Appendix 1. Details of methods for census, surveys, experimental games, and analyses.

Community engagement prior to census, surveys, and experimental games:

Prior to initiation of the study, we advertised and held public meetings in each community to explain the nature of the research, and seek permission from the communities to travel from household to household conducting surveys. Establishing a rapport with residents and community leadership was facilitated due to one author's (King) history of conducting research in the area since 2001. All communities cordially welcomed the research. We consulted with and sought permission from community leadership again prior to holding rounds of experimental economic games.

Census and survey enumerator selection, training and translation:

To conduct census and questionnaire surveys of households, we employed thirteen community residents (8 male, 5 female) who were fluent in English and Maasai. Candidates were identified by community leaders or referred by word-of-mouth. Each enumerator worked in his or her home community, and was offered employment for the duration of the field component of the study. Since the authors do not speak Maasai, we used direct instruction in English as well as peer-to-peer learning in order to train local enumerators. We explained in English the meaning, purpose, and intent of each question, then engaged the enumerators to discuss the best ways to translate the questions into Maasai, in efforts to reduce the differences in the way each enumerator translated the questions. The generality of the wording of questions relating to ecological variables was intentional. We did not wish to impose our specific and foreign concepts of what constitutes land health, livestock health, or benefits to wildlife. In our experience, and in accordance with extensive anthropological research, herders tend to have an intimate understanding of land health, livestock health, and the relationship between the two. Also, since the study area is home to diverse wildlife species, pastoralists demonstrate strong knowledge of wildlife habitat preferences, seasonal abundance, watering needs, etc. Thus while some individuals interviewed may have held slightly different conceptions of what these terms mean, we found that nobody was confused by the questions, and everyone did seem have some clear idea of what "land health" meant to them.

On most questions, possible responses were constrained to yes/no, a few choices (e.g., less than, greater than, or about equal), or a numerical response (e.g., 3 days). We relied on the enumerators to appropriately convey the questions to respondents while conducting surveys, and to align responses with the possible choices, asking for clarification if necessary. While this approach curtailed the nuance we could capture in questionnaires, we felt it was important to reduce the opportunity for translation ambiguity from the respondent to the recorded data. Given that each enumerator only worked within one community, we were particularly concerned about generating community-to-community bias and inconsistencies in the way responses would be translated back to English.

Household census and surveys:

Enumerators conducted exhaustive census of all residential compounds in each community, which were considered the household unit in this study. Enumerators systematically traveled through areas where compounds were scattered, approaching each compound, explaining the nature of the census, and asking if the residents were willing to participate. Every compound was cooperative. Since livestock herd size and family size were self-reported,

inaccurate reportings were possible. However, enumerators were also community members and thus familiar with the general livestock wealth and family size of each compound. They were able to flag any questionable numbers, and in those cases, the reported census numbers were excluded from analysis.

A stratified subsample of all households was selected for additional questionnaire surveys. The questionnaires were designed as part of a larger, more complex study of social capital, governance, external relations, and natural resource management (Kaye-Zwiebel 2011), so they contained several other question topics that are not considered or presented in this report. For most questions, one adult per household was interviewed. There was a subset of questions, however, for which one male and one female were interviewed whenever both were available when visiting a household. Only one of those questions was analyzed in this report, Survey Question #7 regarding subdivision. Completed surveys were scrutinized for missing data and indicators of faulty data recording. For some households, surveys were not fully completed or had missing responses for some questions. Such households were included in the analyses of the questions that were correctly recorded in their survey. As a result, the sample sizes for some questions are smaller than the total number of households visited, which were for each community: C1=28, C2=51, C3=32, C4=42, C5=38.

C1 Tiemamut n=28
C2 Koija n-51
C3 Il Motiok n=32
C4 Kijabe n=42
C5 Musul n=38

English text of survey auestions analyzed in this study:

1. In terms of what the land can support, is the total number of animals living on your Group Ranch:
   1 more than
   1 about equal to
   1 less than
   the number that the land can support?

2. In terms of meeting your family's needs, is the number of animals you own:
   1 more than
   1 about equal to
   1 less than
   what you need?

3. If you think the conservation zone is a good idea, do you think it is good because:

1Yes 1No We get a monetary reward if we keep it
1Yes 1No It makes our land healthier
1Yes 1No It makes our herds healthier
1Yes 1No It helps wild animals
1Yes 1No It helps water points retain water

1Yes 1No It provides employment
Are there other reasons that the conservation zone is good? __(*n=6, not analyzed*)___

4. How many days in the past month did people in this manyatta eat food that was given or lent to you? _____ days

5. Does anyone in this manyatta own animals that are living with another family in order to help that family? 1Yes 1No

6. In the past 3 years, has anyone in this manyatta been fined? 1Yes 1No
   For what reason(s)?_____(*tabulated by category, not analyzed*)_____

7. In southern Maasailand, there are group ranches that have subdivided, so that families own smaller pieces of land privately. Would doing that here be:
   1 mostly good
   1 in between (translated as mixed, tolerable, ok)
   1 mostly bad

