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USE OF SPECIALIZED QUESTIONING TECHNIQUES TO DETECT DECLINE IN GIRAFFE MEAT CONSUMPTION

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Use of Specialized Questioning Techniques to Detect Decline in Giraffe Meat Consumption

Biodiversity conservation depends on influencing human behaviors, but when activities are illegal or otherwise sensitive, actors can be hesitant to admit engagement with illicit behaviors. We applied Specialized Questioning Techniques (SQT) to estimate and compare behavioral prevalence of giraffe meat consumption between direct questioning and two SQTs, Randomized Response Technique (RRT) and Unmatched Count Technique (UCT), from 2017 to 2019. Comparisons between the two samples yielded significant differences across all three methods, with confidence intervals distinctly divergent between years. The significant disparity between the two samples for all three methods suggests that there was a true reduction in giraffe meat usage from 2017 to 2019. A key change in the study area between the two time periods was the introduction of a community-based program for giraffe conservation. Primary program activities, including ecological monitoring, community outreach and education, and collaboration with wildlife security teams, align with other conservation programs that have demonstrated reduced poaching pressures. This study demonstrates an application of SQTs to detect a decline of giraffe meat consumption, providing an alternative to self-reported data for monitoring sensitive behaviors related to direct exploitation and illegal uses of wildlife.

Keywords: unmatched count technique; randomized response technique; giraffe; wild meat; consumption

1. Introduction

Overexploitation of wildlife from unsustainable hunting poses a direct threat to global biodiversity (Hoffmann et al., 2011; Schipper et al., 2008). Unsustainable hunting has caused declines in a range of species (Rogan et al., 2017) and across entire taxa, like birds (Szabo et al., 2012) and mammals (Ripple et al., 2016). Wild meat (otherwise referred to in the literature as bushmeat) hunting is one form of direct exploitation (Milner-Gulland & Bennett, 2003), and can be defined as non-domestic terrestrial animals that are harvested for food (Nasi et al., 2008). Along with negative pressures on biodiversity, wild meat practices are tied to a range of social impacts (Cooney et al., 2015). As many people in rural areas rely on wild meat for protein or income, wildlife population declines are also cause for human development concern (Fa et al., 2003, 2015). Further, policies that regulate wild meat use are tied to health, social, and economic implications, as seen recently with the Ebola virus disease outbreak (Bonwitt et al., 2018) and COVID-19 (Booth et al., 2020; Watsa et al., 2020).

Many African countries have responded to biodiversity declines that are tied to wild meat and corresponding social impacts by establishing and enforcing regulations that ban or permit hunting (Lindsey et al., 2013b). Impacts from illegal and unsustainable wild meat hunting are differentiated from policies on legal harvest of meat produced and managed on ranches and communal lands in southern Africa (Funston et al., 2013; Lindsey et al., 2013a). As there is growing evidence of the threat that unsustainable wild meat hunting poses to biodiversity in African savannas, there is need for concerted efforts to research dynamics of wild meat hunting and consumption in savanna ecosystems, as well as the interventions aimed to mitigate associated impacts (van Velden et al., 2018; van Velden et al., 2020).

1.1 Wild Meat Consumption as a Threat to Giraffe

Across sub-Saharan Africa, total numbers of giraffe (*Giraffa* spp.) have been reduced by 30% over the past three decades (Giraffe Conservation Foundation, 2019), but there is variance in population trends for different giraffe species and local populations (Muller et al., 2018). Though southern giraffe (*Giraffa giraffa*) populations are mostly stable or increasing (Marais et al., 2018), there have been overall declines of giraffe in East Africa. This includes an approximate 50% decrease in populations of both reticulated giraffe (*Giraffa reticulata*) (Muneza et al., 2018) and Masai giraffe (*Giraffa tipppelskirchi*) (Bolger et al., 2019). Primary reasons for giraffe population declines include loss of habitat from degradation, development, and land conversion, as well as overexploitation from illegal hunting (hereby referred to as poaching) (Muller et al., 2018). Though poaching has been identified as a key threat, the use and trade of giraffe parts and products are not well understood. In 2019, based on the precautionary principle, all giraffe species were placed on Appendix II by the Conference of the Parties to the Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES). However, varying giraffe population trends based on species and regions, as well as the diverse regulatory contexts in giraffe range counties, highlight the need to understand relevant threats for giraffe at local and national levels. Furthermore, the preliminary research of Dunn et al. (*forthcoming*) showed that giraffe meat is the most common giraffe product used in East Africa. There is a clear need for research on consumption of giraffe, particularly giraffe meat. In addition, there is an overall lack of research into wildlife consumption in Kenya, relative to work based in the forest biomes of Central Africa (Fa and Brown, 2009; Lindsey et al., 2013a).

There is also a limited understanding of effective Specialized Questioning Techniques (SQTs) for assessing prevalence of behavior, in general in conservation (e.g. Nuno & St. John, 2015). It is therefore necessary to work toward finding and refining methods that can be effectively used to investigate wildlife consumption prevalence. Outcomes of such research are relevant to conservation policy and practice, as they serve to identify areas in which giraffe part usage poses a higher relative threat. In addition, using appropriate SQTs can help to more accurately evaluate the impacts of on-going conservation interventions aimed at reducing behaviors such as the poaching and use of parts, and evaluation on efficacy of conservation initiatives is needed to ensure time and money are well-spent (Veríssimo et al., 2018; Veríssimo & Wan, 2019).

The purpose of this study is to accurately estimate the prevalence of reticulated giraffe meat use in northern Kenya, between 2017 and 2019. This type of research into part consumption, as well as the levels of giraffe poaching, is embedded in some countries' conservation management strategies. Reticulated giraffe, which are limited in range mostly to northern Kenya (O'Connor et al., 2019), have special considerations in Kenya Wildlife Service's (KWS) National Recovery and Action Plan for Giraffe. In their plan, a key conservation target is to "reduce the proportion of giraffe illegally killed by 50% [by 2022]" (KWS, 2018, p.31). Ability to monitor progress toward this goal rests in part on the application of appropriate methods for measuring giraffe poaching and related consumption.

1.2 Sensitive Behavior and Conservation

Rules that limit or restrict human use of natural resources is a frequent practice in conservation policies and programs (Keane et al., 2008). A lack of data on non-compliance with conservation rules hinders collective understanding of motivations for both rule-following and rule-breaking, and in turn, conservationists' ability to address non-compliance issues. The illicit nature of poaching and illegal use of wildlife products means the actors involved are reticent to identify themselves (Solomon et al., 2007). Alternative methods to direct questioning can reduce the errors associated with social desirability and non-response biases (Gavin et al., 2010; St. John et al., 2010). Methods such as Randomized Response Technique (Warner, 1965) and Unmatched Count Technique (Droitcour et al., 2004) add layers of anonymity for research participants and remove the possibility of self-incrimination by respondents.

Randomized Response Technique (RRT) uses a randomization device, such as a dice, to add an element of probability into individuals' responses. Interviewers instruct participants to direct their responses based on the randomization device (e.g. answer of "yes" when the device prompts that response OR when the device prompts a truthful answer and the individuals' response is "yes"). The device is shielded from the interviewer, so that an affirmative response to a sensitive behavior cannot be deciphered as to whether or not that response was forced by the device. Further, affirmative responses cannot be connected to an individual, protecting respondents from self-incrimination. Prevalence of the sensitive behavior within a sample is estimated using probability theory. RRT has been used in various conservation settings, including studies that estimated levels of illegal killing of carnivores in Taiwan (St. John et al., 2015) and illegal take of natural resources in Uganda (Solomon et al., 2007). Each of these examples produced higher estimated levels of the sensitive behavior than through direct questioning methods. There have also been instances, however, in which RRT did not yield higher estimates of the sensitive behavior. This divergence could occur when the behavior of interest is not perceived to be sensitive, as was the case for illegal wild meat consumption in Madagascar, where regulatory knowledge of protected species was low (Razafimanahaka et al., 2012). Efficacy of RRT can also depend on respondents' understanding of how to operate the randomization device, as well as respondents' level of trust in the technique, as was the case estimating prevalence of bear parts use in Cambodia (Davis et al., 2019).

Unmatched Count Technique (UCT) involves the use of lists to isolate the sensitive behavior in question. The sample is evenly spilt into control and treatment groups. The control group is presented with a list of non-sensitive items. The treatment group receives the same list of items, with the addition of the item/behavior of interest. All respondents are asked to respond with the number of items that are relevant to them, but not to identify which items they are including in their total count. Estimated prevalence is calculated by removing the mean difference of the control group from that of the treatment group. Like RRT, applications of UCT in conservation research have yielded higher levels of sensitive behaviors. Nuno et al. (2013) estimated 18% of households to be involved with wild meat hunting in the western Serengeti, presenting a higher estimate than previous studies in the area. They also reported that the majority of respondents felt the UCT protocols were easily understood. Simplicity in the design of UCT can be an advantage when applying the method in contexts with low literacy or numeracy (Nuno & St. John, 2015). However, UCT is often characterized by high variability, which can make targeted estimates of a sensitive behavior challenging (Davis et al., 2020; Olmedo et al., 2019). Moreover, if a behavior is relatively low prevalence, UCT can also fail (e.g. Ibbett et al., 2019), or as with RRT, if individuals distrust the method, as happened in one site in Davis et al.'s study (2019).

Though SQTs are now increasingly applied in conservation settings, there are limited instances of SQTs used for research in East Africa, and to our knowledge, no published studies that use multiple SQTs to monitor levels of illegal wild meat consumption over time. Therefore, beyond the comparison of SQTs in an East African context, an aim of this study was to trial the application of RRT and UCT as monitoring tools for conservation management of reticulated giraffe in northern Kenya. Prevalence estimates of giraffe meat consumption at multiple time points will, in turn, support regional efforts to monitor the trends of giraffe populations in Kenya. As conservation planning is implemented within dynamic systems, longitudinal studies are important to detect change over time.

2. Materials and Methods

2.1 Study Area

The study area included communities within Naibunga, Ol Dnyiro, and Kirimon Community Conservancies that border Loisaba Conservancy in Laikipia County, Kenya, and villages within the Nalowuon and Ngilai units of Namunyak Conservancy in Samburu County, Kenya. Population estimates within the study areas included 1,400 adults in the communities around

Loisaba and 4,500 adults in Namunyak. The communities sampled for this study were comprised predominantly of Samburu and Maasai ethnicities, with societal practices characterized by semi-nomadic pastoralism (Northern Rangelands Trust, 2019). Though livestock rearing is the primary livelihood for the majority of community members within the study area (Kanyuuru et al., 2017), additional livelihoods include wildlife-based occupations, nature-based tourism operations, and small business ownership (Pellis et al., 2015). These community areas function as collectively owned and governed conservancies, led by locally elected boards and committees. Community conservancies share the landscape with wildlife, differing from government-managed protected areas that lack human settlements. The study area falls within the southern range of reticulated giraffe (O'Connor et al., 2019).

2.2 Data Collection

Preceding data collection, the research team met with community leadership to obtain permission to conduct this study. A questionnaire was used during face-to-face interviews to collect data. Maa is the shared language among community members in the study area. Questionnaire items were originally constructed in English, and then translated to Maa. The translation process was completed by a team of local research assistants, and back-translated to English during the instrument design and pilot testing phases to ensure reliability of item wording. The questionnaire instrument was pre-tested in October 2016. Data were collected from November 2016– July 2017 for the first sample and from July-December 2019 for the second sample. The questionnaire included additional items, outside of the scope in this study, which were less sensitive than questions about giraffe part usage. These non-sensitive items were asked in the beginning of the interview, so the flow of the interview built toward the SQTs.

The direct question (DQ) about giraffe meat consumption was asked in the middle of the interview, along with additional questions about frequency of part usage in each respondent's lifetime and recent nearby poaching instances. During the 2016/17 data collection, the DQ item was presented as, "*When was the last time you consumed giraffe meat or parts?*" (Table 1). In 2019, DQ items concerning giraffe meat and giraffe parts were asked separately and later combined for the purposes of these analyses. Responses for the DQ in both time periods were recorded as categorical variables with the following response options: *never, within the last year, between 1-5 years ago, between 6-10 years ago, more than 10 years ago*. Responses were recoded as a dichotomous variable (i.e. *yes, no*), based on whether the respondent reported to have consumed giraffe meat. Following the demographic information, items for UCT and RRT were asked at the end of the interview, as they required additional instructions and materials. The entire interview lasted approximately 40-45 minutes. Exact wording for the DQ and SQTs items are listed in Table 1.

2.3 Specialized Questioning Techniques Protocol

The interviewer recited instructions for each method and began with a practice question to gauge respondents' understanding. If the interviewer noted a lack of respondent comprehension (e.g. asked numerous questions, revealed which color dice was rolled, or named animals on the UCT cards), the interview was concluded without administering the SQTs.

For UCT, the sample was split into two groups to receive treatment and control cards. Interviewers alternated assignment of control and treatment cards with each interview. Respondents were asked to review a set of cards that listed animals with written names and accompanying pictures. They were instructed to respond with only a number, and refrain from identifying to which animals they were referring. The card used for the control interviews had a set of four animals that included livestock and wild animals; the treatment card included the same animals and the addition of giraffe. Pictures of each animal were used on the cards to account for varying levels of literacy. Animals were selected based on probability of consumption, to ensure the list included items with high likelihood (e.g. goat) and low likelihood (e.g. zebra, which are taboo to consume in Samburu or Maasai communities). These items were selected to avoid floor and ceiling effects, where individuals either answer affirmatively to none of the behaviors or all, thus negating the anonymity of the test (e.g. Hinsley et al., 2019).

Table 1. Item wording for measurement of giraffe part consumption, in order of appearance during the interviews.

Direct Questioning (DQ)	
2016/17	When was the most recent time you used giraffe meat or other parts of giraffe?
2019	When was the most recent time you used giraffe meat? When was the most recent time you used other parts of giraffe besides meat?
Response options	Never, within the last 12 months, between 1-5 years ago, between 6-10 years ago, more than 10 years ago; Recoded as dichotomous (0) no and (1) yes for within the last 12 months
Unmatched Count Technique (UCT)	
I want you to tell me how many of these animals you or a member of your household has eaten in the last 12 months. Please do not tell me which ones.	
Control	Treatment
Goat	Goat
Cattle	Cattle
Dik dik	Dik dik
Zebra	Zebra
	Giraffe
Randomized Response Technique (RRT)	
Have you eaten giraffe meat in the last 12 months?	

To administer RRT, a dice was used as the randomization device. Interviewers asked the participant to shake the dice and keep view of which face the dice landed on within the opaque cup to him or herself. For the 2016/17 survey, the dice contained two red faces, two green faces, and two blank/white faces. There was a 1/3 probability of forced truth responses. For the 2019 survey, interviewers used an adjusted dice that contained one red face, one green face, and four blank/white faces, so that the probability of forced truth was 2/3 of responses. For each question and dice roll, the respondent answered by holding up a paddle with their response as "*yes*" or "*no*".

2.4 Sampling Strategy

Quota sampling was used for this study. Targets for each community and manyatta area (village) were selected based on total household estimates gathered from community elders and conservancy management. The target for total interviews during each survey was set at approximately 600, based on resources available for this study. The research team approached manyatta areas and the surrounding grazing areas to invite study participants.

The majority of the population in the study area had not completed primary school, so based on literacy levels, written consent protocols were not appropriate. Interviewers obtained verbal consent with a protocol that included the purpose of the study, explanation of measures to ensure confidentiality, the voluntary nature of participation in the study, right to cease participation at any time, and contact information for where questions or concerns could be directed. All research team members received training prior to interviews on ethical research protocols. Interview training also included techniques for how to reduce biases during interviews, record data, and instruct participants on specialized questioning techniques. Ethical approvals were reviewed and approved by the Institutional Review Board (IRB# 02156e) of Miami University, Ohio.

2.5 Data Analysis

Estimates for behavioral prevalence of giraffe meat consumption were calculated with the following formulas for each method. For Direct Questioning (DQ), prevalence was calculated as the proportion of total respondents that reported "*within the last 12 months*" as the most recent time they had consumed giraffe meat or parts.

Estimated prevalence from UCT methods was calculated using the formula:

$$\pi = \bar{\chi}_A - \bar{\chi}_B$$

Where π is proportion of the sample that included the sensitive behavior in their list count, $\bar{\chi}_A$ represents the mean list count number given by the treatment group, and $\bar{\chi}_B$ reflects the mean list count of the control group (Droitcour et al., 2004).

For RRT, prevalence of giraffe meat consumption was estimated using the following equation:

$$\pi = \frac{\lambda - \theta}{s}$$

Where π is proportion of the sample that had truthfully reported to have done the sensitive behavior, λ is the total proportion of the sample that reported "*yes*, " θ is the probability of forced "*yes*" responses, and s is the probability that respondents were prompted to respond truthfully (Hox & Lensvelt-Mulders, 2004; Nuno & St. John, 2015).

All data analyses were performed in the software program R (R Core Team, 2016) and figures were created using the package ggplot2 (Wickham, 2016). The package "list" was used for the UCT estimate (Blair & Imai, 2011), and the package "zapstRR" was used to calculate

RRT (Chang & Maarten, 2017). Confidence intervals for 95% were calculated for each prevalence estimate, in lieu of null hypothesis significance testing (Greenland et al., 2016).

3. Results

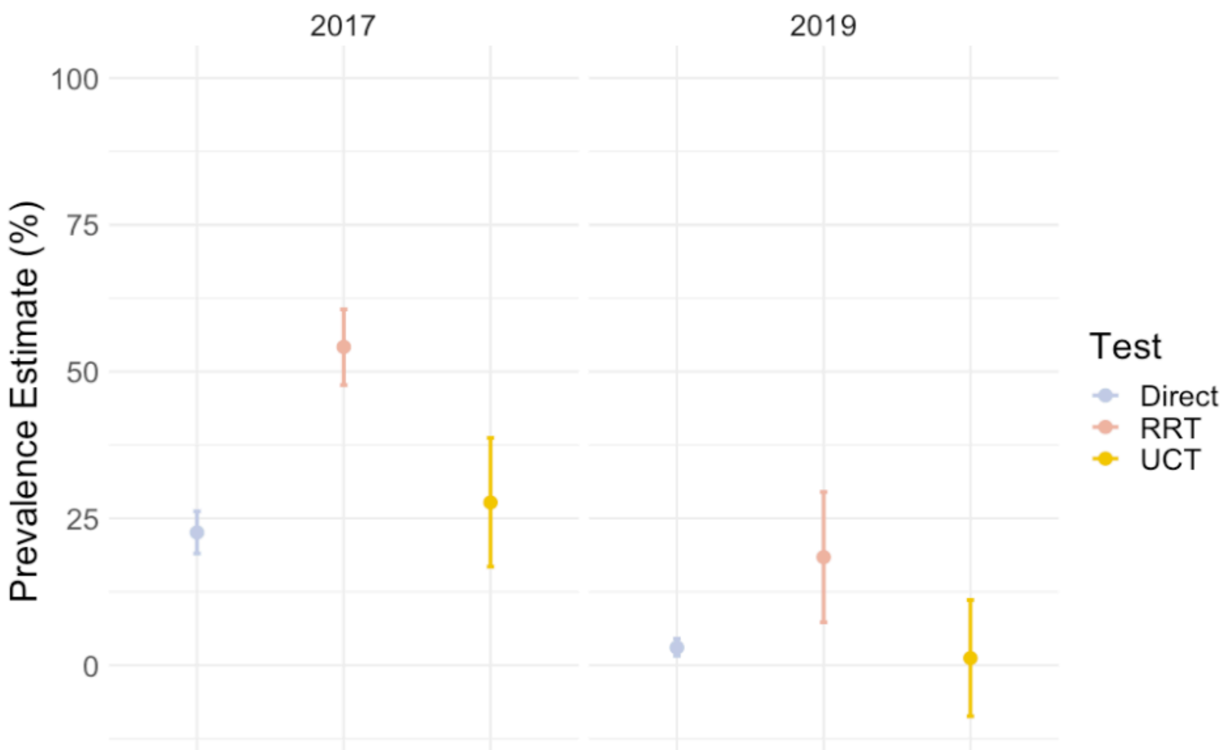
3.1 Sample Characteristics

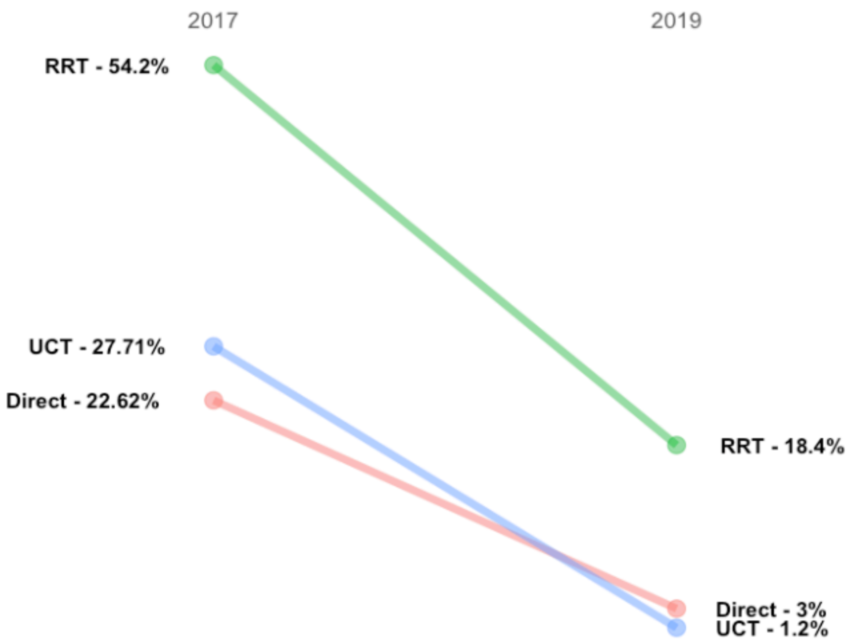
The total sample sizes for direct questioning (2016/17, *n*=526; 2019, *n*=560), UCT (2016/17, *n*=528; 2019, *n*=670), and RRT (2016/17, *n*=519; 2019, *n*=674) were slighter larger in 2019. The estimate for total number of households generated by Namunyak Management increased in 2019, so additional interviews were conducted in that study area. In both years, the gender ratio was close to even, the majority of respondents (~65%) has not completed formal education, the mean ages of the sampled population were 38 and 42, and the most frequent occupation was livestock herder/pastoralist (Table S1).

3.2 Estimates of Giraffe Meat Consumption

The prevalence estimates for both the 2016/17 and 2019 surveys provide a range for the proportion of community members sampled that had consumed giraffe meat within the previous 12 months (Figure 1). For both surveys, RRT yielded the highest estimated prevalence of giraffe meat consumption; the RRT estimate was 54.2% in 2016/17 (CI=47.7%-60.6%; SE=.033) and 18.4% in 2019 (CI=7.3%-29.5%; SE=.056). Direct questions yielded 22.6% prevalence in 2016/17 (CI=19.0%-26.2%; SE=.018) and 3.0% prevalence in 2019 (CI=1.6%-4.5%; SE=.007). The estimates based on UCT estimated the prevalence to be between those obtained through DQ and RRT at 27.7% prevalence in 2016/17 (CI=16.8%-39.0%; SE=.060). Results from UCT then reduced to an estimated prevalence to 1.2% in 2019 (CI=-9.0%-11.1%; SE=.050). Comparisons between the two samples yielded significant differences across all three methods, with confidence intervals distinctly divergent between years (Figure 1).

a)





b)

Figure 1a) levels of estimated prevalence based on direct questioning, randomized response technique, and unmatched count technique methods. Bars depict 95% confidence intervals and b) slope graph depicting the decline in prevalence estimates for giraffe meat consumption between the 2016/17 and 2019 samples.

4. Discussion

We compared estimated levels of giraffe meat consumption by utilizing Direct Questioning (DQ), Unmatched Count Technique (UCT), and Randomized Response Technique (RRT). Based on our findings, there was an observed decline in giraffe meat consumption, as measured through these three methods over the two survey time periods of 2016/2017 and 2019.

4.1 Application of Specialized Questioning Techniques

Estimated prevalence from Specialized Questioning Techniques (SQTs) were higher than the results of Direct Questioning (DQ) for the 2016/17 survey. This difference between DQ and SQTs methods is consistent with other studies (Davis et al., 2019; Solomon et al., 2007; St. John et al., 2010). In this study and in those cited above, face-to-face methods were used for data collection, and the SQTs addressed potential biases from social desirability and non-response. It is possible that those biases do not exert as much pressure when data about sensitive behaviors are not collected in person; for example, Hinsley et al. (2017) found non-significant differences between UCT and DQ, possibly due to their application of a self-administered online survey, which conferred heightened anonymity to respondents. Our higher estimates of giraffe meat consumption from both RRT and UCT in the 2016/17 survey, however, support the utility of SQTs in studies when data collection methods are limited to face-to-face interviews. In a location like northern Kenya, where levels of literacy and access to the internet are variable (Kazi et al., 2017), face-to-face data collection is often most practical and appropriate for obtaining representative samples, so researchers working in similar contexts should consider the use of SQTs for reducing sample biases.

Though RRT outperformed the other two methods during both surveys, the estimates for consumption from UCT were slightly lower than DQ in 2019. Our results suggest that the prevalence of giraffe meat consumption did decline between the two surveys, and the low prevalence of our behavior of interest in 2019 likely affected the utility of the SQTs methods. UCT is not recommended for measuring rare behaviors, as the variances and standard errors associated with this indirect technique are larger than those expected with DQ (Droitcour et al., 2004; Ibbett et al., 2019; Thomas et al., 2015). The low precision of UCT means that large sample sizes are needed (Ulrich et al., 2012), which can still yield wide margins of error (e.g. Davis et al., 2020; Nuno et al., 2013). Though our sample size was lower than some studies that use UCT, there was no overlap in the confidence intervals from the two samples, likely pointing to an actual difference in prevalence of the behavior over time.

4.2 Decline in Giraffe Meat Consumption

We have strong reason to believe that there was a true reduction in giraffe meat consumption between the two survey periods, according to the significant disparity between years in three separate measures of giraffe meat consumption prevalence (Figure 1). The observed decline prompts the question of what caused this change. A key difference between the two surveys was the introduction and expansion of Twiga Walinzi, a community-based giraffe conservation program, in the study areas. The program involves ecological monitoring of reticulated giraffe, community engagement activities, and documentation of locations and suspected causes of giraffe mortalities. It is not possible to discern with existing data which elements of the Twiga Walinzi program instigated change in the study area.

There are, however, aspects of Twiga Walinzi similar to other conservation programs that demonstrated progress toward their intended conservation outcomes (Bolam et al., 2020). Based on information from community leadership, we have reason to believe that giraffe meat is more likely to be sourced from local kills than purchased and transported back to communities within the study area. Thus, poaching events were likely to precede the instances of giraffe meat consumption included in our prevalence estimates. Poachers are less likely to act with increased risk of detection (Leader-Williams & Milner-Gulland, 1993). The regular monitoring performed by Twiga Walinzi, and community members' perception of increased vigilance due to these activities, may have influenced a would-be poacher's decision to act.

The Twiga Walinzi education and outreach activities, including school-based wildlife lessons, community gatherings, and annual festivals, comprise another set of potential influences on levels of giraffe meat consumption. Some studies have demonstrated reduced poaching pressures (Steinmetz et al., 2014), improved knowledge of conservation rules (Keane et al., 2011), and community support for wildlife tolerance (Western et al., 2019), as tied to interventions guided by conservation education and outreach. In addition, conservation jobs becoming simply more embedded within a community may shift social norms against poaching (Biggs et al., 2017).

The observed change in giraffe meat consumption could have been driven (alternatively or collectively) by factors beyond those embedded in the Twiga Walinzi program. Increased law enforcement and prosecution can deter poaching activity. Some studies have shown that illegal activities are inversely related to perceived risk of detection and punishment (St. John et al., 2015). There could also have been fluctuations in food security correlated with drought, or other factors, that influenced use of wild meat in Kenya. There is limited research based in Kenya on the use of wild meat, and whether wild meat is consumed out of necessity, preference, or other motivations. Changes in livelihood practices may have influenced levels of wealth, shown to be connected with wild meat consumption (Mgawe et al., 2012). Ecological factors may have also played a role in reduced consumption. Lower abundance of giraffe or variable movement patterns could decrease opportunities to obtain giraffe meat, although there is currently a lack of published data documenting changes in giraffe population at a scale comparable to this study.

Though program evaluation for Twiga Walinzi is beyond the scope of this study, recent attention and efforts have been put toward evaluation of conservation interventions (Baylis et al., 2016; Bottrill et al., 2011). Counterfactual approaches, which delineate the difference between outcomes of an intervention and those that occur in the absence of the same intervention, come with challenges in practice; namely, observation of a comparable control group can be difficult based on the limited resources of many conservation programs and ethical considerations of engaging with a community as a control (Travers et al., 2019b). For the case of Twiga Walinzi, data to serve as a control has been unobtainable, both in terms of comparable timeframe and social characteristics similar to communities within the program area. Qualitative evaluation offers an alternative approach. In the absence of baseline data, qualitative evaluation can give insights to the causal processes that lead to observed outcomes (Chen, 2012). Salazar et al. (2019) applied qualitative methods, General Elimination Methodology (GEM), to evaluate conservation efforts to protect a threatened parrot species in Bonaire. GEM can be used for evaluation by guiding the development of theories of change with relevant stakeholders and the elimination of alternative explanations to systematically isolate cause and effect relationships (Scriven, 2008). A similar qualitative approach could assess the potential program impacts of Twiga Walinzi and additional factors that have reduced levels of giraffe meat consumption in northern Kenya.

4.3 Limitations of the Study

To note, there are a few limitations to the application and comparison of SQTs in this study. One potential source of error comes from discrepancies in item wording. The first difference is in regard to which giraffe products are included in the three methods. In 2016/17, the Direct Questioning (DQ) item included giraffe “meat or other parts,” whereas the SQTs questions referred to meat only. However, even with the broader scope for the DQ item, the estimated prevalence was lower than the SQTs. In 2019, the reference to meat and other parts were split. Very few instances of part usage were reported, and those cases were combined with the meat DQ to be comparable with the first survey. We therefore believe that the item wording did not have a significant effect on the results.

The UCT item questioned behavior at the household, rather than the individual, level. This may have increased the estimated prevalence by UCT, though the estimate was still lower in

2019 than the other two methods. All three methods used the previous 12 months as a relevant time frame. Recall bias (Junger-Tas & Marshall, 1999) may have introduced error for those that had more difficulty bounding their past behavior within that time frame. In addition, respondents with color blindness could have faced difficulty with the dice and paddles used for the RRT. We could not find information on the rates of color blindness in Samburu and Maasai communities. Finally, factors and covariates associated with part use were beyond the scope of this study, including the estimated prevalence for use of other giraffe parts, motivations for usage, and supply routes.

5. Conclusions

Direct exploitation and illegal uses of wildlife pose serious threats to global biodiversity. The ability to understand and monitor these pressures depends on accurate data regarding human behavior. Specialized Questioning Techniques (SQTs) provide an alternative to self-reported data for information that people may be reticent to share. This study demonstrates an application of SQTs to estimate levels of giraffe meat usage in northern Kenya and detects a decline of giraffe meat consumption after the introduction of local giraffe conservation efforts.

For SQTs to be used for monitoring levels of illegal giraffe hunting and part usage, implementation is required at broader levels. Research efforts guided by Kenya's National Action and Recovery Plan for Giraffe can adapt the methods trialed during this study to provide wider scale estimates of giraffe part use. Such research should also include potential explanatory variables for giraffe meat consumption so that conservation interventions can be designed to address drivers of illegal behaviors (Travers et al., 2019a).

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Supplementary: Comparison of Demographic Profiles

Table S1. Demographics for 2016/17 and 2019 Samples.

Demographics		2016/17	2019
Gender	Male	50.9% (*n*=295)	50.4% (*n*=344)
	Female	49.1% (*n*=284)	49.6% (*n*=338)
Age	Range	18-88	18-90
	Mean	38	42
	Median	35	40
Education	None	65.1% (*n*=377)	65.7% (*n*=445)
	Primary	23.8% (*n*=138)	14.0% (*n*=95)
	Secondary	6.9% (*n*=40)	16.1% (*n*=109)
	University	4.1% (*n*=24)	4.1% (*n*=28)
Occupation	Livestock herder/pastoralist	85.3% (*n*=493)	80.2% (*n*=538)
	Livestock broker	n/a	7.6% (*n*=51)
	Tourism worker	2.8% (*n*=16)	4.2% (*n*=28)
	Business (non-livestock)	5.9% (*n*=34)	4.3% (*n*=29)
	Wildlife-related	0.6% (*n*=4)	2.1% (*n*=14)
	Other	5.4% (*n*=31)	1.6% (*n*=11)

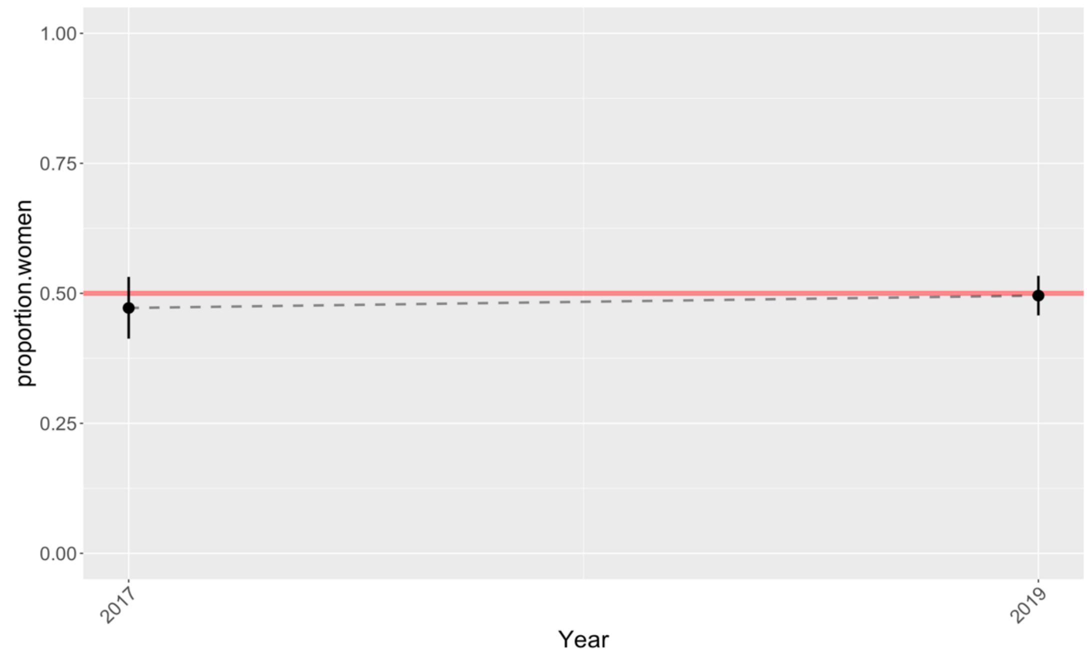

Figure S1. Proportion of Female Respondents in 2016/17 and 2019**.**

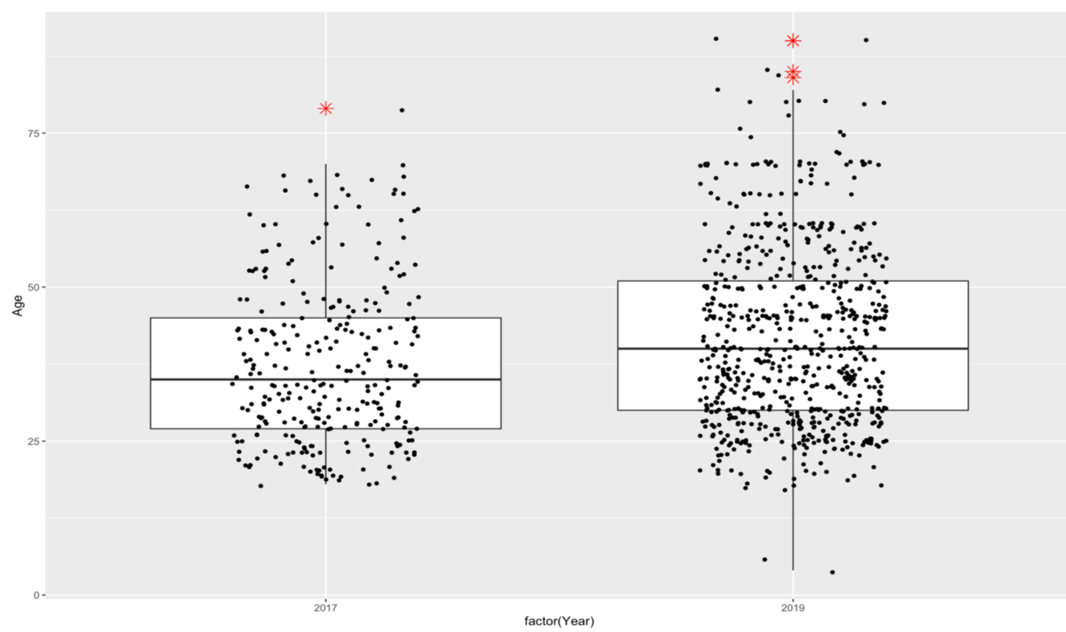

Figure S2. Distribution of Age between the 2016/17 and 2019 Samples**.**

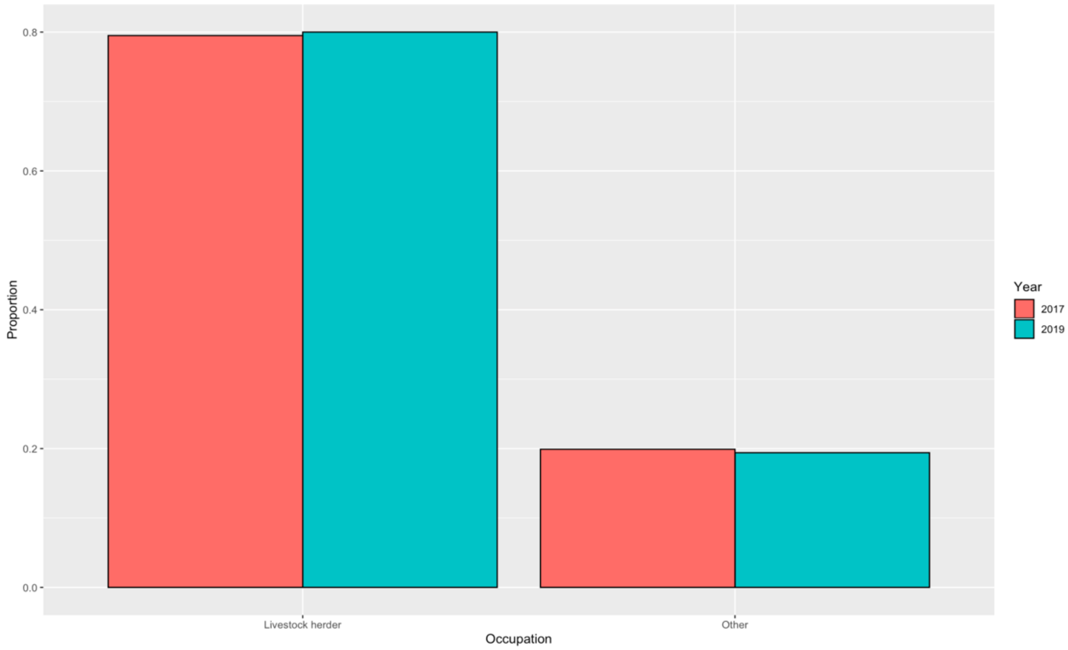

Figure S3. Relative Frequency of Livestock Herder as Primary Occupation**.**

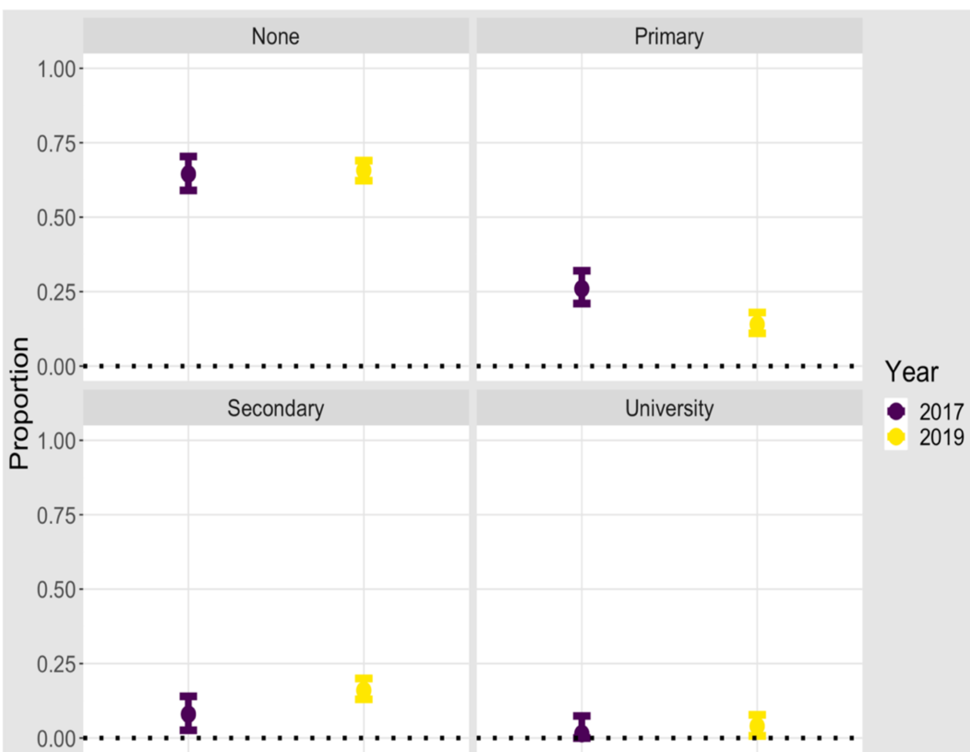

Figure S4. Levels of Education. Proportion of highest completed levels of education in 2016/17 and 2019 samples.

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