





Inter-annual prey fluctuation of *Odocoileus virginianus* in Maya group hunting (batida) in the Yucatan Peninsula

Fluctuación interanual de presas de *Odocoileus virginianus* en la cacería maya grupal (batida) en la Península de Yucatán

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ABSTRACT. In Neotropical environments, we know little about the abundance of wild vertebrates traditionally hunted. Based on subsistence hunting records (2005-2019) as well as ethnographic information from Maya peasant-hunters, we assessed the inter-annual capture rate of white-tailed deer (*Odocoileus virginianus*) in a rural community in the northwest of the Yucatan Peninsula. We found that the number of prey decreased over the years, showing a declining capture rate (prey/trip) that decreased by as much as 50% from the first (2005-2006) to the third period (2010-2011) of records. The majority of peasant-hunters interviewed (74%; N = 31) perceived this reduction in deer to have taken place mainly over the past 10 years as consequence of hunting (71%). The agreement between the hunting trend and peasants' perceptions regarding the abundance of white-tailed deer suggests that this species may be at risk in future scenarios of use in northwest of contemporary Mayab.

Key words: Conservation, Los Petenes Biosphere Reserve, Maya batida, subsistence hunting, ungulates, white-tailed deer.

RESUMEN. En ambientes Neotropicales, sabemos poco sobre la abundancia de vertebrados silvestres tradicionalmente cazados. Con base en registros de cacería de subsistencia (2005-2019) así como en información etnográfica proveniente de campesinos-cazadores mayas, evaluamos la fluctuación interanual en la tasa de captura de venado cola blanca (*Odocoileus virginianus*) en una comunidad del noroeste de la Península de Yucatán. Encontramos que el número de presas disminuyó con los años, mostrando una tasa de captura (presas/salida) a la baja hasta 50% menor entre el primer (2005-2006) y tercer periodo (2010-2011) de registros. La mayoría de los entrevistados (74%; N = 31) percibieron dicha disminución del venado principalmente en los últimos 10 años y asociada a la cacería (71%). La consistencia entre la tendencia de caza y la percepción de los campesinos sobre la abundancia del venado sugiere que esta especie podría estar en riesgo ante futuros escenarios de uso en el noroeste del Mayab contemporáneo.

Palabras clave: Batida Maya, cacería de subsistencia, conservación, Reserva de la Biósfera Los Petenes, ungulados, venado cola blanca.

INTRODUCTION

In Neotropical environments, food subsistence is linked to peasant hunting and the consumption of wild vertebrates (Fa *et al.* 2002, Carignano *et al.* 2018), whose wild meat provides 30-50% of the animal protein present in the diet of the rural population (Stearman and Redford 1995, Zapata 2001, León and Montiel 2008). In this context, the link between rural people and the consumption of wild fauna, in addition to its subsistence nature, has deep sociocultural roots (Montiel *et al.* 1999, Quijano-Hernández and Calmé 2002, Barrera-Bassols and Toledo 2005). This has led to the recognition of peasant hunting as a paradox for the conservation of biodiversity (Petriello and Stronza 2020), given that it generates resources (wild meat) that are critical for the subsistence and development of rural society, but in a manner that could lead to a decline of the species being exploited (Briceño-Méndez *et al.* 2021).

Among the game species (N = 799) targeted by rural hunters in Latin America, the white-tailed deer (*Odocoileus virginianus*) is fifth in the list (Petriello and Stronza 2020), traditionally comprising one of the two most hunted species in the Yucatan Peninsula (Mandujano and Rico-Gray 1991, Montiel *et al.* 1999, Quijano-Hernández and Calmé 2002). Hunting of this ungulate is very important in Maya communities due to the type of meat that it provides to Maya peasant-hunters and their families (Quijano-Hernández and Calmé 2002, León and Montiel 2008). The above is notable in the context of traditional group hunting or batida that is mainly practiced in the lowlands of the Yucatan Peninsula (Rodríguez *et al.* 2012, Plata *et al.* 2019). In contrast to individual forms of hunting like stalking, opportunistic hunting and night-light hunting (León and Montiel 2008), through batida not only do the participants obtain approximately 2 kg per capita on each trip of wild meat, mainly deer, they also establish a social space for recreation and coexistence, reinforcing their identity as hunters in the community context (Rodríguez *et al.* 2012). As such, the multiple sociocultural benefits of batida underpin its notable importance in Maya communities of the Yucatan Peninsula (Rodríguez *et al.* 2012; Plata *et al.* 2019).

