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Adaptation strategies in wildlife hunting practices among the Tehit Knasaimos Ethnic Group, South Sorong, Southwest Papua, Indonesia

RUDI APRIANTO MATURBONGS[1,2,♥], ARLAN KAPISA[1], MELIZA S. WORABAI[1], MATHEUS BELJAI[1]

[1]Faculty of Forestry, Universitas Papua. Jl. Gunung Salju, Amban, Manokwari 98314, West Papua, Indonesia. Tel./fax.: +62-986-211050, ♥email: r.maturbongs@unipa.ac.id

[2]Graduate Program, Universitas Papua. Jl. Gunung Salju, Amban, Manokwari 98314, West Papua, Indonesia

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Abstract. *Maturbongs RA, Kapisa A, Worabai MS, Beljai M. 2024. Adaptation strategies in wildlife hunting practices among the Tehit Knasaimos Ethnic Group, South Sorong, Southwest Papua, Indonesia. Biodiversitas 25: 3309-3319.* This research investigates the adaptation strategies employed by the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua Province, Indonesia to sustain their wildlife hunting practices. Employing a descriptive methodology that integrates both qualitative and quantitative approaches, the study focuses on the villages of Manggroholo and Sira. It explores how the community reconciles traditional hunting and fishing practices with the pressures of modern development by incorporating modern tools and economic practices. This analysis examines how traditional practices are adapted to meet the dual demands of cultural preservation and economic necessity. Key findings indicate a significant shift from traditional barter systems to cash-based transactions, highlighting the impact of modern economic integration on traditional economies. Additionally, a noticeable adoption of more durable materials in hunting and fishing gear suggests a move towards more sustainable practices that could reduce environmental degradation. Notably, the research emphasizes the continued relevance of cultural practices such as totemism and the management of sacred forests (*hutan pamali*), which play a pivotal role in wildlife conservation. The study further underscores the critical role of indigenous leadership and community collaboration in maintaining the sustainability of these practices. By fostering a communal approach to resource management, the Tehit Knasaimos community can navigate the challenges of external economic and environmental pressures. These insights contribute significantly to a broader understanding of how indigenous communities adapt to external challenges while preserving their cultural heritage and promoting ecological sustainability. This study enriches the discourse on sustainable development and offers valuable lessons on the resilience of indigenous adaptation strategies in the face of global change.

Keywords: Adaptation, ethnozoology, Southwest Papua, Tehit Knasaimos Ethnic, traditional hunting

INTRODUCTION

New Guinea boasts a high biodiversity of flora (Cámara-Leret et al. 2020) and a very diverse fauna (Kartikasari et al. 2012). The rich biodiversity in New Guinea results from various factors, including the region's diverse physiography and topography, climate, edaphic conditions, and geological history (Moura et al. 2016; Zheng et al. 2024). The eastern part of New Guinea is the country of Papua New Guinea (PNG). In contrast, the western part is an Indonesian territory comprising six provinces and seven customary regions, home to 270 indigenous ethnic groups (Eberhard et al. 2020).

Hunting wildlife is a way for ethnic communities in Papua to obtain much-needed animal protein for their livelyhoods, but it also serves economic purposes (Pattiselanno et al. 2015; Gilmore et al. 2020). Many indigenous communities integrate cultural and spiritual values into their hunting practices, which supports sustainability (Fa et al. 2020). This holistic approach to natural resource management ensures that hunting remains a sustainable activity that supports the subsistence needs of the community while also conserving biodiversity (Antunes et al. 2019).

Wildlife hunting conducted by local communities typically employs traditional tools or weapons, resulting in harvests that do not exceed families' subsistence needs. Consequently, traditional hunting is not considered to disrupt the stability of natural wildlife populations. It is believed to maintain the stability of wildlife species populations by targeting surplus individuals who leave the parent population due to competition within abundant populations (Koster et al. 2020). Traditional weapons and environmentally friendly hunting methods help prevent the overexploitation of wildlife populations, unlike modern hunting methods, which are more destructive (Ponta et al. 2019).

The flora and fauna protected under Indonesian law are regulated by the Indonesian Minister of Environment and Forestry Regulation Number: P.106/MENLHK/SETJEN/KUM.1/12/2018. This regulation enumerates all species of wildlife prohibited from being hunted due to their drastically declining populations and endangered status. Consequently, while local communities may hunt non-protected wildlife to fulfill their needs for animal protein, they must do so judiciously to ensure the stability of wildlife populations in the wild. Pattiselanno and Lubis (2014) conducted research in Tambrauw District, Southwest Papua Province, focusing on traditional hunting practices by the Karon ethnic group in four villages: Waibem, Wau, Warmandi, and Saubeba. Their study

revealed that hunting serves multiple purposes but is predominantly conducted for trade. They identified six mammal species and three bird species frequently hunted using various techniques, with wild boar and deer being the primary targets to meet both market and household meat demands. Additionally, Pattiselanno et al. (2020) noted that hunting for trade remains a secondary livelihood in West Papua Province, with more than half of the respondents selling their catch within their villages.

Kapisa et al. (2023) reported that among the Tehit Knasaimos Ethnic group in South Sorong District, 19 animal species are hunted, including seven mammals, five birds, two reptiles, one fish, and three crustaceans. Wild boar (*Sus scrofa* (Linnaeus, 1758)) and the dusky pademelons (*Thylogale brunii* (Schreber, 1778)) are the most commonly utilized species, with high utilization values (UVs = 0.59-0.61). Further research is needed to understand the relationship between Indonesian wildlife protection regulations and the species targeted by traditional hunting practices in this region.

