Widespread Use of Traditional Techniques by Local People for Hunting the Yellow-Footed Tortoise (Chelonoidis denticulatus) Across the Amazon

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Widespread Use of Traditional Techniques by Local People for Hunting the Yellow-footed Tortoise (*Chelonoidis denticulatus*) across the Amazon

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Abstract. Understanding the repertoire of hunting techniques used by traditional peoples in tropical forests is crucial for recognizing the role of traditional knowledge in hunting activities, as well as assessing the impact of harvests on game species. We describe the hunting techniques used across Amazonia by Indigenous and non-Indigenous peoples for hunting yellow-footed tortoises (*Chelonoidis denticulatus*), one of the most consumed species in the biome. We interviewed 178 local people in 25 communities living in seven study areas in the Peruvian and Brazilian Amazon. We used a Principal Coordinate Analysis (PCoA) and Analysis of Similarity (ANOSIM) to compare the hunting techniques between ethnic groups and the ages of the interviewees. Four different techniques were reported: (1) trapping with bait (46%; n = 122); (2) hunting with dogs (35%; n = 92); (3) active searching (14 %; n = 37); and (4) visiting fruiting trees (5%; n = 14). Trapping with bait was alleged to be the most cost-effective technique by 67% of the interviewees. Among the baits used, 93% involved the use of wild species as rotten meat. Hunting with dogs was also frequently cited and involved eight different methods of training. The hunting techniques recorded were not significantly different among ethnic groups or generations. The consonance among the technique repertoire likely reflects a shared knowledge still in use across different cultural groups. There is a potential for applying the hunting techniques to large scale community-based monitoring and management programs, but the impact on additional species affected, such as species intentionally captured to be used as bait, should be considered. Local assessments and community-based management plans that incorporate traditional ecological knowledge are recommended to guarantee the maintenance of livelihoods and ensure the species' conservation in Amazonia.

Keywords: chelonian, cross-culture comparison, traps, traditional ecological knowledge, wild meat.

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Introduction

Rituals and cultural customary practices are underpinned by Traditional Ecological Knowledge (TEK) (Berkes et al. 2000). This is particularly true of hunting practices which involve several techniques employed by local people to optimize harvest rates (Hames 1989). Hunting practices have been improved over generations through gradual development of TEK regarding population trends and behavior of target species, as well as environmental dynamics (Barboza et al. 2014; Berkes et al. 2000). Therefore, techniques used for hunting and population management can be perceived as a feature of TEK (Ohmagari and Berkes 1997).

Documenting TEK associated with hunting techniques in tropical forests can contribute to the involvement of local knowledge and practices for the sustainable engagement with wildlife, from local, community-based management programs all the way up to international conservation agendas (Chandler et al. 2017; Dobson et al. 2019; van Vliet et al. 2018). The international agreement intended to guide management of protected areas worldwide, "The Promise of Sydney," developed at the International Union for Conservation of Nature (IUCN) World Parks Congress 2014, already explicitly recommends the involvement of local people and their practices in the monitoring and management of natural resources (Sandwith et al. 2014).

Understanding and documenting TEK regarding hunting techniques can also help to improve scientific research methods. The lack of appropriate methods for capturing certain animal species hinders the collection of scientific data to support informed conservation strategies and decision-making. Since traditional techniques have evolved to maximize the harvest of animals with the least amount of effort possible, they can be useful to researchers during fieldwork. Studies on secretive species with low detectability can be especially benefited by this knowledge (El Bizri et al. 2016; Huntington 2000).