To date, little empirical information exists on how hunting trends are related to the abundance of game species such as white-tailed deer (Briceño-Méndez *et al.* 2021). The objective of this study was to estimate the abundance of white-tailed deer in a Maya community in the northwest of the Yucatan Peninsula. For this, we analyzed batida records from four dry-season periods and complemented them with ethnographic information on abundance perceived by peasant-hunters regarding one of the main hunted species in the contemporary Mayab.

MATERIALS AND METHODS

Our study was conducted in the community of Los Petenes, one of 19 rural populations in the zone of influence of Los Petenes Biosphere Reserve (LPBR; 20° 31'-19° 49' N, 90° 45'-90° 20' W), located in the northwest of the Yucatan Peninsula (Figure 1). The climate in the region is warm and sub-humid, with a mean monthly temperature of 26 °C and mean annual precipitation of 819 mm, which is strongly seasonal with a dry season from December to May (mean monthly precipitation = 13.2 mm ± 3.3 mm) and a rainy season from June to November (mean monthly precipitation = 149 mm ± 41.0 mm) (Montiel *et al.* 2006).

LPBR is a federal protected area (surface = 282 858 ha, 36% terrestrial, 64% marine; CONANP 2006) that includes a notable coastal wetland, characterized by the presence of forested islands or petenes (forest-mangroves), developed naturally on elevations of ground that escape the flooding during the rainy season (Montiel *et al.* 2006). In the zone of influence of LPBR, the rural population practices subsistence hunting of at least 12 wild vertebrate species, particularly white-tailed deer (León and Montiel 2008).

The community of Los Petenes has a human population of 1 100 inhabitants (531 women and 569 men; INEGI 2020), the majority of them bilingual (Maya-Spanish). In this Maya community, men mainly work in seasonal agriculture (milpa), charcoal production and subsistence hunting, with batida being the form most commonly practiced locally (Rodríguez *et al.* 2012, Oliva *et al.* 2014).

