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FROM SUBSISTENCE TO PRESTIGE: CONTEMPORARY USE OF WILDLIFE IN ECOTONAL LANDSCAPES WITH HIGH ROAD CONNECTIVITY IN BRAZIL'S MID-NORTH REGION

DA SUBSISTÊNCIA AO PRESTÍGIO: O USO CONTEMPORÂNEO DA FAUNA SILVESTRE EM PAISAGENS ECOTONAIS COM ALTA CONECTIVIDADE VIÁRIA NO MEIO-NORTE DO BRASIL

DE LA SUBSISTENCIA AL PRESTIGIO: EL USO CONTEMPORÁNEO DE LA FAUNA SILVESTRE EN PAISAJES ECOTÓNICOS CON ALTA CONECTIVIDAD VIAL EN EL NORTE DE BRASIL

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Abstract

Wildlife hunting in dry tropical landscapes and ecotonal regions remains comparatively poorly understood, particularly where urban populations, mobility, communication technologies, and local markets interact with longstanding hunting practices. We investigated contemporary wildlife use and trade among urban hunters in the Caatinga-Cerrado ecotone of Northeast Brazil, a highly road-connected area in Brazil's Mid-North. Semi-structured interviews, open-ended conversations, guided tours, and non-member participant observation were conducted with 15 hunters in Regeneração, Piauí State. We characterized participants' socioeconomic profiles, hunting practices, species use, and local wildlife trade, and estimated the relative importance of species used for food and traditional medicine using Use Value indices (UV). Hunters reported 32 wild vertebrate species, of which 26 were used as wild meat and 11 as zootherapeutic resources. Mammals, particularly armadillos, had the highest Use Values for wild meat, whereas medicinal use involved fewer species and was generally secondary to food-oriented exploitation. Hunting was predominantly nocturnal and relied on firearms, dogs, artificial lighting, and motorcycles, while mobile phones reportedly facilitated commercial transactions and deliveries. Recreational motivations predominated, although wildlife sales also helped cover hunting-related expenses and household needs. Wild-meat prices varied among species, with armadillos reaching the highest values, suggesting that wild meat may function as a socially valued and economically differentiated food rather than solely as a subsistence resource. Hunters also perceived declines in several frequently hunted species over the previous decade. Overall, contemporary wildlife use in this ecotone reflects an increasingly interconnected socioecological system, with important implications for conservation, monitoring, and culturally informed wildlife governance.

Keywords: Bushmeat; Wildlife trade; Zootherapy; Caatinga-Cerrado ecotone; Conservation.

Resumo

A caça de fauna silvestre em paisagens tropicais secas e regiões ecotonais ainda é relativamente pouco compreendida, particularmente onde populações urbanas, mobilidade, tecnologias de comunicação e mercados locais interagem com práticas tradicionais de caça. Investigamos o uso e o comércio contemporâneos da fauna silvestre entre caçadores urbanos no ecótono Caatinga-Cerrado do Nordeste do Brasil, uma área fortemente interconectada por estradas no Meio-Norte do Brasil. Entrevistas semiestruturadas, conversas abertas, visitas guiadas e observação participante do tipo não-membro foram conduzidas com 15 caçadores em Regeneração, estado do Piauí. Caracterizamos os perfis socioeconômicos dos participantes, as práticas de caça, os usos das espécies e o comércio local da fauna silvestre, e estimamos a importância relativa das espécies utilizadas para alimentação e medicina tradicional por meio de índices de Valor de Uso (VU). Os caçadores relataram 32 espécies de vertebrados silvestres, das quais 26 eram utilizadas como carne de caça e 11 como recursos zooterapêuticos. Os mamíferos, particularmente os tatus, apresentaram os maiores Valores de Uso para carne de caça, enquanto o uso medicinal envolveu menos espécies e foi geralmente secundário à exploração voltada à alimentação. A caça foi predominantemente noturna e baseada no uso de armas de fogo, cães, iluminação artificial e motocicletas, enquanto

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telefones celulares foram relatados como facilitadores de transações comerciais e entregas. As motivações recreativas predominaram, embora a venda de fauna silvestre também contribuísse para cobrir as despesas relacionadas à caça e às necessidades domésticas. Os preços da carne de caça variaram entre as espécies, com os tatus alcançando os maiores valores, sugerindo que a carne de caça pode funcionar como um alimento socialmente valorizado e economicamente diferenciado, e não apenas como recurso de subsistência. Os caçadores também perceberam declínios em várias espécies frequentemente caçadas ao longo da última década. De modo geral, o uso contemporâneo da fauna silvestre nesse ecótono reflete um sistema socioecológico cada vez mais interconectado, com importantes implicações para a conservação, o monitoramento e a governança da fauna culturalmente informada.

Palavras-chave: Carne de caça; Comércio da fauna silvestre; Zooterapia; Ecótono Caatinga-Cerrado; Conservação.

