Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Understanding community perceptions to integrate Traditional and Cultural Ecological Knowledge in the conservation of an endangered and endemic species

Thatiana Souza Andrade

thati.sandrade@gmail.com

Federal University of São Carlos (UFSCar)

Daniele Rodrigues Costa

Universidade Estadual de Campinas (UNICAMP)

Maila Brandão Couto

Chico Mendes Institute for Biodiversity Conservation (ICMBio)

Luciana Leite

Environmental Justice Foundation

Rosana Louro Ferreira Silva

University of São Paulo (USP)

Erica C. Pacífico

Federal University of São Carlos (UFSCar)

Research Article

Keywords: Environmental perception, Human–wildlife coexistence, Community-based conservation, Caatinga, Lear's Macaw

Posted Date: November 12th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10885187/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Title: Understanding community perceptions to integrate Traditional and Cultural Ecological Knowledge in the conservation of an endangered and endemic species

Author(s) and Affiliation(s):

Thatiana Souza Andrade[1,2*]; Daniele Rodrigues Costa[2,3]; Maila Brandão Couto[4]; Luciana Leite[5]; Rosana Louro Ferreira Silva[6]; Erica C. Pacífico[1,2,3]

1. Graduate Program in Wildlife Conservation, Federal University of São Carlos (UFSCar), São Carlos, SP, Brazil.
2. Lear's Macaw Research and Conservation Group (GPCA), Bahia, Brazil.
3. Department of Animal Biology, University of Campinas (UNICAMP), Campinas, SP, Brazil.
4. Chico Mendes Institute for Biodiversity Conservation (ICMBio), Breves, PA, Brazil.
5. Environmental Justice Foundation, Campo Grande, MS, Brazil.
6. Department of Zoology, University of São Paulo (USP), São Paulo, SP, Brazil.

***Corresponding author:** Thatiana Souza Andrade

E-mail: thati.sandrade@gmail.com

Abstract:

Traditional and Cultural Ecological Knowledge (TEK and CEK) integrate social, cultural, and environmental dimensions developed through generations of interactions with nature, with CEK emphasizing the cultural contexts that shape relationships between communities and biodiversity. Environmental perception, shaped by knowledge, values, and lived experiences, influences human attitudes toward wildlife and can inform conservation planning. We investigated 43 communities within Lear's Macaw (*Anodorhynchus leari*) distribution range in the Caatinga of Bahia, Brazil, to assess community perceptions, ecological knowledge, and values attributed to the species. Between 2023 and

2025, we conducted semi-structured interviews with 460 interviewees, on species recognition, ecological knowledge, perceived threats, natural resource use, and attributed values. Among interviewees, high species recognition (93.9%) and frequent observations in the wild (95.2%) indicated strong local familiarity. Most interviewees (52.8%) perceived a recent population increase, consistent with population monitoring data. Knowledge of feeding ecology emphasized the importance of licuri palm (*Syagrus coronata*) and maize (*Zea mays*), resources of socioeconomic importance that are also associated with human-wildlife interactions and conflicts. Electrical infrastructure (38.1%) and retaliatory hunting associated with crop damage (14.8%) were among the most frequently perceived threats. Most respondents (87.6%) rejected removing animals from the wild. Values attributed to the species were predominantly aesthetic (e.g., beautiful), ecological (e.g., seed dispersal), and moral (e.g., living being, preservation). These findings show that local ecological knowledge can complement ecological monitoring by revealing how communities perceive population trends, ecological relationships, threats, and coexistence with Lear's Macaw. Integrating CEK and community perceptions into participatory conservation and educational initiatives can strengthen locally grounded strategies for the long-term protection of the species.

Keywords: Environmental perception, Human–wildlife coexistence, Community-based conservation, Caatinga, Lear's Macaw.

1. Introduction

Traditional knowledge encompasses the cultural, historical, social, ecological, economic, practices and beliefs transmitted across generations within local communities [1,2]. When this knowledge concerns the relationships between living organisms and their environment, it is referred to as Traditional Ecological Knowledge (TEK) [3–7]. In this study, the concept of Cultural Ecological Knowledge (CEK) is adopted as

a complementary perspective to emphasize that ecological knowledge is inseparable from the social, cultural, and spiritual dimensions that shape relationships between communities and nature [8]. This perspective is consistent with the biocultural diversity framework, which recognizes the interdependence between biological and cultural diversity [9,10].

Communities that integrate both TEK and CEK play a fundamental role in biodiversity conservation by contributing to the long-term availability of natural resources and supporting sustainable natural resource management, as these knowledge systems incorporate adaptive strategies developed over generations [9,6,2,11,12]. However, the increasing disconnection between people and nature has weakened the intergenerational transmission of this knowledge. Knowledge traditionally transmitted across generations often emphasizes exotic organisms over native fauna and flora, thereby reducing people's perception of their local environment [13,14].

CEK and environmental perception contribute to recognizing the ecological, economic, and cultural values of biodiversity, providing essential information for developing conservation strategies better aligned with local realities and needs [15,16]. In the recognition that effective biodiversity conservation depends not only on ecological knowledge but also on understanding the human dimensions that shape interactions between people and nature [17,18]. Environmental perception plays a central role by reflecting the experiences, knowledge, values, and sociocultural factors that shape human attitudes toward wildlife [19,20]. Therefore, assessing environmental perceptions is essential not only for understanding the relationships between local communities and biodiversity but also for informing conservation strategies that are socially relevant and adapted to local contexts. Among these strategies, environmental education plays a prominent role, as initiatives grounded in the knowledge, values, and conflicts identified within communities can more effectively foster public engagement and catalyze pro-conservation behavioral change [21,22,18].

Conservation of threatened species depends not only on species management interventions but also on local communities support and engagement [18]. A compelling example is the Lear's Macaw (*Anodorhynchus leari*), which has been the focus of long-term interdisciplinary conservation initiatives over the past five decades [23,24].

Endemic to the Caatinga Biome (Tropical Dry Forest) in Brazil, the Lear's Macaw was recently reclassified from Endangered (EN) to Vulnerable (VU) on the Brazilian National Official List of Threatened Fauna, reflecting the success of conservation efforts over recent decades [25]. This species has a small restricted distribution and can only be found in to two geographically isolated regions in northeastern Bahia: the Raso da Catarina (RASO), which supports the largest and increasing population, and the Boqueirão da Onça (BDO), where the population is dependent on active management to reverse the ongoing local decline, with a population reinforcement programme currently underway [26,24].

Over the past decades, the Lear's Macaw population in the RASO has increased substantially, from only 21 individuals in 1978 to more than 2,500 in 2024, accompanied by an expansion of its distribution range [26,24]. In contrast, the BDO population experienced a marked decline during the 1990s and became functionally extinct [27]. Since 2019, population reinforcement actions led by the Lear's Macaw Research and Conservation Group and partner institutions have promoted the species' return to the region, contributing to the recovery of its ecological role and strengthening the relationship between local communities and the species [28].

Despite recent conservation gains, the species continues to face anthropogenic threats, including retaliatory killing in response to damage to maize crops (*Zea mays*) and the macaws' feeding on the fruits of licuri palm (*Syagrus coronata*), as well as illegal capture for the international wildlife trade [15, 21]. Habitat loss has intensified with increasing deforestation in Caatinga, while expanding human activities have also increased other threats, including electrocution on power distribution lines and competition for

natural nesting cavities with invasive honeybees [30,31]. These persistent challenges highlight the need to better integrate the human dimensions of conservation into long-term management strategies.

In this context, understanding how local communities perceive and value Lear's Macaw is a fundamental step toward informing participatory conservation strategies and environmental education actions that strengthen CEK and community engagement. By integrating local ecological knowledge into threatened species conservation, this study also contributes to the objectives of Sustainable Development Goal 15 (Life on Land), particularly those related to halting biodiversity loss, conserving terrestrial ecosystems and promoting the sustainable use of biodiversity [32]. Therefore, this study aimed to analyze community perceptions and the values attributed to Lear's Macaw in order to inform conservation strategies and environmental education initiatives that support the long-term protection of the species and the natural resources it depends upon.

2. Materials and Methods

2.1 Study area

The study area is located in northeastern Brazil, in the north-central Bahia State, within the Caatinga Morphoclimatic Domain, classified as a Tropical Dry Forest with a hot semi-arid climate (BSh, Köppen-Geiger classification) [33]. The study was conducted within the distribution range of Lear's Macaw and encompassed two ecoregions: (A) RASO (09°53′11″S, 38°39′28″W), including the municipalities of Canudos, Jeremoabo, Euclides da Cunha, Santa Brígida, and Sítio do Quinto; and (B) the Southern Sertaneja Depression, in the BDO region (10°08′52″S, 41°08′26″W), including the municipalities of Campo Formoso and Sento Sé (Fig. 1). The latter region contains a wildlife reintroduction area (Área de Soltura

de Animais Silvestres Boqueirão da da Onça), for a population reinforcement program that is ongoing for the focal species [28].

