



Ethnozoological Knowledge and Human Nature Relationship: A Comparative Study of Animal Use among Three Ethnic Groups in North Sulawesi, Indonesia

Raden Garsetiasih¹, Moh. Andika Lawasi², Diah Irawati Dwi Arini^{1*}, Pristiwanto³, Salmin Djakaria⁴,
Hasanuddin Anwar³, Irna Saptaningrum⁵, Ndoheba Kenda²

¹ Research Center for Biota System, National Research and Innovation Agency, Bogor 16911, Indonesia

² Research Center for Society and Culture, National Research and Innovation Agency, South Jakarta 12710, Indonesia

³ Research Center for Environmental Archaeology, and Cultural Sustainability, National Research and Innovation Agency, South Jakarta 12710, Indonesia

⁴ Research Center for Manuscripts, Literature, and Oral Traditions, National Research and Innovation Agency, South Jakarta 12710, Indonesia

⁵ Research Center for Prehistoric and Historical Archaeology, National Research and Innovation Agency, South Jakarta 12710, Indonesia

Corresponding Author Email: diah014@brin.go.id

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ABSTRACT

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Ethnozoological knowledge reflects complex interactions between humans and fauna embedded within cultural and environmental contexts. This study examined animal use among the Minahasa, Bolaang Mongondow, and Sangihe-Talaud communities in North Sulawesi, Indonesia. Data were collected through semi-structured interviews, participant observation, and field documentation involving 30 key informants selected through purposive and snowball sampling. A total of 74 species were documented, dominated by mammals (33.78%), birds (28.38%), and reptiles (17.57%), comprising the largest shares, while other taxa were less represented. Species were primarily used for food, mythology, art, symbolism, and traditional medicine. Vertebrates were more likely than invertebrates to serve multiple cultural functions beyond subsistence. Over 70% of species were sourced from the wild, and one-third were classified as threatened under the IUCN Red List. Traditional practices, including hunting taboos, socially regulated wildlife use, and cultural protection of certain species, were shown to support community-based conservation planning. The substitution of animal parts with replicas made from wood, resin, or plastic represented a local adaptive strategy that reduced pressure on threatened species and promoted culturally informed conservation approaches.

1. INTRODUCTION

The rapid loss of global biodiversity underscores the urgent need for comprehensive documentation of traditional ethnozoological knowledge, which provides a vital foundation for culturally informed conservation planning and sustainable wildlife management [1]. Indonesia is recognised as the most biodiverse country in the ASEAN region [2], with ecological diversity distributed across a vast archipelago encompassing both terrestrial and marine environments [3]. Among its major islands, Sulawesi is particularly significant, exhibiting exceptionally high levels of floral and faunal endemism shaped by a complex geological history and long-term isolation [4]. Within this ecologically distinctive landscape, long-standing interactions between human communities and the ecosystem have developed over centuries [5].

Administratively, Sulawesi is divided into six provinces comprising 81 districts and municipalities [6]. North Sulawesi, one of these provinces, is inhabited by multiple ethnic groups, with the Minahasa, Bolaang Mongondow, and Sangihe-Talaud

forming the demographic core. The Minahasa people occupy most areas of North Sulawesi and are traditionally divided into nine subgroups. The Bolaang Mongondow communities are primarily distributed in the western part of the Minahasa mainland, while Sangihe-Talaud people inhabit the smaller northern islands. Migration and interregional movement have resulted in the wider dispersal across the main island and the surrounding archipelagos, which comprise 294 islands, although not all are inhabited [6]. Other ethnic communities, including Gorontalo, Suwawa, Bolango, Atinggola, and Mongondow, are also present.

The geographical and cultural settings of the Minahasa, Bolaang Mongondow, and Talaud communities provided a compelling context for examining the human-fauna relationship. The Minahasa people, who primarily inhabited the main island, were historically engaged in hunting, agriculture, and trade, which shaped distinctive patterns of animal use [7]. In contrast, Bolaang Mongondow communities occupied both mountainous and coastal landscapes, resulting in diverse interactions with terrestrial and aquatic fauna [8].

Meanwhile, the Talaud communities on remote northern islands developed a close relationship with marine resources integral to their ecological surroundings [9, 10].

Culturally embedded knowledge shapes how communities perceive, classify, and utilise animal and plant resources, contributing to a cultural legacy that reflects ecological knowledge and shared social values [11-15]. Animals have been shown to play a particularly prominent role within this cultural landscape. Their representations in art, folklore, and religious ceremonies offered insight into how societies interpreted and valued the natural world [11]. Specific species are often embedded in community myths or associated with moral teachings and spiritual meanings. Traditional practices, including hunting, animal husbandry, and the preparation of animal-based medicines, further illustrate the enduring and intimate relationships between humans and their surrounding environments [12].

Previous ethnohistorical studies in North Sulawesi have documented among specific ethnic groups, such as the Minahasa [16, 17], Bolaang Mongondow [18, 19], and Sangihe-Talaud communities [20, 21]. These studies, however, generally focused on single cultural domains (e.g., medicinal or food use), often emphasising plants rather than animals, and were limited to specific localities. As a result, systematic comparisons of animal use across multiple domains remain less studied. Consequently, knowledge on how cultural practices influence wildlife management, species selection, and multifunctional roles of fauna is fragmented and poorly integrated [22]. The communities maintain rich cultural traditions and ethnozoological knowledge related to animal use, much of which is orally transmitted by elders, customary leaders, and cultural practitioners, rendering it vulnerable to loss [23, 24].

To capture this complexity, animal use in the present study was categorised into six interconnected cultural domains, adapted and modified from previous ethnozoological frameworks [11]. These domains included food, ritual, mythology, art, symbolism, and traditional medicine. Together, they reflect the multiple ways in which animals are

embedded in cultural practices and belief systems. Based on this framework, the objective of the present study was to document, analyse, and systematically compare ethnozoological knowledge among Minahasa, Bolaang Mongondow, and Talaud communities, thereby contributing to broader discussion on human-nature dynamics in biodiversity-rich regions. The study examined similarities and differences in animal use across cultural domains and explored the ecological and cultural factors shaping this diversity. The findings were organised by domain and discussed in relation to their implications for cultural continuity, wildlife conservation, and forest ecosystems management in North Sulawesi.

2. MATERIALS AND METHODS

2.1 Study area and ethical approval

This study was conducted in North Sulawesi, Indonesia, focusing on three major ethnic groups: Minahasa, Bolaang Mongondow, and Talaud. Data were collected between June and September 2025. Sampling sites were purposively selected based on the presence of active traditional communities, the persistence of wildlife-related cultural practices, accessibility, time constraints during the fieldwork period, and the residence of key informants.

Data collection was undertaken in several locations: Manado City for the Sangihe-Talaud ethnic group; Minahasa Regency (Tondano and Pineleng) and Tomohon City for the Minahasa ethnic group; and Kotamobagu City for the Bolaang Mongondow ethnic group. A total of four data collection points were established. Ethical approval was obtained from the Ethical Committee on Social Studies and Humanities, Indonesian National Research and Innovation Agency (BRIN) (Approval No. 978/KE.01/SK/12/2024). The locations of the study sites and data collection points are presented in Figure 1.

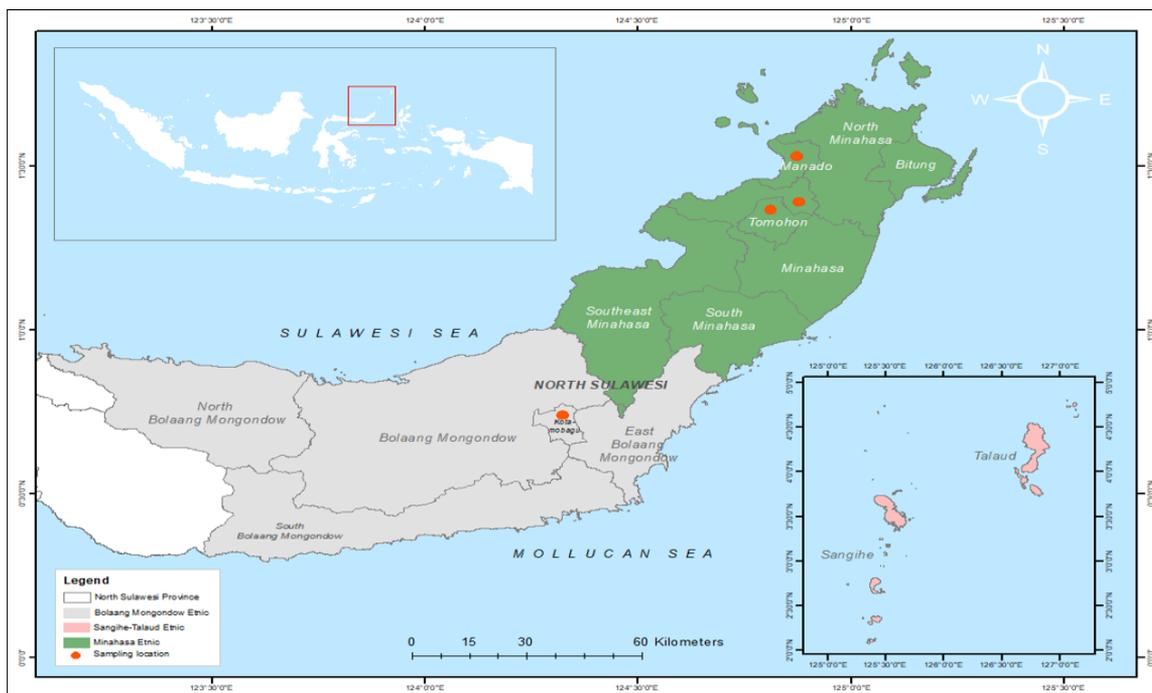


Figure 1. Study area and distribution of dominant ethnic groups in North Sulawesi

2.2 Data collection

Data were collected through semi-structured interviews with key informants [25] and local figures using a pre-developed interview guide designed to obtain comprehensive and in-depth ethnozoological information. The interview guide was structured around five core ethnozoological domains: (1) animals used for consumption, (2) medicinal uses, (3) customary/religious rituals, (4) artistic/aesthetic values (e.g., crafts, ornaments, symbolic representations), and (5) mystical meanings and omens/signs. Within each domain, the guiding questions elicited local knowledge on species identification (local names and recognition), contexts of use, preparation/practice, and associated meanings or cultural significance.

Informants were identified and selected using a snowball sampling approach, which is commonly applied in qualitative research to access knowledge holders through social networks and referrals [19, 26]. The selection process began with several initial informants who met the inclusion criteria and were subsequently approached for interviews. Each informant was

then asked to recommend other individuals who possessed relevant knowledge and were willing to participate. This referral process continued until data saturation was reached, indicated by the absence of substantially new information [27].

As presented in Table 1, the demographic profile of the key informants was predominantly male (63.3%), and the largest age group was 31–50 years (43.3%). In terms of ethnic composition, the Minahasa group constituted the majority (70.0%), whereas the Sangihe–Talaud group was the least represented (3.3%), which was influenced by temporal and geographical constraints during the data collection period. Informants classified as N/A or Not Specified (13.3%) were identified as non-native residents, mainly comprising government officials responsible for conservation management. A variety of professional roles were included to ensure a multi-stakeholder perspective. Local wildlife users represented the largest proportion (26.7%), followed by cultural historians and anthropologists (13.3%), while other specialized roles, such as traditional leaders, conservation officers, and museum officers, were represented in smaller but balanced proportions.

Table 1. Demographic characteristic of key informants

| Characteristic | Category / Range | Percentages (%) |
|----------------|--|-----------------|
| Gender | Male | 63.3 |
| | Female | 36.7 |
| | Minahasa | 70.0 |
| Ethnicity | Bolaang Mongondow | 13.3 |
| | Sangihe-Talaud | 3.3 |
| | N/A / Not specified | 13.3 |
| Age group | 15 - 30 | 23.3 |
| | 31 - 50 | 43.3 |
| | > 50 | 33.3 |
| | Traditional leader | 6.67 |
| Role | Cultural artisan and costume vendor | 6.7 |
| | Cultural historian / Cultural anthropologist | 13.3 |
| | Cultural practitioner | 6.7 |
| | Cultural preservation/museum officer | 6.7 |
| | Local government cultural officer | 6.7 |
| | Local wildlife user | 26.7 |
| | Wildlife conservation officer | 10.0 |
| | Wildlife meat trader | 10.0 |
| | Traditional dancer | 6.7 |

2.3 Data analysis

The collected data were thematically classified into six sub-themes based on an analytical framework [11] that was adapted and modified for the present study. These sub-themes encompassed the roles of animals as food resources, ritual elements, carriers of myths, sources of artistic inspiration, symbols of cultural meaning, and components of traditional medicine. The data were further analysed descriptively and qualitatively following established qualitative research procedures [27]. Data organisation and analysis were supported using Microsoft Excel and RStudio software. The results were presented in the form of tables, figures, and illustrative examples, accompanied by narrative explanations to highlight patterns, similarities, and differences across cultural domains and ethnic groups.