Resumen

La caza de fauna silvestre en paisajes tropicales secos y regiones ecotonales sigue siendo relativamente poco comprendida, particularmente en contextos donde las poblaciones urbanas, la movilidad, las tecnologías de comunicación y los mercados locales interactúan con prácticas de caza de larga data. Investigamos el uso y el comercio contemporáneos de fauna silvestre entre cazadores urbanos en el ecótono Caatinga-Cerrado del Nordeste de Brasil, un área con alta conectividad vial ubicada en el Medio-Norte de Brasil. Se realizaron entrevistas semiestructuradas, conversaciones abiertas, recorridos guiados y observación participante no miembro con 15 cazadores en Regeneração, estado de Piauí. Caracterizamos los perfiles socioeconómicos de los participantes, las prácticas de caza, los usos de las especies y el comercio local de fauna silvestre, y estimamos la importancia relativa de las especies utilizadas para alimentación y medicina tradicional mediante índices de Valor de Uso (VU). Los cazadores reportaron 32 especies de vertebrados silvestres, de las cuales 26 fueron utilizadas como carne de caza y 11 como recursos zooterapéuticos. Los mamíferos, particularmente los armadillos, presentaron los mayores Valores de Uso para la carne de caza, mientras que el uso medicinal involucró menos especies y fue generalmente secundario a la explotación orientada a la alimentación. La caza fue predominantemente nocturna y se basó en el uso de armas de fuego, perros, iluminación artificial y motocicletas, mientras que los teléfonos móviles facilitaron, según los relatos, las transacciones comerciales y las entregas. Predominaron las motivaciones recreativas, aunque la venta de fauna silvestre también contribuyó a cubrir gastos relacionados con la caza y necesidades domésticas. Los precios de la carne de caza variaron entre especies, con los armadillos alcanzando los valores más altos, lo que sugiere que la carne de caza puede funcionar como un alimento socialmente valorado y económicamente diferenciado, y no únicamente como un recurso de subsistencia. Los cazadores también percibieron disminuciones en varias especies frecuentemente cazadas durante la última década. En general, el uso contemporáneo de fauna silvestre en este ecótono refleja un sistema socioecológico cada vez más interconectado, con importantes implicaciones para la conservación, el monitoreo y una gobernanza de la fauna culturalmente informada.

Palabras clave: Carne de animales silvestres; Comercio de fauna silvestre; Zooterapia; Ecotono Caatinga-Cerrado; Conservación.

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1. Introduction

Wildlife hunting and the use of wildlife-derived products have been deeply embedded in human societies across diverse environments for thousands of years (Alves and Albuquerque, 2017; Alves et al. 2018; Souto et al. 2026). These practices are shaped by multiple, often interacting drivers, including taste preferences, local cultural norms, limited access to alternative protein sources, meat prices, species body mass, and income-generating opportunities (Van Vliet et al. 2015a; Chausson et al. 2019; Aragão Silva et al. 2023; Nguyen, 2023; D'Cruze et al. 2024; Paudel et al. 2025). In tropical regions, however, the contexts and dynamics of wildlife hunting and use are increasingly being reshaped by socioeconomic and infrastructural changes, including the incorporation of modern hunting technologies, the expansion of road networks within or adjacent to natural areas, urbanization, and other forms of encroachment into wildlife habitats (El Bizri et al. 2015; Bowler et al. 2020; Fa et al. 2022; El Bizri et al. 2024; Lemos et al. 2025).

The popularization of motor vehicles, together with more efficient communication strategies among hunters and other actors involved in wildlife supply chains, has further expanded the spatial reach, coordination, and market connectivity of wildlife exploitation (Souto et al. 2017; Razkallah et al. 2019; Chaves et al. 2021; El Bizri et al. 2024). Consequently, these developments may intensify the exploitation of wild fauna for both subsistence and commercial purposes.

Within this changing context, demographic expansion and urban growth have emerged as particularly important, yet still unevenly understood, drivers of wildlife exploitation. Human population growth, especially in urban areas adjacent to natural habitats, can intensify pressure on wildlife through increased purchasing power, market demand, and the concentration of consumers with access to wildlife products (McDonald et al. 2019; Ingram et al. 2021; Li et al. 2022). At the same time, rural and economically vulnerable populations may continue to exert pressure on wildlife through direct consumption, particularly where access to alternative sources of animal protein remains limited or financially constrained (McNamara et al. 2019; Ingram et al. 2025; Spencer et al. 2025). These overlapping pressures, together with

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Pages: 1-34

the growing connections among urban populations, rural hunting areas, and wildlife markets, indicate that contemporary wildlife use can no longer be understood solely as a rural subsistence activity.

The consequences of these dynamics are now widely evident. In several tropical contexts, current levels of wildlife use are unsustainable, and many populations have become severely depleted (Ripple et al. 2016; Benítez-López et al. 2019; Osuri et al. 2020). Benítez-López et al. (2017), for example, estimated that in hunted areas across the tropics, bird abundance declines by approximately 58% and mammal abundance by approximately 83% compared with non-hunted areas. Such declines are not limited to population-level effects. Unsustainable wildlife hunting can reshape local ecosystems by altering species interactions and ecological processes (Vanthomme et al. 2010), while also generating broader biogeographic consequences for ecosystem services, nutrient transfer, and energy flows (Kurten, 2013; Galetti et al. 2017; Brodie and McIntyre, 2019).

Much of the current understanding of hunting, wildlife use, and their associated impacts comes from humid tropical regions, especially the Amazon, the Congo Basin, and the forests of Southeast Asia (Bastos Silva et al. 2022; Chaves et al. 2023; D'Cruze et al. 2024; Arobaya et al. 2025). By contrast, comparatively less attention has been given to dry tropical biomes, even though these systems, including the Caatinga (deciduous, thorny dryland vegetation) and the Cerrado (Neotropical savanna), represent important components of tropical biodiversity and are increasingly recognized as conservation priorities because of their high biodiversity value and growing anthropogenic pressures (Fernandes et al. 2020; Ocón et al. 2021; Santos et al. 2024). Ecotonal landscapes connecting these biomes, such as the Caatinga-Cerrado ecotone, may be particularly relevant in this context because they combine distinct ecological conditions while also linking human populations, natural habitats, and resource-use systems across environmental boundaries.

These transitional landscapes, however, are increasingly exposed to overlapping human pressures. Rapid urban and rural population growth, for example, is strongly associated with increased demand for natural resources, intensified pressure on wildlife, and environmental degradation, thereby compromising

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Pages: 1-34

biodiversity and ecosystem services (Ferreira et al. 2018; Van Velden et al. 2018; Maja and Ayano, 2021). These pressures are especially evident in the Brazilian Cerrado, a Neotropical savanna where approximately 50% of the biome has already been converted into agricultural land and where marked urban expansion has occurred since the mid-20th century (Colli et al. 2020; Pompeu et al. 2024). Despite this extensive transformation, Cerrado biodiversity remains incompletely understood, and new species continue to be described every year, indicating that a substantial portion of its biological diversity is still undocumented (Colli et al. 2020). Against this background of rapid habitat conversion, biodiversity loss, and limited biological knowledge, bushmeat hunting and wildlife trafficking represent important pressures on vertebrate populations across this biome and its associated ecotones (WWF, 2015; Paula et al. 2017; Souto et al. 2017; Santos et al. 2024).

