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Combining social and genetic methods to understand changes in a cultural ceremony

The use of cheetah and leopard skins in Northern Kenya

Pictures by Daniel Burgas

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Master's thesis

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Abstract

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Abstract:

Biocultural practices are integral to social and environmental sustainability, involving traditional knowledge and cultural values that support sustainable resource management. However, as indigenous people and local communities integrate into the global economy, there is often a shift towards commercially driven activities, leading to traditional knowledge erosion, human-nature disconnection, and loss of biodiversity and cultural heritage. My thesis examines these processes through the Dimi ceremony of the Daasanach in Northern Kenya. Traditionally, men must wear a cheetah (*Acinonyx jubatus*) or leopard (*Panthera pardus*) skin during Dimi rituals. I integrated social and genetic methods to investigate changes in the value of ritual skins, the impact of felid decline on hunting and trade, and the connection to traditional knowledge loss. I recorded the skin numbers of this year's ceremonies, conducted 93 semi-structured interviews to explore values, knowledge, and skin acquisition methods, and sequenced 26 samples to identify possible origins of the cheetah skins. Results indicate that nowadays skins are often rented or bought instead of traditionally hunted as part of the rite of passage. This has led to a significant change in the value attributed to skins, from bravery and social status to economic value. Despite the increase in trade, both the interviews and genetic data suggest skins are still primarily locally sourced. Interviewees struggled to accurately differentiate between cheetah and leopard, potentially indicating a significant human-nature disconnect. Both the disconnection from ceremonial symbolism and from local carnivores raise concerns for social and environmental sustainability. Synthetic heritage furs are proposed as an alternative to prevent cultural erosion and reduce pressure on wildlife populations.

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Preface

This master's thesis is part of a broader project focused on the sustainability of cultural practices that involve the use of endangered wildlife, initiated in 2016 by the Global Change and Conservation research group (University of Helsinki) in Northern Kenya. Through insightful dialogues and shared stories, the decline of cheetah (*Acinonyx jubatus*) and leopards (*Panthera pardus*) was raised as an important concern, especially due to their key ceremonial role.

The project was interrupted by the pandemic in 2020. However, this break was used to start building a network of international collaborators to address cheetah conservation (Action for Cheetahs in Kenya), the use of synthetic furs as a sustainable alternative (Heritage furs, from the Furs for Life programme from Panthera NGO) or the genetic monitoring of cheetah populations (Biodiversity Genomics, University of Oulu). I saw this project as an opportunity to combine two of my main research interests: genetics and ethnoecology.

Conducting this master's thesis entailed living close to the Daasanach, isolated from the western world, re-establishing the trust with the community, navigating tensions and recording cultural changes. In addition, the project involved the introduction of a heritage fur to members of the community and the collection of their first impressions and willingness to future collaboration for Panthera NGO.

Because of my interest in conservation genetics, I explored ways in which felid genetics could be integrated to answer questions related to the sustainability of the Daasanach cultural practices. I helped in the development of genetic methods to study the cheetah regional populations through a HiLIFE traineeship. These methods, relevant to the master thesis, build upon on-going research on cheetah genetics that is currently unpublished.

1. Introduction

Society is currently facing challenges of unprecedented dimensions due to globalization, technological development, resource overexploitation and environmental change. These global changes are threats to biodiversity (IPCC, 2014), but also to cultural diversity and human-nature relationships, therefore affecting social and environmental sustainability (Maffi, 2005; Fernández-Llamazares *et al.* 2021).

1.1 Links between cultural and biological diversity

There is growing evidence that cultural and biological diversities are intertwined. Biodiversity "hotspots" are often also areas with high cultural diversity (Maffi, 2005). Unfortunately, this correlation is also seen when biodiversity declines are associated with less linguistically and culturally diverse areas (Gorenflo *et al.* 2012). Global changes have greatly impacted socio-ecological systems, decreasing their diversity and resilience (Fernández-Llamazares *et al.* 2021).

Because of their close dependency on natural resources, indigenous people and local communities (IPLC) are especially vulnerable to biodiversity loss (Fernández-Llamazares *et al.* 2021). IPLC are ethnic groups who are descended from, and identify with, the original inhabitants of a given region, in contrast to groups that have settled, occupied or colonized the area more recently (Lyver *et al.* 2019). With changes in ecosystem resources, IPLC need to adapt livelihood strategies, including cultural practices (Pandey *et al.* 2025). While cultural institutions are updated constantly by engaging with the local environment (Lyver *et al.* 2019), its continuous degradation has led to the replacement or loss of traditional practices (Pandey *et al.* 2025).

Through many generations interacting with wildlife, IPLC have developed knowledge systems to understand and use their environment sustainably. Traditional Ecological Knowledge (TEK) is defined as the "accumulated environmental knowledge, resource management practices, related social institutions and worldview of local and indigenous people" (Berkes, 2002). TEK is known to be dynamic and highly adaptive to environmental changes (Tang & Gavin, 2016). However, concerns have been raised about an alarming rate of its erosion (Fernández-Llamazares *et al.* 2021). Some of the

threats to the loss of TEK include the loss of transmission pathways, the change in traditional practices and local environmental change (Tang & Gavin, 2016).

The decline or disappearance of certain species can have an important effect on human-wildlife interactions and TEK. For example, in New Zealand, the cultural harvest of grey-faced petrels (*Pterodroma gouldi*) was stopped due to its population declining, endangering an important cultural practice and local ecological knowledge of the species (Lyver *et al.* 2008). Species population declines can therefore mean a loss of TEK and difficulties to uphold important cultural practices (Pandey *et al.* 2025). The loss of TEK leads to disconnection from the environment, resource overexploitation and lack of adaptation to environmental changes (Lyver *et al.* 2019).

1.2 The cultural significance of big cats (and its implications for conservation)

Large carnivores interactions with humans have always had an important place in human cultures (Williams *et al.* 2025). Due to their role as top predators and competitors, they are often associated with fear (Johansson *et al.* 2016), but are also symbols of strength and bravery (Saunders, 1994). Felines in particular have had, and continue to have, a prominent role. Archaeological evidence of the use of cave lion pelts in ritual activities dating to 14,800 cal BC (Cueto *et al.* 2016) show the long-standing symbolic value of these predators. Felines have also been associated with royalty and spiritual entities (Williams *et al.* 2025). For example, the jaguar in Mesoamerica has often been depicted as a symbol of social status, royalty and strength, but also been associated with shamans (Saunders, 1994). Several societies have also used cheetahs (*Acinonyx jubatus*) as hunting animals, such as the Egyptian and Mughal empires (Pang *et al.* 2018). At present, felines are still used in traditional medicine and in cultural practices (Williams *et al.* 2025).

Recently, changes in the use of felid products have occurred due to several factors. Human population growth has increased the demand of skins for cultural ceremonies (Naude *et al.* 2020; Torrents-Ticó *et al.* 2023a). In addition, declines in felid populations have led to an increase in prices and the use of smaller species to replace large felines in West African wildlife markets (Horion *et al.* 2025). Declining populations have also

diverted the pressures of wildlife trade to other felid species, as they are increasingly being used as substitutes (Williams *et al.* 2017).

A growing concern about the sustainability of fur trade and its impact on endangered felids has also led to conservation and legislative efforts to abandon certain traditional practices. For example, the use of snow leopard skins for decorative purposes and traditional clothing in Mongolia is now forbidden (Munkhtsog *et al.* 2024). In other cases, affordable synthetic furs are effectively substituting natural products in cultural ceremonies in South Africa (Naude *et al.* 2020). Animal rights movements and ethical considerations are also shaping the public opinion on fur trade (Munkhtsog *et al.* 2024). These dynamics may lead to changes in the symbology and cultural significance of large felines, also leading to cultural erosion. The loss of cultural identity and traditional human-nature interactions can further lead to a disconnection from the environment. This disconnection, coupled with retaliatory actions and poaching in response to legislative restrictions, can actually have a negative effect on felid populations (Goldman *et al.* 2013; Fernández-Llamazares *et al.* 2020). Moreover, shifting baselines because of disconnection from the environment can lead to resource overexploitation and a lack of appreciation of conservation (Fernández-Llamazares *et al.* 2015).

Despite felids being widely present in African cultures (Williams *et al.* 2025), there is little research on the dynamics of human-felid relations in the light of cultural practices and globalization. There are few studies with a holistic approach to address the social and ecological impacts of a changing traditional practice. With a long history of conservation efforts associated with cultural changes (Goldman *et al.* 2013; Fernández-Llamazares *et al.* 2020), Kenya provides insightful case studies for biocultural research, such as the Dimi and the Daasanach community (Torrents-Ticó *et al.* 2023a).

1.3 The Daasanach community and the Dimi

The Daasanach are an agro-pastoralist community whose traditional territories are found around the northeastern shore of Lake Turkana in Kenya, southern Ethiopia, and South Sudan (Torrents-Ticó *et al.* 2023a). They mainly herd cattle, sheep and goats, but opportunistically grow maize and sorghum. With recent droughts, fishing is becoming increasingly common. The Daasanach territories are isolated from developed urban

centres in Kenya and Ethiopia, with low access to the power grid, lack of public infrastructures and limited access to trade and education (Torrents-Ticó *et al.* 2023b).