In order to include traditional hunting techniques in community-based management programs or in the development of novel scientific methods, it is crucial to understand changes in TEK (Álvares 1997; Berkes 2008; Menzies and Butler 2010). In the past several decades, for example, with increased access to modern tools, different cultures have abandoned traditional hunting techniques (Hames 1979; Mena et al. 2000; Redford and Robinson 1987). In the Amazon, blowguns used to be the most popular technique for hunting arboreal prey, whereas spears were used for large terrestrial animals; currently, both techniques have been replaced by firearms (Mena at al. 2000). Such changes are particularly noticeable in younger generations that have distanced themselves from local traditions due to increased access to urban centers, presence of missionary activities, and establishment of a formal education system that does not value local knowledge (Ohmagari and Berkes 1997; Reyes-García et al. 2013). In some instances, the loss of traditional hunting knowledge can be the result of a perception that TEK does not effectively prepare young people to deal with the new socioeconomic realities and conditions they currently face (Reyes-García et al. 2013).

TEK related to hunting techniques and practices may also vary considerably among different cultures. For instance, hunting can be performed in solitary or group expeditions (Welch 2014). The time spent hunting and the financial resources needed for acquiring and maintaining hunting tools (such as shotguns or snares) are also critical correlates of adherence to a particular technique (Dobson et al. 2019). Local cosmology and taboos can also dictate techniques used or avoided during hunting, with avoidance being especially related to those techniques that may deplete stocks of target species (Colding

and Folke 2001). Food preferences can influence target species and management practices as well (Berkes et al. 2000), which ultimately determine the hunting techniques developed and used.

In this study, we chose the yellow-footed tortoise (*Chelonoidis denticulatus*) as a model for better understanding how traditional hunting practices vary among different ethnic groups (Indigenous and non-Indigenous) and generations. Notably, this is one of the most commonly-hunted species across the Amazon for which no ammunition or weapon is required for its capture (Morcatty and Valsecchi 2015; Peres 2000; van Vliet et al. 2014), but the traditional knowledge associated with hunting this elusive and little-studied species is still poorly known and understood. We also discuss the hunting techniques in terms of possible impacts on other taxa and their potential for improving scientific research methods.

Materials and Methods

Study Areas and Cultural Context

This study was conducted in seven locations in the Peruvian and Brazilian Amazon, totaling 25 communities sampled (Figure 1). Four locations are inhabited by Indigenous groups and three are inhabited by non-Indigenous people (Table 1). The non-Indigenous people interviewed are traditional Amazonian peoples resulting from a mix of Indigenous ethnicities and immigrant ancestry from different origins due to the processes of colonization of the Amazon. The communities sampled are located in or hunt within the territory of the following areas: (1) Pucacuro National Reserve (Pucacuro NR) (02°42′25″S, 75°06′30″W) located on the Pucacuro River, Peru; (2) Pacaya-Samiria National Reserve (Pacaya-Samiria NR) (5°15′00″S, 74°40′00″W), located at the confluence of the Marañón and Ucayali Rivers, Peru; (3) Maijuna-Kichwa Regional Conservation Area (Maijuna-Kichwa RCA) (3°2′5″S, 72°9′5″W), situated along the Sucusari River, Peru; (4) Nueva Esperanza (Yavarí-Mirín) River basin (04°19′5″S, 71°57′33″W), Peru; (5) Auatí-Paraná Extractive Reserve (Auatí-Paraná ER) (2°0′58″S, 66°25′10″W), located in the northern bank of the Auatí-Paraná River, Brazil; (6) Mamirauá Sustainable Development Reserve (Mamirauá SDR) (03°08′S, 64°45′W), located at

