Attitudes towards leopards the Sri Lankan leopard *(Panthera pardus kotiya)* in two rural communities with varying levels of cattle rearing, and considerations for human-leopard coexistence

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Supplementary Table 1 Percentage of responses to 8 statements relating to attitudes towards leopards in the Palatupana (n = 61) study site, scored on a Likert scale (strongly agree = 5, strongly disagree = 1). Responses are from the raw data, prior to creating weighted composite scores for each individual through EFA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statement** | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly disagree** |
| The nature and wildlife of Sri Lanka is a national treasure and should be conserved | 68.9(n=42) | 3.3(n=2) | 26.2(n=16) | 1.6(n=1) | 0.0(n=0) |
| I respect leopards for the economic value they bring to the country through wildlife tourism | 50.8(n=31) | 14.8(n=9) | 27.9(n=17) | 3.3(n=2) | 3.3(n=2) |
| My livelihood is more important than current leopard populations | 91.8(n=56) | 6.6(n=4) | 0.0(n=0) | 1.6(n=1) | 0.0(n=0) |
| It does not matter if a leopard kills a few of my cattle, they are wild animals trying to survive | 26.2(n=16) | 13.1(n=8) | 21.3(n=13) | 8.2(n=5) | 31.2(n=19) |
| At this farm we cannot tolerate leopards killing any cattle at any time | 68.9(n=42) | 19.7(n=12) | 6.6(n=4) | 4.9(n=3) | 0.0(n=0) |
| I would be happier if there were fewer leopards around where I live and raise my cattle  | 65.6(n=40) | 4.9(n=3) | 14.8(n=9) | 3.3(n=2) | 11.5(n=7) |
| I do not want to kill leopards, but if they kill my cattle I might have to | 72.1(n=44) | 3.3(n=2) | 14.8(n=9) | 1.6(n=1) | 8.2(n=5) |
| I would like to communicate and work together with scientists, government staff and organizations to find a solution that works for everyone | 52.5(n=32) | 9.8(n=6) | 32.8(n=20) | 1.6(n=1) | 3.3(n=2) |

Supplementary Table 2 Percentage of responses to 8 statements relating to attitudes towards leopards in the Maskeliya (n = 52) study site, scored on a Likert scale. Responses are from the raw data, prior to creating weighted composite scores for each individual through EFA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statement** | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly disagree** |
| The nature and wildlife of Sri Lanka is a national treasure and should be conserved | 13.5(n=7) | 0.0(n=0) | 78.9(n=41) | 7.7(n=4) | 0.0(n=0) |
| I respect leopards for the economic value they bring to the country through wildlife tourism | 9.6(n=5) | 0.0(n=0) | 82.7(n=43) | 7.7(n=4) | 0.0(n=0) |
| My livelihood is more important than current leopard populations | 57.7(n=30) | 38.5(n=20) | 3.9(n=2) | 0.0(n=0) | 0.0(n=0) |
| It does not matter if a leopard kills a few of my cattle, they are wild animals trying to survive | 0.0(n=0) | 0.0(n=0) | 15.4(n=8) | 7.7(n=4) | 77.0(n=40) |
| At this farm we cannot tolerate leopards killing any cattle at any time | 75.0(n=39) | 3.9(n=2) | 19.3(n=10) | 0.0(n=0) | 1.9(n=1) |
| I would be happier if there were fewer leopards around where I live and raise my cattle  | 11.5(n=6) | 19.2(n=10) | 61.5(n=27) | 7.7(n=4) | 9.6(n=5) |
| I do not want to kill leopards, but if they kill my cattle I might have to | 15.4(n=8) | 3.9(n=2) | 77.0(n=40) | 0.0(n=0) | 3.9(n=2) |
| I would like to communicate and work together with scientists, government staff and organizations to find a solution that works for everyone | 86.5(n=45) | 3.9(n=2) | 9.6(n=5) | 0.0(n=0) | 0.0(n=0) |

Supplementary Table 3 Summary of key issues analysed from individual and group interviews with a subset of respondents in Palatupana (n=32) and Maskeliya (n=19), Sri Lanka, accompanied by an illustrative quote.

