Analysis

Prices, poaching, and protein alternatives: An analysis of bushmeat consumption around Serengeti National Park, Tanzania

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ABSTRACT

The consumption of meat from wild animals (or bushmeat) occurs throughout Africa and highlights the conflict between two distinct development goals: food security and biodiversity conservation. Growing human populations throughout the greater Serengeti ecosystem rely heavily on bushmeat as a source of protein, which places pressure on migratory wildlife populations. This paper uses unique data from protein consumption surveys from 131 households over 34 months in a generalizable empirical framework to estimate price, cross-price, and expenditure elasticities of protein sources, and analyze the potential economic effects of policies to mitigate bushmeat hunting and consumption. Results suggest that: (1) directly increasing the price of bushmeat through enforcement or other policies to reduce supply will have the most direct and largest effect of bushmeat consumption; (2) increasing income increases bushmeat consumption as well as consumption of other meat sources; (3) if surrounding fisheries experience a negative shock, or collapse, this will lead to a dramatic increase in bushmeat consumption. Overall, these results strongly indicate that policies to reduce bushmeat hunting while maintaining food security must be considered in a broad and comprehensive framework.

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1. Introduction

Increasing human population density in Sub-Saharan Africa has resulted in more rural communities living in close proximity to protected wildlife populations. These protected areas are meant to ensure that wildlife is conserved for future generations. However, surrounding communities, with access to large wildlife populations, often rely on meat from wildlife hunting, or bushmeat, as an important source of protein. Consumption of bushmeat creates a conflict between the competing goals of wildlife conservation and household food security, especially if wildlife is not harvested sustainably. In West and Central Africa, bushmeat hunting has decimated many once common species. To mitigate the threat of bushmeat hunting to wildlife populations it is important to understand the dynamics of the bushmeat market.

The conflict between sustainability and bushmeat hunting as a means of maintaining food security has been documented in the literature (Barnett, 2000; Bennett, 2002; Fa et al., 2003; Loibooki et al., 2002; Mainka and Trivedi, 2002; Milner-Gulland and Bennett, 2003; Nasi et al., 2008; Robinson and Bennett, 2002; Robinson and Bennett, 2004). In Tanzania, where bushmeat hunting is illegal, rural poverty and food insecurity remain a challenge, with 36% of rural households

living below the basic needs poverty line (National Bureau of Statistics Tanzania, 2002). The motivations for bushmeat hunting and consumption are diverse, lack of abundant protein sources is a key reason for bushmeat hunting (Barnett, 2000; Jambiya et al., 2007; Loibooki et al., 2002), however bushmeat consumption tends to be concentrated close to protected areas (Campbell et al., 2001; Knapp et al., 2010). Cultural preferences for bushmeat are also an important factor (Bennett, 2002; Campbell et al., 2001; Fa et al., 2003; Loibooki et al., 2002; Mainka and Trivedi, 2002; Ndibalema and Songorwa, 2008).

The threat of bushmeat hunting to conservation objectives has been examined both using theoretical models as well as empirical econometric models. Damania et al. (2005) and Barrett and Arcese (1998) both employ theoretical models to examine the likely interactions between economic incentives and bushmeat hunting. Damania et al. (2005) find that increased bushmeat prices will likely lead to changes in technologies used for bushmeat hunting, and that policies that address bushmeat sales rather than hunting are more likely to be effective. Barrett and Arcese (1998) suggest that directly addressing fluctuations in rural agricultural incomes will offer the most enduring solutions to the conflict between household food security and wildlife conservation. These theoretical findings provide important inputs into thinking about the bushmeat market using an empirical approach.

The use of data and empirical analysis is a more common methodology for examining the bushmeat market. Previous empirical studies have shown, for example, that an increase in bushmeat consumption is correlated with the decreased availability of alternative protein sources

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including livestock and fisheries (Brashares et al., 2004; Kümpel et al., 2010; Nasi et al., 2008; Nyahongo et al., 2009; Rowcliffe et al., 2005; Wilkie et al., 2005; Loibooki et al., 2002). Several studies have previously examined income effects and price responses of bushmeat and other available meat protein sources directly. Wilkie et al. (2005) find that wealth and protein consumption are positively related in Gabon and Brashares et al. (2011) also find a positive relationship between wealth and protein consumption in a cross-country study in Ghana, Cameroon, Tanzania, and Madagascar. East et al. (2005) substantiate this positive relationship in urban Equatorial Guinea. Evidence of price and cross-price effects between bushmeat and other protein sources is scarcer. Wilkie et al. (2005) find suggestive evidence (though not statistically significant) that fish is a substitute for bushmeat while Apaza et al. (2002) find some evidence of this same substitution between bushmeat and fish as well as domestic livestock from Bolivia's Amerindian communities. Another study in Bolivia by Wilkie and Godoy (2001) finds that decreases in the price of domestic livestock prices will reduce the consumption of fish substantially but have little effect on the consumption of bushmeat.

The few previous attempts to estimate price, cross-price, and expenditure elasticities have generally employed a single equation approach, which is inconsistent with demand theory. In this study, we use data from monthly household surveys for 131 households that measure meat consumption, prices, and time-varying household characteristics. These data were collected from households in eight communities surrounding Serengeti National Park in Tanzania each month for 34 months. We apply a generalizable methodology using these data to rigorously evaluate the demand for bushmeat and other protein sources and obtain estimates on price, cross-price, and expenditure elasticities for bushmeat and other protein sources using an Almost Ideal Demand System (AIDS).

