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Effect of cropping policy on landowner reactions towards wildlife: a case of Naivasha area, Kenya

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EFFECT OF CROPPING POLICY ON LANDOWNER REACTIONS TOWARDS WILDLIFE: A CASE OF NAIVASHA AREA, KENYA

Abstract:

Wildlife policy in Kenya has in most part been protectionist with little incentives to private landowners, who host wildlife in their farms to participate in their conservation. However, in recognition of the role of incentives in conservation, the Kenya Wildlife Service (KWS) piloted a wildlife utilization policy in which organized landowners were allowed a cropping quota based on the number of wildlife present within their land. This study investigates the impact of such policy on human-wildlife conflicts using data compiled from a list of complaints lodged at the KWS warden's office from farms around Lake Naivasha. Using this data, Poisson and negative binomial regression models are employed to estimate the effect of the wildlife cropping and policy and other factors on the frequency of wildlife damage incidences reported at the KWS offices. Results indicate that the policy may not have worked as intended since rather than reducing the number of conflict reports, it had an unexpected effect of increasing problem reports to KWS. The results are discussed and some recommendations provided.

Word count: 171

Introduction:

The Nakuru Wildlife Conservancy (NWC) covers an estimated 350,000 acres, encompassing the area between Lake Nakuru and southwards towards Mount Longonot (figure 1). This area lies in what until the 19th century was part of the sprawling Maasai grazing country. It is within this zone that a wide variety of land uses are practiced including livestock ranching, pastoralism, subsistence and commercial agriculture (with horticulture and flower farming being an important feature) and which accounts for approximately 60-70% of Kenya's cut flower exports. The area also houses several conservancies including the 56,000 acre Soysambu Conservancy, a recent initiative converting a livestock ranch to accommodate, among other animals, eland, zebra, gazelle, buffalo and warthogs resident within the ranch. Other areas housing significant numbers of wildlife include Oserian wildlife sanctuary, Kigio Conservancy, Marula, Kedong and Loldia farms. The area is composed of savannah, is relatively dry with a rainfall gradient running north-south with an average annual rainfall of 965mm at Lake Nakuru (LNKR) to 620mm towards the south on the shores of Lake Naivasha (LNSA) with temperatures of 17.3ºC (Siderius and Muchena 1977). Natural vegetation of scattered leleshwa (*Tarchonanthus camphoratus*) and acacia bushland with scattered forests of yellow fever acacia trees (*Acacia xanthophloea*) along the rivers and close to the lakes characterizes most of the area. The area sustains a diverse wildlife community, including buffalo, hippo, giraffe, waterbuck, impala, zebra and over 350 bird species. Between 1975 and 2008, the area has undergone landuse changes with notable increases in settlement, annual crops and irrigated cropland and a decline in grass cover, forest and shrubland (SPARVS, 2009). Whereas wildlife numbers in East Africa (except ostrich) have declined by at least half in the last 30 years, privately protected areas hosting about 40% of wildlife have become important sanctuaries in the recent past. Private wildlife sanctuaries located in the NWC show a non significant increase between 1996-2003 (Western et.al., 2006). This can be cast against countrywide losses inside and outside protected areas recorded for the last 30 years (Western et.al, 2009).

Wildlife management

Wildlife management policies can be detrimental or beneficial to conservation depending on key parameters and the type of competition on output markets (Bulte and Damania 2005). In addition, it is recommended that policy adopt a suite of economic, financial and market instruments, possibly including differential land use taxes, conservation subsidies and easements, and lease back agreements since creating positive net benefits from wildlife is not enough (Norton-Griffiths, 2000)[1]. In place of pure compensation for wildlife damage, performance payments tied to wildlife population can be used (Ferraro and Kiss, 2002). Such a 'Payment for Ecosystem Services' scheme is an effective means of inducing conservation while at the same time compensating those who incur costs. In the case of wildlife, instances of 'leakage' from a PES scheme are shown to lead to sub-optimal results such as overstocking by pastoralists during droughts although it increases global welfare (Bulte et.al., 2006). In Kenya's Mara area, residents suggested the introduction of personal compensation for loss of property and a less bureaucratic process

