THESIS

FORMAL EDUCATION AND TRADITIONAL ECOLOGICAL KNOWLEDGE TRANSMISSION IN SAMBURU, KENYA: RESEARCH AND REVITALIZATION

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ABSTRACT

FORMAL EDUCATION AND TRADITIONAL ECOLOGICAL KNOWLEDGE TRANSMISSION IN SAMBURU, KENYA: RESEARCH AND REVITALIZATION

There is increasing concern that the traditional ecological knowledge (TEK) of indigenous communities is eroding due to globalization. Such erosion is seen as a threat to both the cultural continuity of indigenous societies and their ability to sustainably manage their natural resources. As in other parts of the world, the indigenous pastoralists of the Waso Ward of Samburu County, Kenya are increasingly concerned that the formal education system is negatively impacting TEK transmission. To investigate these concerns a participatory, community-based study was launched in the Waso Ward to characterize the threat of TEK erosion by comparing the ethnobotanical knowledge of students with their *moran* (non-student) counterparts. Through statistical analysis we determined that *moran* have more ethnobotanical knowledge than students and that this difference is possibly due to the fact that moran herd more frequently and thus have more opportunities for contextualized learning. Therefore, we recommend schools in Samburu collaborate with local knowledge specialists to develop opportunities for place-based instruction with an emphasis on TEK. The following thesis contains a review of the literature surrounding these concepts, a manuscript of the above-mentioned research, my personal reflection on my role as an outsider in TEK research and a summary of our team's efforts to improve TEK transmission in the Waso Ward.

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DEDICATION

For the wazee.

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CHAPTER 1:

INTRODUCTION

Traditional ecological knowledge (TEK) is essential to both the identity and subsistence of indigenous cultures across the world. There is widespread recognition within natural resources disciplines that the TEK systems of indigenous communities can inform sustainable land use practices (Warren 1992, Benz 2000, Berkes et al. 2000, Ellis 2005, Pierotti and Wildcat 2000). Such groups often develop complex socio-ecological arrangements using an intimate environmental knowledge that is passed on and refined over generations (Drew 2005). Beyond the values intrinsic to indigenous cultures these knowledge systems can broaden the way all societies conceptualize and solve environmental problems, and they add variety to a land manager's toolkit, ultimately improving a socio-ecological system's resilience (Folke et al. 2002).

However, the future of many traditional knowledge systems is uncertain. As indigenous communities like those in Samburu, Kenya undergo rapid transformations through processes of globalization, the inter-generational transmission of traditional knowledge may be compromised. This sort of TEK *erosion* may weaken a community's ability to sustainably manage its resources, and undermines its cultural cohesiveness (Berkes et al. 2000, UNEP 2006, Speranza et al. 2010).

TEK can be described as a subset of indigenous knowledge relating to culturally transmitted insights, practices and beliefs derived from people's interaction with their local biotic community (Berkes et al. 2000, Fernandez-Gimenez et al. 2006). It is often developed over time and adaptively across generations. TEK is also dynamic, the development of knowledge is

continuous and corrective as communities respond to new insights and social or environmental changes (Berkes 1999).

Such knowledge plays an important role in the lives of the nomadic pastoralists in the Waso Ward of Samburu County, Northern Kenya, where TEK is woven into cultural identity and spiritual life [Samburu (un-italicized) henceforth refers to the place, Samburu County, whereas *Samburu* (italicized) will refer to the tribe/cultural group, other tribes/cultural groups will be italicized accordingly]. To this day, many in Samburu use their collective ethnobotanical knowledge in regular medicinal practice, day-to-day material use and in the management of local resources. Specifically, for many pastoralists a strong ethnobotanical repertoire has been essential to maintaining their semi-nomadic lifestyle in the dry *Acacia-Commiphora* bushlands of Northern Kenya.

However there is rising concern within the Samburu community that their traditional knowledge will be extinguished as more and more young people transition to sedentary, modern lifestyles which favor western knowledge systems. Specifically, elders in this area assert that while there are clear benefits and needs for a *formal education system,* that same system is complicit in cultivating a cultural rift and contributing to the collective erosion of TEK. They also contend that such transformations contribute to some of Samburu's most pressing environmental problems, including the mismanagement of vegetative resources.

In response to concerns that TEK erosion was occurring within this community as a result of increasing school enrollment (in lieu of pastoralism), this participatory study was launched to assess the accuracy of those perceptions and extent of the problem. The aim was to explore differences in knowledge between students and non-school-going youths to develop inferences

about the interaction between Kenya's formal education system and intergenerational TEK transmission among pastoralists in Samburu County.

This is primarily a quantitative study, focusing on ethnobotanical knowledge as a proxy for TEK more broadly. It was designed to circumvent some of the methodological issues encountered in similar works (although not without its own set of constraints), concentrating on the TEK of young male students enrolled in formal primary education versus the TEK of their less formally-educated peers known in Samburu as *moran*.

This first chapter of the thesis consists of a literature review about the relevance of TEK for natural resource management, the issue of TEK erosion and the limits to current conceptions of the relationship between formal education and TEK. This chapter will also provide background information regarding the use of place-based education (PBE) as a means for TEK transmission. It will then introduce the Waso Ward in Samburu County, Kenya, the study site of the research article presented in Chapter 2. Finally, there is a brief justification for the research and a description of the next two chapters in this thesis.

Traditional Ecological Knowledge

There are numerous definitions for TEK. Some refer to it as "a subset of indigenous knowledge that includes knowledge and beliefs handed down through generations by cultural transmission and which is related to human-environment interactions (Raymond et al. 2010, p. 1768). Fernandez-Gimenez and others (2006) describe it as "a system of experiential knowledge

gained by continual observation, and transmitted among members of a community" (p. 306). The definition used here is that by Berkes, Colding and Folke (2000), who describe TEK as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (p. 1252). This is a suitable definition in the context of this thesis because it encompasses the concepts of the previous two, but also emphasizes the adaptive nature of TEK. Which is important because this study represents a snapshot in time, such that the knowledge represented here embodies the current prevailing knowledge-base of the community, not necessarily all historically held TEK.

While the norms and culture of the *Samburu* tribe remain dominant in the Waso Ward, many *Turkana, Somali* and *Borana* people have made their homes there as well, no doubt contributing to the sum of the community's biocultural knowledge. So in the context of the Waso Ward, the term *local* ecological knowledge (LEK) (Berkes et al. 2000) is in some ways more appropriate, as it includes not only the long-held knowledge of a single culture, but even that recently developed knowledge generated by the totality of cultures within a particular community. The terms LEK and TEK are interchangeable in most situations (Berkes et al. 2000). Use of the word "traditional" in this context is increasingly unfashionable, described by some as "too vague and misleading" (Haselmair et al. 2014, p. 2). However, the term TEK is maintained here because it remains more widely recognizable and because the *Samburu* and *Turkana* elders who provoked this study characterize their ethnobotanical/ecological knowledge as "traditional" and "cultural." It should be noted that TEK in this study includes the knowledge of the multiple indigenous groups represented in the Waso Ward. It is also worth noting that TEK and LEK are used nearly synonymously with indigenous ecological knowledge (IEK), ethnoecological

knowledge (subsets including ethnobotanical, ethnoveterinary and ethnomedicinal knowledge), and biocultural knowledge.

TEK is generally held in contrast to western knowledge systems which are favored as drivers of 'development' (Menzies and Butler 2006). For reference, Reid and others (2002) detail a full juxtaposition of TEK and western knowledge systems. In comparison, according to the "classic paradigm" of natural resources research, TEK may seem too irrational and unwieldy to inform practical decision making (Blaike et al. 1997). However, the body of TEK research generally contradicts such notions, recognizing TEK as "highly rational, empirical and pragmatic" (Kimmerer 2002, p. 436). It is often 'knowledge in practice;' used in day-to-day subsistence, TEK encompasses the myriad of utilitarian discoveries by indigenous people, including the use of medicinal plants, fiber production, observations of seasonal patterns, dietary uses and the like (Berkes 1999). Of course, to outsiders, TEK systems can offer not only useful insights and 'novel' practices, but entirely unique ways of conceptualizing man's relationship with nature (Pierotti and Wildcat 2000).

It is further characterized as holistic, infused in virtually every aspect of traditional life (Berkes 1999, Houde 2007). TEK often informs much of a society's spirituality and many of its moral perspectives (Kimmerer 2002). So even practical knowledge may be conceptualized and used in an ethical, narrative, or spiritual manner (Berkes 1999). It is important to note that in many ways TEK is in an essential component of a community's cultural identity (Houde 2007).

TEK is also dynamic, evolving over time in response to environmental and social changes (Berkes 1999, Menzies and Butler 2006). Any increment of knowledge may have passed through a dozen generations or it may have been discovered only the day before (Menzies and

Butler 2006). Perhaps most importantly TEK is the currency of living adaptively on a landscape, improving a community's resilience to ecological change (Folke et al. 2002).

TEK & Natural Resources Management

Sustainable land management often requires sufficient accumulation, storage and transmission of knowledge gained through years of interaction with a landscape (Ghimire et al. 2004, Drew 2005). TEK is often, but not always, a product of a group's persistence for many generations on a landscape, it is generally the knowledge gained through the trial and error process of interacting with, and managing natural resources (Menzies and Butler 2006). Unsustainable management strategies are purged over time, in favor of strategies that ensure continued use (Berkes et al. 2000). Consequently, TEK is increasingly seen as relevant to the sustainable management of natural resources (Berkes 1999, Benz et al. 2000, Berkes et al. 2000, 2002, Kiptot 2007, Roba and Oba 2008).

This inherent utility is exemplified by indigenous pastoralist communities throughout the world. In Northern Kenya the customary grazing patterns of semi-nomadic groups have enabled them to avoid Hardin's (1968) "tragedy of the commons" scenario by allowing pastures time to recuperate after grazing periods (Dalle et al. 2006, Kiptot 2007). Such patterns are informed by traditional knowledge and enforced through customary institutions (Dalle et al. 2006), and they are often threatened by adoption of fragmented pasture management per the advice of western grazing professionals (Hobbs et al. 2008). For example, in her study on *Maasai* vegetative knowledge (a group closely related to the *Samburu*), Kiptot (2007) maintains that the

pastoralists' complex knowledge of grazing and fodder resources has supported sustainable landscape management over many generations.

Wildlife conservationists have also taken interest in instances where indigenous customs coincide with their own agendas. One note-worthy example is highlighted by Kideghesho (2008) in his research on the importance of traditional practices and knowledge in facilitating the coexistence of wildlife and indigenous communities in the Serengeti ecosystem. According to Kideghesho, tribes like the *Samburu* and *Maasai* have regarded many of their local megafauna, such as elephants, as 'totem' animals that are spared from (most) hunting for spiritual reasons (also see Kuriyan 2002). Some suggest that were it not for those beliefs, the diversity and abundance of east African wildlife would not be what it is today (Kideghesho 2009).

However, indigenous customs do not support the interests of natural resource professionals in every context (Blaike et al. 1997, Bollig and Schulte 1999). Quite often, as the economic, land-use or technological context changes, so too do the requirements for sustainable land management. For example, Stump (2010) asserts that TEK in Africa may well have supported resilient socio-ecological regimes in the past, but that without a firm understanding of how that system has changed (by changes in land-use, climate, species composition etc.) it would be ill-advised to assume that such knowledge is as relevant in a modern-day context. Moreover, TEK and its positive impacts are easily over-romanticized; although it may sometimes result in sustainable practice, it does not necessarily spring from an enlightened or altruistic worldview, but from practical, socially-situated experimentation (Pierotti and Wildcat 2000, Reed et al. 2007).

Such sentiments may be a little too dismissive. Certainly there are a number of scenarios where TEK has been shown to be supportive of conservation and sustainable NRM efforts: as

seen in fishery management in Canada (Fraser et al. 2006), forest preservation in Ecuador (Becker and Ghimire 2003), sustainable grassland management in Tanzania (Lane 1990), and marine conservation globally (Drew 2005). While TEK and conservation may often be rooted in different ethics, conservationists and land managers can surely benefit from understanding those indigenous perspectives. Also, at the least, TEK has been recognized as an important tool, contributing a broader range of management and policy options than western science alone can provide (Berkes et al. 2002, Fraser et al. 2006).

Integrating Natural Resource Science & TEK

While pairing TEK with scientific knowledge can improve natural resource management practice, integrating the two can be a significant challenge. In some of the attempts to do so there has been emphasis on accumulating and assimilating TEK into western institutional frameworks (Reed et al. 2007; e.g., Fraser et al. 2006), a tendency that seems to presume that scientific approaches are superior. 'Traditional' natural resources research, has long preferred quantifiable and empirical data, which seems inherently at odds with TEK - which is largely qualitative (Ghimire et al. 2004). There has been criticism that the fusion of these two ways of knowing often ends with traditional knowledge being forced into scientific terms, and that TEK is only included when it has been deemed credible by comparison to scientific information (Ellis 2005). This "scientization of traditional knowledge" will likely remain a serious concern to those interested in "legitimizing" and assimilating TEK in research and public policy (Ellis 2005, p. 72).

Despite these frustrations, natural resource researchers and practitioners should continuously seek out ways to bridge the gaps between these dissimilar, but sometimes

complimentary knowledge systems. It is important to bear in mind that traditional knowledge systems actually tend to be developed out of pragmatism and that the integration of "cultural values and moral perspectives" is complimentary to, not competitive with, wise decision making (Kimmerer 2002, p. 436).

In the context of pastoralism, for example, rangeland management professionals in arid regions often neglect to incorporate indigenous knowledge to the detriment of their research and practice (Davis 2005). In his work with nomadic pastoralists in Morocco, Davis (2005) uncovered ecological evidence that challenges the etic, "expert," narrative of rangeland experts that overstocking by nomadic pastoralists was causing desertification. He maintains that if the indigenous knowledge of those pastoralists had been adequately explored, researchers would have better understood the dynamics of those socio-ecological systems and more sound policy decisions might have been made. A similar story is unfolding in the rangelands of East Africa, where the notion of severe desertification as a result of mismanagement by indigenous herders is challenged in light of mounting ecological evidence to the contrary and recognition that, where intact, the traditional management and monitoring strategies of nomadic pastoralists support resilient and adaptive socioecological systems (Lane 1990, Niamir-Fuller 1998, 1999, Kiptot 2007, Hobbs et al. 2008, Luvanda 2014).

Among those studies that have made inroads towards such integration are the efforts of Roba and Oba, with others (e.g., Stave et al. 2007, Roba and Oba 2008), who have advocated for a more participatory approach towards working with various Kenyan pastoral groups to development semi-quantitative assessments of rangeland health that are based on traditional observation strategies. They contend that this sort of hybrid knowledge formation is the key to

ensuring sustainable rangeland management, and that it may be one of the only ways to ensure that indigenous pastoralists are involved in the policy making process (Roba and Oba 2008).

Fittingly, there has been a push in natural resource management and research towards such integration (e.g., Fraser et al. 2006, Kiptot 2007, Reed et al. 2007), but any efforts to continuously incorporate TEK into NRM will hinge on the availability and ultimately the persistence of traditional knowledge. This requires an understanding of how knowledge is maintained within indigenous communities.

TEK Transmission

TEK transmission can be defined as the process of TEK transfer between, or by, individuals of a particular indigenous community. Like TEK itself the primary modes of transmission are dynamic, varying with place and across time (McCarter et al. 2014). TEK acquisition commonly occurs through direct interaction with one's environment (Cristancho and Vining 2009). Many "learn by doing" (Lozada et al. 2006) as exemplified in Prince and others' (2001) study of Luo children in western Kenya who learned ethnomedcinal practice through the process of contending with their own illnesses (with guidance from peers and adults). TEK is also frequently conferred during normal social interaction, and by oral transmission through story-telling (Berkes et al. 2002, Cristancho and Vining 2009).

While TEK transmission most often occurs through intentional periods of intergenerational, or *vertical instruction,* by family members (Adekannbi et al. 2014; e.g. Reyes-García et al. 2010, Haselmair et al. 2014) it can also happen though more spontaneous,

horizontal, interactions between peers. Guglielmino and others (1995) suggest that horizontal transmission is less conservative of traditional knowledge than vertical transmission, allowing for innovation through "environmental adaptation" (p. 7586). In other words, knowledge may be more likely to evolve when it is transmitted (and modified) among peers, perhaps contributing to perceptions that knowledge is being lost.

It is important to consider that knowledge is generally held heterogeneously among members of indigenous communities (Niamir-Fuller 1998, Berkes 1999). While TEK erosion may occur among say, the school-going segment of a population, that knowledge is often retained among knowledge specialists or simply among those with a heightened interest. For example, in her study with the Rarámuri people in Mexico Wyndham (2010) detected TEK erosion overall among students, but also found that *some* individuals were highly TEK proficient. This sort of specialization may even be an adaptive response to the erosion of knowledge among other community members (Wyndham 2010).

Conversely, in some communities, where the number of knowledge specialists is decreasing, non-specialists may take on the task of retaining and transmitting TEK. In their study on ethnobotanical knowledge transmission in a rural Patagonian community Lozada and others (2006) found that, while designated knowledge holders (*shamans*) probably played a significant role in TEK transmission in the past, familial transmission seems to have taken over as an efficient substitute where shamans are no longer prevalent.

So, given the adaptive nature of TEK transmission, in some cases the greatest concern may not be the erosion of TEK continuity at the *community scale*, but perhaps the erosion of its *perceived relevance* to a growing segment of the population.

While the act of transmission is often simple (for example, a parent taking time to explain why they are using a particular medicinal plant to their child), the nature of transmission at the community-level is complex and fluid. In order to make sense of how and why some modes of transmission might be changing it is important to first examine the various factors that are believed to impact TEK transmission.

Factors Effecting TEK Transmission

The influence of globalization on the retention of traditional knowledge is an issue of increasing concern (Benz et al. 2000). This loss has been attributed to a number of factors, including the spread of formal education (derived from western models), western medicine, westernized political systems, western religion, and the intrusion of western culture through changes in technology (Benz et al. 2000, Haselmair et al. 2014, Reyes-García et al. 2014). It is a trend associated with a host of interconnected factors, including "cultural assimilation, loss of traditional territories, destruction of ecosystems, in and out migration, poverty, climate change, urbanization, and the death of community elders, among others" (Cristancho and Vining 2009, p. 230). A report by the United Nations Environmental Program (UNEP) in 2006 provides a full list of 23 barriers to traditional knowledge transmission in Africa, including "changes in education systems," "lack of formal recognition of the value and contribution of T[E]K," "religion," "livelihood and poverty" and "the use of new technologies" (p. 31). Wane (2005) contributes the "transition from oral to written cultures" to this list. Such factors are thought to lead to TEK erosion by shifting cultural norms, increasing the availability of western medicine, emphasizing western knowledge over other forms, reducing the amount of time young people spend outside and ultimately by contributing to biodiversity loss (Wyndham 2010, McMillen

2012, Reyes-García et al. 2014). See Zent (2013) for an extensive list of research pertaining to TEK erosion.

