasons (Lindzey, 1967). Turkeys are promiscuous and adult males compete for reproductive access to multiple females (Bailey, 1967; Williams et al., 2010). The combination of socially dominant males that prevent other males from mating and the ability to mate with multiple females, results in a numerical excess of adult-males required for reproductive purposes. Female turkeys are exclusively responsible for incubation and parental care, therefore the harvest of adult-males after mating occurs does not adversely affect reproductive success (Williams et al., 2010). Typically turkeys begin breeding in February or March, and by April female turkeys begin to separate from breeding flocks and remain solitary while nesting (Bailey and Rinell, 1967; Steadman et al., 1979; Williams et al., 2010). The gradual decrease of available hens provokes increased calling by breeding males, thus facilitating their harvest precisely as their contribution to annual reproductive effort wanes (Bailey and Rinell, 1967; Steadman et al., 1979; Williams et al., 2010). Breeding male turkeys exhibit several physical and behavioral traits that facilitate locating and distinguishing them from females (Williams et al., 2010).

Due to natural predation most of the young produced each year do not survive until six months of age in most turkey populations, after which the annual probability of survival ranges between 40% and 60% (Mosby, 1967). In response to high natural mortality turkeys have evolved a number of traits that contribute to high fecundity, which also contributes to resilience to harvest pressure. Female turkeys can reproduce at one year of age, lay large clutches of eggs, and often make additional nesting attempts if initial clutches are lost to egg predators (Gonzalez et al., 1998; Williams et al., 2010). Due to the combination of high mortality and fecundity, slightly more than half of turkey populations entering the breeding season are 1-year old birds hatched the previous year (Lindzey, 1967). Male turkeys typically do not attempt to breed until their second year; therefore selective adult-male harvests are further mitigated by the recruitment of juvenile males into the breeding component of the population each subsequent breeding season (Mosby, 1967).

Relative to many timber and NTFP resources, turkey populations respond to and are capable of recovering from unsustainable harvest pressure within relatively short periods. High mortality rates, rapid sexual maturity, and high fecundity lead to population turnover in 3–4 years (Mosby, 1967; Williams, 1989). Even without direct efforts to monitor turkey populations, significant changes in abundance would have easily observable effects on hunting success. If harvests exceed production or have significant negative impacts on the productivity of turkey populations, then a decline in abundance would be noticeable within a few years. In such cases, adjusting harvest levels or suspending harvest activities should be

sufficient to allow populations to recover within a few breeding seasons (Williams, 1989). Thus, long-term commercial sport hunting of the same populations has an inherent feedback loop that limits the potential for inflicting significant damage to the resource base. Commercial efforts will only be able to attract customers and remain in business if hunting success is high, requiring that turkeys are abundant enough to guarantee that each client has the opportunity to hunt successfully (optimally more than one turkey per client), placing the onus on hunt operators and management authorities to assure harvest sustainability (Baur et al., 2008).

2.3. History of the project

The PP was conceived in the late 1990's as interest in the Ocellated Turkey was increasing among Wild Turkey hunters. Due to the fact that essential elements of the North American conservation model such as effective law enforcement, management capacity, and supporting financial mechanisms were not well-developed where the species occurs, it was feared that sport hunting would not contribute meaningfully to the conservation of the Ocellated Turkey as it has in the USA (Baur et al., 2008). Because the status of Ocellated Turkey populations appeared to be determined by rural subsistence hunters, it was decided that a mechanism needed to be found for sport hunting to provide conservation incentives directly to local resource users (Williams et al., 2010). The original project concept was a sport hunting model in which rural residents would have primary responsibility for field operations in order to earn a substantial proportion of hunt income as a financial incentive to mitigate their own subsistence use. Initial efforts to develop a community-based sport hunting project in Quintana Roo, Mexico were unsuccessful due to a lack of suitable local counterparts and to poor hunting success as a result of excessive local subsistence pressure (Baur et al., 2008).

Efforts in Guatemala began in 1999 with the assistance of additional stakeholders with rural development experience in the MBR that were interested in developing wildlife management initiatives for the nascent community forest concession system in the reserve (Baur et al., 2008). The design of the PP became more comprehensive, based on the expectation that a successful management program for the Ocellated Turkey could have broader conservation impacts (Freese and Saavedra, 1991; Baur et al., 2008). Prior research indicated that local subsistence pressure was inversely related to employment opportunities, which are typically reduced during the dry season (Baur, 1999), thus one of the primary objectives of the PP has been to generate local employment alternatives to subsistence hunting.