The Daasanach hold strong socio-cultural values for wildlife, as exemplified in cultural ceremonies and folktales (Torrents-Ticó *et al.* 2023a). The Dimi is their traditional coming-of-age ceremony (Houtteman, 2011). Every man should go through Dimi when his first-born daughter reaches puberty. Daasanach men must undergo the Dimi ceremony to become respected elders and true members of the community. The aspirants wear ritual attire, including ostrich feathers, giraffe and oryx tails, and a cheetah or leopard (*Panthera pardus*) skin to bless the fertility and future marriage of his daughter (Torrents-Ticó *et al.* 2023a). Aspirants go through the ceremony simultaneously as cohorts in an event that lasts months and gathers clans and villages.

For the aspirants, wearing a *muor* (common Daasanach name for cheetah [*gosoch*] and leopard [*mo'r dhatka'*]) skin is mandatory. While attending two Dimi ceremonies in 2018 and 2021, Torrents-Ticó *et al*. (2023a) counted a total of 83 and 121 skins respectively, each worn by one of the year's Dimi aspirants. Skins came mainly from leopards and cheetahs, but serval (*Leptairilus serval*), common genet (*Genetta genetta*) and African civet (*Civettictis civetta*) skins were also observed. As the Daasanach are currently living in an extremely defaunated landscape (Torrents-Ticó *et al.* 2021), the source of such considerable amount of skins remains uncertain.

In last decades, the ceremony has gone through major changes in frequency, duration, number of participants and cultural meaning (Torrents-Ticó *et al.* 2023a). The study reports that Daasanach elders recall the Dimi ceremony only happening once every 5-7 years for the whole Daasanach community, while at present the ceremony is held regionally and annually.

Worldwide, the ritual hunting of felids is usually associated with strength and power (Saunders, 1994). For example, Maasai warriors have traditionally hunted lions as a way to gain prestige (Goldman *et al.* 2013). For the Daasanach, the hunting and use of *muor* skins for the ceremony was also traditionally associated with strength and power (Houtteman, 2011). However, a recent study indicated a possible shift in ways of obtaining the skins, including loans, rentals and purchasing from traders (Torrents-Ticó

et al. 2023a). The relative importance of this share, its dynamics and its social and ecological implications are however unknown.

1.4 Leopard and cheetah conservation status

Despite being the most widespread felid and highly adaptive (Kingdon & Hoffmann, 2013), the leopard shows declining trends across its range and is classified as "vulnerable" by the IUCN (Jacobson *et al.* 2016). Major threats suffered by leopard populations include habitat loss and fragmentation, loss of prey, human-leopard conflict, unsustainable legal trophy hunting and the trade in skins and parts (Jacobson *et al.* 2016). In Kenya and Ethiopia, leopards are distributed across the country (Jacobson *et al.* 2016; Broekhuis *et al.* 2022), but are also threatened by habitat loss, land-use change, illegal trade and bushmeat hunting (KWS, 2021; Asfaw *et al.* 2025).

The global cheetah population is estimated at 7,100 individuals and considered as "vulnerable" by the IUCN (Durant *et al.* 2017). Durant *et al*. (2017) also showed that the cheetah's current range is heavily fragmented and represents only 9% of the historical distribution. As most of their distribution falls outside of protected areas, cheetahs are especially vulnerable to land-use change, persecution, illegal trophy hunting and trade as pets and pelts (Tricorache *et al.* 2018). In Kenya, the cheetah population is estimated at around 1,160 individuals distributed across the country (KWS, 2021; Broekhuis *et al.* 2022), while in Ethiopia they are mainly confined to the southern Rift Valley (Durant *et al.* 2017).

1.5 Cheetah conservation genetics

Genetic tools are increasingly being used to inform conservation initiatives (Tkach & Watson, 2023). They are used for taxonomic identification, the delineation of management units and the management of wild and captive populations (e.g. Prost *et al.* 2022). Moreover, genetic markers are used to identify the geographical origin of seized skins from illegal wildlife trade (Mondol *et al.* 2015). However, these tools often require previous knowledge on the genetic background of the studied local population.

Cheetahs have been widely studied in conservation genetics for their low levels of genetic diversity caused by a small population size prolonged over time (reviewed in Schmidt-Küntzel *et al.* 2018). Despite a considerable debate in the past, inbreeding

depression appears to be minimal in wild cheetah populations. However, their low genetic diversity makes them extremely vulnerable to changes in their environment (Prost *et al.* 2022).

There are five subspecies of cheetah with distinct ranges and limited gene flow (Prost *et al.* 2022). In East Africa, *Acinonyx jubatus soemmeringii* is found in Ethiopia, while the *A.j. rayneii*'s range includes Kenya and Tanzania. Prost *et al.* (2022) observed a barrier between the two subspecies at the border between Kenya, Ethiopia and South Sudan. This phylogeographical pattern is also seen in other species (e.g. in lions (*Panthera leo*) [Bertola *et al.* 2016]). However, cheetah genetic samples from the area are scarce and are needed for a better understanding of the cheetah phylogenetic and evolutionary history.

The high genetic differentiation between geographical populations have allowed the development of simple genetic markers (e.g. Prost *et al.* 2022; Meißner *et al.* 2023). These markers are able to cost-effectively classify individuals into the different known geographical populations (Meißner *et al.* 2023). The cheetah skins used at the Dimi ceremony allow further testing of these markers, while informing on their geographical provenance. This can shed light on hunting and trade patterns in the area.

1.6 Aims of the study

The dynamics observed in recent years related to the use of skins highlight the Dimi ceremony as a relevant case study to better understand how culture is shaped in and by a changing environment. Therefore, through a combination of social and genetic approaches, I intend to elucidate how the decline of carnivore populations has affected the ceremony as well as TEK on these species. These changes may have led to a change in values and cultural erosion, threatening both social and environmental sustainability (Figure 1).

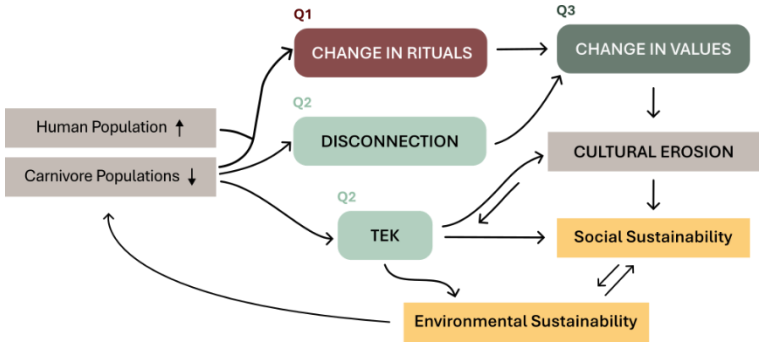

Figure 1. Theoretical background of the research questions. An increase of human populations and a decrease of carnivore populations induce changes in rituals, human-wildlife disconnection and loss of traditional ecological knowledge (TEK). These factors cause a change in values and lead to cultural erosion, negatively impacting social and environmental sustainability.

1.7 Research questions and hypotheses

My thesis addresses changes in sourcing, TEK and symbolism by focusing on the following questions:

Question 1. *Skin provenance dynamics:* a) *Has the number of skins at the Dimi decreased over time?* b) *Has the way of obtaining a skin changed over time?* c) *What is the current spatial range of skin obtention?*

I hypothesize that due to cheetahs and leopards being almost extinct in the area Daasanach inhabit (Torrents-Ticó *et al.* 2021), there will be a decrease in the amount of skins and a higher proportion of rented and bought skins in recent ceremonies. Moreover, newer skins might come from distant populations. I therefore expect genetic results indicating a diverse set of skin sources.

Question 2. *Is the ability to differentiate cheetah from leopard reduced in young members and non-herders?*

I hypothesize that with a decreasing need for hunting-related knowledge, cultural disconnection and less intergenerational contact to share experiences and traditional knowledge, I expect non-herders and young members of the community to be less able to differentiate between cheetah and leopard than elders of the community and herders.

Question 3. *Change in the skin value:* a) *Has the meaning of wearing a skin during Dimi changed over time?* b) *Is the meaning related to the way of obtaining the skin?*

I hypothesize that with a decrease in hunting and the impact of an emerging fur trade, there has been a shift from the skin representing bravery and strength to the skin being associated with wealth and economic opportunities.

2. Materials and methods

In this master's thesis, I use an integrated approach to acknowledge the biophysical and sociocultural components of socioecological systems (Gavin *et al.* 2015). I use a combination of social and genetic methods to answer my research questions (Table 1).

Table 1. Main methods used and comparisons performed for each research question.