Of course, while certain modes of transmission are threatened by globalization, new avenues can emerge as communities undergo social and economic changes. This has been observed among some Tyrolean (Austrian) chefs who have become an avenue for extensive traditional food knowledge transmission as they share recipes and practices in modern restaurants (Haselmair et al. 2014). Likewise, as some Tanzanian communities transition to market economies, McMillen (2012) found that community markets may actually serve as "reservoirs" and exchange points, where merchants from different tribes actually exchange plant knowledge with one another. So in some contexts globalization could actually improve the maintenance of TEK, further indication that the relationship between TEK transmission and broader social change is variable and complex.

In order to effectively address TEK erosion within any given community it is imperative to first identify which barriers to transmission are most significant in that place and which factors can be feasibly mitigated. It is also important to develop an understanding of how some of these barriers might interact with one another and to monitor changes in those factors over time. To date only a handful of studies begin to address these research imperatives among East African pastoralists (see Kideghesho 2002, McMillen 2012, Batibo 2013).

Formal Education & TEK Erosion

While formal education is frequently said to have a negative impact on TEK continuity, research has shown that the nature of this relationship varies considerably across communities and circumstances (Mathez-Steifl and Vandebroek 2011). Many studies do confirm these suspicions, however, counter to that prevailing discourse, some communities are not experiencing significant degradation in overall TEK (e.g., Lozada, et al. 2006, Mathez-Steifl et al. 2012), and still others may be experiencing TEK erosion, but formal education does not appear to be a major contributory factor (e.g., Mathez-Steifl and Vandebroek 2011). With such variability it is useful to explore the findings of TEK erosion research across different contexts, beginning with some of those works that have shown a negative correlation between formal education and TEK continuity.

Evidence of for negative formal education/TEK transmission correlation

In her ethnobotanical research with the Rarámuri people in Sierra Tarahumara, Mexico, Wyndham (2010) found that school children possessed less ethnobotanical knowledge than would be expected given the knowledge held by adults within the community. She attributes this in part to the competing interest of formal education, but emphasizes that differences individual interests probably account for more of the variability. In a similar study conducted in Columbia and Guatemala by Cristancho and Vining (2009) the emerging prevalence of formal education systems was cited as a major factor contributing to the degradation of intergenerational TEK transmission. Another study by Srithi and others (2009) found that TEK among Taiwanese youths was negatively correlated with informants' levels of education. Voeks and Leony (2004) also found evidence that a persons' ability to identify medicinal plant is negatively associated

with literacy and the number of years they had attended school within certain communities in eastern Brazil.

Ambiguous findings regarding formal education/TEK transmission correlation

However, in many works the relationship between formal education and TEK erosion is more ambiguous. McMillen (2012) found only a weak negative correlation between the number of years a person spent in school and their knowledge of medicinal plants. Moreover, she acknowledges that her findings in regards to education are not conclusive given that the majority of her study participants were educated. Quinlan and Quinlan (2007), in Dominica, also revealed only a weak negative correlation between formal education and plant knowledge; complicated by a high degree of variability in plant knowledge among participants who had completed primary school. Another study with the *Tsimane´* of Bolivia (Reyes-García et al. 2010) found that the magnitude of the negative association between formal schooling and TEK was low, but that there was a slightly stronger negative association between TEK and academic skill. According to the authors the two knowledge forms compete for a student's time. Another noteworthy example of a study with ambiguous findings in this regard was conducted by Stanford Zent (2001) with the *Piaroa* people of Venezuela. Zent developed a means for quantifying traditional plant knowledge competency using a plot-survey methodology (that resembles the procedure used in this study, see Chapter 2 for full article). He compared various types of plant knowledge against an individual's age, years in school and level of Spanish competency. Zent found a strong positive correlation between age and plant knowledge (explained by the natural acquisition of knowledge over time), and a weak negative correlation with the number of years a person has attended school, concluding that education does seem to explain a certain degree of TEK erosion, but that

it is difficult to distinguish from the effect of age. However high Spanish competency did strongly correlate with TEK erosion and Zent pointed out that bilingualism is a direct result of formal education.

It can be difficult to parcel out what causes TEK erosion when comparison groups are differentiated by multiple, potentially confounding, characteristics -most notably, age. Some studies, like those by Zarger and Stepp (2004) and Cristancho and Vining (2009) were limited to an evaluation of differences in ethnobotanical knowledge *between generations*, unable to fully address various potential confounding factors, such as a 'shifting baseline' in available plant diversity (Hanazaki et al. 2013). According to Hanazaki and others (2013) those TEK erosion studies that compare people of different age groups often cannot determine if differences in TEK between groups are not simply the result of changes in plant diversity over time. Longitudinal studies might be able to circumvent this 'shifting baseline syndrome' (Quinlan and Quinlan 2007). Measuring differences in TEK between differently aged groups may also give the impression that younger generations are losing knowledge when the difference is actually attributable to some TEK being inherently acquired at later stages in life (Mathez-Steifl et al. 2012). Another work, by Godoy and others (2009) tackle this problem specifically, treating age as a confounding variable, and finding no significant long term TEK loss in its particular Amazonian community. Studies, such as that presented in Chapter 2, that compare the knowledge of students to their non-school-going peers, can also avoid the constraints of intergenerational comparisons (e.g. shifting-baseline syndrome and confounding variables such as age).

Perhaps some of the ambiguity in TEK research also stems from limitations in elicitation techniques. A number of works partly rely on "free-listing" where participants are asked to name

the important plant species (and sometimes their uses) as a means of quantifying participants' relative knowledge (e.g., Quinlan and Quinlan 2007, Beltrán-Rodríguez et al. 2014, Mathez-Steifl and Vandebroek 2011, Mathez-Steifl et al. 2012). According to Mathez-Steifl and Vandebroek (2011), who took measures to limit biases in their use of free-listing, "the disadvantage of this tool is that the plant might not be mentioned, because it was simply "forgotten" during the exercise, as opposed to lack of knowledge about it" (p. 15). They suggest that the use of collected plant specimens (or photographs) would ensure that the plants are easily recalled. Therefore techniques that rely on living specimens in the environment, as employed by Zent (2001), and Leony and Voeks (2004), are more likely to allow participants to fully recall and express their knowledge. Bearing in mind those methodological constraints, the Mathez-Steifl and Vandebroek study found that a participant's level of education had no effect on overall plant knowledge, suggesting that *individual motivation* is more influential in the high Andes.

Evidence for neutral/positive formal education/TEK transmission correlation

Indeed some studies have shown that education is not a strong explanatory variable for TEK erosion (e.g., Godoy et al. 2009, Mathez-Stiefel et al. 2012). Zarger and Stepp (2004) replicated a "plant trail" elicitation strategy by Stross (1970; 1973 as cited by Zarger and Stepp 2004) conducted in the same Tzeltal Maya community in the late 1960s. By comparing plant knowledge of children from 40 years apart Zarger and Stepp were able to show that plant knowledge had persisted in spite of several decades of modernization. A mixed methods study in Western Nigeria (Adekannbi et al. 2014) found little quantitative support for any correlation between education and TEK transmission, but their qualitative work "revealed that a minimum

level of formal education, at least at primary level, is essential for recording traditional medical knowledge in order to prevent its loss" (p. 8).

Schools' impact on TEK transmission

When there is a negative relationship between TEK acquisition and formal education there remains the question: by what mechanisms does education have its presumed negative impact? There are two prevailing notions: **1)** Time is the limiting factor to TEK transmission among students (Reyes-García et al. 2010). If students devote the bulk of their time (and resources) to school-related activities then they will simply miss the opportunity to acquire knowledge that is generally acquired through engagement in cultural and livelihood activities, such as herding. **2)** Schools inadvertently engender dismissive attitudes towards traditional knowledge through emphasis of western knowledge (McCarter et al. 2014). The role of these mechanisms in Samburu is explored in Chapters 2 & 3.

The connection between TEK erosion and education is probably much more complex than current research has been able to show (McMillen 2012), so it may be impossible to develop a unifying theory that can predict how education will interact with TEK in any particular community. It is therefore incumbent on indigenous groups and researchers to examine this relationship on a community-by-community basis (McCarter et al. 2014). Although there have been studies that describe TEK in Samburu, and that allude to the consequences of its loss (e.g., Bussman 2006, Nanyingi et al. 2008), there has been no quantitative research specific to TEK erosion and its relationship to formal education in this area. The study described in Chapter 2 of this thesis is an attempt to address this deficiency. Such empirical research is seen as critical for

making “informed policy decisions”, developing “learning materials” and contributing to “professional development” for educators (Owuor 2008, p. 31). By developing a stronger understanding of whether and how the formal education system effects the intergenerational transmission of TEK the research community can facilitate the integration of TEK into formal education.

TEK Maintenance & Revitalization

The imperative for mitigating TEK erosion in Africa is well established. The loss and erosion of TEK among Africa's indigenous communities has been cited as one of the greatest challenges to the continent in terms of cultural continuity and sustainable resource management (UNEP 2006). The loss, and lack of recognition, of TEK are also cited as two of six of the greatest threats to biodiversity conservation in Africa (UNEP 2006). Of course this imperative extends beyond the immediate concerns of natural resource management and into the realms of maintenance of traditional medicine, cultural identity and spirituality (UNEP 2006). Efforts to maintain and revitalize TEK are emerging across the globe, including in some parts of Sub-Saharan Africa (McCarter et al 2014; e.g., Kimmerer 2002, Ruiz-Mallen et al. 2009, Barndhart 2014, McCarter and Gavin 2014).

In practice TEK maintenance and revitalization can take a number of forms. In their systematic review of the literature on TEK maintenance McCarter and others (2014) categorized such efforts into five non-exclusive categories: securing intellectual property, database development, formal education (at the national level), and community-based [TEK]

maintenance. In particular, the notion that changes within the formal education system can actually improve TEK transmission merits further exploration.

Integrating TEK & Formal Education

While formal education systems may contribute to TEK erosion it is widely believed that, with some adjustments to the curriculum and teacher training, they can be leveraged to *support* TEK transmission (Owuor 2008, Reyes-García et al. 2010, McCarter et al. 2014). Owuor (2008) asserts that education is "instrumental in harmonizing the different forms of knowledge bases and creating a social fabric for societies that can engender social, economic and political sustainability" (p. 21). Others make similar claims that the two knowledge systems can complement one another. Kimmerer (2002) advocates for the inclusion of traditional knowledge in biological education on a number of premises, including the holistic integration of science and culture.

One advantage of formal education is that it is the systemization of knowledge transfer. Above all else, western education models create efficient opportunities for learning, a function that can be used to promote rather than stifle cultural knowledge (e.g., Cruz- García and Howard 2013). According to Mathez-Steifl and Vandebroek (2011) "schooling may even indirectly strengthen medicinal plant knowledge" by imparting the skills and motivation for self-directed study (p. 14). Certainly, their note-taking and memorization skills can be used by students who take an interest in TEK, as observed in this study (see chapter 3).

The integration of TEK into formal schooling may also have positive impacts on education outcomes by engaging students with locally relevant materials (Ignas 2004). According to Reyes-García and others (2010) "contextualized learning enhances the acquisition

of curricular content among indigenous peoples" (p. 306). Some of the same authors demonstrated this in a study (Ruiz-Mallen et al. 2009), finding that *Zapotecan* students who participated in a TEK-inclusive, community-based environmental education program regarding forest management were markedly more knowledgeable about curricular ecological concepts than their peers who had not participated.

Of course there are examples where TEK does not seem to improve education outcomes. Prince and others' (2001) for one, found that Kenyan students who scored high on indigenous knowledge scored lower on "crystallized" (vocabulary) tests, suggesting that indigenous knowledge may be acquired at the expense of curricular knowledge (Sternberg 2004). However this may have more to do with the previously described relationship between TEK and formal education then the effect of bringing TEK into the classroom.

According to Owuor (2008) the Kenyan school system has long acknowledged the importance of instruction with traditional, locally-relevant knowledge, however there has been little tangible progress in this regard. She outlines some of the challenges to such integration including the historical dominance of foreigners influencing curriculum innovation, following a time when education was designed to facilitate "economic exploitation" and the maintained preference for western means of development (p. 25). Owuor advocates for "curriculum reconstruction" to reflect an "endogenous approach to education" (2008, p.22). If the integration of TEK and formal education is to be effective in this regard it is imperative that it not be "disembodied from context" (Owuor 2008, p.31). Such curricular changes might occur under the auspices of *place-based education*.

Place-based education

Where formal education can be shown to have a negative relationship with TEK transmission place-based educational (PBE) programs may be an effective means of improving TEK acquisition (Cruz- García and Howard 2013). David Sobel, a leading advocate of place-based education (PBE) best describes it as:

> The process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum. Emphasizing hands-on, real world learning experiences, this approach to education increases academic achievement, helps students develop *stronger ties to their community, enhances student's appreciation for the natural world,* and creates a heightened commitment to serving as active, contributing citizens. Community vitality and environmental quality are improved through the active engagement of local citizens, community organizations, and environmental resources in the life of the school [emphasis mine] (Sobel 2004).

McInerny (2011) adds that PBE "acknowledge[s] students as producers rather than consumers of knowledge" (p. 4). By its definition PBE is a means of local knowledge transmission, often with an ecological focus. TEK in this context is integrated with other sources of knowledge, such as etic, scientific information, so PBE is not exclusively a pedagogy of TEK, but usually a hybrid of "textbook information" and local (ecological) history (Sobel 2004). PBE is closely linked throughout the literature to the field of environmental education which tends to view locally relevant, outdoor, experience-based, and inquiry-based learning as precursors to responsible environmental behavior (Ignas 2004, Wells and Lekies 2006, Bruyere et al. 2011, Louv 2011).

TEK has been incorporated into PBE programs to help address economic and environmental issues. Ingas (2004), in her work with the First Nation people of British Columbia, is among those that reports positive outcomes. She specifically sought out TEK that was relevant to the community's own "economic development, environmental responsibility and

cultural resilience" (p. 50) to design a locally applicable, place-based, science curriculum. It is her contention that providing students with the opportunity to explore environmental issues through their own cultural context allows them to value the environmental wisdom of their elders as much as that of western science (Ignas 2004). This sort of work may help address one of the potential inhibitory factors to TEK transmission: the devaluation of TEK in formal education (McCarter et al. 2014).

Glasson and others (2006) developed a similar participatory study with teachers in Malawi, to ascertain their receptiveness to including PBE in their curriculum, as a means of mobilizing young Malawians to address deforestation. Place-based outdoor learning, with an emphasis on TEK, played a significant role in building a meaningful curriculum that was appreciated by teachers (Glasson et al. 2006). Such efforts to engage teachers in creating place-based, culturally-situated explorations of environmental issues may contribute to TEK maintenance and empower youths to address those issues.

Indeed there have been a number of efforts to develop such contextualized instruction as a means of mitigating TEK erosion (McCarter et al. 2014; e.g., Kimmerer 2002, Barndhart 2014, McCarter and Gavin 2014). However, such efforts are by no-means a "panacea" as McCarter and others (2014) point out. TEK revitalization requires a holistic approach and its success will ultimately depend on the willingness and capacity of indigenous communities to adapt their transmission approaches.

As part of this work, the research team and local collaborators developed a set of Samburu-specific, PBE programs that is discussed in Chapter 3 of this thesis. Those programs were inspired by the team's research in the Waso Ward of Samburu County, Kenya.

Study Site

This study focuses on communities in the vicinity of Archer's Post (~0.6500° N, 37.6800° E), Kenya, situated on the northern bank of the Ewaso Nyiro River (see Figure 1.1). The town is the largest settlement within the federally-designated Waso Ward [formerly of the Samburu East District, population 59,000 (KNBS 2010)], of Samburu County. Archer's Post serves as a center of commerce for the semi-nomadic pastoralists of the surrounding areas. This part of Waso is characterized as the relatively flat expanses of acacia bushland, punctuated with occasional rocky hills, north of the Ewaso Nyiro River and south-east of the highlands surrounding Wamba. The population of Waso is largely comprised of people from the *Samburu* and *Turkana* tribes, with some migrant *Somali* and *Borana* families.

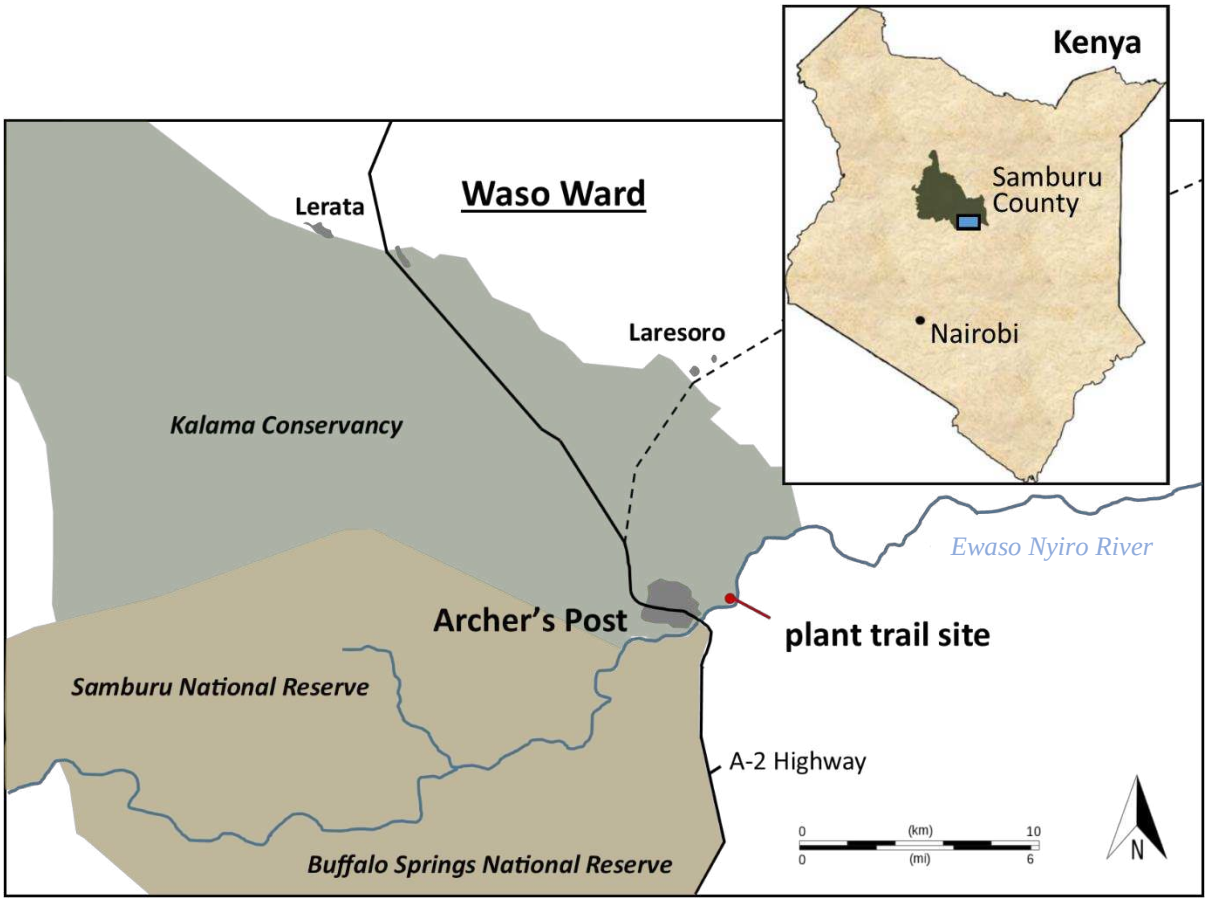

Figure 1.1: Map of study area. Waso Ward of Samburu County, Kenya, with plant trail site.