Accordingly, increasing attention has been given to wildlife hunting and trade, particularly regarding the diversity of species exploited, the pressures imposed on target populations, and the socioeconomic factors underlying wildlife use (Van Vliet et al. 2014; Oliveira et al. 2018; Souto et al. 2018, 2026; Aragão Silva et al. 2023; Ingram et al. 2025; Zisadza et al. 2025). Nevertheless, important questions remain about how contemporary wildlife use is being reshaped by interactions among urbanization, mobility, communication technologies, and local markets, particularly in less-studied dry tropical landscapes and ecotonal regions. Within this context, we assessed contemporary hunting dynamics and wildlife use in the Caatinga–Cerrado ecotone of Northeast Brazil. Specifically, we investigated the diversity and uses of wild vertebrates, the socioeconomic and technological dimensions of hunting, and the local commercialization of wildlife for food and medicinal purposes in an urban community.

2. Material and Methods

2.1 Study area

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Pages: 1-34

This study was conducted in the urban area of the municipality of Regeneração (6°14′22″S; 42°41′18″W), located in the midwestern region of Piauí State, Northeast Brazil (Figure 1). Regeneração is located approximately 160 km from Teresina, the state capital. The municipality covers 1,247.5 km² and has an estimated population of 17,400 inhabitants, approximately 80% of whom live in the urban area (IBGE, 2025). Highly anthropized areas, characterized by partial or complete absence of vegetation, increased from 278.5 km² to 637.57 km² between 1986 and 2016, mainly because of agricultural expansion and the development of rural roads (Costa et al. 2020). Agriculture, local commerce, and public-sector employment are the main sources of income in the municipality (IBGE, 2025).

The study area lies within an extensive Caatinga–Cerrado ecotonal zone (Jacomine et al. 1986). The climate is tropical monsoon, with an annual mean temperature above 26 °C and annual rainfall ranging from 1,300 to 1,600 mm (Alvares et al. 2013). Regeneração is crossed by the PI-236 state highway, which connects to PI-373, PI-217, and BR-343, all of which pass through the municipality's rural area. These roads connect Regeneração to municipalities in northern Piauí, western Maranhão, and southern Piauí. BR-343 has been identified as a route associated with illegal wildlife trade involving hunters and traders in other municipalities (Souto et al. 2017). Regeneração is the most populous municipality in its microregion (Cidade Brasil, 2021) and has a traditional street market that attracts traders and consumers from several municipalities in Piauí and Maranhão. Together, these characteristics create a landscape in which urban and rural areas, transportation routes, and local markets are geographically interconnected (Souto et al. 2017).

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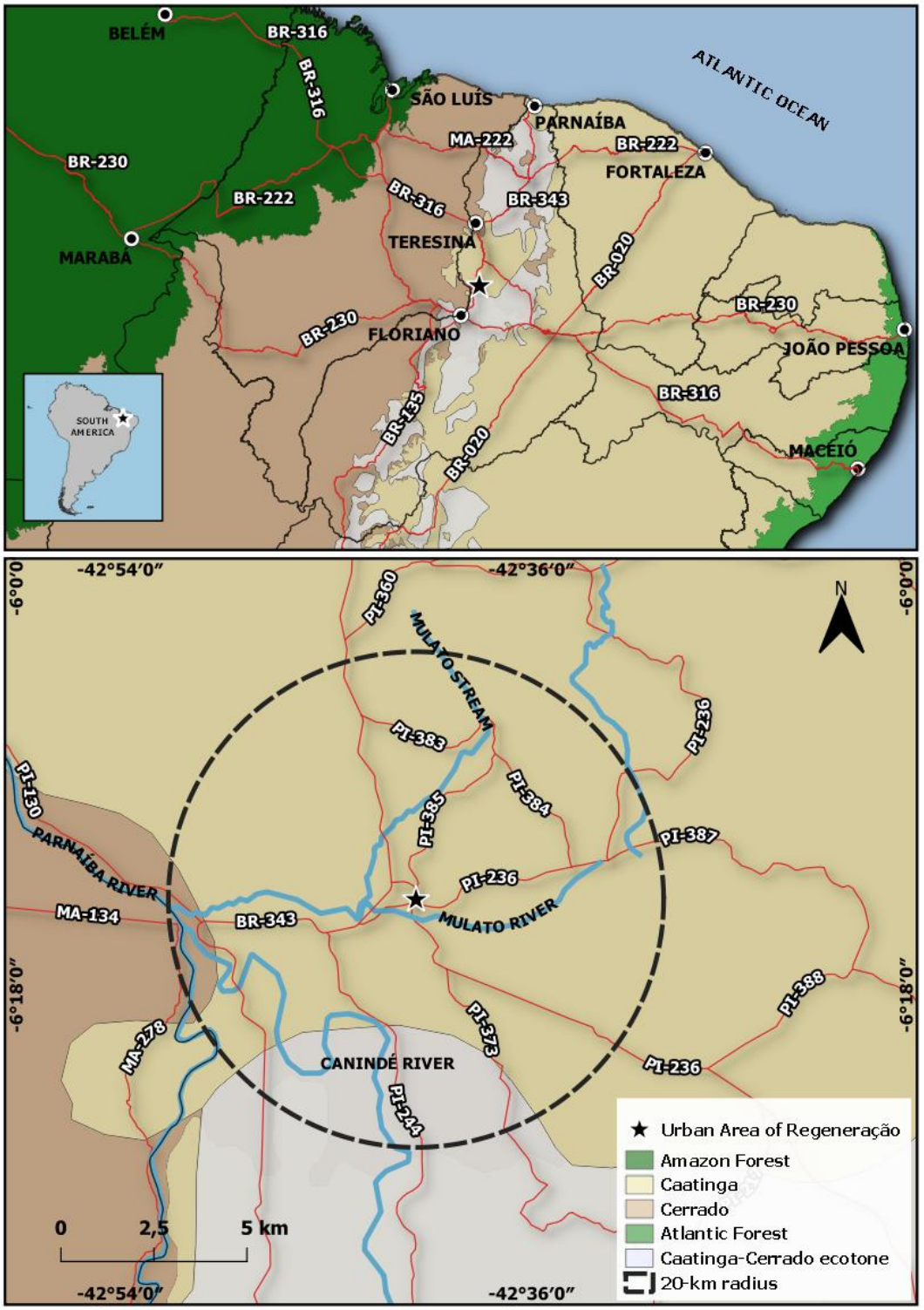
Figure 1. Location of the study area in the municipality of Regeneração, Piauí State, northeastern Brazil.



