Economic incentives and poaching of the one-horned Indian rhinoceros in Nepal

Simulation modelling of policies to combat the poaching of Rhino in Royal Chitwan National Park, Nepal

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Abstract

Abundant in the past, the one-horned rhinoceros that inhabits the low-lying Terai region of Nepal has come under pressure due to the loss of habitat and poaching. Efforts to protect the species continue to face considerable challenges, including: (i) economic constraints associated with protecting these species in one of the poorest countries in the world; and (ii) the ineffectiveness of current policies due to a number of socio-economic and political factors. This study models poaching behaviour to provide information about the effectiveness of current interventions and to simulate alternative policies. Our goal is to help design more effective policies to combat poaching, while at the same time ensuring that local livelihoods are supported. This study considers some salient features of the rhino conservation/poaching problem in Nepal, such as: rhino population dynamics; crop damage due to rhinos; park-community revenue sharing programmes; the collection of resources from the park; and tourism employment etc., when running a simulation model. Indeed, all of these factors were entered as submodels within the overarching simulation model. The simulation model was run over a ten-year period from 2004-2013 (inclusive) for four policy scenarios. The current policy scenario represents the baseline and the three other hypothetical scenarios represent three distinct policy alternatives. The simulation results indicate that although a conventional conservation strategy, emphasising the role of anti-poaching units (APUs), is likely to increase the rhino population to a greater extent than the other strategies, it produces less overall benefits to local communities. Conversely, incentive-based conservation strategies that target farming and non-farming households through economic incentives (such as compensation for crop damage, increased employment opportunities, and greater access to park resources), along with some anti-poaching enforcement, are likely to increase the rhino population and at the same time produce greater overall benefits for local communities. It is inherently difficult to ensure all stakeholder groups simultaneously benefit from a single policy measure. However, the simulation results show that any policy that tries to incorporate the concerns of different stakeholders by providing different economic incentives is more likely to help protect rhinos, and at the same time improve local livelihoods.

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1. Introduction

Nepal is a small country with a very diverse ecological landscape. An important part of this diversity is the one-horned rhinoceros (*Rhinoceros unicornis*) that inhabits the low-lying Terai region along the border with India. Abundant in the past, the one-horned rhino has come under pressure due to loss of habitat and poaching. Efforts to protect the species continue to face considerable challenges. Considering the importance of maintaining biodiversity and the status of the one-horned rhino as an endangered species, it is imperative that the reasons behind a recent increase in poaching be understood. This understanding would help in the design of more effective policies to combat poaching, while at the same time ensuring that local livelihoods are supported. Ideally, these two objectives should be pursued together. This working paper is concerned with modelling poaching behaviour to provide information about the effectiveness of current interventions and to simulate alternative policies. An economic modelling exercise was carried out, drawing on primary and secondary data; this working paper describes that work, together with the simulation modelling of various policy options.

The research presented in this working paper takes into account the salient features of the rhino-poaching problem in Nepal. For example:

- Some park revenues (e.g., entrance fees) are shared with local communities, creating some incentive to maintain the rhino population;
- Households engage in agricultural activities around the parks and experience crop damage due to rhinos;
- Many households collect thatching grasses from the park;
- Local people may own or be employed by tourism businesses, creating an incentive to maintain rhinos for employment purposes;
- Some local households, together with outside gangs, poach rhinos for private profit;
- Government officials are involved in managing the park, controlling poaching and encouraging regional economic development;
- The rhinos attract tourists (residents and non-residents) to the national parks; tourism visitation and revenues are a function of the rhino population.

For the simulation exercise, the first step involved constructing a population dynamics model for the rhino. A discrete, stage-class population model with a one-year time step was used for this purpose. The complete rhinoceros population model was coded and run using the Stella 5.1.1 software package. A full description of this model is provided in another working paper. The poaching of rhino was modelled in another working paper and the details are not repeated here. The poaching model is a reduced form model of poaching that was derived from a fairly standard open access formulation of the poaching problem.

Subsequent steps in constructing the simulation model are described in this working paper. These involved linking the reduced form poaching function described above with the population dynamics model to form a single sub-model. The simulation model was then extended to include two additional sub-models; the first one compiled components of household income in the buffer zone, and the second one set the revenue-expenditure balance in the community share of national park revenues. The relationships comprising the former sub-model (household income) were derived using i) agricultural and natural resource use data from the household survey, ii) simulated rhino population data from the population dynamics modelling, iii) secondary data on tourism visitation and associated economic spinoffs (employment), and iv) econometric estimation techniques. The latter sub-model refers to the 50% share of all the RCNP revenues that are disbursed to buffer zone communities. The full model, therefore, consisted of three sub-models that together tracked over time the rhino population and poaching losses, components of regional income and the allocation and use of the community funds derived from the national park. This set of indicator variables was then plotted as different simulations were run. The simulations differed in terms of the policy mix assumed, including variations in i) the level of anti-poaching enforcement, ii) compensation paid to farmers for crop losses due to rhino-associated damage and iii) local employment initiatives.

2. Poaching and rhino population dynamics sub-model

2.1 Brief overview of the sub-model components

The poaching and rhino population dynamics sub-model consists of two components – the poaching component, and the population dynamics component – that interact with and affect each other. The poaching component represents the socioeconomic and policy factors that affect the historic level of poaching in the RCNP, and generate the level of poaching each year for a given level of exploitable population. The socioeconomic and policy factors in the poaching component include the level of anti-poaching enforcement, per capita GDP in Nepal, per capita GDP in Hong Kong, and the Maoist problem in Nepal in recent years. The level of poaching each year is equivalent to the harvest from the rhino population and gets taken off the population in that year. The population dynamics component estimates the total annual population of rhinoceros in the RCNP using a discrete stage-class model. Calves, sub-adults and adults are the three main age classes included in the population component, and the model includes the natural mortality rate for each of these age classes. Other processes represented include the birth rate and the carrying capacity of the park, as well as the process of translocation (from park to park) for a number of years. The population is assumed to experience density-dependent regulation described by a logistic growth model.

2.2 Simulating poaching and rhino population dynamics

Since poaching assumes the role of harvest (although illegal), it affects the rhino population component negatively. On the other hand, the population component has a positive affect on poaching as a higher population leads to the probability of higher catch and harvest. Although data on the number of rhinos poached in the RCNP since its establishment have been very well recorded, there are a lot of gaps in the population data for the species. So, the rhino population had to be simulated from the early years onwards, to fill these gaps. The best fit model from these simulations that used the observed figures for the rhinoceros poached (Rothley *et al.* 2004) was used in the estimation of the poaching function in LIMDEP 7.0 (Retrospective model – Working Paper 1). The estimated coefficients for the poaching function were then introduced in the STELLA 5.1.1 for simulation of the poaching and rhino population dynamics sub-model. In the poaching component, most of the socio-economic and policy factors can be altered for the purpose of simulation. For example, the number of APUs active during a year can be altered to depict scenarios with varying degrees of enforcement. Alternatively, the GDP growth rate in Nepal and in Hong Kong can be altered to analyse differing effects of economic factors on the level of poaching, or the 'Maoist factor' can be set to 0 or 1 to depict the level of poaching under different political scenarios.