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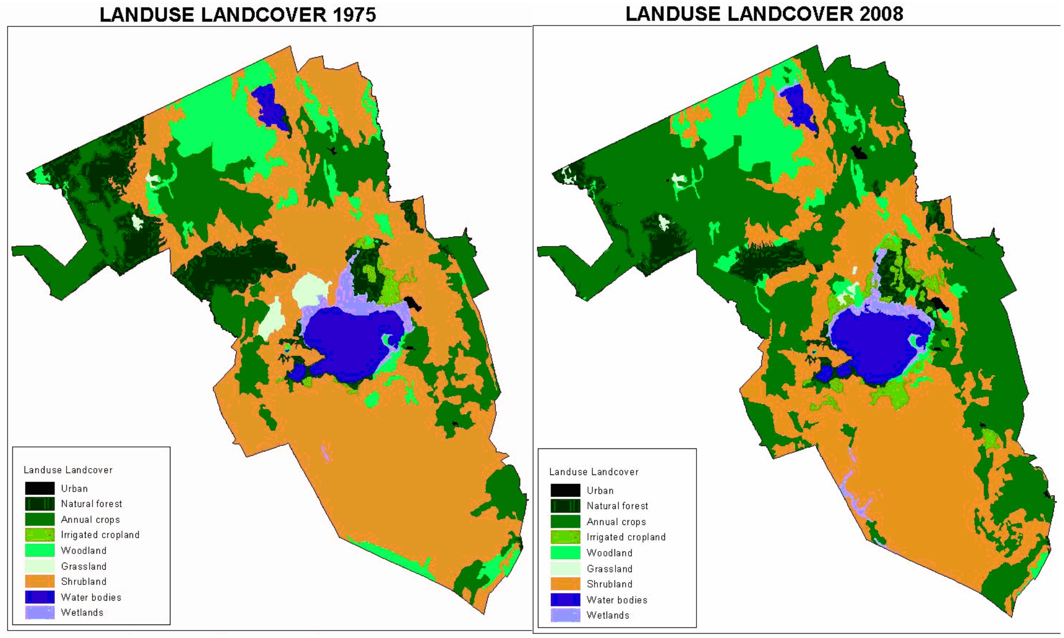
[1] For instance, EMCA which is a framework law provides for environmental easements in support of wildlife management.

of doing this while at the same time opting for the separation of wildlife from humans. Norton-Griffiths (1996) concludes that consumers of conservation should compensate conservationists while Damania and Bulte (2007) present a case for wildlife farming while Bulte and Rondeau (2005) argue for incentives linked to conservation outcomes and not pure compensation due to the risk of moral hazard. Some studies conducted in Machakos show that game cropping may not be more compatible with nature conservation than standard pastoralist practices (van Kooten et.al., 1997). They also argue that cropping reduces wildlife populations, but increases their stability.


LANDUSE LANDCOVER 1975

LANDUSE LANDCOVER 2008

Figure 1: Landcover within the NWC in 1975 and 2008 (SPARVS, 2009)

Incentives to private entities to induce conservation depend on compensation mechanisms, property rights, contract structure and the presence of markets to internalize external benefits of protection (Innes and Frisvold, 2009). Attitudes towards wildlife especially those that pose greater damage, in the absence of user rights too will determine success of conservation effort. Such attitudes differ across individuals and groups. For instance, work in Laikipia indicated that among pastoralists and small-holders, wildlife ownership was not important while the opposite was true for large landowners (Wambugu, 2007). This may explain why cattle losses from wildlife attacks are difficult to estimate as reports to KWS are rarely made, even in Samburu (Kuriyan, 2002). However, for landowners, direct benefits from wildlife are important (Wambugu, 2007). It has also been shown that economic incentives are important in inducing positive perceptions about wildlife (ibid). An example of different attitudes towards Asian elephants is made (Bandara and Tisdell, 2003, 2004) and the dual tag of wild species (pest or resource) is discussed (Tisdell and Zhu, 1998). Whether a species presence is economically positive has an effect on attitudes towards conservation while willingness to pay for conservation is also strongly determined by human attitudes towards the species (Martín-López, et.al., 2007). The same authors show that mean WTP for species that generate crop damage was lower than for those that cause damage to cattle, those that are a fishing or hunting resource or those species that are a nonconsumptive tourist resource (Martín-López, et.al., 2008). In Canada, a study of coyote shows that WTP for conservation is negative for those who have had trouble with coyotes (Martínez-Espiñeira, 2007). In Zimbabwe, some studies imply that many households do not consider elephants worth conserving and this is an argument against the devolution of conservation to communities unless adequate economic incentives are made (Muchapondwa et.al., 2006). In Zambia, management of buffers between wildlife parks and agricultural areas is threatened by crop destruction with increasing wildlife populations and the pressure on available land from immigration and such conflict is a major impediment to socioeconomic development (Fernandes et.al., 2009). Bandara and Tisdell (2002) cite compensation as a means of ameliorating such effects since elimination of wildlife is not a Kaldor-Hicks preferable state (Bandara & Tisdell, 2004). Interestingly, even with compensation for predation, livestock keepers in Botswana for instance do not change their attitudes towards predators (Gusset et.al., 2008). Others have argued that compensation for damage though administratively ineffective can depress wildlife numbers for reasons that are deeply rooted in the structure of the ecological economic system and also have ambiguous effects on local welfare (Rondeau and Bulte, 2007).

Kenyan wildlife policy

Kenya's wildlife policy outside protected areas had until 1977 provided incentives to landowners to maintain wildlife resources by allowing sport hunting, cropping, compensation for depradation, loss of grazing crop damage but was abandoned since they were deemed ineffective (Norton-Griffiths, 2000). The cost of wildlife presence is about 48% of net production (Norton-Griffiths, 2007). In 1992, the KWS established the Community Wildlife Service department charged with management outside protected areas and also granted wildlife use rights in some areas until 2002 (Kemeri-Mbote 2005). These areas included Laikipia, Kajiado, Nakuru, Meru, Samburu and Machakos (Elliott and Mwangi, 1997). This program required landowners to keep track of the number and variety of species found on their properties, numbers which were used to estimate a cropping quota. It was expected that providing landowners with user rights would internalize the costs and benefits associated with wildlife presence on their land. Among the species that were targeted in the program included among them, buffalo and zebra.