Note: The dashed circle represents a 20-km radius from the urban area of Regeneração, beyond which some hunters reported traveling to reach hunting sites. Red lines indicate the main highways connecting the study area to surrounding municipalities and broader regional areas. **Source**: Authors (2025).

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Pages: 1-34

2.2 Data collection

We used snowball sampling, a procedure commonly employed in ethnobiological research when data collection is challenging because of the sensitive nature of the topic and the difficulty of identifying and recruiting participants (e.g., Souto et al. 2019; Bastos Silva et al. 2022; Nijman et al. 2022; Santos et al. 2024). The first hunters contacted were either known to one of the authors (FAAN) or had previously been observed by him in possession of hunting equipment or captured wild animals. Subsequently, participants referred to other hunters from the community. Prior contact with local residents was established to build rapport before the interviews (Oliveira et al. 2018; Nijman et al. 2022). The final sample comprised 15 hunters. This relatively small sample size was primarily related to the illegal status of hunting in Brazil, which makes the identification and recruitment of hunters particularly challenging. In addition, law-enforcement operations by environmental agencies occurred on three occasions during the study period and were reported in the local media, further constraining participant recruitment.

We conducted interviews between December 2016 and February 2017 and between December 2018 and May 2019 using a semi-structured questionnaire. The questionnaire comprised two sections and was complemented by open-ended interviews and informal conversations. The first section addressed participants' socioeconomic characteristics, including age, education level, family size, personal and household income, receipt of government assistance, access to basic services, internet access, computer ownership, and ownership of a motorized vehicle. The second section addressed general aspects of hunting activities, including motivations, hunting frequency, means of transportation to hunting sites, hunting methods, and preferred target species. One of the authors (FAAN) also accompanied participants on guided tours to document hunting activities through non-participant observation (Fetterman 2009). In addition, five participants provided information on the local wildlife trade through open-ended interviews. Ethical approval was obtained from the Ethics Committee of the Federal University of Piauí (CAAE No. 4788.7015.9.0000.5214). Participants were informed about the objectives of the

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study and provided verbal consent for the use of interview data, with no identifying information recorded or reported.

2.3 Species identification, taxonomic nomenclature, and conservation status

Species recorded during interviews, including photographic records of specimens observed in respondents' homes, commercial establishments, and during guided tours, were identified by wildlife biologists with expertise in the regional fauna of the study area. The taxonomic classification and scientific nomenclature of birds, reptiles, and mammals followed Pacheco et al. (2021), Guedes et al. (2023), and Abreu et al. (2025), respectively. Each taxon identified to the species level was classified according to its conservation status on the IUCN Red List (IUCN 2026).

2.4 Data analysis

Socioeconomic characteristics and general information on hunting activities were summarized using descriptive statistics. Species richness, taxonomic composition, use categories, citation frequencies, and reported market prices were also summarized descriptively. The Use Value (UV) index was calculated separately for each use category, using an equation modified from Lucena et al. (2012), to estimate the relative importance of each species for the reported uses: $UV = \Sigma U/n$, where UV is the use value of a species within a given use category, U is the number of citations for that species in that category, and n is the total number of participants. Information on the therapeutic uses of animal parts and by-products was classified according to the International Statistical Classification of Diseases and Related Health Problems (ICD-11), following Almeida et al. (2020).

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Pages: 1-34

3. Results

3.1 Socioeconomic profile of participants

A total of 15 hunters participated in the study, all of whom were male. Participants ranged in age from 16 to 81 years (39.2 ± 19.8 years). Most participants (60.0%) reported receiving government assistance through the Bolsa Família program. Households had access to basic services, including electricity and piped water. Although only one-third of participants reported having a computer at home, internet access was more widespread, primarily through smartphones. Ownership of motorized vehicles was also common, particularly motorcycles, which were reported by 66.7% of participants. Selected socioeconomic characteristics of the participants are presented in Table 1.

Table 1. Socioeconomic characteristics of hunters interviewed in the urban area of Regeneração, Piauí State, northeastern Brazil.

Socioeconomic characteristics	n	%
Age (years)		
≤ 20	2	13.3
21–35	7	46.7
36–50	2	13.3
> 50	4	26.7
Education level		
Very low (illiterate or semi-literate)	3	20.0
Low (incomplete or complete primary education)	8	53.3
Medium/High (secondary school or university)	4	26.7
Family size (number of household members)		
1–2	4	26.7
3–4	4	26.7
≥ 5	7	46.6
Personal income		
≤ 1 minimum wage	7	46.7
>1–2 minimum wages	5	33.3
>2 minimum wages	3	20.0
Government assistance (Bolsa Família)		
Yes	9	60.0

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Socioeconomic characteristics	n	%
No	6	40.0
Internet access		
Yes	9	60.0
No	6	40.0
Computer at home		
Yes	5	33.3
No	10	66.7
Motorized vehicle(s) ownership		
Yes	9	60.0
No	6	40.0

Note: One Brazilian monthly minimum wage in 2017 was BRL 937. **Source**: Authors (2025).