The development of a region can impact the traditional lifestyles of the ethnic communities residing there, including their traditional hunting systems (Su et al. 2020; Kadykalo et al. 2021). The Saubeba community in Manokwari, West Papua Province, uses traditional and modern wildlife hunting (air rifles) to meet animal protein needs (Sawaki et al. 2022). Southwest Papua Province has developed into a technologically advanced area in the Bird's Head Peninsula of New Guinea (Kardoso 2023). This development has affected the traditional lifestyles of the people in the region, including the traditional hunting system of the Tehit Knasaimos Ethnic group in the Saifi Sub-district of South Sorong District. Although studies have been conducted in the Bird's Head region, it remains unclear which aspects of the Tehit Knasaimos traditional hunting system have been altered by developmental progress. It is uncertain whether their traditional hunting system has remained intact or undergone significant shifts. Further research is necessary to understand the adaptation strategies in wildlife hunting practices among the Tehit Knasaimos Ethnic group in South Sorong District to achieve sustainable hunting in this area.

MATERIALS AND METHODS

Study site

This research was conducted in the village forest area of the hometown of Tehit Knasaimos Ethnic Group in Manggroholo Village and Sira Village, Saifi Sub-district, South Sorong District, Southwest Papua Province, Indonesia (Figure 1). The study area encompasses 472.05 km², situated in Papua's Bird's Head Peninsula. It consists of a valley with numerous rivers, featuring flat to gently rolling topography, with elevations ranging from zero to 100 meters above sea level. The annual rainfall averages 3,827 mm, or approximately 319 mm per month, with 281 rainy days per year, averaging about 23.42 days per month. The average household size in this area is four to five individuals (Kardoso 2023). The Tehit Knasaimos Ethnic Group effectively maintains the lowland forest ecosystem within their region.

Data collection and analysis

A descriptive method was used in this research to describe the hunting system of the Tehit Knasaimos Ethnic Group. A mixed-method approach, combining qualitative and quantitative techniques, was employed to study the current hunting system (Fofana et al. 2020). Respondents, comprising men who engage in traditional wildlife hunting and women who fish, were members of the Tehit Knasaimos Ethnic Group. The snowball sampling technique was used to select respondents (Vincent and Thompson 2022), resulting in 35 local adults aged 20-66 years (23 men and 12 women), with 18 from Manggroholo Village and 17 from Sira Village. Data were collected through open and in-depth interviews (Rutledge and Hogg 2020) using a prepared questionnaire that included questions about the purpose of their hunting, the frequency and yield of hunting, hunting locations, techniques (individual or group hunting?; morning, afternoon, or evening?), preferred hunting tools, the existence of sacred or forbidden forests, and awareness of government regulations on the hunting of protected wildlife (Pattiselanno et al. 2019). The data collected from the field were analyzed descriptively and presented in tables and figures.

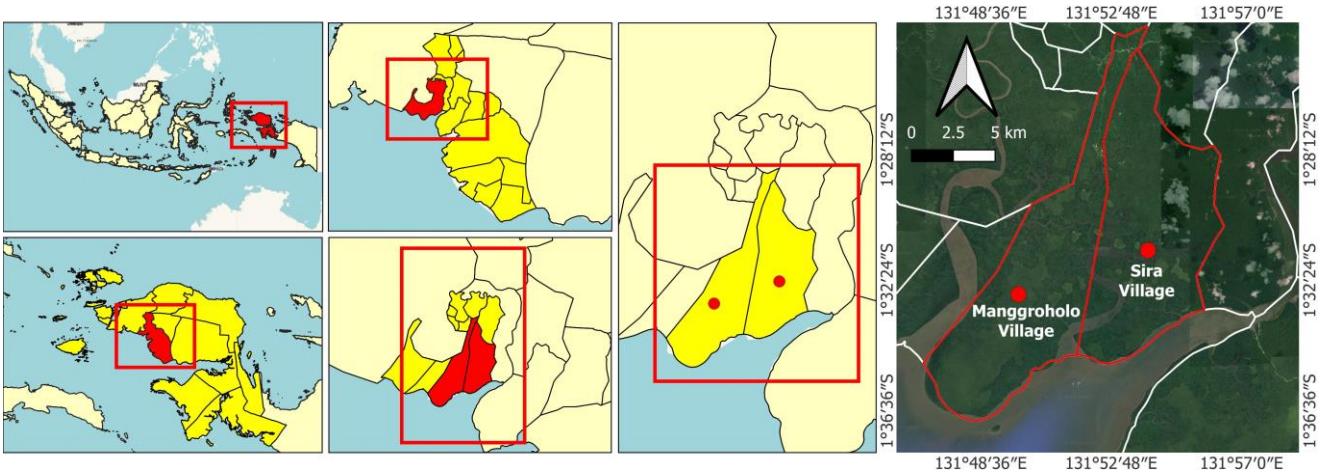

Figure 1. Research site at Manggroholo and Sira Villages in Saifi Sub-district, South Sorong District, Southwest Papua Province, Indonesia

RESULTS AND DISCUSSION

Traditional wildlife hunting system of the Tehit Knasaimos Ethnic Group

Why do they hunt wildlife?