3. Components of buffer zone (regional) household income sub-model

Rather than constructing a full household model, we concentrate on components of income that relate to park use and rhino conservation (a 'partial' model of income). In addition, we model these components of income at the regional level, where the level of aggregation is the RCNP buffer zone. This zone contained 36,193 households in 1999. Our components of regional income are confined to various revenues earned by households without any deduction of costs of labour or materials (except for repayment of micro-credit loans). In this sense, we do not work with concepts of income that are consistent with usual economic theory. However, as our main interest is in tracking general trends, we feel that this simpler approach (which was imposed due to a lack of data) works quite well for our analysis.

We consider five components of regional income. These are agricultural income (adjusted for any compensation for crop damages), Y_A; income in-kind from collecting resources from the RCNP, Y_c; income from off-farm employment (here assumed to be park-related only, e.g., tourism and anti-poaching units (APUs)), Y_T; and income stemming from micro-credit schemes supported by the conservation authority, Y_R.

In addition, we argue that households take the population dynamics of rhino into account when making decisions about cropping and employment. In turn, the rhino stock determines some components of income. We can model each component of income in turn. Where relationships were estimated econometrically, we used LIMDEP 7. Note that time subscripts are suppressed.

3.1 Agricultural Income

Model

Agricultural income derives from a single seasonal crop (rice) with price p_A and quantity Q_A. To capture the damage from rhinos we incorporated crop losses, but we were not able to include the allocation of labour for protecting crops from damage or any protective expenses (e.g. trenches). In the latter case, the relationships were to be derived from household survey data but these did not prove useful. Ideally, we also wanted to account for any crop-switching to less palatable but also less profitable crops; however, this was difficult to do and therefore not included. Ignoring purchased agricultural inputs, we follow Damania *et al.* (2003) in modelling aggregate agricultural income, Y_A, and crop losses from rhino:

$$Y_A = p_A \left[Q_A(L_A, A) - D(X, d, A) \right] N \tag{1}$$

where p_A is the price of the agricultural crop, $Q_A(..)$ is the rice production function, with L_A the household labour input (including allowance for any purchased labour) and A the average cropped area per household. $D(..)$ is a damage function showing the quantity of crop lost as a result of rhino trampling of crops, where X is the rhino stock and d is the distance from the park. Distance is included as an argument in the damage function, since obviously the more distant the household, the lower the expected damages (all other factors remaining constant). The damage function $D(..)$ can be thought of as 'expected damages' and further divided into two functions. The first represents the probability that an average household might experience any rhino damages at all, and the second measures the amount or 'intensity' of this average loss should a loss occur. Finally, the full relationship is multiplied by N, the number of farming households in the buffer zone (or within a particular sub-group) to yield aggregate income from rice production. In this formulation, it is assumed that all farming households are identical; however, we later vary this assumption in the simulation to allow for weighted income deriving from various subsets of farmers (according to the frequency of rhino sightings).

Estimated relationships

Production function for seasonal rice

This model is a simple agricultural production model. It was estimated from data collected in the household survey, based on a sample of 224 seasonal rice farmers. We obtained the following OLS result using a Cobb-Douglas specification:

$$\begin{gathered} Q_A = 0.676\, L_A^{0.266} A^{0.812} \\ R^2 = 0.81, \quad F[2,221] = 478.95, \quad DW = 1.57 \end{gathered} \tag{2}$$

The estimated equation provides a good fit, and all the coefficients are significant ($P < 0.05$). The relationship indicates slightly increasing returns to scale; this would make sense given the economies arising from farming a larger (but contiguous) plot of land. Pre-multiplying the production function by the price of rice gives revenues, and subtracting labour costs provides net returns. Local crop and other prices were collected in the field.

Optimal labour use for rice production was needed for the simulations and was estimated for households grouped according to frequency of rhino sightings (see below). Net returns were maximized using an agricultural wage of 120 NR/day and ignoring other input costs. Results for optimal labour use were generally in the range of 30 days/household, based on an average land holding of 15.18 *kathas*.

Probability of crop damage from rhinos

The two components of the damage function *D(…)* were also determined from survey data. The fixed size of the rhino population might be expected to present difficulties for the estimation of damages using cross-sectional data (all households face the same rhino stock). However, we were able to overcome this problem by using variables in our estimation for the number of sightings of rhino by households, and by assuming these would increase with any change in the rhino population.

The probability of damages occurring was modelled using a logistic (or 'logit') specification and the sample population of 224 rice farmers. As indicated above, the influence of rhinos was incorporated by accounting separately for households sighting rhinos daily (*Rd*), weekly (*Rw*) and monthly (*Rm*) as dummy variables. To avoid the dummy variable trap, the default situation was 'no sightings by the household'. In addition, the model included the distance from the park (*d*), which was not highly correlated with rhino sighting data, and a quadratic distance term as well. To capture the possibility of a varying rhino population, the estimated logit equation was scaled using the term X_t^3 / X_0^3; where the numerator is the current year's rhino population and the denominator is the rhino population in the base year when the survey was undertaken, i.e., 2003. Each term in this ratio was cubed, as this provided a more credible profile.

We obtained the following result:

$$\Pr[D>0] = \frac{1}{1+\mathbf{e}^{\left(-\frac{Xo^3\,(-1.568+3.454\,Rd+2.269\,Rw+1.496\,Rm-.538\,d+.055\,d^2)}{Xt^3}\right)}} \qquad (3)$$

In terms of goodness of fit, the underlying Logit model was able to correctly predict 169 observations out of 224, or 75%.

Intensity of losses from rhino-related crop damage

The second component of the damage function concerned the intensity of loss of rice production from rhino-related damage. This relationship was estimated with OLS and used variables found in the production function (cropped area, *A*) and the probability of loss function (*Rd,Rw,Rm* as dummy variables and distance from the national park, *d*). Based on 130 observations and a log-log specification, we obtained the following result:

$$D|_{\Pr>0} = \frac{\mathbf{e}^{(-2.935+2.052\,Rd+1.566\,Rw+1.180\,Rm)}\,A^{.505}}{d^{.231}} \qquad (4)$$

$$R^2 = 0.36, \quad F\,[5, 124] = 15.57, \quad DW = 1.67 \qquad (5)$$

While the goodness of fit on this model was somewhat less encouraging, all the estimated coefficients had the correct sign and were significant ($P < 0.01$) after correction for heteroskedasticity.

3.2 Collection of natural resources from the RCNP

Model

Thatching grasses are collected legally from the park during a designated harvest period, while other resources (such as fuelwood and fodder) are collected clandestinely. We did not use a conventional price times quantity formulation, which involves estimating output as a function of labour and any other inputs. This is because it does not explicitly allow for consideration of the number of days the national park is open for collection activities. Instead, we explicitly model labour used in collection (from our household survey) as a function of various influences, including days the national park is open for collection of natural resources. Then we multiply this labour use (in person-days) by the value of natural resources collected per person-day and subtract the permit fee in order to yield in-kind income from this activity.