3. RESULTS

A total of 74 animal species were traditionally utilised across the three ethnic groups. These species comprised

Mammalia (33.78%), Aves (28.38%), Reptilia (17.57%), Actinopterygii (9.46%), and Insecta (4.05%), while other classes, including Sarcopterygii, Amphibia, Gastropoda, Chilopoda, and Malacostraca, each accounted for 1.35% of the total species recorded in this study. Based on their functions, the species were classified into six categories of use: food (40 species), ritual (5 species), mythology (25 species), art (23 species), symbolism (16 species), and traditional medicine (16 species). Several species fulfilled more than one functional role and were therefore included in multiple use categories (Figure 2).

The use of animals as food represented the most dominant form of human–fauna interaction across the three ethnic groups, with 32 species recorded in Minahasa, 18 in Bolaang Mongondow, and 5 in Talaud. These values represent the number of edible species reported within each ethnic group, and some species were shared among groups and therefore may appear in more than one ethnic group. The mythology or omen category ranked second, with 18 species documented in Minahasa and 15 in Bolaang Mongondow and 1 in Sangihe-Talaud, underscoring the symbolic and cosmological roles attributed to animals within local belief systems. The art

category was particularly prominent in Minahasa, where 20 species were recorded, reflecting the widespread incorporation of animal motifs and materials in carvings, ornaments, and traditional performances. This pattern suggested that artistic

expression played an important role in maintaining and transmitting animal symbolism as part of cultural identity (Figure 3).

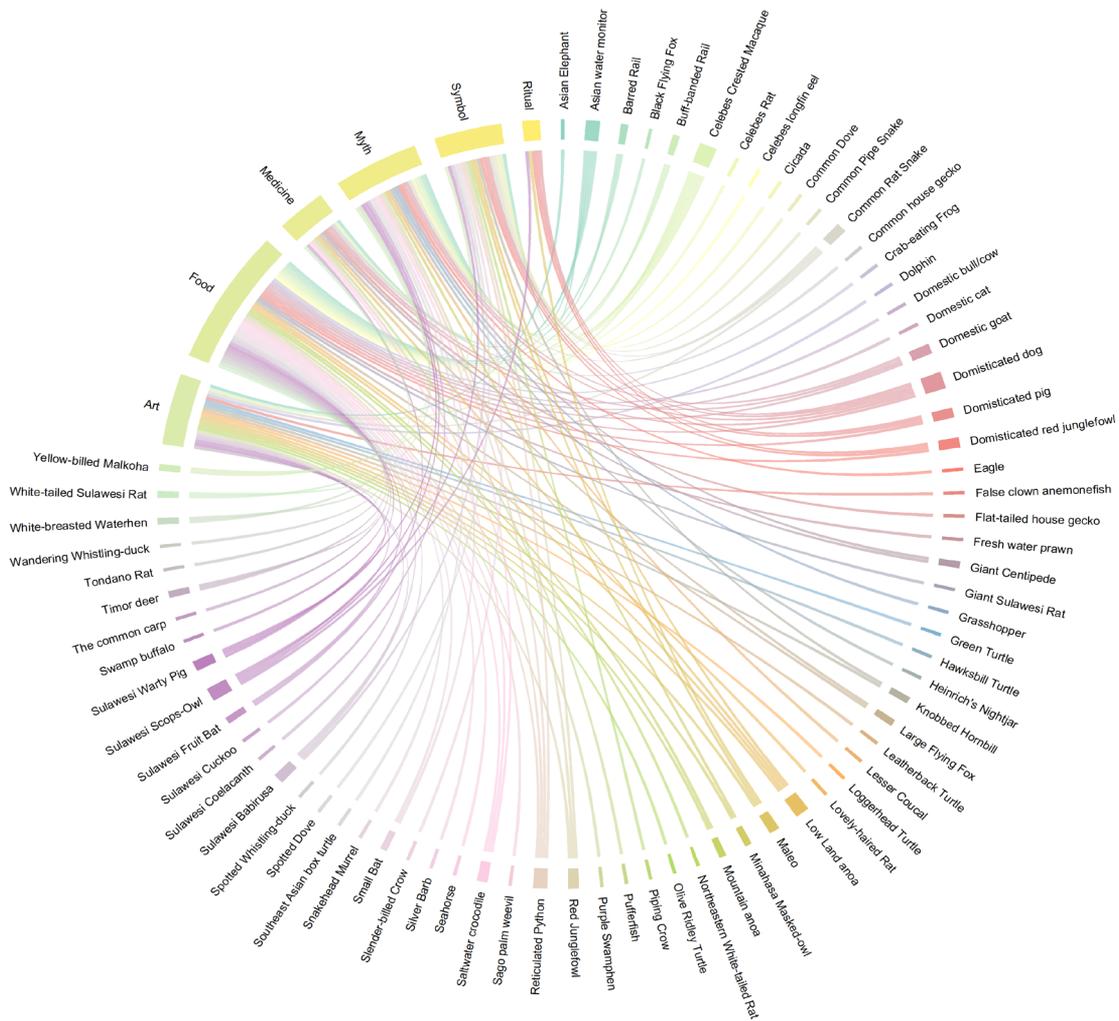


Figure 2. Chord diagram showing the relationship between animal species and utilization categories

The majority of the recorded species were wild animals (72.97%), while the remainder were domesticated species (27.03%), calculated from the species data listed in Table A1 in the Appendix. This pattern indicated a relatively high reliance on wild fauna within local cultural systems to meet daily needs. Wildlife originating from diverse habitats, including forests, rivers, coastal areas, and marine environments, was utilised not only as food resources but also as elements within belief systems and cultural expressions.

A total of 27 species (36.48%) were endemic to Sulawesi, indicating a strong connection between region-specific fauna and the cultural systems of local communities. Endemic species such as the Celebes crested macaque (*Macaca nigra*), Gursky’s spectral tarsier (*Tarsius spectrumgurskyae*), Sulawesi babirusa (*Babyrousa celebensis*), Sulawesi fruit bat (*Acerodon celebensis*), and the maleo (*Macrocephalon maleo*) were frequently referenced in myths, folklore, and traditional symbolism. These species were commonly attributed with spiritual and symbolic meanings, functioning as protective

symbols or indicators of natural and environmental change.

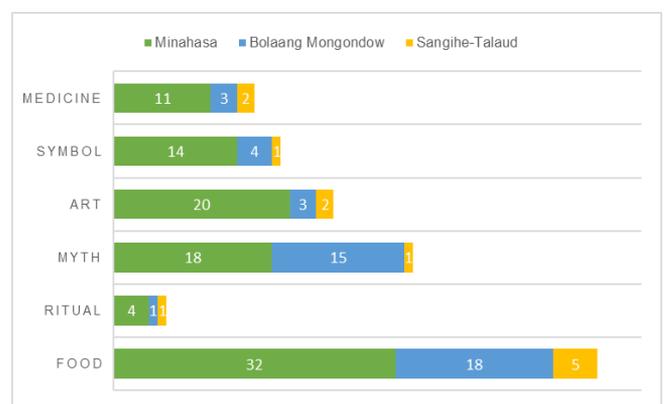


Figure 3. Comparison of the number of species and traditional uses in each ethnic group

Analysis of conservation status indicated that 24 species (32.43%) were classified as Vulnerable (VU), Endangered (EN), or Critically Endangered (CR) according to the IUCN Red List, while 29 species (39.19%) were listed as protected under the Indonesian Minister of Environment and Forestry Regulation No. 106 of 2018. Among the recorded taxa, the lowland anoa (*Bubalus depressicornis*), mountain anoa (*Bubalus quarlesi*), Sulawesi babirusa (*Babyrousa celebensis*), Celebes crested macaque (*Macaca nigra*), maleo (*Macrocephalon maleo*), and several marine turtle species, including *Chelonia mydas* and *Eretmochelys imbricata*, were identified as having high conservation priority.

The following section presents the ethnozoological knowledge identified in this study. The results are reported sequentially across the main categories: animals as food, animals as ritual elements, animals associated with specific myths, animals as inspirations for local crafts, animals represented in symbols and emblems, and animals used as ingredients in traditional medicine.

3.1 Animals as food

A total of 40 species were recorded as being consumed, with mammals representing the dominant group (55%), followed by Aves (17.5%) and Actinopterygii (12.5%). No substantial differences were observed in patterns of animal consumption by taxonomic class among the three major ethnic groups, with mammals consistently representing the most frequently consumed class.

Sulawesi. The most frequently consumed species included the Sulawesi fruit bat (*Acerodon celebensis*), white-tailed Sulawesi rat (*Maxomys hellwaldii*), Asian water monitor (*Varanus salvator*), and reticulated python (*Malayopython reticulatus*) (Figure 4).

Overall, patterns of animal consumption among the Minahasa, Bolaang Mongondow, and Talaud communities reflected complex and culturally significant human-fauna relationships. The findings demonstrated that food choices were not merely determined by taste or preference but reflected deep entanglements between consumption practices, value systems, local ecological knowledge, and community adaptation to social and environmental change [28, 29]. Consumption, therefore, did not function solely as a culinary activity but operated within a normative system that regulated who was permitted to consume particular animals, under which conditions, and through specific preparation methods [23]. These practices formed a dynamic cultural mosaic in which acts of consumption were shaped by symbolic meanings, customary norms, and contextual factors of space and time.

Within ceremonial and ritual contexts, several animal species occupied central roles as cultural markers and symbolic mediators expressed through consumption. The Sulawesi warty pig (*Sus celebensis*) and domesticated red junglefowl (*Gallus gallus domesticus*) represented prominent examples. The warty pig was an essential component of *Kumanlaker*, or “big meal”, a communal thanksgiving feast among the Minahasa, and was also required in *Mongundam Konlippu*, a protective ritual practiced by the Bolaang Mongondow. The domesticated red junglefowl was used in divination practices in both ethnic groups, although distinct symbolic rules applied. In Minahasa, the use of salt was prohibited when preparing the bird for the *Rumarages* ritual, whereas in Bolaang Mongondow, the junglefowl used in the *Mongimanuk* ritual was required to be black. These contrasting practices indicated that while spiritual purposes were broadly aligned, cultural expressions were shaped by community-specific norms. This illustrated how a single species could hold parallel meanings while being enacted through different ritual procedures.

Beyond ritual contexts, food categories associated with special occasions and daily consumption also revealed clear variations. In Minahasa, selected species such as the Sulawesi fruit bat (*Acerodon celebensis*) and white-tailed Sulawesi rat (*Maxomys hellwaldii*) were regarded as prestigious delicacies reserved for *Kumanlaker*, restricting their consumption to sacred celebratory moments. In contrast, rail species (Rallidae), including the buff-banded rail (*Hypotaenidia philippensis*), barred rail (*Hypotaenidia torquata*), and purple swamphen (*Porphyrio porphyrio*), were commonly consumed as daily food, although hunting techniques differed between Minahasa and Bolaang Mongondow communities. Differences in perceived value were also evident for the Celebes longfin eel (*Anguilla celebensis*), which was regarded as an ordinary food item in Minahasa but considered a prestigious dish in Talaud. These contrasts demonstrated that value was not inherent to the animal itself but was socially constructed through ecological availability, location, and cultural context [23].