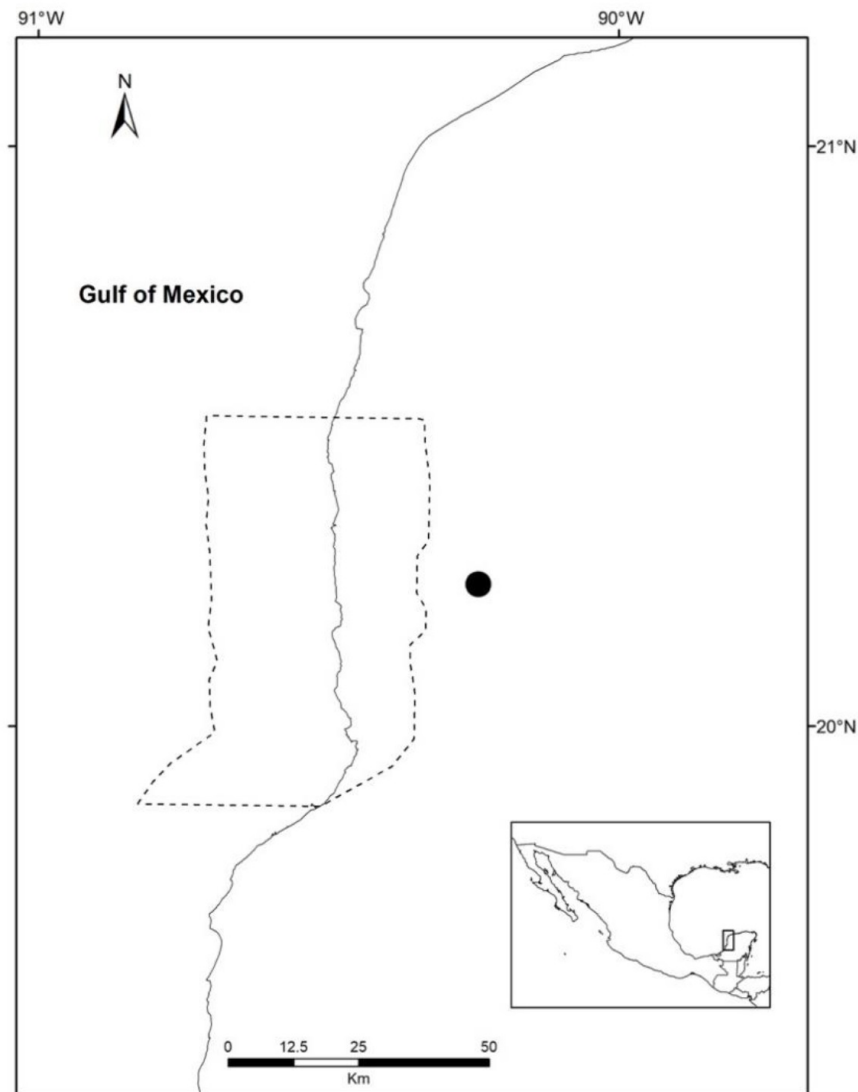


Figure 1. Location of the area and study community in the northwest of the Yucatan Peninsula, Mexico. The Maya community of Los Petenes (black dot) is located out of the terrestrial border but included in the zone of influence of Los Petenes Biosphere Reserve (dashed line polygon).

Batida consists of ambushing potential prey (mainly white-tailed deer) through the actions of two hunting groups. The first group, the pujeros or “beaters” move to the interior of the hunting zone and with the help of dogs attempt to drive the prey towards the opposing boundary of the zone, where the second group, the tiradores or “shooters”, await the animal in order to shoot it. On obtaining the prey, the meat is shared between each of the participating hunters, including the dogs (Rodríguez *et al.* 2012, Plata *et al.*

2019).

Hunting records

Our study in Los Petenes included records of batida hunting of white-tailed deer during the dry season (December-May, the high season for Maya subsistence hunting; León and Montiel 2008) over a period of 15 years (2005-2019). Specifically, we recorded the number of hunting trips carried out in the study community and the number of prey obtained

by a group of peasant-hunters in three interannual periods (2005-2006, 2008-2009, 2010-2011) and a single intra-annual period for 2019 (February-April). Hunting records (2005-2011) represents an historical data subset (only for batida) from our previous studies. Data for 2019 came from fieldwork done by the first author at the middle of the dry season. For all periods, hunting activity was recorded in situ in the study community and with the help of a local peasant-hunter.

Ethnographic information

From September 2018 to April 2019, semi-structured interviews were applied by the first author to local peasant-hunters on two main topics with an emphasis on batida: 1) characteristics of its execution and expectations regarding subsistence hunting, and 2) individual and group perceptions on the use and conservation of white-tailed deer. In order to obtain up-to-date information on possible perceived changes in deer abundance, an evaluation was performed by asking the respondent to recall hurricane Isidoro (which occurred in 2002) as a reference point in time, given that this weather event had a significant impact on the inhabitants. Consequently, all the interviewees had at least 15 years of experience as hunters at the time of this study. Additionally, in-depth interviews were applied to peasant-hunters experienced in batida (known locally as chingones; Rodríguez *et al.* 2012).

Analysis of the information

The total number of prey and hunting trips were compared across the four record periods and in order to identify differences in the number of preys between study periods the chi-square test of homogeneity was used with an alpha of 0.05. Likewise, the records of three interannual periods, from the regional dry season in the months of December-May, available only between 2005 and 2011 were used to evaluate the variations in deer abundance taking into account hunting effort. A comparison of prey at the beginning and the end of the records in our study was done using the available hunting data for three continuous months of the dry season (for years 2006 vs. 2019).

The deer capture rate was calculated using the number of prey per total trips (monthly mean), obtaining an index of abundance for each period. Following Creswell (2007), the interview responses were ordered and classified into three topics: 1) perceived abundance of deer, 2) factors impacting deer abundance and 3) expectations regarding the continuity of deer. For each of the categories, verbatim opinions of the interviewees were identified, which helped better interpret the response frequencies of the interviews.

RESULTS AND DISCUSSION

For the periods analyzed, we recorded a total of 146 deer obtained in 136 of the trips or batidas. The largest number of prey were obtained in the first period (2005-2006; $n = 39$). In the two following periods, the number of prey decreased by as much as 50% (2008-2009 period) compared to the first period ($\chi^2 = 27.11$, $P < 0.05$). Conversely, hunting effort increased from the first ($n = 37$ trips, 2005-2006) to the third period ($n = 42$ trips; 2010-2011) ($\chi^2 = 53.46$, $P < 0.05$). Furthermore, a downward trend was found in the capture rate (prey/hunting trip) was found over the periods, with the monthly mean 60% lower in third (capture rate = 0.34, 2010-2011) than in the first period (capture rate = 0.83, 2005-2006) (Figure 2).