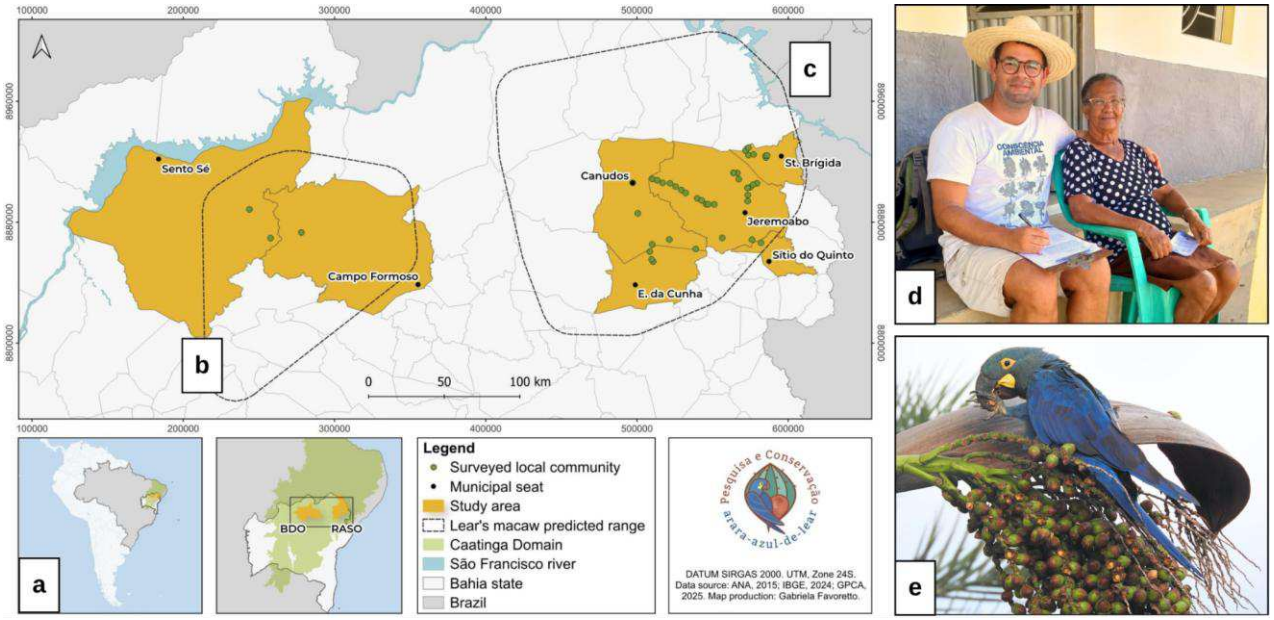


Fig. 1 (a) Current occurrence area of the endangered Lear's macaw (*Anodorhynchus leari*), in the central north of Bahia State, in the Caatinga Domain (light yellow) in the range of the Lear's Macaw and sampled municipalities highlighted in orange. Green dots are localities sampled in this study where interviews were conducted with local villagers, at (b) Boqueirão da Onça Region (BDO); (c) Raso da Catarina region (RASO); (d) Interviewing with a local resident; (e) Lear's macaw the focal species of this study and its main food resource the licuri palm (*Syagrus coronata*) fruits. Map (a–c) created by Gabriela R. Favoretto and reproduced with permission. Written permission for its use and publication was obtained from the copyright holder. Written informed consent for publication was obtained from the identifiable individuals appearing in the photograph in panel (d)

2.2 Selection of surveyed communities

A total of 43 communities were selected within the distribution range of Lear's Macaw, including rural, peri-urban, and urban communities across the RASO and BDO ecoregions (Fig. 1). Community selection was based on nearby feeding areas, particularly the licuri palm. Movement routes, roosting sites, and release sites were also included, representing different interaction styles between local communities and the species [27, 28]. This sampling strategy captured a broad range of human-wildlife coexistence contexts across the Lear's Macaw distribution range.

2.3 Semi-structured interviews

Between 2023 and 2025, semi-structured interviews were conducted with residents of the selected communities using a questionnaire consisting of 38 questions; 23 closed-ended and 15 open-ended questions used to expand and contextualize the responses obtained from the closed-ended questions (Questionnaire). Interviewees were selected using the snowball sampling technique whereby initial participants identified and referred other potential participants from their networks [36]. Interviews were conducted individually at locations chosen by the interviewees after the objectives of the study had been explained and informed consent had been obtained (see Licences and Authorizations for ethical approvals and research permits). Interviewees' responses were transcribed verbatim during interviews for subsequent content analysis.

The questionnaire was organized into seven thematic sections: i) respondent demographic characteristics (sex, age, and educational level); ii) recognition of the focal species, the Lear's Macaw, using a plate containing scientific illustrations of different psittacine species that included a control exotic species; iii) perceptions of Lear's Macaw; iv) knowledge of the species' ecology, including feeding ecology,

distribution, and observations of ecological interactions in the wild; v) perceptions of threats affecting Lear's Macaw; vi) use, importance, and shared use of natural resources provided by the licuri palm; and vii) aspects related to human-wildlife coexistence, including conflicts and perceptions regarding the removal of wild animals from nature.

2.4 Content analysis

Responses obtained from the different thematic sections of the questionnaire were analyzed using Bardin's [37] Content Analysis approach, following three stages: i) pre-analysis, ii) material exploration, and iii) treatment and interpretation of the results. During the pre-analysis stage, the responses recorded verbatim during the interviews were subjected to floating reading to establish the analytical corpus. Subsequently, recording units, defined as words, expressions, or phrases that synthesized respondents' perceptions of Lear's Macaw and its natural resources, were identified [37]. The treatment of results consisted of organizing and analyzing the frequency of occurrence of responses and recording units within each thematic section, allowing the preparation of descriptive tables and graphs.

2.5 Classification of values attributed to the species

The open-ended responses regarding the importance attributed to Lear's Macaw were subjected to an additional analytical step. The definitions adopted for each value category, along with examples of classification indicators and representative interview excerpts, are provided in “Value category definition”. When appropriate, a single recording unit could be assigned to more than one value category. In addition, key terms were extracted from respondents’ answers regarding the perceived importance of Lear’s Macaw. A word cloud was generated using R packages *ggplot2* and *ggwordcloud* [38,39], based on the

frequency of these terms, with word size proportional to their frequency of occurrence, highlighting the most frequently mentioned terms [40,41].

3. Results

3.1 Participant profile

A total of 466 community members participated in the study. From this group, six were excluded from the analyses because they reported not being familiar with Lear's Macaw, precluding the assessment of their perceptions of the species. Consequently, the analyses were based on 460 respondents distributed across 43 communities within the species' distribution range. Women represented 58% (N=267) of the respondents. Interviewees ranged in age from 18 to 85 years, with most respondents (37.4%) aged between 40 and 59 years. Educational attainment was generally low, with incomplete elementary school being the most frequent level (45.7%) and 15.7% of respondents reporting no formal education. The complete distribution of age groups and educational attainment is presented in Fig. 2.

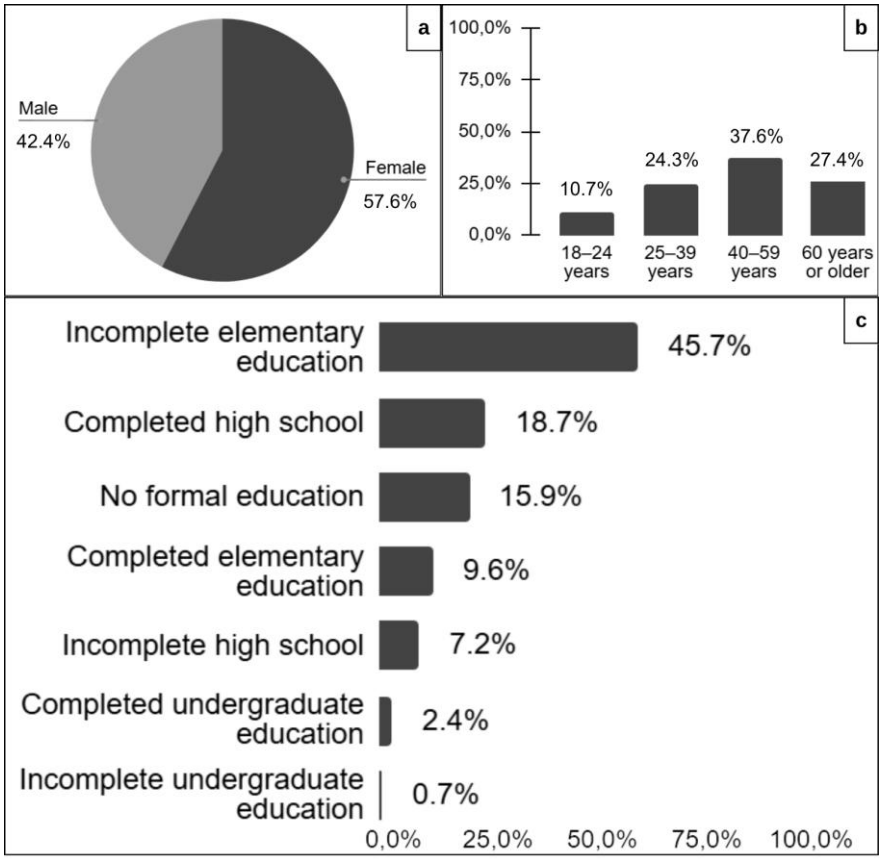


Fig. 2 Sociodemographic profile of respondents interviewed in communities within Lear's Macaw distribution range (n = 460). interviewees distribution by (a) biological sex, (b) age group, and (c) educational attainment, presented as a percentage of the total of interviewees

3.2 Familiarity and species recognition

Using the identification plate, 93.9% of respondents (*n* = 432) correctly recognized Lear's Macaw (Fig. 3), indicating a high level of local familiarity with the species.