Shifts in social and regulatory contexts also resulted in notable changes in consumption practices. Several species that were formerly consumed, including the Celebes crested macaque (*Macaca nigra*) and anoa (*Bubalus* spp.), were no



Figure 4. Some examples of forest wildlife used as local food: (A) Asian water monitor (*Varanus salvator*), (B) Sulawesi fruit bat (*Acerodon celebensis*), (C) White-tailed Sulawesi rat (*Maxomys hellwaldii*), (D) Reticulated python (*Malayopython reticulatus*)

The contexts of animal consumption were further classified into three categories: daily subsistence, special occasions such as important holidays or Thanksgiving feasts, and traditional ceremonies or rituals. Wildlife used for daily consumption was obtained either through hunting activities in forested areas or through purchase at traditional markets. Animals sold in these markets were commonly sourced from nearby localities as well as from other regions, including central and southern

longer eaten due to their protected status. This transition illustrated the influence of conservation policies on traditional food practices [30, 31]. At the same time, new forms of consumption emerged. In Bolaang Mongondow, domestic cattle (*Bos taurus indicus*) became obligatory dishes during wedding celebrations, while domestic goats (*Capra aegagrus hircus*) were incorporated into Islamic rituals such as *Aqiqah* or ceremonial haircutting of newborns, adapted to local customs. These patterns reflected ongoing processes of acculturation in which religious norms and contemporary celebrations were integrated with existing traditions rather than replacing them [32].

Overall, consumption practices reflected the dynamic characteristics of local cultures in responding to external pressures, including conservation regulations, changes in resource availability, and evolving religious and economic values. Consumption functioned as a space where tradition and change intersected, while simultaneously reinforcing cultural identity. The selection of species, timing of consumption, and use of specific preparation techniques, such as cooking with coconut milk, preparing soups, grilling or roasting, and distinctive local methods including *rica-rica* or *garo rica*, *rintheke wu'uk*, and *masak buluh*, reinforced connections between food, symbolism, and community. Viewed collectively, these patterns demonstrated that animal consumption among the three ethnic groups in North Sulawesi extended beyond the act of eating. It functioned as a cultural mechanism through which continuity was maintained while allowing space for adaptation to changing social and environmental conditions.

3.2 Animals as ritual elements

The findings indicated that ritual practices involving animals were more prevalent among Minahasa communities than among the other ethnic groups examined. Several of these practices were still actively performed, while others had undergone shifts in meaning as a result of the influence of incoming religions and broader social and ecological changes. Each species involved in ritual contexts carried a distinct symbolic role, functioning as an offering in ceremonial events, a medium for divination, a form of spiritual protection, or an indicator of social status during communal celebrations, depending on the cultural setting. These patterns highlighted the diversity of ritual functions and illustrated how communities continuously negotiated their relationships with both the social environment and the spiritual realm.



Figure 5. The *Rumarages* ritual using a domesticated red junglefowl (*Gallus gallus domesticus*) (A) Slaughtering a chicken for its blood, (B) The chicken blood offering ceremony at Waruga Lotta, Pineleng, Minahasa

The most dominant ritual pattern identified in this study was associated with divination or fortune-telling practices. A number of animals were employed as divinatory media within ritual contexts that followed highly specific rules and procedures. One prominent example was the domesticated red junglefowl (*Gallus gallus domesticus*). Among the Minahasa, this species was used in the *Rumarages* ritual (Figure 5), in which the direction of the bird's head after slaughter was interpreted as an omen for future events.

The individual selected for this ritual was required to be bright red in colour (locally referred to as *ko'ko randang*), with a body that was completely intact and free from physical defects. In addition to junglefowl, the Sulawesi warty pig (*Sus celebensis*) and the domestic pig (*Sus scrofa domesticus*) also played central roles in divinatory practices. These species were required in *Tumembo*, a ritual in which the pig's heart was split and symbolically “read” to convey messages related to prosperity, safety, and well-being.

Another culturally significant species was the endemic Minahasan owl known locally as the “Manguni” (*Otus manadensis*). This species was regarded as one of the most sacred and emblematic animals for the Minahasa community and had been adopted as a symbol of regional identity. Within ritual contexts, the Manguni owl functioned as an auditory medium for divination in practices known as *Kumatau* or *Tumalinga si ko'ko* (listening to the voice of the *Manguni*). When the owl vocalised between nine and twenty-one times, the calls were interpreted as conveying a message regarding the suitability of a location for settlement or the anticipated future of a community.

Beyond divinatory practices, another prominent ritual pattern identified in this study was associated with offering rituals that embodied concepts of total sacrifice and negotiation with the spiritual realm through the use of animals. The notion of total sacrifice was reflected in the *Rumaha* ritual, in which a domestic dog (*Canis familiaris*), often a companion animal of the household, was sacrificed as a symbol of sincerity during the construction of a new house. In this ritual, the dog's blood was applied to specific corners of the building as a protective and symbolic marker, while its meat was consumed in a restricted manner by selected ritual participants, including the owner. This practice illustrated how emotional bonds, sacrifice, and spiritual intentions were intertwined within the material and symbolic dimensions of ritual life.

The concept of negotiation with the spiritual realm was reflected in the *Mongundam Pombarroy* ritual, in which a Maleo egg (*Macrocephalon maleo*) was offered whole, without being cooked or otherwise processed, to non-human spiritual entities. This practice represented a form of negotiation and co-existence with beings perceived to inhabit the supernatural domain, in which the integrity of the offering was considered essential to its symbolic efficacy. Another ritual pattern identified in this study involved the use of animals as symbolic agents of atonement within the socio-cultural life of the community. Among the Talaud ethnic group, cases of *kawin sumbang* or consanguineous marriage required a ritual in which a white chicken was slaughtered. The blood of the animal was symbolically applied to sever existing kinship ties, thereby allowing a man and woman who shared a blood relation to be socially and ritually permitted to marry. This practice illustrated the role of animals as mediating agents of atonement and as instruments for restoring social order. The sacrifice of the white chicken marked a symbolic rupture of kinship relations while simultaneously creating a culturally

legitimate space for the marriage to proceed. In this context, the animal's blood functioned as a marker of purification and status transition, indicating that customary sanctions were not solely punitive in nature but also served as mechanisms for reconciliation and the restoration of family honour.

It is important to note that much of the ritual knowledge documented in this study was esoteric and accessible only to specific individuals or groups. At present, this knowledge appears to be at risk of erosion. The expertise required to interpret a pig's heart in *Tumembo* or to read the vocalisations of the Manguni owl in *Tumalinga si ko'ko* was held by only a small number of practitioners and was typically transmitted through particular familial or ritual lineages. This situation pointed to the vulnerability of local knowledge systems in the face of modernisation, religious transformation, and intergenerational shifts in worldview [1]. These findings underscore the urgency of documenting and safeguarding such forms of intangible cultural heritage, particularly those that remain closely embedded in ritual practice and oral transmission.

3.3 Animals carrying special myths or omens

Field data indicated that the 25 animal species associated with myths or omens functioned as symbolic references and interpretive markers within community life. Taxonomically, these species were distributed across six major groups, including Aves (12 species), Mammalia (5 species), Reptilia (5 species), Insecta (2 species), and Chilopoda (1 species). This composition demonstrated that birds were most frequently linked to mythic and omen-related interpretations, followed by mammals and reptiles, while the remaining groups were represented in smaller numbers.

The data on myths and omens revealed a complex system of local knowledge in which animals functioned as signs and mediators in the relationships between humans, the spiritual realm, and the social environment. Within this system, the Minahasa and Bolaang Mongondow communities were identified as possessing particularly rich and well-developed interpretive traditions related to animal presence and behaviour. One of the most prominent forms of omen-related knowledge documented in this study involved auditory-based divination practices, which emerged as a distinctive cultural feature.

Among the Minahasa, the vocalisations of the Manguni owl (*Otus manadensis*) were interpreted as conveying specific meanings based on four recognised call types. These included *Mahwanguni* (a normal call) and *Maapi* (a high-pitched call), both of which were interpreted as signs of favourable events, as well as *Karengkom* (a low-pitched call) and *Rawoy* (a faint or soft call), which were associated with warnings or impending misfortune. A comparable interpretive system was identified within the *Monarrenga* tradition of Bolaang Mongondow, where the calls of birds, particularly the same owl species (*O. manadensis*) and the Lesser Coucal (*Centropus bengalensis*) were used to anticipate future events, including the outcomes of local political processes. In this context, interpretations were based on variations in sound volume, intensity, and timing.

Another species closely associated with auditory divination was the Minahasan masked owl (*Tyto inexpectata*), whose calls were interpreted in relatively consistent ways across the three ethnic groups. The intensity of its vocalisation, together with the direction of its flight, was commonly understood as a

sign indicating birth, death, or social disruption. In addition, the grasshopper (Orthoptera) was identified as an animal whose sound carried divinatory meaning, although interpretations varied according to spatial context. Sounds produced from outside the house were interpreted as signs of impending misfortune, whereas calls originating from within the house were understood as indicating the presence of ancestral spirits that required respect. Collectively, these auditory-based practices underscored a high degree of cultural sensitivity to the acoustic environment and illustrated how natural phenomena were transformed into a coherent and socially shared interpretive framework [33, 34].

In addition to sound-based signs, communities also possessed knowledge related to animals whose physical presence was interpreted in multiple ways across symbolic and practical contexts. Species frequently associated with such interpretations included the black snake or Sulawesi black racer (*Ptyas dipsas*), fruit bats (*Pteropus* spp.; *Acerodon* spp.), and the Asian water monitor (*Varanus salvator*). From a more pragmatic perspective, the appearance of the Maleo bird (*Macrocephalon maleo*), the black cat (*Felis silvestris catus*), and again the black snake (*P. dipsas*) was associated with specific environmental indicators, particularly among the Bolaang Mongondow community.

Within symbolic belief systems, the appearance of a black snake among the Minahasa was interpreted as a sign of ancestral presence. Fruit bats were associated with different meanings across groups: among the Minahasa, their presence was believed to convey ancestral messages, whereas among the Bolaang Mongondow, the nocturnal sounds and movements of fruit bats were interpreted as indications of potentially harmful human activity near settlements. The Asian water monitor was consistently regarded across all three ethnic groups as an omen of misfortune when it entered a house. Although the species could be consumed in other contexts, individuals encountered within domestic spaces were not eaten. Instead, they were killed and discarded, and in some cases, households performed small protective rituals to neutralise the perceived negative implications of the encounter.

From a pragmatic standpoint, the appearance of black snakes, Maleo birds, and black cats in certain locations was interpreted by the Bolaang Mongondow as an indicator of gold deposits in the surrounding area. This practice may be understood as a form of locally grounded environmental interpretation derived from long-term observation and accumulated ecological experience, in which recurring associations between animal presence and landscape features informed practical decision-making.

Overall, knowledge related to myths and omens in North Sulawesi exhibited two interrelated dimensions. While such knowledge has often been framed externally as superstition or as a remnant of past belief systems, within the communities, it functioned as a living and adaptive body of understanding through which people interpreted uncertainty and made sense of their environment. For a segment of traditional society, these interpretive frameworks continued to inform everyday decisions, ranging from personal concerns to broader social and environmental circumstances.

3.4 Animals as local craft inspiration

Field investigations documented 23 animal species that were incorporated into local arts and crafts, either as direct

material components of craft products or as visual inspirations expressed through carved motifs and decorative representations. These species belonged to several taxonomic classes, including Mammalia (9 species), Aves (5 species), Reptilia (6 species), Actinopterygii (2 species), and Gastropoda (1 species). The use of animals in artistic practices was grouped into three main forms: the direct use of animal body parts, the creation of replicas or motifs inspired by animals, and the incorporation of animal elements into tools or household objects.

Direct use was illustrated by the incorporation of the skull of the Sulawesi crested black macaque (*Macaca nigra*), the tusks of the Sulawesi babirusa (*Babyrousa celebensis*), and the feathers of domestic junglefowl (*Gallus gallus domesticus*) as ornaments on Kabasaran attire among the Minahasa. Deer antlers (*Rusa timorensis*) were also displayed decoratively in the homes of Bolaang Mongondow households, where they functioned as markers of prestige and social standing.

The study also recorded the use of elephant ivory fashioned into bracelets worn by *Tonaas* (traditional leaders). As Sulawesi has no native populations of either the Asian elephant (*Elephas maximus*) or African elephants (*Loxodonta* spp.), the ivory used for these ornaments originated outside the island. Historical accounts from the Portuguese and VOC periods documented those traders from Makassar and Ternate. Within this historical context, ivory bracelets likely functioned as symbols of status among *Walak* (heads of sub-tribes) and *Tonaas*. In Minahasan social life, bracelets made from rare materials such as gold, bronze, and ivory were commonly worn on the upper arm or wrist during customary ceremonies and symbolized honour, wealth, and connections to wider regional and international trading networks.