Historically, the *Acacia-commiphora* bushland surrounding Archer's Post limited economic activity to nomadic pastoralism. However, increasingly, the town offers alternative livelihood opportunities in the forms of trade, day labor, and services for tourists who visit the nearby national reserves and conservancies. Still, many of the town's residents either engage in animal herding themselves or are partly dependent on the herding work of family members.

It is worth noting that the Waso area is a popular tourist destination. The front entrance to Samburu National Reserve (SNR) is just over three kilometers outside of Archer's Post and at least five new settlements have sprung up over the last two decades to cater to tourists interested in *Samburu* culture. It is in the best interest of the people in these communities to maintain

traditional style dwellings and to dress in a way that appeals to tourists, so certain cultural elements are arguably maintained for this purpose.

It is important to bear this unusual set of circumstances in mind when making sense of TEK transmission for this particular community. While the community appears to adhere diligently in some aspects to *Samburu* tradition, there is also a possibility that some youth do not see cultural practices that are not on display for tourists. In other parts of the world, such as in certain communities in eastern Brazil (Voeks and Leony 2004), it is believed that the influx of tourists may simultaneously create an incentive for the maintenance of ethnobotanical knowledge that is interesting to tourists and negatively impact TEK transmission through acculturation by those outsiders.

The economic benefits of SNR extends beyond these tourist *manyattas* (villages), the park and its lodges employ dozens of Archer's Post residents, its revenues support the local government and are also dispersed to all citizens in Samburu County and the flow of tourists is a source of income for many of the shops along the A2 highway.

Education

Many families have taken up sedentary, or quasi-sedentary, lifestyles around Archer's Post specifically so they can send their children to school. At its center is Archer's Post's most populous school, Gir Gir Primary with over 900 students. Within the Archer's Post area there are two additional public primary schools (and 2-3 smaller private ones), Lorubae and Muslim Primary Schools, with around 200-400 pupils each.

Kenya's school system is modeled after that of the United Kingdom, whereby students attend primary school for eight years (standards 1-8), and for some, four years of secondary

school (equivalent to high school in the United States) and finally four years of college. Admittance into secondary school (and college) is contingent upon national standardized exam scores, so a strong focus of education delivery is dedicated to exam preparation. The schools in Archer's Post, like most in Kenya, require that families pay for books, uniforms and other supplies, which can be economically strenuous on families that enroll multiple children. Many pupils are forced to take occasional leave until they have enough funds to cover these costs; as a result, many students will take more than eight years to complete their primary education, and many others drop out altogether.

With the attention given to national exams, instruction is based primarily on the official Kenyan curriculum and therefore does not leave much room for traditional knowledge education, despite the fact that the Kenyan government has sought ways to incorporate traditional knowledge into the curriculum since the 1970s (Owuor 2008). However there are a number of culture-oriented, non-TEK, extra-curricular activities that do take place in the Samburu area, such as dance competitions that celebrate indigenous customs. Also, a student's time is largely dedicated to school or studying, so their ability to engage in day-to-day traditional life is limited.

Moranhood

Traditionally *Samburu* males are organized into a complex age-based cohort system that holds sway over nearly every facet of their lives (Holtzman 2009). During early childhood boys' duties include helping their mothers gather fire wood, prepare food, fetch water and maintain their compounds. As they mature they are often charged with herding their family's animals (usually goats) on short, day-long outings, and by in their early to mid-teens boys begin the transition to moranhood.

Once the young men have entered moranhood, they are accountable to a number of cultural expectations, such as the prohibition of eating or drinking at one's mother's house, which functions to maintain a power structure that favors elder males who have more authority over community affairs (Spencer 1970). At this stage moran function primarily as warriors, guardians of their community and its livestock. Moran live a more transient life than they did as children, they frequently embark on longer cattle herding expeditions, sometimes not returning home for months at a time. Reportedly, it is while they are walking for hundreds of miles in the bush, often with older men, that moran acquire a fairly extensive repertoire of plant knowledge.

According to Samburu elders, moran possess more TEK than students, because the moran spend most of their days walking long distances through the bush, sleeping in it, drawing sustenance from it and treating their ailments with available plant resources. Many in Samburu believe that males gain most of their ethnobotanical knowledge through direct interaction with their environment and through informal social learning with older moran and elders. This is consistent with current research on how TEK is passed on within many of the world's indigenous cultures (Cristancho and Vining 2009). However, it can be problematic to make this sort of assumption without some sort of systematic evaluation. It is important to verify that these are in fact the major avenues of TEK transmission, and that other compensatory means of TEK transmission do not arise in the absence of extended interaction with the natural environment.

Social Division

A young male in Samburu may take any number of paths in life, but the decision to go to school seems to be a dividing line within the community. While many people have left 'bush life' for a more sedentary lifestyle in Archer's Post, many of its younger residents have moved to

even larger towns, mostly in search of economic opportunity (Fraser 2009). Receiving an education is often a key consideration in such decisions as it is seen as a "marker of success" (Lesorogol 2005, p. 1962).

TEK & Semi-Nomadic Pastoralism

TEK is considered to be an integral component of sustainable rangeland management for African pastoralists in arid and semi-arid regions (Lane 1990, Davis 2005, Reed et al. 2007, Nkedianye et al. 2011). The complex, semi-nomadic, customary grazing strategies that have been developed over generations of East African herders have afforded them adaptability and resilience in a demanding environment (Niamir-Fuller 1998, 1999, Kiptot 2007, Machan 2011, Hobbs et al. 2008, Luvanda 2014). Such mobility is also thought to be important to the *ecological function* of such arid regions, whereby vegetation is given time to grow between grazing periods (Lane 1990). Traditionally, herders in Northern Kenya have followed quasi-rotational grazing regimes, using poorer grazing areas during the rainy season, when grass is plentiful and reserving the best grazing areas, in the highlands, for the dry season when grass is scarce. The distances between dry-season, rainy-season and intermittent pastures is often vast enough to require a degree of transhumance, sometimes prompting entire villages to move several times each year.

Whether it is valued as a sustainable rangeland management strategy or for its cultural importance, such transhumance may only be possible with an intimate knowledge of local biocultural resources. Moran and other herders often rely on an extensive repertoire of ethnobotanical knowledge to treat both their own, and their animals' ailments that are contracted

on the move (See Morgan 1981, Bussman 2006, and Nanyingi et al. 2008 for records of *Samburu* and *Turkana* ethnobotanical knowledge). In fact virtually every life sustaining function, be it the procurement of food, fiber, medicine or shelter is in some way contingent upon a herder's ability to utilize their immediate environment. Moreover, the decisions of how and when to move are carefully, and constantly, weighed by male elders and are largely based off of subtle observations of changing weather and fluctuating patterns in the biotic community (Spencer 1970, Niamir-Fuller 1998). There should be concern that a decreased interest in ethnobotanical knowledge may coincide with a decreased interest in such traditional land management practices.

Other Roles of Ethnobotanical Knowledge

Ethnobotanical knowledge also plays an important role in daily life outside of the context of herding. Traditional remedies are still widely used for everything from skin infections to post-natal care throughout Samburu, and there is reason to believe, at the national level, that Kenyans are increasingly returning to traditional medicine to address their general health needs (Morgan 1981, Bussman 2006, Nanyingi et al. 2008). Local plant resources are also widely used in construction, tool-making, fuel for cooking, nutritional supplementation and for cultural adornment (Morgan 1981, Bussman 2006). There has yet to be research into whether the use of local plant resources in Samburu results in a net attempt to conserve plant resources or whether it results in a net depletion. However, it is clear that grazing and fuelwood resources are being depleted around settlements such as Archer's Post (Beh et al. 2013).

TEK is in many ways central to the cultural identity of the *Samburu* and *Turkana* pastoralists of the Waso area. Their ethnobotanical knowledge is infused in daily life and persists

as an important alternative (and potential resource) to western medicine. It also remains essential to their nomadic herding practices, enabling the continuity of sustainable rangeland management practices. The potential loss of TEK may threaten immediate socioecological interactions and signify greater social changes in Samburu over the long-term. There is thus an imperative to investigate the extent and drivers of TEK erosion in this community and to develop strategies to maintain and revitalize such knowledge systems.

Purpose of Study

The primary purpose of this thesis is to compare local knowledge between moran and their school-going peers, in order to characterize the relationship between the formal education system and TEK transmission, in the Waso Ward of Samburu County, Kenya. This is presented in article form, intended for submission to a peer-reviewed journal, as Chapter 2.

In Chapter 3 I share my own thoughts and reflections about the context of TEK erosion in Samburu in more detail, reflect on the role of westerners in TEK research, discuss the merits and tradeoffs of community-based research, delve into some of the methodological issues encountered during the study and describe the team's experiences in putting TEK preservation to practice.

In addition, prior to this study, the research team and myself sought to identify and describe vegetation species through a lens of TEK. The results of this preliminary project are not described in detail in this thesis. However, included as Appendix A is a field guide that resulted

from this work. It features both taxonomic and ethnobotanical information about some of the most important plant species. To develop this guide we accompanied local ethnobotanical experts on several field excursions, across the range of habitats in the Waso area, photographing what amounted to several dozen of the most important plant species to the *Samburu* and *Turkana* people. Concurrently, we held several group conversations with more than 30 other elders and ethnobotanical experts. Through these conversations and excursions we elucidated their perceptions about TEK erosion, developed a ranked list of the most valued species and gathered use-knowledge concerning those plants.

While information and photographs were collected for most of the species just 25 of the most important were included in the guide. Only ethnobotanical information that was contributed by three or more plant experts, or otherwise confirmed by similar inventories (i.e., Bussman 2006, Nanyingi et al. 2008), was ultimately included. To provide scientific information a plant taxonomist from the University of Nairobi accompanied us on several of our field excursions, and maintained close and ongoing consultation throughout the development of the guide. The knowledge and insights from this process were later used in the study (described in Chapter 2) to inform the procedure, site selection, and to confirm the plant information provided by our study participants (moran and students).

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CHAPTER 2:

THE RELATIONSHIP BETWEEN FORMAL EDUCATION & TRADITIONAL ECOLOGICAL KNOWLEDGE TRANSMISSION IN SAMBURU, KENYA

There is widespread recognition in the field of natural resource management that the traditional ecological knowledge (TEK) systems of indigenous communities can inform sustainable land use practices (Warren 1996, Berkes 1999, Berkes et al. 2000, Ellis 2005). TEK systems can broaden the way we conceptualize and solve environmental problems, and they add variety to a land-manager's toolkit, ultimately bolstering a socio-ecological system's resilience (Folke et al. 2002).

However, the erosion, or loss of TEK among Africa's indigenous communities has been described as one of the greatest challenges to the continent in terms of cultural continuity and sustainable resource management (UNEP 2006). The loss and lack of recognition of TEK were also cited as two of six of the greatest threats to biodiversity conservation in Africa by the United Nations Development Program Convention on Biological Diversity (2006). The importance of these losses is critical as there are a number of studies that highlight the importance of TEK in the development and maintenance of sustainable East African pastoral socio-ecological systems (e.g., Lane 1990, Bollig and Schulte 1999, Kiptot 2007). Several call attention to the problem of TEK erosion (Kideghesho 2008, Dalle et al. 2006), but there is need for more research on the contributory factors to TEK erosion globally (Reyes- García 2006, Cristancho and Vining 2009)

and especially in East Africa (exceptions include: Prince et al. 2001, Kiptot 2007, McMillen 2012, Batibo 2013).

There are a number of institutions that are said to propagate the erosion of TEK including formal education, western medicine, westernized political systems, western religion and the intrusion of other cultures by emergent technologies (Benz et al. 2000, Reyes- García 2014). These institutions will impact TEK transmission differently in each community (Reyes- García et al. 2010) so the extent of this interaction must be studied on a community-by-community basis in order to determine the best strategies for mitigating TEK loss and devaluation.

While formal (westernized) education systems are widely seen as a probable contributors to TEK erosion, their relationship to TEK transmission varies between communities worldwide (Reyes- García et al. 2010). However, few studies have examined such relationships in Africa, and fewer still in the pastoral communities of East Africa.

In Samburu, Kenya there is concern that TEK is eroding as successive generations seek western amenities and so-called *modern* lifestyles which favor western knowledge systems [Samburu (un-italicized) henceforth refers to the place, Samburu County, whereas *Samburu* (italicized) will refer to the tribe/cultural group; other tribes/cultural groups will be italicized accordingly]. Specifically, there has been concern that as more youths in Samburu enter the formal education system there is a generation-wide shift away from pastoralism and growing disinterest in TEK. More specifically, in Samburu culture young men carry primary responsibility for tending to family livestock, a role that is historically inherited in early adolescence. Today, with greater emphasis and value placed on education, these boys are increasingly more likely to be enrolled in school. The purpose of this research is to assess if attending school in lieu of practicing pastoralism contributes to an erosion of TEK. We

hypothesize that those adolescent males who do not attend school, and who engage in more regular herding activities, will be able to identify more local plant species and provide more traditional facts about them than their school-going counterparts.

TEK Defined

TEK has been defined as "a subset of indigenous knowledge that includes knowledge and beliefs handed down through generations by cultural transmission and which is related to human-environment interactions (Raymond et al. 2010, p. 1768). Fernandez-Gimenez and others (2006) described it as "a system of experiential knowledge gained by continual observation, and transmitted among members of a community" (p. 306). The definition we used for this study is that by Berkes, Colding and Folke (2000), who described TEK as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (p. 1252). This is a suitable definition in the context of this study because it encompasses the concepts of the previous two, but also emphasizes the adaptive nature of TEK. Which is important because this study represents a snapshot in time, such that the knowledge represented here embodies the current prevailing knowledge-base of the community, not necessarily all historically held TEK.

TEK & Sustainable Resource Management

TEK is an important component to a number of concepts within community-based natural resource management (CBNRM) and similar community-oriented conservation ethics, including resilience, community participation and stakeholder collaboration (Berkes et al. 2000, Menzies

and Butler 2006, Plummer and Armitage 2007). Collectively, the push for natural resource management that is inclusive of indigenous customs and oversight is seen as an important step towards the creation and maintenance of sustainable socio-ecological systems (Berkes 1999, Benz et al. 2000, Berkes et al. 2000, Kiptot 2007). Indeed, much of the power of these paradigms is derived from the inherent utility of TEK systems (Berkes et al. 2000).

Sustainable land management often requires sufficient accumulation, storage and transmission of knowledge gained through years of interacting with a landscape (Ghimire et al. 2004). For example, in her study on *Maasai* vegetative knowledge (a group closely related to the *Samburu*) Kiptot (2007) found that they possess a complex knowledge of grazing and fodder resources which has supported sustainable landscape management over many generations. Similar relationships have evolved within nomadic pastoral communities throughout the world, where herders base their decisions an intimate, culturally embedded knowledge of their environments (e.g., Niamir-Fuller 1998, Bollig and Schulte 1999, Davis 2005, Fernandez-Gimenez 2006). If the intergenerational transmission of this knowledge is damaged, resilience may be lost and successive generations may be ill equipped to contend with environmental challenges as they arise (Folke et al. 2002).

TEK Transmission

TEK transmission is the process of TEK transfer between, and by, individuals of a particular indigenous group. Like TEK itself the primary modes of transmission are dynamic, varying with place and across time (McCarter et al. 2014). TEK acquisition commonly occurs through direct interaction with one's environment (Cristancho and Vining 2009). Many "learn by doing" (Lozada et al. 2006) as exemplified in Prince and others' (2001) study of Luo children in

western Kenya who learned ethnomedcinal practice through the process of contending with their own illnesses (with guidance from peers and adults). TEK is also typically conferred during normal social interaction, and by oral transmission through story-telling (Berkes et al. 2002, Cristancho and Vining 2009).

While TEK transmission most often occurs through intentional periods of intergenerational, or *vertical instruction* by family members (Adekannbi et al. 2014; e.g., Reyes-García et al. 2010, Haselmair et al. 2014) it can also happen through more spontaneous, *horizontal* interactions between peers and *oblique* transmission from extra-familial mentors (Guglielmino et al. 1995).

Communities may shift to alternative modes of transmission when the primary avenues are weakened or as more efficient alternatives develop. In their study on ethnobotanical knowledge transmission in a rural Patagonian community, Lozada and others (2006) found that, while knowledge specialists (*shamans*) probably played a significant role in TEK transmission in the past, familial transmission seemed to have taken over as an efficient substitute where shamans are no longer prevalent. Similarly, new avenues can emerge as communities undergo social and economic changes. This has been observed among some Tyrolean (Austrian) chefs who have become an avenue for extensive traditional food knowledge transmission in restaurants (Haselmair et al. 2014). Likewise, as some Tanzanian communities transition to market economies, McMillen (2012) found that community markets may actually serve as "reservoirs" and exchange points, where merchants from different tribes actually exchange plant knowledge with one another. Such developments solidify the notion that the relationship between TEK transmission and broader social change is variable and complex. In order to make sense of why

the modes of knowledge diffusion might be changing in a particular place it is important to first examine the various factors that are believed to threaten TEK transmission broadly.

Factors effecting TEK transmission

The influence of globalization on the retention of traditional knowledge is an issue of increasing concern (Benz et al. 2000). This loss has been attributed to westernization in terms of formal education, medicine, political systems, religion and technology (Benz et al. 2000, Speranza 2007, Haselmair et al. 2014, Reyes-García 2014). It is a trend associated with a host of interconnected factors, including "cultural assimilation, loss of traditional territories, destruction of ecosystems, in and out migration, poverty, climate change, urbanization, and the death of community elders, among others" (Cristancho and Vining 2009, p. 230). A report by the United Nations Environmental Program (UNEP) in 2006 presents a full list of 23 barriers to traditional knowledge transmission in Africa, including "changes in education systems," "lack of formal recognition of the value and contribution of T[E]K," "livelihood and poverty" and "the use of new technologies" (p. 31). Such factors are thought to lead to TEK erosion by shifting cultural norms, increasing the availability of western medicine, emphasizing western knowledge over other forms, reducing the amount of time young people spend in the natural environment and ultimately, by contributing to biodiversity loss (Wyndham 2010, McMillen 2012, Reyes-García 2014). For example Reyes- García and others (2013) attribute the erosion of ethnomedicinal knowledge among young *Tsimane'* men in Bolivia to the partial adoption of western medicine and stigmatization of traditional diets. For reference, Zent (2013) provides an extensive overview of research pertaining to TEK erosion.

In order to address TEK erosion within a community it is important to first identify which barriers to transmission are at play in that particular place. For example, in this study, Samburu elders suggested that formal education is a predominant barrier to TEK transmission. But to date, no studies have explored this concern in Samburu and only a handful of works address similar research imperatives among other East African pastoralists (see Kideghesho 2002, McMillen 2012, Batibo 2013).

