Biological Conservation 209 (2017) 17–26

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/bioc

Continuity and change in hunting behaviour among contemporary indigenous peoples

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ARTICLE INFO

Article history:
Received 21 March 2016
Received in revised form 30 December 2016
Accepted 2 February 2017
Available online 11 February 2017

Keywords:
Food security
Game abundance
Game species conservation
Market integration
Small-scale societies
Tsimane' Amerindians

ABSTRACT

Though subsistence hunting in tropical rainforests contributes to local food security and livelihoods, it also constitutes a major challenge to wildlife conservation. In this paper we examine different hunting practices of contemporary Tsimane', an Amazonian indigenous society native to Bolivia, and discuss their potential impact on wildlife. We also explore whether such different practices relate to greater integration into the national society and the market economy. Between 2009 and 2010, we conducted interviews with 344 Tsimane' adult men from 40 villages to collect information on their 1) hunting engagement, success, effort, offtake and prey profile and 2) their individual level of integration into the national society and the market economy. Overall, 71% of the interviewed men engaged in subsistence hunting albeit using different practices and achieving different outcomes. We used hierarchical cluster analysis to classify hunters into four groups according to their engagement and success in hunting. Two large groups of hunters had a diversified prey profile and targeted resilient species, whereas the two remaining groups were smaller, displayed high levels of offtake and efficiency, and targeted mainly ungulates and primates. We argue that the potential impact of expert hunters on wildlife is higher because they target more vulnerable species. Our results also suggest that there are no clear pathways relating hunting strategies and individual levels of integration into the national society and the market economy. However, our study provides evidence of how rapid and increasing contact with mainstream society affects hunting and subsistence livelihoods of contemporary indigenous peoples, posing severe potential impacts on biodiversity conservation.

1. Introduction

In addition to habitat degradation and loss, overhunting is among the largest challenges to biodiversity conservation in tropical rainforests (Fa et al., 2003; Milner-Gulland et al., 2003; Peres, 2010). Overhunting can have dramatic impacts on ecosystems, potentially contributing to alter forest composition, structure, and dynamics due to the loss of ecological interactions (Peres and Palacios, 2007), trophic meltdown (Estes et al., 2011), the decline of wildlife populations (Peres, 2000), and species extinction (Bodmer et al., 1997; Redford, 1992). Apparently undamaged tropical forests may be, in fact, heavily hunted thus resulting in vast areas of land with significantly reduced densities of game vertebrate species (Redford, 1992; Wilkie et al., 2011).

Nevertheless, overhunting is not only a major threat to biodiversity but also to the millions of people who depend on wildlife for their livelihoods (Brashares et al., 2011). Indeed, wildlife remains a vital source of protein and income for many indigenous peoples and rural populations worldwide (Brashares et al., 2011, 2004; Milner-Gulland et al., 2003; Robinson and Bennett, 2000). Due to the significant overlap between indigenous territories and the world's remaining areas of high game species abundance and diversity (Gorenflo et al., 2012), researchers have shown special interest in understanding how indigenous peoples use

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http://dx.doi.org/10.1016/j.biocon.2017.02.002
0006-3207/

game resources (Bodmer, 1995; Constantino et al., 2008; Peres and Nascimento, 2006; Smith, 2008), with conflicting views on the topic: while some researchers have argued that indigenous and local peoples play an important role in biodiversity conservation (Alcorn, 1993; Schwartzman and Zimmerman, 2005), others have argued that biodiversity is decreasing due to local people's pressure on natural resources (Hames, 2007; Smith and Wishnie, 2000).

Irrespective of how traditional resource management has affected wildlife in the past, it is widely accepted that contemporary indigenous societies now face changes that affect their traditional livelihood strategies, including hunting. Drivers of these changes are population growth (Robinson and Bennett, 2004), access to the markets (Lu, 2007; van Vliet et al., 2015), sedentary settlement patterns (Stearman, 2000), infrastructure development (Suárez et al., 2009), access to modern technology (Dounias, 2016; Levi et al., 2009), encroachment by productive or extractive activities (Orta-Martínez and Finer, 2010; Reyes-García et al., 2012), or changes in their belief systems (Guèze et al., 2015; Luz et al., 2015). Besides local game abundance (e.g., Jerozolimski and Peres, 2003; Peres and Nascimento, 2006), hunting is also largely dependent on individual and community level factors (i.e., individual knowledge and skills, market demand, technology, or mobility (e.g., Gill et al., 2012; Morsello et al., 2015; Reyes-García et al., 2016; Vasco and Sirén, 2016). Therefore, a shift in any of these factors, generated by the new pressures faced by indigenous peoples, may also have an impact on wildlife conservation through hunting success (Friant et al., 2015).

Here we examine the relation of one of these drivers, integration into the national society and access to markets, on hunting behaviour. Previous research has addressed how integration into the national society and access to markets change indigenous or rural people's hunting patterns and two pathways have been suggested. Some authors have argued that integration into the national society and the market economy results in increased pressure on game species (Suárez et al., 2009) because access to markets is concomitant with access to new forms of transportation and technologies (e.g., canoe motors, guns) that improve hunters' efficiency; this seems to be the case in areas where bushmeat commercialization represents an income opportunity (Nuno et al., 2013; van Vliet et al., 2014). Conversely, other authors have advocated that increased access to markets reduces the amount of time people devote to activities which do not provide cash income – including hunting in areas without or with limited access to bushmeat markets (Gill et al., 2012; Lu, 2007). In such situations, wildlife hunting may decrease, hence easing the pressure on local game populations (Gray et al., 2015; Vasco and Sirén, 2016).