Figure 6. Some examples of animal-inspired crafts: (A) Owl carving, (B) Deer skin drum, (C) Bentenan Minahasa woven fabrics, (D) Deer antlers as decoration

Animal replicas and motifs were also widely represented in carvings depicting the endemic Minahasan owl Manguni

(*Otus manadensis*), tarsiers (*Tarsius* spp.), and several turtle species (*Caretta* sp.; *Chelonia* sp.; *Eretmochelys* sp.; *Lepidochelys* sp.; *Dermochelys* sp.). These motifs appeared in handicraft souvenirs as well as in the patterns of Bentenan woven textiles characteristic of Minahasa. In addition, animals were incorporated into tools and musical instruments. Notable examples included the shell of the giant triton trumpet (*Charonia tritonis*), locally known as *Bia*, which was used as a wind instrument by the Bantik people (a Minahasan sub-ethnic group) in Talaud; deer skin (*R. timorensis*), which was used as the membrane of traditional drums; and horn bone from the anoa (*Bubalus* spp.), which was utilized in local fishing-net equipment in Bolaang Mongondow (Figure 6).

Taken together, these practices revealed a consistent pattern in which animals were not perceived solely as material resources but as culturally meaningful elements that expressed relationships with nature, spirituality, and collective identity. Comparative analysis further indicated similarities in the species used as craft materials by both the Minahasa and Bolaang Mongondow communities, particularly the anoa (*Bubalus* spp.), the knobbed hornbill (*Rhyticeros cassidix*), and the Timor deer (*R. timorensis*). These shared practices were interpreted as reflecting ecological proximity, overlapping access to natural resources, and participation in comparable networks of knowledge exchange and social prestige. Such parallels were likely shaped by long-standing hunting traditions and intersecting cosmological frameworks that informed each group's relationship with the natural world.

In contemporary contexts, the use of animals in arts and crafts, especially in the production of replicas and souvenirs, has undergone a gradual shift in meaning. Tourism-driven economic opportunities and increasing conservation awareness have redirected the primary function of these objects from expressions of spiritual significance and internal social status to aesthetic commodities intended for external audiences. Souvenirs depicting tarsiers or *Bentenan* textiles featuring *Manguni* motifs were increasingly produced as travel mementos rather than as direct expressions of local cosmology.

Furthermore, the introduction of regulations protecting endangered species such as the babirusa and the anoa encouraged material substitution. Wooden or resin replicas have largely replaced the use of original animal parts. Rather than indicating a loss of cultural value, this transition reflected an adaptive process through which cultural meanings were renegotiated in response to changing ecological, legal, and socio-economic conditions.

3.5 Animals with symbols and emblems

Field investigations documented 16 animal species used as symbols and emblems across communities and regions. These representations appeared in logos and insignias, as well as in motifs, carvings, and decorative objects. Taxonomically, the species were grouped into Mammalia (4 species), Aves (8 species), and Reptilia (4 species). Five prominent patterns were identified in the symbolic use of animals. These included animals representing social status and leadership, symbols of strength and protection, markers of professional or social roles, symbolic elements embedded in ritual and transcendent belief systems, and sources of moral teaching. Each pattern encompassed several species, and some animals appeared across multiple categories, reflecting the layered nature of symbolic meaning.

Within the domain of social status and leadership, species such as the anoa (*Bubalus* spp.) and the knobbed hornbill (*Rhyticeros cassidix*) were consistently selected as emblems of authority and prestige. The anoa was interpreted as a symbol of physical strength and leadership legitimacy. This symbolism was expressed through the placement of its horns on Minahasan Kabasaran ceremonial headdresses, on *Bogani* (traditional leader) statues in Bolaang Mongondow, and in carved motifs on ancient stone tombs (Waruga). The knobbed hornbill, represented through both male and female beaks in Kabasaran attire, was associated with wisdom and loyalty—qualities considered essential for leadership. In addition, the white-feathered junglefowl functioned as a symbol of leadership acting on behalf of nature, reinforcing the cosmological dimensions embedded within local social structures.

Animals were also widely employed as symbols of strength and protection. Body parts such as horns, tusks, and skulls were incorporated into ceremonial attire and weaponry. The tusks of the Sulawesi babirusa (*Babyrousa celebensis*) and bracelets bearing black snake (*Ptyas dipsas*) motifs worn in Kabasaran dress were interpreted as sources of physical strength and spiritual protection. Similarly, skulls of hunted animals such as the anoa, babirusa, and Sulawesi crested black macaque (*Macaca nigra*), attached to necklaces, signified the wearer's identity as a hunter while also functioning as talismans symbolizing resilience and vigilance.

Animals further served as markers of professional or social identity in historical community contexts. This role was evident in carvings on Waruga, which functioned as visual records of the deceased's occupation. Motifs depicting the Asian water monitor (*Varanus salvator*) and dogs (*Canis familiaris*) indicated individuals associated with hunting, whereas carvings of chickens represented livelihoods related to animal husbandry. These symbols were not merely decorative; they acted as biographical markers documenting social roles and contributions during an individual's lifetime.

Within ritual and transcendent belief systems, several animals were regarded as intermediaries between humans and the spiritual realm. The Manguni owl (*Otus manadensis*) was believed to convey prayers and messages to the Divine, particularly through rituals such as *Tumalinga si ko'ko*, in which its presence or vocalisations were interpreted as signs of cosmic approval. Beyond ritual contexts, the Manguni owl also functioned as an emblem for religious institutions, including the Christian Evangelical Church in Minahasa (GMIM), and for several governmental entities across North Sulawesi. The black snake likewise carried transcendent symbolism. In *Waruga* carvings, the snake was interpreted as a vehicle transporting ancestral souls to the afterlife, reflecting cosmological beliefs linking the earthly and spiritual realms.

Finally, animals served as sources of moral instruction conveyed through proverbs and traditional counsel. The reproductive behaviour of the maleo bird (*Macrocephalon maleo*), which leaves its eggs unattended, inspired the Bolaang Mongondow expression *dikadeana nin tuwanggoy*, reminding parents not to neglect their responsibilities in child-rearing. Similarly, the Yellow-billed Malkoha (*Phaenicophaeus calyborhynchus*), known for looking back before moving forward, functioned as a metaphor for caution and adaptability, particularly for young people preparing to leave their home communities.

3.6 Animals as traditional medicine ingredients

Field studies identified 16 animal species used as ingredients in traditional medicinal practices. Taxonomically, these species were classified into Mammalia and Reptilia (7 species each), as well as Actinopterygii and Chilopoda (1 species each). Several recurring patterns characterised their medicinal use.

One notable pattern involved the use of animals in live or raw forms to treat specific illnesses, particularly respiratory conditions such as asthma. The house gecko (*Hemidactylus frenatus*) and the white-tailed rat (*Maxomys hellwaldii*) were used as remedies for respiratory problems by swallowing them alive. Only small individuals were used, and in the case of rats, newborns rather than adults were required. Another species consumed in raw form was pufferfish (Tetraodontidae), whose liver was believed to accelerate recovery following medical treatment. These practices reflected a belief that the therapeutic properties of animals were most effective when used in an unprocessed state.

A second pattern concerned the use of animals to enhance vitality and male adult health. Species commonly associated with this purpose included the anoa (*Bubalus* spp.), reticulated python (*Malayopython reticulatus*), Asian water monitor (*Varanus salvator*), and saltwater crocodile (*Crocodylus porosus*). Body parts such as anoa horns, python bile, monitor lizard meat, and crocodile genital organs were prepared as medicinal dishes or remedies. These animals were believed to enhance stamina and fertility, reflecting symbolic associations with strength and masculinity.

One of the most distinctive practices documented was the use of dog limbs (*Canis lupus familiaris*) as a traditional remedy for fever and malaria in children. The preparation involved cleaning and boiling the dog's legs at high temperatures to produce a decoction. This practice was still practiced among the Minahasa and Talaud communities and was believed to address immune-related illnesses commonly affecting children.

In addition to ingestion-based treatments, several animals were processed into topical oils used to treat skin conditions and muscle cramps. Species included the Asian water monitor (*V. salvator*) and the giant centipede (*Scolopendra subspinipes*). These oils were applied to relieve itching, swelling, and soreness. In some cases, particularly among Talaud communities, the preparation process incorporated ritual elements. For example, coconuts used as mixing ingredients were required to be "peeled by a wild boar," a symbolic condition believed to impart spiritual efficacy to the oil. This illustrates that traditional medicinal practices were not solely therapeutic but were deeply embedded within symbolic and spiritual frameworks.

Despite their cultural significance, these practices face increasing challenges related to species conservation and public health. Several animals used in traditional medicine, such as the anoa and the Sulawesi crested macaque, are legally protected. In addition, the consumption of live or raw animals poses potential risks of zoonotic disease transmission [35, 36]. A balanced and integrative approach is therefore needed to reconcile cultural continuity, public health considerations, and biodiversity conservation. Further scientific research is required to evaluate the efficacy of these traditional remedies, which remain based on oral knowledge and accumulated community experience. Nonetheless, the documented practices provided valuable insights into culturally informed

pathways through which traditional knowledge could be ethically and ecologically integrated with modern medicine and pharmacology.

These patterns suggest that animal use among local communities operated within adaptive cultural systems, in which cultural practices simultaneously mediated subsistence needs and regulated human–fauna interactions through informal governance mechanisms.

4. DISCUSSION

4.1 Interpreting local ethnozoological knowledge as a multi-domain system of meaning

The human–animal relations documented among the Minahasa, Bolaang Mongondow, and Talaud peoples of North Sulawesi are best understood as an adaptive cultural system in which subsistence needs, ethical–moral order, and customary cosmology are mutually constitutive and tightly interlocked [37, 38]. Within the ethnozoological lens applied in this study, animals are not merely “used” or reduced to objects of “exploitation”; they also shape how communities read landscapes, calculate risk, and anticipate future contingencies. In this respect, animals’ function both as material resources that are directly appropriated especially through the use of particular body parts such as meat, blood, horns, and skulls and as indirectly mobilized entities [39], insofar as communities attend to animals’ movement directions, vocal patterns, acoustic rhythms, and echo signatures, which are then treated as a legitimizing medium for collective decision-making. This interpretive mode aligns closely with the methodological framework of multispecies ethnography, which foregrounds the entanglement of human life with non-human organisms in the ordinary practices of everyday social worlds [40].

In the domain of consumption, these ethnozoological findings further indicate that animal consumption operates as a social device that regulates propriety and solidarity, rather than merely reflecting taste preferences [41]. The differentiation between everyday consumption, consumption during festive moments (holidays), and ritual consumption suggests that the choice of species is governed by local rules or norms and by specific social occasions [42]. Within this framework, several wild species, such as the Sulawesi fruit bat (*Acerodon celebensis*), white-tailed rat (*Maxomys hellwaldii*), water monitor lizard (*Varanus salvator*), and reticulated python (*Malayopython reticulatus*), emerge as “meaningful foods” [11, 42], whose procurement is shaped not only by ecological availability through hunting but also by commodity circulation when demand rises during particular moments. Accordingly, these species can be understood as situated at the intersection of forest-landscape subsistence and market dynamics, consistent with findings from the study of wildlife markets in North Sulawesi that document extensive trade networks dominated by taxa such as flying foxes, wild pigs, rats, and snakes supplied through market channels [16]. However, the sharper analytical contribution of these findings lies not in the inventory of species per se, but in reconstructing the meanings through which communities assign “value” to animals. A pattern of “shared taxonomy, divergent semantics” becomes evident when Sulawesi fruit bats and white-tailed rats in Minahasa are positioned as prestige foods reserved for *Kumanlaker* (a tradition of communal feasting on specific

occasions), whereas *Weris* birds (*Rallidae*) are more commonly associated with everyday consumption; conversely, the eel (*Anguilla celebensis*) is regarded as ordinary in Minahasa yet considered prestigious in Talaud. This variation suggests that prestige is shaped by local scarcity, histories of access, and celebratory contexts [42, 43] such that “value” is a social construction sustained by collective memory and status differentiation [12, 42].

Moreover, consumption shifts driven by conservation regulations and religious transformation point to a non-linear form of adaptation, in which tradition does not unfold as a simple “disappearance versus persistence,” but rather as an ongoing negotiation of norms. The cessation of consuming protected species such as Celebes crested macaque (*M. nigra*) or Anoa (*B. depressicornis*/*B. quarlesi*) does not automatically sever the social function of communal feasting. Instead, what emerges is substitution and a recombination of rules, for example, the obligation to serve beef at wedding feasts in Bolaang Mongondow (as a substitute for increasingly scarce wild game) and the incorporation of goat dishes into Islamic rites such as *aqiqah* (as a prescription embedded in a newly adopted belief system). Theoretically, these findings position religion and policy not as “tradition erasers,” but as new normative regimes that are braided into local feasting logics to sustain social cohesion [44].