3.2 Hunting practices, mobility, and motivations

Hunting knowledge was primarily acquired through family networks. Seven participants (46.7%) reported learning to hunt from their fathers, whereas others identified uncles or brothers as their main sources of hunting knowledge. Only two participants reported friends as their primary source of learning. Most hunters (66.7%; n = 10) used motorcycles to access hunting areas, and nine participants reported frequently traveling to hunting sites located more than 20 km from their homes. Some participants stated that they used motorcycles only when they had sufficient resources to cover fuel and food expenses during hunting trips. Hunting activities were predominantly nocturnal. Participants reported using both active and passive hunting methods. Active hunting included pursuit with firearms and hunting with dogs, whereas passive hunting relied mainly on ambushes with firearms, often combined with flashlights. Nearly all hunters reported a preference for hunting on weekends.

Hunting with dogs was the most frequently cited hunting method and was used primarily to capture armadillos, *Salvator merianae*, and *Coendou prehensilis*. Ambush hunting with firearms was the second most frequently cited hunting method (*n* = 58 citations; 29% of all hunting-method citations) and was reported for the capture of doves (Columbiformes), tinamous, aquatic birds, cracids, pumas, lowland pacas, and deer. Other methods included traps, such as “jequi” (a funnel-shaped live trap) and “arapuca” (a pyramidal cage trap), and slingshots; however, all hunters

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reported that the use of traps had been abandoned in recent years. Recreational hunting was the primary motivation reported by 10 participants (66.7%). Although at least seven participants reported involvement in wildlife trade, none identified commercial purposes as their primary motivation for hunting. Some participants reported selling wild animals to obtain resources needed to sustain hunting activities, including ammunition, fuel, and motorcycle maintenance, or to purchase other food.

3.3 Diversity and uses of hunted vertebrates

A total of 32 wild vertebrate species were recorded as hunted in the study area, representing 28 genera and 24 families. Of these, 26 were used as sources of wild meat and 11 as zootherapeutic resources. Birds comprised 15 species (46.9%), mammals 12 (37.5%), and reptiles five (15.6%). The highest Use Values for wild meat were recorded for *Dasypus novemcinctus* and *Euphractus sexcinctus* (UV = 1.00) (Table 2). Participants consistently described armadillo meat as highly palatable and frequently compared it with domestic chicken. Some hunters also reported that armadillos could be readily sold as whole animals. By contrast, *Tamandua tetradactyla* was described as having tough, less palatable meat and low commercial value.

Species used for zootherapeutic purposes generally had lower Use Values than species used as wild meat (Table 2). Of the species reported as sources of zootherapeutic products, six were used exclusively for traditional medicine (Table 3). The remaining species were also associated with other forms of wildlife use, including consumption. The zootherapeutic products reported included animal fat, meat, blood, bones, feathers, skin, teeth, liver, hooves, and other body parts (Table 3). Animal fat was the most frequently cited zootherapeutic product and was reportedly obtained from at least nine species, particularly *Salvator merianae*, *Cerdocyon thous*, *Dasypus novemcinctus*, *Eunectes murinus*, *Crotalus durissus*, and *Euphractus sexcinctus*. Participants reported that animal fat was administered orally, whereas hard body parts, such as hooves and bones, were roasted and ground into powder for use in teas. Meat was also cooked with spices, and the filtered broth was stored for medicinal use.

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Animal parts and by-products were reportedly used to prepare remedies for nine types of diseases or ailments, which were grouped into seven ICD-11 disease categories (Table 3). Conditions related to the musculoskeletal system or connective tissue, such as muscle pain, rheumatism, and back pain, were the most frequently cited, followed by diseases of the ear or mastoid process, particularly earache.

Table 2. Wild vertebrate species used for food and traditional medicine by urban hunters in Regeneração, Piauí State, northeastern Brazil.

Scientific name	Food use (UV)	Medicinal use (UV)	IUCN status
Dendrocygna viduata	0.07		LC
Cariama cristata	0.13		LC
Leptotila verreauxi	0.60		LC
Leptotila rufaxilla	0.60		LC
Zenaida auriculata	0.07		LC
Columbina talpacoti	0.27		LC
Columbina squammata	0.27		LC
Penelope superciliaris	0.53		NT
Porphyrio martinica	0.20		LC
Rhynchotus rufescens	0.07		LC
Crypturellus tataupa	0.73		LC
Crypturellus undulatus	0.07		LC
Nothura boraquira	0.13		LC
Rupornis magnirostris	0.07		LC
Cyanocorax cyanopogon	0.13		LC
Puma concolor	0.07		LC
Cerdocyon thous		0.13	LC
Subulo gouazoubira	0.47		LC
Dicotyles tajacu	0.07		LC
Dasypus novemcinctus	1.00	0.33	LC
Dasypus septemcinctus	0.20		LC
Euphractus sexcinctus	1.00	0.40	LC
Tamandua tetradactyla	0.73	0.20	LC
Dasyprocta cf. prymnolopha	0.73		LC
Cuniculus paca	0.27	0.40	LC
Coendou prehensilis	0.07		LC
Callithrix jacchus		0.07	LC
Salvator merianae	0.13	0.20	LC
Eunectes murinus		0.13	LC

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REMUNOM
ISSN 2178-6925

Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

Scientific name	Food use (UV)	Medicinal use (UV)	IUCN status
Crotalus durissus		0.20	LC
Paleosuchus palpebrosus		0.13	LC
Chelonoidis carbonarius		0.13	NL

Legend: IUCN categories: LC, Least Concern; NT, Near Threatened; NL, Not listed in the IUCN Red List. **Source**: Authors (2025).