Because PP activities only require a limited number of employees, policies were developed to distribute economic benefits at the community level to avoid the perception that benefits are limited to a minority (Stoian et al., 2009). In order to support community management in participating concessions, a proportion of local project income each year is provided to local management authorities. As an incentive to replace subsistence hunting pressure local residents with agricultural parcels located within the turkey harvest areas are paid approximately (USD) $70 in local currency when a client hunts a turkey on their parcel (equivalent to nearly two weeks wages or 14–18 times the subsistence value of a turkey). Local PP profits are also used to help support civic projects such as community school and potable water initiatives (Baur et al., 2008).

When the PP was proposed to CONAP in 1999 Guatemala did not have an operational system for administering sport hunting. After an extensive evaluation of the potential impacts of the project, permission was obtained to develop a community-based sport hunting project licensed as a scientific investigation for an experimental five-year period. During that time the project was required to monitor the response of Ocellated Turkey populations to the selective harvests, and focused its activities on the development of harvest policies and field procedures, and the research of ecological attributes of the species relevant to management (Baur et al., 2008). Early PP efforts centered on Uaxactún, a village with almost 1000 residents that in 1999 was negotiating terms for co-management of an 83,000 ha community forest concession with CONAP (Baur et al., 2008). Public meetings were held in Uaxactún to establish a relationship with the community and discuss expectations for participation in the PP. The proposed project activities and a basic wildlife management plan were subsequently included in the master management plan that was approved for the resulting Uaxactún concession (OMYC-NPV, 1999).

The PP first tested field operations in Uaxactún in 2000 and held its first Ocellated Turkey hunt in 2001. The PP proceeded to evaluate three additional forestry concessions and in 2004 incorporated the 53,000 ha community concession of Carmelita, a village with 400 residents (the other two units were not incorporated due to infrastructural and governance liabilities). National hunting legislation and a hunting license administration system were finalized in 2004, after which the PP transitioned from an experimental to a commercial legal context and in the process renegotiated mutually acceptable terms of agreement with the management authorities of participating concessions. The PP continued to grow until 2008 when it integrated a third, uninhabited community forest concession of approximately 52,000 ha managed by an association from the nearby town of San Andrés (Fig. 3).

3. Project activities and performance

3.1. Organizational structure

The PP is a product-oriented partnership with both local community and private-sector components (e.g., Ros-Tonen et al., 2008. In participating concessions PP harvest income, field operations, and personnel are managed by local committees that function as subsidiaries of each concession's management authority. A US-based company owned and operated by the project's founder is responsible for marketing, client communication, payment collection, and disbursement of funds to the Guatemalan project components. A Guatemala-based company operated by the in-country project manager is responsible for processing permits and licenses. The private-sector project components accompany the entire annual operations process to ensure service quality and client satisfaction, to provide logistical and material assistance to the community groups, and to manage affiliated activities.

The design, development, and management of the project have primarily been the responsibility of the project's private sector components. Institutional support for the project's development was provided by the NWTF, which provided partial funding, and by the Guatemalan program of the Wildlife Conservation Society (WCS), which provided assistance in developing local relationships and partial financial support for population monitoring efforts. Affiliated research was partially supported by WCS (New York) and by the University of Florida (Gainesville). Several small grants were awarded to the project in support of community participation by the United States Agency for International Development (USAID) through the organization Counterpart International (CPI).

3.2. Resource inventory

Although it required the project to monitor harvest impacts during the experimental phase, CONAP did not have established population monitoring protocols, so the PP developed methods that were affordable, could be executed with local labor, and could