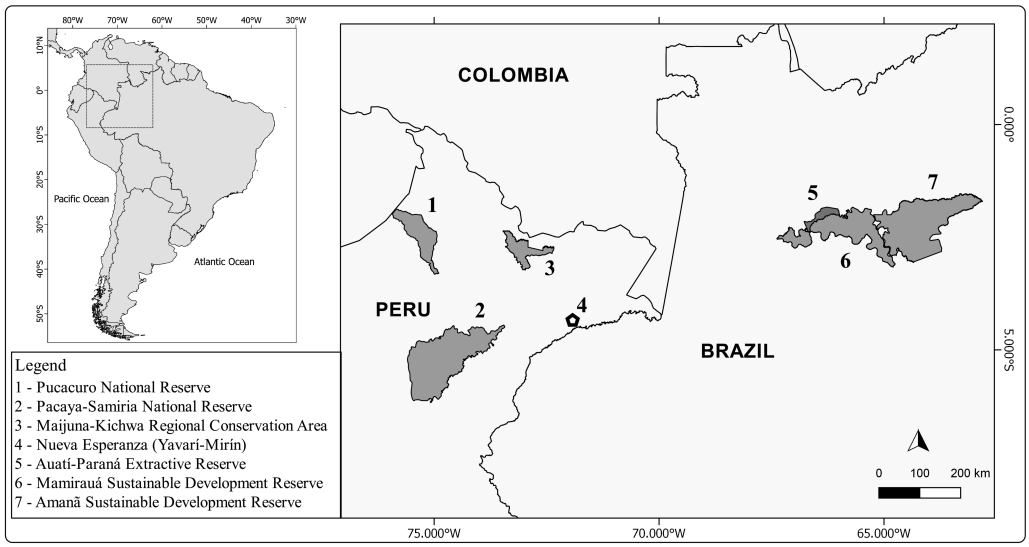

Figure 1. Map showing the location of the sampled areas within the Peruvian and Brazilian Amazon.

Table 1. Demographic details of the sampled communities and the interviewees in the Peruvian and Brazilian Amazon.

Study sites	Ethnicity	Status of the used area and management strategies	Nº of interviewees	Nº communities sampled	Average inhabitants per community (SD)	Total number of hunters (% of hunters interviewed)
Pucacuro National Reserve	Kichwa	Community located nearby an uninhabited protected authorized to hunt within the protected area; Existence of a management plan.	10	1	500	100 (10%)
Pacaya-Samiria National Reserve	Kukama-Kukamilla	Communities located within a protected area for sustainable use; Existence of a management plan.	50	2	270 (180)	108 (46%)
Maijuna-Kichwa Regional Conservation Area	Maijuna (59%), mestizos (35%), Kichwa (6%)	Community located near an uninhabited protected area authorized to hunt within the protected area; Existence of a management plan.	46 Ethnic groups proportionally sampled	1	166	26 (57%)
Community in the Yavarí-Mirín River basin	Yagua	Community located and using non-protected areas; Existence of informal zoning and management programs for logging and fishing.	7	1	300	60 (12%)
Amanã Sustainable Development Reserve	Non-Indigenous people	Communities located within a protected area for sustainable use; Management plan in development.	31	5	149 (96)	150 (21%)
Mamirauá Sustainable Development Reserve	Non-Indigenous people	Communities located within a protected area for sustainable use; Existence of a management plan.	22	5	114 (74)	108 (23%)
Auatí-Paraná Extractive Reserve	Non-Indigenous people	Communities located within a protected area for sustainable use; Existence of a management plan.	12	10	90 (45)	160 (7.5%)

the confluence of the Solimões and Japurá Rivers, Brazil; and (7) Amanã Sustainable Development Reserve (Amanã SDR) (01°54′00″S, 64°22′00″W), located between the Negro and Japurá Rivers, Brazil. Further details of the sampled communities can be found in Table 1.

Apart from Mamirauá SDR and Pacaya-Samiria NR, which comprise exclusively white-water flooded forests, the study areas are comprised of upland forests, floodplain forests, and swamps. Both Indigenous and non-Indigenous people interviewed maintain their habits intrinsically related to nature and rely on subsistence activities that include swidden-fallow agriculture, hunting, fishing, and the gathering of various forest products. To generate income, community members may sell agricultural products, domesticated animals, a variety of non-timber forest products, and game meat.

