The Impact Of Wildlife Conservation On Rural Welfare In Zambia

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Robert B. Richardson, Ana Fernandez, and David Tschirley
Michigan State University
OUTLINE

- Food Security Research Project
- Zambia and sustainable tourism
- Game Management Areas
- Data and methods
- Model results
- Conclusions

Acknowledgements
Food Security Research Project, MSU
U.S. Agency for International Development (USAID)
Swedish International Development Agency (SIDA)
The World Bank
Food Security Research Project

- Objective: *to integrate research into policy dialogue and program design to promote sustainable agricultural growth as a means to cut hunger and poverty*

- Focus on individual and collective action
- Regional, village, household, gender-level impacts
- Impacts on policy analysis
- Partnerships with African institutions
Food Security (continued)

Research themes:

1. Improving food systems performance
2. Understanding household income and livelihood dynamics
3. *Understanding food security and natural resource management interactions*
Zambia

- Landlocked country in southern Africa
- Tropical climate
- Flat plateau (1000-1500 meters)
- Nine provinces
Zambia (continued)

- Population: 11.5 million
- Rural population: 65%
- GDP per capita: $1,273
- Living below $1 per day: 64%
- Living below $2 per day: 87%
- Malnourished population: 46%

- Life expectancy at birth: 41.2 yrs (178/179)
- People without improved water: 42% (106/123)
- Illiteracy rate: 32% (93/127)
- Human development index: 0.43 (165/177)

UNDP, Human Development Report, 2006
Sustainable Tourism

- Tourism increasingly important source of economic development
  - Dependent on wildlife, habitat, natural resources
  - Micro-level impacts (job creation, income)
  - Macro-level impacts (foreign exchange, GDP)

- Rural tourism
  - Potential impact on livelihoods and income

- Impact of policies on rural development
  - Wildlife conservation
  - Tourism development
Average Annual Tourism Growth

(1990-2005)

Source: UN World Tourism Organization
Tourism in Zambia

- **International tourist arrivals**
  - 2004: 515,000
  - 9.7% avg annual growth (1990-2004)

- **Tourism receipts (US$)**
  - 2004: $161 million
  - 9.8% avg annual growth (1990-2004)
  - 12.7% of exports

- One of three priority sectors in national development plan
Zambia Map
Game Management Areas

- Buffer zones around national parks
- Licensed safari and subsistence hunting are controlled by permit
- Protected Area system covers about 30% of Zambia
  - 19 national parks
  - 35 game management areas (GMAs)
Zambia National Parks & Game Management Areas
Game Management Areas (continued)

- Zambia Wildlife Authority (ZAWA)
- Shares hunting license revenues and wildlife management responsibilities with communities
  - Community Resource Boards (CRBs)
  - Village Action Groups (VAGs)
- Dual objectives of wildlife conservation and rural development
  - Employment of village scouts
  - Development projects
Impact of Game Management Areas

- **Benefits**
  - Rural employment
  - Revenue sharing
  - Meat distributed after hunting
  - Development projects
- **Crop damage**
- **Opportunity cost of alternative land uses**
Research Questions

- How do GMAs affect household welfare?
  - Household income
  - Distributional effects

- What are the marginal effects of GMAs on crop losses from wildlife damage?
Data

- Stratified two-stage cluster sampling
- 139 statistical enumeration areas (SEAs) adjacent to four national park systems
- Rural household survey (cross-sectional data)
- 2,800 households selected
  - About half GMA and non-GMA (control)
  - Only about 32 non-response (1.1%)
Methods

Two models

1. Ordinary least squares (OLS) regression
   - Determinants of household income

2. Cragg double-hurdle model
   - Probability and value of crop losses from wildlife damages
Model 1: OLS Regression

- Welfare measured as total household income
- OLS regression

\[ \ln Y_i = \alpha + \beta X_i + \gamma G + \varepsilon_i \]

- \( Y_i \) = total income for household \( i \)
- \( X_i \) = vector of household and community characteristics (education, size of household, assets, infrastructure)
- \( G = 1 \) if household lives in a GMA
Empirical Model

- OLS estimation
  - Welfare regression (determinants of income)