The current purposes of wildlife hunting by the Tehit Knasaimos Ethnic group in the Saifi Sub-district, South Sorong District, are primarily for consumption, economic reasons, and obtaining materials for cultural adornments. Subsistence consumption includes food for families, religious ceremonies, and cultural events. Pattiselanno and Lubis (2014), Pattiselanno et al. (2015, 2019, 2020) state that the primary purpose of traditional hunting in New Guinea is to meet families' animal protein needs, followed by secondary purposes, including commercial objectives. As long as traditional hunting is aimed at meeting subsistence needs, it is unlikely to threaten the stability of wildlife populations because the number of animals hunted is limited to the family's nutritional (animal protein) requirements (De Paula et al. 2017; Camino et al. 2018). The Tehit Knasaimos Ethnic group hunts certain wildlife, such as the sulphur-crested cockatoo (*Cacatua galerita* (Latham, 1790)) and the palm cockatoo (*Probosciger aterimus* (Gmelin, 1788)), primarily for their feathers, although the meat is still consumed. Other cultural accessories, such as skins, teeth, fangs, and bones, are obtained from hunting byproducts. This practice is similar to other ethnic groups in the Papua region who hunt for traditional accessories (Arobaya et al. 2021). It is essential to preserve the purpose of traditional hunting in the Tehit Knasaimos community so that it continues to be conducted wisely while maintaining their local wisdom values, such as the belief that the forest is their life. The forest provides food, medicine, and other necessities for the community; hence, hunting activities must not damage it. All indigenous communities share this local wisdom in New Guinea.

The Tehit Knasaimos Ethnic Group employs a straightforward method for selling their hunting yields, utilizing three units of measure: portions, bundles, and piles (Table 1). Portions are used to sell large mammals such as wild boars or deer, including body parts like thighs, chests, and heads, with prices ranging from IDR 20,000 to 150,000, depending on size; more significant portions fetch higher prices. Bundles for small to medium-sized mammals and fish species contain two to three pieces of mammal meat or three to five fish, priced between IDR 20,000 to 150,000. Piles are reserved for crustaceans such as shrimp, crabs, and shellfish, comprising five to seven individuals, with each pile priced from IDR 20,000 to 150,000. In the Abun and Amberbaken Districts, deer meat is priced at IDR 25,000 per kg and pork at IDR 15,000 per kg. The median monthly income from selling hunted meat ranges from IDR 1,100,000 to 1,300,000 (Pattiselanno et al. 2019).

How many times a month do they hunt wildlife?

Figure 2 illustrates the hunting yields of various species and the average yield per hunter at different monthly hunting frequencies. The group of hunters who hunt 2-3 times per month secures 24 animals, averaging 4.8 animals per hunter, indicating that a lower hunting frequency results in a relatively high yield per hunter. Conversely, the group that hunts 4 times monthly totals 52 animals, averaging an average of 4.33 animals per hunter. Although the total number of animals hunted is higher than other groups, the average yield per hunter is slightly lower than that of the group hunting 2-3 times per month. The group hunting 8 times per month secures 27 animals, averaging 4.5 animals per hunter; despite hunting more frequently, their yield per hunter aligns closely with the group hunting 2-3 times per month and exceeds that of the group hunting 4 times per month. The Tehit Knasaimos group hunts 17 terrestrial and arboreal species for consumption, yet only the meat of three species—wild boar (*S. scrofa*), dusky pademelon (*T. brunii*), and Javan deer (*Rusa timorensis* (Blainville, 1822))-is sold within the community and market (see Figures 3) (Kapisa et al. 2023). Pattiselanno et al. (2019) noted that local hunters frequently sell deer and wild boar meat in the Bird's Head region of New Guinea.

Where do they hunt wildlife?

The wildlife hunting grounds used by all the Tehit Knasaimos Ethnic groups are secondary and primary forests (see Figure 4). Primary forest areas are characterized by dense stands of forest and several trees with diameters exceeding 50 cm DBH (Diameter at Breast Height). The dominant tree species in the primary forests include Merbau (*Intsia bijuga* (Colebr.) Kuntze), Matoa (*Pometia pinnata* J.R.Forst. & G.Forst.), various species of fig trees (*Ficus* spp.), Red Damar (*Agathis dammara* (Lamb.) Rich. & A.Rich.), White Damar (*Agathis labillardieri* Warb.), and Meranti (*Vatica rassak* (Korth.) Blume).

Table 1. Sales of hunting yields by the Tehit Knasaimos Ethnic Community in Manggroholo and Sira Villages, South Sorong District, Southwest Papua, Indonesia

Units	Animal groups	Prices
Portions	Mammals	IDR 20,000-150,000
Bundles	Mammals and Pisces	IDR 20,000-150,000
Piles	Crustasea	IDR 20,000-150,000

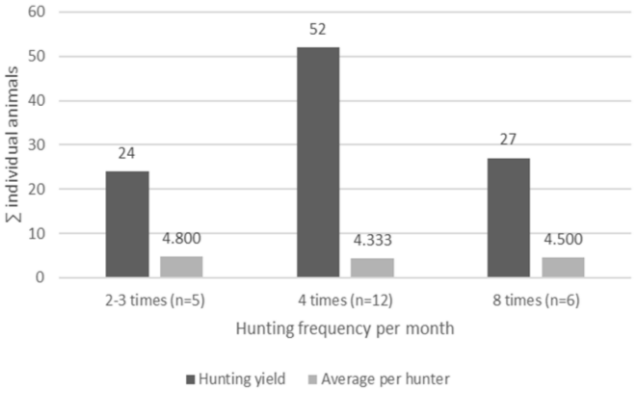

Figure 2. Frequency and yield of wildlife hunting per month by the Tehit Knasaimos Ethnic Group, South Sorong District, Southwest Papua, Indonesia

Figure 3. Several types of hunting animals of the Tehit Knasaimos Ethnic Group, South Sorong District, Southwest Papua, Indonesia. A. Wild boar (*Sus scrofa*); B. Javan deer (*Rusa timorensis*); C. Dusky pademelon (*Thylogale brunii*); D. A pile of game meat being smoked over embers, one method of preserving meat in the wild