In the ritual domain, animals function as a “technology of certainty” through which communities manage the uncertainties of life. Practices such as *Rumarages* (“reading” the direction of a chicken’s head), *Tumembo* (observing a pig’s heart), and *Tumalinga si ko’ko/Kumatau* (listening to the call of the *Manguni* (*Otus Manadensis*)) are not merely private beliefs; rather, they are collective procedures that generate the legitimacy of decisions, ranging from safety and well-being to the suitability of a place to live. What is especially distinctive is the stringency of the protocols (e.g., the selection of specific individual animals for ritual use, prohibitions on using salt in ritual meat, and the counting of bird calls), because such protocols make interpretations socially recognizable and not simply dependent on personal intuition.

Sacrificial and expiatory rites also reveal an ethical dimension in human–animal relations that is often missed in utilitarian readings [42, 45]. *Rumaha* ritual positions a companion dog as a medium of sincerity and protection in house construction; *Mongundam Pombarroy* requires an intact Maleo egg offering as a strategy for negotiating with non-human entities; while the *kawin sumbang* rite in Talaud, involving a white chicken, uses blood as a marker of transition to restore the kinship order. Here, animals are not merely “ritual materials,” but instruments of reconciliation that close social crises, normalize relations, and restore family honour through signs that are collectively recognized.

The category of myths and omens further underscores that ethnozoological knowledge also operates as a semiotic system for reading risk and the environment, particularly through acoustics. The typology of *Manguni* calls and the *Monarrena* tradition in Bolaang Mongondow indicate a form of ecological literacy attuned to soundscapes, in which variations in volume, intensity, timing, and direction of movement/flight are translated into shared social information and are even used to interpret local political dynamics. When omens are understood as a “language of vigilance,” they function as an orienting device that helps individuals navigate uncertainty, while also reinforcing the authority of particular forms of knowledge within the community [46].

In the domain of arts, symbols, and emblems, animals are materialized into biocultural identity through body parts (babirusa tusks, Celebes crested macaque skulls, anoa horns), representational forms (the *Manguni* motif in carvings and *Bentenan* textiles), and biographical archives (faunal motifs on Waruga that index a person's occupation). This pattern aligns with the concept of cultural keystone species [47], in which particular species become anchors of identity because their roles cut across domains encompassing diet, ritual, material culture, and public symbolism so that changes affecting these species can potentially unsettle how communities make sense of themselves and their histories [48].

The zootherapy domain adds an important layer because it reveals a form of "cultural pharmacy" intertwined with symbols of strength and efficacy. Practices such as swallowing live geckos or baby rats for asthma, consuming pufferfish liver, using python bile or crocodile genital organs for vitality, and boiling dog feet for fever/malaria indicate that animal bodies are read as reservoirs of vitality and healing. Zootherapy scholarship emphasizes that animal-based practices are widespread cross-culturally, yet carry dual implications for public health and conservation, especially when they involve raw consumption or species whose populations are under pressure [49, 50].

The practical significance of this study becomes most evident when situated within the "One Health" agenda, which recognizes the interconnectedness of human, animal, and ecosystem health [50, 51]. Rather than relying on criminalization that severs trust, these findings support culturally sensitive risk-reduction strategies: mapping "cultural keystone" species and the contexts in which they are used (food-ritual-medicine); engaging in dialogue with customary and ritual authorities to formulate substitutions that preserve symbolic functions; and providing risk-mitigation guidance at key points of vulnerability (e.g., practices of raw/live consumption and market circulation), in line with disease-risk management guidelines for wildlife trade [50].

4.2 Integration of conservation and local wisdom

Wildlife conservation in North Sulawesi was unlikely to be sustained through scientific approaches and regulatory enforcement alone. The long-term persistence of fauna in the region depends on the recognition and reinforcement of traditional knowledge systems embedded within the cultural practices [52] of the Minahasa, Bolaang Mongondow, and Talaud communities. The findings of this study indicated that more than 70% of the animal species used by local communities were sourced from the wild, while approximately 32% were classified as threatened (VU-CR) according to the IUCN Red List. These patterns underscored the need for conservation frameworks that address not only species protection but also the cultural values and local ecological knowledge shaping human-wildlife relationships.

The first priority involved the systematic documentation and revitalization of local knowledge. Customary practices such as prohibitions on hunting culturally sacred animals (e.g., the Sulawesi scops-owl and the Maleo), restrictions on hunting seasons, and obligations to conduct thanksgiving rituals prior to harvesting natural resources functioned as informal regulatory mechanisms. Historically, these practices contributed to maintaining wildlife populations and regulating resource use. Documenting such knowledge and integrating it into regional conservation strategies would be consistent with

national commitments to recognise and incorporate local wisdom, as articulated in Indonesia's National Strategy for Local Wisdom for Biodiversity 2023–2030.

The second priority concerned strengthening collaboration among key stakeholders, including indigenous communities, research institutions, local governments, and conservation organisations. Such collaboration was essential because communities engaged across the six ethnozoological domains from food and ritual practices to traditional medicine possessed detailed, place-based knowledge of habitats, seasonal cycles, and animal behaviour. This knowledge represented a critical resource for adaptive wildlife management. Community-based conservation models that actively involve local residents in population monitoring and habitat protection could support the conservation of endemic and threatened species [53], including the Celebes crested macaque (*Macaca nigra*), the Sulawesi babirusa (*B. celebensis*), the anoa (*B. quarlesi* and *B. depressicornis*), and Gursky's spectral tarsier (*T. spectrumgurskyae*).

The third priority focused on intergenerational knowledge transmission and the integration of cultural values into education and local livelihoods. Animal symbolism expressed through myths, artistic traditions, and rituals provided culturally resonant material that could be incorporated into local curricula, educational media, and culture-based ecotourism initiatives [54]. Such approaches may support younger generations in understanding the ecological significance of wildlife while fostering a sense of cultural identity and stewardship [55]. In this context, conservation was framed not only as an ecological responsibility but also as a moral responsibility and an expression of social identity.

At the same time, implementing local-wisdom-based conservation requires anticipating practical challenges that often emerge at the interface between customary practice, public health, and statutory conservation law [56]. A key challenge is reconciling culturally embedded medicinal practices with species-protection regulations, particularly when remedies involve threatened or legally protected fauna [56, 57]. A pragmatic approach is to develop a tiered management pathway: first, systematically identify medicinal uses that involve protected or IUCN-listed threatened species [57]; second, prioritise culturally acceptable substitutions (species substitution, plant-based alternatives, or non-lethal derivatives where feasible) and provide harm-reduction guidance for practices involving raw ingestion [58]; and third, where substitution is not socially viable, negotiate legally compliant arrangements that avoid criminalising local knowledge while still reducing extraction pressure [58], e.g., community-agreed moratoria for highly threatened taxa, locally monitored limits for non-protected species [59] and, where appropriate, regulated captive-rearing for taxa that can be ethically and ecologically managed. Such reconciliation also requires an explicit cross-walk between customary norms and state regulations so that conservation objectives are pursued through locally legitimate rules rather than solely through punitive enforcement.

A second challenge concerns governance and equity: participatory conservation can inadvertently instrumentalise communities as mere "data providers" or low-cost labour for externally defined agendas. To prevent tokenism and power asymmetries, local communities should be positioned as primary rights-holders and decision-makers through clear safeguards, including Free, Prior and Informed Consent (FPIC) procedures; co-management agreements that specify

decision authority, benefit-sharing, and accountability; and community control over sensitive ethnozoological information (to prevent unintended facilitation of hunting or trade). Transparent compensation for monitoring and stewardship work, locally accessible grievance mechanisms, and periodic community-led evaluations are also necessary to ensure that partnerships remain socially equitable and that cultural knowledge is not extracted without reciprocal benefits. In this framework, “participation” is treated as community sovereignty over conservation priorities rather than as an instrument to legitimise external interventions [60].

All of these recommendations could be further strengthened by aligning local-wisdom-based conservation initiatives with existing regulatory frameworks, including the Regulation of the Minister of Environment and Forestry No. 106 of 2018 concerning protected plant and animal species, as well as mechanisms for safeguarding traditional knowledge outlined in national environmental strategies. Greater synchronization between state regulations and customary practices was likely

to contribute to conservation systems that are more adaptive, participatory, and socially equitable.

4.3 Comparative analysis of similarities and differences across the three ethnic groups

Despite a broadly shared ethnozoological repertoire, the Minahasa, Bolaang Mongondow, and Talaud communities show clear differences in species use (Figure 7). A small set of animals, including the Asian water monitor, domesticated red junglefowl, Minahasa Masked-owl, reticulated python, saltwater crocodile, and Sulawesi Warty Pig, is common to all groups, while each community also maintains unique species, with Minahasa exhibiting the largest number of exclusive taxa. These patterns highlight how local ecological availability and cultural preferences shape species use alongside shared regional practices across food, medicine, ritual, material culture, and omens.

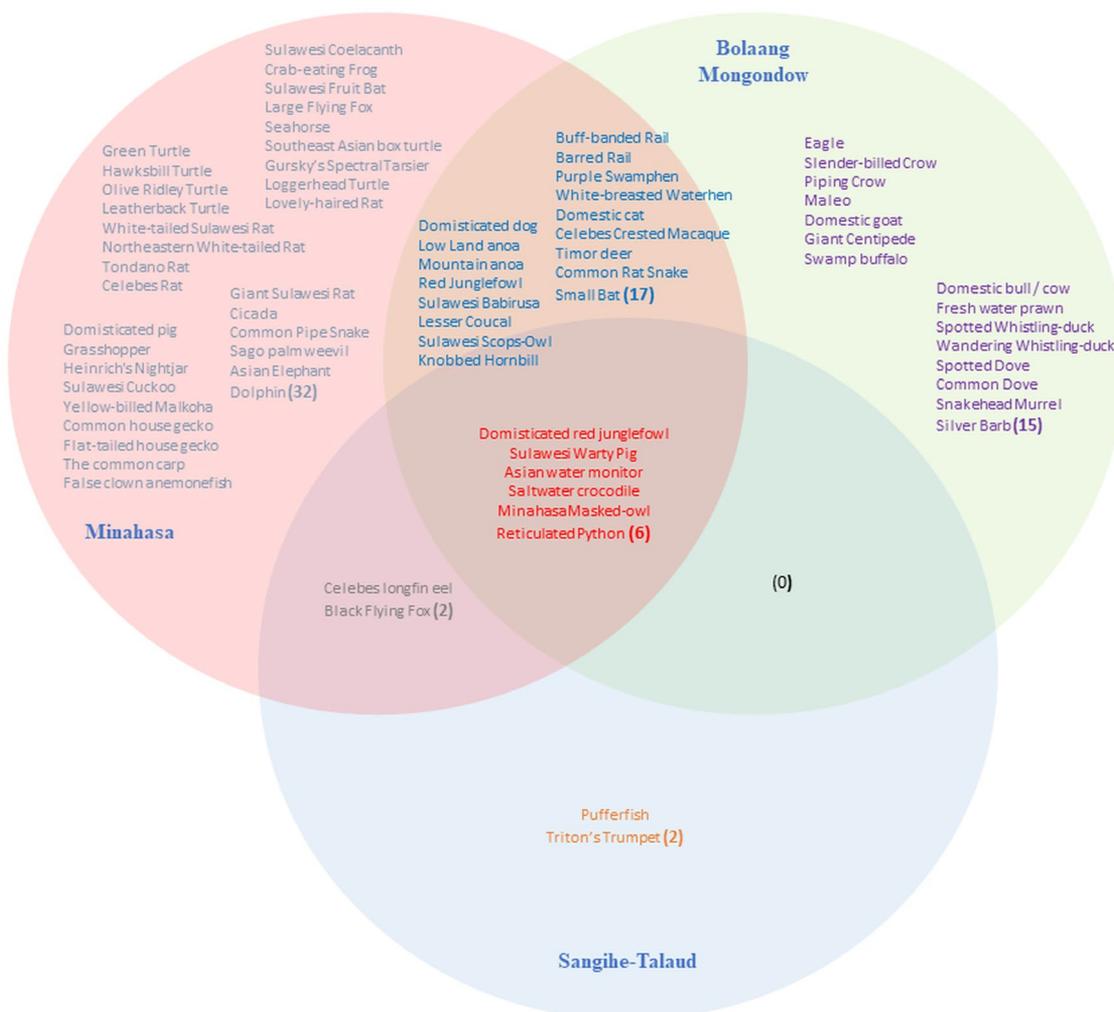


Figure 7. Venn diagram showing shared and unique animal species used by the three ethnic groups (Minahasa, Bolaang Mongondow, and Sangihe-Talaud) Numbers in parentheses indicate the total number of species in each area.

