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Do responsibly managed logging concessions adequately protect jaguars and other large and medium-sized mammals? Two case studies from Guatemala and Peru

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ABSTRACT

Large areas of tropical forest have been designated for timber production but logging practices vary widely. Reduced-impact logging is considered best practice and third-party certification aims to ensure that strict standards are met. This includes minimizing the number of roads constructed, avoiding sensitive areas and strictly regulating hunting. Large scale camera trap grids were utilized in Guatemala and Peru to evaluate the impact of reduced-impact logging in certified concessions upon the large and medium-sized mammal fauna with special emphasis on jaguars (*Panthera onca*). Spatial capture-recapture models showed that jaguar density in Peru (4.54 ± 0.83 ind. 100 km^{-2}) was significantly higher than in Guatemala (1.52 ± 0.34 ind. 100 km^{-2}) but in both regions, densities were comparable to protected areas. Camera traps detected 22 species of large and medium sized mammals in Guatemala and 27 in Peru and a multi-species occupancy model revealed that logging had no negative impact on any of the species studied and actually had an initial positive impact on several herbivore species. We found no avoidance of logging roads; in fact, many species, especially carnivores, frequently used logging roads as movement corridors. Our results indicate that well-managed logging concessions can maintain important populations of large and medium-sized mammals including large herbivores and large carnivores as long as hunting is controlled and timber volumes extracted are low. Responsible forest management would therefore be an ideal activity in the buffer zones and multiple use zones of protected areas creating much less impact and conflict than alternatives such as agriculture or cattle ranching while still providing economic opportunities. Logging concessions can also play an important role in maintaining landscape connectivity between protected areas.

1. Introduction

Over the last few decades deforestation of humid tropical forests around the world has continuously increased (Achard et al., 2014; Asner et al., 2009; Hansen et al., 2013). In Southeast Asia and Central America over 70% of the original humid tropical forest has been lost or greatly degraded (< 50% tree cover) and in South America this figure is 36% (Asner et al., 2009). About 40% of the remaining forests are affected by commercial logging that often leads to forest degradation, loss of carbon stock, increased vulnerability to fire and increased access to such areas by hunters and small farmers (Asner et al., 2009; Blaser et al., 2011; Laurance et al., 2014; Nepstad et al., 1999).

Management practices of logging operations vary greatly, ranging from clear-cutting to selective reduced-impact logging. Many countries have established forest reserves, logging concessions or other systems for leasing state owned forests to private companies for the extraction of timber with the goal of managing these forests sustainably for long-term production (Blaser et al., 2011). Forest certification was created as an independent third-party verification of responsible forest management with strict standards. The Forest Stewardship Council (FSC), which was established in 1993, has a global forest certification system that accredits companies that use sound social and environmental practices for forest management (FSC, 2016). FSC-certified logging operations are required to practice reduced impact logging, control or

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prohibit hunting within the concession, set aside high conservation value forest, and avoid, repair, or mitigate environmental impacts (FSC, 2016). While this comes at a significant cost for the logging company (Gullison, 2003), certified wood sells for a higher price in international markets and companies get increased market access, resulting in a net financial benefit. Although the global area of certified forests has continuously increased over the last two decades, the largest increases happened in boreal forests in Europe and North America (FSC, 2016; PEFC, 2017). In 2011, only 13% of tropical forests were considered sustainably managed and only 4–5% were certified (Blaser et al., 2011).

The conservation of biodiversity is an explicit goal of the FSC certification scheme (FSC, 2016), but the number of studies that have evaluated how well certified forest management under the FSC label protects biodiversity are few in number. Several studies have looked at responses by either single species or small numbers of species of large and medium-sized mammals to certified forest management approaches, leading to the generation of management recommendations (Clark et al., 2009; Davies et al., 2001; Polisar et al., 2017; Rayan and Mohamad, 2009), but far fewer have examined the effects on the entire mammal community (Roopsind et al., 2017; Sollmann et al., 2017). Moreover, several studies have found negative impacts of logging on species richness with effects varying greatly by taxonomic group, geographic region, and logging intensity (Burivalova et al., 2014; Chaudhary et al., 2016; Gibson et al., 2011). For tropical forests, reduced impact logging has been found to have the least negative effect, with some forests under reduced-impact logging retaining between 80% and 100% of their species richness (Bicknell et al., 2014; Chaudhary et al., 2016; Gibson et al., 2011; Putz et al., 2012).

In this study, we use large-scale camera trap surveys to evaluate terrestrial mammal communities in FSC certified logging concessions in Guatemala and Peru. Camera traps are ideally suited to assess mammal communities in tropical forests and, unlike other methods such as line transects, they are also able to collect data on cryptic and nocturnal species (Ahumada et al., 2013; Tobler et al., 2008; Tobler et al., 2015). We used multi-species occupancy models (Dorazio and Royle, 2005; Dorazio et al., 2006; Yamaura et al., 2011) to examine community structure and distribution of mammals in the logging concessions, and assessed the density of the top predator, the jaguar, using spatial capture-recapture models (Borchers and Efford, 2008; Efford et al., 2009; Royle and Young, 2008).