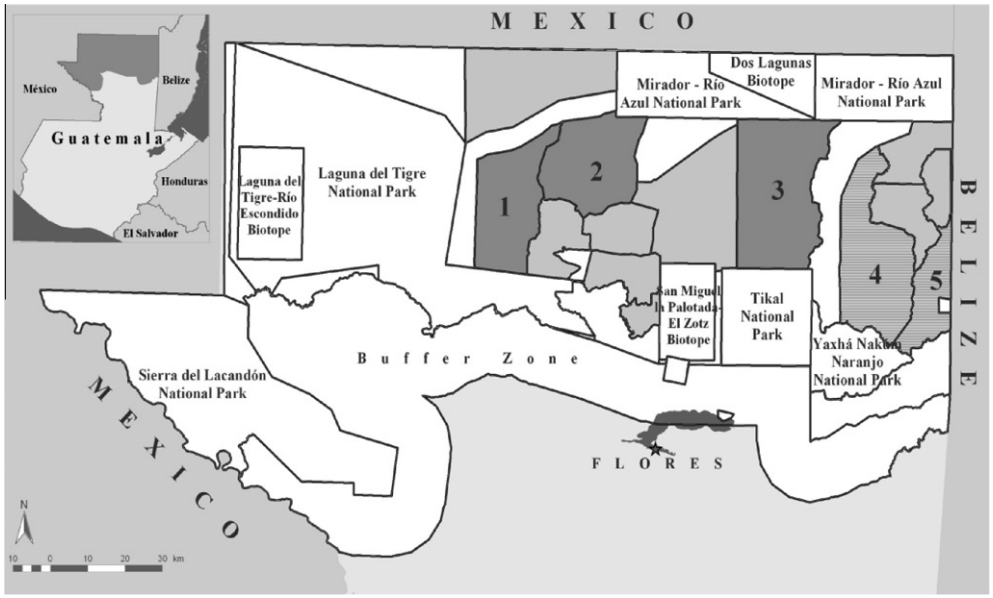

Fig. 3. Map of the Maya Biosphere Reserve in Petén, Guatemala indicating the forest concessions of the Multiple-use Zone (shaded polygons). The community forest concessions participating in the Ocellated Turkey project correspond to the following numbers in the map: San Andrés (No. 1), Carmelita (No. 2), and Uaxactún (No. 3). Community concessions Árbol Verde (No. 4) and El Esfuerzo (No. 5) were also evaluated but were not integrated into the project.

be applied systematically over large areas and multiple management units. Like many non-arborescent NTFPs, wildlife resources are not always amenable to timber inventory methods applied to sessile species (Guariguata et al., 2010). Wildlife resources exhibit daily and often seasonal movements, and respond to exploitation with shifts in habitat use, daily activity periods, and tolerance of human activity (Lancia et al., 1994; Reyna-Hurtado and Tanner, 2005). Describing wildlife abundance is further complicated by natural population fluctuations due to variability in reproductive success, survival, immigration, and emigration; which can have significant impacts on population size on a seasonal or inter-annual basis (Glanz, 1982; Lancia et al., 1994). Annual population fluctuations of up to 50% of the long-term mean are considered normal in North American turkey populations (Mosby, 1967). Rather than attempt to accurately census wildlife populations to monitor harvest impacts, it is more practical to monitor trends in abundance indices or the relationships between harvest levels (number of animals harvested within a defined period and unit) and harvest effort (e.g., the cumulative number of days spent hunting by all hunters in a particular unit during the course of a harvest) (Strickland et al., 1994).

If they are not hunted, Ocellated Turkeys habituate to human presence and can be accurately counted where they frequent large open areas, such as in the Tikal National Park unit of the MBR (Steadman et al., 1979; Sugihara and Heston, 1981). Extended direct observation of entire flocks is virtually impossible, however, in forest habitat where turkeys are hunted and remain wary of human presence. The PP developed survey methods based on a simplified form of line-transect sampling that provides data that can be used to generate conservative density estimates of adult-male turkeys (Burnham et al., 1980).

Although monitoring has not been required since 2005 the project has continued conducting annual surveys as a means to assure CONAP of the project's commitment to sustainability. Twenty or more sample routes consisting of equal-length sections (currently 2 km each) along existing roads and foot-trails are measured and marked at regular intervals throughout the harvest area in each concession. Local residents who are trained to collect survey data sample the routes systematically from mid-March through mid-May. Survey workers conduct samples by walking slowly along each route during crepuscular periods and recording the location of all observations of adult-male turkeys or their distinctive breeding calls. In each concession workers conduct between 120 and 200 samples per season for a total effort between 240 and 400 km. Comparisons of annual adult-male density estimates between seasons make it possible to monitor abundance trends over time. To increase the management value of the surveys, data is also collected on other species. During the project's experimental phase surveys included the four other bird species most hunted for subsistence purposes. Since 2005 surveys have included all legal game species including 8 mammal species and 12 other bird species (CONAP, 2006).