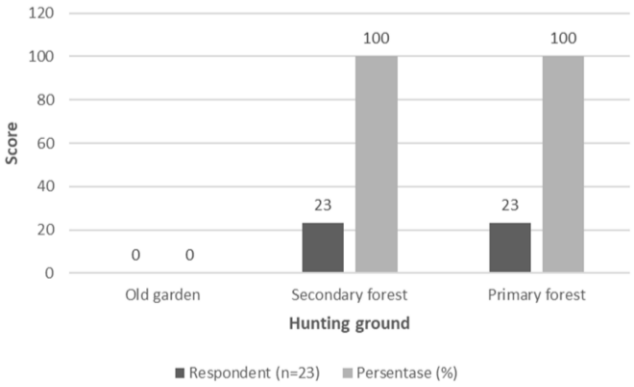

Figure 4. Hunting grounds of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia

Wildlife is more abundant in these forests because they provide ample food sources, play areas, resting spots, and nesting habitats. These forests also contain numerous swamps and small rivers extending to the coastal areas. The hunting grounds are designated as village forests, and the government established them through the Indonesian Minister of Environment and Forestry Decree No. SP.66/HUMAS/PP/HMS.3/9/2016.

Hunting huts are an essential part of the hunting practices of the Tehit Knasaimos community. Due to the high annual rainfall, totaling 3,827 mm, and the substantial number of rainy days (281 days per year), the Tehit Knasaimos people have adapted to the local climate by constructing huts for shelter during rain in the forest. The Tehit Knasaimos Ethnic Group has built 10 hunting huts in Manggroholo and Sira Villages in the Saifi Sub-district. These huts are strategically located on the edges and outside the forest.

The Tehit Knasaimos community's hunting grounds feature four types of hunting huts, as illustrated in Figure 5. All four types have roofs constructed from palm leaves (*Metroxylon sagu* Rottb.), while the other components are made from various tree species, and the pole ties are secured using rattan (*Calamus* spp.) sourced from the forest. Elevated hunting huts with walls are typically used for extended hunting periods (Figure 5.A), whereas lower-elevated huts (Figures 5.B and 5.C) are utilized for shorter stays. Ground-level hunting huts (refer to Figure 5.D) serve as emergency shelters for hunters while the older huts undergo rehabilitation or reconstruction. Additionally, they have utilized nails in the construction of larger and sturdier hunting huts.

How do they hunt wildlife?

The Tehit Knasaimos community consistently hunts in groups of three to five people, with 100% of respondents reporting this practice. The reason for group hunting is that they use various tools (see Figures 6 and 7) that require multiple individuals to operate effectively. Additionally, managing large game such as wild boar and deer is more feasible with several people rather than individuals.

Figure 5. Several types of hunting hut of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia. A. Elevated Hunting Hut with Walls; B. Tall Elevated Hunting Hut; C. Low Elevated Hunting Hut; D. Ground-Floor Hunting Hut

Terrestrial and arboreal wildlife hunting is led by a group leader who meets specific criteria: possessing customary rights to the hunting forest area, owning complete hunting tools, and providing food for the group while in the forest. While in the forest, the hunters stay in huts constructed explicitly for this purpose. Before hunting, each group convenes to discuss and assign tasks to each member and then prays to God according to their beliefs. Teenage boys aged 10 to 15 are typically invited to join the group to learn and practice responsible hunting in nature. Sawaki et al. (2022) note that the Saubeba community in North Manokwari District includes teenage boys in hunting groups to pass down hunting knowledge and skills to the younger generation.

What do they use to hunt wildlife?

The five basic pieces of equipment for a Tehit Knasaimos hunter include a spear, air rifle, hunting dog, trap, and sagu hiding technique (see Figures 6 and 7). The spear, the most favored hunting tool, is commonly used to hunt medium to large mammals such as dusky pademelons, wild boars, and deer. The spearheads are made of flattened iron shaped into sharp triangular points, while the shafts are crafted from rugged, durable wood. Materials for making spears are readily available and inexpensive. The air rifle, the second most preferred tool, is valued for its ease of use and effectiveness in targeting animals such as birds and small mammals from a distance. Traps are ranked third in locations frequently visited by wildlife, including bandicoots and deer. Sagu hiding involves the hunter waiting for the target animal from a concealed position near sago stalk bait, which still contains starch to attract wild boars. Although the Tehit Knasaimos Ethnic Group has historically used bows and arrows, these have largely been replaced by air rifles, which have been noted for their accuracy and easier handling for shooting wildlife at long distances. However, the cost of air rifles is prohibitive for some, with prices ranging from IDR 3 to 6 million, leading to their limited use in areas like North Manokwari District, as observed by Sawaki et al. (2022). Hunting dogs, though standard across various Indonesian ethnic groups are used less frequently by the Tehit Knasaimos, with only a few hunters employing them due to the challenge of finding dogs with strong hunting instincts. Overall, spears, air rifles, and traps are preferred by the Tehit Knasaimos Ethnic group for their ease of use and efficiency compared to other hunting tools.

Bachmann et al. (2022) state that traditional hunting is usually carried out with traditional weapons and methods that limit the number of captures, making it more sustainable than commercial hunting, which uses modern technology and operates on a larger scale. Therefore, strict regulations and awareness of the importance of customary laws in maintaining wildlife population sustainability are essential.