As a result, we model the aggregate income from this production activity as:

$$Y_c = N\left\{V_c L_c(LF, DY, D_c, d, Z) - p_z\right\} \tag{6}$$

where V_c is the average value of natural resources collected per person-day (from our household survey); L_c is the labour expended in collecting thatch and other products; LF is the household labour force; DY is the number of days the park is open for collecting annually; D_c is the total consumption (from all sources) of natural resources available from the park (a proxy for demand); d is the distance from the park; Z is a vector of household cultural characteristics; and p_z is the permit fee for collecting. This permit is a fixed fee of NR 5 per individual collector: it allows an individual to return any number of times while the park is open for thatch collection.

Estimated relationships

Our model required estimation of the relationship describing the average number of labour days used by a household for the collection of natural resources from the RCNP. Initially we considered a count model (Poisson regression) to estimate this dependent variable, but this performed poorly in predicting the average number of days used for collecting per household within the relevant range (e.g. mean of 3.55 days/year in our sample). Although the model fit well, we chose an alternative estimation method using simple OLS regression instead. The key policy variable was 'the days the park is open for natural resource collection' (DY) but as our model was cross-sectional, this did not vary across households. We circumvented this difficulty by specifying a new variable (labour days available) that was constructed from LF and DY by taking the product of these two independent variables. We obtained the following estimated relationship:

$$L_c := 3.67 + .042\, Dc + 2.047\, Z - \frac{10.007}{LF\, DY} - .257\, d \tag{7}$$

$$R^2 = 0.40,\ \ F\,[4{,}439] = 76.08,\ \ DW = 1.62 \tag{8}$$

In our final OLS model, the variable Z (household cultural characteristics) was proxied using a dummy variable indicating whether the household belonged to an indigenous group ($Z = 1$ if so), which provided a positive influence on labour days used per household. Although the count model has the benefit of not permitting negative values, the fitted OLS equation produced positive values for the range of values for DY of policy interest (3 days or more, annually). Moreover, the OLS equation predicted 3.62 days per household when mean values for the independent variables were used, which was very close to the sample mean. In contrast, the count model produced an estimate greater than 5 days/household. All coefficients in the estimated equation were of the correct sign and highly significant ($P < 0.01$). The model explained 40% of the variation in labour days used per household, which is relatively good for a cross-sectional model.

3.3 Tourism employment income

Model

For now we assume only selected park-related employment, comprising jobs and income in the eco-tourism industry and anti-poaching patrols (APUs). Bookbinder *et al.* (1998) indicate that the current rate of tourism employment in the RCNP region is very low: only 4% of households surveyed reported having members working in the local eco-tourism industry. At present, all original APUs in the RCNP are restructured, but there are proposals to re-establish up to 10 APUs in the park (DNPWC 2003a, 2003b).

The number of tourism jobs in the buffer zone is clearly a function of the level of tourist visitation to the RCNP, since these jobs are dependent on providing services to the tourists. We assume that i) employment opportunities depend on the number of visitors to the park in some fixed proportion, and ii) that the number of visitors in turn depends (at least partly) on the stock of rhinos. Following Bulte and van Kooten (1999) we do not explicitly model visitation but rather treat it as a function of the rhino stock, adding other variables that may help explain visitor numbers. Visitation is unlikely to rely on the rhino population alone.

In addition, we make an adjustment in our model for employment of local people vs. outsiders. Bookbinder *et al.* (1998) indicate that about 72% of employment in tourism is local. As a result, we assume the following relationship determines local vs. outsider jobs in the local tourism industry:

- Local jobs:

$$\{0.72\eta V(X,M,S)\} + \frac{R}{0.5w_T} \tag{9}$$

- Outsider jobs:

$$\{0.28\eta V(X,M,S)\} - \frac{R}{0.5w_T} \tag{10}$$

where w_T is the average wage paid to employees in the tourism industry; η is a coefficient translating visitor days into employment; $V(X,M,S)$ is an expression yielding the number of visitor days as a function of the rhino population and other factors (e.g. incomes, political disturbances, etc.); R is the funding level to support increased local hire (which is a policy variable). Note that we assume that a subsidy or training allowance of 50% is required per job transferred from an outsider to a local person. In the case of employment of outsiders, we assume that only 50% of the wage income accrues as income to local households (within the buffer zone). To account for APU employment, we add the income share (50%) of the annual cost per APU and multiply this by the annual cost per APU and the number of APUs employed annually by the park (see section 4.2.1 for details). Thus, our final statement for household income accruing from employment in tourism, assuming that there is no subsidy ($R = 0$), is:

$$Y_T = 0.86 w_T V(X, M, S) + 0.5 * C_{APU} * APU \quad (11)$$

Estimated relationships

We estimated the function $V(X,M,S)$ using regression techniques and the parameter η from employment data for the buffer zone of the RCNP. Visitor entry statistics are available for the RCNP for several decades and we were able to use a simulated time series for rhino numbers generated by our own research. Employment data relating to the eco-tourism sector is provided by Bookbinder *et al.* (1998). Relating visitor numbers to the rhino population was more challenging, since a proper survey and study of this has not been carried out. However, we hypothesize that the relationship between visitor numbers and the rhino population should show a characteristic *S*-shape: visitation will increase rapidly as the number of rhino initially rises from a low number, but then begins to flatten out as the number of rhino grows. This latter assumption reflects our belief that an additional increment in rhino numbers once the population is quite large should have relatively little influence on visitor numbers. An inspection of the plotted rhino population and visitor numbers supported our hypothesis.

As a result, we specified our relationship as a logistic equation and used a common linear transformation in order to estimate it with OLS (see Knowler, forthcoming). The key issue was choosing an asymptote to govern the relationship, i.e. an estimate of the maximum number of tourist visitors. To date, the maximum number of annual visitors to the RCNP has been 117,000, so we tried values of 120,000, 150,000 and 200,000 for the maximum. The value of 150,000 performed best so it was retained in the analysis. Using time series data for 1974 to 2001, the estimated equation for visitor days in the RCNP was:

$$V(X, M, S) = 150000 \frac{1}{1 + e^{(8.16210 - 0.01206X - 0.00057M + 1.14075S)}} \quad (12)$$

$R^2 = 0.97$, $F\,[3, 24] = 252.60$, $DW = 1.07/1.78$ (after AR1 correction) (13) where X is the rhino population in a given year, M is the real world GDP per capita and S is a dummy variable that captures the sudden collapse in visitation after the assassination of the Royal family in Nepal in 2001 ($S = 1$ for 2001). The equation fits well: all signs are correct and all coefficients are significant ($P < 0.05$). Given the autocorrelation in the data, an AR1 procedure was employed in the final model.

To convert visitor numbers into tourism employment, we used park and buffer zone data for 1999. To calculate η we took the ratio (total tourism jobs in the buffer zone/total tourist visitors), which yielded a value of (2300/117,500) or 0.0195. Since tourist visitation during the study period was at its highest level in 1999, our estimated η could be slightly low. Bookbinder *et al.* (1998) obtained an average wage in the local tourism sector of US$ 600 per year from survey data.