Data Collection

Between May 2014 and October 2015, we conducted interviews with a pre-set semi-structured questionnaire to 178 randomly selected heads of households living in the 25 sampled communities (Table 1). When both men and women were available in the same household, we interviewed the man. We interviewed 131 men and 47 women. The interviewees' ages ranged between 18 and 77 years old (average = 44 years). In these interviews, we asked the interviewees the following questions: their age, whether they actively hunt tortoises, what hunting techniques they know or use for hunting tortoises, and what technique they consider to be the most efficient. We also asked the interviewees to describe the application of the techniques in the field. If any technique involved dogs, we asked what strategies they know or use to train the dog to detect tortoises. If the technique involved baits, we asked what bait they know or use for capturing tortoises. When the bait mentioned involved animal products, although we did not ask whether they used it as sub-product of wild meat hunting or whether they killed animals specifically intended to use them as bait, we recorded this information accordingly. The species used as bait were taxonomically identified based on local names and cross-checked with the expected occurrence for the region according to taxonomic guides and specialists. In cases where the identification involved similar species occurring in sympatry, such as for sloth and some plant species, the most abundant taxon expected to occur in the region was considered.

Respondents were free to participate or leave the study at any stage; all visited household heads agreed to participate. All interviewees were provided with an Informed Consent Form detailing the project aims and guaranteeing that we would not disclose their identity. The study was approved by the Instituto Chico Mendes de Conservação da Biodiversidade (License SISBIO 40358-3) and the Committee on the Ethical Use of Animals and Plants for Research of the Mamirauá Institute (Protocol no. 001/2011 and 010/2013).

Data Analysis

We used descriptive statistics to analyze the data on the use and efficiency of the different tortoise hunting techniques. We used a Principal Coordinate Analysis (PCoA) with Gower Similarity Coefficient and a posteriori Analysis of Similarity (ANOSIM) to assess the difference in the use of hunting techniques cited according to their cultural background (Indigenous vs. non-Indigenous people), their ethnicity (non-Indigenous, Kichwa, Maijuna, Kukama-Kukamilla, and Yagua), and the interviewee's age. For assessing whether there was a generational change on traditional knowledge of tortoise hunting techniques, we divided the age of interviewees into three classes: $\leq$ 29 years old, 30–49 years old, and $\geq$ 50 years old (hereafter generations). We used QGIS 2.18 to build the map and *vegan* R-package in R 3.5.1 software for all statistical analyses.

The significance of the ANOSIM analysis was considered when $p < 0.05$, indicating that the probability of the result occurring by chance was less than 5%.

Results

Most Cited Hunting Techniques

Interviewees reported four different techniques used specifically for hunting tortoises in the Amazon: trapping with bait, hunting with dogs, active searching, and visiting fruiting trees. Trapping with bait was the most frequently recorded (n = 122, 46%), followed by hunting with dogs (n = 92, 35%), active searching (n = 37, 14%), and visiting fruiting trees (n = 14, 5%) (Figure 2). Among the four techniques, trapping with bait was cited as the most efficient one by the majority of the interviewees (67%, n = 52), followed by active searching, hunting with dogs, and visiting fruiting trees (28%, 3%, and 1%, respectively) (Figure 2). Trapping with bait and hunting with dogs were the most widespread techniques, cited by interviewees in all localities and ethnicities sampled, while active searching was cited by all ethnicities but not in all localities; visiting fruiting trees was cited by all groups except Yaguas and Maijunas.

Eight different types of dog-training were mentioned by interviewees (Table 2). The most cited training technique was giving certain herbs to the dog to smell right before going hunting (34%, n = 39). Some training techniques also incorporated timing with the phase of the moon (Table 2). Although not frequently cited, training may involve parts of other animals, such as ant nests, jaguar whiskers (*Panthera onca*), or a burned gold tegu lizard (*Tupinambis teguixin*).