Wildlife and more formally, wildlife numbers are assumed to be at Ψ^1 on figure 2 before a cropping policy. At this point, without user rights, landowners experience damages that far outweigh benefits (divergence between damages and benefits). Upon providing landowners with cropping quotas, say a quota which moves Ψ^1 towards Ψ^2 where damages are fully internalized, their incomes increase from sales of wildlife related resources (MB) and damages (MD) from wildlife are reduced. A quota equal in magnitude to $(\Psi^1 - \Psi^*)=q$ will essentially be better than a wild population Ψ^1 since property owners can recoup some of the costs associated with wildlife presence. It would be expected that such a policy shifts attitudes towards wild species favorably and property owners view them as resources rather than pests. Following this argument, it would suffice to say that if damage is an increasing function of wildlife numbers, then reports of problem wildlife is an increasing function of wildlife numbers (moving from left to right). If **y** are reports of problem wildlife, then $\mathbf{y}_{\Psi 1} > \mathbf{y}_{\Psi *}$. Similarly, it would be expected that at Ψ^2, $\mathbf{y}_{\Psi 2} \rightarrow 0$ since most of the problems associated with the population size Ψ^1 have been taken care of by the quota reducing wildlife numbers to Ψ^*. At Ψ^1, landowners incur wildlife control costs (c) which are similarly assumed to be an increasing function of wildlife density. It is easy to show that $c_{\Psi 1} > c_{\Psi 2}$ meaning that when the policy is on, wildlife control costs also shift downwards. We can also assume that since land is fixed, the size of Ψ depends on habitat available for wildlife and is a decreasing function of human settlement and an increasing function of habitat productivity (biological carrying capacity).

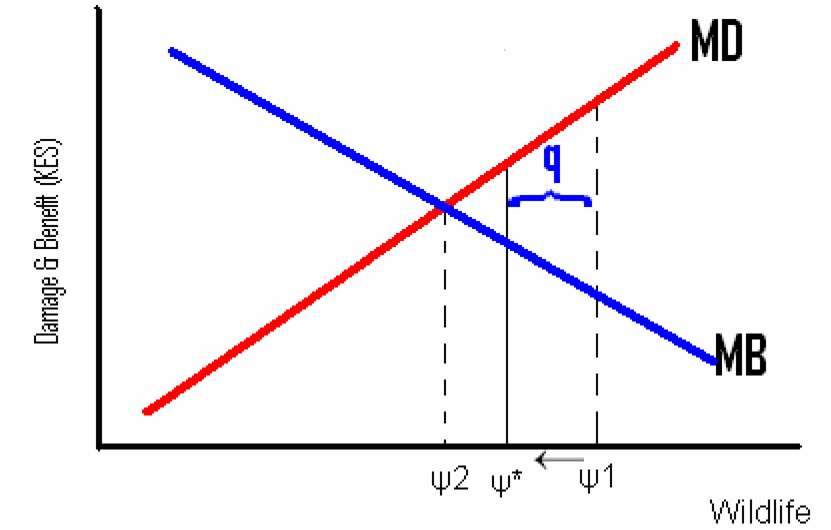


Figure 2: Stylized impact of quota allowed to property owners

The NWC has a variety of wildlife including the African buffalo (*Syncerus caffer*). The buffalo is a large heavily built animal with ox like features, with a massive body and relatively short limbs. It has a large broad bare and moist muzzle, short neck, large ears long tail with a terminal tuft. It has massive horns with an equally massive base, but are less well developed in females. Adult buffalo can weigh up to 1,800 lbs. The animal has a poor sight and hearing but has a better developed scent. They are primarily grazers feeding on grasses and just like cattle, require water and must drink each day; hence, the presence of water dictates very much their spatial distribution. In places with dense human habitation, buffalo prefer to graze in the night. The buffalo is placid, mostly nocturnal, except in protected areas staying hidden among dense foliage during the day. The animal however has a bad reputation of being deliberately savage especially when cornered or wounded (Dorst and Dandelot, 1990). Buffalo also tend to be non-migratory, inhabiting a home range which is largely exclusive to that group Nowak (1991) and home ranges can vary in size from 126 to 1,075 square kilometers, supporting population densities between 0.17 and 3.77 individuals per square kilometer. Within the NWC, buffalo number about 4,000 individuals representing about 6% of the wild species in the area.

Objectives

This paper traces the evolution of reports during the wildlife quota pilot period and after and singles out reports to the KWS of the African buffalo (*Syncerus caffer*) over the 1993-2007 period. These counts are taken to be an indication of buffalo associated damage severity for each reporting farm. Impact of policy on the number of reports is analysed by use of a dummy variable in a count regression while ‘’ covariates include wildlife counts, landuse and landsize. The probability of experiencing crop damage from wildlife is determined by wildlife densities (Fernandes et.al., 2009) and therefore, reports to KWS are assumed to reflect damage severity. In the absence of complete data on buffalo numbers for the entire period, monthly rainfall figures are used as one of the covariates. This is so since rainfall is a good predictor of standing biomass (Coe et.al., 1976, East 1984, Rasmussen *et.al*, 2006, Caro and Scholte, 2007), it is used here to account for seasons above ground primary production and thus, when pasture is expected to be abundant and therefore changes in standing biomass and differences in wildlife-human competition. This relationship has been found to be significant especially in areas with rainfall of less than 700mm (Coe et.al., 1976).