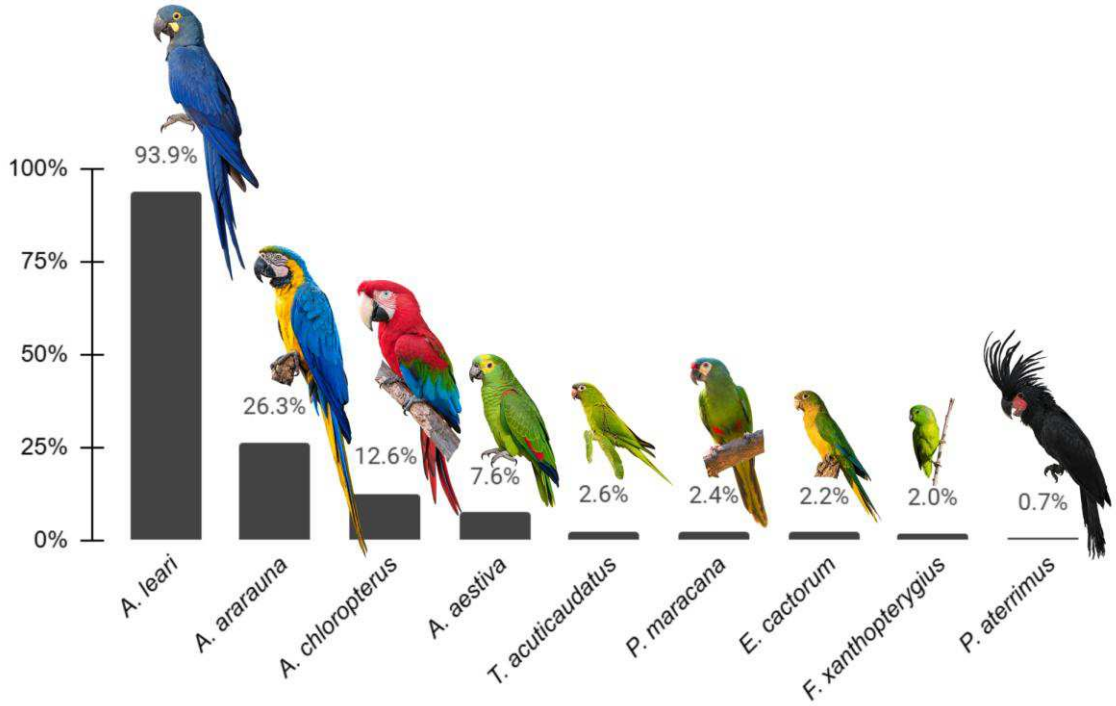


Fig. 3 Frequencies with which interviewees recognized psittacine species from images presented on the identification board during the interviews (*n* = 460). The species, from left to right: Lear's Macaw (*Anodorhynchus leari*), Blue-and-yellow Macaw (*Ara ararauna*), Red-and-green Macaw (*Ara chloropterus*), Turquoise-fronted Parrot (*Amazona aestiva*), Blue-crowned Parakeet (*Thectocercus acuticaudatus*), Blue-winged Macaw (*Primolius maracana*), Caatinga Parakeet (*Eupsittula cactorum*), Blue-winged Parrotlet (*Forpus xanthopterygius*) e Palm Cockatoo (*Probosciger aterrimus*). The Palm Cockatoo was introduced as a 'control' species, species known to be absent from a region, to control for false-positive reporting rates among interviewees. Image credits: *Ara ararauna*: Letícia da Silva Souza; *Thectocercus acuticaudatus*, *Eupsittula cactorum* and *Forpus xanthopterygius*: Nathália Diniz Bastos e Silveira; *Probosciger aterrimus*: Marcia Weinzettl (Loro Parque Fundación). All third-party photographs are reproduced with permission from the respective copyright holders. Photographs of Anodorhynchus leari, Ara

chloropterus, Amazona aestiva, and Primolius maracana were taken by and are owned by the corresponding author. Images were cropped and/or had their backgrounds removed for presentation; no intentional alterations were made to diagnostic morphological characteristics.

Because respondents could recognize more than one psittacidae species, the percentages presented are not mutually exclusive. The Blue-and-yellow Macaw (*Ara ararauna*) was the second most frequently identified (26.3%, *n* = 121), whereas all remaining species were recognized by fewer than 13% of respondents (Fig. 3). Only 6.1% of respondents (*n* = 28) did not recognize Lear's Macaw among the scientific illustrations presented. Consistent with these findings, 95.2% of respondents (n = 438) reported having observed Lear's Macaw in the wild. Among them, more than half (54.3%, n = 238) had observed the species within the previous year, whereas 34.0% (n = 149) reported that their last observation had occurred more than one year before the interview. The control species was rarely mentioned by the interviewees (0,7%).

3.3 Local ecological knowledge and resource use

Most respondents perceived that the number of Lear's Macaws in the region has increased over recent years (52.8%, *n* = 243). In contrast, 16.7% (*n* = 77) believed the population had decreased, 4.3% (*n* = 20) perceived no change, and 26.1% (*n* = 120) reported not knowing (Fig. 4).

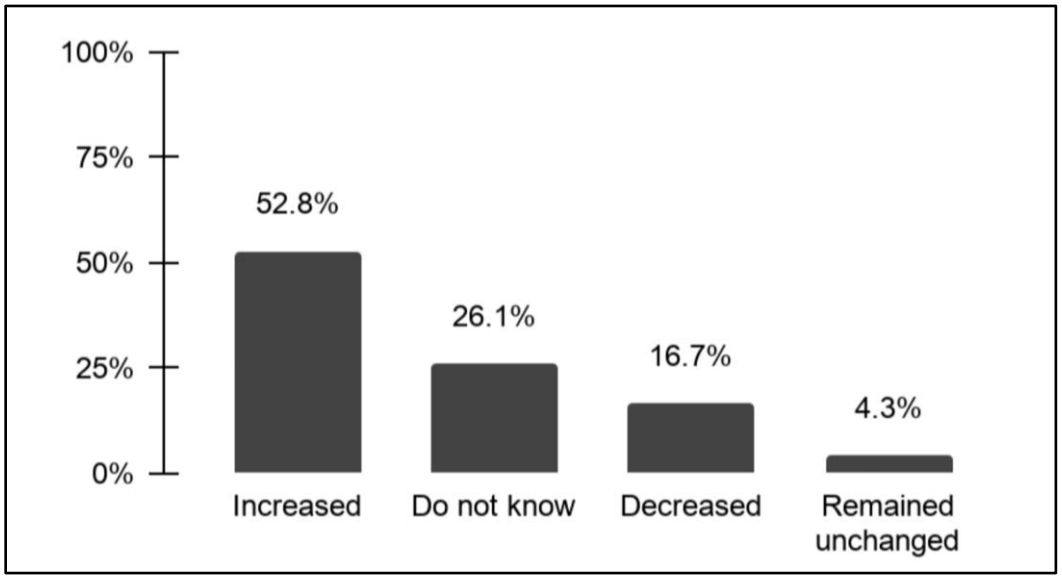


Fig. 4 interviewees' perception of changes in the number of Lear's Macaws (*Anodorhynchus leari*) in the region over the past 10 years (*n* = 460)

3.3.1 Diet of the Lear's Macaw

Regarding the diet of the Lear's Macaw, most interviewees (91.1%, *n* = 419) reported knowing what the species feeds on, whereas 8.9% (*n* = 41) answered that they did not know. Among those who reported knowing the diet, 404 respondents (96.4%) mentioned at least one possible food item.

The licuri palm (*Syagrus coronata*) was by far the most frequently cited food resource (92.1%, *n* = 372), followed by maize (*Zea mays*) (67.3%, *n* = 272). Other food items were mentioned less frequently, including unspecified fruits (5.9%, *n* = 24), brauna (*Melanoxylon brauna*) and cashew nut (*Anacardium occidentale*) (1.2%, *n* = 5), mandacaru (*Cereus jamacaru*), nance (*Byrsonima crassifolia*) and Brazil plum (*Spondias tuberosa*) (1.0%, *n* = 4), and pinhão-bravo (*Jatropha mollissima*) and mucunã (*Dioclea*

grandiflora) (0.7%, *n* = 3). All remaining food items were cited by less than 0.5% of respondents (Fig. 5) (Food Resources).

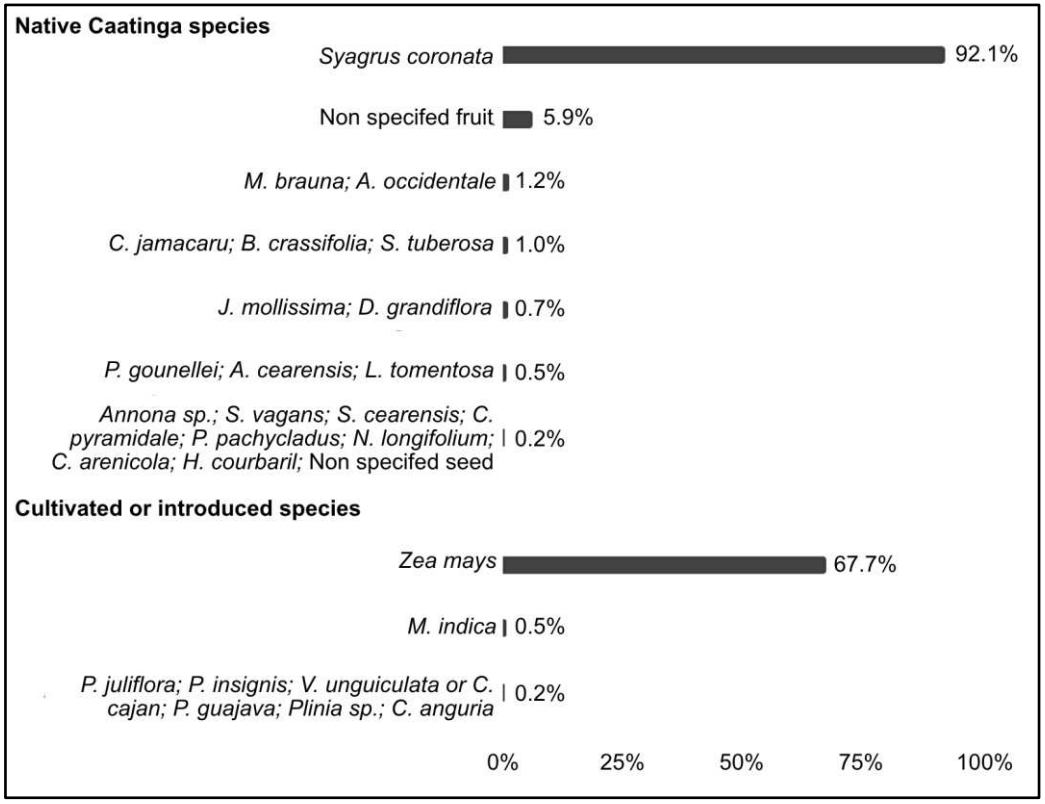


Fig. 5 Frequency of food items consumed by Lear's Macaw mentioned by the respondents, grouped into native Caatinga species (e.g. *S. coronata, M. brauna, A. occidentale, C. jamacaru, B. crassifolia, S. tuberosa, J. mollissima, D. grandiflora, Pilosocereus gounellei, Amburana cearensis, Annona sp., Syagrus vagans, Syagrus cearensis*) and cultivated or introduced species. Each respondent could mention more than one food resource (*n* = 404)

Most interviewees (80.3%, *n* = 372) reported owning or regularly visiting farmland, indicating a strong connection with rural activities. Among these respondents, 150 (40.3%) reported licuri palms on their farmland, whereas 259 (69.6%) reported cultivating maize (Fig. 6a-b). Direct observations of Lear's Macaws feeding on these resources were frequent. Among respondents reporting licuri palms on their farmland (*n* = 150), 121 (80.7%) had observed the species feeding on licuri, while 21 (14.0%) had not and 8 (5.3%) were unsure. Similarly, among respondents cultivating maize (*n* = 259), 152 (58.7%) had observed Lear's Macaws feeding on maize, whereas 107 (41.3%) had not (Fig. 6c-d).