The majority (n = 129, 93%) of the 139 reports on baits employed in traps consisted of rotten meat, viscera, or other animal products. The remaining baits cited were fruits: yellow mombin (*Spondias mombin*; n = 5), marirana (*Couepia* sp.; n = 2), muru-muru (*Astrocaryum muru-*

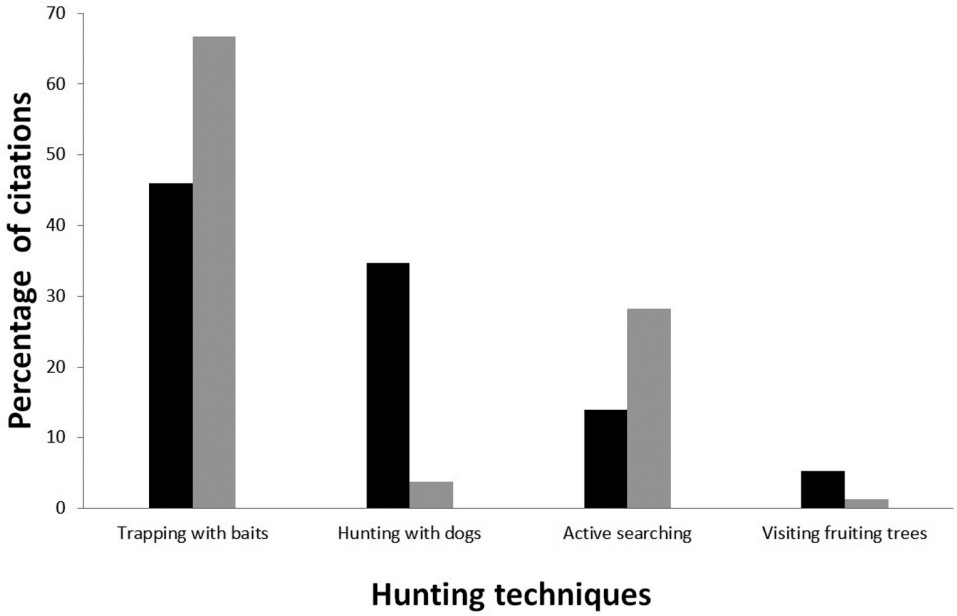

Figure 2. Hunting techniques cited as known and most efficient for hunting tortoises in the Amazon. Black columns represent the proportion of citation by the interviewees for known technique and gray columns for the most efficient technique.

Table 2. Training methods of dogs, including the number of times reported, locations where they were reported, and type of moon required for each training method.

Dog training strategies	N mentions (%)	N locations (%)	Moon required (N citations)
Give the dog herbs (with or without tobacco and chili pepper) to smell before going hunting [such as cannonball tree (*Couroupita guianensis*), chiric sanango (*Brunfelsia* sp.), catahua (*Hura crepitans*), lobosanango (*Tabernaemontana* sp.), and pucunillo (Asteracea)].	59 (41%)	6 (86%)	New moon (14) Full moon (1)
Feed the dog tortoise ticks (with or without gunpowder).	26 (18%)	5 (71%)	New moon (1)
Allow the dog to interact with (play, sniff) a live tortoise before going hunting.	15 (10%)	3 (43%)	_
Drip tortoise bile on the muzzle of the dog.	13 (9%)	2 (29%)	New moon (5)
Take the dog to the forest and continuously encourage it to search places likely to house a tortoise, such as fallen trees.	10 (7%)	6 (86%)	_
Feed the dog tortoise meat (with or without gunpowder).	9 (6%)	3 (43%)	_
Allow the dog to interact with parts of a dead tortoise (feed the dog in the carapace, hang a tortoise scale or bone on the dog's neck).	8 (5%)	3 (43 %)	_
Rub the dog's muzzle on an ant nest, on jaguar whiskers (*Panthera onca*), in tortoise urine, or on a burned lizard (*Tupinambis teguixin*).	6 (4%)	2 (29%)	_