Data description and analytical framework

To investigate the relationships above, we rely on reports made to the KWS of problem animals. Reports made on account of buffalo are isolated and the date of the report is recorded. These reports are then cumulated for each respective month and this figure represents the record of report severity and acts as the dependent variable in the analysis described below. Recorded rainfall data from the Kenya Agricultural Research Institute is used to provide a backdrop of climatic conditions likely to impact on the severity of problem animals since dry periods will often see wildlife becoming bolder and coming closer to settled areas and competition with human activity becomes stiffer. GIS maps tracing the changes in landuse over time are used to estimate the changes from ‘wildlife habitat’ to agricultural use as well as settlement. Since land available is constant, conversion to uses that are incompatible with wildlife presence are used to identify the influence of such change on the frequency of these reports. The landuses are as presented in figure 1 and these include annual crops, irrigated crops and urban settlement which are treated here as incompatible with wildlife. Generally, land under these uses in 1993 was 1,141km^2 which had risen to 1,440km^2 in 2007 and these are the figures used in the estimations. The effect of policy thus takes a dummy variable form (1=reports made within the 1993-2002 period). The model to estimate is;

Reports $(\boldsymbol{y}_i) = f(\beta \boldsymbol{x}_i)$

Where $\boldsymbol{y}$ are number of reports and $\boldsymbol{x}$ is a matrix of covariates thought to influence the number of problem reports made to KWS while $\boldsymbol{\beta}$ is a vector of unknown coefficients to be estimated. These covariates include the effect of policy, rainfall and landuse.

Econometric approach

The basic foundation of most count data models is the Poisson distribution (Cameron and Trivedi, 1998). The Poisson regression is a member of a class of generalized linear models, an extension of classical linear models but allows the mean of a population to depend on a linear predictor through a nonlinear link function allowing the response probability distribution to be any member of an exponentional family of distributions (McCullagh and Nelder 1989). In the Poisson model, the mean *rate of occurrence* of events per unit of time is λ_i and the probability distribution of the number of events observed per unit of time then will be

$$P(y_i) \;=\; \text{Prob}[\mathbf{y}_i = j] \;=\; \exp(-\lambda_i)\,\lambda_i^{\,j} / j!,\ j = 0,1,...$$

$$\text{where Var}[\mathbf{y}_i|\mathbf{x}_i] = \lambda_i.$$

The Poisson distribution has conditional mean function $E[y_i] = \lambda_i$. The regression model is produced by specificying λ_i to depend upon a set of covariates $\mathbf{x}$. The standard approach which guarantees a positive mean uses $\lambda_i = \exp(\boldsymbol{\beta}'\mathbf{x}_i)$. The log-likelihood, gradient, hessian and marginal effects are (Greene, 1997)

$$\begin{aligned}
&\log\text{-}L \;=\; \Sigma_i\,(-\lambda_i + y_i(\boldsymbol{\beta}'\mathbf{x}_i) - \log y_i!),\\
&\partial\log\text{-}L/\partial\boldsymbol{\beta} = \Sigma_i\,(y_i - \lambda_i)\mathbf{x}_i,\\
&\partial^2\log\text{-}L/\partial\boldsymbol{\beta}\partial\boldsymbol{\beta}' \;=\; \Sigma_i\,-\lambda_i\mathbf{x}_i\mathbf{x}_i'.\\
&\partial\text{E}[y_i|\mathbf{x}_i]/\partial\mathbf{x}_i \;=\; \lambda_i\boldsymbol{\beta} \;=\text{E}[y_i|\mathbf{x}_i]\boldsymbol{\beta}.
\end{aligned}$$