However, the social distribution of value differs: Minahasa more prominently frames certain wild taxa as prestige foods embedded in communal feasting (e.g., *Kumanlaker*), thereby stabilizing “value” through commensality, status display, and public social occasions; Bolaang Mongondow shows stronger evidence of normative recombination in food practices, where ritual and celebratory consumption increasingly intersects

with religious prescriptions and formalized rules (e.g., beef obligations for weddings and goat dishes in Islamic rites such as *aqiqah*); while Talaud displays distinct prestige hierarchies and expiatory rites (e.g., eel as a prestige food and *kawin sumbang* involving a white chicken), indicating that symbolic intensity and ritual specificity remain particularly salient. Consequently, the same or similar taxonomic categories can

carry divergent semantics across groups. What is ordinary in one setting may be prestigious, ritually obligatory, or morally regulated in another. This indicates that “use” is not merely ecological but is deeply institutional and relational [42, 43]. These inter-ethnic differences are best explained by the interaction of several main drivers that structure human–animal relations at different scales. First, ecological availability and local scarcity shape which animals become routine foods versus special-occasion resources, but scarcity alone does not determine meaning; rather, scarcity is translated into social value through local institutions [42, 43, 61]. Second, market integration and procurement channels (hunting/capture versus commodity circulation) modulate when and how wild taxa enter consumption, particularly around festive moments when demand rises [41], thereby amplifying the interface between forest landscapes and marketplaces [62]. Third, religious transformation and normative enforcement, including doctrinal prescriptions and shifting moral economies, appear to function as a powerful re-scripting mechanism. This is especially visible in Bolaang Mongondow, where species substitution and rule recombination occur without eliminating the social function of feasting. Fourth, the strength of ritual institutions and knowledge authority (who may interpret signs, who may perform rites, and how protocols are standardized) governs how animals become legitimizing media for collective decisions, from divination to expiation. Taken together, these drivers account for the patterned variation observed across the three groups and clarify why similar animals can be mobilized differently as foods, medicines, signs, and identity anchors, while still remaining within a shared regional framework of adaptive ethnozoological knowledge.

5. CONCLUSIONS

This study demonstrated that fauna in North Sulawesi played complex and multifaceted roles in the lives of the Minahasa, Bolaang Mongondow, and Sangihe–Talaud communities. Six ethnozoological domains were identified: food, ritual, myths or omens, arts and crafts, symbols, and traditional medicine. Overall, the findings indicated that human–animal relationships in this region extended well beyond the fulfilment of physiological needs and were deeply embedded within cultural systems, belief structures, and locally grounded ecological knowledge.

The use of animals as sources of food reflected an adaptive system of food-related knowledge shaped by environmental conditions and seasonal availability. Animals were perceived not merely as sources of protein, but as resources whose use was regulated through customary norms and ecological awareness. This system contributed to long-standing food security and illustrated the close relationship between communities and their surrounding environments. In spiritual contexts, animals occupied central positions in ritual practices, where selected species were believed to mediate relationships between humans, ancestors, and supernatural forces, thereby reinforcing collective identity and cultural continuity.

Several animals were associated with myths or omens that influenced everyday behaviour and decision-making. The presence, movement, or vocalisations of particular species functioned as locally embedded systems of environmental interpretation, assisting communities in navigating uncertainty. These beliefs were not treated simply as inherited

narratives but as practical knowledge integrated into daily life. From an aesthetic and material perspective, animals also served as sources of inspiration and raw materials for local crafts. Animal forms and body parts were transformed into ornaments, carvings, textiles, and other artistic expressions that carried both cultural and economic value, reflecting technical skills as well as a deep appreciation of local fauna.

Certain species further functioned as symbols representing moral and social values. Attributes such as courage, loyalty, wisdom, and responsibility were associated with particular animals, allowing them to operate as moral metaphors within community life. Through these symbolic associations, animals contributed to the transmission of ethical principles, the reinforcement of social structures, and the preservation of local philosophies. The use of animals in traditional medicine likewise reflected a rich body of ethnomedical knowledge developed through long-term observation and experience. Preparations derived from specific animal parts were based on culturally grounded understandings of therapeutic efficacy, illustrating how healthcare practices were aligned with available natural resources.

Although similarities and differences were observed among the ethnozoological practices of the Minahasa, Bolaang Mongondow, and Sangihe–Talaud—shaped by geography, subsistence histories, and processes of cultural change—the shared foundation of local wisdom is increasingly under pressure. Modernization, weakening intergenerational knowledge transmission, and habitat degradation affecting key species have contributed to the declining use or disappearance of several culturally important animals. These findings highlight the urgency of systematic documentation and the careful integration of traditional knowledge into contemporary conservation frameworks. Approaches that combine community participation, cultural revitalization, and species protection (such as community-based management initiatives and improved regulation of wildlife exploitation) offer important pathways for sustaining both biodiversity and the cultural systems that depend upon it.

Theoretically, this study contributes in two principal ways. First, it provides a systematic cross-ethnic comparative ethnozoological dataset for North Sulawesi by documenting animal uses across six domains (food, ritual, omens, arts/crafts, symbols, and medicine) and by mapping how similar taxa acquire divergent meanings across Minahasa, Bolaang Mongondow, and Sangihe–Talaud. Second, it clarifies the cultural logic of multifunctional animal utilization, showing how single species can simultaneously operate as food, moral symbol, ritual mediator, and therapeutic resource, thereby linking subsistence practices with ethical order and customary cosmology.

Practically, the findings offer a culturally grounded basis for species-focused conservation and management, particularly for endemic and/or threatened fauna that are embedded in local practices. By identifying culturally salient species and the contexts in which they are used, the study enables targeted recommendations, such as prioritizing community-led monitoring and habitat protection for high-risk taxa, promoting culturally acceptable substitution pathways where protected species are involved (especially in medicinal and ritual contexts), and aligning customary stewardship mechanisms with existing conservation regulations, so that conservation interventions protect both biodiversity and the social institutions through which wildlife management is locally enacted.

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REFERENCES

- [1] Aswani, S., Lemahieu, A., Sauer, W.H. (2018). Global trends of local ecological knowledge and future implications. *PloS One*, 13(4): e0195440. <https://doi.org/10.1371/journal.pone.0195440>
- [2] Von Rintelen, K., Arida, E., Häuser, C. (2017). A review of biodiversity-related issues and challenges in megadiverse Indonesia and other Southeast Asian countries. *Research Ideas and Outcomes*, 3: e20860. <https://doi.org/10.3897/rio.3.e20860>
- [3] Borelli, T., Keim, A., Sujarwo, W., Koostanto, H., Pawera, L., Gullotta, G., Jalonen, R., Lombardo, A., Hunter, D. (2024). Invisible treasures: Assessing Indonesia's unique agrobiodiversity for food and nutrition security. *Sustainability*, 16(22): 9824. <https://doi.org/10.3390/su16229824>
- [4] Setiawan, A. (2022). Indonesia's biodiversity: Problems and conservation efforts. *Indonesian Journal of Conservation*, 11(1): 13-21. <https://journal.unnes.ac.id/nju/index.php/ijc/article/view/34532>.
- [5] Olmos-Martínez, E., Romero-Schmidt, H.L., Blázquez, M.D.C., Arias-González, C., Ortega-Rubio, A. (2022). Human communities in protected natural areas and biodiversity conservation. *Diversity*, 14(6): 441. <https://doi.org/10.3390/d14060441>
- [6] BPS-Statistic of Sulawesi Utara Province. (2022). Sulawesi Utara Province in Figures, BPS-Statistic of Sulawesi Utara Province, Sulawesi Utara. <https://sulut.bps.go.id/en/publication/2022/02/25/58020909848743d283b68afa/provinsi-sulawesi-utara-dalam-angka-2022.html>.
- [7] Purba, A., Sinjal, J.C., Mumekh, I.M.O., Crismas, G., Sitepu, B., Anto, A., Nduru, P., Lukalemba, A.A., Winoto, D.E. (2023). Minahasa cultural customs. *International Journal of Multicultural and Multireligious Understanding*, 10(2): 549-557. <https://ijmmu.com/index.php/ijmmu/article/view/4356>.
- [8] Mokoginta, M.P.A., Amir, A., Tanjung, I.L., Hamid, A.R. (2023). Tracing the maritime footsteps of the Bolaang Mongondow people: 16th – 19th centuries. *Gema Wiralodra*, 14(1): 137-155. <https://doi.org/10.31943/gw.v14i1.376>
- [9] Bawias, I., Lungari, F. (2023). The effect of locations adjacent to other countries on the development of fishery technology in the Sangihe and Talaud Islands. *Maritime Technology and Society*, 2(2): 61-65. <https://doi.org/10.62012/mp.v2i2.27430>
- [10] Sumolang, S., Sampe, S., Kumayas, N. (2023). The marine space of the Sangihe-Talaud Islands community on the Indonesia-Philippines border: "Spice Route, Maritime Culture, and Marine Resource Management". https://repo.unsrat.ac.id/4632/1/Ruang%20Laut%20sangihe%20-%20buku%20Steven%20Final_compressed.pdf.
- [11] Alves, R.R.N. (2012). Relationships between fauna and people and the role of ethnozoology in animal conservation. *Ethnobiology and Conservation*, 1: 1-69. <https://doi.org/10.15451/ec2012-8-1.2-1-69>
- [12] Alves, R.R.N., Souto, W.M.S. (2015). Ethnozoology: A brief introduction. *Ethnobiology and Conservation*, 4. <https://doi.org/10.15451/ec2015-1-4.1-1-13>
- [13] Jamil, R.N. (2023). Religious insight: Ethnozoology of Tota'an dove Jember. *El Harakah: Jurnal Budaya Islam*, 25(2): 368-385. <http://doi.org/10.18860/eh.v25i2.24383>
- [14] Yuniati, E., Indriyani, Serafinah, Batoro, J., Purwanto, Y. (2020). Ethnozoology of the ritual and magic of the to Bada ethnic group in the Lore Lindu Biosphere Reserve, Central Sulawesi, Indonesia. *Biodiversitas*, 21(6): 2645-2653. <https://doi.org/10.13057/biodiv/d210636>
- [15] Rahmawati, N.T., Hastuti, J., Suriyanto, R.A. (2023). Anthropometric characteristics of four groups of indigenous people of Wallacea in East Indonesia. *Anthropological Review*, 86(2): 51-63.
- [16] Latinne, A., Saputro, S., Kalengkongan, J., Kowel, C.L., et al. (2020). Characterizing and quantifying the wildlife trade network in Sulawesi, Indonesia. *Global Ecology and Conservation*, 21: e00887. <https://doi.org/10.1016/j.gecco.2019.e00887>
- [17] Tsang, S.M. (2015). Quantifying the bat bushmeat trade in North Sulawesi, Indonesia, with suggestions for conservation action. *Global Ecology and Conservation*, 3: 324-330. <https://doi.org/10.1016/j.gecco.2015.01.003>
- [18] Pandiangan, D., Raming, S.A., Rumende, R.R.H. (2025). Inventory of traditional medicinal plants of the Mongondow Tribe in Ambang II Village Bolaang Mongondow Regency, North Sulawesi. *International Journal for Multidisciplinary Research*, 7(6): 1–12. <https://www.ijfmr.com/papers/2025/6/62846.pdf>.
- [19] Suparno, Y.A., Ahmad, J., Utina, R., Dama, L., Lamangantjo, C.J., Kandowanko, N.Y. (2025). Ethnobotanical study of medicinal plants by the Java-Tondano tribe, Bolaang Mongondow District, Indonesia. In 2nd International Conference on Sciences, Mathematics, and Education 2023 (ICOSMED 2023), pp. 231-238. https://doi.org/10.2991/978-2-38476-410-5_23
- [20] Hamzah, A.H.P., Harijati, S., Pangerapan, S.B., Suriani, C. (2023). Ethnobotanical identification of medicinal plants used by the Sangihe tribe in Sangihe archipelago district, North Sulawesi. *Jurnal Penelitian Pendidikan IPA*, 9(7): 5765-5772. <https://doi.org/10.29303/jppipa.v9i7.3924>
- [21] Pandiangan, D., Silalahi, M., Dapas, F., Kandou, F. (2019). Diversity of medicinal plants and their uses by the Sanger tribe of Sangihe Islands, North Sulawesi, Indonesia. *Biodiversitas: Journal of Biological Diversity*, 20(3): 621-631.
- [22] Dhakal, P., Chettri, B., Lepcha, S., Acharya, B.K. (2020). Rich yet undocumented ethnozoological practices of socio-culturally diverse indigenous communities of Sikkim Himalaya, India. *Journal of Ethnopharmacology*,