3.4 Income from micro-credit schemes

We included an element in local household incomes to capture the use of micro-credit schemes. These support the livelihoods of particularly marginalized people in the buffer zone. Since we could not be specific about how these funds might be used, we constructed a simple model of a small household-based craft enterprise. This exercise produced a crude income multiplier that we applied to funds originating from such a scheme. The simple model was based upon the following assumptions:

- One unit produced per day per NR 1000 of capital investment;
- Selling price of NR75 per unit and 120 days of production per year;
- Equity contribution of 30% of capital investment with an opportunity cost of 30% per year over 10 years;
- Capital recovery of the 70% contribution from the micro-credit loan over 10 years at a rate of 10% per year;
- Loan amount amortised over 10 years at 10%, giving an annual repayment value of NR162.7 for each NR1000 of micro-credit loan; and
- Default rate of 50% on the repayment (on average) giving an average repayment value of NR81.35 per year on micro-credit of NR1000

This simple model produces a return per labour day of about NR147, which is slightly higher than the daily agricultural wage of NR120 used elsewhere in our modelling. Before allowing for repayments, our simple model produced a multiplier of 8.8331 for each NR1.0 of micro-credit provided under such a scheme. We assume that the households start debt repayment from the second year of the scheme, and that the amount repaid goes back into the community fund. The net income (after deducting annual repayment amount) from the micro-credit scheme contributes towards the regional household income.

3.5 Simulating components of regional household income

The components of regional household income in this simulation exercise, in their crudest form, consist of <u>agricultural income</u>, the <u>value of natural resources</u> collected from the park, income from <u>employment in tourism</u>, and the income from <u>micro-credit schemes</u> for all the households residing within the buffer zone of the RCNP. Each component of regional household income is independent of the others, but they are all affected by the park, the rhino population, and policy scenarios in one way or another. For example, agricultural income is affected negatively by the rhino population, as rhino cause damage to the crops; yet, tourism employment income is affected positively, as more rhinos attract more visitors and hence create more job opportunities and income. On the other hand, the number of days the park is open determines the overall value of natural resources that the communities collect from the park. Furthermore, the portion of the communities' share of revenue from the park (this in turn is affected by visitor numbers) that is allocated to micro-credit schemes determines the income from this source. At least one of the components of regional income is affected by any change in the baseline scenario, and this can be followed to give a rough idea of the overall change in regional household income for each alternate policy scenario.

As described earlier, the intensity of crop loss suffered by a household was estimated using the frequency of rhino sightings in addition to usual factors, like the area under agriculture. Taking this information into account, farming households were differentiated into four groups in the farming component – those who have daily sightings, weekly sightings, monthly sightings, and no sightings. The actual production (after losses have been incurred) and potential production for each group were estimated, and the total rice loss due to the rhinos calculated. The actual production and loss from each household group were then weighted by the proportion of households in each group in the survey (assuming these proportions hold for the entire buffer zone household population). Then the total rice production and rice loss for the buffer zone was estimated by aggregating over all farming households in the buffer zone. This total production was multiplied by the prevailing market price of rice to obtain the total income from rice production in the buffer zone. Any rice loss compensated for by a policy change would be added to the total rice income in later simulations.

The estimated coefficients on the variables that affect the collection of natural resources from the park (see above) were used in the resource collection component. The only factor determined by a policy change in this component is park open days in a given year. For a given number of open days, the model estimates person-days spent by each household in collecting the resources from the park. From the current survey, we have estimated the average days the park is entered (during the open period) by a household and the average value of resources collected per person-day. Assuming these two averages stay constant over the period of simulation, the product of these averages and the person-days spent by each household gives us the total value of natural resources collected by a household. This summed across all the buffer zone households gives us the total value derived by the buffer zone households from park resource collection.

In the tourism and park-related employment component, we used the information from Bookbinder *et al.* (1998), and DNPWC/PPP (2001) to obtain a rough estimate of i) jobs created in the RCNP tourism sector per visitor, ii) average annual income for a tourism sector employee, and iii) the proportion of jobs going to local people vs. outsiders. We assume all of the income of a local employee contributes to the 'regional income', whereas only half of the income of an employee from outside the region contributes to the 'regional income'. A policy factor called tourism jobs subsidy is included in the model which increases employment opportunities for the locals at the expense of outsiders. However, the number of available jobs depends upon the number of visitors, which in turn depends upon the number of rhinoceros in the park.

Finally, in the micro credit component of the regional income model, we assume that the balance of the policy budget (after funding components such as APUs, jobs subsidies, and crop damage compensation) would be used to provide micro-credit for the buffer zone households in any given year. The amount of credit provided to each household is a policy factor that can be changed to depict different policy scenarios. The ratio of total budget available for micro-credit and the amount provided to each household receiving the credit, gives the total number of households benefiting from micro-credit schemes in a year. From the estimated model (section 3.4), we get a conversion factor that converts this capital investment into income for households involved in micro-credit schemes. The micro-credit repayment amount (as per the payment scheme assumed above) is subtracted from the micro-credit income to obtain net income from micro-credit schemes in the region.

4. Community fund revenue and expenditures sub-model

This sub-model takes account of the budgetary impact of the measures incorporated elsewhere in the model. It ensures that measures with a high budgetary cost, but with other attractive features, can be distinguished from those with a lower budgetary cost. The main component of the sub-model on the revenue side is the share of gate receipts from the RCNP retained by the communities. On the expenditure side, we include the cost of anti-poaching operations, compensation paid for wildlife crop damages, training/subsidies to promote local hire in the tourism industry and the cost of micro-credit schemes.

Funding received from international organizations (e.g. WWF) and penalties/rewards either collected or paid out as a result of the capture and conviction of poachers are ignored. We might assume that these latter two components (penalties/rewards) approximately offset each other, so we would not need to model these explicitly.

4.1 Revenues

We model total National Park revenue as the sum of entry fees and other tourist revenues, revenues from the collection of natural resources in the RCNP and other fixed revenue sources (e.g. royalties from tourist lodges). The share allocated to communities can vary from 30% to 50%, according to Nepali statutes. Currently, the recycling of revenues bylaw sees 50% of park receipts distributed to local communities. As a result, about $400,000 is being provided for local development activities in the RCNP buffer zone. It is these funds that we estimate and then track in our simulation model.

4.2 Expenditures

Cost of anti-poaching patrols

We include the cost of patrolling for poachers, which is based on the concept of community-based wildlife management. Here, community groups i) take on patrolling to prevent poachers encroaching or passing through their village area and ii) report suspicious activities that could be poaching related, or even tied to local farmers setting traps to kill marauding rhinos (more rare). However, in keeping with the emerging thinking on community-based wildlife management, communities are unlikely to take on such responsibilities unless they have incentives to do so. These incentives may be financial, if patrolling is a sufficiently well-paid activity, or if they obtain some other sort of benefit from the presence of rhino, e.g. revenue shares from tourists paying to visit the park or jobs in the local tourism industry.

The Nepalese government has invested in wildlife protection since at least 1940, when two anti-poaching units (APUs) were set up to protect rhinos. In 1973, with the passing of the Wildlife Act, more concentrated efforts to protect wildlife were initiated, including the use of army patrols and later on, the establishment of additional APUs. To model community based anti-poaching activities, we use historical data for government APUs. Thus, we assume that community patrolling is configured in a similar way to government APUs. Then we multiply the number of APUs by a fixed cost per community-based APU of NR 500,000 (C_{APU}). This figure was taken from DNPWC records and budgetary documents from WWF, and then updated from the mid-1990s to the present with an inflation factor.