Comparing hunting data for three continuous months of the dry season, at the beginning and the end of the records available in our study (years 2006 vs. 2019), the number of prey was found to be significantly greater in the three-month period of 2006 ($N = 26$) compared to the three-month period of 2019 ($N = 12$) ($\chi^2 = 9.71$, $P < 0.05$), and there was a similar figure for the number of batidas carried out in those years (24 and 15 trips, respectively) ($\chi^2 = 12.47$, $P < 0.05$).

These results revealed fluctuations, in the last 15 years, in the capture rate of white-tailed deer by batida in the Los Petenes environment. This is supported by the downward trend from 2005 to 2019 in the number of deer obtained by batida during the dry season (the high season for hunting regionally; León and Montiel 2008).

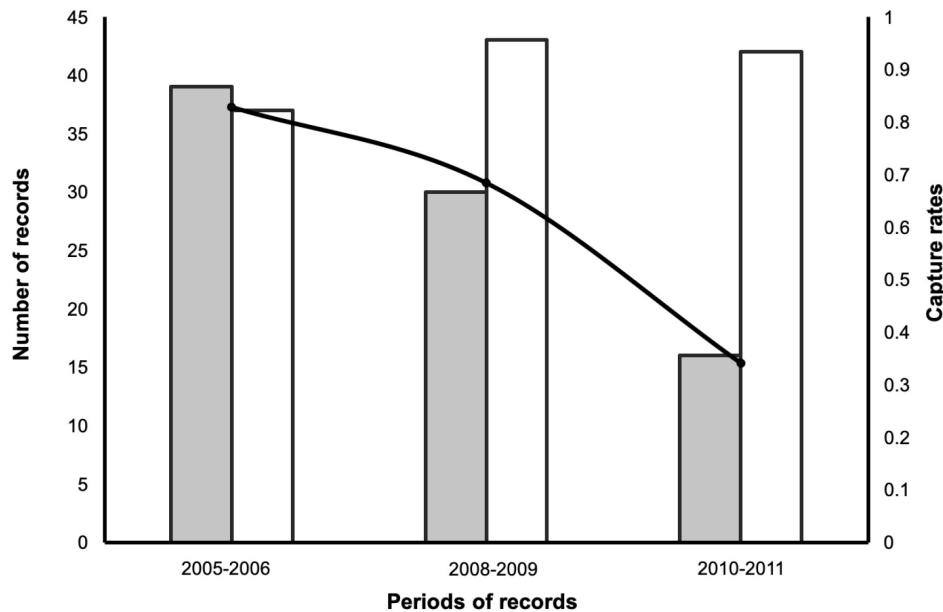


Figure 2. Number of prey (white-tailed deer) obtained by batida (dark bars) and number of hunting trips (light bars) recorded in three periods corresponding to the dry season (December-May). The third axis on the right refers to the mean monthly capture rate (prey/hunting trip) for each period (see tendency black line). Note the gradual reduction in the number of prey obtained between periods with a similar hunting effort between them.

The peasant-hunters interviewed ($N = 31$) were men born in the community (97%) with a mean age of 48 years (range = 27-72). All interviewees stated that white-tailed deer is the preferred prey, not just because of the characteristics of its meat (e.g. flavor and tenderness), but also because it is a relatively easy prey to hunt, both in individual forms of hunting and in batida. Nevertheless, the majority of peasant-hunters (74%) indicated that the presence of white-tailed deer had decreased in the past 10 years, and that it was increasingly hard to find during batidas on community land. In contrast, a smaller group of interviewees (26%) stated that the deer population has remained constant, but it has become more difficult to capture them when performing batidas, meaning that they had to increase their efforts for these hunting trips. The majority perception of peasant-hunters about the decline of deer on community lands is similar to hunting records. However, this suggestion should be taken with caution, mainly due to the opinions of those peasant-hunters who mention that decrease in the capture of deer could be related to other factors and not due to a decrease in the population of white-tailed

deer.