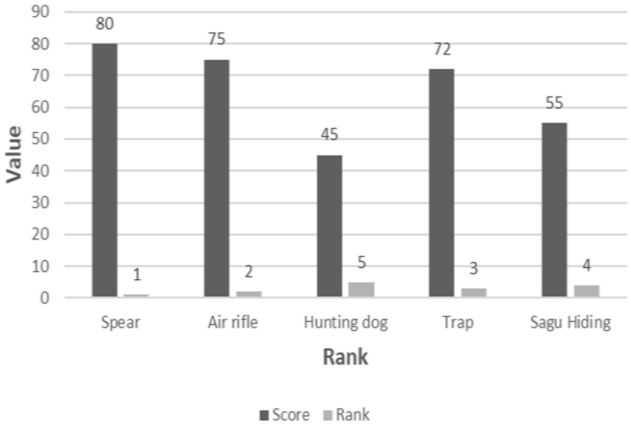

Figure 6. Hunting techniques and tools of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia (n = 23)

Figure 7. Several types of hunting tools of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia: A. Spearhead made of hard metal; B. Air rifle; C. Trap; D. Hunting dog; E. Sagu hiding

Table 2. Wildlife species believed to be ancestors according to clans of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia

English name	Common name	Local name	Scientific name	Clan
Papuan eagle	Elang papua	*Saras*	*Harpyopsis novaeguineae* (Salvadori, 1875)	Kladit
Green tree python	Sanca hijau	*Klikti*	*Morelia viridis* (Schlegel, 1872)	Sremere and Srefle
Monitor lizard	Biawak/Soasoa	*Karmpet*	*Varanus Salvadorii* (Peters & Doria, 1878)	Wagarefe
Eclectus parrot	Bayan papua	*Klenwyo*	*Eclectus polychloros* (Scopoli, 1786)	Sreklefat

Table 3. Community knowledge of wildlife species protected by the government in the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia

Village	Aware	Percent (%)	Unaware	Percent (%)
Manggroholo (n = 17)	1	5.9	16	94.1
Sira (n = 18)	2	11.1	16	88.9
Average	3	8.5	32	91.5

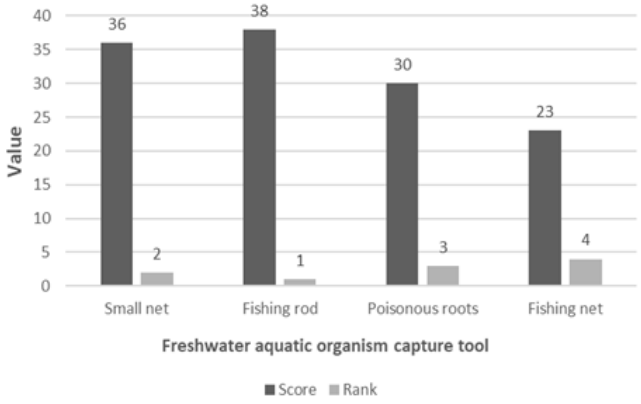

Figure 8. Techniques and preferences for freshwater aquatic life capture tools of the Tehit Knasaimos Ethnic Group in South Sorong District, Southwest Papua, Indonesia (n = 12)

Fishing and freshwater biota collection by women

Fishing for freshwater biota within the Tehit Knasaimos community is primarily conducted by women, typically working in groups of two or three. Children, including girls and boys, frequently accompany their mothers during these activities, assisting in fishing and gathering other freshwater organisms. This involvement allows children to gain hands-on experience in traditional fishing methods, learning directly how their parents harvest fish and other aquatic life from the rivers. When hunting efforts fall short of the desired wildlife yield, the hunters join the women in fishing and gathering other organisms from the rivers. These activities are concentrated in the Klihi, Kcomfo, and Kcafa Rivers. Kitolelei et al. (2021) discuss the critical role of Indigenous Fishing Knowledge (IFK) in the sustainability of marine and freshwater ecosystems in Fiji and the Pacific, emphasizing the importance of preserving traditional practices passed down through generations. Such knowledge is vital for maintaining ecological balance and supporting the livelihoods of these communities. Figure 8 shows four tools for women to catch freshwater fish and other aquatic organisms. The fishing rod is the most preferred, followed by the small net, poisonous roots, and fishing net.

Wildlife species believed to be ancestors (Totems) by the Tehit Knasaimos Ethnic Group

The wildlife species regarded as ancestral to the Tehit Knasaimos Ethnic group in the villages of Manggroholo and Sira are linked to specific clans. Four of these species are strictly protected, with hunting or consumption by the associated clans being prohibited (refer to Table 2). The list below identifies the wildlife species considered ancestral or forebears based on clan affiliations in these villages. According to Jimoh et al. (2012), cultural taboos and indigenous beliefs play a significant role in biodiversity conservation. The study highlights that these traditional practices, often overlooked by modern conservation approaches, are crucial in safeguarding species and ecosystems.

Four wildlife species-the Papuan eagle, green python, monitor lizard, and Papuan Eclectus-are considered ancestral by five clans in the Saifi Sub-district: Kladit, Sremere, Srefle, Wagarefe, and Sreklefat. This belief in totemism offers a valuable opportunity to raise community awareness about the importance of conserving local wildlife species. Jimoh et al. (2012) argue that prohibiting hunting or consuming species regarded as sacred or ancestral allows Indigenous communities to effectively manage and conserve local biodiversity. They advocate for integrating these cultural practices into broader conservation strategies to enhance ecological sustainability and respect indigenous knowledge. During fieldwork, we encountered hunters who had captured monitor lizards and Papuan Eclectus. This raises the question of whether totemism is becoming less understood by the younger generation, which would be an interesting topic for further study.

Local knowledge of protected wildlife species

Local knowledge about the protection and conservation of the local environment is based on the experiences and practices of daily life that are adapted to the community's local ecosystem or environment.