Other expenditures

Other expenditures from community funds in the sub-model consist of crop compensation payments, assistance to increase local tourism employment and micro-credit assistance.

- Crop losses due to rhinos have already been derived as a component (negative) of household income (above). We simply include this amount within this sub-model as well, since it must be financed from community funds;
- For tourism subsidies/training we assume that these activities help transfer jobs from outsiders to local people and that the subsidy/training costs equal 50% of the wage, as noted above. We use the formulation provided in Section 3.3.1 to introduce this into the simulation model;
- For micro-credit expenditures, the budget amount allocated for the micro-credit schemes is simply transferred from the community revenue fund (see Sections 3.4 & 3.5). The repayment of micro-credit forms part of the community revenue. It is added to the community revenue fund from the second year of simulation when the repayment begins.

4.3 Simulating the components of revenues and expenditures

This component looks at the total amount coming into the community funds through the revenue sharing agreement with the RCNP. This currently stands at 50% of the total park revenue. From this community share of the revenue, four main components that originate through various policy scenarios, are considered as the expenditures. These are: the amount of rice loss compensated for, the amount spent on subsidising tourism jobs for local people, the amount of credits provided to households involved in micro-credit schemes, and the amount spent on funding the APUs (or the community patrols). The total expenditure in any given year is the sum of all these expenditure components. Depending on the policy scenarios simulated, the community share of revenues and total expenditure changes.

5. Simulation of sample policy options

5.1 Description of policy scenarios for simulation

Three hypothetical alternative management/policy scenarios were considered for the simulations in addition to the current (i.e. baseline) scenario (see table in Appendix 2). The alternative scenarios reflected a varying degree of emphasis on a number of key factors that influenced the rhino population and income of the buffer zone households. It is assumed that 50% of the revenue received by the community from the national park (i.e., half of the community's share of the park revenue) would be allocated to fund these hypothetical policy scenarios. Descriptions of each of these scenarios follow.

Scenario 1 (Baseline/As Is)

In this scenario, all the policy variables are kept at the current (2003) level. Community patrols, crop damage compensation and the micro-credit scheme are at zero level in the current scenario. No additional jobs are subsidised to the locals and the park is open for 3 days for natural resource collection. This scenario serves as a baseline to which the simulation results from all other scenarios are compared.

*Scenario 2 (Conventional conservation strategy with **high emphasis on APUs**)*

This is the first hypothetical alternative management scenario which emulates the conventional approach to rhino conservation in the RCNP. In this scenario, high emphasis is placed on anti-poaching enforcement through the use of community anti-poaching patrol units. A total of 15 community patrol units are assumed to be in place each year throughout the simulation period. Additional jobs amounting to two percent of total jobs are assumed to be subsidised for the locals. The surplus of the budget (after allocating for the APUs and jobs subsidy) is put towards funding income generation through micro-credits at NRS 1500 per recipient household. The two other policy variables (crop damage compensation and park open days) are assumed to remain unchanged throughout the simulation.

Scenario 3 (Incentives-based conservation strategy with ***emphasis on incentives to farmers****)*

Unlike the conventional conservation strategy (Scenario 2), this scenario focuses on providing incentives to local communities, in addition to traditional rhino conservation strategies. Incentives to the farming households are emphasised in this scenario, with 25% of crop loss assumed to be compensated. This scenario assumes a lower anti-poaching effort with four APUs each year over the simulation period. Moreover, additional jobs equalling 5% of total tourism jobs are assumed to be subsidised for the locals, and the park open days are increased to 5 days a year (from 3 days in the baseline scenario). Finally, the surplus budget (after allocating for APUs, crop damage compensation, and job subsidies) is put towards funding income generation schemes through micro-credits at NRS 1000 per recipient household.

Scenario 4 (Incentives-based conservation strategy with ***emphasis on incentives to non-farmers****)*

Scenario 4 is another hypothetical management option that focuses on an incentive-based strategy for rhinoceros conservation. In this scenario, incentives to non-farming households are emphasised with higher job subsidies, more micro-credit per household and more days of park opening. As in Scenario 3, this scenario assumes a lower anti-poaching effort, with four APUs each year over the simulation period; however, the level of crop loss compensation is set at 10% as opposed to 25% in Scenario 3. The level of additional jobs subsidised to the locals is assumed to be at 15% of total jobs in the tourism sector and the park open days for natural resource collection is increased to 7 days a year. Finally, funding for the local income generation schemes through micro-credits is assumed at NRS 2000 per recipient household.

5.2 Simulation results for hypothetical policy scenarios

Simulations were carried out using the STELLA 5.1.1 software package (High Performance Systems Inc. 1998), in the following sequence: For each time period, any optimizations are first carried out, based on previous period values, to determine the values of key variables. Then these new variable values are entered into the simulation and new values for the current period are derived. The equations to be simulated are those associated with the three sub-models and policy scenarios described above. The timeline for the simulation is a ten-year period from 2004 – 2013. The first simulation is carried out using the current values for all the policy variables, and recorded as the baseline scenario against which results from all other alternative scenarios (that involve changes in one or more of the policy variables) are compared to.

Results from ten-year simulation for each management/policy scenario

Scenario 1 (Baseline)

As all the policy variables are kept at the current (2003) level in this scenario, there is no budget allocation to be made and hence total share of the revenue that communities receive from the park is used in ongoing community development activities. The simulation results for this scenario shows that the population of rhinoceros drops to 447 in the first year (2004) from 461 in the current year (2003). From the year 2005 onwards, the rhino population is seen to rise at around 1.3 to 2.3 % per year (7 to 10 rhinos), reaching a population of 529 at the end of simulation period in 2013. The number of rhinoceros poached, on the other hand, is estimated at 5-7 per year for the first seven years, reaching nine rhinos in the year 2013. The number of visitors to the park is also expected to rise in this scenario with around 54,600 visitors expected for the year 2004, to around 112,100 expected visitors for the year 2013. With the increase in visitor numbers, local jobs in the tourism industry are also expected to rise from 769 in the first year of simulation to 1581 in the final year (averaging around 7% increase per year). As the number of rhinos is expected to rise, total rice production is expected to decrease slightly in this scenario, with total production decreasing from about 465,000 quintals in the year 2004 to about 457,000 quintals in the year 2013 (an average decrease of about 0.2% per year). The community's share of park revenue is expected to decrease in the first year of simulation (2004) by about 5% from the current level (2003) but increase thereafter. In monetary terms, the community's share of the park revenue is expected to be around 17.5 million rupees in 2004 rising to about 29 million in the year 2013.