Research questions	Data collection	Locations	Comparisons
Q1a. *Has the number of skins at the Dimi decreased over time?*	Skin count questionnaire	Bubua	**Time** 2018* | 2021* | 2025
Q1b. *Has the way of obtaining a skin changed over time?*			**Time** 2020** | 2025
Q1c. *What is the current spatial range of obtention of the skins?*	Genetic sampling	Bubua and Hado	**Current spatial range**
Q2. *Is the ability to differentiate cheetah from leopard reduced in young members and non-herders?*	Semi-structured interviews	Bubua, Nangolei, Watali, Guoro and Selicho	**Age-groups** Before Dimi | During Dimi | Elders
			Livelihood Herder | Non-herder
Q3a. *Has the meaning of wearing a skin during Dimi changed over time?*			**Age-groups** Before Dimi | During Dimi | Elders
Q3b. *Is the meaning related to the way of obtaining the skin?*			**Obtention methods** Hunted | Rented+Bought | Inherited+Borrowed

* Skin count data from Torrents-Ticó *et al*. (2023a)

** Interview data from Torrents-Ticó *et al*. (2023a)

2.1 Study area

I conducted the study in the surroundings of Ileret Ward, Marsabit County, Northern Kenya. This area is located between the northern border of the Sibiloi National Park and the southern border of Ethiopia, on the eastern shore of Lake Turkana (Figure 2A).

The study area is located within the traditional territories of the Kenyan Daasanach (locally known as *Gál urru*, 'people of the south'). The area is greatly isolated from urban and modern centres in Kenya and Ethiopia, with few public infrastructures and a lack of access to education and employment opportunities (Torrents-Ticó *et al.* 2023b). While

Selicho and Ileret are the main villages with permanent infrastructures (e.g. administration and school) and trade, the rest of the villages (such as Watali, Nangolei and Guoro) consist of semi-permanent huts inhabited by herding families.

2.2 Appraisal of ceremony skins

In February 2025, I visited a Dimi ceremony held in Bubua (Figure 2A). The ceremony setup consisted of two circles of huts called *dol gerge* and *dol badit*, which separate the sons and fathers generations (Houtteman, 2011). The temporary village is built especially for this occasion and gathers all the men ready to go through the Dimi. In this case, the ceremony had a duration of 4 months.

During the ceremony, the skins are worn during rituals (i.e. traditional dances, songs and livestock sacrifices). When not in use, skins are displayed on a pole in front of each participant's hut. To count the skins, I systematically walked around the two circles stopping at each pole, recording the species, and estimating the skin age as 'fresh' (< 1 year old) or 'old' (> 1 year old), based on the rigidity of the skin, its coloration and wear and tear (Torrents-Ticó *et al.* 2023a). Due to sun, wind and rain exposure during the duration of the ceremony, skins that had been used in previous ceremonies were easily identifiable. I added a 'very old' category to identify skins that stood out for their poor condition. Due to some rain on the previous day, some skins were covered by a blanket and the owner not present, so the skin was classified as 'Undetermined'. At each pole, if the aspirant or an adult member of his family was present, I asked i) how did they obtain the skin; ii) if rented or bought, how much did they pay and from whom did they obtain it; and iii) if hunted, where.

In March 2025, a second Dimi ceremony started further north, held by another subgroup of the Daasanach people. Paul Kanisa (PK) and Raphael Arkol (RA), members of the Daasanach community, that had been trained as research assistants during the Bubua skin appraisal, had the initiative to visit the ceremony and collect further data, motivated by their growing interest in the practice and its changes. They shared this data with me.

2.3 Genetic analysis

Because it is taboo for non-aspirants to touch the skins during the ceremony, local research assistants, PK and RA, cut a 1x1 cm sample from the cheetah skins only once

the Dimi was over in March 2025. The skins were sampled always in agreement with the skin owner, first indicating the amount of skin to be cut, and asking the owner to select the less conspicuous area of the skin to be removed, to avoid losing cultural or economic value. For each sample, we asked its owner for the approximate date of skin obtention.

To analyse the DNA samples, I worked alongside the local teams of the Wildlife Forensics laboratory in Nairobi, Kenya. I extracted the DNA from each sample using the E.Z.N.A Tissue DNA kit (Omega Bio-tek, United States) and amplified the sequences following the protocol outlined in Meißner *et al*. (2023).

To identify the subspecies of origin of the skin samples, I used Cheetah Subspecies-specific Amplicons (CSAs) that contained relevant SNPs to differentiate between the cheetah subspecies (Meißner *et al*. 2023). From the primers used in Meißner *et al*. (2023), I combined AMP1 forward with AMP3 reverse and AMP4 forward with AMP6 reverse, as they amplify all the CSAs (AMP1 to AMP6) and allow me to effectively discriminate between the Ethiopian (*A. j. soemmeringii*) and the Kenyan (*A. j. raineyi*) subspecies. In addition, I added a third pair of primers (AMP7) that increases the resolution for the classification and further study of the Eastern African populations (unpublished data).

I then performed a Polymerase Chain Reaction (PCR) to amplify the CSAs using the Mastermix from the Multiplex PCR Kit (Qiagen, Germany) an following the protocol outlined in Meißner *et al*. (2023). The PCR consisted of 38 cycles with an annealing temperature of 55ºC. As some samples did not amplify, I repeated a PCR, changing the annealing temperature to 54ºC. All the successful PCR products were sequenced with Sanger sequencing by Inqaba Biotec East Africa Ltd. (Nairobi, Kenya).

For the bioinformatic analysis, I first cleaned the sequences by removing the primer sequences and aligned them to the mitochondrial data available. To ensure the right classification of the samples, I used three different mitochondrial datasets: 1) the dataset from Prost *et al*. (2022) consists of two mitochondrial regions and samples from which the origin is well known; 2) the dataset from Meißner *et al*. (2023) included a wider range of sequences from the CSAs regions; and 3) the unpublished dataset contains

more sequences from East Africa and allows the use of AMP7 (unpublished data). I aligned the sequences using the MAFFT online service (Katoh *et al.* 2019). As some sequencing results were of poor quality, I followed several steps to recover some lost sequences. As the CSAs regions are highly conserved (Meißner *et al.* 2023), in uncertain reads, I kept the most common nucleotide seen in other sequences at the same position. When only the forward or reverse sequence was of good quality, I only included that one for further analysis. Finally, if any of the CSAs were missing, I still kept the available ones for further analysis.

I reconstructed medium-joining networks based on the CSAs (AMP1-3, AMP4-6 and AMP7) separately using the freeware tool PopART v. 1.7 (Leigh & Bryant, 2015). For each alignment, I reconstructed the networks for i) a subset of the better quality sequences and ii) for all the samples by eliminating all positions that were not genotyped across all individuals. For the samples where the three amplifications were correctly sequenced, I reconstructed the networks with the combined sequences. Finally, I classified each sample into the different known groups using all the networks available. I marked the sequences that were more complete as highly certain and the less complete as classified with some uncertainty. The combination resulted in a consensus classification.

2.4 Semi-structured interviews

To study the sociocultural values associated with the spotted carnivore skins, I, together with my local research assistants (PK and RA), conducted interviews to the members of the Daasanach community during January and February 2025. The interviews took place in Bubua (where the ceremony was held), as well as in the villages of Nangolei, Watali, Guoro and Selicho. While most of the villages are mainly inhabited by herding families, fishermen mostly live in Selicho. The interview questions were translated to Daasanach and the interviewees answers translated to English by my local research assistants. The interviews had an approximate duration of 30 minutes and contained questions about the Dimi ceremony, the use of carnivore skins and their cultural meaning, local perceptions and perceptions about the cheetah and leopard and reflections about the future of the Dimi ceremony (see Appendix 1 for the full interview questionnaire). I also collected demographic information to identify differences in the answers between

community groups. Before starting to collect data, I discussed the interview structure with my local assistants, who are members of the community, and performed five pilot interviews to ensure the questions were respectful and relevant to the study, and to ensure that they were able to translate all the questions.

Only Daasanach men were interviewed, as they are the main participants in the ceremony. Because the exact age of interviewees was difficult to determine by asking or even estimating by the physical appearance, the interviewees were grouped relative to Dimi: young members not gone through the Dimi (Before Dimi), current aspirants (During Dimi) and elders of the community who had already celebrated Dimi previously (Elders). Although the age ranges of the three groups might overlap, this classification represents the three important social levels for men, which have distinct roles, perspectives and aspirations within the Daasanach society. From now on, I refer to this classification of interviewees as age groups.

2.5 Focus groups

I also conducted focus groups with members of the community in two of the villages, Watali and Nangolei, where trust with the community has been established by the research group over the past years. Different groups of the community, including elders, women and young men, participated in these discussion groups to share an overall picture of the Dimi and their concerns about its future. The number of participants in the focus groups ranged from 7 to 20. The focus groups at the beginning of the fieldwork (early February 2025) allowed me to build trust with the community and ask for their consent regarding this study. Moreover, it led to some modifications to the interview questions, such as the different values associated with the skins. The focus groups at the end of the interview period (late February 2025) allowed me to confirm and investigate deeper into some aspects of the Dimi ceremony. Additionally, together with the participants, we discussed matters related to the future and sustainability of the Dimi ceremony, focusing on different alternatives to the use of spotted carnivore skins and presenting the heritage fur from Panthera NGO. These discussions allowed me to better interpret and discuss the results obtained from the data collected.