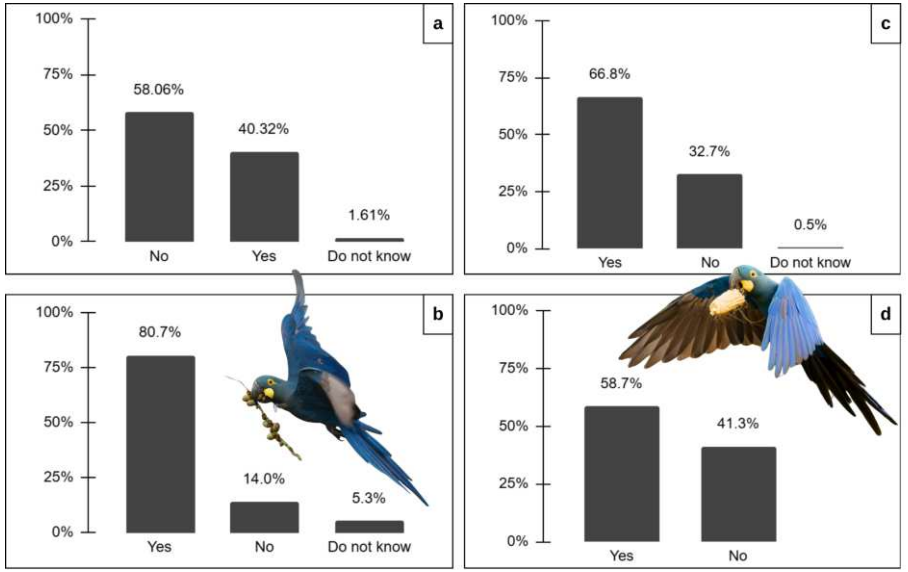


Fig. 6 Availability of licuri palms and maize on farmland owned or regularly visited by respondents and direct observations of Lear's Macaws (*Anodorhynchus leari*) feeding on these resources. (a) Presence of licuri palm patches (*Syagrus coronata*) on respondents' farmland; (b) Presence of maize (*Zea mays*) cultivation on respondents' farmland; (c) Observations of Lear's Macaws feeding on licuri among respondents who reported the presence of licuri palms on their farmland; (d) Observations of Lear's Macaws feeding on maize among respondents

who reported cultivating maize. Percentages in panels “a” and “b” were calculated using respondents who owned or regularly visited farmland (*n* = 372), whereas percentages in panels “c” and “d” were calculated only among respondents reporting the presence of the corresponding resource on their farmland (*n* = 150 for licuri; *n* = 259 for maize); Photographs by Cristine Prates, reproduced with permission. Written permission for their use and publication was obtained from the copyright holder

3.3.2 Community uses of licuri

Of the 460 interviewees, 421 (91.5%) reported using some part of licuri palms, whereas 39 (8.5%) stated not to use them. Among those who reported using the palm, human food was, by far, the most mentioned purpose (99.5%; n = 419), followed by tool manufacturing (32.3%; n = 136), construction (8.8%; n = 37) and income generation (8.6%; n = 36). Other purposes include animal feed (2.6%; n = 11), accessories and clothing (1.9%; n = 8), cosmetics (1.9%; n = 8) and toys (0.2%; n = 1) (Fig. 7).

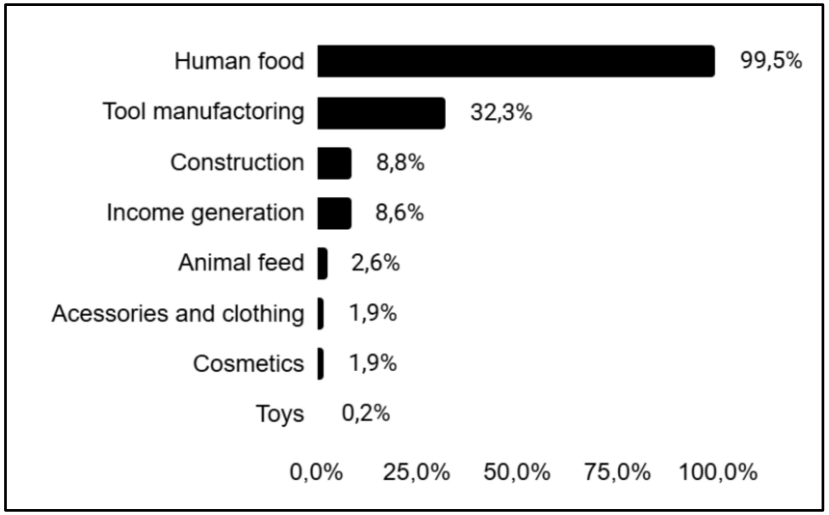


Fig. 7 Reported uses of licuri palm (*Syagrus coronata*) resources by the interviewees . Percentages were calculated among respondents who reported using the species resources (*n* = 421)

3.4 Perceived threats and human–wildlife coexistence

Of the 460 interviewees, 160 (34.8%) reported that Lear's Macaws are exposed to threats in the region, whereas 241 (52.4%) considered that the species is not currently threatened. 59 respondents (12.8%) did not answer this question.

Among the 160 interviewees who acknowledged the existence of threats, 155 (96.9%) mentioned at least one threat category (Fig. 8). Power lines and electrical infrastructure were the most frequently cited threat (38.1%, *n* = 59), followed by Humans (threat not specified) (23.9%, *n* = 37), retaliatory hunting (14.8%, *n* = 23), wind power (14.2%, *n* = 22), and hunting in general (11.6%, *n* = 18). Wildlife trafficking/capture was mentioned by 7.7% (*n* = 12) of respondents, whereas habitat loss/deforestation and food shortage were each cited by 3.9% (*n* = 6). Predation (1.9%, *n* = 3), lack of law enforcement (0.6%, *n* = 1), and conflicts with telecommunication infrastructure (0.6%, *n* = 1) were less frequently reported. Interviewees could mention more than one threat category.

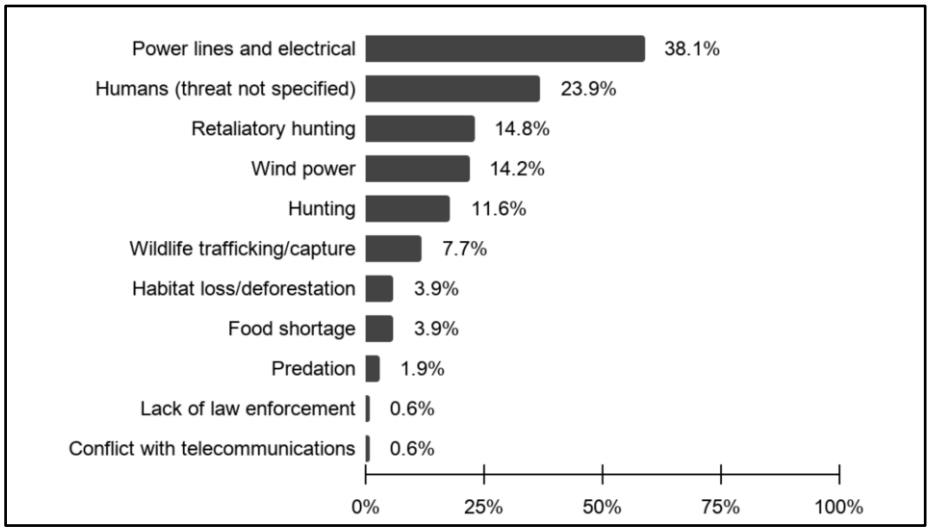


Fig. 8 Frequency of threat categories affecting Lear's Macaw, mentioned by respondents who perceived the species as threatened (*n* = 155). Respondents could mention more than one threat category

The majority of respondents (87.6%; *n* = 403) said they disapprove the removal of animals from the wild. A small share recognized this practice as part of the local culture while still disapproving of it (3.7%; *n* = 17), whereas the same proportion of people considered it part of culture without expressing disapproval (3.7%; *n* = 17). Only 2.2% (*n* = 10) stated approving the removal of animals from the wild, 1.7% (*n* = 8) stated to have not formed an opinion on the subject and 0.4% (*n* = 2) stated neither approval nor disapproval (Fig. 9).