Scenario 2 (Conventional conservation strategy with ***APU emphasis****)*

The simulation results for this hypothetical policy scenario show some characteristic differences from the baseline scenario (Appendix 3). Firstly, as expected, the number of rhinoceros poached per year has decreased significantly – going down to zero for the first six years. Poaching at the end of the simulation period is about 88% less than that for the baseline scenario. The rhino population, on the other hand has gone up, and is at a higher level than in the baseline scenario for every year from 2005 onwards. At the end of the simulation period, the population is about 10% higher than that for the baseline scenario. Furthermore, park visitation has also risen by nearly 14% at the end of the simulation period compared to that in the baseline scenario. The rise in the level of local employment in the tourism and park-related sector is above 21% at the end of the simulation period compared to the same period in the baseline scenario; the level of local employment is higher than the baseline in each year from 2005 onwards. In the farming sector, rice production has decreased by nearly 2%, whereas rice loss has increased by about 28% in the final year compared to that in the baseline. The community's share of revenue from the park under this scenario is about 12% higher at the end of the simulation period compared to that in the baseline scenario.

Scenario 3 (Incentives-based conservation strategy with ***farmer emphasis****)*

The results from the simulation of Scenario 3, as expected, show differences in a number of variables compared to the baseline (Appendix 3). The number of rhinoceros poached under this management strategy is lower than that in the baseline scenario, by about 3 rhinos per year on average. Poaching at the end of the simulation period is about 27% less than that in the baseline scenario. The rhino population at the end of the simulation period under this management strategy is about 5% higher than that under the baseline scenario. Furthermore, park visitation has also risen by about 7% at the end of the simulation period, compared to that in the baseline scenario. The level of local employment in the tourism sector has risen by almost 16% at the end of the simulation period, compared to that in baseline scenario. In the farming sector, rice production has decreased by about 1%, whereas rice loss has increased by about 13% in the final year compared to that in the baseline. The community's share of revenue from the park under this scenario is about 6% higher at the end of the simulation period, compared to that in the baseline scenario.

*Scenario 4 (Incentives-based conservation strategy with **non-farmer emphasis**)*

As anti-poaching effort in this scenario is the same as that in Scenario 3, the number of rhinos poached and the rhino population level are the same as in Scenario 3; hence the difference compared to the baseline is also the same (Appendix 3). Total rice production and rice loss due to rhinos are also the same as in the previous scenario, and the comparison to the baseline made above still holds. The same applies to park visitation. However, the number of jobs available to locals in this scenario is significantly higher than that in the baseline scenario, due to higher job subsidies. The level of local employment in the tourism sector under this strategy is about 31% higher at the end of the simulation period, compared to that in the baseline scenario. The community's share of revenue from the park under this scenario is also about 6% higher at the end of the simulation period, compared to that in the baseline scenario.

5.3 Discussion

The main objective of the simulation runs of our hypothetical policy scenarios was to test the usefulness/applicability of the models to capture impacts of these policies at the aggregate level of the buffer zone. The results from these runs provide some important insights into the effects of various policy variables on the rhino population, level of poaching, tourist visitation, and income to the local households (through tourism jobs, through rice production or through the micro-credit schemes). Although changes in some specific policy variables, such as crop damage compensation, or the micro-credit scheme only contribute to the income of certain stakeholder groups directly (as per our assumptions); as components of the regional income, they contribute to overall community income in the buffer zone.

One policy variable that affects all stakeholders, either negatively or positively, is the level of community patrol (APUs). Although community patrols do not directly reduce rice production, they do so indirectly by decreasing poaching (and increasing the population of rhinos). On the other hand, an increase in community patrols has a positive effect on household incomes through the increased job opportunities created by higher visitor numbers; this, in turn, is partly the result of higher numbers of rhino (due to increased patrols). With regard to the rhino population, Scenario 2 (with the provision of 15 patrolling units) is the best scenario, as it gives the highest population at the end of the simulation period (and a higher rhino population in each year of the simulation compared to other scenarios). Although buffer-zone communities under Scenario 2 suffer a higher rice loss (and hence lower production) due to the greater rhino population, the increased share of revenue they receive from the National Park and the increased income they receive from the growing tourism sector more than compensates for this loss at the community level. In fact, the aggregate community income with this policy option is almost 14% higher at the end of the simulation period compared to that of the baseline scenario. If we compare this with Scenarios 3 and 4, which assume 4 APUs each and focus more on providing incentives to local communities through crop loss compensation, higher tourism jobs subsidies, more days of park opening and a higher micro-credit per household (in Scenario 4), we find that although Scenarios 3 and 4 provide greater benefits to specific household groups (such as farmers, through higher compensation in Scenario 3, and non-farmers through increased jobs subsidies, park open days, and micro-credit facilities in Scenario 4), the aggregate community income under these policy scenarios is lower than that in Scenario 2. The results show that the aggregate community income under Scenario 3 and Scenario 4 is about 6% higher in the final year of the simulation compared to the baseline scenario. Analysing the components of this aggregate community income (as influenced by the policy scenarios), it becomes clear that although rice income increases under policy Scenarios 3 and 4 compared to under Scenario 2, this increase is not as significant as the increase in tourism-related income and the National Park revenue (and hence the community's share of this) in Scenario 2; hence the aggregate income suffers in Scenarios 3 and 4 compared to that in Scenario2.

If we analyse the impacts of each policy scenario on the specific groups of households, it becomes clear that Scenario 2 would have a negative impact on the income of farming households. This is because it increases their rice loss by about 28% compared to the baseline scenario, and reduces total production by about 2%. Scenarios 3 and 4 would also have negative impacts on the income of farming households, though these would be less severe than under Scenario 2. However, with 25% of the loss compensated for, rice-related income in Scenario 3 (after this compensation) is higher by about 1% compared to the baseline; hence, farming households are more likely to prefer this policy option than Scenario 2. Although Scenario 4 provides 10% crop compensation, rice income is still lower than that in the baseline scenario (but significantly higher than in Scenario 2). Thus, unless farming households look for other benefits from this policy option (such as longer park open days, higher jobs subsidies, and higher micro-credit facilities) they are less likely to prefer this scenario to Scenario 3. In terms of non-farmer households, all of the alternative policy scenarios (2, 3 and 4) represent an improvement from the baseline, and hence their choice of policy option is likely to depend on the level of improvement in their preferred components (such as local jobs subsidies, park open days, and micro-credit). Overall, since Scenario 4 provides a higher level of jobs subsidies and micro-credits, and longer park open days, it is more likely to be preferred by non-farmer households compared to other alternatives.

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Appendix I Variable codes and definitions for simulation model

Table 1 Rice farming.