2.6 Statistical analysis

2.6.1 Skin obtention and origin data

To look for potential changes in the skin use at the Dimi, I compared the data obtained with the counts and interviews performed by Torrents-Ticó *et al*. (2023a). I compared the number of skins and species proportions with the counts conducted in 2018 and 2021 at the Bubua Dimi ceremony. As Torrents-Ticó *et al*. (2023a) did not ask the aspirants about how they obtained their skin, I used the interview data from 2020 from the same study to compare with current obtention methods. Because of the small sample sizes, I used Fisher's exact tests to check for significant differences in obtention methods between years at the Bubua Dimi ceremony. I grouped together inherited and borrowed skins, as well as rented and bought skins, as the latter imply an economic transaction (Torrents-Ticó *et al*. 2023a). I also compared with a Fisher's exact test the skin species proportions between years (2018, 2021 and 2025, for the Bubua ceremony) and between ceremony localities (Bubua and Hado in 2025).

I mapped the hunting areas and trading ethnic groups approximately using information gathered from interviewees and local informants. I used the ArcGIS PRO 3.2.2 software (Esri, 2023) to create the maps and extracted the Sibiloi National Park area from UNEP-WCMC & IUCN (2025). The locations are approximate and only meant for visual description of the data.

2.6.2 TEK on carnivores and the cultural ceremony

I conducted some exploratory and statistical analysis to investigate the local knowledge on carnivores, especially cheetah and leopard, and their relationship with the Dimi ceremony.

I used two indicators to test for the interviewees' ability to differentiate cheetah from leopard. As the interviewees were asked to separate cheetah from leopard pictures (Q21,

Appendix 1), I first tested if the grouping was done at random with a Fisher Exact Test for each interview. Second, I calculated a "grouping score" for each interviewee, indicating the proportion of pictures correctly identified. As the score ranges from 0 to 1, I fitted a

beta regression model to analyse the effect of livelihood, community group and the last time a carnivore was seen on the ability to differentiate between cheetah and leopard (Equation 1).

$$\text{GroupingScore}_i \sim Beta(\mu_i, \theta)$$
$$\text{logit}(\mu_i) = \beta_0 + \beta_1 \cdot \text{AgeGroup}_i + \beta_2 \cdot \text{Livelihood}_i + \beta_3 \cdot \text{LastCarnivore}_i \quad \text{(Equation 1)}$$

Due to small sample size for some groups, Livelihood was categorized as herder versus non-herder. I combined the last reported sighting of a cheetah and a leopard (Q22 and Q24,

Appendix 1) into the "LastCarnivore" variable, keeping the most recent sighting. I was not able to explore potential interactions between variables, as some combinations of variable categories had too few observations. I validated the beta regressions model assumptions by checking the homoscedasticity and the distribution of the model's residuals.

To explore the correlation between local carnivore knowledge and cultural knowledge related to the Dimi ceremony, I performed a Multiple Component Analysis (MCA), which is used to analyse and visualize the relationships between categorical variables (Greenacre & Blasius, 2006). For the MCA, I added variables related to knowledge on carnivores and the use of skins for the ceremony: animals used in Dimi, animals preferred, skin patterns used, skin pattern preferred, grouping score and naming score (i.e., interview questions Q19a, Q19b, Q20a, Q20b, Q20c, Q21, Appendix 1). For the questions related to choosing pictures of skin patterns (Q19a and Q19b), I separated answers into three broader categories: i) only cheetah and leopard (including a synthetic leopard skin pattern); ii) adding smaller spotted carnivores (serval and civet cat); and iii) answers involving lion and hyaena skins, as they are not considered acceptable for the ceremony. Similarly, I categorized the answers from Q20b, in which interviewees where asked which animals can be used as skins at the Dimi into answers i) only involving cheetah and leopard, ii) adding serval, and iii) other answers. Traditionally, only cheetah and leopard skins are worn at Dimi. Currently, smaller spotted carnivores are used as a replacement. The categorization allowed me to interpret the answers as ranging from

stricter perspectives on skin use to a more flexible perspective or disconnection from cultural norms.

As indicators of carnivore knowledge, I used the grouping score (explained above) and the naming score (Q20a). In question Q20a, I asked interviewees to name the carnivores shown in the pictures. I then scored the pictures giving 1 point for each correct answer. For the MCA, I categorized the grouping score into low, average and high scores setting the average group to be all scores between the interval of the mean ± standard error. For the naming scores, which go from 0 to 6, I defined high as above 4, medium as scores between 3 and 4, and low as below 3.

To check for differences in the cultural value associated with the skin (Q8) between community groups and obtention methods, I used the Fisher's exact test. As young men that have not gone through Dimi have yet to obtain a skin, I only considered elders and Dimi participants' answers to test cultural values associated with skin obtention methods.

2.7 Ethical and research permits

This study was authorised by the National Commission for Science, Technology and Innovation (NACOSTI/P/25/415555) and by the Chief of Ileret ward, the recognized administrative authority for the Daasanach community. This research project is in full accordance with the ethical guidelines of the University of Helsinki and was reviewed and approved by the Laikipia University Institutional Scientific Ethics Review Committee (LU/APP/124/2025). I obtained verbal Free, Prior and Informed Consent (FPIC) from all community members involved in this study. I guaranteed anonymity, confidentiality and data protection throughout the project.

A concern however arose during the project. I initially planned to conduct all my research in Kenya and thus all research permits comply with Kenyan requirements. However, my research assistants collected and shared additional data by self-initiative at Hado, which is a neighbouring locality but at the other side of the border (Ethiopia). The Daasanach community is a cross border community that does not attend to border differences. However, I was left thinking whether in order to utilize any data collected in Ethiopia I would need the country's corresponding research permits. After careful

consideration, I have decided to include in this thesis the data collected by Paul Kanisa and Raphael Arkol in the Ethiopian side, as the responses were kindly and spontaneously provided by the Daasanach community to me and were an interesting complement to the research design. However, I consider that this poses an ethical challenge and would need to be solved for further analysis and publishing of results.

3. Results

3.1 Skin acquisition and provenance dynamics

3.1.1 Skin count questionnaires

A total of 76 and 90 skins were counted during the Dimi ceremonies in Bubua and Hado, respectively. The skins were mostly from cheetahs and leopards, but some serval and civet skins were also observed (Table 2). There is no significant change in the proportions of used species (p-value = 0.076) across the years (2018, 2021 and 2025) in the Bubua ceremony. However, there is a significant difference in the relative proportions of species used in Bubua and Hado in 2025 (p-value < 0.05). While the leopard is predominant at the Dimi in Bubua, the cheetah is the most used species in Hado.

From the skins used in 2025 at Bubua, 12 were hunted, 25 bought, 18 rented and 2 borrowed. At the Hado Dimi, 19 were hunted, 27 bought and 36 rented. In both Dimis, a skin was rented on average at 3,100 KES (exchange rate: 146.68 KES = 1 € in May 2025), but price ranged from 1,300 to 15,000 KES. In Bubua, skins were bought for 8,000 KES on average (range from 2,000 to 26,000 KES), while the mean price in Hado was 13,600 KES (range from 4,400 to 32,000 KES).

Dimi participants in Bubua and Hado reported hunting the skins in neighbouring areas or buying and renting the skins within the Daasanach community and from neighbouring ethnic groups (Figure 2A). The Fisher's exact test shows a significant change in obtention methods between interview data from 2020 (Torrents-Ticó *et al.* 2023a) and count questionnaire data from 2025 in Bubua (p-value < 0.001). The proportion of participants borrowing or inheriting a skin has decreased considerably compared with the year 2020, with only 2 records in Bubua and none in Hado for 2025 (Figure 2B). In absolute

numbers, there were more hunted skins in 2025 (n = 12 and n = 19 in Bubua and Hado respectively) than in 2020 (n = 6).

Table 2. Number of skins observed at Dimi ceremonies in 2018 and 2021 from Torrents-Ticó *et al*. (2023a) and two Dimi ceremonies from 2025. Skins are classified by species and state (fresh/old).