3.3. Turkey management areas

Within each participating concession the project designates an Ocellated Turkey management area of 25,000–30,000 ha where field operations are conducted. Management areas are not delimited physically, but are indicated on maps within harvest management plans that are provided by the project to CONAP and local management authorities, and on public notices occasionally posted by the project in participating communities. Management areas are designated on the basis of two criteria: turkey population status and vehicular access. Like other hunted species, the density of turkey populations is directly correlated with the distance from human settlements due to a gradient of hunting pressure, which is greatest where human activities are concentrated (Redford and Robinson, 1987; Polisar et al., 1998; Baur, 1999; Robinson and Bennett, 2000), therefore management areas are located as far from villages as possible. Management areas need to be located where there is a pre-existing road network because vehicular access to multiple hunting areas from a centrally located camp is required during harvest activities.

3.4. Annual field operations

The project's annual field operations occur from March through May, which overlaps both the regional dry season and the species' breeding season. Occasionally field operations begin with brush removal at sites used consistently by adult-male turkeys as breeding

display areas. Breeding male Ocellated Turkeys are attracted to open habitats which facilitate their energetic reproductive displays, and regularly patrol favored display areas (Williams et al., 2010). Preferred habitats for display areas include both natural clearings such as marsh edges, intermittent creek channels, and natural depressions, and also artificial clearings such as abandoned timber yards and NTFP camps, roads, pastures, and fallow fields. In each turkey management area the PP maintains the roads, footpaths, and campsites used during the hunts. Rustic camps consisting of several open-sided, palm-thatched huts constructed with local forest resources are used to house clients and field staff during field operations.

Harvest activities are scheduled from the second week of April through the first week of May, which corresponds with the average peak of reproductive singing by male turkeys (Williams et al., 2010). Prior to the arrival of clients, management areas are thoroughly searched for adult-male turkeys by listening for reproductive calling during crepuscular periods. The communities provide four days of hunt services and the right to harvest one adult-male turkey to each client for a standard fee. Each hunt day clients leave camp well before dawn in vehicles and are dropped off accompanied by local guides within walking distance of a roosted turkey. When the turkeys begin calling at daylight hunters begin to play recorded calls from handheld devices to attract birds into areas where they can hunted. Hunting continues throughout the morning until hunters return to camp, and the process is repeated again in the afternoons until sundown.

3.5. Harvest impacts

The turkey harvests have minimal environmental impacts compared to the other extraction activities conducted in the concessions (timber and botanical NTFPs). In particular, the biomass and nutrients removed annually from the forest as a result of each turkey harvest is limited to less than 30 kg of turkey skins and feathers that are exported by clients. Based on analyses of survey data, the low-density harvests conducted by the PP have not had any observable impacts on the size of turkey populations (Williams et al., 2010). Annual harvest intensities range from 0.03 to 0.11 turkeys per km^2, representing approximately 5–15% of the adult males and between 0.7% and 4.0% of the overall local Ocellated Turkey populations based on abundance estimates derived from annual survey data (Baur, unpublished data). The PP's efforts are the only known attempts at monitoring the response of Ocellated Turkey populations to hunting pressure, however, there are documented cases of Wild Turkey populations sustaining annual harvests of up to 40% of adult-males and over 10% of the total population (Mosby, 1967).

4. Compatibility of turkey harvesting with other forest uses

4.1. Harvesting of timber and non-timber forest products

Overall, there is a high degree of compatibility between PP activities and timber harvesting. In two of the three participating community forest concessions, timber harvests have overlapped spatially with turkey management areas. Direct interactions between the two activities are minimal due to temporal separation, as timber field operations are typically in their final stages by the time that the turkey harvests begin. When the two activities do overlap both spatially and temporally, the PP is unable to hunt turkeys within timber harvest areas due to associated machinery noise and human activity. Avoidance of timber harvest activities has not been a serious impediment to the PP due to the relatively small area of annual logging compartments (400–1200 ha) relative to the size of the turkey management areas (25,000–30,000 ha). More often than not, the hunting activities only overlap with the period when trucks are transporting felled timber to the mills, which occasionally presents traffic hazards to PP vehicles. Conflicts with timber operations related to the availability of local labor are minimal. Timber harvesting indirectly benefits project activities by providing skid trails and logging roads that are often used to access hunt areas and to conduct wildlife surveys. The PP also benefits from the forest openings created by logging roads and timber yards which are often attractive as display areas to breeding male turkeys. The PP field operations have no effect on timber harvest activities.