Variable	Definition	Availability	Value	Remarks
RICE_PRICE	Price of rice/quintal	Current average from the survey	Rs 896.36	
WAGE	Daily labour wage rate	Current average from the survey	Rs 101 (Avg.) Rs 117.50 (Avg. for male) Rs 85 (Avg. for female)	
PROP_DAILY PROP_WEEKLY PROP_MONTHLY PROP_NEVER	Proportion of the rice farmers who sight rhinoceros daily, weekly, monthly, and never	Obtained from the current survey	0.5267 0.2366 0.1428 0.0939	
A_DAILY A_WEEKLY A_MONTHLY A_NEVER	Area of rice plantation for farming households who sight rhinoceros daily, weekly, monthly, and never	Current average from the survey	17.7915 katha 12.9811 katha 11.1563 katha 12.6190 katha	
L_DAILY L_WEEKLY L_MONTHLY L_NEVER	Labour used in rice production for farming households who sight rhinoceros daily, weekly, monthly, and never	Estimate of the current optimal labour	36.09 days 25.46 days 21.53 days 24.68 days	
X_0	Baseline rhino population (year 2003)	From population function	461	
X_t	Rhino population for the current year	From population function	Varies each year	
AP_DAILY AP_WEEKLY AP_MONTHLY AP_NEVER	Actual rice production by the farming households who sight rhinoceros daily, weekly, monthly, and never	Estimated for the current year (2003) and simulated for future years (up to 2013)	17.38 quintals 12.58 quintals 10.74 quintals 12.42 quintals	Current estimate - per household on average for each group

Variable	Definition	Availability	Value	Remarks
PP_DAILY PP_WEEKLY PP_MONTHLY PP_NEVER	Potential rice production for farming households who sight rhinoceros daily, weekly, monthly, and never	Estimated for the current year (2003) and assumed to stay constant over future years (up to 2013)	18.17 quintals 12.82 quintals 10.84 quintals 12.43 quintals	Current estimate - per household on average for each group
LOSS_DAILY LOSS_WEEKLY LOSS_MONTHLY LOSS_NEVER	Loss in rice production for farming households who sight rhinoceros daily, weekly, monthly, and never = PP_... - AP_...	Estimated for the current year (2003) and simulated for future years (up to 2013)	0.80 quintals 0.25 quintals 0.10 quintals 0.01 quintals	Current estimate - per household on average for each group
TOT_AGR_HH	Total farming households in the buffer zone	Obtained from DNPWC-PPP (2001) RCNP Buffer Zone Profile	31741	Figure from survey conducted by PPP in 1999
TOTAL_RICE_PRODUCTION	Estimate of total rice production in the buffer zone = sum[AP_... x PROP_...] x TOT_AGR_HH	Estimated for the current year (2003) and simulated for future years (up to 2013)	470,638.90 quintals	Current estimate
TOTAL_RICE_LOSS	Estimate of total loss in rice production in the buffer zone = sum[LOSS_... x PROP_...] x TOT_AGR_HH	Estimated for the current year (2003) and simulated for future years (up to 2013)	15,634.04 quintals	Current estimate
TOTAL_RICE_INCOME	Estimate of total income from rice production in the buffer zone = RICE_PRICE x TOTAL_RICE_PRODUCTION	Estimated for the current year (2003) and simulated for future years (up to 2013)	Rs 421,692,452.09	Current estimate
TOTAL_RICE_INCOME_LOSS	Estimate of total loss in income from rice production in the buffer zone = RICE_PRICE x TOTAL_RICE_LOSS	Estimated for the current year (2003) and simulated for future years (up to 2013)	Rs 14,008,099.95	Current estimate

Table 2 Retrospective model.

Variable	Definition	Availability (years)	Value	Remarks
POACHED	Number of rhinoceros poached during the year	1973 – 2003		
POPN	Population of rhinoceros (estimated from population model)	Estimated/Simulated for all years		
POACH	Estimated number of rhinoceros poached (using the model)	Estimated/Simulated for all years		
APU	The number of anti-poaching units active during the year	1973 – 2003		
GDPC_NEP	Per capita GDP of Nepal in 1990 prices (USD)	1970 – 2003		
GROWTH_RATE_NEP	GDP growth rate for Nepal	Assumption	2 %	
GDPC_HK	Per capita GDP of Hong Kong in 1990 prices (USD)	1970 – 2003		
GROWTH_RATE_HK	GDP growth rate for Hong Kong	Assumption	4.8%	
MAOIST	Dummy variable equal to 0 up to 1996 (year of the start of Maoist uprising), and equal to 1 for 1997 onwards	1973 – 2003		

Table 3 Tourist visitation and regional tourist income.

Variable	Definition	Availability (years)	Value	Remarks
TOURIST	Number of visitors to the RCNP during the year	Estimated/simulated over all years		
POPN	Population of rhinoceros in that year	From population function		
VISITOR_MAX	Maximum visitor carrying capacity of the RCNP	Assumption	150,000	
GDPC_WD	Per capita world GDP in 1990 prices (USD)	1970 – 2003		
GROWTH_RATE_WD	GDP growth rate for World	Assumption	2%	
KILL	Dummy variable equal to 0 before 2001 (year of royal family assassination), and equal to 1 for 2001 onwards	1973 – 2003		
AVG_FEE_PER_VISITOR	Average fee per person visiting the RCNP (includes entry fee, elephant ride, camping etc.)	Obtained from DNPWC Annual Reports 2001-02 & 2002-03	Rs 468	Average estimate from the specified years

Variable	Definition	Availability (years)	Value	Remarks
ENTRY_FEE_FOR	Entry fee to the RCNP for other foreign (non-SAARC) visitors	Current	Rs 500	
ENTRY_FEE_SAR	Entry fee to the RCNP for SAARC visitors	Current	Rs 200	
ENTRY_FEE_NEP	Entry fee to the RCNP for Nepali visitors	Current	Rs 20	
TOT_BASELINE_VISITOR	Total number of visitors for the baseline year (1999)	Obtained from the RCNP Records	117512	
AVG_YR_INC	Average yearly income of employees in tourism sector in the RCNP	Obtained from Bookbinder et. al. (1998)	USD 600 = RS 46909.20	Average exchange rate for 2003 (oanda.com) – 1 US$ = Rs 78.182
TOT_BASELINE_JOB	Total number of jobs in tourism sector	Obtained from Bookbinder et. al. (1998), and DNPWC-PPP (2001)	2300	Excludes business owners such as cafe owners, hotelier, restaurateur
PROP_LOCAL_EMP	Proportion of employees in the tourism sector that are locals	Obtained from Bookbinder et. al. (1998)	0.72	

Table 4 APUs.

Variable	Definition	Availability (years)	Value	Remarks
COST_PER_APU	Annual cost to support an anti-poaching unit	Extrapolated from earlier reports (e.g., Maskey, 1998)	Rs 500,000	

Table 5 Park resources collection.

Variable	Definition	Availability (years)	Value	Remarks
PERMIT_FEE	Fee per permit for the collection of resources from the RCNP during yearly open period	Current	Rs 5	
THATCH_PRICE	Village level price per bhari of thatch.	Current – from survey	Rs 70	

Variable	Definition	Availability (years)	Value	Remarks
REED_PRICE	Village level price per bhari of reed.	Current – from survey	Rs 200	
FUELWOOD_PRICE	Village level price per bhari of fuelwood.	Current – from survey	Rs 100	
ROPEBARK_PRICE	Village level price per mutha of rope bark.	Current – from survey	Rs 12	
BABIYO_PRICE	Village level price per mutha of thatch.	Current – from survey	Rs 8	
AVG_PRICE_PER_BHARI	Weighted average price of park resources (thatch, reeds etc.) per bhari	Current – from survey	Rs 110	This value is an average for thatch, fuelwood, reeds, babiyo & rope bark.

Table 6 Micro credits.

Variable	Definition	Availability (years)	Value	Remarks
CREDIT_PER_HH	Amount of micro credit provided per household	Assumption	Varies under different policy scenarios	
HH_RECEIVING_CREDIT	Total number of households receiving credit	Assumption	2000 (~ 5% of the buffer zone households)	

Appendix II Policy scenario assumptions

Table 7 .