For count data however, the specification $\text{E}[\mathbf{y}|\mathbf{x}] = \mathbf{x}\boldsymbol{\beta}$ is inadequate as it permits negative values of $\text{E}[\boldsymbol{y}|\boldsymbol{x}]$ for similar reasons the linear probability model is inadequate for binary data (Cameron and Trivedi, 1998). The Poisson is also often criticized for its restrictive assumption of equi-dispersion and in real-life applications, count data often exhibits over-dispersion and excess zeros (Cameron and Johansson, 1997, Liu and Cela 2008). A Poisson regression then under conditions of overdispersion leads to deflated standard errors of parameter estimates and therefore inflated t-statistics (Cameron and Trivedi 1998, Liu and Cela 2008, Sileshi, 2008). One method to handle the extra Poisson variability is to build in an unobserved heterogeneity with a parametric distribution and the gamma distribution is a common choice for the heterogeneity, partly because it is flexible and partly because the integral for the marginal distribution has an analytic solution (Lindsey, 1995). This results in the Negative Binomial model which comes in handy to deal with over-dispersion which has qualitatively similar consequences as the failure of the assumption of homoskedasticity in a linear regression (Cameron and Trivedi, 2001). The negative binomial instead assumes a gamma density for an unobserved frailty factor but the method does not recognize an irregular distribution such as that with an extra amount of zeros (Cheung, 2002). Data can contain excess zeros which has been shown is a strict implication of unobserved heterogeneity (Mullahy, 1997). Zeros however can be generated from two sources, and not one as assumed in the hurdle model. To counter these problems, Negative Binomial Models, Zero Inflated models and even hurdle models can be used to model count data. The hurdle model is similar to a Zero Inflated Poisson (ZIP) model except that it does not mix zeros from the binary and count processes (Hoef and Jansen, 2007). A Zero-Inflated model provides additional opportunities for testing hypotheses on group heterogeneity as well as subject heterogeneity (Tin, 2008). Zero-Inflated Poisson models provide a powerful way of dealing with the problem of excess zeros found in count data and such methods have been used (e.g., Martínez-Espiñeira, 2007, Sileshi 2008, Sileshi et.al., 2009). They assume that the count data exhibiting excess zeros are a mixture of two separate data generation processes: one generates only zeros, and the other is either a Poisson or a negative binomial data-generating process (Erdman et.al, 2008). The ZIP and ZINB regression models simultaneously model the two components of the distribution. For our instance, there may be those who choose not to report problem animals so reports are zero while similarly, there are those who do not experience problem animals and so their reports are equally zero. Ideally, this decision to report is made at the individual level. However, we could extend this same reasoning to times when reporting problem animals is not made or times when problem animals do not appear. To account for the many zeros in the data, we can use a Zero-Inflated Poisson (ZIP) or the Zero-Inflated Negative Binomial (Chou and Steenhard, 2009).

In many count data studies, cross sectional data is used and heterogeneity as opposed to dynamics is the focus. We therefore take the static route and model these reports as a function of rainfall, landuse changes and the application of official programs meant to ameliorate the presence of wildlife. We apply several of these estimations (Poisson, Negative Binomial, ZIP and ZINB) to investigate the likely impact of the cropping program on monthly reports to KWS.

Results

Crop damage by wildlife is the most frequently cited problem and buffalo, hippopotamus and zebra make up 82% of all reported cases with the percentages as 43.8%, 28% and 10.3% respectively. Crop destruction and threat to human life account for 50% and 44% of reported cases at the KWS offices respectively. Leopards are the most occurring canids in the reports representing 63% of the reported cases of livestock predation while hyenas contribute 13% of these cases. Many of these reports though spread out over the entire NWC show a tendency to concentrate on farms on the eastern edge of Lake Naivasha and five of these large farms together reported 25% of the problem animals out of a total of 199 reporting farms between 1993 and 2007 (50% of the reports are from 12% of the farms). From all reports, buffalo appears to be the offending species represented in 1,221 of the reports to KWS. 48% were in respect of human threats, 51% on crop destruction and only 1% relating to threat to livestock.

The total number of reports for respective years is graphed on figure 3 with rainfall figures are superimposed for comparison. The graph indicates that there was a peak in reports during 1999 but soon after, reports in the next year dropped by almost half and further down in 2001. The period of El-Nino may have caused this although for the Naivasha area, the rainfall index was not as favorable as say 2004, a year which received over 1,000mm of rainfall compared to the longterm average of 600mm (figure 3). The frequency of reports does not seem to have a particular pattern although they increase with time until 1999, then drops till 2001 and picks up in 2002. Serial correlation was tested for the dependent variable (reports) autocorrelation plots derived. All of the estimated parameters (MA1,1; MA1,2 and AR1,1) save for AR(2,1) have relatively large t-statistics, which indicates that these parameters cannot be omitted from the model. To account for seasonality therefore, the month of the year is used as one of the covariates since the data shows the presence of a unit root. Since our aim is not to provide suitable forecasts of reports, we do not labor too much to on seasonality. Separately, we also use trigonometric components to model for seasonality as used in Nelson and Leroux (2006) but these do not alter the conclusions made in the paper (results of these regressions are available from the authors on request) and are not reported here.