2. Methods

2.1. Study areas

2.1.1. Peru

Peru has 62.5 million ha of lowland tropical rainforest with historically low annual deforestation rates (around 0.2% per year between 1990 and 2015 (FAO, 2015)). In 2000, the Peruvian government passed a new law of Forestry and Wildlife (Ley Forestal y de Fauna Silvestre, Ley N° 27308) that designated about 8 million ha of permanent production forest. Within these areas the government can grant concessions of between 5000 and 50,000 ha for durations of up to 40 years. The concession holders are required to develop a five-year management plan and an annual operating plan in which they agree to restrictions including limits on timber extraction to 5% of the available basal area and limits on subsistence hunting (commercial hunting is strictly prohibited). Each concession is divided into 20 blocks representing a 20-year harvest cycle with timber being extracted from one block annually.

In the department of Madre de Dios there are 1.3 million ha of logging concessions of which 422,959 ha are FSC certified (DGFFS, 2013). These concessions go through an annual review process undertaken by an outside certification organization that evaluates compliance with all the FSC standards to ensure sustainable management practices.

Our study was carried out in the north-eastern part of Madre de Dios in two FSC certified logging concessions (Forestal Otorongo and Aserradero Espinoza) south of the Tahuamanu river (Fig. 2). These concessions are part of a large block of logging concessions towards the north, south and west and are bordered by agriculture land and Brazil nut concessions (for the extraction of Brazil nut from mature forests) to the east. Logging in these concessions started in 2003 but was preceded by unregulated selective extraction of mahogany and a few other high-value hard-wood species for almost a decade. The average volume of timber extracted from the concessions is between 2 and 3 m^3/ha. Hunting is strictly prohibited within the concessions.

The topography is flat with elevation ranging from 150 m to 300 m and the vegetation is lowland Amazonian moist forest with several areas dominated by large patches of bamboo. The mean annual temperature is 24 °C and mean annual rainfall is between 2500 and 3500 mm.

2.1.2. Guatemala

Over a thousand years ago Guatemala's lowland Department of Petén was the epicenter of the Maya culture. In the 20th century, the economy of the northern Petén was dominated by extraction of gum from chicle trees (*Manilkara zapota*), a market that has since dwindled. Until recently, this, the largest of Guatemala's 22 departments was isolated from the rest of the country due to the lack of well-maintained access routes and long distances from principal cities (Hodgdon et al., 2015).

In 1990, the Guatemalan government via the Consejo Nacional de Áreas Protegidas (CONAP, Guatemala's National Council of Protected Areas) created the Maya Biosphere Reserve (MBR) in the northern portion of the Petén with the goal of "combining the conservation and sustainable use of natural and cultural resources in order to maximize the ecological, economic and social benefits for Guatemala" (Secaira et al., 2015). The reserve was divided into three zones: (a) the core zone (36% of the MBR) is formed by national parks where only scientific investigation and low impact tourism are allowed, (b) a 15 km-wide buffer zone (24% of the MBR) along the southern border of the MBR where agriculture, farming, and other productive activities are permitted with the aim of reducing the pressure on the other two zones, and (c) a 848,440 ha multiple use zone (40% of the MBR) where sustainable and low-impact land uses are allowed including controlled logging of hardwood tree species in forest concessions (Hodgdon et al., 2015; Radachowsky et al., 2012; Secaira et al., 2015).

Between 1994 and 2002, CONAP granted 533,132 ha of the multiple use zone (MUZ) of the MBR to 14 forest concessions for a period of 25 years. They included two industrial concessions (private companies), six non-resident community concessions (communities in the buffer zone), two resident community concessions with forest-based history (communities established as chicle harvesting centers more than a century ago) and four resident community concessions for recent immigrants (Hodgdon et al., 2015; Radachowsky et al., 2012; Secaira et al., 2015). Three of the four resident community concessions for recent immigrants were cancelled or suspended due to a lack of compliance with the contract agreements while the other 11 concessions were granted FSC certification between 1998 and 2004 (Carrera et al., 2006; Hodgdon et al., 2015; Radachowsky et al., 2012). The harvest intensities in these concessions (1.2–3.0 m^3/ha) are among the lowest in the world.

Our study was carried out in the territory of five non-resident community concessions: La Unión, Las Ventanas, Chosquitan, Rio Chanchic and Yaloch managed by Sociedad Civil Custodios de la Selva, Árbol Verde, Sociedad Civil Laborantes del Bosque, Sociedad Civil Impulsores Suchitecos, and Sociedad Civil El Esfuerzo respectively (Fig. 1). These concessions are exclusively used for logging; no people besides the workers are living inside the concessions and there is no hunting. Forty-three percent of the study area was harvested before the sampling period and the entire area reported 0% of deforestation during 2000–2013 (Hodgdon et al., 2015). The MBR is classified as