The data in Table 3 highlights interview results from respondents in the villages of Manggroholo and Sira regarding their knowledge of protected or prohibited wildlife species, indicating that 89-94% of respondents in these villages are unaware, while only 6-11% are aware. This suggests that the majority of the Tehit Knasaimos community is largely unaware of the species protected by the Indonesian government. In other words, public awareness regarding government regulations on protected species is very low. As outlined in the Minister of Environment and Forestry Regulation No P.106/MENLHK/SETJEN/KUM1/12/2018 there is a need for serious attention from all parties to raise awareness among local communities in the Saifi Sub-district about plant and wildlife protection regulations.

Conservation status of wildlife species

The conservation status of wildlife species based on Ministerial Regulation No. 106/MENLHK/2018, IUCN, and CITES, as obtained from the research site, is detailed in Table 4. Out of 19 wildlife species, five fall into three different conservation status categories:

Table 4. Wildlife species conservation status based on regulation of P.106/MENLHK 2018, IUCN and CITES

English name	Class and Common name	Local name (Tehit language)	Scientific name	P. 106/ MENLHK. 2018	IUCN 2024-1	CITES 2023
Mammalia						
Wild boar	*Babi hutan*	*Korik*	*Sus scrofa* (Linnaues, 1758)	-	LC	-
Dusky pademelon	*Walabi abu*	*Sample*	*Thylogale brunii* (Schreber, 1778)	√	VU	-
Javan deer	*Rusa*	*Rusa*	*Rusa timorensis* (Blainville, 1822)	√	VU	-
Common spotted cuscus	*Kuskus tutul*	*Dontaik*	*Spilocuscus maculatus* (É.Geoffroy Saint-Hilaire, 1803)	√	LC	Appendix II
Common spiny bandicoot	*Tikus tanah*	*Donkra*	*Echymipera kalubu* (Fischer, 1829)		LC	Appendix II
Western long-beaked echidna	*Babi duri*	*Amsa*	*Zaglosus bruijnii* (Peters & Doria, 1876)	√	CR	Appendix II
Large flying fox	*Kelelawar*	*Siwar*	*Pteropus vampyrus* (Linnaeus, 1758)			Appendix II
Aves						
Southern cassowary	*Kasuari gelambir tunggal*	*Simat*	*Casuarius casuarius* (Linnaeus, 1758)	√	LC	-
Victoria crowned pigeon	*Mambruk*	*Mprit*	*Goura victoria* (Fraser, 1844)	√	NT	Appendix II
Jobi's brushturkey	*Maleo*	*Songka*	*Talegalla jobiensis* (A.B.Meyer, 1874)	√	LC	-
Pinon imperial pigeon	*Kumkum*	*Klenosya*	*Ducula pinon* (Gaimard, 1823)		LC	-
Sulphur-crested cockatoo	*Kakatua hoki*	*Awet*	*Cacatua galerita* (Latham, 1790)	√	LC	Appendix II
Palm cockatoo	*Kakatua raja*	*Yauwya*	*Probosciger aterrimus* (Gmelin, 1788)	√	LC	Appendix I
Reptilia						
Monitor lizard	*Biawak/Soasoa*	*Karmpet*	*Varanus salvadorii* (Peters & Doria, 1878)		LC	Appendix II
Papuan olive python	*Ular sanca papua*	*Klikti*	*Apodora papuana* (Peters & Doria, 1878)	√	LC	Appendix II
Pisces						
Estuarine catfish	*Ikan sembilan*	*Eren*	*Euristhmus microceps* (Richardson, 1845)	-	-	-
Crustacea						
Mangrove clam	*Kerang kapah*	*Mpiyeng*	*Geloina expansa* (Mousson, 1849)	-	-	-
Mangrove crab	*Kepiting bakau*	*Kowin*	*Scylla serrata* (Forsskål, 1775)	-	-	-
Banana prawn	*Udang kali*	*Mongkot*	*Fenneropenaeus merguiensis* (De Man, 1888)	-	-	-

According to Indonesian Government Regulation No. P.106/MENLHK/SETJEN/KUM.1/12/2018, ten wildlife species, including the dusky pademelon (*T. brunii*), Javan deer (*R. timorensis*), and Victoria crowned pigeon (*Goura victoria* (Fraser, 1844)), are legally protected. Among these, the IUCN Red List classifies the dusky pademelon and Javan deer as Vulnerable (VU), the Victoria crowned pigeon as Near Threatened (NT), and the Western Long-beaked Echidna (*Zaglossus bruijnii* (Peters & Doria, 1876)) as Critically Endangered (CR). Additionally, eight species, such as the common spotted cuscus (*Spilocuscus maculatus* (É.Geoffroy Saint-Hilaire, 1803)) and sulphur-crested cockatoo (*C. galerita*), are listed in CITES Appendix II, indicating that while they are not currently endangered, their trade must be carefully regulated to prevent potential threats to their populations.

Rarely encountered wildlife species

The Western Long-beaked Echidna (*Z. bruijni*), locally known as *Amsa* (Figure 9), is considered the most challenging wildlife to hunt, according to observations and interviews conducted with respondents in the village forest areas of Manggroholo and Sira. *Amsa* is a protected species listed as Critically Endangered (CR) on the IUCN Red List and categorized under CITES Appendix II. Within the Tehit Knasaimos Ethnic group, *Amsa* is hunted exclusively for consumption. The hunting technique employed for this species involves using traps or snares.

Figure 9. *Amsa* (*Zaglossus bruijnii*), a rare species

Adaptation strategies in traditional wildlife hunting for sustainability

The sustainability of the Tehit Knasaimos Ethnic Group's traditional hunting practices is maintained through various critical factors, including the objectives behind hunting, the frequency and duration of hunting activities, the volume of game harvested, the types of hunting tools utilized, the techniques employed, and associated practices in fishing and capturing other freshwater organisms. Ogar et al. (2020) underscores the significance of traditional knowledge in Indigenous wildlife conservation, emphasizing that incorporating practices like hunting into modern conservation strategies is vital for sustainable biodiversity management. Herse et al. (2020) also advocate for integrating traditional hunting practices into governmental conservation efforts, recognizing their potential to enhance sustainability and ecological balance.