Formal education & TEK erosion

While formal education is frequently said to have a negative impact on TEK continuity, research has shown that the nature of this relationship varies considerably (Mathez-Steifl and Vandebroek 2011). Among those that confirm these suspicions a study among Taiwanese youths (Srithi et al. 2009) found that TEK transmission is negatively correlated with the number of years a person had been in school. Another study conducted in Columbia and Guatemala by Cristancho and Vining (2009) the emerging prevalence of a formal education system was cited as a major factor contributing to the degradation of intergenerational TEK transmission. Others have found similar evidence confirming a negative relationship (e.g., Voeks and Leony 2004, Srithi et al. 2009, Wyndham 2010).

Further research examined this notion, and concluded that the constraints that formal education places on a student's time (Reyes- García et al. 2010), and a dismissiveness of traditional knowledge and embrace of more western knowledge (McCarter et al. 2014) can be driving factors behind this negative TEK-formal education relationship.

However, in many works the relationship between formal education and TEK erosion is more ambiguous. Among rural communities in Tanzania, McMillen (2012) found only a weak

and negative correlation between the number of years a person spent in school and their knowledge of medicinal plants, though a limit to this work, by the author's own account, is that the majority of her study participants were educated. Among the Piaroa people of Venezuela Zent (2001) found a strong positive correlation between age and plant knowledge (explained by the natural acquisition of knowledge over time), and only a weak negative correlation with the number of years a person spent in in school, concluding that education does seem to explain a certain degree of TEK erosion, but that it is difficult to distinguish from the effect of age. Similarly ambiguous findings are reported elsewhere (e.g., Quinlan and Quinlan 2007, Reyes-García et al. 2010).

Indeed some studies have shown that education is not a strong explanatory variable for TEK erosion (e.g., Godoy et al. 2009, Mathez-Stiefel et al. 2012). By comparing plant knowledge of children from 40 years apart Zarger and Stepp (2004) were able to show that plant knowledge had persisted in spite of several decades of modernization and formal education. A mixed methods study in Western Nigeria (Adekannbi et al. 2014) found little quantitative support for any correlation between education and TEK transmission, but their qualitative work "revealed that a minimum level of formal education, at least at primary level, is essential for recording traditional medical knowledge in order to prevent its loss" (p. 8). Moreover, Mathez-Steifl and Vandebroek (2011) found that a participant's level of education had no effect on plant knowledge, suggesting that *individual motivation* is more influential in the high Andes.

It is also important to consider that knowledge is held heterogeneously among members of indigenous pastoral communities (Niamir-Fuller 1998). While TEK erosion may occur among the school-going segment of the population that knowledge is often retained among knowledge specialists such as elders (e.g., Lozada et al. 2006). For example in her study with the Rarámuri

people in Mexico Wyndham (2010) did detect TEK erosion overall among students, but also found that some individuals were highly TEK proficient. This sort of specialization may even be an adaptive response to the erosion of knowledge among other community members (Wyndham 2010). So in some cases the greatest concern may not necessarily be the loss of TEK continuity at the *community scale*, but the erosion of its *perceived relevance* to a growing number of people.

Given this complexity, it is incumbent on indigenous groups and researchers to examine this relationship on a community-by-community basis (McCarter et al. 2014). Although there have been studies that describe TEK in Samburu, and that allude to the consequences of its loss (e,g., Bussman 2006, Nanyingi et al. 2008), there has been no quantitative research specific to TEK erosion and its relationship to formal education in this area. This study is an attempt to address that deficiency.

Study Site

This study focuses on communities in Archer's Post, situated along the Ewaso Nyiro River in northern Kenya (see Figure 1.1: Map of study area). Archer's Post is the largest settlement within the federally-designated Waso Ward [formerly of the Samburu East District, population 59,000 (KNBS 2010)], of Samburu County. This area is characterized as the relatively flat expanses of *Acacia-Commiphora* bushland north of the Ewaso Nyiro River and south-east of the nearby highlands.

Archer's Post is a market town that serves as a center of commerce for the semi-nomadic pastoralists of the surrounding areas (~0.6500° N, 37.6800° E). The arid acacia bush-land surrounding the town historically limited the primary economic activity to nomadic pastoralism. Increasingly, in the wake of ongoing development and infrastructure improvements, the town offers alternative livelihood opportunities, mostly in the forms of trade, day labor, and services for tourists.

Education

Many families have moved to Archer's Post specifically to send their children to school. It has the largest concentration of primary schools in the area, and the only secondary school in the Waso Ward. Kenya's school system is modeled after that in the United Kingdom. Students attend primary school for eight years (standards 1-8), and might continue to four years of secondary school and four years of college. Admittance into secondary school (and college) is contingent upon national standardized exam scores so much of instruction is built around a nationalized curriculum and exam preparation. Moreover, many do not finish school as some families are unable to cover certain costs (i.e., tuition, boarding, supplies).

Traditional Life

The population of Samburu, Kenya consists largely of the *Samburu* and *Turkana* ethnic groups, with some migrant *Somali* and *Borana* families. Traditionally, *Samburu* males in their early-to-mid-teenage years assume the roles of moranhood. At this stage in life the moran function primarily as warriors, guardians of their community and its livestock. As nomadic pastoralists they frequently embark on long cattle herding journeys that sometimes last for

months. During this time, in which they are tending to livestock in the landscape throughout the day and sleeping in makeshift camps at night, they presumably gain significant knowledge about the natural environment, including its vegetation, topography, wildlife as well as the ecological effects of their interaction with it. This is known to contribute to the adaptability and resiliency of these and similar pastoral populations (Lane 1990, Niamir-Fuller 1998).

Specifically, the complex, semi-nomadic, grazing strategies that have been developed over generations of *Samburu/Turkana* herders have likely afforded them adaptability and resilience in a demanding environment. Such movements are known to be vital to the ecological function of semi-arid regions across East Africa (Lane 1990, Bollig and Schulte 1999, Kiptot 2007). It is important to note that many of the lands surrounding Archer's Post are rapidly becoming privatized, which is already limiting the area available to herders and disrupting their movements. In other parts of Kenya such changes are considered a threat to traditional semi-nomadic management systems (Kiptot 2007). It can be argued that the fate of these traditional grazing institutions is closely linked with changes in TEK transmission. .

Not only is TEK continuity potentially threatened by a shift away from semi-nomadic pastoralism (through land privatization), but the erosion of TEK by other forces (i.e., formal education) may also weaken a community's inclination and ability to maintain a semi-nomadic lifestyle. Such transhumance might only be possible with an intimate knowledge of local biocultural resources. The decisions of how and when to move are carefully, and constantly, weighed by male elders and are largely based off of subtle observations of changing weather and fluctuating patterns in the biotic community (Spencer 1970). Moreover, moran and other herders often rely on an extensive repertoire of ethnobotanical knowledge to treat both their own, and their animals' health issues as they arise on the move (Nanyingi et al. 2008). In fact virtually

every life sustaining function, be it the procurement of food, fiber, medicine or shelter, is in some way contingent upon a herder's ability to utilize their immediate environment (Nanyingi et al. 2008).

In fact ethnobotanical knowledge remains important to daily life both in, and outside of the context of pastoralism. Even in permanent settlements traditional remedies are still widely used for everything from skin infections to post-natal care throughout Samburu (Bussman, 2006, Nanyingi et al. 2008). Local plant resources also remain commonly used in construction, tool-making, nutritional supplementation and for cultural adornment (Bussman 2006, Nanyingi et al. 2008). So TEK remains in many ways essential to day-to-day life and cultural identity in this area.

Methods

This study was guided by principles of participatory and community-based research. The community's concerns about TEK erosion were originally expressed in a project described in Beh, Bruyere and Lolosoli (2013). Stakeholders were consulted at the inception (e.g., identification of the problem and research question) and throughout the research, following advice set forth in Reid and others' (2009) continuous engagement model. Locals in Samburu participated as researchers, were empowered to influence data collection methods and provided insight into findings.

Field work began by first identifying, in partnership with local elders, or *wazee*, those plants that they deemed most important to the *Samburu* and *Turkana* people in the Waso Ward.

In addition, several meetings were held with wazee to elicit their beliefs about TEK and barriers to its transmission, and to develop a final list of the most culturally-important plants. These plants were located, photographed and identified by their scientific names with the help of local plant experts and a botanical expert from the University of Nairobi. This information was then used to select a site for a path that became part of the 'plant trail' research strategy described below.

Sample

Virtually all young males who do not go to school join the moran, a group that is partly defined by the amount of time its members interact with the natural environment. More direct inference can be drawn about the importance of time in nature to TEK transmission by focusing on this group. Moreover, moran were known to congregate in certain parts of Archer's Post on a regular basis, enabling efficient and relatively random participant recruitment (young women do not congregate as predictably). For these reasons this study focused on moran (given their traditional role as herders) and male students enrolled in school (given their attendance at school and presumed minimal herding experience). While there are some people from other tribes in the Waso Ward (i.e., *Somali* and *Borana*) the vast majority of the population is either of *Samburu* or *Turkana* descent and sufficient background TEK data could not be collected to represent those other groups - so only *Samburu* and *Turkana* youths were solicited to participate. Students were selected from standards 7 and 8, systematically sampled from the three largest public, primary schools in Archer's Post. All standard 7 and 8 males formed a line and a total of 33 were randomly selected using numbers from a previously generated list. Due to the nomadic nature of moran, they were selected via convenience sampling from the town center of Archer's Post,

based largely on their willingness to participate. Many were not permanent residents of the town, though based on conversations all were from within a 25 km radius. A total of 26 moran were selected.

Data Collection

Plant identification and associated plant facts were used as proxies to measure TEK more broadly from the two groups, a practice that is common within TEK research (e.g., Benz et al. 2000, Cristancho and Vining 2009, Srithi et al. 2009, Reyes- García 2010). A field site was identified along a vegetated riparian area of the Ewaso Nyiro River that that consisted of 10 points along a temporary 'plant trail' where 15 of the plant species determined to be of cultural and traditional value by wazee were present. The 10 points were flagged. Participants were accompanied by at least one researcher or research assistant who asked them to stand at each point and name all of the plants they could identify within a 10m radius. They were also asked to provide any use-knowledge they had specific to those 15 important species as each was encountered. The time to complete the activity varied between approximately 30 and 120 minutes for each participant. This approach is similar to the methods employed by Voeks and Leony (2004), and by Stross (1970, 1973, as cited by Zarger and Stepp 2004) in a Mayan community, later replicated by Zarger and Steppe (2004) in the same location roughly 35 years later. However, it differs in that the participants of those studies identified and described specifically marked plants along a *continuous* path as opposed to point-by-point.

Data Analysis

Data was analyzed along three major parameters: number of total species correctly identified, number of "important" species (as deemed by wazee, out of 15) identified, and number of total (and correct) facts the students reported about those 15 important species. Each respondent's information was entered into a statistical software package (i.e., SPSS), and descriptive statistics and comparisons between students and moran (i.e., t-tests) were conducted. In addition, participants provided basic demographic information such as their age, tribal affiliation (*Samburu* or *Turkana*), primary area of residence, years spent in school, and frequency of herding (on a scale of 1 – never to 5 – daily).

In addition to student/moran comparisons, we examined if age and herding frequency were likely to influence plant identification and knowledge. Due to methodological limitations, the moran group was, on a whole, a few years older than students so it was important to make sure that differences between the two groups could not be explained by age as a covariate. Herding frequency was measured to determine whether differences in TEK acquisition could be partly attributed to differences in time spent interacting with nature.

Results

A total of 33 students and 26 moran participated. Moran identified significantly more plant species ($p < .01$) overall than students, with mean counts of 38 plants and 20 plants, respectively (Table 2.1). While the mean total for moran was almost twice that of the students,

there was considerable variability within each group as evidence by the standard deviation of at least 9.19 for both groups.

Table 2.1: Average number of plants identified for students and moran.

		Students/Moran			
		Students	Moran	*t*-value	*p*-value
Total # plants ID[1]	$\bar{x}$	20.18	38.04	7.15	< .01
	s	9.78	9.19		

[1] Total number of plants participant identified across all points.

To account for the fact that the moran group appeared, on average, older than the student group, a one-way ANCOVA analysis was conducted that treated age as a covariate to group (see Table 2.2). In Samburu, few people know their date of birth as many are born at home in remote locations where time/date is of minimal relevance. Consequently, responses about age are difficult to treat. In any case, further analysis revealed that age was not a significant predictor of number of plants correctly identification ($p > 0.5$; $\eta_p^2 = .05$) and did not covariate with social grouping (moran/student), which remains a significant predictor of plant identification ability after accounting for age ($p < .01$; $\eta_p^2 = .17$, see Table 2.2)

Table 2.2: Analysis of covariance for social group (Student/Moran)[2] with Age[3] as a covariate as predictors of total plant identification ability[1].

	df	*F*	Sig.	η_p^2
Corrected model	3	20.34	< .01	.57
Student/Moran[2]	1	9.36	< .01	.17
Age[3]	1	2.53	.12	.05
S/M*Age[4]	1	6.09	.02	.12

[1] Dependent variable: Total # of plants identified by participants among all points.
[2] Independent variable: Social group: student or moran.
[3] Covariate: Age of participant.
[4] Interaction between social group (Student/Moran) and Age.

A standardized regression analysis suggests that 30% of the variability in total plant identification (r-squared) can be explained by herding frequency (Table 2.3).

Table 2.3: Standardized regression for herding frequency as a predictor of total # of plants identified.

	Standardized regression coefficient (β)	*t*	Sig.	*F*	Adjusted R^2
(Constant)		1.28	.21	22.42	.30
Herding Frequency	.56	4.74	< .01		

Culturally Important Species

Participants were asked to identify and describe the uses of 15 specific species that were chosen for their cultural importance. Overall, moran were able to identify an average of 13 of the

15 species compared to students who could only identify an average of nine (Table 2.4) ($p < .01$, $t=6.30$)

Table 2.4. Difference between students and moran in ability to identify *culturally important* plant species.

		Student/Moran		*t*-value	*p*-value
		Student	Moran		
Total # *important* plants ID[1]	$\bar{x}$	8.61	12.87	6.30	< .01
	s	3.32	1.69		

[1] Total number of *culturally important* plants (out of total 15) participants identified across all points.

Some common and ubiquitously utilized species like Ltepes (*Acacia tortilis*) (χ^2 =.76, p >.38) and Sukuroi (*Aloe secundiflora*) (χ^2 =3.10, p >.07) were known by almost all participants, so no significant difference in identification ability existed between the two groups for those plants (see Table 2.5). For others the disparity in knowledge between the two groups was relatively strong. Moran were significantly more likely to identify 9 of the 15 than students (χ^2 varies, p <.01). Moran were especially more adept at distinguishing between two similar looking species Sakurdumi (*Kedrostis gijef*) (χ^2 = 11.20, p <.01) and Sakurtuti (*Cissus quandrangularis*) (χ^2 = 15.55, p <.01); and for species with primarily ceremonial importance, like Lominara (scientific name unknown) (χ^2 = 29.68, p <.01), which is mostly used as a perfume. None of the plants were more widely identifiable by students than moran.

Table 2.5. Differences in percentage of students and moran that could identify *culturally important* plants, by species.

Species: **Samburu** (Turkana) **names** *Scientific name*	Student/Moran[1] Student	Moran	*Chi-square*	Sig.
Lawai (Ekurchanalt) *Delonix elata*	81.3%	100%	5.04	<.03
Ldupai (Emojo) *Sanserveria intermedia*	68.8%	100%	9.13	<.01
Lgiriai (Ethajait) *Lawsonia inermis*	75%	100%	6.73	<.01
Lpupoi (Engumo) *Grewia villosa*	81.3%	100%	5.04	<.03
Lominira (Ekaretrete) *unknown*	18.8%	95.2%	29.68	<.01
Lordanyai (Lorkirdanyai) *Loranthus sp.*	21.9%	43.5%	2.92	>.08
Lparuai (Engwael) *Hyphaene thebaica*	87.5%	100%	3.23	>.07
Ltepes (Etiir & Ewoi) *Acacia tortilis*	96.9%	100%	0.76	>.38
Ngirman (Egong) *Hildebrandtia sepalosa*	32.3%	69.6%	7.88	<.01
Sakurdumi (Emoni) *Kedrostis gijef*	18.8%	62.5%	11.20	<.01
Sakurtuti (Lobara) *Cissus quadrangularis*	9.3%	58.3%	15.55	<.01
Salapani (Etuntun) *Cordia sinensis*	71.9%	100%	7.73	<.01
Serichoi (Edung) *Boscia coriacea*	53.1%	95.5%	11.20	<.01
Sukuroi (Echuchuka) *Aloe secundiflora*	87.5%	100%	3.10	>.07
Sumanderi (Ethimanderi) *Commiphora schimperi*	59.4%	95.8%	9.72	<.01

[1] Percentage of participants in social group (student of moran) that correctly identified species.

When a participant identified one of the 15 culturally-significant plant species, they were asked to share any traditional information they knew about the species. Moran recalled a higher average number of facts (17.87) (see Table 2.6) than students (9.32) and the difference was statistically significant ($p < .01$, $t=3.63$).

Table 2.6: Average number of cultural facts recalled about plants by students and moran.

		Student/Moran			
		Student	Moran	*t*-value	*p*-value
Total # true facts[1]	$\bar{x}$	10.28	17.87	3.63	< .01
	s	6.18	9.32		

[1] Total number of true, traditional facts about plants participants provided across all points.

Discussion

The regression results indicate that herding frequency, more than any other measured factor, influences an individual's ability to identify plant species and gain ethnobotanical knowledge about the species. We failed to reject our initial hypothesis that moran, who spend far more time herding than their student counterparts, could identify more local plant species and provide more traditional facts about them.

During informal conversations moran cited 'herding with peers and elders' as the time when most TEK transmission occurs. According to the moran it happens both as horizontal, peer-to-peer knowledge sharing while TEK is being put to use (learning by doing) and by more

intentional acts of mentorship (when the primary purpose is instruction) usually with older moran or elders (vertical/oblique transmission). In either case transmission seems to occur best when there is both tangible/practical interaction with living plants and the presence of other herders. For males herding provides an impetus and context for their most intimate interactions with their environment. If herding serves as conduit for TEK acquisition, and students herd much less frequently than moran, as the data here suggests, then it is reasonable to suspect that school attendance impedes TEK transmission by limiting the amount of time spent herding. This is further supported by the fact that moran could identify more than twice as many plants as students, and on average could share 70% more facts about traditional uses of key plant species.

This suggests that TEK erosion is occurring among those who attend school. Yet, while those with a formal education represent an increasing proportion of the people in Samburu, there remains an abundance of moran, many of whom possess a strong TEK repertoire. So it is unclear the extent to which erosion is occurring at the *community level* and whether the results are more indicative of knowledge specialization, whereby TEK will remain intact, but mostly among herders (moran).

In any case, during our conversations, the wazee expressed concern that the students themselves lack TEK and a broader appreciation for *Samburu/Turkana* customs. They recognize that their ability to maintain traditional community dynamics and to enforce customary rules depends in part on the majority of the community acknowledging the value of their traditional knowledge systems. For instance, the maintenance of a semi-nomadic grazing regime requires a tacit appreciation for the traditional knowledge of herders and wazee, but a growing number of students may be learning to value more western approaches to landscape management, which are arguably inappropriate for the Samburu socioecological system. It follows that as a growing

proportion of the community is instilled with western knowledge, land used decisions may be increasingly based on non-local practices.