In general, NTFP extraction activities are also compatible with PP field operations. The road and trail maintenance conducted by the PP often facilitates NTFP harvest efforts. Camps maintained by the PP are occasionally occupied by NTFP collectors outside of the hunting season. Normally this is not problematic but in some cases NTFP harvesters have altered hunting camps to the point where they were rendered unsuitable for continued use by the PP, resulting in additional construction costs for their replacement. The allspice and *chicle* harvests occur later in the year (July–December) and therefore are temporally separated from PP field activities. Typically the only NTFP extraction that occurs during PP field activities is the harvest of *xate* palm fronds. Minor conflicts have occurred when *xate* camps are within the turkey management areas during or immediately preceding scheduled hunts because the presence of the collectors makes the turkeys more wary and difficult to locate and hunt. The local PP committees, however, have been largely successful in convincing *xate* harvesters to avoid using the turkey management areas during PP field operations. One consistent problem for the PP has been subsistence hunting by local residents, including loggers and NTFP harvesters who occasionally shoot Ocellated Turkeys within the turkey management areas.

4.2. Compatibility with the management of community forest concessions

Project activities benefit local concession management authorities in a number of ways. Local PP committees pay an average of 4% of annual harvest revenues to their respective management authorities. The employment generated by the PP benefits local governance efforts. There is constant public pressure on concession management authorities to provide employment for local residents. At peak capacity the PP provides temporary work for 25–30 community members in each concession annually, buffering expectations on concession authorities and helping maintain social contentment with concession operations. Over the years, the PP developed local policy and organizational precedents that have served as models for community involvement in other activities. PP activities cultivate local human resources by providing experience and development in financial management skills, social organization skills, providing services applicable to tourism, and the logistics and planning of remote, group field activities.

Road and trail maintenance by the PP improves local response readiness immediately prior to the time of year that vulnerability to forest fire is greatest. On numerous occasions PP personnel have provided direct assistance to local forest fire monitoring and suppression efforts. The presence of PP personnel for prolonged periods in remote areas of each concession unit also assists local vigilance efforts by discouraging both outsiders and locals from engaging in unauthorized activities. On several occasions PP personnel have encountered and reported unauthorized groups of NTFP harvesters and poachers that were operating illicitly within concession limits. The PP has accumulated years' worth of abundance data on wildlife resources that offer local databases

for relevant management initiatives. In one participating concession the PP produced the most detailed map currently available of the topography, camp locations, and existing road and trail network within the unit, which has been subsequently utilized repeatedly by concession authorities and other organizations for planning vigilance and NTFP extraction efforts.

5. Economic impacts of turkey harvest operations

Prior to the advent of the PP Ocellated Turkeys were primarily exploited locally for subsistence purposes, although some hunters sell game meat to neighbors to supplement their income (Roling, 1995; Baur, 1999). Annual subsistence harvests in Carmelita and Uaxactún of approximately 50 and 75 turkeys respectively have a current local value (in USD) as game meat of $250–375 (OMYC-NPV, 1999; Baur et al., 2008). In Mexico, Ocellated Turkey hunt prices range from $2000–3250. The project's developers and donor organizations paid the local start up costs and have subsidized participating concession operations to ensure financial viability at the community level. Consistent efforts have been made to improve service quality so that the project could improve profitability by raising client fees. As service quality improved prices were raised incrementally from an initial price of $2200 per hunter to a current price of $3000. The standard fees from each client to the communities for hunt services and the right to hunt one turkey were raised from an initial $1250 to $1450. With the advent of the hunting law additional turkeys became a legal option and the communities now also retain 70% of second-turkey revenues ($700) and 100% of third-turkey revenues ($500).

To date Uaxactún has served 122 clients, harvested 200 turkeys, and earned cumulative harvest revenues of approximately $237,575 (USD). In Uaxactún, the annual turkey harvest income was equivalent to 5–18%, and averaged 10% of the value of annual timber income between 2006 and 2009 (OMYC, unpublished data). Over a shorter period Carmelita and San Andrés have served 65 clients, harvested 96 turkeys, and earned cumulative harvest revenues of $112,600. At the local level a relatively higher proportion of community income is spent internally compared to timber expenditures because the PP does not have costs associated with heavy machinery rental or need to transport significant amounts of biomass. Consistently, the greatest annual community outlay is on local labor which has averaged 49% of expenses (Baur, unpublished data).

In addition to direct harvest income, participating communities benefit economically from related PP activities. Camp personnel earn additional income from tips and fees paid directly by hunters for the preparation and packaging of trophy specimens. Much of the research and development costs during the project's experimental phase were spent locally. The communities have been the primary beneficiaries of grants received by the project. To date secondary PP activities have contributed over $80,000 to participating concessions.