Policy Variables[1]	Policy Scenarios			
	Scenario 1 As Is	Scenario 2 Conventional conservation strategy	Scenario 3 Incentives based conservation (Farmer emphasis)	Scenario 4 Incentives based conservation strategy (Non-farmer emphasis)
Community patrols (APUs)	0	15	4	4
Crop damage compensation	0	0	25%	10%
Tourism jobs subsidised for locals (% of total jobs)	0%	2%	5%	15%
NR collection days in the RCNP	3	3	5	7
Income generation/ micro-credit	0	1500[2]	1000	2000

[1] Cost Assumptions
APUs: NR 500,000 per APU per year
Job subsidy : NR 23,000 per job per year

[2] Only from excess budget after allocating to APUs

Appendix III Simulation results for hypothetical policy scenarios

Table 8 Rhino number.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	461	461	461	461
2004	447	447	447	447
2005	455	461	459	459
2006	465	477	472	472
2007	476	492	485	485
2008	486	508	499	499
2009	496	524	511	511
2010	506	539	524	524
2011	514	554	535	535
2012	522	569	545	545
2013	529	582	555	555
% change from the baseline for the final year		10.09	4.86	4.86

Table 9 Rhinos poached.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	19	19	19	19
2004	7	0	3	3
2005	5	0	2	2
2006	5	0	2	2
2007	5	0	3	3
2008	6	0	3	3
2009	7	0	4	4
2010	7	1	4	4
2011	8	1	5	5
2012	9	1	6	6
2013	9	1	6	6
% change from the baseline for the final year		-87.79	-27.55	-27.55

Table 10 Visitor number.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	58226	58226	58226	58226
2004	54591	54,591	54591	54591
2005	60212	63,222	61987	61987
2006	67384	72,551	70436	70436
2007	74848	82,177	79115	79115
2008	82238	91,686	87656	87656
2009	89325	100,696	95748	95748
2010	95924	108,895	103140	103140
2011	101945	116,108	109702	109702
2012	107349	122,266	115388	115388
2013	112155	127,401	120233	120233
% change from the baseline for the final year		13.59	7.20	7.20

Table 11 Local empoloyment (incl. APUs employment).

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	821	821	821	821
2004	769	866	843	950
2005	849	991	954	1076
2006	950	1126	1082	1219
2007	1055	1265	1212	1367
2008	1159	1403	1341	1513
2009	1259	1533	1463	1650
2010	1352	1652	1574	1776
2011	1437	1757	1673	1888
2012	1513	1846	1759	1985
2013	1581	1920	1832	2067
% change from the baseline for the final year		21.49	15.91	30.80

Table 12 Total rice production.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	465,428	465,428	465,428	465,428
2004	466,944	466,944	466,944	466,944
2005	466,134	465,380	465,690	465,690
2006	464,968	463,646	464,193	464,193
2007	463,730	461,765	462,603	462,603
2008	462,477	459,752	460,955	460,955
2009	461,236	457,623	459,279	459,279
2010	460,038	455,404	457,615	457,615
2011	458,898	453,119	455,994	455,994
2012	457,831	450,798	454,449	454,449
2013	456,842	448,469	453,005	453,005
% change from the baseline for the final year		-1.83	-0.84	-0.84

Table 13 Total rice loss.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	20,845	20,845	20,845	20,845
2004	19,329	19,329	19,329	19,329
2005	20,139	20,893	20,583	20,583
2006	21,305	22,627	22,080	22,080
2007	22,543	24,508	23,670	23,670
2008	23,796	26,521	25,318	25,318
2009	25,037	28,650	26,994	26,994
2010	26,235	30,868	28,658	28,658
2011	27,375	33,154	30,279	30,279
2012	28,442	35,475	31,824	31,824
2013	29,431	37,804	33,268	33,268
% change from the baseline for the final year		28.45	13.04	13.04

Table 14 Total national park revenue.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	34,848,352	34,848,352	34,848,352	34,848,352
2004	33,147,370	33,147,370	33,189,441	33,207,471
2005	35,777,788	37,186,557	36,650,633	36,668,663
2006	39,134,263	41,552,833	40,604,689	40,622,719
2007	42,627,467	46,057,574	44,666,836	44,684,866
2008	46,086,364	50,507,575	48,663,912	48,681,942
2009	49,402,778	54,724,481	52,450,915	52,468,945
2010	52,490,954	58,561,435	55,910,317	55,928,347
2011	55,308,849	61,937,144	58,981,526	58,999,556
2012	57,838,028	64,819,028	61,642,319	61,660,349
2013	60,087,229	67,222,506	63,909,707	63,927,737
% change from the baseline for the final year		11.87	6.36	6.39

Table 15 Communities share of National Park revenue.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	18,232,869	18,232,869	18,232,869	18,232,869
2004	17,424,176	17,424,176	17,424,176	17,424,176
2005	16,573,685	16,573,685	16,594,720	16,603,735
2006	17,888,894	18,593,278	18,325,317	18,334,332
2007	19,567,131	20,776,416	20,302,345	20,311,360
2008	21,313,734	23,028,787	22,333,418	22,342,433
2009	23,043,182	25,253,788	24,331,956	24,340,971
2010	24,701,389	27,362,240	26,225,457	26,234,472
2011	26,245,477	29,280,718	27,955,158	27,964,173
2012	27,654,424	30,968,572	29,490,763	29,499,778
2013	28,919,014	32,409,514	30,821,159	30,830,174
% change from the baseline for the final year		12.07	6.58	6.39

Table 16 Total community revenue.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	18,232,869	18,232,869	18,232,869	18,232,869
2004	17,424,176	17,424,176	17,424,176	17,424,176
2005	16,573,685	16,631,515	16,686,600	16,703,074
2006	17,888,894	18,612,420	18,350,529	18,353,767
2007	19,567,131	20,869,163	20,352,178	20,339,696
2008	21,313,734	23,206,137	22,419,489	22,391,336
2009	23,043,182	25,519,093	24,456,134	24,413,468
2010	24,701,389	27,714,895	26,386,834	26,331,678
2011	26,245,477	29,716,563	28,150,937	28,085,865
2012	27,654,424	31,480,447	29,716,500	29,644,243
2013	28,919,014	32,988,536	31,071,810	30,994,918
% change from the baseline for the final year		14.07	7.44	7.18

Table 17 Aggregate of the components of HH income influenced by policy scenarios.

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2003	539,527,091	539,527,091	539,527,091	539,527,091
2004	537,206,929	539,001,729	550,818,960	554,020,814
2005	540,067,941	539,854,571	548,312,922	550,254,827
2006	546,001,587	554,745,054	557,733,941	558,168,491
2007	552,464,480	570,954,845	568,614,305	567,546,359
2008	558,923,626	587,344,255	579,566,122	577,106,653
2009	565,136,904	603,151,514	590,019,318	586,362,294
2010	570,931,418	617,722,570	599,556,848	594,948,931
2011	576,208,413	630,578,927	607,887,998	602,591,182
2012	580,928,719	641,486,981	614,917,425	609,176,218
2013	585,101,976	650,409,998	620,674,970	614,694,598
% change from the baseline for the final year		11.16	6.08	5.06