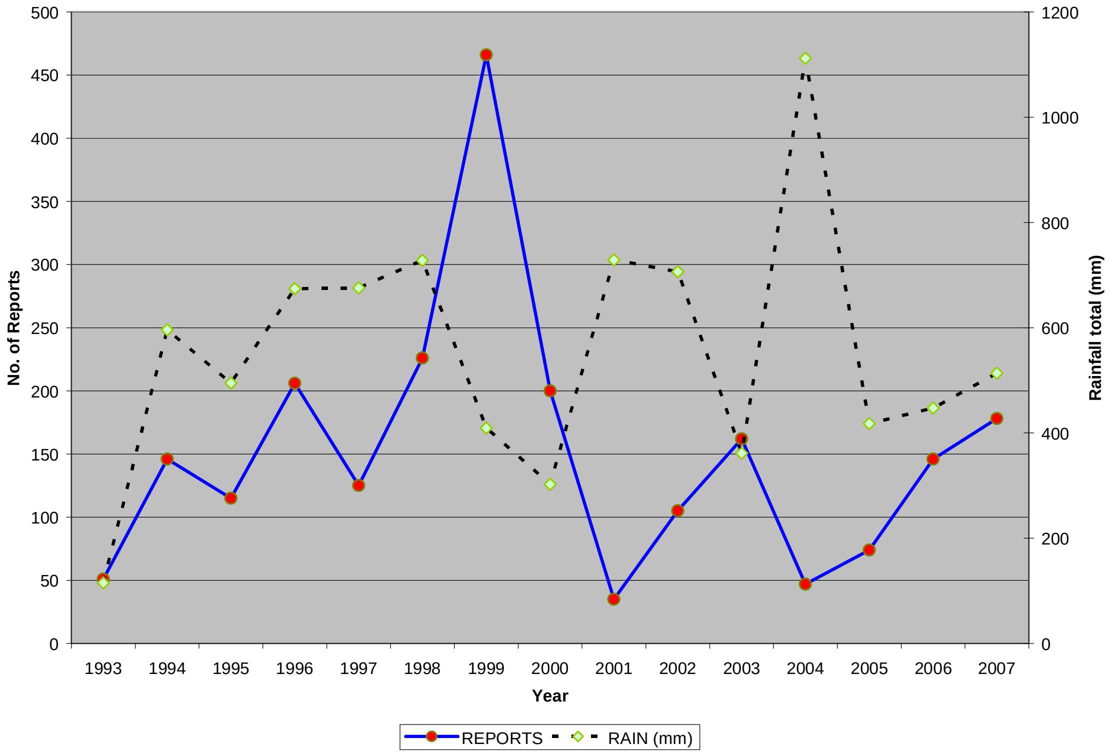


Figure 3: Rainfall and reports for NWC, 1993-2007

Table 1: Summary of variables used in the estimations

Variable	Description	N	Mean	Std dev	Min	Max
Count	No. of reports to KWS during month	171	3.28	4.85	0	26.0
Rainfall	Rainfall recorded at KARI Naivasha during month in mm	171	48.402	44.745	0	201.90
KWSprogram	KWS pilot program If report occurs during the period 1993-2002, KWSProgram =1, else=0	171	0.579	0.495	0	1
Landuse	Area under the uses (annual crops, irrigated crops and urban) in km^2	171	1,277.2	88.377	1,141.4	1,440.6
Month	Month during which report is recorded	171	Dummy variable each representing the 12 months of the year			

The report frequencies are shown on figure 4. The graph clearly reveals that reports are on average 3.3 with a variance of 23.5 thereby justifying the use of the family of non-normal distributions. The regression implemented in SAS using the variables described on table 1 yields the results that are displayed on table 2 below. Seasonality is proxied by use of month as an additional regressor and December is used as the reference period.

Table 2: Results of different count data estimations

Variable	Poisson	Negative Binomial	ZIP		ZINB	
Intercept	-8.739 <0.0001	-14.993 0.0003	-8.8191 <0.0001	-2.0834 0.6967	-12.9678 0.0084	-4.1341 0.7518
Rainfall	0.0032 0.0007	0.0043 0.1306	0.0037 0.0001	0.00018 0.9628	0.0045 0.0982	-0.00097 0.8784
Policy	1.447 <0.0001	2.3929 <0.0001	1.5427 <0.0001	0.3920 0.5712	2.098 0.0008	0.6103 0.6732
Landuse	0.0071 <0.0001	0.01147 0.0001	0.00738 <0.0001	0.00188 0.6246	0.01617 0.0029	0.0041 0.6411
January	-0.4379 0.0322	-0.3294 0.5620	-0.5325 0.0104	0.9036 0.3379	-0.5228 0.2937	4.3661 --
February	-0.5017 0.0172	-0.5698 0.3196	-0.5550 0.0126	-0.1155 0.8888	-0.4677 0.3766	-0.3318 0.8420
March	-0.6214 0.0041	-0.6550 0.2563	-0.1778 0.4121	-0.8768 0.2630	-0.1301 0.8226	-1.4757 0.3478
April	-0.5805 0.0064	-0.4762 0.4054	-0.2409 0.2561	-0.5799 0.4611	-0.1258 0.8222	-1.1703 0.4555
May	-0.6019 0.0051	-0.6880 0.2349	-0.5208 0.0189	-0.2042 0.7996	0.5423 0.3116	-0.5531 0.7323
June	-0.1300 0.4874	-0.3084 0.5916	0.1574 0.4052	-0.5885 0.4476	0.06297 0.9060	-1.2056 0.4396
July	0.1079 0.5439	0.04669 0.9333	0.3411 0.0615	-0.2735 0.7250	0.3471 0.5084	-0.9870 0.5401
August	-0.0585 0.7513	-0.0743 0.8947	-0.2027 0.2808	0.7158 0.4141	-0.2471 0.6088	3.8111 --
September	-0.4877 0.0190	-0.7691 0.1749	-0.0683 0.7459	-0.9951 0.1986	-0.2051 0.7127	-1.4952 0.3410
October	-0.3770 0.0631	-0.6918 0.2320	-0.6261 0.0040	0.7076 0.4744	-0.7901 0.1111	4.7017 0.7110
November	-0.6454 0.0026	-0.9390 0.1110	-0.7504 0.0010	0.0603 0.9434	-0.9857 0.0594	0.4842 0.8280
α		1.9578 <0.0001			0.8502 0.0006	
-2LL	1210.4	738.3	851.7		718.7	
AIC	1242.4	770.3	911.7		780.1	
BIC	1292.6	820.5	1006.0		877.5	