Table 3. Wild vertebrates, animal by-products, and reported medicinal uses in Regeneração, Piauí State, northeastern Brazil

Scientific name	Citations (n)	Body part(s) used and preparation	Therapeutic indication	ICD-11 category
Cuniculus paca	6	Fel (4), Shell (1)	Snakebite treatment, Stroke.	Injury, poisoning or certain other consequences of external causes; Diseases of the nervous system.
Euphractus sexcinctus	6	Shell (1), Fat (2), Blood (2)	Stroke, Earache, Muscle pain, Rheumatic pain, Warts.	Diseases of the musculoskeletal system or connective tissue; Diseases of the ear or mastoid process; Diseases of the nervous system; Skin diseases.
Cerdocyon thous	2	Fat (2,4), Meat (3)	Hemorrhoids, Rheumatic pain.	Diseases of the musculoskeletal system or connective tissue; Diseases of the digestive system.
Dasypus novemcinctus	5	Fat (2)	Earache.	Diseases of the ear or mastoid process.
Tamandua tetradactyla	3	Urine and tail (2), Fat (2)	General pain, Earache, Toothache, Muscle pain.	Diseases of the ear or mastoid process; Symptoms, signs or clinical findings, not elsewhere classified; Diseases of the musculoskeletal system or connective tissue.
Callithrix jacchus	1	Meat (3)	Rheumatic pain.	Diseases of the musculoskeletal system or connective tissue.
Salvator merianae	3	Fat (2)	Earache.	Diseases of the ear or mastoid process.
Eunectes murinus	2	Fat (2)	Rheumatic pain.	Diseases of the musculoskeletal system or connective tissue.
Crotalus durissus	3	Fat (2)	Rheumatic pain.	Diseases of the musculoskeletal system or connective tissue.
Paleosuchus palpebrosus	2	Fat (2), Leather (1)	Rheumatic pain, Spinal disorders.	Diseases of the musculoskeletal system or connective tissue.

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REMUNOM
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Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

Scientific name	Citations (n)	Body part(s) used and preparation	Therapeutic indication	ICD-11 category
Chelonoidis carbonaria	2	Shell (1), Fat (2)	Spinal disorders, General pain.	Diseases of the musculoskeletal system or connective tissue.

Legend: Preparation and administration: (1) roasted and prepared as tea; (2) topical application to the affected area; (3) cooked and consumed as food; (4) consumed raw. **Source**: Authors (2025).

3.4 Wildlife trade and commercialization

According to the interviewed hunters, until a few years prior to the study, the local trade in wild meat and zootherapeutic products involved bar owners and street-market traders, with intermediaries connecting these actors to local consumers. Among the five participants who provided information on wildlife trade, all reported using mobile phones, including calls and messaging applications, to communicate with different actors along the trade chain. Wild meat and other wildlife products were also reportedly transported by motorcycle. Participants further reported that other local hunters used similar communication and transportation strategies.

Wild-meat prices varied considerably among species. Most animals were reportedly sold whole, whereas *Subulo gouazoubira* and *Dicotyles tajacu* were sold by weight. *Dasypus novemcinctus* and *Euphractus sexcinctus* were reported as the most expensive species. Prices for *D. novemcinctus* ranged from BRL 100.00 to BRL 150.00 per animal, whereas those for E. sexcinctus ranged from BRL 70.00 to BRL 100.00 per animal. Prices for zootherapeutic products were more difficult to obtain and were generally reported to be lower than those of wild meat sold for consumption.

4. Discussion

4.1 Contemporary wildlife use in an increasingly interconnected ecotonal landscape

Our findings indicate that contemporary wildlife use in the Caatinga-Cerrado ecotone is embedded in a socioecological context characterized by increasing

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REMUNOM
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Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

connectivity among urban populations, rural hunting areas, transportation networks, and local markets. Although family-based knowledge transmission remains an important feature of local hunting practices, our results also suggest that contemporary hunting activities are influenced by technological innovations, greater mobility, and new forms of market connectivity. Together, these findings support the view that wildlife use in this ecotonal landscape is maintained not only by longstanding cultural traditions, but also by broader socioeconomic and technological changes occurring in the study area (see Souto et al., 2017).

The predominance of family members, particularly fathers, as the primary source of hunting knowledge is consistent with previous studies showing that vertical cultural transmission remains a key mechanism through which hunting practices are maintained across generations in tropical regions (see Alves et al. 2009; Bachmann et al. 2020; Hewlett et al. 2024). At the same time, the participation of brothers, uncles, and friends as additional sources of learning suggests that horizontal transmission networks may also contribute to the diversification and persistence of hunting knowledge (Alves et al. 2009; Dira and Hewlett, 2016; Mrosso et al. 2022; Jang and Redhead, 2025).

Nevertheless, the persistence of traditional knowledge transmission does not imply that hunting practices themselves remain unchanged (Souto et al. 2026). In the present study, the widespread use of motorcycles to reach distant hunting areas, together with the reported use of mobile phones to facilitate wildlife trade, suggests that contemporary hunting operates through transportation and communication networks that link urban residents, rural hunting areas, and local markets. Similar patterns have been reported in other tropical regions, where motorized transport, mobile communication, and expanding market connectivity have reshaped wildlife use by increasing hunters' mobility, facilitating commercialization, and strengthening links between rural production areas and urban demand (Van Vliet et al. 2015b, 2017; Chaves et al. 2019; Jones et al. 2019; Souto et al. 2019, 2026; Oliveira et al. 2020; El Bizri et al. 2024). In this context, hunting is not necessarily associated with permanent residence in rural environments but may involve urban hunters who travel to distant hunting areas and subsequently reconnect wildlife products with urban

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REMUNOM
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Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

consumers through local trade networks (Chaves et al. 2021; Emogor et al. 2025; Lemos et al. 2025).