6. Looking forward

Currently the PP is the only example of a community-based, sport hunting conservation project in Guatemala, as well as the only regional example for the Ocellated Turkey. PP revenues grew steadily over the history of the project until 2008 and in the process the PP captured a significant share of the Ocellated Turkey sport hunting market. Between 2001 and 2009 approximately 20% of the Ocellated Turkey specimens registered with the NWTF came from the PP's operations in Guatemala (NWTF, 2010). Due to the economic downturn in the USA project operations declined to half capacity in 2009, were suspended due to low demand in 2010, and were held on a limited basis in 2011. Although the niche market for Ocellated Turkey sport hunting enabled the financial success of the PP and the diversification of participating community forest concessions for many years, reliance on a single market and species ultimately became a liability.

6.1. Persistent barriers

Despite general improvement over time, regulatory procedures within relevant government bureaucracies have consistently challenged project operations. National legislation and corresponding permitting procedures for both hunting and firearm regulation have changed completely during the history of the project. Most governmental agencies in Guatemala are centralized in the capital. Agency bureaucrats are usually urban and well-educated, and are often completely out of touch with rural reality in Guatemala. Permitting processes often have multiple stages or are subject to change, idiosyncrasies, or arbitrary modification without notice. It is not uncommon for licensing and permitting procedures to require considerable travel and time commitments, and in many cases third-party paralegal assistance to complete. Despite consistent efforts by the PP to engage and involve CONAP personnel, bureaucratic procedures related to hunting have been repeatedly hampered by high personnel turnover and the historical lack of experience in regulating hunting within the agency and relevant curricula at the university level in Guatemala.

Socio-political dynamics have also presented consistent challenges to the project. Considerable time and effort was required to develop the human resources, policies, and organizational models on the community level that were necessary for efficient project operations and achieving high levels of service quality. Periodic changes in the leadership of local management authorities have sometimes complicated the project's relationship with participating communities. The Petén region of Guatemala is a frontier society with a long history of immigration from different areas, which limits social cohesion in many rural communities (Schwartz, 1990). On several occasions individuals unassociated with the project have threatened on local, regional, and national levels to hinder, usurp, or else terminate the project for a variety of motives. At the local level the PP is vulnerable to intentional malicious efforts such as deliberate hunting of turkeys in PP harvest areas and vandalism to the project's camp facilities. It should be noted that similar bureaucratic and social challenges also apply to other natural resource management initiatives such as timber and NTFP extraction efforts.

6.2. Factors contributing to project success

Many factors have contributed to the success of the project. The Ocellated Turkey is highly suitable for, and resilient to selective harvest pressure. The existence of a specialty market for Ocellated Turkey hunts among North American turkey hunters that places high value on a quality hunting experience was critical to the project's financial viability. The interest and ability of various institutions to support the development of the project made it possible to bring the PP to fruition. The individuals involved in developing and managing the project had complementary interests, experiences, and abilities. Successful efforts to improve service quality were a key part of the project's achievements. Due to a long local history of economic reliance on NTFP extraction, the residents of participating communities have highly suitable skill sets for the type of services required by the enterprise. The concurrent advent of the community forest concession system at the beginning of the project, its resulting empowerment of local communities in the management of natural resource extraction, and the willingness of local management authorities to participate in the project were

essential to the project's success. The ecological integrity of the participating concessions and the healthy status of resident Ocellated Turkey populations have also helped make it possible to maintain high levels of hunting success.

7. Conclusion

The achievements of the PP prove that sport hunting can be an effective means of diversifying multiple-use management of tropical forests and compatible with timber and other NTFP extraction activities in situations similar to those currently practiced in the community forest concessions of Petén. If the Ocellated Turkey sport hunting market recovers sufficiently, there is no reason that similar efforts could not be successful throughout the geographic range of the species. In the absence of full market recovery, similar efforts could be successful if they were supported by organizations that are not completely dependent on hunting revenues. Although the PP has not attempted to do so, the project's field facilities and human resources would be highly suitable for diversification; either of the species hunted or through related activities such as eco-tourism. Where there are abundant populations of appropriate game species, access to sport hunting markets, and the management capacity to control access to and the use of wildlife resources, deliberate efforts by committed stakeholders can create opportunities for sustainable sport hunting to contribute to multiple-use management and forest conservation goals.

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