Experimental Games

We invited community members to participate in this game on a volunteer basis. At two locations in each community, the date, time, and nature of the game was advertised through the Group Ranch leadership, and through community liaisons working with other organizations. We announced that a simple game would be played, with a chance to win money, and that all adults from the community arriving within 45 minutes of the start time would be able to participate. Players were assigned numbers in the order of their arrival; those with odd numbers would be proposers and those with even numbers would be responders. The even and odd numbers were randomly paired and recorded on a list, but the players themselves did not know the identity of their paired partner. Once participants were assembled, the game was explained and illustrated with a few demonstration rounds until all participants acknowledged that they understood the game. Players also understood that they would receive cash payouts, at the rate of KSh 10 per goat in the scenario, according to their offers and whether the offer was accepted. Thus each team would either share or lose KSh 200 (US$2.50, or approximately one day's basic labor wage).

In the execution of the game, each of the "proposers" was called by number, taken aside and asked in private what they would offer their anonymous partner. Their offer was recorded next to their number, and they were asked to wait in a separate location (under a different tree) from the participants who had not yet played. Then we called each of the respondents by number, took them aside, and told them the offer made by their anonymously paired partner. They responded to accept or reject the offer, and their response recorded. After all rounds were played, we told each proposer whether their offer was accepted, and if so, they were paid. Then we paid each responder their offered share, unless they rejected, in which case they received no payment. We played the game at two locations on separate days in each community, and there were a total of 280 pairs of participants across all communities.

Demographics

From the census data, we calculated active adult male equivalents (AAME), modified from Lesorogol (2008), where adult males/warriors = 1, adult females = .86, children of any age = 0.85 AAME. We converted household and community livestock holdings to tropical livestock units (TLU), following Galvin (1992), where cattle = 1, goats or sheep = 0.10, camels = 2.5 TLU. Empirical data of forage productivity in the five communities were unavailable, yet we wanted some corroboration of our qualitative observations that forage availability did not vary dramatically among communities. We used three sources of information to support observations of general similarity across communities. First, the Global Livestock Early Warning System (GLEWS) uses vegetation transects, NDVI and NOAA weather data, and a forage production model to generate co-kriged maps of average forage standing crop for the study region. GLEWS outputs show similar average standing forage of 980 to 1055 kg/ha for the study communities (CNRIT 2011). In rapid assessments of grazing condition in three of the communities (C1, C2, and C4), conditions were fair to poor in all land use zones in each community (Oguge 2005). Lastly, a 2007 herding study in three communities (C1, C2, and C3) showed comparable grass densities when averaged across livestock grazing routes in each community (E.G. King and D. I. Rubenstein, unpublished data).

Table A1.1 Summary of statistical analyses performed. Variables in italics are continuous variables; all other variables are categorical.

Dependent variable	Explanatory variable	Source of Data	Statistical Method	Sample Size (C1,C2,C3,C4,C5)
Perceptions of Ecosystem Services				
a) Perception of forage sufficiency (y/n) b) Perception of herd sufficiency (y/n)	Community (n=5)	a) Survey question #1 b) Survey question #2	Chi-square contingency	N=178 HHs (25, 49, 30, 40, 34)
a) Perception of forage sufficiency (y/n) b) Perception of herd sufficiency (y/n)	1) Household wealth (TLU) 2) Per capita wealth (TLU/AAME) 3) *respondent age (yr)*	Census data, a) Survey question #1 b) Survey question #2	Logistic regression	N=177 HHs across all communities
Perception of forage sufficiency (y/n)	Perception of herd sufficiency	Survey questions #1 and #2	Chi-square contingency	N=177 HHs across all communities
Proportion perceiving forage sufficiency	*Grazing availability (ha/TLU)*	Census data; question #1	Linear regression	N=5 communities
Benefits from conservation areas: (y/n) a) helps land health b) helps herd health c) helps wildlife d) monetary reward e) provides employment	1) Community (n=4) 2) *respondent age (yr)*	Survey question #3 parts a-e	1) Chi-square contingency 2) Logistic regression	N=157 HHs (24, 47, 30, 39, 0)
Perception of benefits to herd health (y/n)	Perception benefits from employment	Survey questions #3b and #3e	Chi-square contingency	N=177 HHs across all communities
Assessments of Social Capital				
Food sharing (days/month received)	Community (n=5)	Survey question #4	ANOVA	N=147 HHs (28, 21, 29, 35, 34)
HH currently lending stock to other HH (y/n)	Community (n=5)	Survey question #5	Chi-square contingency	N=154 HHs (27, 29, 30, 35, 33)
HH member fined in the last 3 years (y/n)	Community (n=5)	Survey question #6	Chi-square contingency	N=155 HHs (27, 29, 30, 35, 34)
Ultimatum Game offers (% of total goats)	Community (n=5)	Ultimatum Game	None	N=280 ‘proposers’ (45, 66, 72, 55, 42)
Land subdivision among families would be: (good/bad/in-between)	Community (n=5)	Survey question #7	Chi-square contingency	N=247; 1 male and 1 female per HH when available (60, 38, 34, 56, 59)