The interviewees ($n = 23$) who perceived a reduction in deer cited the following as the main reasons: 1) constant hunting (71%), 2) the actions of natural predators (25%) and 3) damage to the forest or "monte" (4%). About hunting pressure on deer, the interviewees mentioned that it could be related to an increase in local hunters, many of them young and inexperienced, and the presence of poachers in the community environment. In the in-depth interviews, the peasant-hunters mentioned that ceaseless hunting of deer had put them on alert and resulted in the animal's ability to evade them, making it an increasingly difficult prey in the community environment. The interviewees associated the decline in white-tailed deer with hunting activity. While the relative impact on the local deer population by hunting type (e.g. subsistence vs. commercial) is unknown, there is documented evidence that poaching has a strong impact on wild fauna, affecting mammal populations globally (Muth and Bowe 1998, Abernethy *et al.* 2013, Morell 2016, Benítez-López *et al.* 2017, Brito *et al.* 2018).

Regarding predators, the interviewees mentioned that the combined actions of jaguars and coyotes may be affecting the abundance of deer locally. In the case of coyotes, they stated that their presence in the community environment is a recent phenomenon that has been the case for no more than 10 years. These arguments do not seek to downplay the detrimental effects on deer related to human activity and predators (e.g. coyotes and feral dogs), but to recognize other causes of the variation in the populations of this ungulate locally and regionally.

Considering the damage to the monte, the interviewees mentioned that the felling of trees for charcoal production has intensified in recent years. The disturbance produced by felling, whether due to noise or habitat loss, has forced the deer off the community lands of Los Petenes. It was difficult to evaluate this claim with any certainty because the magnitude or degree of deforestation caused by local practices such as charcoal production and their possible impact on wild fauna are still unknown (Oliva *et al.* 2019).

Regarding the conservation of deer, 65% of all interviewees (N = 31) stated that, while deer appear to be declining, they do not consider it likely that they will disappear from the community environment. This is because they believe that there are still community lands left with the minimum conditions (e.g. regenerating forest, availability of food and refuge) for the survival of white-tailed deer. The social expectation that deer will not be eradicated in Los Petenes in the coming years, could be because the downward trend observed for deer could reflect the population fluctuations (in 15-year cycles) commonly observed for Neotropical ungulates within of its distribution area (Fragoso 1997, 2004).

Another possibility is that deer adapt their behavior to evade hunting risk when hunter pressure is greatest, for example, by dispersing to areas with low hunting pressure or by modifying their activity times (Little *et al.* 2014, Little *et al.* 2016). A possible escape zone that deer could encounter is the core zone of the LPBR, which could provide the minimum critical area to maintain viable populations of this mammal (Mandujano and González-Zamora 2009). The latter is suspected by the statements of the hunters, who

recognize that the deer have become a difficult prey to obtain because they can detect the peasant-hunters, which causes them to move further away from the community environment.

An historical database with hunting activity records in the study community was partially used for this research. This provided a valuable source of information that allowed inferences to be made regarding the changes in abundance of white-tailed deer. The use of historical records of prey extraction comprises a reliable basis for monitoring game species in socially-inclusive protected areas (e.g. biosphere reserves) (Gatica and Hernández 2003, Quiroz *et al.* 2005, Villaseñor *et al.* 2016). We can consider that the above advantages were obtained in this study due to a long-term perspective that provided coverage over time (at least a decade) and the availability of systematic data on batida.

On the other hand, social perceptions have not often been used as a source of information for studying resource conservation, because quantitative information is usually relied on for this purpose (Delfín-Alfonso *et al.* 2009, Piña and Trejo 2014). In accordance with Bennett (2016), social perceptions of a resource can justifiably be assumed to constitute a quick, reliable and relatively low-cost tool for gaining a preliminary understanding of the state of a species of interest in protected sites such as biosphere reserves. The hunting records and social perceptions can be established as a strategy for monitoring the state of the species, as well as for promoting social participation in conservation strategies (e.g. participative monitoring, Villaseñor *et al.* 2016).

In conclusion, the information presented in this study comprises an initial diagnosis of the state of conservation of white-tailed deer in the region. Thus, the agreement between the hunting trend found and peasants' perceptions regarding the abundance of white-tailed deer suggests that this species may be at risk in future scenarios of use in northwest of contemporary Mayab.

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