- 249: 112386. <https://doi.org/10.1016/j.jep.2019.112386>
- [23] Gittelsohn, J., Vastine, A.E. (2003). Sociocultural and household factors impacting on the selection, allocation and consumption of animal source foods: Current knowledge and application. *The Journal of Nutrition*, 133(11): 4036S-4041S. <https://doi.org/10.1093/jn/133.11.4036S>
- [24] Ali, M.Y., Punia, A.S. (2021). The impact of oral histories on preserving indigenous knowledge and cultural traditions. *International Journal for Advanced Research in Science & Technology*, 11(12): 1683-1688. <https://www.ijarst.in/public/uploads/paper/700931710328246.pdf>
- [25] Nkengbeza, N.S., Nana, E.D., Abwe, E.E., Koh-Dimbot, J.P., Mesame, N.L., Akongte, P.N., Fokam, E.B. (2024). Exploring local ecological knowledge to inform the conservation of the endangered and understudied Preuss's monkey (*Allochrocebus preussi*) in Ebo forest, Cameroon. *Ethnobiology and Conservation*, 13. <https://doi.org/10.15451/ec2024-03-13.11-1-19>
- [26] Bansa, L.A., Rodney, R., Pimid, M., Frias, L., Sánchez, S.G., Hasan, N.H. (2025). Exploring human-flying fox interaction in sabah Malaysia borneo: Observations, cultural-utilitarian practices, conflicting interactions and trade. *Ethnobiology and Conservation*, 14:1-30 <https://doi.org/10.15451/ec2025-10-14-33-1-18>
- [27] Nowell, L.S., Norris, J.M., White, D.E., Moules, N.J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1): 1-13. <https://doi.org/10.1177/1609406917733847>
- [28] Enriquez, J.P., Archila-Godinez, J.C. (2022). Social and cultural influences on food choices: A review. *Critical Reviews in Food Science and Nutrition*, 62(13): 3698-3704. <https://doi.org/10.1080/10408398.2020.1870434>
- [29] Nurti, Y. (2017). Food studies in an anthropological perspective. *Jurnal Antropologi: Isu-isu Sosial Budaya*, 19(1): 1-10. <https://doi.org/10.25077/JANTRO.V19.N1.P1-10.2017>
- [30] Olesen, R.S., Powell, B., Kilawe, C.J., Rasmussen, L.V. (2024). Food environment change on wild food consumption in rural Tanzania. *Food Security*, 16: 1203-1221. <https://doi.org/10.1007/s12571-024-01469-6>
- [31] Hiller, C., M't Sas-Rolfes, M. (2025). Systematic review of the impact of restrictive wildlife trade measures on conservation of iconic species in southern Africa. *Conservation Biology*, 39(1): e14262. <https://doi.org/10.1111/cobi.14262>
- [32] Berry, J.W. (2005). Acculturation: Living successfully in two cultures. *International Journal of Intercultural Relations*, 29(6): 697-712. <https://doi.org/10.1016/j.ijintrel.2005.07.013>
- [33] Pijanowski, B.C., Villanueva-rivera, L.J., Dumyahn, S.L., Farina, A., Krause, B.L., Napoletano, B.M., Gege, S.H., Pieretti, N. (2011). Soundscape ecology: The science of sound in the landscape. *BioScience*, 61(3): 203-216. <https://doi.org/10.1525/bio.2011.61.3.6>
- [34] Seyfarth, R.M., Cheney, D.L. (2003). Meaning and emotion in animal vocalizations. *Annals of the New York Academy of Sciences*, 1000(1): 32-55. <https://doi.org/10.1196/annals.1280.004>
- [35] Trifiletti, E., Crovato, S., Capozza, D., Paolo Visintin, E., Ravarotto, L. (2012). Evaluating the effects of a message on attitude and intention to eat raw meat: Salmonellosis prevention. *Journal of Food Protection*, 75(2): 394-399. <https://doi.org/10.4315/0362-028X.JFP-11-120>
- [36] Zhou, M., Zhang, N., Zhang, M., Ma, G. (2020). Culture, eating behavior, and infectious disease control and prevention. *Journal of Ethnic Foods*, 7(1): 40. <https://doi.org/10.1186/s42779-020-00076-y>
- [37] Alvard, M.S. (2003). The adaptive nature of culture. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews*, 12(3): 136-149. <https://doi.org/10.1002/evan.10109>
- [38] Colombi, B.J., Smith, C.L. (2012). Adaptive capacity as cultural practice. *Ecology and Society*, 17(4). <https://doi.org/10.5751/ES-05242-170413>
- [39] Kendie, F.A., Mekuriaw, S.A., Dagneu, M.A. (2018). Ethnozoological study of traditional medicinal appreciation of animals and their products among the indigenous people of Metema Woreda, North-Western Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 14(1): 37. <https://doi.org/10.1186/s13002-018-0234-7>
- [40] Kirksey, S.E., Helmreich, S. (2010). The emergence of multispecies ethnography. *Cultural Anthropology*, 25(4): 545-576. <https://doi.org/10.1111/j.1548-1360.2010.01069.x>
- [41] Rahayu, S.M., Hakim, L., Batoro, J., Sukenti, K. (2025). Ethnozoological study of animal consumption by the Sasak tribe: Implications for biodiversity conservation in Lombok, Indonesia. *International Journal of Design and Nature and Ecodynamics*, 20(6): 1397-1407. <https://doi.org/10.18280/ij dne.200620>
- [42] Tjoa, M., Kunda, R.M., Lelloltery, H., Puttileihalat, M.M. (2025). Animals in tradition and culture: An ethnozoological study of the indigenous people of Seram Island. *Jurnal Penelitian Pendidikan IPA*, 11(7): 685-692. <https://doi.org/10.29303/jppipa.v11i7.11286>
- [43] García del Valle, Y., Naranjo, E.J., Ruan-Soto, F., Sánchez-Cortés, M.S., Carrillo-Reyes, A. (2025). Determinants of cultural significance in consumed wild mammals: A case study from the Lacandon Forest, Mexico. *Journal of Ethnobiology and Ethnomedicine*, 22: 2. <https://doi.org/10.1186/s13002-025-00839-4>
- [44] Ellen, R.F. (2014). Pragmatism, identity and the state: How the Nuaulu of Seram have re-invented their beliefs and practices as 'religion'. *Wacana. Wacana: Jurnal Ilmu Pengetahuan Budaya*, 15(2): 254-285.
- [45] Leo Neto, N.A., Brooks, S.E., Alves, R.R. (2009). From Eshu to Obatala: Animals used in sacrificial rituals at Candomblé "terreiros" in Brazil. *Journal of Ethnobiology and Ethnomedicine*, 5(1): 23. <https://doi.org/10.1186/1746-4269-5-23>
- [46] Dillon, D., Pang, J. (2017). Deer who are distant: Response congruency to relative pronouns across human and nonhuman entities. *Society & Animals*, 28(5-6): 447-471. <https://doi.org/10.1163/15685306-12341482>
- [47] Lukawiecki, J., Moola, F., Roth, R. (2024). Cultural keystone species and their role in biocultural conservation. *Conservation Science and Practice*, 6(11): e13224. <https://doi.org/10.1111/csp2.13224>
- [48] Garibaldi, A., Turner, N. (2004). Cultural keystone species: Implications for ecological conservation and restoration. *Ecology and Society*, 9(3): 18. <https://www.jstor.org/stable/26267680>
- [49] Alves, R.R., Alves, H.N. (2011). The faunal drugstore: Animal-based remedies used in traditional medicines in Latin America. *Journal of Ethnobiology and*

Ethnomedicine, 7(1): 9. <https://doi.org/10.1186/1746-4269-7-9>

[50] Karesh, W.B., Grillo, T., Machalaba, C., Roberts, H., Diaz, F., Muset, S., Hamilton, K. (2025). Guidelines for addressing disease risks in wildlife trade. *One Health*, 20: 100998. <https://doi.org/10.1016/j.onehlt.2025.100998>

[51] Mackenzie, J.S., Jeggo, M. (2019). The one health approach—Why is it so important? *Tropical Medicine and Infectious Disease*, 4(2): 88. <https://doi.org/10.3390/tropicalmed4020088>

[52] Gautam, S.K. (2019). The role of indigenous knowledge in biodiversity conservation: Integrating traditional practices with modern environmental approaches. *Environmental Reports*, 1(2): 1-3. <https://doi.org/10.51470/ER.2019.1.2.01>

[53] Sele, J.P., Mukundi, M.B. (2024). Community-based approaches to environmental conservation: Empowering local initiatives. *Greener Journal of Social Sciences*, 14(2): 289-299. <https://doi.org/10.15580/gjss.2024.2.122024211>

[54] Murtiningsih, B.S.E., Meidiyawati, N., Veronika. (2025). Sustainability communication based on local wisdom in ecotourism development in Waturaka Village, Ende District. *Pertanika*, 1(1): 61-66. <https://doi.org/10.47836/pp.1.1.013>

[55] Morar, F., Peterlicean, A. (2012). The role and importance of educating youth regarding biodiversity conservation in protected natural areas. *Procedia Economics and Finance*, 3: 1117-1121. [https://doi.org/10.1016/S2212-5671\(12\)00283-3](https://doi.org/10.1016/S2212-5671(12)00283-3)

[56] Hidayatulloh, M.M., Ibrahim, M.H. (2025). Realizing the right to a healthy environment through customary forest conservation: A local wisdom approach. *Jurnal Antropologi: Isu-Isu Sosial Budaya*, 27(2): 317-327. <https://doi.org/10.25077/jantro.v27.n2.p317-327.2025>

[57] Wardani, E.K., Sugianto, F., Budianto, A. (2025). Challenges in the implementation of animal in law protection in Indonesia. *Journal of International Trade, Logistics and Law*, 11(2): 176-187. https://www.jital.org/index.php/jital/article/view/665/pdf_354.

[58] Yan, D., Luo, J.Y., Han, Y.M., Peng, C., et al. (2013). Forensic DNA barcoding and bio-response studies of animal horn products used in traditional medicine. *PloS One*, 8(2): e55854. <https://doi.org/10.1371/journal.pone.0055854>

[59] Bachmann, M.E., Junker, J., Mundry, R., Nielsen, M.R., et al. (2019). Disentangling economic, cultural, and nutritional motives to identify entry points for regulating a wildlife commodity chain. *Biological Conservation*, 238: 108177. <https://doi.org/10.1016/j.biocon.2019.07.022>

[60] Larsen, P.B., Chanthavisouk, C. (2024). Free, prior, and informed consent, local officials, and changing biodiversity governance in Hin Nam No, Laos. *Conservation Biology*, 38(6): e14388. <https://doi.org/10.1111/cobi.14388>

[61] Zukmadini, A.Y., Rohman, F., Dharmawan, A., Sari, M.S., Rochman, S., Razak, S.A. (2024). Potential biodiversity from ethnozoology of Enggano Island: Utilization, a quantitative analysis, list of animals conserved by local people, and application of research findings empowering species literacy in biology student teachers. *Indonesian Journal of Science and Technology*, 9(2): 463-496. <https://doi.org/10.17509/ijost.v9i2.71581>

[62] Reuter, K.E., Randell, H., Wills, A.R., Janvier, T.E., Belalaky, T.R., Sewall, B.J. (2016). Capture, movement, trade, and consumption of mammals in Madagascar. *PloS One*, 11(2): e0150305. <https://doi.org/10.1371/journal.pone.0150305>