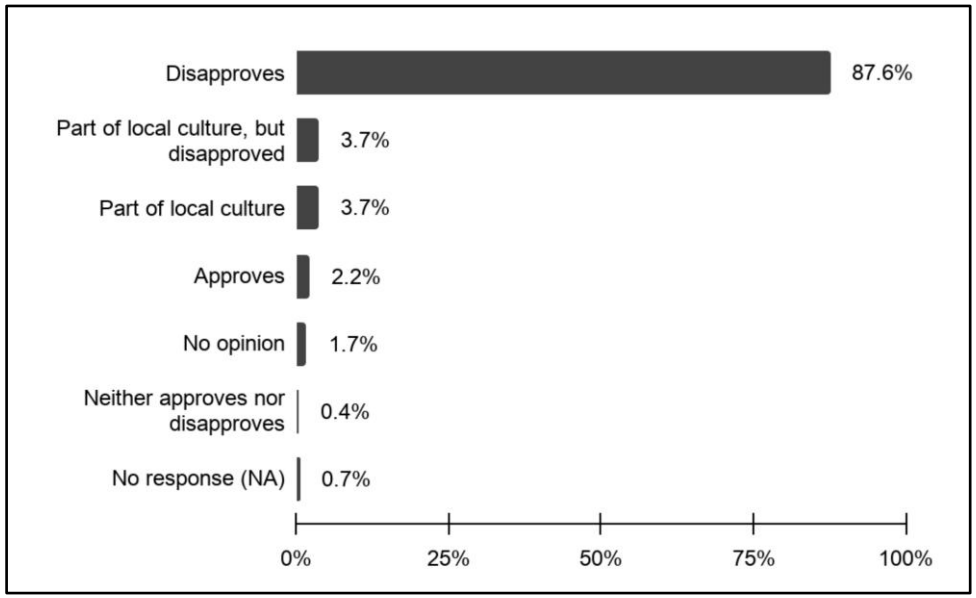


Fig. 9 interviewees' opinions on removing animals from the wild, regardless of the purpose of the practice (*n* = 460)

3.5 Values attributed to Lear's Macaw

Of the 460 interviewees, 351 (76.3%) attributed at least one value category to Lear's Macaw and were included in this analysis, whereas 109 (23.7%) did not express any identifiable value. Overall, nine value categories were identified (Fig. 10).

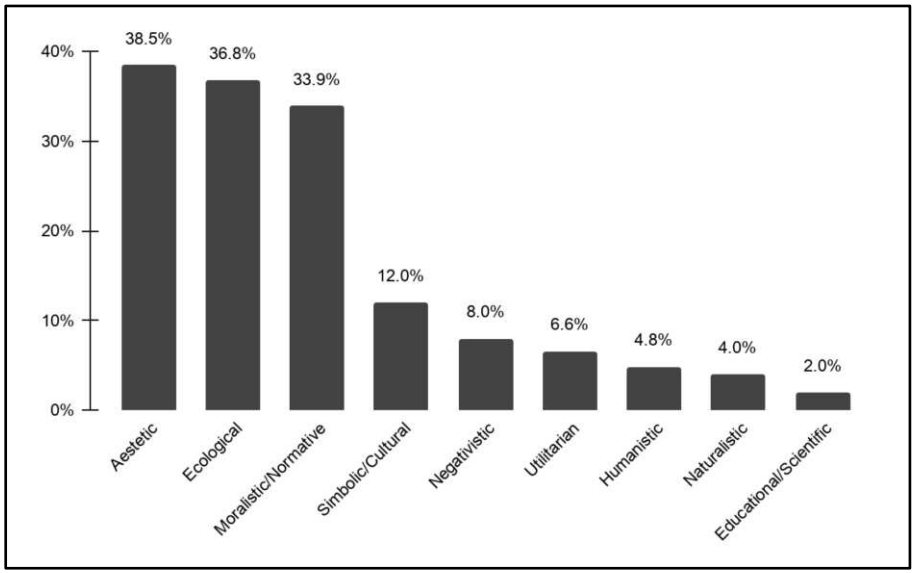


Fig. 10 Frequency of value categories attributed to Lear's Macaw, classified according to the adapted typology proposed by Kellert [19]. Of the 460 respondents, 351 attributed at least one value to the species. Each participant could express more than one value category

Aesthetic values were the most frequently attributed (38.5%; *n* = 135), followed by ecological (36.8%; *n* = 129) and moralistic/normative values (33.9%; *n* = 119). Symbolic/cultural values were attributed by 12.0% (*n* = 42) of respondents, whereas negativistic (8.0%; *n* = 28), utilitarian (6.6%; *n* = 23), humanistic (4.8%; *n* = 17), naturalistic (4.0%; *n* = 14), and educational/scientific values (2.0%; *n* = 7) were less frequently attributed. Because respondents could attribute more than one value to the species, the value categories are not mutually exclusive.

3.5.1 Word Cloud

Respondents described the importance of Lear's Macaw using their own words, resulting in 549 word mentions. After standardizing words with equivalent meanings (e.g., *bonito*, *bonita*, *boniteza*, and *lindo* as *beautiful*), these mentions were represented by 75 distinct terms in the word cloud (Fig. 11). The most frequent terms were *beautiful*, *nature*, *preservation*, *living being*, *function/use*, *licuri*, *important*, *harmless*, *dispersion*, and *joyful*. Terms associated with negative perceptions were less frequent and included *damage* and *enemy*, which were mentioned in relation to crop damage and human-–wildlifeLear's Macaw conflicts.



Fig. 11 Word cloud summarizing interviewees' perceptions of Lear's Macaw and what the species represents. The size of each word is proportional to the frequency with which it was mentioned

4. Discussion

4.1 Participant profile

The interviewees' close relationship with rural environments and local natural resources provides a suitable context for documenting local ecological knowledge about Lear's Macaw. Rather than depending primarily on formal education, knowledge of wildlife in rural communities is largely acquired through repeated interactions with the environment and accumulated through everyday experiences, observations, and social transmission [42,43]. Recent studies have shown that local knowledge can provide reliable information on species ecology, distribution, and population status, often complementing conventional ecological surveys and supporting conservation planning [11,42].

Likewise, integrating local ecological knowledge with scientific evidence has been increasingly recognized as an effective approach for improving biodiversity conservation and guiding management decisions for threatened species [43].

4.2 Familiarity and species recognition

The exceptionally high recognition of Lear's Macaw demonstrates that the species remains a prominent component of the socioecological landscape throughout its distribution range. Decades of coexistence between local communities and the species have likely made Lear's Macaw a familiar element of daily life in the Caatinga, reinforcing its social and ecological importance within the region [44]. Its conspicuous characteristics, including large body size, striking blue plumage, loud vocalizations, gregarious behavior and predictable daily movements, increase opportunities for direct observation. This interpretation is consistent with evidence that large-bodied and highly gregarious birds are more readily represented in

observational records, partly due to increased detectability [45]. Frequent interactions with wildlife strengthen species recognition and people's connection with nature, contributing to the development of local ecological knowledge and positive perceptions toward biodiversity [13,46].

Interestingly, the Blue-and-yellow Macaw was the second most frequently recognized species despite not occurring naturally in the study region. This suggests that species recognition is influenced not only by local occurrence but also by the public visibility of charismatic species, which often become widely recognized regardless of their geographic distribution [47]. Respondents may have associated the Blue-and-yellow Macaw with the Lear's Macaw because both share a similar body shape, large size, blue plumage and loud vocalizations, particularly during distant observations when diagnostic traits are less apparent [48]. Likewise, the isolated identification of Palm Cockatoo, a species absent from Brazil, may reflect the local use of the term "black macaw" to describe the dark ventral surface of Lear's Macaw wings, illustrating how popular nomenclature and general appearance can occasionally influence species identification.

The high proportion of respondents reporting recent observations indicates that much of the knowledge documented in this study is based on current interactions with the species rather than historical memories. Similar findings have been reported for other threatened birds, where local ecological knowledge helped to refine information on species occurrence and distribution [49]. Likewise, previous studies have shown that the frequent encounters with Blue-and-yellow Macaws promoted high familiarity among local residents in other geographies [50].

4.3 Local ecological knowledge and resource use

The perception that Lear's Macaw populations have increased over recent years is consistent with the species' documented recovery. Following decades of intensive conservation actions, the population has

increased, leading to its recent reclassification from Endangered to Vulnerable in the Brazilian Red List [51,24,25]. The predominance of this perception among respondents suggests that local communities are not only frequently observing the species but are also detecting long-term changes in its abundance. Similar studies have shown that Local Ecological Knowledge (LEK) can accurately capture temporal trends in wildlife populations, complementing scientific monitoring and providing valuable information for conservation planning [52,53].

4.3.1 Diet of Lear's Macaw

The food items mentioned by the interviewees largely correspond to those previously described as part of the diet of Lear's Macaw. Licuri was the most mentioned food item, followed by maize, as well as other native Caatinga species, such as Brazil plum (*S. tuberosa*), mandacaru (*C. jamacaru*), mucunã (*D. grandiflora*) and brauna (*M. brauna*), which have been previously recorded as components of the species diet [35,54,23]. These results reveal that local communities recognize the main food resources of Lear's Macaw described in the literature, indicating that LEK is consistent with scientific knowledge on the species' feeding ecology.

Although the main food items have been widely recognized, knowledge was concentrated primarily on licuri and maize, whereas few interviewees mentioned other components of the diet. This pattern suggests that LEK is influenced by the frequency with which these interactions are observed in daily life, and not necessarily by the vegetable species' knowledge by itself. Thereby, food items whose use by the macaw is more evident tend to be more readily regarded [7,55]. Similarly, this knowledge is concentrated on resources of greater practical and cultural importance to local communities [56,57].

In addition to native Caatinga species, the interviewees also mentioned cultivated or introduced species, such as maize, mango (*Mangifera indica*) and mesquite (*Prosopis juliflora*). These responses indicate

that local communities recognize Lear's Macaw's use of available resources in human-modified landscapes. This pattern is compatible with studies that demonstrate that psittacines and other frugivorous birds may incorporate cultivated or exotic species in their diets when these resources are available, particularly in human-modified environments, although native resources remain essential to the maintaining natural populations [58,59].

4.3.2 Community uses of licuri

The widespread use of licuri by local communities reinforces the fact that this species' relevance extends beyond its feeding value for Lear's Macaw. The main purpose mentioned by the interviewees was human food, followed by tool manufacturing, construction and income generation, a pattern consistent with ethnobotanical studies conducted in semiarid regions, which recognize licuri as a multipurpose species, used for food, handicraft, construction and regional trade [60,61].