	Bubua									Hado		
	Dimi 2018*			Dimi 2021*			Dimi 2025			Dimi 2025		
	n	Fresh (%)	Old (%)	n	Fresh (%)	Old (%)	n	Fresh (%)	Old (%)	n	Fresh (%)	Old (%)
Leopard *Panthera pardus*	**32**	9	91	**60**	37	63	**38**	39	61	**29**	38	62
Cheetah *Acinonyx jubatus*	**36**	0	100	**51**	12	88	**28**	18	82	**46**	43	57
Serval *Leptailurus serval*	**13**	46	54	**8**	75	25	**4**	25	75	**7**	57	43
Common genet *Genetta genetta*	**0**	-	-	**2**	100	0	**0**	-	-	**0**	-	-
African civet *Civettictis civeta*	**2**	100	0	**0**	-	-	**2**	100	0	**0**	-	-
Unknown	**0**	-	-	**0**	-	-	**4**	-	-	**8**	-	-
Total	**83**	13	87	**121**	30	70	**76**	30	70	**90**	43	57

* Count data from Torrents-Ticó *et al*. (2023a)

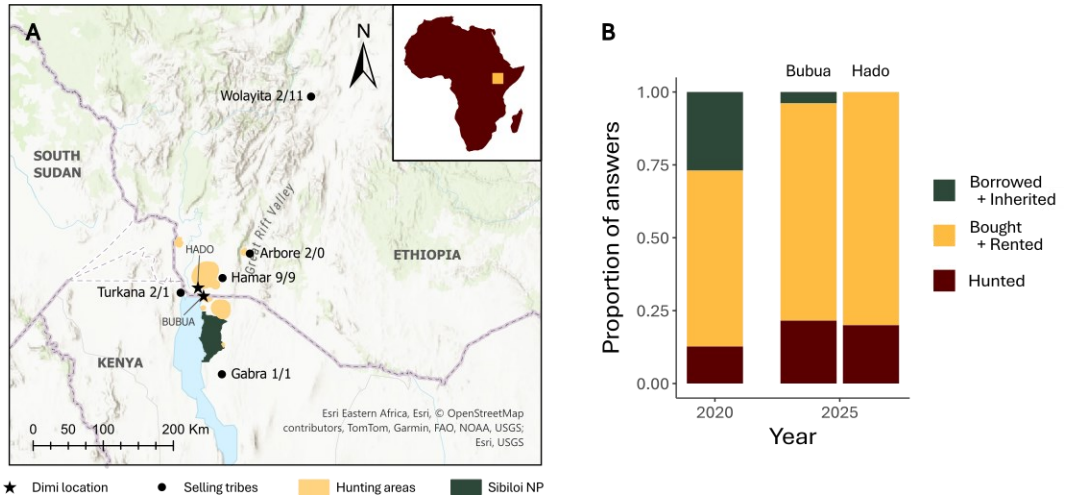

Figure 2. (A) Distribution map of the origin of skins for the Dimi ceremonies in Bubua and Hado. Areas where animals were hunted for skins are marked in yellow, while points show approximate locations of neighboring tribes from whom skins were bought. Numbers indicate the number of skins bought in Bubua/Hado. The background map used is from ESRI East Africa. **(B)** Change in the proportions of skins obtained by hunting, buying or renting and borrowing or inheriting between years in Bubua and Hado Dimis. Data from 2020 were obtained from Torrents-Ticó *et al*. (2023a).

3.1.2 Genetic analysis

A total of 27 cheetah skins were sampled, representing 96% of the cheetah skins present at the Bubua Dimi ceremony. After amplification, sequencing and analysis, 24 skins were successfully classified (Table 3), though 22 were only partially classified (classification was not obtained for the three CSAs). From the sequences obtained, one was identified as a leopard (*Panthera pardus*) and one as sheep (*Ovis aries*).

Table 3. Count of skin samples used at each analysis step from amplification to classification into regional groups. The percentages are calculated from the total amount of cheetah skin samples available.

Primer	Amplified	Sequenced	Analysed	Classified
AMP13	27 (100%)	26 (89%)	13 (48%)	6 (22%)
AMP46	24 (89%)	20 (74%)	18 (67%)	18 (67%)
AMP7	26 (96%)	26 (96%)	21 (78%)	18 (67%)

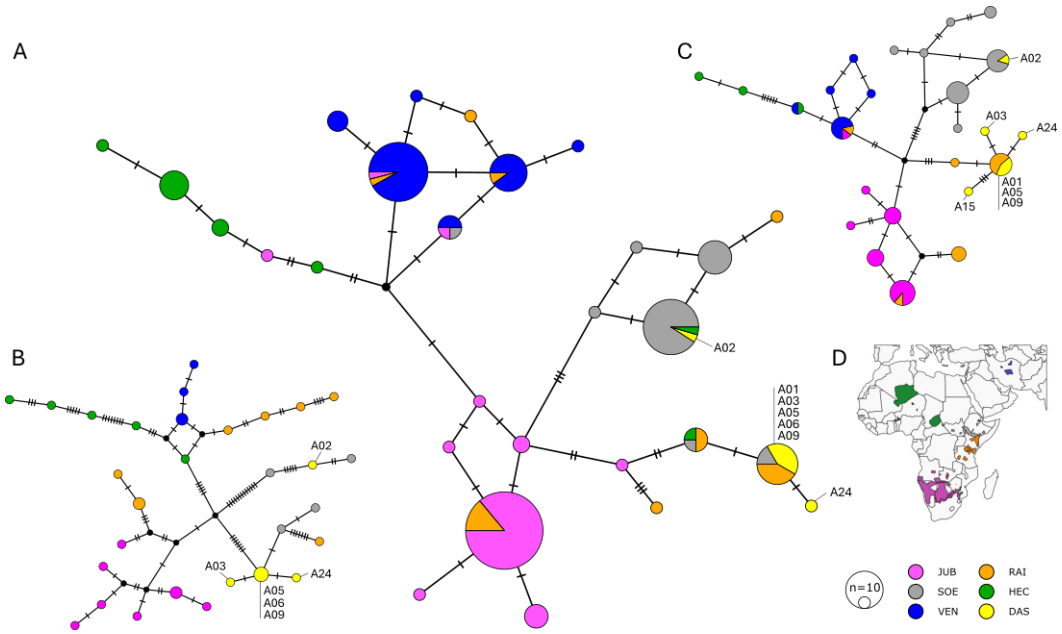

Figure 3. Median Joining Networks for mitochondrial sequences (AMP16 for A and B, AMP17 for C) obtained from Dimi skin samples and combined with data from Meißner *et al*. (2023) (A), Prost *et al*. (2022) (B) and unpublished results (C). The coloring shows the assigned subspecies: *A.j. jubatus* (JUB), *A.j. raineyi* (RAI), *A.j. soemmerengii* (SOE), *A.j. hecki* (HEC) and *A.j. venaticus* (VEN). Samples obtained in this study are in yellow (DAS). The map, obtained from Prost *et al*. (2022), shows the subspecies distribution colored accordingly (D).

Table 4. Sample classification using all the Median Joining Networks for the three mitochondrial datasets (unpublished data; Meißner *et al.* 2023; Prost *et al.* 2022). Both separate (AMP13, AMP46, AMP7) and combined (AMP16, AMP17) sequences are used. Cell colors indicate the level of certainty of the classification: high certainty (green), some uncertainty (yellow) and too uncertain to classify (red).

Sample ID	Unpublished data				Meissner data			Prost data			Final classification
	AMP13	AMP46	AMP7	AMP17	AMP13	AMP46	AMP16	AMP13	AMP46	AMP16	
A01	NG	SOE_RAI	NG	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A02	SOE_3bp	SOE_3bp	SOE_3bp	SOE_3bp	SOE	SOE_3bp	SOE_3bp	SOE_3bp	SOE_3bp	SOE_3bp	SOE_3bp
A03	NG	SOE_RAI	SOE_RAI	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A04			SOE_3bp								SOE_3bp
A05	NG	SOE_RAI	SOE_RAI	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A06	NG	SOE_RAI	SOE_RAI	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A07		SOE_RAI	SOE_RAI			SOE_RAI					SOE_RAI
A08	NG	SOE_RAI	SOE_RAI	SOE_RAI	8_22_23	SOE_RAI	SOE_RAI		RAI	RAI	SOE_RAI
A09	NG	SOE_RAI	SOE_RAI	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A11		SOE_RAI	SOE_RAI			SOE_RAI					SOE_RAI
A13		SOE_RAI				SOE_RAI			RAI		SOE_RAI
A14		SOE_RAI	SOE_RAI			SOE_RAI			RAI		SOE_RAI
A15	15_16_22	SOE_RAI	NG	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A16	15_16_22	SOE_RAI	SOE_RAI	SOE_RAI		SOE_RAI	SOE_RAI		RAI	RAI	SOE_RAI
A17			SOE_3bp								SOE_3bp
A19		SOE_RAI				SOE_RAI			RAI		SOE_RAI
A20			SOE_3bp								SOE_3bp
A22	15_16_22		SOE_RAI		8_22_23			RAI			SOE_RAI
A23	23_29		NG		8_22_23			RAI			SOE_RAI
A24	NG	SOE_RAI	SOE_RAI	SOE_RAI	NG	SOE_RAI	SOE_RAI	RAI	RAI	RAI	SOE_RAI
A25		SOE_RAI	SOE_RAI			SOE_RAI					SOE_RAI
A26		SOE_RAI	NG			SOE_RAI			RAI		SOE_RAI
A27		SOE_RAI	SOE_RAI			SOE_RAI			RAI		SOE_RAI
A29	23_29		SOE_RAI		NG			RAI			SOE_RAI

RAI: clustering with *A.j. raineyi* individuals; SOE_RAI: clustering with a mixed group of *A.j. soemmeringii* and *hecki* individuals; SOE_3bp: clustering with the *A.j. soemmeringii* that present a 3bp deletion; 8_22_23, 23_29, 15,16,22: clustering with unknown individuals; NG: samples with not enough resolution to classify with certainty

The three mitochondrial datasets used allowed to group the Daasanach samples with sequences which their geographical location is known (Figure 3). Across the Median Joining Networks for the three datasets, 20 Daasanach samples were classified with certainty and 4 samples were classified with some degree of uncertainty (Table 4). From the total number of cheetah sequences, 4 grouped with known *A.j. soemmeringii*

individuals that present the 3 bp deletion in the ND5 gene (previously described in Charruau *et al.* 2011). The rest of sequences (n = 20) clustered with a group of individuals from the region. This group gathers individuals from the *A.j. soemmeringii* and the *A. j. raineyi* subspecies. Therefore, all sampled skins were likely sourced from local populations.