The traditional hunting system of the Tehit Knasaimos Ethnic Group has indeed changed. However, this is a highly rational process, as it represents the long-term adaptation of their traditional knowledge to the modern development surrounding them. Recent studies underscore the critical role of Indigenous and traditional knowledge systems in adapting to modern development's environmental and societal challenges. These adaptations are often viewed as rational responses to external pressures and are essential for sustaining Indigenous communities. Nalau et al. (2018) highlight the significance of Indigenous knowledge in ecosystem-based adaptation strategies, particularly when confronting contemporary challenges. Similarly, Kumar et al. (2021) examine how traditional knowledge is preserved and adapted to advance sustainable development goals within Indigenous communities. Schramm et al. (2020) explore how Indigenous practices are evolving to address climate change's and modernization impacts.

Modern development has necessitated that the Tehit Knasaimos Ethnic Group acquire cash to facilitate transactions with other ethnic groups within the socio-economic framework of the Saifi Sub-district. Transactions in the public market, which mandate the use of IDR cash as stipulated by the Central Government, starkly contrast with the traditional barter system, which remains confined to internal exchanges within the ethnic group. To secure the cash required for necessities, the group markets some of the wildlife they hunt, as well as fish and other freshwater biota, in demand by the general public. These items fetch prices ranging from IDR 25,000 to 150,000. This adaptation to engage in the modern market economy exemplifies how the Tehit Knasaimos have modified traditional practices. Recent research by Zant et al. (2023) underscores how Indigenous communities are transitioning from barter to cash-based transactions in response to modern economic pressures. This transition represents an economic shift and the integration of traditional knowledge with contemporary market systems to maintain livelihoods.

The monthly hunting frequency within the community does not impact the stability of wildlife populations in the Saifi Sub-district. An analysis of data concerning hunting yields per activity each month reveals a non-linear relationship between hunting frequency and yield per hunter, indicating that a higher frequency of hunting does not necessarily correlate with an increase in animals per hunter (Figure 2). For example, the group that hunts four times a month reports a lower average yield per hunter than the group that hunts 2 to 3 times a month. Similarly, research conducted in Africa, such as a study in Zambia, has shown that increased hunting frequency does not always result in higher yields. Factors such as fatigue, animal population pressure, and the effectiveness of hunting techniques contribute to this phenomenon. It is evident that wildlife yield reaches a peak and then declines as hunting frequency increases, as demonstrated by findings from Garshelis et al. (2020) and Šprem et al. (2024).

The Tehit Knasaimos Ethnic Group has adapted their hunting system to ensure their practices remain effective and sustainable from social, economic, and ecological perspectives. They now use spearheads crafted from iron or hardened metal, sharpened into a triangular shape (Figure 7.A), replacing traditional spearheads made from bamboo blades, hardwood, or animal bones. The Tehit Knasaimos Ethnic Group favors spears due to their high effectiveness and ease of use in hunting large mammals like wild boar and deer. Lombard (2020) investigated the effectiveness of spears during the Middle Stone Age in South Africa, analyzing archaeological evidence to assess their design and impact on hunting practices. The study concludes that spears were particularly effective for hunting large games due to their reach and impact, making them a favored tool in prehistoric times. This detailed analysis provides valuable insights into spear technology's historical and practical significance in hunting.

Trap ropes (snares), previously made from forest vines and rattan, have been replaced with nylon ropes and steel wire (Figure 7.C). Passive hunting using traps or snares is intended to capture deer, wild boar, dusky pademelons, bandicoots, cassowaries, and monitor lizards. Bizri et al. (2016) provide an in-depth examination of the efficiency of traps in wildlife research and management. The study assesses various types of traps and their effectiveness in capturing different species over time. The results indicate that traps are reliable and efficient tools, particularly useful for passive and long-term monitoring of wildlife populations. The article supports traps' high evaluation and ranking due to their practicality and effectiveness in various hunting scenarios.

The hunting tools that have remained unchanged include hunting dogs and the Sagu Hiding method (Figures 7.D and 7.E), which are still utilized as they were historically. Ogar et al. (2020) explore the role of hunting dogs in wildlife conservation, highlighting their effectiveness in tracking and capturing various species. Despite lower scores in some evaluations, the study emphasizes the vital role of trained hunting dogs in locating elusive prey. The Sagu Hiding method used explicitly for wild boar hunting, is discussed by Morcatty et al. (2020), who analyze camouflage and strategic positioning techniques. Their research indicates that these methods, while demanding skill and patience, can substantially enhance hunting success by reducing the hunter's visibility, which aligns

with the moderate effectiveness score assigned to Sagu Hiding. In the Tehit Knasaimos community of Saifi Sub-district, an adaptation is evident in replacing traditional weapons such as bows and arrows with air rifles (Figure 7.B), which are more effective and practical despite their higher cost. Air rifles hunt birds, cuscus, dusky pademelons, and reptiles. Decker et al. (2014) examined the use of air rifles in controlling overabundant animal populations, highlighting their precision, effectiveness, and humane aspects. This study emphasizes that air rifles are highly effective for recreational hunting and wildlife population management due to their accuracy and ability to euthanize target species humanely.