In addition to direct consumption, the interviewees reported use of licuri fruits in traditional food preparations, such as licuri milk, 'cocadas' (traditional Brazilian coconut-based sweets), highlighting the continued importance of licuri in local food practices and cultural identity. This result reinforces its importance as one of the main sociobiodiversity products of the Caatinga, encompassing ecological, cultural and economic values [62]. In this context, sustainable management and strengthening of sustainable extractive activities represent key strategies to reconcile palm conservation, the sustainable use of its resources, and the recognition and empowerment of communities that depend on this resource [63].

The shared importance of licuri as a resource for both local communities and Lear's Macaw highlights its central role in the human–wildlife socioecological relationship. This convergence in resource use demonstrates that conserving of licuri palm groves can simultaneously benefit biodiversity and local ways

of life, reinforcing the potential of conservation strategies that integrate protection of the species and valorization of resources used by local communities [60,62].

However, some responses revealed that sharing this resource can also cause conflicts, especially when the availability of fruit interferes with extractive activities and income generation for the families. A similar pattern was observed in maize, but it was more frequently mentioned as a source of crop losses and retaliatory hunting, corroborating records of crop predation in the Sertão region of Bahia [64]. Altogether, these results show that the main food resources of the macaws also represent the resources around which sharing relationships and conflicts between the species and local communities are established.

4.4 Perceived threats and human–wildlife coexistence

Although nearly half of respondents perceived that Lear's Macaws are currently not threatened, those who recognized the existence of threats identified the principal pressures described in the scientific literature. Power lines and electrical infrastructure were the most frequently cited threats, followed by retaliatory hunting, wind power, wildlife trafficking and habitat-related impacts. This close correspondence between local perceptions and documented threats suggests that communities possess an updated understanding of the main factors affecting the species, reinforcing the value of LEK for identifying conservation challenges [11,43].

The threats identified by respondents closely match those reported for Lear's Macaw in recent decades. Electrocution has emerged as one of the leading causes of mortality following the expansion of electrical infrastructure across the species' distribution [31]. Retaliatory hunting associated with crop damage also remains a major challenge for coexistence between people and Lear's Macaws [29,51]. Such conflicts are often driven by the need to protect subsistence resources rather than by negative attitudes toward the species, a pattern widely documented in human–wildlife conflict studies [20]. The mention of wind

power likely reflects the period when the Wind Complex “Canudos I” was undergoing environmental licensing and installation. During this process, LEK, together with recommendations from environmental agencies and researchers, helped inform the development of mitigation measures to reduce potential impacts on Lear's Macaw, illustrating the value of integrating community knowledge into environmental decision-making [65,66]. Habitat degradation and reduced food availability remain additional threats to the species’ long-term persistence [51,34].

Wildlife trafficking was mentioned by relatively few respondents, yet its recognition remains important because illegal capture was historically one of the principal drivers of the species' decline. During the twentieth century, the rarity and ornamental value of Lear's Macaw fueled intense demand from the illegal pet trade, contributing substantially to population collapse [27,51]. The relatively low frequency with which trafficking was cited may reflect the success of long-term conservation actions and strengthened law enforcement, although illegal capture remains a potential threat requiring continuous surveillance [51].

The widespread rejection of removing animals from the wild provides additional insight into changing community attitudes toward wildlife. Nearly 90% of respondents stated disapproval of this practice; However, morally sensible questions may be influenced by social expectations and by the interviewer effect, once participants may adjust their answers according to what is perceived as socially acceptable or desirable by the interviewer [67,68]. These expectations may also vary between cultural contexts in which values and social norms influence what's perceived as an acceptable answer [69]. Interviews revealed that historical wildlife use in the Caatinga was strongly influenced by recurrent droughts, food insecurity and limited economic opportunities. Under these conditions, hunting often represented a subsistence strategy rather than a recreational activity, and wildlife was used opportunistically to meet immediate family needs [51]. More than one elderly respondent recalled hunting macaws to feed their families during periods of food scarcity. Although parrots and macaws are more commonly associated

with the pet trade than with human consumption, birds have historically served multiple purposes in northeastern Brazil, including as a food source during periods of scarcity [70,71]. This testimony illustrates that occasional hunting of Lear's Macaws was primarily associated with subsistence during periods of severe socioeconomic vulnerability, rather than with a cultural preference for consuming the species.

4.5 Values attributed to Lear's Macaw

The predominance of aesthetic, ecological and moralistic values indicates that local perceptions of Lear's Macaw extend beyond species recognition to encompass emotional, ecological and ethical dimensions. These values were not mutually exclusive, as many respondents simultaneously described the species as beautiful and ecologically important while also acknowledging crop-related conflicts. Similar patterns have been reported for jaguars (*Panthera onca*), where respondents perceived the species as beautiful, important and dangerous at the same time, demonstrating that wildlife values are complementary rather than contradictory [72]. Likewise, Hunter and Brehm [73] showed that attitudes toward wildlife emerge from personal experiences and social contexts, allowing different value orientations to coexist within the same individual.

Long-term coexistence with Lear's Macaw, together with decades of conservation initiatives, may explain the predominance of aesthetic, ecological and moralistic values observed in this study. According to Kellert [19], aesthetic appreciation is one of the main pathways through which people develop positive relationships with wildlife, whereas ecological and moralistic values are closely associated with pro-conservation behaviour [18,21]. Likewise, Manfredo [74] argues that wildlife values are built through cumulative experiences with nature and form the basis of conservation attitudes and environmental decision-making.

Although less frequently expressed, symbolic and cultural values reinforce the importance of Lear's Macaw as part of the biocultural identity of the Caatinga. References to the species as a regional symbol demonstrate that its significance extends beyond ecological functions, reflecting the close relationship between biological and cultural diversity [75]. Negative and utilitarian values were comparatively uncommon, yet they remain important because they reveal that human coexistence with Lear's Macaw still involves conflicts associated with crop damage and resource use. Their relatively low frequency indicates that these concerns do not outweigh the predominantly positive perceptions documented in this study. Instead, the coexistence of positive and negative values reflects the complexity of human–wildlife relationships, in which appreciation, conflict and responsibility toward conservation may occur simultaneously [53, 56].

This finding is consistent with recent studies showing that people's perceptions of wildlife are shaped by cultural background, direct experiences and everyday interactions with nature, resulting in multiple and dynamic ways of valuing biodiversity [76].

4.5.1 Word Cloud

The value dimensions identified through content analysis were consistently reflected in the spontaneous vocabulary used to describe Lear's Macaw. Rather than replacing the quantitative classification, these expressions provide a more nuanced understanding of how local communities perceive and relate to the species. The predominance of terms such as *beautiful*, *nature*, *preservation*, *living being*, *important* and *joyful* reinforces the strong emotional and ethical connections previously identified. While Le Busque and Litchfield [41] displayed only the 50 most frequent words in their analysis of shark perceptions, we retained all 75 standardized terms, including those mentioned only once. This approach preserved less frequent but meaningful perceptions that may reflect individual experiences, cultural meanings, and local

interactions with the species. The reference to ecological concepts and natural resources suggest that appreciation of the macaw is closely associated with an understanding of its ecological role in Caatinga. Similar qualitative approaches have shown that spontaneous language reveals aspects of wildlife perception that are often not fully captured by predefined categories, complementing analyses of environmental perception and conservation attitudes [77].

Conflict-related expressions, including *damage* and *enemy*, appeared less frequently, corroborating the quantitative results showing that negative perceptions coexist with the predominantly positive relationship between local communities and Lear's Macaw. This combination of appreciation, ecological understanding and occasional conflict reflects the dynamic nature of human-wildlife relationships, which are continuously shaped by personal experiences, cultural background and everyday interactions with biodiversity [73,72,76]. Together, the value categories and the spontaneous vocabulary reveal that local perceptions are multidimensional, providing a more comprehensive understanding of how communities experience and assign meaning to this endangered species.

5. Conclusion

Our findings demonstrate that Cultural Ecological Knowledge is a key component of Lear's Macaw conservation. The close correspondence between community perceptions and ecological evidence highlights the importance of integrating local perspectives into conservation planning for threatened species, particularly in human-dominated landscapes [7,18,11]. Overall, our results show that decades of coexistence between local communities and Lear's Macaw have generated a valuable biocultural heritage that can strengthen conservation actions and support more socially relevant species management strategies.

Strengthening partnership between local communities and conservation initiatives should remain central to future efforts to protect Lear's Macaw. The information generated by this study provides a valuable basis for environmental education programs, participatory conservation actions and public policies grounded in local realities [22,18]. In addition, our findings indicate that species recognition is shaped not only by ecological exposure but also by cultural references and visual experiences, an aspect to consider when designing educational materials and future perception surveys involving morphologically similar species.

By valuing CEK alongside scientific knowledge, conservation initiatives can become more inclusive, locally supported and ultimately more effective, strengthening both the future of Lear's Macaw and the connection between local communities and the biodiversity of Caatinga.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The raw interview data are not publicly available due to ethical commitments regarding participant confidentiality and anonymity. The questionnaire used for data collection and additional supporting information are provided in the Supplementary Material.

Ethics approval

This study was approved by the Research Ethics Committee of the Institute of Biosciences, University of São Paulo (IBUSP), Brazil (CAAE: 35770720.4.0000.5464), and by the Research Ethics Committee of Universidade Nove de Julho (UNINOVE), Brazil (CAAE: 87924918.3.0000.5511). All methods involving human participants were performed in accordance with the relevant Brazilian national ethical guidelines and regulations, namely Resolution No. 510, of April 7, 2016, of the Brazilian National Health Council

(Conselho Nacional de Saúde – CNS), which establishes the ethical standards applicable to research in the Human and Social Sciences, and Resolution No. 466, of December 12, 2012, of the Brazilian National Health Council (CNS), which establishes guidelines and regulatory standards for research involving human participants.