3.2 Local disconnection from carnivores

From the total amount of people interviewed (n = 93), 47% were elders (After Dimi, n = 44), 23% were going through Dimi (During Dimi, n = 21) and 30% were young men before their Dimi (Before Dimi, n = 28). Most of the interviewees have had no formal education, with only 14 (15%) having a wide range of levels of formal education. Fishermen were mostly interviewed in Selicho, while Bubua, Guoro, Nangolei and Watali were mostly herding communities.

When asked to group images from cheetah and leopard, interviews identified correctly 53.2 % of them on average (n = 87). Fisher's exact tests for each interview resulted in only 3 out of 93 rejecting the null hypothesis ($p < 0.05$), i.e. not being a random grouping. In the beta regression model, the last time an interviewee had seen a carnivore (cheetah or leopard) is the only significant variable (Table 5). The grouping scores increases when the last carnivore observation was more than one year ago (Figure 4).

Table 5. Estimated regression parameters, standard errors, z-values and p-values for the beta regression model presented in Equation 1.

	Estimate	Std. error	z-value	p-value	
Intercept	-0.4817	0.3091	-1.558	0.119	
AgeGroup_Elder	-0.1281	0.1841	-0.696	0.487	
AgeGroup_BeforeDimi	-0.1226	0.2130	-0.575	0.565	
Livelihood_NonHerder	-0.0093	0.1630	-0.057	0.954	
LastCarnivore_Between1-5Years	0.7750	0.2944	2.633	0.008	**
LastCarnivore_MoreThan5Years	0.7220	0.3011	2.398	0.016	*

* p-value < 0.05
** p-value < 0.01

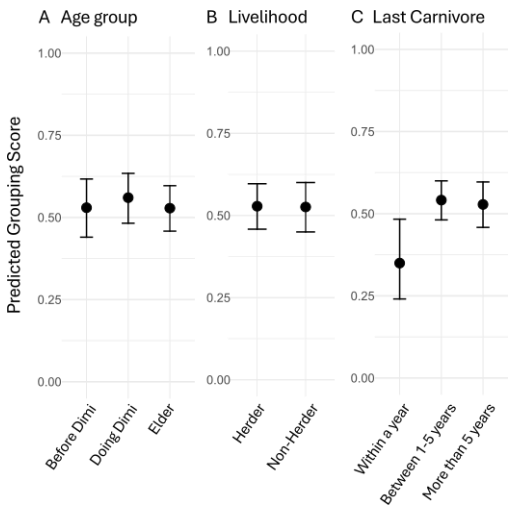

Figure 4. Mean grouping scores and standard errors predicted by the beta regression model. Scores are shown for each age group (A), livelihood (B) and time since last carnivore observation (C).

The Multiple Correspondence analysis shows how the interviewees group following their answers to questions involving knowledge on local carnivores and the cultural use of their skins (Figure 5). Dimension 1 explains 15.2% of the data's variability, while Dimension 2 explains 13.1%. Naming and grouping scores both contribute to Dimension 1, while questions involving the choosing of animals and skin patterns for the Dimi are contributing to Dimension 1 and Dimension 2 (Table 6). The MCA does not show any clear separate groups. Nevertheless, outliers can be clearly identified as interviewees that had low knowledge on both carnivores and skin use. These outliers are mainly elders last having seen a cheetah or a leopard more than one year ago (Figure 5).

Table 6. Association values (η^2) between variables and dimensions in the Multiple Correspondence Analysis

Variable	Dimension 1	Dimension 2
Grouping score	0.3926	0.0185
Naming score	0.1597	0.0339
Skin pattern	0.2901	0.4485
Skin pattern preferred	0.4954	0.6504
Carnivore used	0.3243	0.3288
Carnivore preferred	0.4608	0.3537

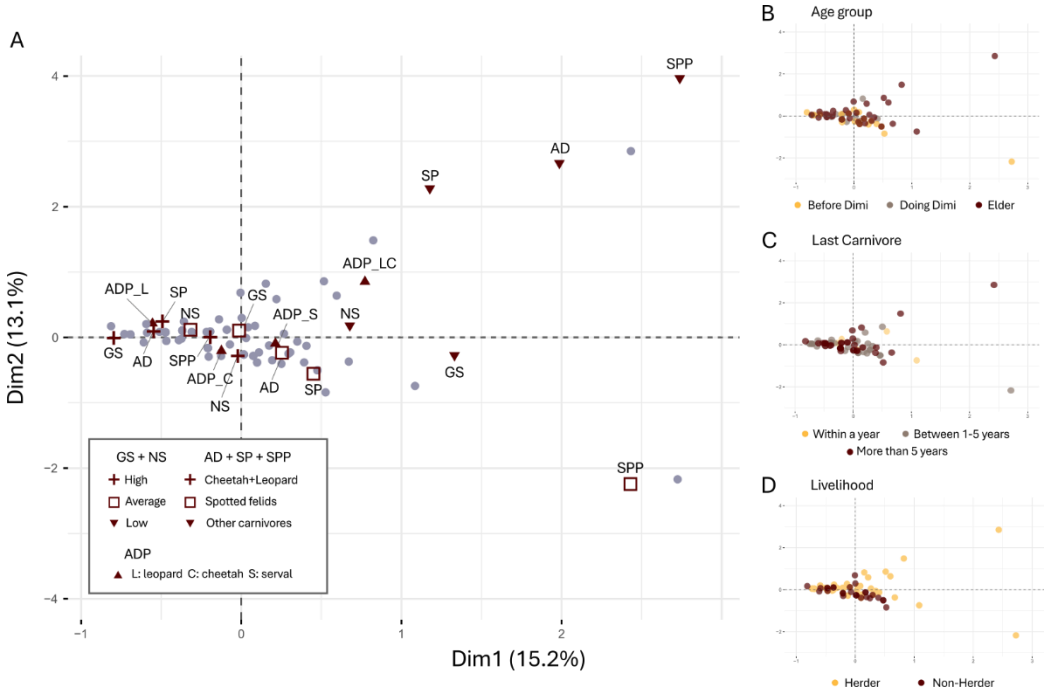

Figure 5. Distribution of interviewees' answers (points) in the first two dimensions of the Multiple Correspondence Analysis. The red icons show the position of the categories for each variable added (A): grouping score (GS), naming score (NS), carnivore used at Dimi (AD), carnivore preferred (ADP), skin pattern used (SP) and skin pattern preferred (SPP). In the plots on the right, individual interviews are colored by age group (B), livelihood (C) and time since last carnivore observation (D).

3.3 Change in the skin value

When asked what the skin represents for them, the interviewees mainly answered richness (37%), tradition (34%) and social status (i.e. to be respected by the community, 21%). Bravery (7%) and fertility (1%) were seldom mentioned. When comparing the values associated with the use of skins at the Dimi ceremony, there are no significant differences between age groups and obtention methods (p-values = 0.285 and 0.386 respectively). However, the skin association with social status is proportionally highest for young people before the Dimi and fertility is only mentioned by one elder (Figure 6A). Bravery is not mentioned as the meaning of the skin by the ones that have hunted it (Figure 6B). Finally, the highest proportion of the answer being richness is found in men doing Dimi and those that have hunted or rented the skin.

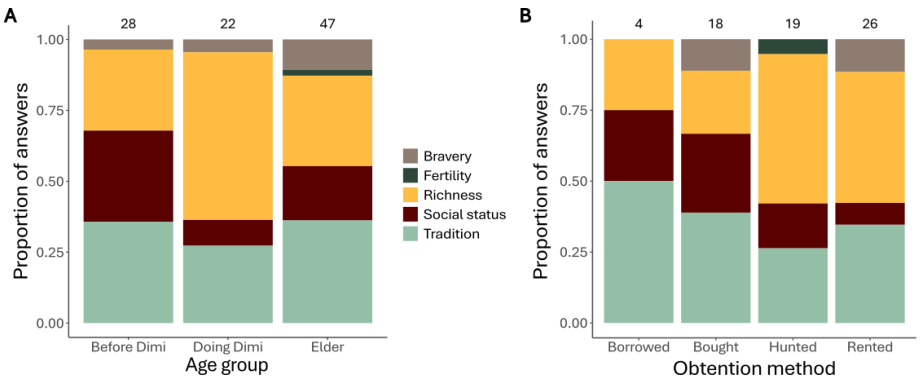

Figure 6. Proportion of interview answers for each value associated with the skin by age group (A) and obtention method (B). Numbers above each bar indicate the number of interviewees in each group.