As most studies on the impact of hunting on wildlife have focused on areas where hunting is both an important livelihood activity and a source of income (e.g., Kümpel et al., 2010; Brashares et al., 2011; Coad et al., 2013), the plausibility of the second argument has largely remained untested. We address this knowledge gap by providing a quantitative assessment of hunting behaviour of a contemporary indigenous society of hunter-gatherers native to the Bolivian Amazon (the Tsimane'), who do not sell the bushmeat they hunt but nonetheless are increasingly exposed to interactions with other segments of the national Bolivian society and the market economy (Luz et al., 2015; Reyes-García et al., 2014).

The goals of this study are two-fold. First, we examine Tsimane' hunting practices and their success in terms of harvest rates and offtake species composition and discuss the potential impact of different hunting behaviours on wildlife conservation. Second, we explore how different practices relate to different levels of access to the national society (e.g., schooling) and the market economy (e.g., income from the sale of agricultural or forest products, or from wage labour). We hypothesize that, in a context where hunting is not a source of cash income, increasing access to the national society and market economy may reduce the time available for hunting which would result in lower hunting effort and, consequently, offtake.

2. Methods

2.1. Study population and area

The Tsimane' are one of the largest native indigenous societies of the Bolivian Amazon, with approximately 14,000 people scattered across 125 villages south of the Department of Beni (Reyes-García et al., 2014). We conducted research in 40 villages located in two formally titled indigenous territories (known in Bolivia as *Territorios Indígenas Originarios Campesinos* or *TIOC – Territories of Native Indigenous Peasants*), the Tsimane' TIOC and the Multiethnic TIOC, as well as in a logging concession, all lying between the foothills of the Andes to the Moxos Savannas. Villages straddle the Maniqui River, two logging roads, and the main road from San Borja to Yucumo (Fig. 1). The sampled area is mostly covered by old-growth Amazonian *terra firme* forest with a highly seasonal climate, including sporadic strong cold winds from the south during the dry season (Guèze et al., 2013; Killeen et al., 1993).

The Tsimane' territory is home to >30 game vertebrate species, yet the encounter rates of large-bodied game species are lower than the rates reported in other Amazonian hunting forest sites (Luz, 2012), a situation reported by the Tsimane' themselves (Fernández-Llamazares et al., 2015; Godoy et al., 2010). Wildlife scarcity in the Tsimane' territory results from previous overhunting and habitat lost. First, the commercialization of pelts during the 1950s–1970s led to the decrease of many game species' populations, which never fully recovered (Huanca, 2008). Tsimane' hunters participated in the commercialization of pelts mainly by helping outsiders to track animals. After this period, species like the white-lipped peccary (*Tayassu pecari*) and the black caiman (*Melanosuchus niger*) were declared extinct in some areas of the Tsimane' territory (Herrera-MacBryde et al., 2000). Second, the arrival of logging companies, cattle ranchers, and highland colonists in the last quarter of the century led to severe deforestation and forest fragmentation (Paneque-Gálvez et al., 2013), affecting wildlife populations. Furthermore, these new settlers became Tsimane' direct competitors for land and natural resources, including bushmeat (Reyes-García et al., 2012).

Nowadays, most Tsimane' continue to rely on foraging and horticulture for subsistence although the production of cash-crops (e.g., rice, plantains, maize, or manioc) –which they sell in local towns or trade to itinerant merchants– has increased (Fernández-Llamazares et al., 2016). Other sources of income include the sale or barter of woven thatch palm panes and wage labour in logging camps, cattle ranches, and on homesteads of colonist farmers (Perge and McKay, 2016). At present there is no commercial hunting reported in the area, neither for bushmeat nor for pelt trade, but subsistence hunting is still a major livelihood activity for the Tsimane'. Zycherman (2013) reports that Tsimane' men enjoy hunting, an activity that –according to reports from 24-h activity recalls– occupies on average 5% of Tsimane' men's time. Furthermore, hunting also has deep cultural meanings for the Tsimane' as excellence in hunting is still a status symbol for Tsimane' men and their families and offering wild meat continues to be a way to bound with other members of the family and neighbours (Reyes-García and Huanca, 2015). Nevertheless, recent changes (e.g., access to school, jobs outside the community) seem to be altering Tsimane' hunting patterns, largely because the Tsimane' –and specially those with schooling- are increasingly allocating more time to new economic activities (e.g., wage labour) (Luz et al., 2015).

2.2. Sampling

Data were collected between March 2009 and July 2010 in 40 Tsimane' villages (out of a total of 125). Before the onset of the study we obtained Free Prior and Informed Consent from the *Gran Consejo Tsimane'*, the political organization representing the Tsimane' in the area surveyed, as well as the agreement of each village and individual participating in the study. None of the villages refused to participate