Consent to participate

All interviewees provided written informed consent prior to participation in the study by signing an informed consent form (Termo de Consentimento Livre e Esclarecido – TCLE). Participation was voluntary, and the confidentiality of interviewees' research data was ensured throughout the study.

Consent for publication

Written informed consent for publication was obtained from the identifiable research participant.

Clinical trial number

Not applicable.

Funding

This research was funded by Voltalia Energia do Brasil, Loro Parque Foundation (101-2025; 157-2026) and Enel Green Power. The funders had no role in the study design, data collection and analysis, interpretation of the results, or preparation of the manuscript.

Competing interests

The authors declare no competing interests.

Author contributions

T.S.A.: Investigation (equal); Methodology (equal); Formal Analysis (equal); Writing – original draft (lead); Writing – review & editing (lead);
D.R.C.: Writing – review & editing (equal); Formal Analysis (equal);
M.B.C.: Investigation (equal); Writing – review & editing (equal);
L.L.: Conceptualization (equal); Methodology (equal); Writing – review & editing (equal);
R.L.F.S.: Methodology (equal); Formal Analysis (equal); Writing – review & editing (equal);
E.C.P.: Conceptualization (equal); Methodology (equal); Resources (lead); Investigation (equal); Formal Analysis (equal); Writing – original draft (equal); Writing – review & editing (equal); Supervision (lead).

Acknowledgments

We thank Tatiana Pongiluppi, Felipa Ribeiro and Thiago Filadelfo for their contributions to discussions on the sampling design. We also thank Fundação Biodiversitas and the Canudos Biological Station for their institutional support, and Loro Parque Fundación for all financial support and cooperation. We are grateful to Dácio M. Alves, Alzir M. N. Barbosa, Dorivaldo M. Alves, Máximo Cardoso de Macedo, João Carlos Nogueira, and Guilherme Feitosa (Canudos field team); Binho and Denor (Baixa do Chico); Gilmar Rodrigues (Cercadinho); and Vitória Carvalho (Gameleira do Dida); the Biologists that assisted field work Marcos Vinícius; Jesilda Borges, Luciana Bacaicoa and Alan Cerqueira. We thank Gabriela R. Favoretto and Fernanda Riera Paschotto for sampling design, license expenditure, seeking research grants, preparing the study-area maps and for reviewing the figures and the final version of the manuscript.

565 References / Bibliography

566 1. Diegues AC. Os saberes tradicionais e a biodiversidade no Brasil. 2000;211.

567 2. Eloy CC, Vieira DM, LUCENA CM de, ANDRADE M de. Apropriação e proteção dos conhecimentos
568 tradicionais no Brasil: a conservação da biodiversidade e os direitos das populações tradicionais. Gaia Scientia.
569 2014;8(2):189–98.

570 3. Berkes F, Colding J, Folke C. Rediscovery of traditional ecological knowledge as adaptive
571 management. Ecological applications. 2000;10(5):1251–62.

572 4. Drew JA. Use of traditional ecological knowledge in marine conservation. Conservation biology.
573 2005;19(4):1286–93.

574 5. Alves JJA, Rocha M da SP, Souto W de MS, Torquato SC, Portela RA. O conhecimento ecológico
575 tradicional no planejamento e na gestão ambiental. Ateliê Geográfico. 2010;4(2):44–60.

576 6. Shen X, Li S, Chen N, Li S, McShea WJ, Lu Z. Does science replace traditions? Correlates between
577 traditional Tibetan culture and local bird diversity in Southwest China. Biological Conservation. 2012;145(1):160–
578 70.

579 7. Berkes F. Sacred ecology. Routledge; 2017.

580 8. Scherer HJ, Pinheiro DK, Essi L. O conhecimento da Biodiversidade: um estudo de caso com
581 estudantes de graduação de uma universidade brasileira. Revista Monografias Ambientais. 2015;14(2):49–58.

582 9. Maffi L. Linguistic, cultural, and biological diversity. Annu Rev Anthropol. 2005;34(1):599–617.

583 10. Maffi L, Woodley E. Biocultural diversity conservation: a global sourcebook. Routledge; 2012.

584 11. Sheppard DJ, Stark DJ, Muturi SW, Munene PH. Benefits of traditional and local ecological
585 knowledge for species recovery when scientific inference is limited. Front Conserv Sci. 2024;5.
586 doi:https://doi.org/10.3389/fcosc.2024.1383611

12. Tran TMA, Gagnon VS, Schelly C. A review of traditional ecological knowledge in resilient livelihoods and forest ecosystems: lessons for restoration sciences and practices. Forests, Trees and Livelihoods. 2025;34(1):27–53.

13. Soga M, Gaston KJ. Extinction of experience: the loss of human–nature interactions. Frontiers in Ecology and the Environment. 2016;14(2):94–101. doi:https://doi.org/10.1002/fee.1225

14. Marques WRA, Rios DL, dos Santos Alves K. A percepção ambiental na aplicação da Educação Ambiental em escolas. Revista Brasileira de Educação Ambiental (RevBEA). 2022;17(2):527–45.

15. Hanazaki N. Comunidades, conservação e manejo: o papel do conhecimento ecológico local. Biotemas. 2003;16(1):23–47.

16. Lima FP, Bastos RP. Perceiving the invisible: Formal education affects the perception of ecosystem services provided by native areas. Ecosystem Services. 2019;40:101029.

17. Mascia MB, Brosius JP, Dobson TA, Forbes BC, Horowitz L, McKean MA, Turner NJ. Conservation and the social sciences. Conservation biology. Wiley Online Library; 2003.

18. Bennett NJ, Roth R, Klain SC, Chan K, Christie P, Clark DA, Cullman G, Curran D, Durbin TJ, Epstein G, Greenberg A, Nelson MP, Sandlos J, Stedman R, Teel TL, Thomas R, Veríssimo D, Wyborn C. Conservation social science: Understanding and integrating human dimensions to improve conservation. Biological Conservation. 2017;205:93–108. doi:10.1016/j.biocon.2016.10.006

19. Kellert SR. The value of life: biological diversity and human society. [Internet]. 1996 [citado 23 de fevereiro de 2026]. 263 p. Disponível em: https://www.cabidigitallibrary.org/doi/full/10.5555/19961806737

20. Kansky R, Knight AT. Key factors driving attitudes towards large mammals in conflict with humans. Biological Conservation. 2014;179:93–105.

21. Schultz PW. Conservation means behavior. Conservation biology. 2011;25(6):1080–3.

22. Jacobson SK, McDuff MD, Monroe MC. Conservation education and outreach techniques. 2º ed. Oxford University Press; 2015.

23. LUGARINI, BARBOSA, DE OLIVEIRA. Instituto Chico Mendes de Conservação da Biodiversidade [Internet]. 2012 [citado 24 de março de 2026]. PAN Arara-azul-de-lear. Disponível em: https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/pan-arara-azul-de-lear/pan-arara-azul-de-lear

24. GPCA, CEMAVE/ICMBio. Relatório Censo 2024 - Arara-azul-de-lear (Anodorhynchus leari) [Internet]. 2024 [citado 6 de abril de 2026]. Disponível em: https://acrobat.adobe.com/id/urn:aaid:sc:va6c2:d635fbe9-0dfc-4142-8e04-7121c8929bf4

25. MMA. Lista Nacional Oficial de Espécies da Fauna Ameaçadas de Extinção [Internet]. PORTARIA MMA Nº 1.704,. 2026. Disponível em: https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/saiba-mais/documentos-e-downloads/10-portaria-mma-no-1-704-de-16-de-junho-de-2026.pdf

26. Pacífico EC. Biologia reprodutiva da arara-azul-de-lear Anodorhynchus leari (Aves: Psittacidae) na Estação Biológica de Canudos, BA [dissertação] [Internet]. Universidade de São Paulo; 2012 [citado 24 de março de 2026]. Disponível em: http://www.teses.usp.br/teses/disponiveis/41/41133/tde-12072012-150324/ doi:10.11606/D.41.2012.tde-12072012-150324

27. Munn CA. Lears Macaw: a second population confirmed. Psitta Scene. 1995;7(4):1–3.

28. Filadelfo T, Pacífico E. Urgent strategy to recover a functionally extinct population of Lear's Macaw and rescue its habitat. Em: International Congress Conservation Biology-ICCB. 2017. p. 459.

29. Santos-Neto JR, Gomes DM. Predação de milho por arara-azul-de-Lear, Anodorhynchus leari (Bonaparte, 1856)(Aves: Psittacidae) em sua área de ocorrência no Sertão da Bahia. Ornithologia. 2010;2(1):41–6.

30. Pacífico EC, Efstathion CA, Filadelfo T, Horsburgh R, Cunha RA, Paschotto FR, Denes FV, Gilardi J, Tella JL. Experimental removal of invasive Africanized honey bees increased breeding population size of the endangered Lear's macaw. Pest Management Science. 2020;76(12):4141–9.

31. Biasotto LD, Pacífico EC, Paschotto FR, Filadelfo T, Couto MB, Sousa AEB, Mantovani P, Silveira LF, Ascensão F, Tella JL. Power line electrocution as an overlooked threat to Lear's Macaw (Anodorhynchus leari). Ibis. 2023;165(3):998–1006.

32. United Nations. Goal 15 | Department of Economic and Social Affairs [Internet]. 2015 [citado 7 de agosto de 2026]. Disponível em: https://sdgs.un.org/goals/goal15

33. Alvares CA, Stape JL, Sentelhas PC, Gonçalves J de M, Sparovek G. Köppen's climate classification map for Brazil. Meteorologische zeitschrift. 2013;22(6):711–28.

34. Paschotto FR. Conservação da arara-azul-de-lear na Caatinga: identificação de habitats críticos a partir de dados de rastreamento por GPS. Universidade de São Paulo; 2025.