muru; n = 2), and peach palm (*Bactris gasipaes*; n = 1). Many hunters (n = 50) reported using by-products of animals hunted for consumption, such as skin and viscera, as bait. A similar number of hunters (n = 49) intentionally kill animals specifically to be used as bait, especially those not usually consumed by the local people (due to local taboo or taste preference) or with special characteristics that allow a longer decomposition time. By-products from white-lipped peccary (*Tayassu pecari*) was most commonly reported (n = 8). Only a few hunters claimed to use tapir (*Tapirus terrestris*; n = 3), deer (*Mazama gouazoubira* and *M. americana*; n = 2), capybara (*Hydrochoerus hydrochaeris*; n = 2), domestic poultry (n = 1), agouti (*Dasyprocta* spp.; n = 1), and tortoise (n = 1) by-products as bait. Another 34 hunters reported using hunting by-products and did not specify the species. Among those animals recorded as being killed intentionally for use as bait, the most commonly reported were caimans (65%; n = 32); both the spectacled caiman (*Caiman crocodilus*; n = 4) and the black caiman (*Melanosuchus niger*; n = 3) were specified. A small number of hunters (n = 12) reported killing primates as bait; when specified, the woolly monkey (*Lagothrix* spp.) was cited three times, while the large-headed capuchin monkey (*Sapajus macrocephalus*) and red howler monkey (*Alouatta seniculus*) were cited once each. Other species were also occasionally reported as being specifically killed for use as bait: snakes three times, and both the sloth (either *Bradypus variegatus* or *Choloepus* sp.) and southern tamandua (*Tamandua tetradactyla*) were cited once each. In addition to by-products of animals hunted for consumption and animals hunted intentionally for use as bait, fish was also reported as bait for tortoise hunting, though by fewer hunters (n = 29). The species cited are often not prized for consumption, for example electric eels (Gymnotidae) and armored catfish (Loricariidae).

Most of the tortoise hunters (42 out of 46) said they hunt tortoises actively,

while only four considered tortoise hunting as mainly opportunistic. The traditional knowledge associated with tortoise hunting did not differ among generations (ANOSIM: $r = 0.015$, $p = 0.16$) (Figure 3a). In addition, we also observed great similarity between the hunting techniques mentioned among Indigenous ethnic groups and non-Indigenous people (ANOSIM: $r = 0.0003$, $p = 0.42$) (Figure 3b-c).

Description of Hunting Techniques

According to our interviewees, "trapping with bait" consists of going into the forest, hanging bait using ropes or fibers extracted from a tree trunk, and waiting for the smell of the bait to attract tortoises. It is also common to build a wooden corral around the bait or dig a hole in the ground below the hanging meat or fruit in which the tortoises may be caught. The trap can be checked a few hours or days later, depending on the size and type of the bait offered.

"Active searching" consists of the hunter walking through the forest looking for tortoises in micro-habitats commonly used by the species. For instance, hunters said they often search for tortoises under fallen trees, since tortoises spend considerable time in such shelters. During the peak of the dry season, hunters focus their search for tortoises in forest ponds and during the peak of the flooding season, hunters look for tortoises on branches of the trees above the water. Hunters usually use their machete or a wooden branch as a tool for their search, in a way that they can reach shelters and dense vegetation without risking contacting venomous animals, such as snakes. According to the interviewees, the tortoises are identified by the noise of the tool hitting the carapace.

The "use of dogs" specialized in tortoise hunting, according to our interviewees, is always preceded by training (for more details see Table 2). There are several variations on the training across cultural background and locations; but they basically involve rubbing the dog's muzzle in, feeding the dog with, or encouraging the dog to play with different materials. Only after the training is the dog taken into the forest to hunt tortoises.