APPENDIX

Table A1. Utilization of various types of species

| No. | Scientific Name | Common Name | Vernacular Name | Use | | | | | Source | IUCN Status | Gov. Reg. No. 106/2018 | Endemic to Sulawesi |
|-----------------|-------------------------------|--------------------|--|------|------|-----|-----|-----|--------|-------------|------------------------|---------------------|
| | | | | Food | Myth | Sym | Rit | Art | | | | |
| Mammalia | | | | | | | | | | | | |
| 1 | <i>Bos taurus indicus</i> | Domestic bull/cow | - | √ | | | | | D | - | - | - |
| 2 | <i>Bubalus depressicornis</i> | Lowland anoa | Langkow (M); Bantong (BM) | √ | | √ | | √ | √ | W | EN | √ |
| 3 | <i>Bubalus quarlesi</i> | Mountain anoa | Langkow (M); Bantong (BM) | √ | | √ | | √ | √ | W | EN | √ |
| 4 | <i>Capra aegagrus hircus</i> | Domestic goat | - | √ | | | | | D | - | - | - |
| 5 | <i>Bubalus bubalis</i> | Swamp buffalo | Karambou/Kalembau (BM) | √ | | | | | D | - | - | - |
| 6 | <i>Rusa timorensis</i> | Timor deer | Molog (BM) | √ | | | | √ | W | VU | √ | - |
| 7 | <i>Sus celebensis</i> | Sulawesi Warty Pig | Wiy'o'o (M); Boke'(BM), Bawingkahurangan (S/T) | √ | √ | | | √ | W | NT | - | - |
| 8 | <i>Babyrousa celebensis</i> | Sulawesi Babirusa | Kalawat (M); Daloet/Ponigoinia (BM) | √ | | √ | | √ | W | VU | √ | √ |
| 9 | <i>Sus domesticus</i> | Domesticated pig | Wawi (M); Boke' (BM); Bawi (S/T) | √ | | √ | √ | | D | | | |
| 10 | <i>Canis lupus familiaris</i> | Domesticated dog | Yasu/Asu (M); Unkgu (BM); Asu/Ahu' (S/T) | | | | | | | | | |
| 11 | <i>Felis silvestris catus</i> | Domestic cat | Tusa (M); Pinggo (BM); Meo (S/T) | √ | √ | | | | √ | D | - | - |
| 12 | - | Dolphin | - | | | √ | | | W | - | √ | - |
| 13 | <i>Pteropus alecto</i> | Black flying fox | Paniki (M); Poniki (BM); Pani'I (S/T) | √ | | | | | W | LC | - | - |

| | | | | | | | | | | | |
|----------------|-------------------------------------|-------------------------------|--|---|---|---|---|---|----|----|---|
| 14 | <i>Acerodon celebensis</i> | Sulawesi fruit bat | Paniki (M); Poniki (BM); Pani'I (S/T) | √ | | | √ | W | VU | - | √ |
| 15 | <i>Pteropus vampyrus</i> | Large flying fox | Paniki (M); Poniki (BM); Pani'I (S/T) | √ | | | √ | W | NT | - | - |
| 16 | - | Small bat | Peret/Rapet (M) | | | | | | | | |
| 17 | <i>Macaca nigra</i> | Celebes Crested Macaque | Yaki/Wolay (M); Boray/Bolay (BM) | √ | √ | √ | √ | √ | W | CR | √ |
| 18 | <i>Tarsius spectrungsurskyae</i> | Gursky's spectral tarsier | Tangkasi/Wunto (M) | | | | √ | W | VU | √ | √ |
| 19 | <i>Elephas maximus</i> | Asian Elephant | - | | | | √ | W | EN | √ | - |
| 20 | <i>Maxomys hellwaldii</i> | White-tailed Sulawesi rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | √ | W | LC | - |
| 21 | <i>Maxomys inflatus</i> | Northeastern white-tailed rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | W | VU | - | √ |
| 22 | <i>Taeromys taerae</i> | Tondano rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | W | VU | - | √ |
| 23 | <i>Taeromys celebensis</i> | Celebes rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | W | LC | - | √ |
| 24 | <i>Taeromys callitrichus</i> | Lovely-haired rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | W | LC | - | √ |
| 25 | <i>Taeromys dominator</i> | Giant Sulawesi rat | Kulo ipus/Kawok Oki (M); Baka' (BM); Bawalo (S/T) | √ | | | | W | LC | - | √ |
| Aves | | | | | | | | | | | |
| 26 | - | Eagle/Hawk | Muniak (BM) | | √ | | | W | - | √ | - |
| 27 | <i>Dendrocygna guttata</i> | Spotted Whistling-duck | Dodoyongit (BM) | √ | | | | W | LC | - | - |
| 28 | <i>Dendrocygna arcuata</i> | Wandering Whistling-duck | Dodoyongit (BM) | √ | | | | W | LC | - | - |
| 29 | <i>Rhyticeros cassidix</i> | Knobbed Hornbill | Uwak (M); Kalow (BM) | | | √ | √ | W | VU | √ | √ |
| 30 | <i>Eurostopodus diabolicus</i> | Heinrich's Nightjar | pikipik (M) | √ | | | | W | LC | √ | √ |
| 31 | <i>Spilopelia chinensis</i> | Spotted Dove | Tarakukuk (BM) | | | √ | | W | LC | - | - |
| 32 | - | Common Dove | Kumkum (BM) | | | √ | | W | - | - | - |
| 33 | <i>Centropus bengalensis</i> | Lesser Coucal | Koloket (M); Tuk-tuk/kalukuk (BM); Sanggelo (T/S) | √ | | | | W | LC | - | - |
| 34 | <i>Cuculus crassirostris</i> | Sulawesi Cuckoo | Sokopek/Sokopet/Kokukuk (M) | √ | | | | W | LC | - | - |
| 35 | <i>Rhamphococcyx calyborhynchus</i> | Yellow-billed Malkoha | Mangenge'kek (M) | √ | √ | | | W | LC | - | - |
| 36 | <i>Gallus gallus domesticus</i> | Domesticated red junglefowl | Ko'ko Randang (M); Manuk (BM); Manu' (S/T) | √ | | √ | √ | D | - | - | - |
| 37 | <i>Gallus gallus</i> | Red Junglefowl | Manu' (M); Lengat/Manuk (BM); Tarau (S/T) | √ | √ | | √ | W | LC | - | - |
| 38 | <i>Macrocephalon maleo</i> | Maleo | Tuwanggoy (BM) | | | √ | √ | √ | W | CR | √ |
| 39 | <i>Hypotaenidia philippensis</i> | Buff-banded rail | Maweruweris (M); Balisik/Weris (BM); Tette'a (S/T) | √ | √ | | | W | LC | - | - |
| 40 | <i>Hypotaenidia torquata</i> | Barred rail | Maweruweris (M); Balisik/Weris (BM); Tette'a (S/T) | √ | √ | | | W | LC | - | - |
| 41 | <i>Porphyrio porphyrio</i> | Purple Swampphen | Maweruweris (M); Balisik/Weris (BM); Tette'a (S/T) | √ | | | | W | LC | - | - |
| 42 | <i>Amauornis phoenicurus</i> | White-breasted waterhen | Maweruweris (M); Balisik/Weris (BM); Tette'a (S/T) | √ | √ | | | W | LC | - | - |
| 43 | <i>Corvus enca</i> | Slender-billed crow | Gatala / Umboh (BM) | | | √ | | W | LC | - | - |
| 44 | <i>Corvus typicus</i> | Piping crow | Gatala / Umboh (BM) | | | √ | | W | LC | - | √ |
| 45 | <i>Otus manadensis</i> | Sulawesi Scops-owl | Ot/Loyot/Manguni (M); Monikulu (BM); Mammeo (S/T) | √ | √ | √ | √ | W | LC | √ | √ |
| 46 | <i>Tyto inexpectata</i> | Minahasa Masked-owl | Mane'ak/Keak (M); Asang-asang (BM) | √ | √ | | | W | LC | √ | √ |
| Reptile | | | | | | | | | | | |
| 47 | <i>Crocodylus</i> | Saltwater | Saudang (M); | √ | √ | | √ | W | LC | √ | - |

| | <i>porosus</i> | crocodile | Kudeteng (BM); Buala (S/T) | | | | | | | | | |
|-----------------------|----------------------------------|----------------------------|---|---|---|---|---|---|----|---|---|---|
| 48 | <i>Varanus salvator</i> | Asian water monitor | Soa-soa/Liwang (M); Libang (BM); Sorra (S/T) | √ | √ | √ | √ | W | - | - | - | - |
| 49 | <i>Hemidactylus frenatus</i> | Common house gecko | Cacak/So'so (M); Toto (BM); Tambalisaccu' (S/T) | | | | √ | W | - | - | - | - |
| 50 | <i>Hemidactylus platyurus</i> | Flat-tailed house gecko | Cacak/So'so (M); Toto (BM); Tambalisaccu' (S/T) | | | | √ | W | - | - | - | - |
| 51 | <i>Ptyas dipsas</i> | Common rat snake | Ule'rendem / renten (M) | | √ | √ | √ | W | LC | - | - | - |
| 52 | <i>Cylindrophis ruffus</i> | Common pipe snake | Ular kepala dua (M) | | | √ | | W | LC | - | - | - |
| 53 | <i>Malayopython reticulatus</i> | Reticulated Python | Manonongko/Patola (M); Balang/Ulag (BM); Patola (S/T) | √ | √ | √ | √ | W | LC | - | - | - |
| 54 | <i>Caretta caretta</i> | Loggerhead turtle | Tuturuga (M) | | | | √ | W | VU | √ | - | - |
| 55 | <i>Chelonia mydas</i> | Green turtle | Tuturuga (M) | | | | √ | W | EN | √ | - | - |
| 56 | <i>Eretmochelys imbricata</i> | Hawksbill turtle | Tuturuga (M) | | | | √ | W | CR | √ | - | - |
| 57 | <i>Lepidochelys olivacea</i> | Olive Ridley turtle | Tuturuga (M) | | | | √ | W | VU | √ | - | - |
| 58 | <i>Dermochelys coriacea</i> | Leatherback turtle | Tuturuga (M) | | | | √ | W | VU | √ | - | - |
| 59 | <i>Cuora amboinensis</i> | Southeast Asian box turtle | Wahu'uk (M); Pompunu/Ompunu (BM) | | √ | | | W | EN | - | - | - |
| Actinopterygii | | | | | | | | | | | | |
| 60 | <i>Channa striata</i> | Snakehead murrel | Onggalok (BM) | √ | | | | W | LC | - | - | - |
| 61 | <i>Anguilla celebensis</i> | Celebes longfin eel | Sogili (M); Sogili/Podungu (BM); Ramangnga/Ramman (S/T) | √ | | | | W | - | - | - | - |
| 62 | <i>Cyprinus carpio</i> | The common carp | Pongkor (M); Ikan mas (S/T) | √ | | | | D | LC | - | - | - |
| 63 | <i>Barbonymus gonionotus</i> | Silver barb | Kurama (BM) | √ | | | | D | LC | - | - | - |
| 64 | <i>Amphiprion ocellaris</i> | False clown anemonefish | Ikan giru (M) | | | | √ | W | LC | - | - | - |
| 65 | <i>Hippocampus</i> sp. | Seahorse | Kuda ;aut (M) | √ | | | | W | - | - | - | - |
| 66 | - | Pufferfish | | | | | √ | W | - | √ | - | - |
| Insecta | | | | | | | | | | | | |
| 67 | <i>Rhynchophorus ferrugineus</i> | Sago palm weevil | Water/Rinsen (M) | √ | | | | W | - | - | - | - |
| 68 | - | Cicada | Rek-rek/Riye-riye (M); Boto-boto (M); | | √ | | | W | - | - | - | - |
| 69 | - | Grasshopper | Alumbati/tarangassa (S/T) | | √ | | | W | - | - | - | - |
| Sarcopterygii | | | | | | | | | | | | |
| 70 | <i>Latimeria menadoensis</i> | Sulawesi coelacanth | | | | | √ | W | VU | √ | √ | √ |
| Amphibia | | | | | | | | | | | | |
| 71 | <i>Fejervarya cancrivora</i> | Crab-eating frog | Karak/Kodok (M) | √ | | | | W | LC | - | - | - |
| Gastropoda | | | | | | | | | | | | |
| 72 | <i>Charonia tritonis</i> | Triton's trumpet | Bia (M) & (S/T) | | | | √ | W | LC | - | - | - |
| Chilopoda | | | | | | | | | | | | |
| 73 | <i>Scolopendra subspinipes</i> | Giant centipede | Ulipan (BM) | | √ | | √ | W | - | - | - | - |
| Malacostraca | | | | | | | | | | | | |
| 74 | <i>Macrobrachium</i> sp. | Freshwater prawn | Gale (BM) | √ | | | | W | - | - | - | - |

Notes: M = Minahasa; BM = Bolaang Mongondow; S/T = Sangihe/Talau; W = Wild; D = Domestic; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern