A tale of three villages: choosing an effective method for assessing poaching levels in western Serengeti, Tanzania

Eli J. Knapp, Dennis Rentsch, Jennifer Schmitt, Claire Lewis and Stephen Polasky

Abstract Poaching for bushmeat is a major problem for conservation of wildlife populations in many parts of Africa, including the Serengeti ecosystem in Tanzania. However, the severity of the poaching problem is often unclear because of a lack of accurate data. Directly asking people to self-report illegal activity faces the obvious problem of under-reporting. Use of arrest records from anti-poaching patrols may reflect levels of poaching activity but could also be driven by funding and quality of anti-poaching efforts. A third method, assessing poaching by asking about bushmeat consumption, is indirect, possibly subject to under-reporting, and also subject to limits on the accuracy of memory of respondents. We compare rates of poaching derived by self-assessment of poaching activities (based on household interviews), dietary recall of bushmeat consumption over a variety of time frames, and arrest records from anti-poaching units. We apply these three methods to assess poaching activities in three villages bordering protected areas on the western boundary of Serengeti National Park. Our results showed that dietary recall of bushmeat consumption and arrest records indicated similar patterns of poaching across the three villages but self-reporting differed significantly. There appear to be significant advantages to coupling results from dietary recall of bushmeat consumption and arrest records to estimate the level of poaching activity. In situations where reliable data from anti-poaching units are unavailable, cost-effective data collection of bushmeat consumption will provide a viable alternative to assess levels of poaching involvement of villages that border protected areas.

Keywords Bushmeat consumption, dietary recall, enforcement, illegal hunting, poaching, Serengeti

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Introduction

Poaching is widespread in many parts of Africa including Serengeti National Park and surrounding areas in western Tanzania (Gibson, 1999; Hilborn et al., 2006). This activity has had a major impact on wildlife populations throughout the Serengeti ecosystem (Arcese et al., 1995; Campbell & Borner, 1995; Sinclair, 1995; Campbell et al., 2001). Wildlife management in Tanzania has historically conserved wildlife without the use of fences or hard boundaries around protected areas. Close proximity of communities and wildlife makes poaching relatively easy and is therefore commonplace. Bushmeat acquired from poaching features prominently in local economies as a source of income and protein (Loibooki et al., 2002). Poaching in Serengeti is driven predominately by local demand for bushmeat and as a source of income for those living adjacent to protected areas. Unlike other parts of Africa, where threatened species are specifically targeted because of a strong preference or market price, bushmeat in Serengeti is typically non-selective (Cowlishaw et al., 2005; de Merode & Cowlishaw, 2006). The primary tools used for hunting are wire snares placed at an optimal height to catch any ungulate. While by-catch often occurs, the species that are caught most frequently are the most abundant (Holmern et al., 2006): wildebeest *Connochaetes taurinus* and zebra *Equus burchelli* during the migratory season, and impala *Aepyceros melampus*, Thomson's gazelles *Gazella thomsonii* and other antelopes throughout the rest of the year (Hofer et al., 1996). Mitigation of poaching in protected areas requires effective strategies for reducing demand or controlling supply of bushmeat. Most strategies aimed at reducing poaching have included both enforcement measures, such as increasing the number of anti-poaching patrols in protected areas to reduce supply, and community-based programmes to improve the well-being of nearby communities and provide alternatives to poaching (Barrett & Arcese, 1996; Hilborn et al., 2006; Kaltenborn et al., 2008).

Understanding the threat to wildlife posed by poaching and assessing the success of anti-poaching programmes require measurement of involvement in poaching. Failure to quantify poaching accurately can lead to the application of anti-poaching strategies, either enforcement-based or community-based, in communities that are not heavily

involved in poaching while neglecting other communities where poaching rates are higher. Distinguishing villages with high poaching rates from those with lower rates is important on the north-western side of Serengeti National Park, where poaching levels vary greatly between villages, ethnic groups and households (Hofer et al., 1996; Knapp, 2007; Ndibalema & Songorwa, 2007).

Poaching around Serengeti National Park has historically been assessed using two main methods: survey and enforcement. The survey method involves self-reporting by individuals who admit to poaching and those who admit to consuming bushmeat, which is also illegal (Loibooki et al., 2002; Kaltenborn et al., 2005; Knapp, 2007). This method is often used with focus groups and key informants to discover how and why individuals poach rather than to determine the total number of poachers. The enforcement method involves use of anti-poaching patrol arrest records to determine poaching levels in protected areas (Dublin et al., 1990; Campbell & Hofer, 1995; Hofer et al., 1996; Hilborn et al., 2006). This method has been used extensively in the Serengeti ecosystem and has revealed temporal variations in the amount of poaching since 1957. Because of a tendency for arrested poachers to give false information and because arrest records often lack a hunter's village of residence, this method has not always shown which communities are most heavily involved in poaching.

Yet another method, not considered further here, uses abundance of species to assess the impact of poaching on wildlife over time (Campbell & Borner, 1995; Hilborn et al., 2006). While knowledge of species abundance is valuable to wildlife managers an increase or decrease in population cannot be directly linked to the level of poaching in a given area because other factors (e.g. disease, forage availability) also influence population levels. Moreover, species abundance that is not spatially explicit, or has too coarse a temporal resolution, cannot be used to ascertain which villages are most involved in poaching.

Here we compare results from three methods for three villages bordering protected areas on the north-western edge of Serengeti National Park: self-assessment of poaching activities, dietary recall of bushmeat consumption, and enforcement. Because each method has potential bias (Rist et al., 2008), we identify the approach or combination of approaches that appear best suited for assessing relative levels of poaching.

Methods

We collected data on hunting activity from three villages bordering protected areas on Serengeti National Park's north-western edge (Fig. 1). Each village included 2,000–5,000 agropastoralist occupants, primarily of East Nyanza Bantu-speaking descent, with a history of bushmeat consumption (Shetler, 2007). These villages were selected at random from those for which comparable data exist and were nearly equidistant from a protected area (i.e. a place where there are restrictions on natural resource use). The protected areas included in the study are Serengeti National Park, Ikorongo Game Reserve, Grumeti Game Reserve and Ikona Open Area. Each study village bordered at least two of these protected areas, providing villagers with easy access for poaching. To protect the confidentiality of the respondents we refer to the three villages as A, B and C and do not report their specific locations.

The three types of areas in our study, national parks, game reserves and open areas, are governed by different regulations. With the exception of park headquarters and tourism lodges, no settlements, and no wildlife hunting, are allowed inside national parks. Such restrictions are enforced by the Tanzania National Park (TANAPA) rangers. Tanzanian game reserves also prohibit settlements and use of natural resources without permission from the management authorities. However, unlike national parks, game reserves allow trophy hunting for 6 months of the year. Game reserves are divided into blocks that hunting companies lease from the Wildlife Division for 5 years. Open areas are multi-use areas controlled by the Wildlife Division. Some open areas are within tourist hunting blocks where hunting is limited to the block owner and their clients. In our study area all forms of legal hunting have effectively ceased. In 2003 the local NGO Grumeti Community and Wildlife Conservation Fund (funded by a private sector commercial tour hunter operator conducting anti-poaching activities in both the Ikorongo and Grumeti Game Reserves) began assisting the Tanzanian Wildlife Division with management and law enforcement throughout the area. They purchase all legal hunting rights yet disallow the use of these rights. This effectively eliminates legal hunting. The Fund has sufficient funding, personnel and equipment to patrol their management area efficiently. They also use global positioning technology to monitor and measure patrol effort. Despite this, however, poaching continues to occur in areas in close proximity to our study villages (B. Walker, pers. comm.).

Self-assessment of poaching activity

A total of 180 household interviews were conducted within the three villages (62 in village A, 26 in village B, 92 in village C) between September 2004 and May 2005. Within each village we randomly selected at least two sub-villages, which are administrative units containing approximately equivalent household numbers. In each selected sub-village 2–3 households were randomly selected from clusters of 10 households. There is an average of 7.7 clusters in each sub-village. Approximately 2.5% of the households in each of the three villages were sampled. Households were defined as a social group that is coordinated in space and time,

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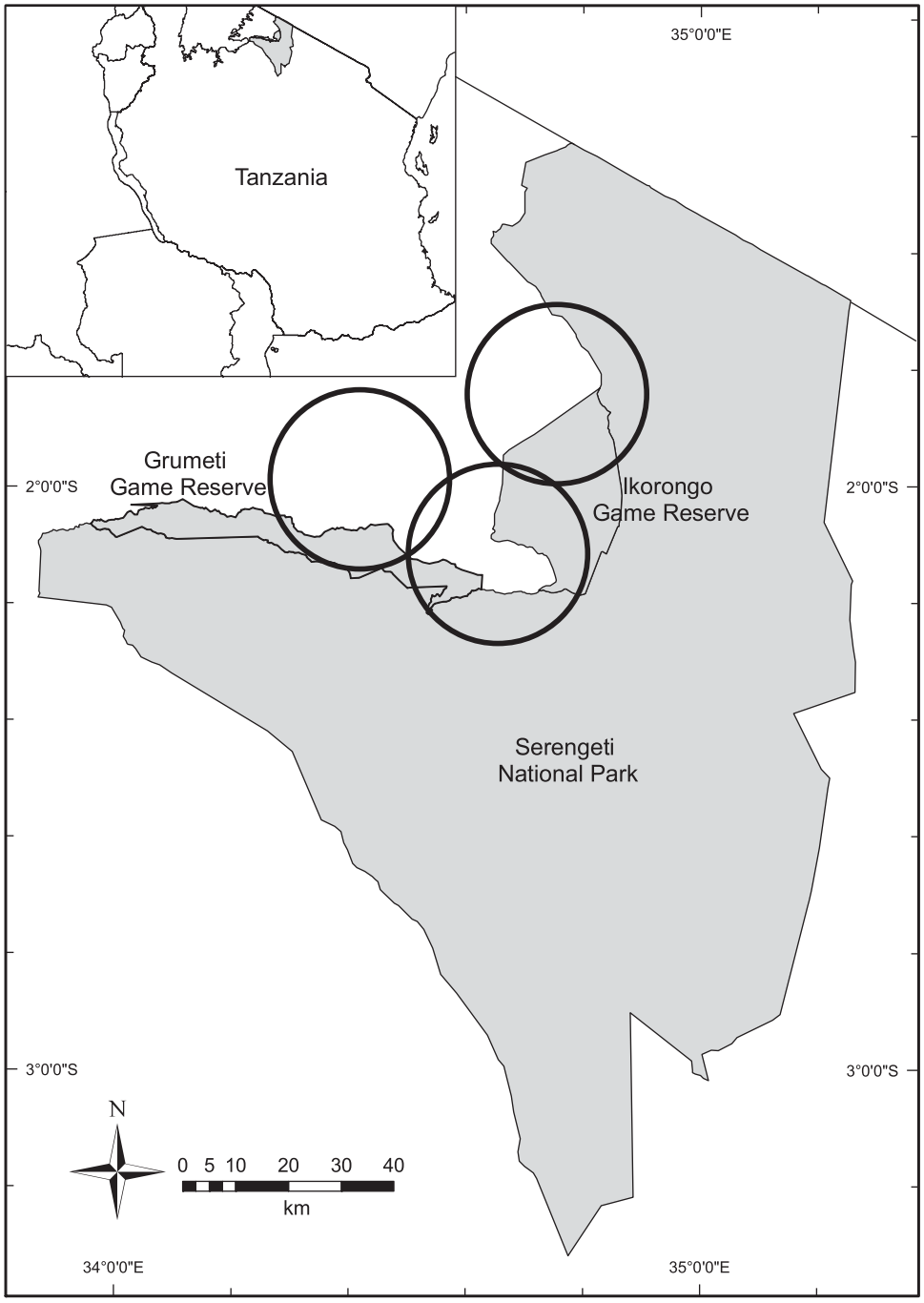

FIG. 1 The location of the three study villages A, B and C (circles; see comments in text regarding confidentiality) outside the Serengeti National Park. The shaded area on the inset indicates the location of the main map in Tanzania.

shares meals and makes collective decisions about resource allocation.

Interviews were conducted by the authors in Swahili, with the head of the household (43% of whom were males and 57% females). If the head of the household was absent, interviews were conducted with the next available occupant provided they were over 18 years of age and possessed adequate knowledge of household affairs. Interviews focused on household livelihood strategies including in-depth sections on agriculture, livestock and household economies. Towards the end of the interview respondents were asked if they engaged in illegal poaching activities. Asking about poaching at the end of the interview was done to take advantage of any trust that had developed over the course of the interview. All respondents were assured that their names and village residences would remain confidential. Two self-assessment questions were asked. Firstly, respondents were asked if they considered themselves (or anyone

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else in the household) to be a hunter. Secondly, respondents were asked how many wildebeest they killed in the past year. Wildebeest were selected because of their abundance (c. 1.3 million; Sinclair et al., 2007) in the Serengeti ecosystem, their disproportionate effects on ecosystem structure, their reputation as being commonly hunted for bushmeat and to add specificity to the survey (Sinclair, 1995; Mduma et al., 1999; Loibooki et al., 2002; Sinclair et al., 2007). The question was directed towards wildebeest killed anywhere as killing wildlife is illegal inside or outside the protected areas.

Dietary recall

The second method used to assess poaching activity was dietary recall. Respondents were asked how many times they had eaten bushmeat (defined as any wildlife meat that was hunted for consumption) within the previous day, week, month and year. Data on these time frames were collected using different sampling methods. The daily recall (n = 180) was included in the household survey described above. Weekly recall (n = 320) was collected from mothers interviewed at a central location in the village when they participated in a programme to weigh and measure children < 5 years of age. For monthly and annual recall 20–30 randomly selected households from each village were interviewed about their frequency of bushmeat consumption (n = 74). Dietary recall surveys were conducted in all three villages (A, B, and C) in September 2006. Self-assessment and dietary recall statistics (analysis of variance and χ^2) were calculated using *SPSS v. 16.0* (SPSS Inc., Illinois, USA).

Enforcement

Enforcement data were collected by the Grumeti Community and Wildlife Conservation Fund. Since 2003 the Fund has managed the hunting blocks surrounding the three study villages, and recruited c. 125 law enforcement scouts to assist the Tanzanian wildlife authorities with anti-poaching patrols in the study area. Eleven camps and nine observation outposts are located throughout the concession areas. Daily patrols are conducted on foot and each camp covers 100 km^2 per week. Since mid 2005 patrol data have been recorded and analysed on a weekly basis and provide direct feedback to scout leaders and management. This is done to redirect operations to specific geographical areas of concern whilst also addressing changes in seasonality of poaching activities. Arrest data were unique in that patrols record the village of residence of each arrested poacher in addition to the number of poachers arrested. We used arrest records for 2006 to match as best as possible the temporal scale of our self-assessment and dietary recall data.

Results

In the self-assessment survey village A had the highest percentage of households (13%) admitting to participating regularly in illegal hunting activities, followed by village B (9%) and village C (3%). A test of the null hypothesis that the proportion of households engaged in illegal hunting was the same in the three villages was non-significant ($\chi^2 = 5.19$, df = 2, P = 0.075). Village A reported the highest average number of wildebeest killed per household in the past year (1.0), followed by village B (0.4) and village C (0.1). The null hypothesis that the number of wildebeests killed per household was the same across all villages was rejected ($F = 6.863$, df = 2, P ≤ 0.001).

In the dietary recall survey households were considered to have consumed bushmeat if they ate it at least once in the given time frame. Village C recorded the highest percentage of households reporting bushmeat consumption for all four time periods but only weekly and yearly time scales were significantly different between villages. For the daily recall 2% of households in village C admitted to consuming bushmeat compared with 0% in village B and village A ($\chi^2 = 1.78$, df = 2, P = 0.41, n = 180). For the weekly recall, 58% of households in village C reported consuming bushmeat compared to 47% in village B and 21% in village A ($\chi^2 = 24.47$, df = 2, P < 0.001, n = 320). Village C also had the highest reported rate of bushmeat consumption in monthly recall (38%) compared to 16% for both village B and village A ($\chi^2 = 4.24$, df = 2, P = 0.120, n = 74). For the yearly recall 71% of households in village C reported eating bushmeat compared with 48% of households in village B and 36% in village A ($\chi^2 = 6.12$, df = 2, P = 0.05, n = 74).

Enforcement records from patrols indicated that households in village B were more heavily involved in poaching activities than those in village C. Both village B and village C were more involved in poaching than village A. During 2006 village B had the highest per capita arrests (1.4% of the village). Villages C and A had 1.0 and 0.1% per capita arrests, respectively. All arrests were in the areas patrolled by Grumeti Community and Wildlife Conservation Fund, including Grumeti and Ikorongo Game Reserves and Ikoma Open Area.

Discussion

The three methods of collecting information do not yield a consistent pattern of poaching activity across the three villages. To understand the patterns presented by the data it is important to recognize both the usefulness and limitations of the three methods. The advantage of the self-assessment technique is that it can probe respondents about their perceptions and the context of hunting activities but the disadvantage is the potential for substantial under-reporting. Survey respondents may be unwilling to admit to

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participation in illegal activities because of fear of sanctions associated with such activity. In western Serengeti the consequences for arrested poachers include substantial fines and possible imprisonment (Holmern et al., 2007). Failure to pay fines can result in up to 10-year imprisonment. Prison sentences depend on the type of violation, availability of witnesses to testify and age of the offender (C. Boma, pers. comm.).

The dietary recall method has a number of advantages. Dietary recall questions appear to be a less threatening approach to quantify poaching activity. Potentially sensitive questions about bushmeat consumption can be softened by including them in a list of questions pertaining to consumption of legal protein sources such as beef, fish, poultry and beans. Additionally, until the cessation of legal hunting in the area in 2003, some bushmeat consumption had been legal and bushmeat had been provided to communities at a low price through the Serengeti Regional Conservation Plan (Holmern et al., 2002). Directing bushmeat consumption dietary recall towards female respondents may also help questionnaire accuracy. Because hunting activities are traditionally male dominated, females may feel less threatened by possible anti-poaching sanctions. For these reasons the dietary recall methodology appears better able than self-reporting of poaching to uncover sensitive information. Many more respondents admitted to consuming bushmeat than admitted to being involved in poaching activities. Bushmeat consumption, however, is an indirect measure of poaching activities and cannot be directly linked to how and where the meat was obtained. Nevertheless, 77% of poachers in our study indicated that they consume bushmeat they procure themselves, whereas only 23% sell it.

Results of dietary recall are influenced by season, the respondent's memory and the temporal scale of the recall (Baxter et al., 2004). The variation within the day, week, month and yearly recall of the different questionnaire time frames showed that results are sensitive to the time frame posed to the respondent or possibly the different sampling methods used. Although the use of one time frame would have standardized responses, varying time frames were used to account for differences in recall because of memory and gender. Poaching is a highly seasonal activity used to procure protein when crops are scarce or, more commonly, when seasonal ungulate migrations pass by the village (Loibooki et al., 2002; Holmern et al., 2007). Except for the 24-hour recall, consumption interviews were conducted in September 2006, several months after much of the wildebeest migration passed through the study area. As a result, bushmeat may have been slightly more available in the villages than during other times of year when the migration is in other parts of the ecosystem. A longer time frame that accounts for seasonality, such as open-ended frequency recall, potentially avoids this bias. However, longer time frames are subject to memory error on the part of the respondent. Because bushmeat consumption is relatively infrequent, daily recall is too short a time scale to gain meaningful results. Dietary recall over a week may be optimal to detect bushmeat consumption because it minimizes the likelihood of memory error. Conducting this survey at various times throughout the year would reduce seasonality bias by capturing consumption levels during changes in crop and livestock production and location and intensity of annual wildlife migrations. Another potential improvement would be to quantify amounts of bushmeat that are consumed. This could serve as a valuable cross-check for the frequency measures used here.

An advantage of anti-poaching enforcement records relative to dietary recall is that they are a direct measure of poaching activities and offer a seemingly objective way to quantify hunting. This method has therefore been favoured by wildlife managers over other methodologies for the assessment of poaching activities (Arcese et al., 1995; Campbell & Hofer, 1995; Hilborn et al., 2006). Estimates of the total number of illegal hunters in a given area are based on arrests per km patrolled during transects conducted by the anti-poaching patrols. Records of the home villages of any arrested poachers can be used to create a village-level index of poaching participation. However, arrest records are influenced by the intensity of anti-poaching efforts and the quality of these efforts. Ranger patrols in the National Park, for example, are often conducted on roads by vehicle and may neglect harder-to-reach locations. Likewise, many illegal hunters readily learn to avoid heavily patrolled areas and observation posts, effectively eluding anti-poaching transects. Given budget fluctuations and changes in management, data regarding time spent in the field, number of rangers and distance travelled per patrol have been particularly difficult to assess (Hilborn et al., 2006).

Of the three villages, village A had the highest rate of respondents admitting participation in poaching and also reported the highest rate of wildebeests killed per household. However, village A also had the fewest households that reported eating bushmeat and the lowest level of per capita arrests for poaching. Several possible explanations could account for this. Bushmeat consumption figures may under-report poaching activity in village A relative to poaching activity in other villages. Lower bushmeat consumption among households in village A could be caused by villagers being more involved in distributing and selling meat to other villages than in consuming the meat themselves. This explanation, however, contradicts findings from north-western Serengeti that suggest poaching is often for local consumption to supplement protein deficiencies and food shortages (Loibooki et al., 2002; Kaltenborn et al., 2005). While it is most parsimonious to interpret this simply as a reflection of the lower poaching level in

village A, it could also be that poachers in village A are more skilled in evading anti-poaching patrols than those from other villages.

Another plausible explanation for the pattern of results across villages is that the rate of under-reporting of poaching activity in the self-assessment is closely tied to fear of arrest, with villages with high rates of arrests for poaching more wary of revealing information. If this is so, the low rates of self-reporting in village C relative to village A reflect greater reluctance to reveal information about poaching, rather than lower poaching activity, and therefore evidence from dietary recall and arrest records would provide more accurate information about poaching rates. This explanation is supported by reports in which village C's officials frankly admitted that poaching is an important activity for people in the village (village C Chairman, pers. comm.), whereas officials in the other two villages suggested lower comparative rates (villages A and B Chairmen, pers. comms.).

Across villages the results from dietary recall and arrest records are more closely aligned than those from self-reporting of poaching activity. Using arrest records from the Grumeti Community and Wildlife Conservation Fund, village B had the highest and village A a much lower per capita percentage of arrests. Using dietary recall village C has the highest rate of activity (although differences relative to village B are not large for weekly recall). For the monthly recall, village B reported a rate equal to village A, whereas village C was much lower. One troubling finding is that the monthly rate of consumption reported was lower than the weekly rate. This pattern could be because of the greater difficulty involved in recalling events further in the past, when questions were asked or the differing sampling methods. If dietary recall samples occur when the annual migration of wildebeest is close to a sampled village, reported rates of consumption are likely to be higher than at other times of year.

If the ultimate aim of assessing poaching levels is to ascertain a village's relative involvement, consumption data appear to be a reliable indicator when high-quality anti-poaching records are not readily available. In contrast to the considerable costs necessary for outfitting large-scale anti-poaching operations and maintaining a database of records, obtaining dietary recall data is simply a matter of administering surveys at various times during the year. This method may be more cost-effective and allow for larger sample sizes to capture more of the variation in the population. If consumption data are used, however, it is advantageous to estimate the amount of trade or sales of bushmeat in the locations studied. Although the informal nature of bushmeat distribution makes it difficult to quantify, an approximation of where and whom bushmeat is coming from would further substantiate consumption measures. Collecting consumption data also appears to be less threatening to the respondents than self-reporting of poaching, as suggested by the lower percentage of those who admitted to involvement in illegal bushmeat activities by calling themselves 'a poacher'. Self-reporting is a useful tool to learn more about those who openly admit to involvement in illegal activities but is not a reliable estimate of relative involvement at a village level, as there are many factors that may motivate individuals to identify themselves as a poacher (e.g. temperament, trust level with the interviewer, fear of sanctions).

We recommend that dietary recall of bushmeat consumption be used in conjunction with arrest records, as each provides useful information and helps to overcome potential problems with using any one data source alone. However, if arrest records are not available dietary recall may serve as a valuable substitute for ascertaining village-level poaching involvement. If any of the three methods we tested are used alone, however, there are clear limitations: uncertainty of anti-poaching enforcement intensity and quality, indirectness of consumption data, respondent memory error or respondent fear. For the dietary recall method to be most accurate our results suggest that the weekly time frame may be optimal, provided that interviews are conducted periodically throughout the year to avoid seasonal bias. Such a time frame is long enough to capture episodic events such as consumption of bushmeat, yet short enough to reduce the chances of respondent memory error.

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