The wazee also recognize that, although some ethnobotanical-based health remedies may have suitable substitutes in western medicine (Bussman 2006), the sustainable management of medicinal plant resources, and ultimately biodiversity in the area, may suffer if those plants are no longer of significant value to the broader community (UNEP 2006).

But the wazees' discomfort with TEK erosion extends beyond ecological implications; such a shift indicates a change in community power dynamics, where elders as the bearers of traditional knowledge may go increasingly underappreciated. Moreover, TEK is an essential part of what it means to be *Samburu* and *Turkana*. To the wazee, maintaining TEK is both a duty and a matter of pride. These imperatives for maintaining TEK continuity among students merit further exploration of the TEK and formal education relationship.

Based on our observations, schools in this region, and Kenya more broadly, almost exclusively teach based on a western knowledge systems, and currently the teaching profession in Kenya is generally not a culture in which innovative approaches such as place-based education (where TEK might be integrated) is taught or incentivized (Owuor 2008). Additionally, the teaching positions are governed by the national Ministry of Education, meaning schools in a place such as Samburu can be assigned teachers from vastly different parts of the country and with minimal or no knowledge about the local environment. Further, while formal education certainly provides a host of highly-important benefits, it also gives students the exposure to, and forum to reflect about, alternative livelihoods for their future that go beyond pastoralism.

So, given that students enrolled in school possess less ethnobotanical knowledge than their moran (herding) peers, and that such knowledge is regarded by the wazee as essential to *Samburu/Turkana* culture, there is a need to develop alternative modes of transmission for students. Most of the educators we spoke with, including administrators and district education personnel, were not aware that students were failing to acquire as much TEK as their moran peers, or that eroding TEK by students was a concern in the community. Perhaps this lack of awareness exacerbates the undesirable relationship between school attendance and TEK transmission. Indeed, while formal education has been implicated as a barrier to TEK transmission in other indigenous communities it has also been suggested in the literature that western and traditional pedagogies are not obligate competitors (Owuor 2008, Reyes- García et al. 2010, McCarter et al. 2014). In fact, researchers such as Owuor (2008) contend that with a tweak in circumstances, formal education systems can actually be leveraged to facilitate TEK transmission.

It can be argued that the simplest way to ensure that younger generations are exposed to traditional knowledge would be to bring that knowledge into the formal education setting. By providing space in the curriculum or during school-sanctioned extracurricular lessons for TEK transmission TEK experts (e.g., moran and wazee) and educators can help legitimate TEK as an alternative way of knowing and integrate biocultural and scientific knowledge.

In conjunction with this study, the research team and local collaborators (wazee, educators and conservationists) developed TEK transmission projects that targeted Samburu students. Among the projects was a plant identification guide featuring *Samburu* and *Turkana* ethnobotanical knowledge that was distributed in the schools. Selected students were taken on an intensive, three day field trip into protected areas where they were given hands-on, place-based

TEK instruction from local wazee and supported by educators and conservation NGO staff. Those students later assisted elders in a series of after-school programs where they brought plant samples to a classroom, and delivered ethnobotanical lessons to their peers. The success of these efforts were not measured as part of this study, but participating elders expressed satisfaction that they were provided an opportunity to convey information about local plants to non-herding youth in their community.

While TEK revitalization might best be achieved through collaboration with schools, encouraging mentorship is another strategy to consider. When asked how they acquired ethnobotanical knowledge, some of the study participants mentioned family members or peers who had taken time to share TEK. Among those participants, some even spoke about their own role as mentors for others. Certainly some of their knowledge is gleaned by direct observation while interacting with the landscape, but much of TEK transmission happens through intentional instruction by a mentor, as has been observed in other parts of the world (e.g., Reyes- García 2010, Haselmair et al. 2014). Some students even spoke of grandparents that would regularly set aside specific time for lessons about traditional plant use, in order to compensate for a lack of time spent herding. Further research should explore this concept in detail.

Conclusion

The data from this study revealed that moran possess more ethnobotanical knowledge, of greater detail, than students. This difference is at least partially explained by disparities in herding frequency and their respective affiliations with social groups: moran or student.

As an integral part of the community's semi-nomadic traditions, and a marker of cultural pride, TEK is an important part of maintaining cultural cohesiveness and sustainable natural resource management in Samburu. The erosion of TEK among students is suggestive of a pervasive social rift that may impact community dynamics and negatively influence people's valuation of, and ability to implement Samburu's traditional, resource utilization practices. It also stands to reason that the sustainable management of local plants, and ultimately plant biodiversity in the area, may suffer if medicinal plant species are no longer perceived to be of significant value by the broader community (UNEP 2006).

One potential strategy for addressing the decline in TEK among students in Samburu (and perhaps other regions of Kenya) may be to leverage the formal education system to advance the legitimacy of TEK (and traditional management strategies). Formal education is, in essence, systemized knowledge transfer, so it seems like an obvious and readily available channel for renewed TEK transmission. Schools in Waso East could continue to collaborate with local TEK experts and elders to incorporate TEK lessons into extracurricular activities. There are also opportunities to work with the various conservation entities in the area to develop TEK related place-based education programs (examples of this include: Cruz- García and Howard 2013, McCarter and Gavin 2014).

Limitations

Moran were recruited for this study from one relatively small community situated in a geographically large area. This created an opportunity for sampling bias, as moran in a given area are typically a tightly-woven social group, and information is often shared within that group. Moran from other areas may have a different level of knowledge or different information about plants. In addition, the moran in this study were recruited because of their presence in and around Archer's Post. It is possible that those moran with more of a tendency to spend time in town were more likely to be sampled over those who spend more time in the bush.

It is also important to note that while few participants knew their exact age (in *Samburu* and *Turkana* culture age is more of a social construct than a numerical measure), by their own estimates, the moran were likely a few years older than the students. This inconsistency in the sample is partly because, while a handful of young men who had completed primary school were included in the study, we were forced to solicit current students to participate, as we were unable to locate a statistically viable number of primary school graduates of the same age as the majority of moran who were available.

Also, the field assessment site was located approximately 1km outside of Archer's Post, so the composition of plant species used in the methods was within a student's immediate daily radius, whereas moran might have knowledge of plants from a wider diversity of locations.

Suggestions for Further Research

This was not a longitudinal study like that by Zarger and Stepp (2004) so it remains uncertain whether knowledge has actually been lost *over time*. A follow up study, using the data

from this study as a baseline could help reveal if such trends exist, especially regarding TEK erosion among the moran.

This study was designed to look at herding, a predominantly male activity, as an important factor that is limited by the formal education system. Similar research could also assess whether similar trends exist among females in Samburu.

Additional analysis of our data hints at the possibility that students may acquire enough TEK after completing primary school to catch up with their moran peers; an idea that also merits further research.

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CHAPTER 3:
ROLES AND OPPORTUNITIES IN FACILITATING TEK TRANSMISSION: A PERSONAL REFLECTION

While the potential for traditional ecological knowledge (TEK) loss among students in Samburu is central to this community's struggle to maintain its cultural identity, the problem has eluded the attention of local educational administrators. The fact that those individuals, with the power to make institutional changes to address the problem, were unaware of its existence provided some of the impetus for this research. My aim has been to quantify and characterize the nature of TEK erosion among students in order to inform and prompt action within said institutional settings. Engaging in this task as a westerner necessitated substantial reflection on the appropriateness of collecting knowledge from a culture that is not my own and on my role in promoting TEK continuity. Ultimately, through a collaborative, community-based approach I believe my project partners and I were able to gather useful information and develop meaningful programs that were designed to address part of the problem, all while maintaining an appropriate relationship with the knowledge and the knowledge-holders.

Emerging Roles for the Formal Education System & the Transmission of TEK in Samburu

"I didn't know!... I was not aware that our students were not learning our cultural knowledge."

~Area education officer, Waso East, Samburu County, Kenya

The Area Education Officer (AEO) who superintends public schools in the Waso East area, had assumed, like many in the formal education system in Samburu, Kenya, that his students were sufficiently exposed to traditional knowledge in their lives outside of school. As someone who remains deeply tied to his *Samburu* roots, the AEO was particularly troubled to learn that this was not the case. Within the formal education administration there has been a lack of awareness about the potential for traditional knowledge loss in the student population, an oversight that may underpin some of the traditional knowledge erosion concern in Samburu. Traditional Ecological Knowledge (TEK) is a marker of cultural identity and a source of pride for the *Samburu* and *Turkana* people living in the Waso Ward. These pastoralists, like those in many parts of the world, have relied on an intimate knowledge of their landscape to subsist in an often harsh, semi-arid environment. To the AEO, and many other *Samburu* people, the prospect of losing this knowledge represents a problematic drift away from their culture.

It was after we had shown the AEO our preliminary results that he became a keen supporter of our research and projects. He was soon a regular face at our many stakeholder meetings, where he would consistently arrive with new ideas, often scrawled out as schematics of some sort, about what kinds of TEK related educational programs we could implement or new ways to organize the group's various activities. Of course the AEO brought much more than his enthusiastic support, he also brought legitimacy to the idea that the formal education system can be a positive force in the project of maintaining TEK continuity in Samburu.

Before meeting the AEO, our research team included a handful of educators from the area, and we had already known that the lack of TEK among students was of concern to at least a handful of teachers, but we had operated under the presumption that all of our work would have to be entirely grassroots, that the education *administration* would not be supportive of a project

to empower indigenous cultural transmission. Such objectives are not in their mandate as part of a government institution (Lanayasunya et al. 2012). The AEO turned this thinking on its head. Not only do several administrators see maintaining cultural continuity as important, but some even have a personal stake in it.

Instances like our first meeting with the AEO crystallized the importance of the work we were doing. It became clear that while many educators were predisposed to appreciate the importance of TEK continuity for their students, very few had been confronted with the fact that, in relation to their being in school, most of the students possessed significantly less plant knowledge (and presumably other sorts of environmental knowledge) than their peers outside of school. To most teachers the importance of the problem was obvious once it was raised in discussion, but few were aware of it before this work.

Of course to the *elders* in the Waso Ward, the degradation of TEK among students was common knowledge, and evidently a subject of much consternation, but this apparently had not been communicated to the local education administration. A possible explanation for this is the cultural disconnect between educators and the local community. The Kenyan education system is structured such that most of the teachers in rural areas come from other parts of the country, so very few of the faculty in the Waso Ward are actually of *Samburu* or *Turkana* heritage. Even among those that are from the area, there is little space in the curriculum to embed traditional knowledge.

There was one particular educator, of Samburu decent, who had taken measures to relay some cursory Samburu TEK to his pupils. As it happened, this teacher had been a part of our

local advisory committee from the start, and had a strong role in program planning and implementation throughout our work in Samburu. I asked him to what extent he had been teaching students about local plants: "hardly at all," he responded. This teacher would use local names in his lectures about plant biology, but that was about the extent of it. His passion for sharing his ethnobotanical knowledge was evidenced in his continuous voluntary involvement in our work, but he perceived that there was little time or institutional support for him to integrate TEK in his teaching.

In fact it was clear, after working with a number of teachers over the course of two field seasons that the institutional culture within the schools was at best minimally supportive of local or traditional knowledge instruction. According to Owuor (2008) there is little "space for classroom dialogue in which the experiences of members of local [Kenyan] communities such as the role of elders can be incorporated in formal classroom knowledge construction" (p. 28). I suspect that a preference for western knowledge was conferred on students, but presumably without the intention to marginalize traditional knowledge. Some students even expressed strong negative attitudes towards moranhood and traditional lifestyles, ideas which were probably not directly passed down through their education, but which are at least able to exist within student group-culture.

The schools may also have impressed upon their pupils aspirations of 'digital' lifestyles in cities, far away from Samburu, and far away from traditional livelihoods and practices. Of course these ideas could also have been engendered in their home lives, through peer interactions or by exposure to various media. But I suspect that the institutional culture within schools has served to at least reinforce such notions.

This cultural divide was further evidenced by some participants' responses to questions about the knowledge of moran. Several of the students described the moran as intellectually inferior, as "knowing nothing." A few respondents even made similar claims that they try not to socialize with moran because the moran would try to convince them to give up school and take up herding full time. Conversely, some moran shared similar sentiments about their student counterparts, also saying that the students "knew nothing" and implying that they could not function effectively in their society.

However, there were several participants who valued the diversity of knowledge and skills held between students and moran, and expressed appreciation for the opportunity for the two groups to edify one another. A few respondents took a historical view, pointing out that the culture and economy in Samburu is undergoing dramatic changes, and that it is important to have a heterogeneous set of knowledge holders within the community. After spending several months in Samburu, I share this sentiment. Certainly, the local school system is opening up a world of possibilities to its pupils and the knowledge imparted on its students can enrich the Samburu community more broadly. But it is clear that the traditional knowledge systems, which have facilitated people's survival in this semi-arid landscape for generations, should remain intact for this and future generations to draw from. For one, such knowledge is intrinsically valued within *Samburu* and *Turkana* culture, and its preservation is linked to the persistence of those cultures in whole. Secondly, ethnobotanical knowledge may remain useful even to non-pastoralists, as evidenced by the nation-wide resurgence in the use of traditional remedies. Also, as I have outlined in previous chapters, TEK remains essential to the function of the semi-nomadic rangeland management system in Samburu, a system that is increasingly characterized by the international community as sustainable and resilient.

To make sense of this cultural change I spoke with a young man who had "defected" from moranhood in his late teens in order to attend school. This young man, "Thomas," was 17 and only in standard six of primary school (roughly the equivalent of sixth grade in the United States). However, he held the position of "headboy" and was given a great deal of deference by his peers. He told me that his father had forbade him from going to school as a child, so that he, as the only son, could watch after their herd (his mother was largely indifferent to whether or not he went to school). By the time his father had died Thomas was already a moran. Without telling anyone, he approached the Lorubae Primary School staff and was admitted into Standard Four. At the time there were two other moran who had made the same decision (they later dropped out, although Thomas still tries to encourage them to re-enroll). He was teased by his moran peers at first, but he remains committed to finishing school so that he can become a wildlife guide for safari tourists. Thomas says he now socializes primarily with students, in order to stay close to his studies, but he is still comfortable interacting with other moran, and believes that they will help him catch up in his traditional knowledge once he has finished school.

While he no longer has time to herd livestock Thomas maintains footing in both social groups. There are certainly trade-offs to choosing one lifestyle over the other, TEK acquisition being one of them, but it seems that at least some students, like Thomas, benefit from living in both worlds.

Our research team heard many stories like these and we recorded a considerable amount of ethnobotanical knowledge over the course of our work. This helped me to develop an understanding of the complex relationships people have with their traditional knowledge systems and gave me an idea of just how important TEK is in Samburu. It was clear that the problem of

TEK loss is intimately tied to the process of globalization and it rose the question as to whether my involvement, as a westerner, could have ethical implications regarding the rights to record and study knowledge that I have no claim to. Given the sensitive nature of the information we collected it was important that I approached our work with a framework for developing appropriate relationships with the community and the knowledge shared with the team and myself.

Of TEK & *Mzungus*

"Before researchers become researchers they should become philosophers. They should consider what the human goal is, what it is that humanity should create."

~Masanobu Fukuoka

Over the history of studying and accumulating environmental knowledge from indigenous communities, outsiders or *mzungus* in Kenya, have impacted those places in varying ways, some of which might be considered ethically questionable. While the role of researchers has diversified significantly over the last few decades, many still engage in work that fails to confer meaningful benefits to the local community. It is important to scrutinize the practices of TEK research as we make sense of the roles and relationships we develop with our host communities. A study in 1997 outlined the range of TEK engagement paradigms that have emerged in the TEK research community (see Blaike et al. 1997). Like myself, the authors are critical of projects that are designed to benefit the researchers more than the community itself.

The following is my own distillation and interpretation of Blaike and others' (1997) characterization of the TEK research community, in combination with insights from my own experience and understanding of the literature:

A TEK researcher may be characterized as one of the following: a '*pharmacologist'*, an '*archivist'*, or a '*collaborator'.*

1: *Pharmacologist*: This is a researcher whose study is not designed to benefit the communities from which they have elicited TEK. Their's is largely an extractive type of research, epitomized by some in the pharmacology field who travel to remote places, ask indigenous communities to show them medicinal plants, collect specimens and take them back to western laboratories for pharmaceutical development. It is often colloquially referred to as "helicopter research," connoting a lack of a community's involvement or stake in the study outcomes.

2: *Archivist*: Just as there are various language preservation projects underway to document the world's endangered dialects, there are researchers whose primary mission seems to be cataloging TEK before it is lost. Their goal is often to document as much as possible, as soon as possible, usually in the pages of books and other recordings, far away from the contexts in which the knowledge was developed. This sort of relationship between researchers and communities is more accessible within academic institutions and seems to be the preferred type of interaction as a matter of convenience for researchers (Reid et al. 2009). Such studies are not especially concerned with the mechanisms of

TEK loss, or with providing specific benefits to the community (e.g., Lado 2004, Green et al. 2010).

3: *Collaborator*: Collaborative researchers are interested in the welfare of communities that still rely on (or may need to revisit) TEK for their well-being. They are concerned more with the state of TEK within the community, what factors are contributing to its loss and barriers to its transmission (e.g., Reid et al. 2009). Effective researchers work in an 'empowering,' participatory fashion and partner with local stakeholders to create strategies for maintaining TEK continuity at its source (Arnold and Fernandez-Gimenez. 2008, Nazarea. 2006).

Our work has been carried out in the spirit of "the collaborator" in hopes of reducing the barriers to TEK transmission in the Waso Ward. I developed a simple 'horseshoe model' (Figures 3.1-3.3) that has also helped me make sense of my role as a western researcher in the process of studying and hopefully alleviating TEK loss.

Westerner's Involvement in Addressing TEK Erosion: The 'Horseshoe Model'

TEK continuity in a community may be disrupted by factors such as the emerging prevalence of available pharmaceuticals or increased formal education enrollment (Figure 3.1). These barriers are often some-what porous, in that a particular unit of traditional knowledge (symbolized as an arrow) may still be transmitted to the next generation, but may be altered or abbreviated in the process.

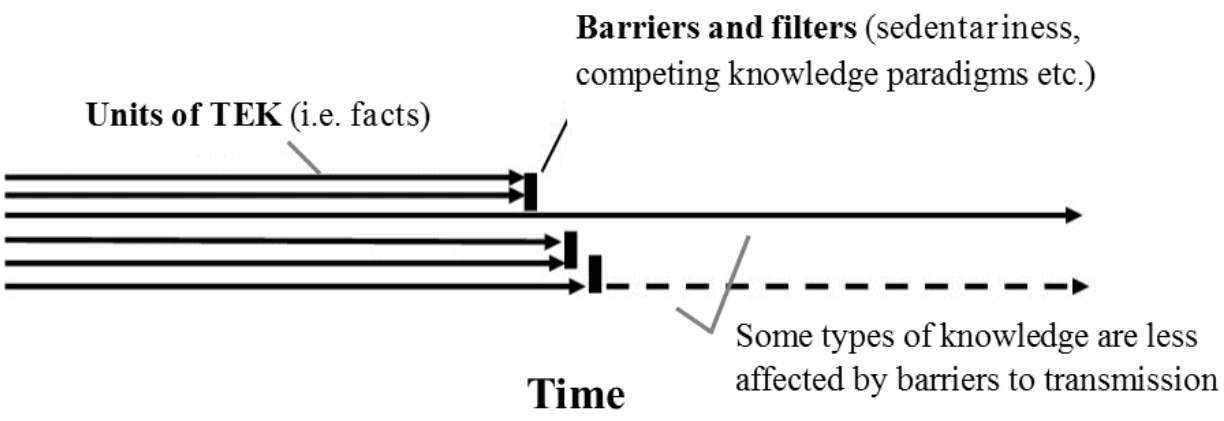

Figure 3.1: TEK continuity and barriers to transmission. Lines represent the persistence of units of traditional knowledge (facts, beliefs, concepts, practices etc.) in a community over time. The continuity of TEK can be disrupted at different points in time by several different types of barriers.