- Independent variables
  - Age, sex of head of household
  - Maximum education of household
  - Size of household (# males, females, children)
  - Remoteness (distance to main road)
  - Assets – durable assets, land holdings, livestock
  - Population density, infrastructure
  - GMA classification (stocking levels, diversity)
## Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>GMA</th>
<th>Non-GMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sample households</td>
<td>2,717</td>
<td>1,574</td>
<td>1,143</td>
</tr>
<tr>
<td>Total household income (Kw)</td>
<td>4,235,762</td>
<td>3,591,253</td>
<td>5,123,301 *</td>
</tr>
<tr>
<td>Household size</td>
<td>5.28</td>
<td>5.08</td>
<td>5.57 ***</td>
</tr>
<tr>
<td>Age of household head (in years)</td>
<td>42.46</td>
<td>41.00</td>
<td>44.48 ***</td>
</tr>
<tr>
<td>Sex of household head (=1 if male)</td>
<td>0.74</td>
<td>0.73</td>
<td>0.76 **</td>
</tr>
<tr>
<td>Maximum education (in years)</td>
<td>6.78</td>
<td>6.42</td>
<td>7.27 ***</td>
</tr>
<tr>
<td>Number of children (&lt; 15 years)</td>
<td>2.55</td>
<td>2.46</td>
<td>2.67 ***</td>
</tr>
<tr>
<td>Number of female adults</td>
<td>1.10</td>
<td>1.08</td>
<td>1.12</td>
</tr>
<tr>
<td>Number of male adults</td>
<td>1.03</td>
<td>1.00</td>
<td>1.07 **</td>
</tr>
<tr>
<td>Distance to nearest main road (km)</td>
<td>5.09</td>
<td>6.08</td>
<td>3.80 ***</td>
</tr>
<tr>
<td>Cropped area (hectares)</td>
<td>0.92</td>
<td>0.93</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Significance based on t-test of unequal variance:

* 10% significance     ** 5% significance     *** 1% significance
## Descriptive Statistics: (continued)

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>GMA</th>
<th>Non-GMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of consumer assets (Kw)</td>
<td>401,588</td>
<td>285,362</td>
<td>561,641  **</td>
</tr>
<tr>
<td>Value of productive assets (Kw)</td>
<td>618,036</td>
<td>256,729</td>
<td>1,115,584  ***</td>
</tr>
<tr>
<td>Population density (per sq km)</td>
<td>35.20</td>
<td>41.41</td>
<td>26.97  ***</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>3.62</td>
<td>3.64</td>
<td>3.59</td>
</tr>
<tr>
<td>Tourist lodge in SEA (=1)</td>
<td>0.07</td>
<td>0.10</td>
<td>0.02  ***</td>
</tr>
<tr>
<td>GMA-1 classification (=1 if primary)</td>
<td>0.17</td>
<td>0.30</td>
<td>n.a.</td>
</tr>
<tr>
<td>GMA-2 classification (=1 if secondary or specialized)</td>
<td>0.20</td>
<td>0.35</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Significance based on t-test of unequal variance:
* 10% significance   ** 5% significance   *** 1% significance
## Impact on Household Income

### Model 1: OLS Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff (std error)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>13.101 (0.12)</td>
<td>***</td>
</tr>
<tr>
<td>Age of household head (in years)</td>
<td>-0.003 (0.00)</td>
<td>*</td>
</tr>
<tr>
<td>Sex of household head (=1 if male)</td>
<td>0.069 (0.06)</td>
<td></td>
</tr>
<tr>
<td>Maximum education (in years)</td>
<td>0.043 (0.01)</td>
<td>***</td>
</tr>
<tr>
<td>Number of children (&lt; 15 years)</td>
<td>0.019 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Number of female adults (15-60 years)</td>
<td>0.113 (0.03)</td>
<td>***</td>
</tr>
<tr>
<td>Number of male adults (15-60 years)</td>
<td>0.070 (0.03)</td>
<td>**</td>
</tr>
<tr>
<td>Distance to nearest main road (km)</td>
<td>-0.005 (0.00)</td>
<td>***</td>
</tr>
<tr>
<td>Cropped area (hectares)</td>
<td>0.039 (0.02)</td>
<td>*</td>
</tr>
<tr>
<td>Log of consumer assets (Kw)</td>
<td>0.020 (0.00)</td>
<td>***</td>
</tr>
<tr>
<td>Log of productive assets (Kw)</td>
<td>0.010 (0.00)</td>
<td>***</td>
</tr>
<tr>
<td>Population density (per sq km)</td>
<td>0.001 (0.00)</td>
<td>***</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>0.032 (0.01)</td>
<td>***</td>
</tr>
<tr>
<td>Tourist lodge in SEA (=1)</td>
<td>0.186 (0.10)</td>
<td>*</td>
</tr>
<tr>
<td>GMA-1 classification (=1 if primary GMA)</td>
<td>0.170 (0.08)</td>
<td>**</td>
</tr>
<tr>
<td>GMA-2 classification (=1 if secondary or specialized GMA)</td>
<td>0.022 (0.07)</td>
<td></td>
</tr>
</tbody>
</table>

R-squared: 0.213

Significance based on t-test of unequal variance:

* 10% significance  ** 5% significance  *** 1% significance
Impact on Household Income (continued)

- Education, number of adults, value of assets – positively associated with income
- Population density, infrastructure – significant positive association with income
- Remoteness, age of household head – negatively associated with income
- Tourist lodge, primary GMAs – positively associated with income
  - Household income in primary GMAs is 17% greater than without the GMA designation
Distribution of GMA Effect