We add to this literature by estimating a demand system for animal based proteins to establish the price and income effects of various protein sources, including bushmeat, simultaneously. We employ the AIDS model to estimate these elasticities, which has numerous advantages over estimating elasticities using a single equation. Firstly, the AIDS model satisfies the axioms of choice, and can be used to test and impose the homogeneity and symmetry restrictions on parameters. Second, by estimating demand for multiple proteins in a system, we can account for cross-equation correlations that cannot be captured using a single equation approach. We assume that demand for multiple meat protein sources are likely to be influenced by similar factors and thus are assumed to be contemporaneously correlated. Lastly, determining which meat sources are substitutes for bushmeat in this system has important policy implications for developing conservation interventions in Serengeti and elsewhere. We use our estimates to quantitatively analyze bushmeat hunting policy in Tanzania. For example, understanding the relationship between bushmeat quantity consumed and fish price helps us understand the potential effects of the depletion of the Lake Victoria fishery on wildlife populations in the Serengeti. Understanding relationships between protein sources, like these, can help target policies more effectively to manage wildlife populations without compromising food security in poor households (Ling et al., 2002).

1.1. The Serengeti Context

The Serengeti ecosystem includes one of the largest mammal migrations on earth, with more than 1.2 million wildebeest and more than 200,000 zebra that transverse the ecosystem annually. As the annual migration passes through various land-use types, wildlife herds are at risk from humans, particularly via bushmeat hunting. Bushmeat hunting is illegal in Tanzania without a permit but remains an important and prevalent economic activity for communities in the greater Serengeti ecosystem (Galvin et al., 2008; Holmern et al., 2004; Kaltenborn et al., 2005; Knapp, 2007, 2012; Loibooki et al., 2002). Illegal

hunting, however, negatively affects wildlife populations (Sinclair et al., 2008; Thirgood et al., 2004) and is considered among the most serious threats to wildlife in the Serengeti ecosystem (Sinclair, 1995). Although selective hunting targeted towards rare and high-valued species bound for high-end external markets is also common, the majority of hunting in Serengeti appears to be more oriented toward local consumption and sale of bushmeat (Barnett, 2000; Campbell et al., 2001; Kaltenborn et al., 2005; Nyahongo et al., 2009). A large proportion of the illegally hunted meat is sold locally within communities, though some proportion is also exported outside of the ecosystem (Barnett, 2000; Campbell et al., 2001). Bushmeat hunting thus serves as both a source of food and income (Barnett, 2000; Bennett et al., 2002; Kaltenborn et al., 2005; Knapp, 2012; Knapp et al., 2010). The local consumption of bushmeat is responsible for the estimated 70,000–129,000 wildebeest deaths per year (Rentsch and Packer, 2012). Previous efforts to understand the motivation for hunting focus on the behavior of producers (hunters) who typically face limited livelihood options in rural agro-pastoral economies (Barrett and Arcese, 1998; Johannesen, 2005; Knapp, 2007, 2012; Loibooki et al., 2002), however this paper approaches this problem by understanding the behavior of the bushmeat consumer and examines the role of alternative protein sources in the decision to consume bushmeat.

The seasonal variation in bushmeat availability influences both prices and consumption of bushmeat and alternative protein sources. We use this seasonal variation in wildlife abundance at the community level to predict protein consumption in our empirical approach. This abundant wildlife access, high human population density in communities surrounding Lake Victoria, and favorable climate for livestock productivity provide a unique opportunity to examine the trade-offs in household consumption of bushmeat, fish, and domestic meat.

Several policy approaches have been used to mitigate illegal hunting in Serengeti. Primarily, bushmeat hunting is combated through enforcement, with extensive anti-poaching units operating throughout the national park and surrounding reserves. The national park has also engaged in community outreach in an effort to meet economic development needs in surrounding communities (Serengeti National Park, 2006), though these programs often suffer from limited funding. Another effort to reduce bushmeat consumption was a game cropping scheme that provided bushmeat legally within villages bordering protected areas (Holmern et al., 2002; Mbano et al., 1995). Despite on-going efforts and an overall increase in spending on law enforcement, all of these strategies to reduce illegal hunting within the ecosystem have had limited results. Understanding the importance of bushmeat in local households' food security strategies and their willingness to substitute away from bushmeat, may help more effectively target efforts to mitigate illegal hunting.

In the remaining sections we first discuss the data used in our analysis, we then present our empirical strategy, report results from the analysis and use the estimated elasticities in a policy simulation exercise, and conclude with a discussion of our results.

2. Data

We use household level dietary recall data collected monthly for 131 households over 34 months. Dietary recall surveys have been shown to be an effective method for measuring the food consumption choices of households (Baer et al., 2005; Bingham et al., 1994; Day et al., 2001; Gersovitz et al., 1978; Hebert et al., 1997). This study uses a weekly recall of only meat-based protein sources to gain a more comprehensive understanding of protein intake and to capture "rare" events, such as the consumption of different bushmeat species (Knapp et al., 2010). While 24-hour recall was found to be the most accurate food recall measure, food-frequency questionnaires which ask respondents to recall dietary intake over longer periods of time were found to be more efficient in that they provide a wider time horizon with which to assess varied