It appears that the role of the hunting group leader, who also owns the hunting grounds, is crucial in maintaining the effectiveness and sustainability of the traditional hunting system. The leader deeply understands the forest ecosystem's dynamics and is responsible for determining which animals may be hunted and the quantity that can be harvested (Pattiselanno et al. 2024). Additionally, the role of the extensive *hutan pamali* (sacred forests) owned by the Keladit, Seremere, Srefe, and Sagisolo clans, which contain key resources, is essential. These areas serve as primary habitats for wildlife, free from disturbances, thus allowing the wildlife to breed and grow effectively. Only those animals that venture outside these traditionally protected forest areas become targets for hunting. This dynamic is well-documented by Garnett et al. (2018), Johnson et al. (2019), Mavhura and Mushure (2019), Sinthumule and Mashau (2020), and Berkes et al. (2021).

As illustrated in Figure 8, fish activity by women demonstrates that while all tools have some level of effectiveness, the fishing rod is the most effective tool for capturing freshwater aquatic organisms. The scoop net, poisonous roots follow it, and finally, the fishing net. Each tool's rank and score provide insights into its relative efficiency and users' preferences. Women prefer fishing rods (ranked 1) and scoop nets (ranked 2) because they are more practical and yield better results. Poisonous roots (ranked 3) are also favored by women for catching freshwater biota, although finding the necessary bore root plants can sometimes be challenging. Mesh nets (ranked 4) are the least preferred by women due to their difficulty in use and the time required to catch various fish and shrimp. Mendoza et al. (2021) highlight how these traditional fishing methods are integral to the local cuisine and culture, reflecting a deep connection between the community and their natural resources in the Laguna Lake area of the Philippines.

These tools for fishing and capturing freshwater biota have long undergone adaptations, with traditional materials being replaced by more advanced ones. For example, hooks originally made from rattan strings and thorns have been replaced with nylon strings and hooks crafted from aluminum. Nets previously constructed from tree bark fibers woven into thread have now been replaced with those made from nylon strings. According to respondents, these material replacements were necessary because they are easier to obtain, more affordable, and offer a longer lifespan than traditional materials. Cañete et al. (2022) specifically focus on sustainable practices and innovations that have transformed traditional fishing methods, including the shift from natural to synthetic materials to enhance durability and efficiency.

The wildlife protected by government regulations is well-preserved through traditional practices, such as the sacred forests (*hutan pamali*) owned by the Tehit Knasaimos Ethnic Group, which communities have stewarded for generations since ancient times. Recent studies have indicated that *hutan pamali* represents traditional ecological knowledge that aligns with or can be integrated into government wildlife conservation programs (Mavhura and Mushure 2019; Morcatty et al. 2020; Shitumule and Mashau 2020). The *Amsa*, or Western Long-beaked Echidna (*Z. bruijnii*), is believed to be well-protected within the extensive *hutan pamali* owned by local communities. This may explain why it is rarely encountered in hunting areas. However, hunters have reported that this species occasionally leaves the *hutan pamali* and is caught in traps set within hunting grounds. A joint survey with the owners of the *hutan pamali* is necessary to verify this assumption. Louys et al. (2014) provide an in-depth review of the status and ecology of the Western Long-beaked Echidna. Their article discusses the species' habitat preferences, foraging behavior, and reproductive biology while emphasizing the significant threats to *Z. bruijnii*, such as habitat loss and hunting. Louys et al. (2014) stress the importance of targeted conservation efforts, including increased research and monitoring, to inform effective strategies. They highlight the need to protect remaining habitats and involve local communities in conservation initiatives. The study offers crucial insights into the species' ecology and the urgent actions required to prevent extinction. Pattiselanno and Koibur (2018) stated that The Javan deer (*R. timorensis*) is an introduced species in Papua that has rapidly proliferated and spread across nearly the entire region. In certain villages, they have even become pests in local gardens. The Indonesian government protects the Javan deer due to its drastically declining population in its native habitat on the island of Java (Ali et al. 2021).

In the villages of Manggroholo and Sira, the community only raises pigs in pens constructed over freshwater fish ponds. In contrast, in other villages, people maintain a more diverse range of livestock, including freshwater fish, chickens, goats, pigs, and cattle. This demonstrates that the communities in both villages heavily rely on animal protein sources from the forest. The local government, through relevant technical departments, urgently needs to implement livestock diversification programs in these two villages. This will enable the community to become familiar with and maintain other species of livestock, which could ultimately provide an easily accessible source of protein, as the community members own them. Indeed, long-term support and time are necessary to successfully introduce and establish new practices in village communities.

In conclusion, the Tehit Knasaimos community has adapted their hunting and fishing methods to ensure sustainability, influenced by the need to balance modern

development with traditional knowledge. This includes transitioning from barter to cash-based transactions in the local market economy. There has been a shift from traditional hunting tools, such as bamboo and hardwood spearheads, to modern materials like iron and nylon. These changes have been driven by the need for more durable and effective tools, reflecting a rational adaptation to external pressures. The community's belief in totemism and protecting sacred species, as seen with the Western Long-beaked Echidna (*Z. bruijnii*), plays a crucial role in conservation. These traditional practices are aligned with modern conservation strategies, highlighting the importance of integrating indigenous knowledge into broader environmental management efforts. The necessity of cash transactions has led the community to sell some of the wildlife they hunt. This economic shift represents an adaptation to modern development's socio-economic framework while maintaining traditional practices. The role of hunting group leaders and the concept of *hutan pamali* (sacred forests) are vital in ensuring the effectiveness and sustainability of hunting practices. Adapting fishing tools and methods from traditional to more advanced materials reflects the community's ongoing effort to sustain their practices while improving efficiency. These leaders possess deep ecological knowledge, which helps regulate hunting activities and protect key wildlife habitats.

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