35. dos Santos-Neto JR, Camandaroba M. Mapeamento dos sítios de alimentação da arara-azul-de-Lear Anodorhynchus leari (Bonaparte, 1856). Ornithologia. 2010;3(1):1–17.

36. Vinuto J. A amostragem em bola de neve na pesquisa qualitativa: um debate em aberto. V. 2. 2014;2.

37. Bardin L. Análise de conteúdo. Edições 70; 1977.

38. Wickham H. Ggplot2: elegant graphics for data analysis. See. New York: Springer-Verlag. isbn; 2016.

39. Le Pennec E, Slowikowski K. Ggwordcloud: A Word Cloud Geom for 'ggplot2' [Internet]. 2024 [citado 23 de agosto de 2026]. Disponível em: https://lepennec.github.io/ggwordcloud/

40. POSIT TEAM. RStudio: Integrated Development Environment for R [Internet]. Boston, MA: Posit Software; [citado 25 de abril de 2026]. Disponível em: https://posit.co/

41. Le Busque B, Litchfield CA. 'Describe sharks in three words': investigating the usefulness of automated statistical packages, and manual approaches, to analyse short descriptions of sharks. Wildlife Research. 2025;52(11):WR25068.

42. Braga-Pereira F, Mayor P, Morcatty TQ, Pérez-Peña PE, Bowler MT, de Mattos Vieira MAR, Alves RR da N, Fa JE, Peres CA, Tavares AS, Mere-Roncal C, González-Crespo C, Bertsch C, Rodriguez CR, Bardales-Alvites C, von Muhlen E, Paim FP, Tamayo JS, Valsecchi J, Gonçalves J, Torres-Oyarce L, Lemos LP, Gilmore MP, Correa MA, Perez NCA, Puertas P, El Bizri HR. Predicting animal abundance through local

ecological knowledge: An internal validation using consensus analysis. People and Nature. 2024;6(2):535–47. doi:10.1002/pan3.10587

43. Takasaki Y, Coomes OT, Abizaid C. Pervasive Indigenous and local knowledge of tropical wild species. Ambio. 2025;54(4):680–95. doi:10.1007/s13280-024-02100-w

44. Vercillo UE, Marchini S, Fritzsons MFBB, Franco JL de A. Coexistence and habitat restoration planning for the reintroduction of Spix's macaw. Conservation Biology. 2025;39(6):e70105.

45. Callaghan CT, Poore AG, Hofmann M, Roberts C, Pereira HM. Large-bodied birds are over-represented in unstructured citizen science data. 2021.

46. Cox DT, Shanahan DF, Hudson HL, Fuller RA, Gaston KJ. The impact of urbanisation on nature dose and the implications for human health. Landscape and urban planning. 2018;179:72–80.

47. Albert C, Luque GM, Courchamp F. The twenty most charismatic species. PLOS ONE. 2018;13(7):e0199149. doi:10.1371/journal.pone.0199149

48. Clucas B, McHugh K, Caro T. Flagship Species on Covers of US Conservation and Nature Magazines. Biodiversity and Conservation. 2008;17:1517–28. doi:10.1007/s10531-008-9361-0

49. Gleave RA, Papworth SK, Bauman D, Portugal SJ, Zhang W, Liu Y, Cao Z, Cheng X, Turvey ST. Can local ecological knowledge establish conservation baselines for the Critically Endangered Blue-crowned Laughingthrush? People and Nature. 2024;6(3):1262–76. doi:10.1002/pan3.10643

50. Calderan A, Tinoco L, Appel S, Guedes N. A percepção dos moradores sobre a maracanã-de-cara-amarela (Orthopsittaca manilatus, Aves: Psittacidae), em área urbana de Campo Grande–MS. Braz J Anim Environ Res. 2021;4:2134–45.

51. Barbosa AE, Tella JL. How much does it cost to save a species from extinction? Costs and rewards of conserving the Lear's macaw. Royal Society open science. 2019;6(7):190190.

52. Cano LS, Tellería JL. Local ecological knowledge as a tool for assessing the status of threatened vertebrates: a case study in Vietnam. Oryx. 2013;47(2):177–83. doi:10.1017/S0030605311001669

685 53. Sheppard DJ, Stark DJ, Muturi SW, Munene PH. Benefits of traditional and local ecological
686 knowledge for species recovery when scientific inference is limited. Front Conserv Sci. 2024;5.
687 doi:10.3389/fcosc.2024.1383611

688 54. Silva-Neto G d, Sousa A, Santos-Neto J dos. Novas informações sobre a dieta da arara-azul-
689 de-lear, Anodorhynchus leari Bonaparte, 1856 (Aves, Psittacidae). Ornithologia. 2012;5(1):1–5.

690 55. Ortega-Álvarez R, Casas A. Biocultural salient birds: which biological and cultural factors define
691 them? Front Conserv Sci. 2023;4. doi:10.3389/fcosc.2023.1215967

692 56. de Medeiros PM, Dos Santos GMC, Barbosa DM, Gomes LCA, Santos ÉM da C, da Silva RRV.
693 Local knowledge as a tool for prospecting wild food plants: experiences in northeastern Brazil. Scientific Reports.
694 2021;11(1):594.

695 57. Evangelista V, Scariot A, Teixeira HM, Júnior IML. Local ecological knowledge and perception
696 as a strategy in the management of ecosystem services. Journal of environmental management.
697 2024;368:122095.

698 58. Mokotjomela TM, Musil CF, Esler KJ. Frugivorous birds visit fruits of emerging alien shrub
699 species more frequently than those of native shrub species in the South African Mediterranean climate region.
700 South African Journal of Botany. 2013;86:73–8.

701 59. Bahia R, Lambertucci SA, Plaza PI, Speziale KL. Antagonistic-mutualistic interaction between
702 parrots and plants in the context of global change: Biological introductions and novel ecosystems. Biological
703 Conservation. 2022;265:109399.

704 60. Andrade Martins de W, Ramos MA, Souto WMS, Bento-Silva JS, Albuquerque Paulino de U,
705 Araújo de Lima E. Knowledge, uses and practices of the licuri palm (Syagrus coronata (Mart.) Becc.) around
706 protected areas in northeastern Brazil holding the endangered species Lear's macaw (Anodorhynchus leari).
707 Tropical Conservation Science. 2015;8(4):893–911.

708 61. Neto EM de FL, dos Reis ARAÚJO É, RODRIGUES PMS, de Oliveira SILVA J. Knowledge, use
709 and management in situ of Licuri (Syagrus coronata (Mart.) Becc.). Revista Ouricuri. 2023;13(1):201–21.

62. dos Santos Guimarães J, Shiosaki RK, Mendes MLM. Licuri (Syagrus coronata): características, importâncias, potenciais e perspectivas do pequeno coco do Brasil. Desenvolvimento e Meio ambiente. 2021;58.

63. Aroucha E, Aroucha ML. Boas práticas de manejo para o extrativismo sustentável do licuri. Brasília: Instituto Sociedade, População e Natureza. 2013.

64. dos Santos-Neto JR, Gomes DM. Predação de milho por arara-azul-de-Lear, Anodorhynchus leari (Bonaparte, 1856)(Aves: Psittacidae) em sua área de ocorrência no Sertão da Bahia. Ornithologia. 2010;2(1):41–6.

65. Armeni C. Participation in environmental decision-making: Reflecting on planning and community benefits for major wind farms. Journal of Environmental Law. 2016;28(3):415–41.

66. Benham CF. Aligning public participation with local environmental knowledge in complex marine social-ecological systems. Marine Policy. 2017;82:16–24.

67. Nuno A, St. John FAV. How to ask sensitive questions in conservation: A review of specialized questioning techniques. Biological Conservation. 2015;Detecting and Understanding Non-compliance with Conservation Rules189:5–15. doi:10.1016/j.biocon.2014.09.047

68. Vesely S, Klöckner CA. Social Desirability in Environmental Psychology Research: Three Meta-Analyses. Front Psychol. 2020;11. doi:10.3389/fpsyg.2020.01395

69. Stefkovics A, Batiz K, Zsófia Grubits B, Sára Ligeti A. What Types of Survey Questions are Prone to Interviewer Effects? Evidence Based on 29,000 Intra-Interviewer Correlations From 28 Countries of the European Social Survey. Sociological Methods & Research. 2025;00491241251372509. doi:10.1177/00491241251372509

70. Alves RRN, Gonçalves MBR, Vieira WLS. Caça, uso e conservação de vertebrados no semiárido Brasileiro. Tropical Conservation Science. 2012;5(3):394–416.

71. Fernandes-Ferreira H, Mendonça SV, Albano C, Ferreira FS, Alves RRN. Hunting, use and conservation of birds in Northeast Brazil. Biodiversity and Conservation. 2012;21(1):221–44.

72. Almeida DF de, Maniva L dos S, Campos3 CEC de. Valores da onça-pintada (Panthera onca) de acordo com alunos secundários. Ciência & Educação (Bauru). 2015;21(1):123–32. doi:10.1590/1516-731320150010008

73. Hunter LM, Brehm JM. A qualitative examination of value orientations toward wildlife and biodiversity by rural residents of the intermountain region. Human Ecology Review. 2004;13–26.

74. Manfredo MJ. Who cares about wildlife? Em: Who cares about wildlife? Social science concepts for exploring human-wildlife relationships and conservation issues. Springer; 2008. p. 1–27.

75. Maffi L, Woodley E. Biocultural diversity conservation: a global sourcebook. Routledge; 2012.

76. Moesch SS, Straka TM, Jeschke JM, Haase D, Kramer-Schadt S. The good, the bad, and the unseen: wild mammal encounters influence wildlife preferences of residents across socio-demographic gradients. Ecology and Society. 2024;29(3). doi:10.5751/ES-15211-290306

77. Drury R, Homewood K, Randall S. Less is more: the potential of qualitative approaches in conservation research. Animal conservation. 2011;14(1):18–24.

8. Appendices

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- FoodresourcesAndrade.docx
- ValuecategorydefinitionAndrade.docx
- Questionnaire.pdf