Finally, "visiting fruiting trees" consists of identifying tree species tortoises prefer feeding on and anticipated its phenology. During fruiting periods, hunters go to those previously recorded trees and search a few meters around them. Tree species from which fruits were claimed to

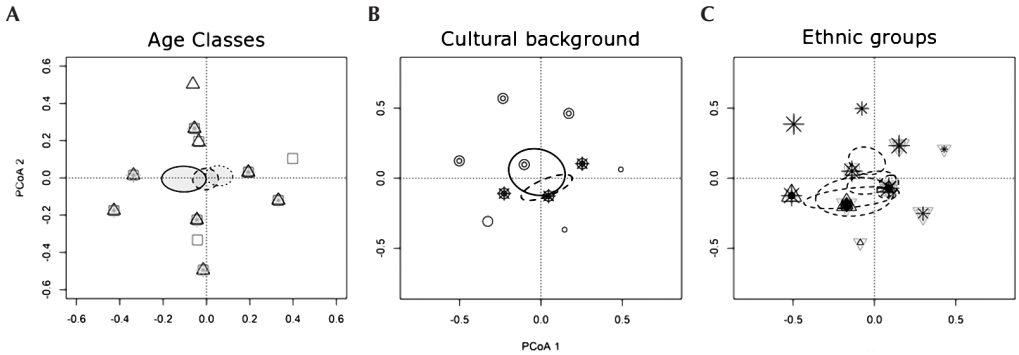

Figure 3. Principal Coordinate Analysis (PCoA) scattergram of hunting techniques cited according to the (a) generations (age classes), (b) cultural background, and (c) ethnic group. Different symbols represent different (a) age class (✳ = < 29y, Δ = 30 − 49y and □ = > 50y), (b) cultural background (○ = non-indigenous people and ✳ = Indigenous People), or (c) ethnic group studied. The size of the symbols varies according to the number of records overlapped on the same PCoA score values. The black ellipses represent the 95% confidence interval for each (a) age class (where solid line = < 29y, dashed line = 30 − 49y and dotted line = > 50y), and (b) cultural background (where the solid line represents non-indigenous people and the dashed line represents Indigenous groups).

be consumed by tortoises were the yellow mombin (*S. mombin*), marirana (*Couepia* sp.), muru-muru (*A. murumuru*), and ambé vine (*Philodendron fragrantissimum*).

Discussion

Our findings showed that TEK related to tortoise hunting is largely shared among hunters from different ethnicities in the Peruvian and Brazilian Amazon. The similarities in the composition of hunting techniques among distinct ethnic backgrounds may have resulted from ancient or modern cultural co-evolution among the studied groups or multiple convergences on the same techniques (Migliano et al. 2020; Murray et al. 2006). Historically, throughout the Amazon basin, Indigenous peoples were semi-nomadic and migrated long distances. Later, in the post-colonial period, vast numbers of rubber workers migrated to the Amazon and occupied Indigenous territories (Alexiades 2009). Those pre- and post-colonial migrations and cumulative encounters among different groups promoted multiple opportunities for the combination of different knowledge aiming at hunting improvement, which may have resulted in a shared knowledge of hunting techniques (Migliano et al. 2020). The results of our study are consistent with such cultural crossover, leading to communities with different cultural backgrounds and as far as 1300 kilometers of linear distance apart having the same hunting repertoire in Amazonia. However, some of the most common hunting techniques were also likely to have been discovered independently. Hunters butcher large hunted mammals before transporting them, leaving viscera in the forest, which will subsequently attract tortoises. Hunters' observations of these unintentional experiences may have led to the adoption of baiting methodologies.

Although there has been reported a generational erosion regarding TEK in the Amazon (e.g., loss of ethnobotanical knowledge, Reyes-García et al. 2013), we did not find evidence of a change in TEK associated with tortoise hunting between generations in the studied localities. The techniques recorded require an understanding of tortoise distribution in the forest with regards to slope, elevation, and shelter (Tavares et al. 2019), tortoise feeding behavior, or the location and phenology of specific fruiting trees attractive to tortoises (Wang et al. 2011). However, all this TEK related to hunting techniques is not static, and future losses may still happen due to unpredictable environmental, social, and economic pressures to which local inhabitants are, and will be, continuously exposed (Álvarez 1997; Berkes 2008; Menzies and Butler 2010).