4. Discussion

The Dimi ceremony and the relationship between carnivores and the Daasanach is a valuable case-study to understand the links between wildlife loss and cultural changes. The data recorded here indicate a change of species, with new species being used, and an increase in skin trade. This has led to a change in meaning of the skin in the context of the Dimi ceremony. As a pastoralist community, I expected the Daasanach to distinguish between cheetah and leopard, due to the two felids differing in their behaviour towards livestock. However, interviewees were not able to distinguish between the two felids, evidencing the community disconnection from the environment. These observations hint towards cultural erosion of the Dimi ceremony and a loss of TEK. The ritual changes recorded are reducing the need for hunting and decreasing the pressures on the spotted carnivore populations. Nevertheless, the increase in economic interests may result in more incentives to hunt. Overall, these dynamics raise concerns on the social and ecological sustainability of the Dimi ceremony (Figure 7).

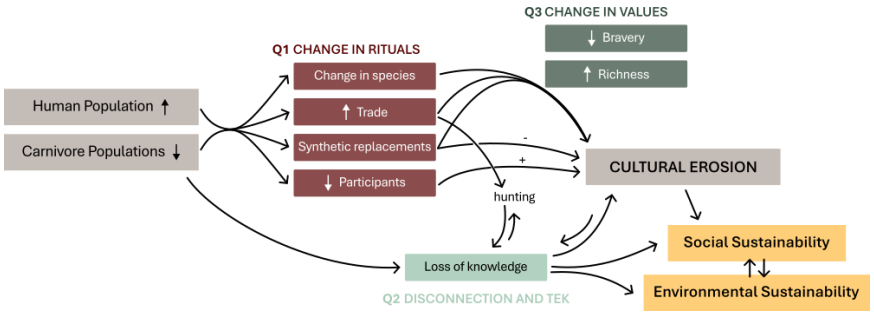

Figure 7. Diagram linking main results to cultural erosion and social and environmental sustainability. Changes recorded in the rituals lead to a change in the meaning of wearing a skin. Moreover, a lower carnivore density and a decrease in hunting cause a loss of traditional ecological knowledge (TEK), contributing to cultural erosion.

4.1 Skin provenance dynamics

The socioecological changes seen in Northern Kenya have started before this last decade, but gradual changes are still happening at present. Therefore, the data available offers a limited timeframe to observe the whole pattern and only serves as a complement to longer anthropological work and the community's comments. Compared to skin counts from Torrents-Ticó *et al*. (2023a), there seems to be a slight decrease in the number of skins recorded at the Dimi ceremony in Bubua. There are several possible explanations for this decrease. First, as spotted carnivore populations, especially cheetahs and leopards, are believed to be decreasing in the region (Torrents-Ticó *et al*. 2021), it is more difficult to find them and hunt them. Second, community members expressed that the ceremony is becoming too expensive for young people. The skin is not the only constraint for the Dimi participation, as severe droughts have made it difficult to gather the livestock required. Despite a continuous increase in human population, the Dimi being compulsory and aspirants often getting help from the family, there might be a decrease in aspirant numbers, contributing to the erosion of Daasanach culture.

There is a significant increase in the rental and purchase of skins for the ceremony from 2020 to 2025, while the borrowing and inheritance of skins has almost disappeared. The change reported here might be inflated, as data from 2020 was obtained through village interviews outside the Dimi (Torrents-Ticó *et al*. 2023a), thus containing overlapped information from different Dimi generations. As interviewees in 2020 could have done the Dimi long ago, it might be that the borrowing and inheritance of skins are older practices that were already decreasing that year. Likewise, as skins can be rented at each Dimi, the proportions of rented skins could be inflated. It is then difficult to know if the proportion of hunted skins has changed.

While skins are mainly rented from within the community, skins are also bought to neighbouring communities. Although the trade is mainly local, it seems that there is a new trading leopard source from the Wolayita community, which could be affecting leopard populations further north. Hunting areas are well established and are likely to indicate the location of the remaining cheetah and leopard populations in the region. Noticeably, most hunted skins used at Bubua were coming from the Suregei Hills, where

the Daasanach herders bring their livestock during drought periods. This suggests that droughts might have driven humans and carnivores closer, increasing the conflict and the chances of hunting for the ceremony. Aspirant stories about their hunt for cheetah or leopard for the Dimi revealed that most of them were retaliatory after an attack on livestock or opportunistic after a sighting during herding or subsistence hunting. Retaliatory killing is common in human-carnivore conflicts (Jacobsen *et al.* 2021; Torrents-Ticó *et al.* 2023b), but here cultural and economic incentives for the hunting are added. A similar scenario is found with the Maasai warriors, whose hunts involve the persecution of problematic lion individuals and an important cultural pride (Goldman *et al.* 2013).

In the past, the hunting was done with spears and bows (Houtteman, 2011). Nowadays, all herders carry or have access to guns, making the hunting more opportunistic and easy. Therefore, there is less need for carnivore hunting TEK. However, this type of hunting might not be considered as respectful as traditional hunting methods (Goldman *et al.* 2013).

4.2 Genetic assessment of skin origin

The genetic analysis of the cheetah skin samples obtained at the Dimi confirmed their local origin. Most of the samples clustered with an haplogroup thought to range between Uganda, South Sudan, Ethiopia and Kenya (Meißner *et al.* 2023), which corresponds with the region under study. The remaining samples clustered with *A.j. soemmeringii* individuals that present the 3 bp deletion in the ND5 gene. Although these are thought to occur in northern Ethiopia, their range is not well known and it is likely that both clusters overlap in their geographical range. No sample clustered with *A. j. raineyi* individuals from southern Kenya, confirming that Daasanach mostly trade with groups in the north, as the region is severely isolated from the rest of Kenya.

Mitochondrial DNA for subspecies classification and identifying lineages is not ideal (Meißner *et al.* 2023). However, the available nuclear and mitochondrial data (Meißner *et al.* 2023; Prost *et al.* 2022) allowed for a cost-effective classification that could be further confirmed by sequencing nuclear DNA. In addition, the newly designed AMP7 improves the resolution of the geographical classification of the samples. The current

results complement the information extracted from interviewees and allow the identification of interesting samples for further investigation of an understudied cheetah population (Prost *et al.* 2022).

As a similar approach was not available, leopard skins were not sampled and would certainly be needed to get a complete picture of Dimi skin origins. Because all sold skins from the Wolayita traders were leopards, it is possible that these results would show a wider origin range than the current cheetah results. In Ethiopia and Kenya, possible illegal trade routes have been recently identified (Evangelista *et al.* 2024). Some of these routes go through the region around Lake Turkana, but there is no evidence of an interaction with the Dimi skin trade.

4.3 Loss of carnivore knowledge and disconnection

Both a decrease in resource use (Lyver *et al.* 2008) and a shift to obtention from markets (Alrhmoun *et al.* 2025) can lead to a loss of TEK. As TEK is built from interactions with the environment (Fernández-Llamazares *et al.* 2015), it is difficult to maintain this knowledge when the interaction is lost. As shown by low scores in the grouping of cheetah and leopard images, the majority of interviewees were not able to successfully differentiate between the two spotted carnivores. It may be that images are not the best tool to ask questions involving TEK in this case. However, the poor results on the grouping are contradicted by the fact that most interviewees answered correctly when asked to name the species in a question where more carnivore pictures were shown. It could be that the concept of species was better understood when more species were shown in the pictures.

Despite a good sample size and variability in the interviewee's answers, the beta regression did not show any significant effect of livelihood and age group. This could mean that the grouping score is not a good indicator of spotted carnivore knowledge or that there is a general inability to differentiate between both species. This is evidenced by the Fisher's exact test reporting that most groupings were done at random. Differentiating between leopard and cheetah does not seem relevant for the Daasanach, as they are both *muor*, used indistinctively for the Dimi. When carnivores are abundant, being able to distinguish them is of great value for pastoralist communities such as the

Daasanach to avoid conflict (e.g. livestock depredation). With the current low densities, opportunistic encounters and changes in hunting dynamics, this knowledge has lost its importance, even for current herders.

The beta regression shows that having seen a cheetah or a leopard in the last year is correlated with a lower score. This might be explained by the younger generations being responsible for herding and being more exposed to encounters with carnivores. The younger generations, however, often hold less TEK of these species. In contrast, elders are often stewards of TEK (Alrhmoun *et al.* 2025).

TEK is involved in and shaped by cultural rituals and practices (Fernández-Llamazares *et al.* 2021). Accordingly, the Multiple Correspondence Analysis (MCA) show an association between local knowledge on carnivores and comprehension of the cultural norms involved in the use of skins for the Dimi ceremony. In the MCA (Figure 5), the first dimension can be interpreted as the level of knowledge on carnivores and the second dimension as the understanding of Dimi skin use. While naming and grouping scores (identifying and differentiating carnivores) are only important for the knowledge, the choice of skin patterns and animals for the Dimi involve both the identification of the animals and the knowledge on which ones can be used. This hints that the loss of TEK could have an impact on biocultural practices.

4.4 Change in the meaning of the skin

Changes in how the skins are obtained, in addition to other factors, might have led to a change in meaning for the use of skins. Traditionally, carnivore skins have been associated with bravery and strength by the Daasanach (Houtteman, 2011; Torrents-Ticó *et al.* 2023a), as well as by other ethnic groups (Goldman *et al.* 2013; Williams *et al.* 2025). However, bravery was seldom mentioned by the interviewees as a value associated with the skins, evidencing a shift in the meaning of their use. Surprisingly, bravery was not mentioned by skin hunters, indicating that it might be a quality more valued by those that were unable to hunt their own skin. As they now use guns, there is also less need for bravery and strength for the hunt.