The second row reports *p*-values. Shaded cells are the zero inflation part

Model choice:

We begin by making a choice of model the model that fits our data best and this is done by examining the improvement in the likelihood-ratio when we consider the alternative models against the Poisson. The dispersion parameter **α** is significant (prob>|t| 0.001) indicating that overdispersion is significant. Overdispersion and the significance of **α** could be due to zero inflation hence, explicitly modeling zeros could be desirable (Martínez-Espiñeira, 2007). The results of the zero inflated models (ZIP and ZINB) are tabulated alongside those of the Poisson and Negative Binomial model (table 2). The Log Likelihood shows a significant improvement of the Zero Inflated Poisson over the Poisson (table 2). Similarly, the same goes for the Zero Inflated Negative Binomial versus the Negative Binomial. A Vuong test is applied pick between the alternative models. A Vuong statistic of 5.2103 (p=0.0000001.88) indicates a significant improvement of the ZIP over Poisson whereas a Vuong statistic 2.2766 (p=0.0228) indicates similarly an improvement of the ZINB over the Negative Binomial. The results will thus be discussed using the parameters from the ZINB although the sign and not the magnitude of the coefficients are of interest to us in this paper.

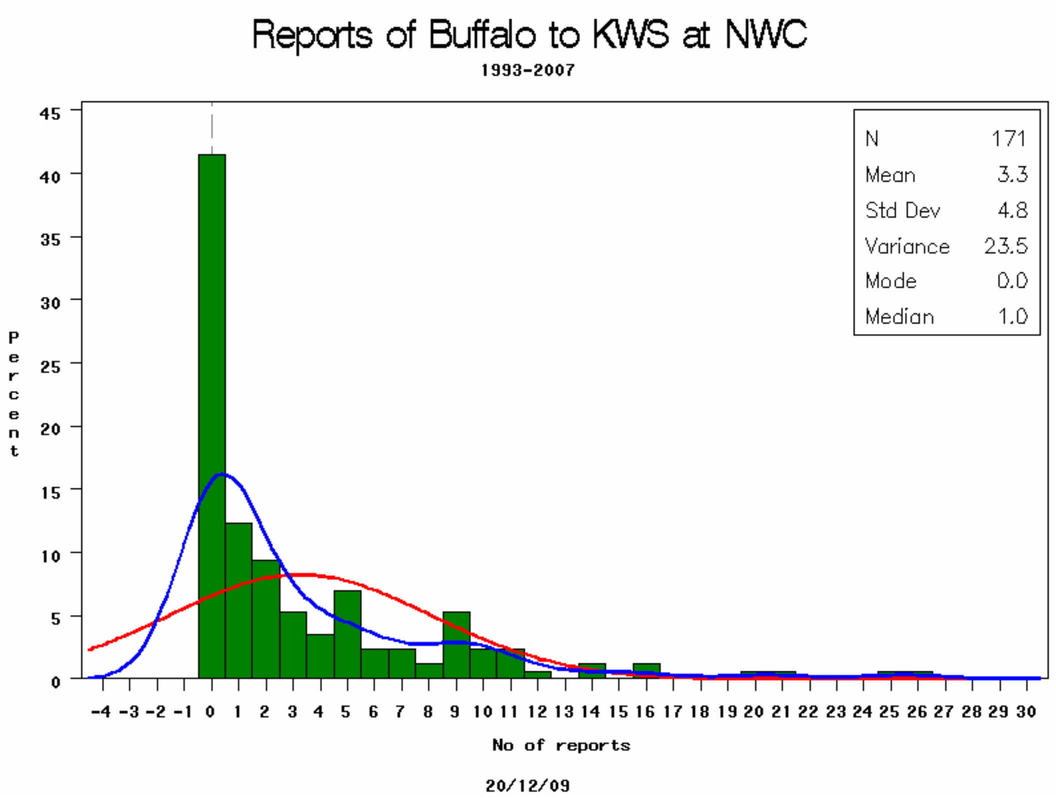


Figure 4: Monthly report frequencies at KWS Station in Naivasha

Coefficient Interpretation

Results tabulated above show that the effect of the parameters on wildlife reports is generally positive i.e. as rainfall and/or landuse under wildlife competing enterprise increase by one unit, a corresponding increase in the number of reports to KWS is expected. The parameter of direct interest in our study (effect of policy) is positive and significant (for all models above). For the Poisson, Negative Binomial, ZIP and ZINB, the estimated change from policy was to increase reporting. The result is hardly one expected since as hinted in the introductory sections, we expected to see a decline in $\mathbf{y}$ as Ψ decreases (i.e. during the time when $\Psi^1 - \Psi^* > 0$). The estimated relationship is positive and significant meaning that more reports were made during this particular period. This raises the fundamental question of the effectiveness of such a policy since the problem of moral hazard could be at play. When the policy was on, property owners could reduce on wildlife control expenditures in the hope that the resource is to be harvested but this then increases the risk of wildlife frequenting such properties. The increasing number of reports up to 1999 could support this argument. Landowners may then have taken to reporting more in the hope that quotas would be increased. This result appears to support the argument against compensation as detailed in Bulte and Rondeau (2007) citing moral hazard as a source of inefficiency. Static optimization could also have occurred with property owners discounting the future at a very high rate and since wildlife is mobile, they over-report in the hope they would capture a larger potion of the available quota. However, the presence of unutilized quotas by some landowners might invalidate this argument.