Well-meaning researchers, such as myself, may try to help a community restore gaps in TEK transmission through a process of collecting, accommodating, assimilating, and finally re-translating TEK. Through this process we essentially westernize traditional knowledge, publishing it in non-traditional formats (books, articles, etc.), under the assumption that the product is an accurate and viable reproduction of traditional knowledge. It is the researcher, acting as a sort of 'archivist,' who prioritizes which sets of knowledge go through this 'restoration' process. Our own TEK-centric plant identification guide (see Appendix A: "Vegetation Guide for Samburu") was partially developed along these lines. However, the ultimate objective was to promote a general *interest* in TEK among students, not necessarily to perpetuate any particular sets of information (discussed in more detail in the last section of this chapter).

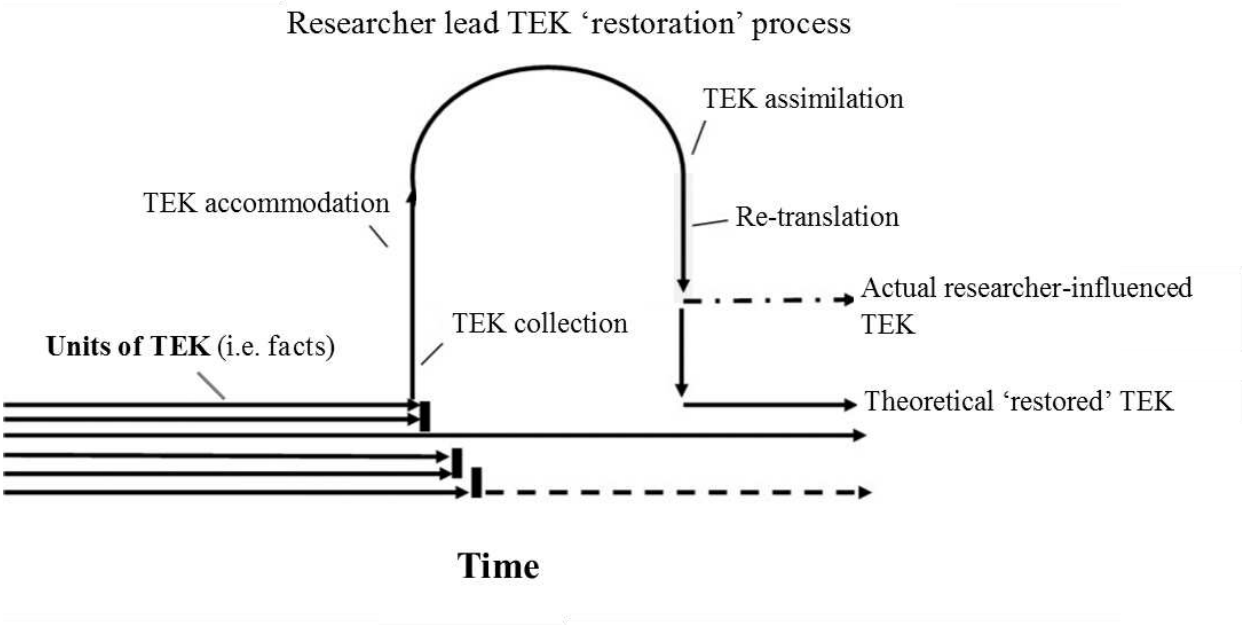

Figure 3.2: The horseshoe model. This is a compensatory process by which TEK research is often meant to restore TEK. It exists in theory only, as the 'restored TEK' will be inevitably altered throughout the 'restoration' process.

In my view, truly collaborative TEK research should focus more on the actual barriers to TEK transmission. Researchers should work with communities to identify the mechanisms of TEK erosion within segments of the population (i.e., school-going youths) and help them to find means for reducing or eliminating such barriers to transmission (Nazarea 2006). This can still entail some degree of TEK restoration via novel forms of transmission (e.g., incorporating TEK into school curricula, or disseminating it through social media). But it requires that the community (and outsiders) work towards maintaining or reestablishing traditional channels of TEK transmission (e.g., through experiential interaction with elders). Our 'elders in schools' project was developed along these line (see last section of this chapter).

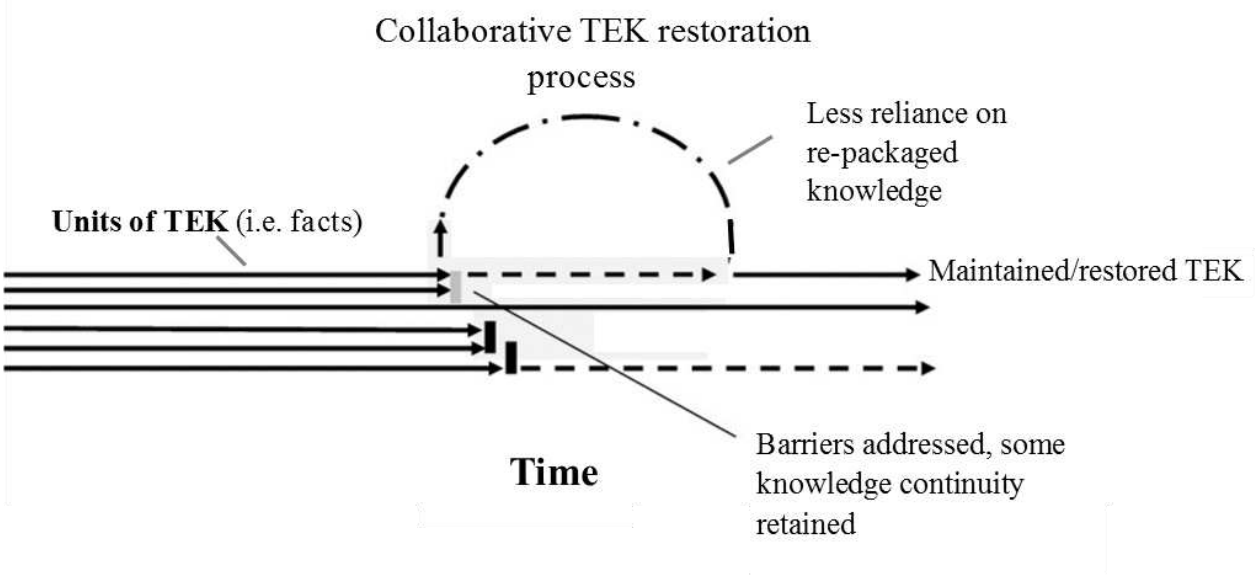

Figure 3.3: 'Collaborative' TEK restoration process. Researchers work with the community to explore novel means of TEK instruction. Simultaneously, the community and researchers work on addressing the barriers to facilitate TEK transmission through traditional means.

Because the barriers to TEK transmission are many and complex empirical studies such as this one can help local people identify said barriers and devise ways to address them. In this way researchers become collaborators with the community, helping to provide clarity where it is needed and offering organizational capacity when they can. In this way our work gains 'catalytic validity, where the central objective is to effect positive social change (Arnold and Fernandez-Gimenez 2008). It is aligned with the principles and practices of community-based natural resource management, from which lessons can be drawn to help communities tackle TEK erosion related issues.

Community-Based Research: My Experience

The terms “community-based,” “participatory” and “collaborative” are often the vocabulary of enlightened natural resources researchers. However, many works can be characterized by these ideas in name only, a fact that may underpin the limited success of some community-based natural resource management (CBNRM) endeavors (Kellert et al. 2000, Kumar 2005, Reid et al. 2010). Garnering community support is a difficult task, to say nothing of trying to base a study on a community's own research ideas and including local stakeholders as genuine partners throughout the design and development of a project. I directed this research, to the best of my ability, in adherence to this way of thinking. However, as in virtually any study or development project, there were a number of practical issues that limited our team’s ability to do so. I believe it is important to discuss the extent to which this study is and is not participatory, collaborative and community-based, as well as some critical insights I gained in the attempt to earn these labels.

We knew, from a previous, largely participatory study (by Beh et al. 2013), that some community members were concerned that the formal education system was interfering with intergenerational TEK transmission. So the impetus for this research was based on community interests. Moreover, the products of this work are largely designed to be used by the community itself (see next section). However, as this research was designed to contribute to my master’s thesis, I pushed for more quantitative data collection than my local partners might otherwise have needed in order to develop a working understanding of the TEK transmission issue. Our findings largely served to confirm the preexisting notions of elders and opinion leaders in

Samburu; I suspect that if our research team was not beholden to operate from an empirical basis, many of our partners would have been just as supportive of our efforts to rehabilitate TEK transmission as they have been with our evidence-driven approach.

The community did not give input over the entire research process. The academic objectives were based largely on my own understanding of similar studies, and my own interests and preconceptions had already influenced the study design before I had even visited Samburu. This is not entirely negative; certainly, as the primary researcher, I should inject my own ideas to the study, but I would have preferred more input from the community nonetheless. Of course, there are practical limitations to how involved non-researchers can be in a research process. Certainly, the development of specific research questions, methods and academically-oriented discussion requires a familiarity with academia that is under-represented in Samburu. In some TEK studies certain members of the community have enough of an academic background to provide continuous input and directive throughout the work, and in a few cases the authors themselves are from the community they are working with (e.g., Wane 2013). But we did not find any partners with such an academic background in Samburu. So this study was community-based in that it explored a community concern and addressed it through community-driven programs, but the research itself could not be entirely directed by the community.

Once I arrived in Samburu, the research was guided, in part, by a committee of local educators, conservationists, research staff and elders, who were convened periodically thereafter during the two field seasons. In this way, the study might be characterized as participatory. We later collaborated with these committee members as well as other local elders and opinion leaders, additional educators, and various conservation-oriented entities (including Samburu National Reserve, Kenya Wildlife Service, Save the Elephants and Kalama Conservancy, among

others) to create place-based education (PBE) programs with strong TEK components (projects described in next section).

As much as I would have preferred to follow Reid and others' (2009) "continuous engagement model," most community participation occurred only during the months of data collection (June-July, 2013-14). The research guidance committee in Samburu was made aware of key elements in our research design and analysis but, for practical reasons (access to technology, knowledge of software/procedures, etc.), data analysis and synthesis fell almost entirely on my shoulders. However, the three research assistants, who were male community members in their early twenties, played an integral role in designing the research procedures and interpreting our results. I also asked them to record their own sets of field notes, which proved extremely useful for identifying the barriers to TEK transmission that each individual participant had experienced.

While I was diligent in seeking input and participation from a range of local stakeholders I was still seen as the leader throughout the work. This was to be expected as I was the primary researcher, after all. However, I often hoped for more leadership from the other stakeholders, who I felt were too quick to defer to my judgment. This might be explained by the fact that I am a western academic and connected to an institution (Colorado State University) that is known for supporting the community in numerous ways (including financially), so I was probably granted more power over the process than to which I was entitled.

I continuously struggled to counter this power imbalance, eventually resorting to removing myself from some of the project planning meetings entirely. To my surprise,

depending on the nature of the meeting objectives, the process was sometimes more efficient without my presence. My absence brought attention to the fact that the stakeholders already possessed all of the capacity necessary to plan and carry out new projects. I have come to believe that there is a fundamental flaw in the way that westerners are usually trained to approach development; we are taught various ways to *build capacity*, when we should be more focused on helping local people realize and use the capacity that they already possess. That said, in all likelihood this particular set of stakeholders would not have come together to talk about TEK transmission without my prompting, and my facilitation was necessary for many parts of the process. So I have come to see my own role as that of an instigator; someone who recognizes an untapped potential for collaboration between different groups with shared interests and who sets the creative process in motion.

Lessons from Community-Based Natural Resource Management

As a scholar of the natural resource sciences I found it useful to apply insights from community-based natural resource management (CBNRM) towards our research and in our efforts to address the barriers to TEK transmission. I have come to believe that TEK research should borrow more from CBNRM. I have added to my personal lexicon the concept of community-based *cultural* resource management or *CBCRM*, which uses the ethics and practices of CBNRM towards the maintenance and evolution of traditional knowledge. Of course the work of collaborative TEK researchers applies both to CBNRM and CBCRM, as we are often interested in maintaining TEK continuity for the sake of facilitating the sustainable use of natural resources.

CBNRM as a discipline has gained hold within the NRM field and, despite some warranted critique (e.g., Kumar 2005), it is widely viewed as an appropriate and useful approach to natural resource issues, especially in rural parts of developing countries (Armitage 2005, Berkes et al. 2000). We can describe CBNRM as "an approach [that] seeks to encourage better resource management outcomes with the full participation of communities and resources users in decision-making activities, and the incorporation of local institutions, customary practices, and knowledge systems in management, regulatory and enforcement processes" (Armitage 2005, p.703). I have come to realize that such ideas can be applied to the management of the vary knowledge systems that CBNRM purports to include. By working towards full participation of the community in guiding our research and project development process, we should, theoretically, conduct our work with optimal deference and benefit to the community itself. This may be even more important for TEK than natural resource management, as there can be no question that the TEK of a community is the property and responsibility of its constituents.

According to Armitage (2005) CBNRM efforts need to focus on developing *adaptive capacity* within the socio-ecological systems they concern. He defines adaptive capacity as "a critical aspect of resource management that reflects learning and an ability to experiment and foster innovative solutions in complex social and ecological circumstances" (p. 703). Within a CBNRM framework land managers are encouraged to continuously observe changes in their socio-ecological system, evaluate the effectiveness of their activities and make adjustments accordingly (Armitage 2005). Incidentally, Berkes, Colding and Folke (2000) point out that this sort of adaptive capacity is often built upon or at least enhanced by a community's traditional knowledge systems.

I contend that it is likewise important to develop adaptive capacity in the management of *cultural* resources (i.e., TEK). Stakeholders need to be practiced in evaluating the mechanisms of TEK loss as they evolve and continuously seek the most appropriate strategies for maintaining transmission. Just as socio-ecological systems are ever changing, TEK is also characterized as dynamic (Berkes 1999), and so too are the barriers to TEK transmission. As collaborative researchers we should work towards ensuring that those changes contribute to TEK continuity and evolution in ways deemed appropriate by the community. Specifically, the relationship between Kenya's formal education system and TEK transfer in Samburu is likely to change over time. Various stakeholders and researchers should work with the local schools to legitimize, and integrate with, TEK systems to the extent feasible.

Despite our limited ability to conduct fully participatory research, during the action-oriented side of our work we were able to achieve continuous stakeholder engagement in the development of programs that address TEK erosion.

TEK Revitalization in Practice

"If you want to go fast, go alone. If you want to go far, go with others."

~African proverb

It should be the goal of any community-based research endeavor to produce actionable knowledge, and to even initiate action when it is appropriate. If the objective of our study was

only to confirm or refute the suspicions of local people it would not have been of much importance to the community. Instead it was the process of exploring the TEK erosion problem and potential solutions, with various community members that made this a meaningful endeavor. By engaging well-positioned community-members in both research and project development we ensured that the TEK erosion problem was of personal interest to those with the capability to address it.

Vegetation Guide for Samburu, Kenya

After our first field season we published a plant identification guide (Figure 3.4) that focused on *Samburu* and *Turkana* ethnobotanical knowledge. Over the course of several weeks our research team went on innumerable field visits with local plant experts and a botanical expert from the University of Nairobi to photograph and name the most culturally-important species in the area. Of the many dozens of species that we cataloged 25 were selected from lists of important species we had generated over several conversations with groups of elders. While the plant booklet might serve as an interesting guide for tourists and or other outsiders, its intended purpose is to inspire curiosity among Samburu's youth about local ethnobotanical knowledge.

In many ways this would appear to be the work of an 'archivist.' However, our intention was not to record knowledge as an exercise in posterity. A handful of such archival studies of TEK in Samburu already existed, such as that by Bussman (2006) and Nanyingi and others (2008), and much of the information relayed to us during the development of the guide was already represented in these works. Instead, our intention was to stimulate an interest in TEK among students (schools were the primary recipients of these booklets), to legitimize TEK by

presenting it in book form, and to garner buy-in by producing a field guide with content that was heavily influenced by local people. We do not yet know whether the booklet was effective in this regard, but when we distributed it around the community it was met with broad appreciation. In fact showing people this book frequently helped our team establish trust among project and research participants.

We ended up with much more plant information than we could represent in the field guide so the local guidance committee and myself decided to create a social media page (Facebook.com: “Samburu Plants”) that is managed by the research team. It is meant to be a forum for conversations about Samburu's ethnobotanical resources, mostly among community members. The hope was that Samburu youths could use this as a way to engage with TEK as they continue to pursue 'digital' lifestyles. We were extremely diligent in collecting community members' opinions about creating the page, making sure they were aware of some of the possible implications of putting traditional knowledge online, and the idea was still met with unanimous support. However, I still have several ethical reservations about the continued development of this page. For one, I am concerned about sharing the intellectual property of our informants in a forum that is open to the entire world. There is a, albeit small, risk that outsiders could use the information from this page to exploit some of the community's botanical resources. Moreover, it is not my own knowledge to share, and I am not sure that there is any amount of approval from the community that could make me feel comfortable about publishing it. For now, it floats in cyberspace, and it has evolved into a space for advocating plant conservation in the community.

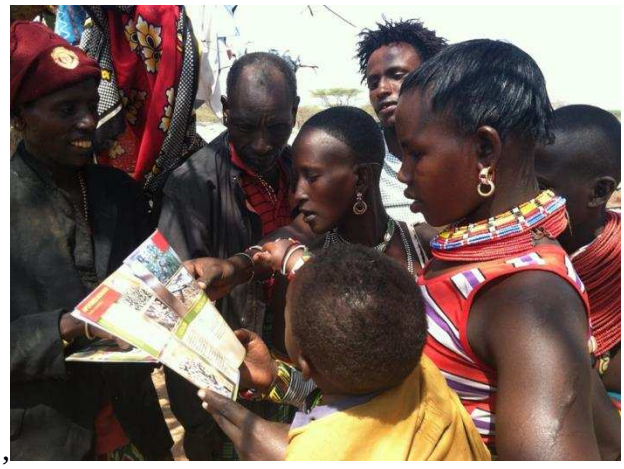

Figure 3.4. "Vegetation Guide for Samburu, Kenya." This reference booklet highlights both botanical and traditional knowledge about local species. Groups were noticeably more willing (and often excited) to participate in our research and projects after seeing the guide.

"Bush Camp!"