Unfortunately, there is not enough statistical power to detect significant differences in skin meaning between age groups or relative to the obtention methods. Nevertheless,

some patterns are worth noticing. First, young men that have yet to go through Dimi more frequently answered that the skin is a sign of social status, allowing the Dimi aspirant to be respected by the rest of the community. This highlights the central role of the Dimi in the life of Daasanach men. Adding to the skins representing tradition, it shows the eagerness of young men to "follow the steps of our ancestors" (common answer during interviews).

Another value strongly associated with the skins is richness. Rental and sale prizes of the skin result in the skins representing an important income for its owner, as they can keep renting them in future Dimi ceremonies. However, the answer "richness" needs to be taken into careful consideration, as its meaning is here overly simplified and there might have been issues with the translation. While richness can be seen as a monetary value, interviewees could also be referring to cultural or spiritual richness, as well as mixing both meanings. As an example, for some Daasanach, the spots indicated the wealth of the man's future herd. Therefore, further discussions are needed to disentangle the symbology around the skin.

The region defaunation and the decrease of carnivore populations as a resource for skins has led to a shift from holistic to economic values. A similar shift has been observed in the Maasai community, where external pressures have forced a change in the cultural value of wildlife (Fernández-Llamazares *et al.* 2020). Further market incentives in the local skin trade could contribute to the loss of holistic values.

4.5 Study limitations

It is illegal to hunt and use wildlife in Kenya, although its cultural use is generally accepted (Torrents-Ticó *et al.* 2023a). Added to a general mistrust towards conservation authorities, the uncertainty on legal consequences may have led interviewees to be less forthcoming about the origin of the skin. However, we (PK, RA and I) clearly stated the anonymity of the answers and our independence from authorities. Added to the fact that aspirants spontaneously and proudly shared hunting stories, it is likely that answers are trustworthy.

The ability to detect changes in both knowledge and cultural symbology of carnivores with the presented data is limited. As there are no similar records for the Daasanach

knowledge on carnivores from the past, it is difficult to ascertain if there has been indeed a loss of knowledge. Different age groups are often used to study changes in TEK (Fernández-Llamazares *et al.* 2015), but no difference was found in this case. This could be caused by the classification of age groups being too broad. As everyone that has gone through the Dimi is considered an elder, this encompasses a broad range of generations (from 20 to 80 years old). Although difficult in this socio-cultural context, it could be important to make further distinctions between generations using temporal baselines or asking when they went through Dimi.

The current data on the Dimi ceremony is also regionally limited to the southernmost Daasanach subgroup. All Daasanach must wear a *muor* skin for the Dimi, but there are substantial differences in how the ceremony is performed between the subgroups (Paul Kanisa, personal communication, February 2025). The different proportion of species in the skins at the Hado Dimi already shows that there are some patterns worth exploring. Moreover, Daasanach in Ethiopia have more contact with other ethnic groups and urban areas, offering more possibilities for skin trade.

4.6 Environmental and social sustainability

On one hand, skins still being locally sourced, the Dimi does not seem to be impacting spotted carnivore populations on a broader geographical range than before. However, the trade identified with the Wolayita is concerning. On the other hand, the current exploitation of local populations remains unsustainable, and the economic incentives for hunting skins to be rented or sold adds more pressure on the local populations. Little is known about the status of cheetah and leopard populations in the area, with the few studies available stating that both species are probably almost locally extinct (Torrents-Ticó *et al.* 2021). The area is heavily defaunated, and thus unable to sustain a big carnivore population (Asfaw *et al.* 2025). Nevertheless, the fresh skins observed are evidence that individuals might still remain. As these populations are currently unaccounted for in national surveys (KWS, 2021), ecological studies are needed for further investigation and the environmental sustainability of the cultural practices.

The interviews conducted have confirmed that the Dimi as a cultural practice has undergone a significant change. While tradition remains an important driver of the Dimi,

the skins do not showcase the bravery of Daasanach men anymore. Skins are now seen as a symbol of wealth and richness. The struggle of obtaining a skin and livestock for the Dimi endangers the future of the Daasanach heritage and important social structures for the community. Daasanach interviewees raised concerns on the social sustainability of the practice and their willingness to find alternative solutions.

As part of the current project with the Daasanach community, sustainable alternatives were discussed in focus groups. One potential solution is the use of synthetic skins. Called heritage furs, these skins have been introduced as an alternative to several traditional groups around Africa (Furs for Life, Panthera NGO). For example, since 2013, more than 18,500 heritage furs have been successfully distributed to the Shembe followers in South Africa, reducing the pressure on leopard populations and protecting cultural heritage (Naude *et al.* 2020). The idea of heritage furs was received with enthusiasm by focus group participants.

Behavioural change has sometimes been used as a conservation strategy, for instance to reduce the demand in illegal wildlife trade (Burgess *et al.* 2020). However, this strategy has found some difficulties were longheld beliefs or cultural behaviours are involved (Burgess *et al.* 2020). In this case, a cultural change has already happened and the impact of the Dimi on carnivore populations is very much perceived by the Daasanach community (Torrents-Ticó *et al.* 2023a). The introduction of heritage furs seems a promising alternative but needs to be handled with caution. On one hand, the replacement of skins could provoke a loss of the positive cultural attitude towards cheetahs and leopards, with only the fear of livestock loss remaining (Johansson *et al.* 2016). On the other hand, the conservation of this tradition could help keeping a connection between the Daasanach and the carnivores, maintaining positive attitudes towards the latter, which are important for conservation (Jacobsen *et al.* 2021). Nonetheless, heritage furs could reduce the economic incentive for hunting, regulate the prices of the market and preserve the Daasanach cultural heritage, enhancing both social and environmental sustainability (Figure 7).

5. Conclusion

Acknowledging and understanding the underlying dynamics between cultures and human-wildlife interactions is crucial for successful biocultural conservation. The Dimi ceremony has gone through major changes, which raises concerns on the social and environmental sustainability of the practice.

Interview and genetic results indicate that the cheetah and leopard skins are still locally sourced. However, there is an increase in skin trade, adding an economic value to the traditional use of skins. While the rental of skins could relieve the pressure of local carnivore populations, it is also an economic incentive to hunt these species, even after having gone through Dimi. Sustainable alternatives, such as the use of synthetic skins, are therefore needed to preserve the Daasanach biocultural heritage and decrease the impact of the ceremony on carnivore populations.

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Appendices

Appendix 1. Carnivore knowledge and Dimi perspectives questionnaire

Interview ID:	Village of origin:	Village of living:
Date:	Age and Gender:	Education:
Interview location:	Translator:	Livelihood:

Community member	Elder	Man doing Dimi	Before Dimi	Other

1. Have you done the Dimi?	Yes		No	
2. Why is the Dimi important for the Daasanach community?				
3. What are the essential elements without which you cannot do the Dimi?				
4. Have you worn a skin cape during Dimi? / Would you wear a skin cap during Dimi?	Yes		No	
5. What animal was the skin from? / What animal would the skin be from?				
6. What does it mean wearing a skin during Dimi for you?				
7. Do you know why the Daasanach started to use skins to celebrate Dimi?				
8. What does the skin represent for you?				

Bravery	Tradition	Beauty	Richness	To be respected	Fertility	Other	
9. How did you obtain your skin for the ceremony? How are you planning to obtain the skin for the ceremony?							
10. Do you know how many people own a skin in your village? How many?							
11. Can the skin be inherited or borrowed from a family member? How does it work?							
12. Do you think it is easier to obtain a skin for the ceremony now or in the past? Why?							
13. Do you own the skin you used?	Yes		No				
14. What do you do with the skin after the ceremony? (+ Do you clean it? Where do you keep it? Do you rent it?)							
15. Would you pass the skin on to your son? If you have more than one son, to whom would you give it?							
16. Do you think it will be easier or harder for your sons to find a skin for the ceremony when it is their time? Why?							
17. Do you think that the Dimi ceremony will change in the future?							
18. Would you change something for the future of the Dimi of your son? What?							
19a. Which ones of these skin patterns can be worn as a cape during Dimi?							

A		B		C		D		E		F		G	
19b. Can you select those that are preferred and explain why?													
A		B		C		D		E		F		G	
20a. Can you name the following animals?													
1		2		3		4		5		6			
20b. From which of these animals can you wear the skin as a cape during Dimi?													
1		2		3		4		5		6			
20b. Can you select those that are preferred and explain why?													
1		2		3		4		5		6			

21. Could you group the pictures that show the same animal species?					
22. When is the last time you have seen a leopard?					
Within a week	Within a month	Within a year	Between 1-5 years	More than 5 years ago	Never
23. Do you think that there are more or less leopards now than in the past?			More	Equal	Less
24. When is the last time you have seen a cheetah?					
Within a week	Within a month	Within a year	Between 1-5 years	More than 5 years ago	Never
25. Do you think that there are more or less cheetahs now than in the past?			More	Equal	Less
26. Would you prefer there to be more, less or the same amount of cheetahs and leopards? Why?					