Increase in area under crops and settlement would then increase the number of reports to KWS. This result is as expected *a-priori* since new land brought into production takes away what would otherwise be habitat for wild animals. An increase in land under annual and irrigated crops as well as settlement will increase the number of reports. Significant changes in landuse from forest, woodlands and rangeland to agriculture, and built-up lands in this area have occurred and if these trends continue, then the models predict greater frequencies of such reports. Conversion of land to annual crop cover has been the biggest contributor to this fall in shrubland, woodlands and forest over the 1975-2008 period growing at an annual rate of 19% (SPARVS, 2009).

Rainfall also yields a positive coefficient (not significant at 0.05 in some of the estimated models). Never-the-less, this was expected since rather than reduce competition from wildlife, rainfall probably makes farmers to respond faster to wildlife presence since they wish to minimize damage on planted crops. Field crops mainly maize and beans are normally planted at the beginning of both the short and long rainy seasons (here November and April). The positive sign may be because buffalo numbers increase following heavy rains and this could also be true for livestock numbers. Hence, when the dry weather comes, competition for use of the land intensifies since livestock keepers are not able to quickly adjust stock sizes immediately to reflect this change. Modeling through the use of actual biomass (actual buffalo numbers) would have been more ideal. One would however argue that with the onset of rains, buffalo have enough to forage on and possibly take a break from planted crops and therefore reducing on the need to make reports to KWS. Besides, births tend to be seasonal where rainfall is limited but for the Naivasha area, it is not clear whether this seasonality arises or that buffalo here breed throughout the year.

Discussion and Conclusions

The results here appear to give credence to the results of the study by Elliott and Mwangi (1997) which estimated that landowners only recouped less than 5% of value added from cropping quotas with other instances of unfulfilled quotas in Laikipia. The cost of culling buffalo and zebra was exorbitant to the extent that the quota available to some landowners was not being exhausted while others opted to leave their quota untouched. Some of the products (e.g. skin) were of low quality as the industry was still developing. The hide and skin sub-sector even for livestock derived hides has been undergoing difficult times in Kenya and the region owing to poor prices some of which is caused by their poor quality and finishing. For instance, many tanneries have closed since the abolishment of the 22% export compensation subsidy in the early 1990s with those in operation operating below their installed capacity. This shortage locally is accompanied by the export of raw hides and skins which attract a low price and the import of finished leather products which then in turn makes the leather industry situation more acute. However, the recent increase in tax on the export of raw hides to 40% may help stem this trend for the leather industry.

For wildlife meat, it may also be that the quota was set at a low level to the extent that did not fully compensate for wildlife losses and thus some opted out from the program if the marginal benefit and marginal costs are at variance. Competition with ‘illegal’ bushmeat can easily drive prices of legal wildlife meat down therefore taking away from the gains that are likely under such a policy. This can be true especially if the ‘illegal’ trade is substantial such that it affects supply and thus can drive down prices. However, meat prices in Kenya have been observed to be stable probably due to possible price fixing by middlemen especially in the terminal markets and since ‘illegal’ meat handlers may not venture into the livestock markets. Therefore, this effect of ‘illegal’ meat on supply might not be straightforward. Similarly, the restrictive regulatory environment by KWS may also have contributed in making landowners to react the way they did in this example. What is also clear is the effect of landuse changes on the number of reports. It follows that as the change into more intensive land uses increases, conflicts will no doubt occur. In addition, when looking at the problem animal reports, it is clear that they are not evenly distributed in space meaning that wildlife presence is also spatially variable. What this means is that any conversion of land from wildlife habitat should take place more in areas away from wildlife presence so as to minimize chances of wildlife-human contact.

Creation of other positive benefits to those living with wildlife have been made and this is the case in the Kitengela area where households are receiving a token for engaging in landuses that are compatible with wildlife presence. The program is reportedly changing local attitudes toward wildlife and is in high demand with these groups of pastoral families. A similarly designed program for an area like Naivasha might also be able to reduce the cases of human-wildlife conflicts. Other programs such as Namibia’s CBNRM program have created conservancies; social units of management, where a group of communal residents get together and agree that they want to have exclusive rights over the wildlife and tourism in their area. The Namibian government then devolves these rights to the local level once certain conditions have been met and thus Gazette these conservancies which today occupy over 13 million ha. The dilemma here is that of balancing development with leaving land undeveloped while taking into account that many of these conservancies have been created mainly on communally held lands as opposed to the private title characterizing an area like Naivasha.

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