If our project/research group had a flagship program, it would have been "Bush Camp" - which took a great deal of planning to get off the ground. In our original proposal we had envisioned a day-long field trip for a small group of students, either in SNR or one of the nearby conservancies (Figure 3.5). The idea was to bring students who had shown strong leadership in their classrooms to botanically diverse areas and have local elders give lessons about TEK, and conservancy staff to teach locally relevant land management strategies. When I brought this idea back to our project planning committee in Samburu the design soon became much more ambitious. We invited staff from SNR, Save the Elephants (STE), Kalama and West Gate conservancies, a local conservation NGO, and the local schools, in addition to local community leaders. As we walked through the budget it became apparent that we could host a three day, two night adventure for a group of students if we pooled our resources. Some of these groups (including the Kenya Wildlife Service (KWS), which came on board later in the project's

development) had already hosted experiential education programs, but had done so largely on their own. By bringing everyone together we were able to craft a more holistic educational experience that incorporated traditional plant knowledge, wildlife conservation, rangeland restoration, sustainable land management and cultural celebration. The cost to each organization was significantly less than it would have been if they had taken on the task with minimal partnership. In fact, subtracting those in-kind contributions such as borrowed tents and waived park entrance fees, and a one-time purchase of mattresses, the entire cost of the program was less than $500 (mostly food and transportation). Half of that price was gladly covered by STE, and there were other organizations such as KWS and the Kenya Forestry Service that expressed an interest in being more directly involved next year. So the continuation of Bush Camp seems likely at least in financial terms, and we certainly built a great deal of organizational capacity over the pilot run.

Figure 3.5. "Bush Camp." Fifteen select students take notes about local plant uses with instruction from a park ranger and local plant expert (left), and enjoy a rare opportunity to spot wildlife with conservationists from Save the Elephants on a walking safari (right) in Samburu National Reserve.

“Elders in Schools”

Our most promising, potentially sustainable, and impactful project was also our simplest and most cost effective. Throughout our research it was apparent that the lack of dialogue between the elders and educators underpinned much of the TEK erosion issue in schools. To address this, we facilitated a conversation between a group of elders and a group of educators with the intention of conceiving a way to expose students to local ethnobotanical knowledge. The group decided it made the most sense for the elders to periodically visit each school with samples of plants and put on ethnobotanical/cultural lessons. The elders, many of whom spent most of their days sitting in the shade, had earlier complained that their expertise was rarely sought out, and took the opportunity to impart their knowledge very seriously. To kick off this 'elders in school' project we went with some of these elders on a plant collection excursion and helped them get acquainted with the faculty of the local schools (Figure 3.6). We then accompanied them to each school where they lead after-school lessons, where our research assistants occasionally chimed in with their own knowledge and insights. This was about the extent of our involvement, the elders and educators soon assumed full leadership, and it seems like this will be something that they will continue to do on their own volition. This was a perfect lesson in the potential of collaboration; all that this really took on our part was the recognition that these two groups needed to spend time talking about a particular issue of mutual concern.


Figure 3.6. "Elders in Schools." A member of our research team introduces a group of plant-expert elders to students at Muslim Primary School in Archers Post (left). One of those elders prepares to cross the Waso Nyiro River with another member of our research team after collecting plant samples for one of the lessons (right).

Conclusion

The relationship between the formal education system and intergenerational TEK transmission in the Waso Ward is complex and dynamic. Young people in this Samburu community are caught between two worlds, that of nomadic pastoralism and that of 'digital' modernism. The continuity of TEK among those who pursue a formal education may rely, to some extent, on local community members (and especially educators) recognizing the barriers to TEK transmission. This can be an important role for us as outsiders, to seek out, make sense of and call attention to such barriers through community-based research. However, TEK continuity is ultimately the charge of those communities in which the knowledge has evolved. When it is appropriate researchers and development professionals can assist communities in maintaining

TEK continuity by helping them recognize their existing collaborative capacity and by instigating meaningful, impactful project development.

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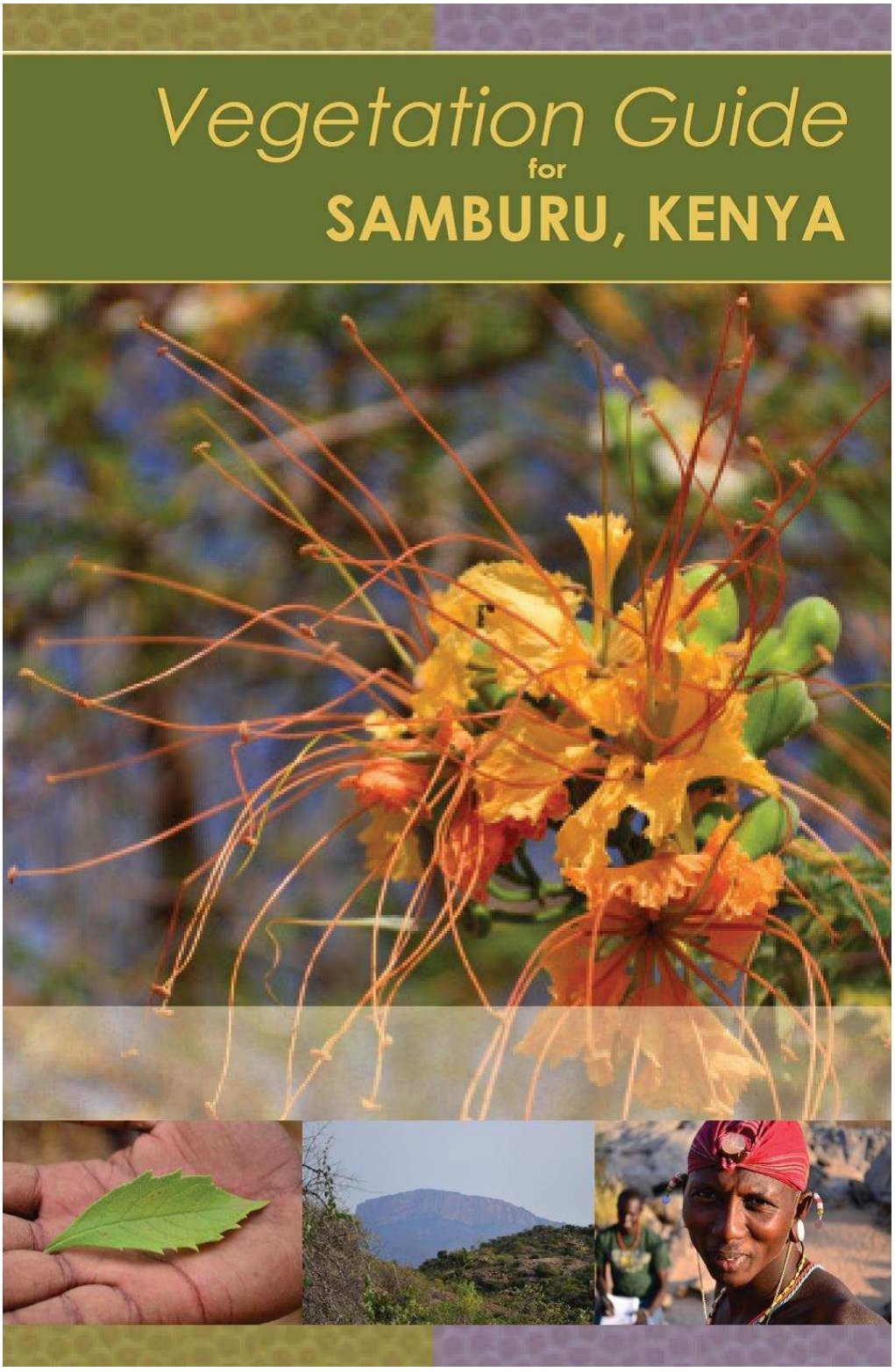
APPENDIX A: VEGETATION GUIDE FOR SAMBURU, KENYA



INTRODUCTION

The purpose of this guide is to serve as a resource about culturally valued vegetation species in the Samburu region of Kenya. The guide is also intended to document knowledge about the landscape gained by generations of pastoralists in the region. In addition to biological data, this guide includes information about historically traditional uses of various species for medicine, as building materials, for livestock and other uses.

This guide was produced in response to an expressed concern by people in Samburu about the need to conserve the local environment, especially species with high significance to the region's pastoral people. Information for this guide was gathered through conversations with elders, plant experts, and manylocal people. We hope this guide inspires people to conserve the natural environment in Samburu for all of its cultural and scientific value.

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PHOTOS

Apin Yasin: Ngalayoi (all photos), Ngirman (all photos)
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Find out more or contribute your own information on our Facebook page: **"Samburu Plants"**

LPARUAI

Scientific: *Hyphaene thebaica*

BIOLOGICAL INFO

An unusual palm (17m), with multiple, forked branches

Habitat:
Riparian areas

Leaves:
1.2 x 1.8m, fan shaped, divided into long segments

Bark/Branches:
Dark grey, covered with old leaf shells at base of crowns.

Flowers:
Small, on finger-like structures with a texture like fish scales, several structures to a stem

Fruit:
Yellow to brown, hardens and falls, fist sized

LOCAL USES

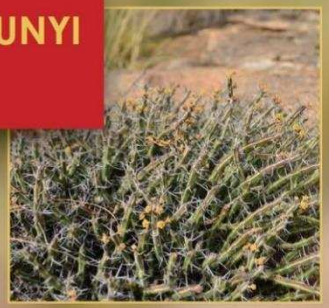
The Doum palm is primarily used for construction. Its wood, while too fibrous to saw can be used for heavier construction, such as in retaining walls. Some people use it for fire fuel or charcoal, but the practice is discouraged as the plants are becoming more rare.

A slow grower, it may take over 18 years before a trunk starts to form. The fruits are highly prized by people and animals alike, being a favourite food of baboons. The leaves can be thatched into roofs for homes, or *manyattas*. They are also used to make brooms.

Edible fruit of Lparuai

MPOPONGI NOMUNYI

Scientific: *Euphorbia sp.*



BIOLOGICAL INFO

Succulent bush (30cm), short and dense

Habitat:
Dry, forested areas, rocky areas

Leaves:
None

Stems:
30cm, branched, succulent green/purple stems

Spines:
Groups of 4, 2 large (2cm) & 2 small

Flowers:
Small, yellow at stem tips, paired above spines

Fruit:
3-lobed, on pedicels

LOCAL USES

There are two types of Mpopongi Nchelelit (*Euphorbia heterochroma*) and Nomunyi (*Euphorbia sp.*). While the larger Nchelelit is also a medicinal species it is not used as frequently as Nomunyi. Mpopongi nomunyi is used as a treatment for ailments of the respiratory tract isuch as asthma and sore throats.

Preparations differ, but most involve removing the thorns, cutting or crushing the stem into a liquid then boiling and drinking the bitter tasting mixture. It is also used as a treatment for skin rashes. Monkeys have been observed eating the plants as well, reportedly, to treat their own colds.

SAKURDUMI

Scientific: *Kedrostis gijef*

BIOLOGICAL INFO

Climbing vine, 5m

Habitat:
Varied soils, at base of trees or rocks

Leaves:
8cm, heart-shaped with 3-5 lobes, wavy edges

Stems:
Light grey, rope-like, cross-section 6-sided

Flowers:
Yellow;
Male: pedicels (2-9mm);
Female: 2.5-6.5mm, alone or in small clusters

Fruit:
1.5 cm, green with light stripes

LOCAL USES

Sakurdumi, known to the Turkana as *Ekitoi lolkwan*, is commonly used to treat upset stomachs. The roots are soaked, boiled (sometimes with Lngiriai) and then consumed, or used as the liquid for an enema. This is said to help remove diseases and gas.

Sakurdumi is also used to clean out the placenta, and prevent infection after a woman gives birth.

SUKUROI

Scientific: *Aloe secundiflora*

BIOLOGICAL INFO

Succulent shrub (30cm), star-shaped, growing in clusters

Habitat:
Rocky areas

Leaves:
30 cm, opposite, succulent, triangle-shaped, toothed edges, green/red with lights spots

Flowers:
Racemic on branch (1m), red and yellow, tubular

LOCAL USES

The dried leaves of Sukuroi, which can often be found attached to the plant, are soaked for a day or more in water that is to be consumed. This simple mixture is said to treat a wide range of ailments including fever that is associated with malaria, yellow fever and stomach problems.

The fluid of *Echuchuka* (Sukuroi's Turkana name), bled from its leaves, can be applied directly to wounds to quicken the drying process and keep flies and parasites away. The same liquid is given to goats to treat their chest diseases. Children frequently play with the stalks of flowers and dried seed pods.

NGALAYOI

Scientific: *Kedrostis sp.*

BIOLOGICAL INFO

Climbing vine (over 3m)

Habitat:
Dry soils near trees/rocks

Leaves:
Obovate, 3-lobed, somewhat hairy

Stems:
Square in cross-section

Fruit:
1-2cm, oval

LOCAL USES

This plant is regarded as one of the most important medicinal species in Samburu. It closely resembles Sakurdumi and some of their uses may be confused.

Ngalayoi may be used to treat stomach problems and symptoms of malaria. It is used by men as a stimulant of sorts at times when they "need extra strength" (ngolon). Most treatments involve boiling and soaking the root material and incorporating it into a soup. However, for chest congestion, eye problems and headaches people may grind the roots and sniff them through the nose.

The fruits, known as ikelelua, are enjoyed by children. Ngalayoi is also eaten by both domestic and wild herbivores.

LMARGUAT

Scientific: *Croton megalocarpus*

BIOLOGICAL INFO

Large tree (30m), spreading crown

Habitat:
Mountains, moist soils

Leaves:
10cm, Lanceolate/eliptic, underside silver/hairy

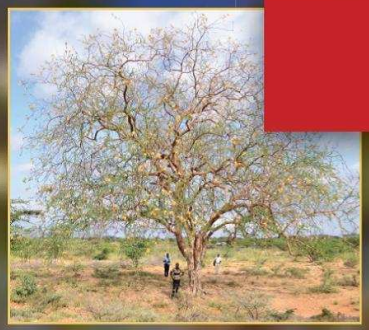
Bark:
Dark grey, rough

Flowers:
Racemic, tufted, yellow

Fruit:
Round, hard, bumpy, 3 seeds

LOCAL USES

This plant is an important medicinal species for people who live in mountainous areas. Its roots or bark are crushed and boiled into a tea which may be used to treat children's colds, malaria, fever, and stomach problems. It may also be used to treat wounds. The leaves can be browsed by domestic and wild herbivores.



LAWAI

Scientific: *Delonix elata*

BIOLOGICAL INFO

Tall tree (up to 15m)

Habitat:
Near streams and gullies

Leaves:
Bipinnate, 10-14 leaflets, 3+ pinnae (divisions of leaf)

Bark:
Smooth, flaking, pink and grey

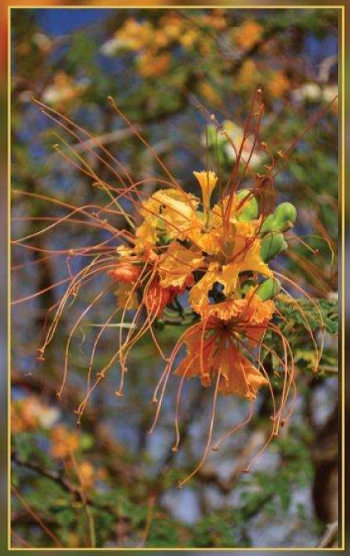
Flowers:
8cm, racemic, white/yellow petals, red stamens.

Fruit:
Long 15+cm, flat pods

LOCAL USES

This large, colourful tree has edible green fruits which are enjoyed by monkeys and people. Its twigs are also edible and may be used as a toothbrush.

Lawai's leaves and dried seeds are highly nutritious for domestic and wild herbivores. The wood may be used for walking sticks, fuel and for making bells to tie around cows' necks. Bee hives from mature trees are said to produce some of the best honey. Pregnant women use Lawai to make their baby more comfortable inside the womb and to remove a stubborn placenta after birth.



SESIAI

Scientific: *Acacia elatior*

BIOLOGICAL INFO

Large Tree (25m), spreading crown

Habitat:
Near rivers

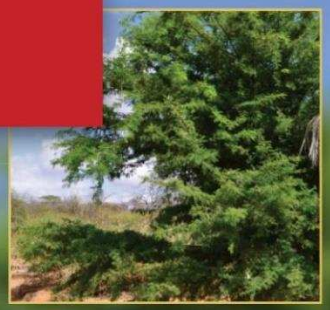
Leaves:
1-6cm, bi-pinnately compound

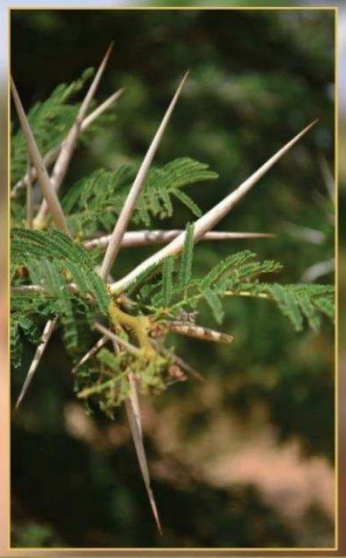
Spines:
1 type, up to 9cm, white, swollen, forming at base of leaves (stipular)

Bark/Branches:
Dark brown. Young branches reddish

Flowers:
White, round ball-shaped heads

Fruit:
3-12 cm, flat, straight pods, brown or purple-brown





LOCAL USES

This important acacia tree is used for home construction, fencing and feeding goats and other livestock. To treat an upset stomach people soak the bark and drink the leftover water. The pods are an excellent source of protein for animals. Sesiai is a nitrogen fixing tree that fertilizes riparian soils in addition to stabilizing them. Sometimes, certain types of ants may even live in the swollen thorns, acting as body guards for the plant, attacking large herbivores such as giraffes or gerenuk.

LDEPE

Scientific: *Acacia nubica*

BIOLOGICAL INFO

Tall bush (1-5m) funnel shaped, flat top

Habitat:
Drylands, near streams and gullies

Leaves:
3cm, pinnate 5-15 pairs of leaflets

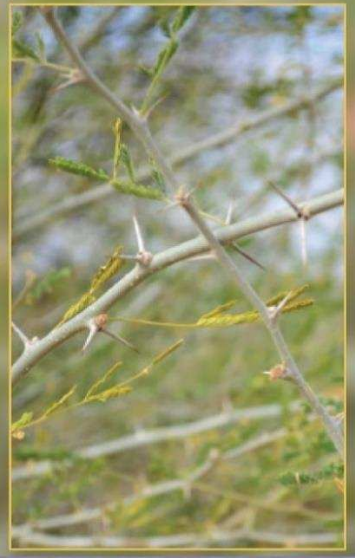
Spines:
1 type, less than 2cm, straight, stipular in pairs

Bark:
Branchlets light grey or light green

Flowers:
White or light yellow, in balls along stem

LOCAL USES

When Ldepe bark is soaked for several hours the leftover water (or tea) is consumed by the Samburu people to treat a number of afflictions. These include the aches and pains associated with malaria and yellow fever, polio, hepatitis and gonorrhea. It is also taken to relieve cold-like symptoms and relieve discomfort during menstruation. It is perhaps most commonly used to strengthen joints and relieve joint pain. A bath in the bark-infused water can also be used to treat trypanosomiases in livestock. The thorny stems make it useful as fencing and, in combination with its odorous leaves, they help deter herbivores. However, it is still a favourite food of giraffes.