Recreational hunting emerged as the predominant motivation reported by participants, whereas the commercialization of hunted wildlife was generally described as a means of covering hunting-related expenses or meeting household needs (El Bizri et al. 2015; Arobaya et al. 2025). Similar patterns have been documented in Brazil, where recreational hunting increasingly involves urban residents traveling to rural hunting areas while maintaining connections with urban markets and social networks (El Bizri et al. 2015). Rather than representing mutually exclusive motivations, these different functions appear to coexist, suggesting that contemporary wildlife use fulfills multiple recreational, economic, and cultural roles within increasingly connected socioecological systems..

4.2 Species preferences and multiple uses of wildlife

The highest Use Values recorded for armadillos (*Dasypus novemcinctus* and *Euphractus sexcinctus*) contrast with patterns commonly reported for the Caatinga. In this biome, birds constitute the principal source of wild meat and zootherapeutic resources, a pattern that has been associated with their high species richness and availability compared with mammals (Alves et al. 2012; Mendonça et al. 2016; Barbosa et al. 2018; Souto et al. 2018; Borges et al. 2021). In contrast, our findings more closely resemble patterns reported for Cerrado landscapes, where mammals constitute the principal source of wild meat despite increasing pressures from habitat loss and hunting (Paula et al. 2017; 2018; Rocha et al. 2018). Although multiple ecological and cultural factors likely influence species selection, the location of the study area within a Caatinga - Cerrado ecotone may partly explain the observed pattern, given that ecotonal landscapes often exhibit ecological characteristics of both adjacent biomes.

Other studies have shown that armadillos are among the most important hunted mammals in South America (Barboza et al. 2016; Van Vliet et al. 2017; Mesquita et al. 2018; Griffiths and Chávez, 2025), partly because they can reach high

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REMUNOM
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Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

prices in illegal markets (Souto et al. 2019). Even in the central and tri-border alluvial plains of the Amazon, armadillos, especially *Dasypus* spp., are among the species most frequently hunted for local subsistence, together with pacas and peccaries, and are regarded as key taxa for local livelihoods (Mesquita et al. 2018; Chaves et al. 2019; El Bizri et al. 2020; Bastos Silva et al. 2022). These findings are consistent with the high Use Values recorded for armadillos in the present study, reinforcing their importance as food resources and commercially valuable game species. By contrast, the relatively high citation frequency of *Tamandua tetradactyla* may reflect opportunistic exploitation during hunting trips targeting more highly valued game species, as anteaters may be killed incidentally during such encounters (Souza and Alves, 2014).

The comparatively lower importance of medicinal use relative to wild-meat use is consistent with previous studies showing that food use generally accounts for greater diversity and frequency of wildlife use than traditional medicine (Alves et al. 2012; Souza and Alves, 2014; Souto et al. 2019; Borges et al. 2021). However, the coexistence of medicinal and food uses for several species indicates that wildlife use is not organized around single-purpose exploitation. Different uses may overlap within the same hunting system, with harvested animals and their products allocated to different purposes according to their perceived value and the needs of hunters, their families, or other consumers. This multifunctional use of harvested wildlife has also been reported in several tropical communities, where different body parts or products may be directed toward distinct purposes (Policarpo et al. 2019; Zanvo et al. 2021; Ameade et al. 2025). At the same time, the occurrence of species used exclusively in traditional medicine suggests that medicinal demand may contribute to the acquisition of a specific taxa, including species with limited importance as food resources. Taken together, these patterns suggest that food and medicinal uses can operate as complementary pathways within local wildlife-use systems.

The prominence of animal fat among the medicinal products reported in the present study is consistent with its widespread use in Brazilian traditional medicine, where it is employed in a variety of therapeutic preparations (Ferreira et al. 2013; Barbosa et al. 2018; Souto et al. 2018; Campos et al. 2021). Previous studies have

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REMUNOM
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Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

likewise documented the use of diverse animal parts, including fat, blood, bones, skin, and other tissues, in traditional remedies in Northeast Brazil and other Neotropical regions (Alves et al. 2017; Policarpo et al. 2019; Souto et al. 2018). The therapeutic indications reported in the present study, particularly those involving musculoskeletal conditions and ear disorders, also overlap with patterns documented in other ethnobiological studies, in which rheumatism, muscle pain, back pain, and earache are commonly treated with animal-derived remedies (Haileselasie, 2012; Alves et al. 2017; Policarpo et al. 2019; Mulugeta et al. 2021; Assefa et al. 2025). These similarities suggest that medicinal wildlife use in Regeneração shares important features with zootherapeutic practices documented across diverse cultural and geographic contexts. By contrast, specific methods of preparing and administering animal-derived products, such as the use of meat broth, differ from those described in some previous studies (Souto et al. 2018; Policarpo et al. 2019; Silva et al. 2020).

4.3 Urban-rural connectivity and wildlife trade

The connectivity discussed above also appears to be reshaping the organization of wildlife trade. Established local market relationships, historically involving traders and intermediaries, now coexist with communication technologies that facilitate interactions among different actors along the trade chain. Similar changes have been documented in illegal wildlife trade elsewhere, where the increasing availability of communication technologies has altered relationships among hunters, intermediaries, and consumers and facilitated the circulation of wildlife products through market networks (Esmail et al. 2020; Wyatt 2021; Wyatt et al. 2022; Gaspar et al. 2025). Rather than indicating the disappearance of traditional market actors, this pattern suggests that communication technologies may be incorporated into existing trade relationships, creating new ways of coordinating transactions within local wildlife markets (Souto et al. 2017, 2018).

Furthermore, wild-meat prices suggest that wildlife products occupy a differentiated position within the local market. Although most species were reportedly sold as whole animals, the higher prices reported for *Dasypus novemcinctus* and

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REMUNOM
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Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

Euphractus sexcinctus suggest that market value varies substantially among species. Similar patterns have been documented in other Neotropical contexts, where wild meat may command prices comparable to or higher than those of domestic meats and therefore represent a differentiated food product, extending beyond its role as a subsistence resource (Chaves et al. 2019, 2023; El Bizri et al. 2020; Mayor et al. 2021; Aragão Silva et al. 2023). In the present study, the comparatively lower prices reported for zootherapeutic products also suggest that food use may currently represent the more economically significant component of local wildlife trade.