- Stratified households by asset quintiles to investigate how GMA effect is distributed

- Poorest 40% (and 60%) of the population are not significantly affected by GMAs

- Wealthiest 40% of the population are significantly and positively affected by GMAs
  - Income gains from living in a GMA are likely to be captured by non-poor segments of the population (better access to financial, human capital)

<table>
<thead>
<tr>
<th>Consumption assets</th>
<th>GMA 1</th>
<th>GMA 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower 2 quintiles</td>
<td>0.033</td>
<td>-0.059</td>
</tr>
<tr>
<td>Lower 3 quintiles</td>
<td>0.031</td>
<td>0.040</td>
</tr>
<tr>
<td>Upper 2 quintiles</td>
<td>0.046**</td>
<td>-0.008</td>
</tr>
</tbody>
</table>
Model 2: Cragg Double-Hurdle

- Impact of GMA and household characteristics on crop damage
- Two-stage model
1. \( P(CD_i=1 | X_i) = \gamma X_i + \mu_i \)
2. \( \ln Y_i = \alpha + \beta X_i + \varepsilon_i \)
   - CD = crop damage variable
   - \( X_i = \) vector of household and community characteristics (education, size of household, assets, infrastructure)
   - \( Y_i = \) value of crop losses
## Variable Means – Crop Damage

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
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<th>Non-GMA</th>
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</thead>
<tbody>
<tr>
<td>Number of sample households</td>
<td>2,717</td>
<td>1,574</td>
<td>1,143</td>
</tr>
<tr>
<td>% of households that reported crop damage</td>
<td>13.6</td>
<td>16.5</td>
<td>9.6</td>
</tr>
<tr>
<td>Value of crop damage (Kw)</td>
<td>28,423</td>
<td>30,079</td>
<td>26,140</td>
</tr>
<tr>
<td>Age of household head (in years)</td>
<td>42.46</td>
<td>41.00</td>
<td>44.48</td>
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<td>0.74</td>
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<td>Cropped area (hectares)</td>
<td>0.92</td>
<td>0.93</td>
<td>0.92</td>
</tr>
<tr>
<td>Population density (sq km)</td>
<td>35.20</td>
<td>41.41</td>
<td>26.97</td>
</tr>
<tr>
<td>Number of scouts</td>
<td>1.00</td>
<td>1.56</td>
<td>0.24</td>
</tr>
</tbody>
</table>
## Cragg Double-Hurdle Results – Impact on Crop Damage

<table>
<thead>
<tr>
<th></th>
<th>Probit</th>
<th>CAPE</th>
<th>UAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head</td>
<td>-0.000</td>
<td>0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td>Sex of household head</td>
<td>-0.006</td>
<td>0.032</td>
<td>-0.046</td>
</tr>
<tr>
<td>Household size (#)</td>
<td>-0.006</td>
<td>**</td>
<td>-0.003</td>
</tr>
<tr>
<td>Distance to nearest road (km)</td>
<td>0.001</td>
<td>**</td>
<td>-0.002</td>
</tr>
<tr>
<td>Cropped area (hectares)</td>
<td>0.010</td>
<td>**</td>
<td>-0.051</td>
</tr>
<tr>
<td>Consumption assets (Kw)</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.005</td>
</tr>
<tr>
<td>Production durable assets (Kw)</td>
<td>-0.001</td>
<td>*</td>
<td>-0.002</td>
</tr>
<tr>
<td>Population density</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>-0.001</td>
<td>-0.002</td>
<td>-0.013</td>
</tr>
<tr>
<td>Number of scouts (#)</td>
<td>0.004</td>
<td>0.006</td>
<td>0.053</td>
</tr>
<tr>
<td>Value of harvest</td>
<td>0.006</td>
<td>**</td>
<td>0.024</td>
</tr>
<tr>
<td>Primary GMA (=1)</td>
<td>0.161</td>
<td>**</td>
<td>0.010</td>
</tr>
<tr>
<td>Secondary GMA (=1)</td>
<td>0.122</td>
<td>**</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Log-likelihood: -1513.7

Significance based on t-test of unequal variance:
* 10% significance
** 5% significance
*** 1% significance
Crop Damage: (continued)

- GMA households more likely to have crop damage
- Distance to main road - positively associated with crop damage
- GMA (primary) - positively associated with crop damage
- GMA (secondary and specialized) - positively associated but to a lesser extent than primary GMAs
Conclusions

- How do tourism and wildlife conservation affect household income?
  - Tourist lodges and primary GMAs are positively associated with income
  - Gains accrue primarily to non-poor households

- How do GMAs affect household welfare in terms of crop damage?
  - Primary GMAs are positively associated with both probability and value of crop damage losses
  - Findings suggest broader role for village scouts to curb crop damage
  - Mechanism for compensating farmers for losses?
Thank You!