LTEPES

Turkana: Lteer
Scientific: *Acacia tortilis*

BIOLOGICAL INFO

Tall tree or bush (20m), spreading crown

Habitat:
Widespread, dry or wet soils

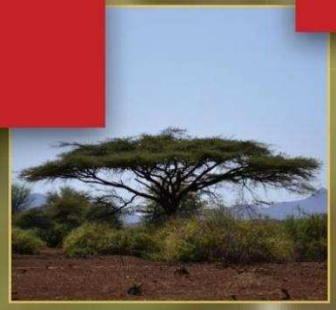
Leaves:
2.5 cm, Bipinnate

Thorns:
Two types: long-straight-white, and short-hooked-dark

Bark/branches:
Dark brown or grey

Flowers:
Round heads, white, fragrant

Fruit:
Coiled seed pods



LOCAL USES

Ltepes, or *Lteer* in Turkana is one of the most common and important trees in Samburu. Its wood is used extensively in daily life for fencing, home construction, and fuel for fires.

The sticky gum is strong enough to hold branches together for setting a broken arm or leg. The inner bark may be used as a rope to tie wandering livestock, or to irritate an animal's backend to make them walk faster. The green seed pods, known as Sagaram, are high in protein. Many herders rely on them to feed their animals during the dry season and they can be boiled into a porridge for children. To reduce constipation in humans the inner bark is soaked and the water drunk.

Ltepes Tree Conservation

A concern among some Samburu people is deforestation of Ltepes. This can be addressed through a simple technique, used by Samburu elders, of cutting or pruning the bottom branches, and leaving the top part of Ltepes to grow. The top part will continue to grow and provide shade to people, animals and grasses. A responsibly-pruned tree will provide lower branches for use year after year.

BEFORE

AFTER

Only the bottom branches are pruned so that the tree remains healthy for next year

Bushes can be pruned into trees

Proper pruning of Ltepes bush will enable it to grow into a tree. Through these three simple steps, upper branches will be encouraged to grow and lower branches can be cut and used for benefits to people and animals. Branches can be used for firewood or to construct fencing, or can be left around the shrub to protect it from animals or cut into smaller pieces and used as mulch. This pruning technique also works for Ltepes stumps with shoots and may be used with many other tree species.

Any of these SHARP tools can be used

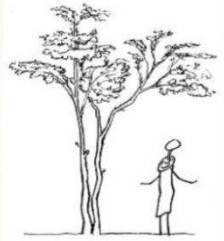
1

1-3 of the healthiest, straightest branches are chosen to prune, which will become trunks. The other branches are cut away completely.

2

The new trunks should be propped or tied so they grow straight up. Then the branches on the bottom half are pruned, and left around the base for protection.

3



The tree needs protection from animals until it grows out of their reach. The bottom branches should be pruned 2-3 times a year.

LORDANYAI

Scientific: *Loranthus sp.*

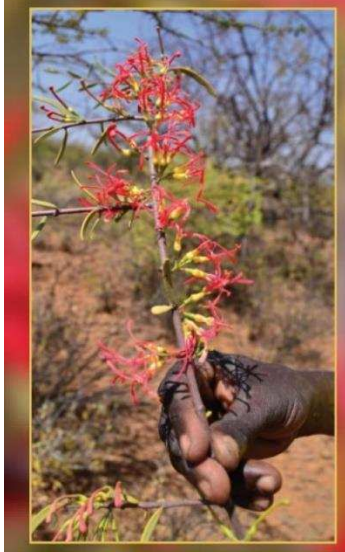
BIOLOGICAL INFO

Parasitic shrub (2m), growing inside the branches of Acacia trees

Habitat:
On tree hosts, such as Ltepes (*Acacia tortilis*), from which they steal water and nutrients

Leaves:
3-7.5cm, oblanceolate, leathery, opposite

Flowers:
3-4.5cm, tubular, red with yellow base



LOCAL USES

This brightly coloured plant is an important food for livestock during the dry season. Herders also use it to increase the fertility of their goats and camels.

It is given to women right after giving birth as a pain killer. A cooked and sieved mixture of the leaves can be used to help clean the birth canal.

LMAKUTIKUTI

Scientific: *Clerodendrum myricoides*

BIOLOGICAL INFO

Large bush (4m), light green

Habitat:
Mountains, wet soils

Leaves:
2-15cm, elliptic, serrate, soft/hairy

Stems:
Soft and hairy

Flowers:
3-4cm, racemic, blue, resemble butterflies

LOCAL USES

Lmakutikuti is reportedly valuable for a number of ailments, including malaria, body aches, and congestion. The plant is also used to treat people with goiters, polio, venereal diseases (gonorrhea), and assists in passing urine.

Preparation techniques differ, depending on how it is used, but root mixtures require extended boiling and a soaking period of 12 days, otherwise Lmakutikuti may be poisonous. In addition to treating some of the above ailments the tea is sometimes combined with sheep's urine to help remove retained placentas (after birth). Dried roots are sometimes snorted to treat headaches.

SILAPANI

Scientific: *Cordia sinensis*

BIOLOGICAL INFO

Shrub or Tree (4-8m), evergreen

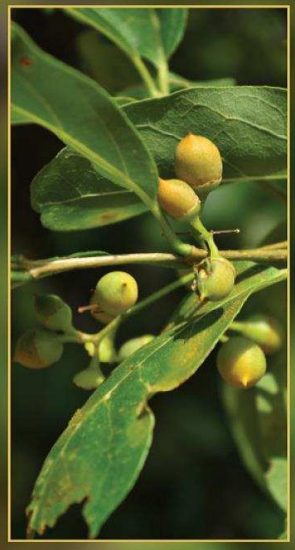
Habitat:
Grassland, wooded areas, stream beds, sandy soils

Leaves:
2-12 cm, Opposite or alternate, obovate or eliptic, glaborous (rough, like sandpaper)

Bark/Branches:
Grey or brown, lenticellate

Flowers:
Small, clustered, 4 petals, white

Fruits:
2-3mm, round, capped, with pointed tip, yellow/red



LOCAL USES

People enjoy the sweet-tasting fruit of Silapani, as do vervet monkeys, baboons, elephants and domestic animals such as goats. The leaves stay green throughout the year, so they are an important source of food for herbivores such as goats, camels and cows during the dry season.

Though its branches are thin, Silapani wood is strong and is used for walking sticks, spears, and supporting poles for *manyattas* (homes).

The bark/roots, soaked for 1-2 days, is said to be able to treat mild coughs and "rib problems" (rib problems may refer to ulcers).

LNGIRIAI

Scientific: *Lawsonia inermis*

BIOLOGICAL INFO

Bush (4m), with leaf-bearing thorns

Habitat:
Wet soils, near rivers and stream beds

Leaves:
1-7 cm, obovate, opposite, light green

Stems:
Act as thorns, white

Bark:
Dark grey/brown, somewhat flaky/cracked

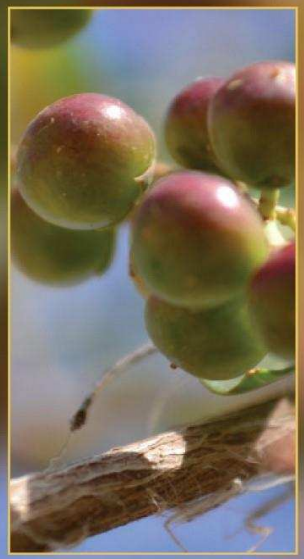
Flowers:
Small, Paniculate, petals red, white stamens

Fruit:
4-6 mm, berries, green and red

LOCAL USES

Lngiriai, known as *Ethajait* in Turkana, is highly valued as a medicinal plant. The roots can be boiled into a tea that, when mixed with milk, can treat a number of stomach ailments. Like Ngirman, the tea, which tastes like quinine, is effective as a laxative, causing diarrhea. Its leaves are eaten by most domestic and wild herbivores, especially camels and goats.

In other parts of the world, its leaves are used to make a temporary dye, called henna, which people use to decorate their skin.



NGIRMAN

Scientific: *Hildebrandtia sepalosa*

BIOLOGICAL INFO

A short bush (1.5m)

Habitat:
Rocky soils

Leaves:
Small, spathulate

Bark:
Grey or brown, with swollen white bumps

Flowers:
Small, tubular

Fruit:
Globose on pedicels

LOCAL USES

This plant's bark is frequently used in a tea that induces diarrhea, to reduce constipation or remove unwanted substances from the digestive tract. It is known to kill certain parasitic worms in the body. Ngirman has been identified as one of the most important plants for pregnant women, easing stomach discomfort during childbirth. Some people report using ngirman to treat malaria and spleen problems.

Ngirman is an important browse plant for goats, sheep, cows, donkeys, camels and wild herbivores such as dik diks.

SEKETET

Scientific: *Myrsine africana*

BIOLOGICAL INFO

Shrub or bush (1-2m), evergreen, small leaves

Habitat:
Dry soils, wooded areas

Leaves:
1-3mm, ovate, serrate tip

Bark:
Light-grey, brown branchlets

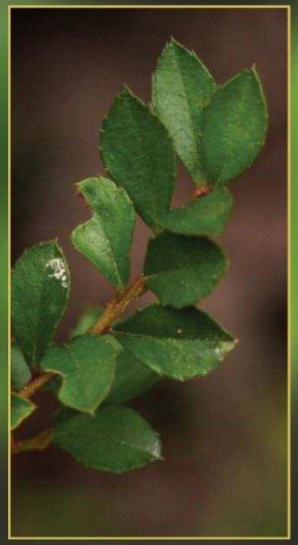
Flowers:
Very small, clustered, light-green or pink

Fruit:
Small berries, purple

LOCAL USES

This shrub is important for killing parasitic worms. People use it to treat themselves for amoebas and intestinal worms, and to treat typhoid and malaria. For amoebas the berries are crushed into a powder and mixed as a tea. It can also be used to dry wounds and prevent pus formation.

Seketet is also used to bring strength to someone who has broken a limb. A concentrate of its leaves can be used to treat spinal and joint pain.



OTHER NOTABLE PLANTS

LDUPAI
Sanserveria intermedia

This succulent plant grows in dense clusters. Unlike Sukuroi (***Aloe secundiflora***) its leaves are round and straight, reaching over 1.5m in height.

Its fibrous leaves are used for making ropes. Thick clusters of Ldupai can form protective nurseries for other plants that would otherwise be eaten by herbivores.

LKIRIANTUS
Plumbago zeylanica

This colourful shrub, with clustered leaves and pale-blue flowers is found in the shady, fertile soils of protected areas along rivers.

Its roots may be used to treat malaria and certain stomach problems.

LPIRENTAI
Adenium obesum

This vibrant tree, known elsewhere as the desert rose, is extremely poisonous. There are reports of people dying from mistakenly eating its bright red petals.

Its boiled bark has been used as a poison for spear tips.

OTHER NOTABLE PLANTS

LPUPOI
Grewia villosa

One of many large bushes in the *Grewia* genus, Lpupoi has soft, hairy leaves which are generally larger than those of similar species.

The plant can be used by pregnant women when they feel sick. It is also used to treat certain stomach problems. The small, sweet fruits (Lgogomi) are eaten by both people and animals.

LTERGESI
Acacia senegal

This common tree is found throughout Samburu, especially in degraded areas where Ltepes (***Acacia tortilis***) and other trees have been suppressed. It is generally shorter than other Acacia trees, with small hooked thorns and purple stems.

People soak the inner bark and drink the tea to treat stomach problems. The branches are used for fencing and as fuel wood for cooking fires.

MPOPONGI NCHELELIT
Euphorbia heterochroma

This leafless succulent somewhat resembles Sakurdumi, Ngalayoi and Sakurtuti, however its ridges have paired white spines between yellow and red flowers. It is much larger than Mpopongi Nomunyi, with square stems that grow well over one meter in height.

The uses for Mpopongi Nchelelit are often confused with those of Mpopongi Nomunyi, but its only clear medicinal use is to treat gonorrhea.

OTHER NOTABLE PLANTS

NKATARAKUI
Myrothamnus flabellifolius

The "resurrection plant," Nkatarakui is found growing in exposed rocky areas on hilltops. During the dry season its leaves dry up and turn dark brown, appearing completely dead. Remarkably, within an hour after a substantial rain the 'dead' leaves uncurl and turn bright green.

Its fragrant dry leaves are steeped and consumed as tea.

SAKURTUTI
Cissus quadrangularis

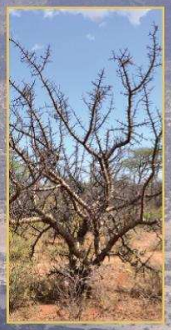
This succulent, climbing plant is frequently confused with Sakurdumi (***Kedrostris gijef***) and Mpopongi Nchelelit (***Euphorbia heterochroma***). Its stems are square in cross-section, and its leaves are split into only three lobes (Sakurdumi has hexagon shaped stems and its leaves can have five lobes). It lacks spines, whereas Mpopongi Nchelelit is covered in spines.

Its roots may be used to treat certain liver ailments in both humans and cattle.

SUMANDERI
Commiphora schimperi

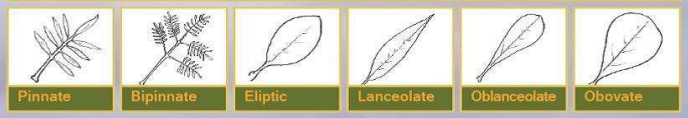
One of the larger *Commiphora* plants in the Samburu area, Sumanderi has a white/yellow flaking bark. Its large spines are modified stems which produce leaves in the wet season.

Sumanderi excretes a sap that is picked directly from its stems and chewed as gum. The spiny branches are useful for fencing. If cut with a sharp tool the branches can be re-planted to grow into new trees as a 'living fence.'

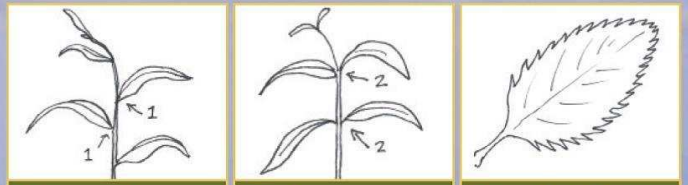


TERMINOLOGY

Leaf shapes



Leaves



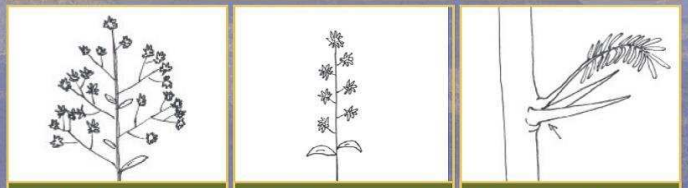
Alternate: one leaf growing from each point on stem.

Opposite: pair of leaves growing from same point on stem.

Serrate: leaf edge that resembles saw teeth.

Succulent: thick and full of water.

Flowers



Paniculate: flowers grow on multiple branches

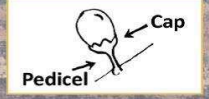
Racemic: Flowers grow from a single stem

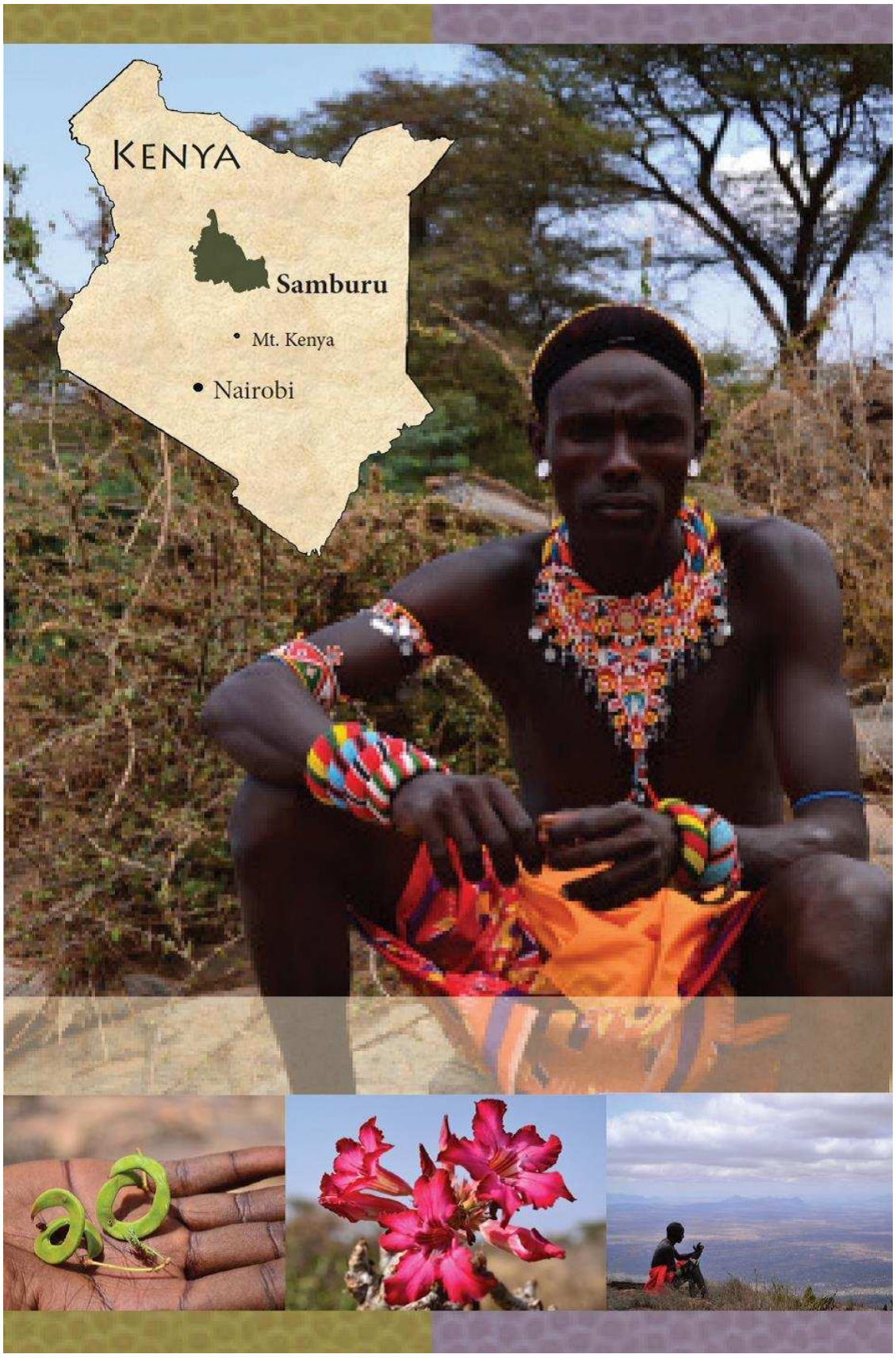
Tubular: flowers that are long and hollow in shape.

Spines

Stipular: growing at base of leaves

Fruit




KENYA
Samburu
Mt. Kenya
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