Thus, these patterns suggest that wild meat may function locally as a socially valued and economically differentiated product rather than solely as a subsistence resource. The coexistence of local consumption and commercial exchange suggests that wildlife products may circulate through the same urban–rural networks while serving different forms of demand, contributing to the diversification of the ways in which wildlife is valued and used (Souto et al. 2026).

4.4 Conservation implications

The patterns outlined above have important implications for wildlife conservation because increasing connectivity may simultaneously expand hunters' access to wildlife, facilitate the circulation of harvested animals, and strengthen links between local hunting and urban demand. Although most species recorded in this study are currently classified as Least Concern (LC) by the IUCN, this status does not necessarily indicate the absence of local population declines or hunting-related pressures. In the present study, hunters reported lower abundance than approximately 10 years earlier for *Dasypus novemcinctus*, *Euphractus sexcinctus*, *Subulo gouazoubira*, and *Dicotyles tajacu*. Although these perceptions do not provide direct evidence of population declines, they are consistent with concerns that sustained hunting pressure, particularly when combined with habitat fragmentation, may contribute to the local depletion or extirpation of wildlife populations (Ripple et al. 2016; Benítez-López et al. 2019; Osuri et al. 2020).

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REMUNOM
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Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

The increasing spatial reach of hunting is particularly relevant in this context. The need to travel farther from urban areas to obtain wild animals may reflect the reduced availability of preferred species in more accessible hunting grounds, although other factors may also influence hunters' selection of hunting locations. Motorized transport can facilitate access to more distant areas and may therefore allow hunting pressure to extend beyond the immediate surroundings of urban centers. Technological innovations may also increase hunting efficiency. For example, the use of artificial lighting during nocturnal hunts has been associated with greater hunting efficiency and may consequently increase the number of animals captured (Souto et al. 2019; Bowler et al. 2020; Becerra et al. 2022). El Bizri et al. (2024) showed that illegal sport hunting, a non-subsistence form of hunting, can contribute to pressures on wildlife populations across different biomes, including the Caatinga. These broader patterns are particularly relevant to the present study, which was conducted in a Cerrado-Caatinga ecotonal region where increasing hunter mobility and technological innovations may jointly shape the intensity and spatial extent of hunting (Wyatt et al. 2022; Gaspar et al. 2025; Lemos et al. 2025). Thus, such changes should not be regarded merely as logistical features of contemporary hunting, but also as factors that may increase pressure on wildlife populations.

The commercialization of wildlife products adds another dimension to these conservation challenges. As discussed above, mobile communication and established trade relationships may facilitate the circulation of wildlife products, while differences in market value may contribute to the continued exploitation of a specific target-species (Van Vliet et al. 2017; Chaves et al. 2021; D'Cruze et al. 2024). These dynamics suggest that conservation strategies focused exclusively on restricting hunting at specific locations may be insufficient when hunters can move across the landscape and maintain connections with consumers through broader market networks (Souto et al. 2019; El Bizri et al. 2024). Effective interventions may therefore need to consider not only hunting activity itself, but also the transportation, communication, and market systems that support wildlife extraction and trade.

Reducing hunting pressure will consequently require approaches that integrate the ecological, economic, and social dimensions of wildlife use. Previous

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REMUNOM
ISSN 2178-6925

Received: 17/08/2026 - **Accepted:** 07/09/2026
Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

studies have highlighted the potential of economic incentives, reciprocal environmental agreements, and adaptive management to reduce dependence on wildlife exploitation while engaging local users in conservation (Caro et al. 2015; Kuenbou et al. 2023; Mannion et al. 2025). In the context of Regeneração, such approaches could be complemented by improved monitoring of wildlife trade, targeted enforcement, environmental education, and income-generating alternatives that recognize the cultural and economic importance of hunting. Rather than addressing hunting solely as an illegal activity, conservation policies should consider the increasingly connected socioecological system through which wildlife is accessed, transported, exchanged, and valued.

5. Conclusions

This study shows that contemporary wildlife use in the Caatinga–Cerrado ecotone is shaped by interactions between longstanding cultural practices and increasingly connected urban–rural systems. Family-based transmission of hunting knowledge remains important, but hunting practices are also influenced by greater hunter mobility, transportation and communication technologies, and local market dynamics. Together, these findings reveal a hunting system characterized by species-specific exploitation, multifunctional use of harvested animals, and the circulation of wildlife products between rural hunting areas and urban consumers. The coexistence of food, medicinal, recreational, and commercial uses indicate that wildlife is embedded in a diversified socioecological system, rather than being exploited solely as a subsistence resource.

More broadly, our findings highlight how ecotonal landscapes may integrate ecological characteristics of adjacent biomes with wildlife-use patterns shaped by both local contexts and contemporary socioeconomic and technological processes. From a conservation perspective, increasing connectivity among hunting areas, transportation networks, communication technologies, and local markets may expand both the spatial reach of hunting and the circulation of wildlife products. Conservation strategies should therefore consider not only where wildlife is hunted, but also the

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REMUNOM
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Vol: 13.19
DOI: 10.66104/dh131409
Pages: 1-34

broader networks through which animals are accessed, transported, exchanged, and traded. Integrating ecological monitoring with context-specific approaches to mobility, trade, environmental education, and alternative livelihoods may be important for addressing wildlife exploitation in rapidly changing anthropogenic landscapes.

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Authors' Contributions

FAAN conducted the field survey and collected the data. WMSS conducted the literature review. JAAS, BAB, RFG, ISB and WMSS interpreted the data and drafted the manuscript. ABS, RRNA, and WMSS critically reviewed and revised sections of the manuscript. All authors read and approved the final manuscript.

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