We highlight the importance of considering the impacts of hunting not only on the species targeted for consumption, but also on other species harvested or affected by the hunting techniques. Two of the described techniques for hunting tortoises—trapping with bait and hunting with dogs—involve the use of other species, which has already led to conservation concerns by other researchers (Álvarez 1995). Meat from caimans, along with Amazon river dolphins (*Inia geoffrensis*), is also traditionally used as bait for catfish (*Calophysus macropterus*) fishing in the Amazon (Brum et al. 2015). In the case of the dolphin, the publicity of its use led to a temporary ban of the commercialization of the catfish in Brazil and Colombia due to possible impacts on dolphin populations (Asher 2018). Further research and monitoring should document the offtake of bait animals for hunting tortoises. If a potential imperilment of any key species by use as bait is detected, rules at local or national levels should be developed to avoid overexploitation. The impacts of each technique for hunting tortoise have to be contemplated in management plans, and local arrangements developed in order to promote the sustainability of hunting (e.g., for turtles, Vieira et al. 2019).

TEK of Indigenous and non-Indigenous peoples, when combined with scientific knowledge, can provide more efficient methods for faster and more reliable research on hunted species in tropical forests (El Bizri et al. 2016; Gadgil et al. 1993; Huntington 2000). Assessing population trends of tortoises, for instance, may guide decision-making for their management, but depends on locating tortoises readily and at a low cost in the field. Current tortoise survey methods, such as linear transects and active searching, have low capture rates (e.g., Guzmán and Stevenson 2008), which could be much improved by using baited traps inspired by the technique used by Amazonian people. Their efficacy against conventional survey methods could be tested considering the particularities of the environment and the type of bait used. Given that the yellow-footed tortoise is currently listed as Vulnerable by the IUCN (IUCN 2019), threatened by overexploitation through most of its range (Morcatty and Valsecchi 2015), and much of the information about its biology and ecology still comes from studies in captivity (Ferrara et al. 2017), this represents a valuable opportunity for the study of the species in the wild.

Turning trapping with bait into a standardized method may also facilitate the establishment of community-based population monitoring for assessing hunting sustainability in relation to the local practices (El Bizri et al. 2016; Gadgil et al. 1993; Huntington 2000). The fact that the people from different cultures are familiar with the method represents the potential for adopting common protocols throughout the Amazon. For instance, the widespread traditional fishing techniques for catching the giant arapaima fish (*Arapaima gigas*) have been incorporated into community-based monitoring methods. This method was then replicated throughout the Amazon for estimating their abundance and, ultimately, defining the fishing quotas for the species' consumption and commercial exploitation (Castello et al. 2009).

The overexploitation of yellow-footed tortoises in Amazonia is a conservation concern (Morcatty and Valsecchi 2015). While the traditional methods of hunting them have been sustainable in the historical context of Amazonia, increasing road access and fragmentation, and increasing supply of wild meat to urban centers have increased pressure on wildlife populations (El Bizri et al. 2020: Espinosa et al. 2014). Incorporating TEK in tortoise hunting management can be an alternative to develop more effective and integrative strategies to conserve both wildlife and local peoples' livelihoods (Lertzman 2009). Apart from the Yavarí-Mirín River basin, all sampled locations in our study are protected areas, which have, or are developing, management plans for the sustainable use of resources. Community management strategies developed by local people have sometimes included restrictions on the use of methods deemed too efficient by those communities (e.g., Berkes et al. 2000; Vieira et al. 2015). For example, Maijuna communities restrict the use of barbasco (*Lonchocarpus* sp.) fish poison (M. Gilmore and M. Bowler, personal observations). In other Amazonian regions, local rules also restrict hunting in mineral licks or using dogs in order to promote sustainable hunting (Montenegro 2004; Vieira et al. 2015, 2019). Using such strategies to regulate and manage tortoise hunting can be combined with methods of monitoring tortoise populations, such as those we recommend, to ensure the persistence of this important source of nutrients and income, and to guarantee food sovereignty for Amazonian communities.

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