|  |  |  |
| --- | --- | --- |
| **Study site** | **Key issue** | **Illustrative quote and respondent number**  |
| Palatupana | Lack of ability to own or develop land  | *“Even though we have the ability, we cannot build a better pen. We need a roof that is strong, the leopard I saw [on top of one of the steel enclosures] came in the night and was lying on the roof until morning”;* P23 |
| Palatupana | Lack of ability to own or develop land | *“Separating the cattle isn’t enough, we have to put them in pens with a strong roof above – a leopard can climb a tree nearby and stalk. There are too many trees around that leopards can always go up”*; P18 |
| Palatupana | Post-war development of surrounding area  | *“Before [when the civil war was taking place] there weren’t as many people or hotels. It was easier to have more cattle. Now there are more people, more roads and less foraging lands”;* P14  |
| Palatupana | Distrust of the Department of Wildlife Conservation (DWC) | *“Many of us have gone to the department about these problems, but they are not**interested. We used to be allowed to stay in the night near our pens but the department banned us from doing that. They do not want us to change our [husbandry] methods, since guard dogs will require more food, more permits will be needed from them and as the number of herders increases more land would be needed. Still, on the 31st of each year we give milk to the DWC to give thanks”;* P32 |
| Palatupana | Distrust of the Department of Wildlife Conservation (DWC) | *“More than 100 people have approached the DWC about this issue [leopards, lack of land] but we are not taken seriously anymore”;* P15 |
| Maskeliya | Infrastructure  | *“Even when we pay to hire a vehicle and for the doctor fee, the doctor will not come because of the bad roads. It is wasted cost and many cows and calves die from infection”;* M14 |
| Maskeliya | Infrastructure | *“The vet doesn’t come up here even if we get together and have the money to pay for his transport, across the lake and up to here. I have lost 2 cows to miscarriages”*; M48 |
| Maskeliya | Loss of dogs  | *“We know many other people who have lost dogs. We heard of leopards coming near to people in other areas, but so far not here”;* M51 |
| Maskeliya | Lack of ability to own or develop land  | *“We are on a private estate, so we cannot lease this land. These sheds for our cattle are extremely expensive to build”;* M42 |

Supplementary Material 1 Complete semi-structure survey administered to 113 respondents from May-August 2018 in two study sites in Sri Lanka, Palatupana and Maskeliya. Each survey involved an individual pastoralist. Informed consent was obtained orally prior to any survey being conducted.

**Administrative Information**

Interviewer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Study site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ GPS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Code: \_\_\_\_\_\_\_\_\_\_ Oral consent: \_\_\_\_\_\_, initials:\_\_\_\_

1. **Background & socio-demographics**

On this farm, you are the

* owner
* manager
* employee
* other\_\_\_\_\_\_\_\_\_\_\_\_\_

Age: \_\_\_\_\_\_

Gender: \_\_\_\_\_

What religion do you consider yourself to be? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

What ethnicity do you consider yourself to be? \_\_\_\_\_\_\_\_\_\_\_\_\_

How long have you worked at this farm? \_\_\_\_\_\_\_\_\_ years

What is the size of this farm? \_\_\_\_\_\_\_\_\_\_perches/acres

How many people work at this farm? \_\_\_\_\_\_\_\_\_\_\_\_

Is dairy farming your primary source of income?

* Yes, around \_\_\_\_\_\_% of income is derived from cattle
* No, around \_\_\_\_\_\_% of income is derived from cattle

How many people directly depend on this farm for their income? \_\_\_\_\_\_\_\_

If there are other sources of income, tick all that apply:

* tourism
* farming (crops)
* other\_\_\_\_\_\_\_\_\_\_\_\_\_
1. **Cattle demographics**

How many adult cattle are there on this farm? Bulls:\_\_\_\_\_ Cows:\_\_\_\_\_\_\_

How many calves are there on this farm? \_\_\_\_\_\_\_

How many pregnant cows are there on this farm? \_\_\_\_\_\_\_\_

Do you have more cattle now than 3 years ago?

* Same (0% change)
* More (0-50% more)
* Many fewer (>50% less)
* Many more (>50% more)
* Fewer (0-50% less)

Do you have more calves now than 3 years ago?

* Same (0% change)
* More (0-50% more)
* Many fewer (>50% less)
* Many more (>50% more)
* Fewer (0-50% less)
1. **Cattle husbandry and mitigation techniques**

How do you keep and graze your cattle? (Husbandry techniques practiced)

* Cinnamon Wild pen – all cattle
* Cinnamon Wild pen – calves
* Cinnamon Wild pen with roof - calves
* No pen – all cattle left out
* Daytime free grazing adults + calves
* Daytime adult grazing, calves penned
* Stick and thorn pen – calves
* Stick and thorn pen – adults + calves
* Adults + calves tied and left outside
* Only calves tied

Please give details on whether these methods occur at certain times of year, during certain times of day, how far apart any shelters are from each other, or any other relevant details:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What methods have you used to try and protect your cattle?

|  |  |  |  |
| --- | --- | --- | --- |
| **Mitigation**  | **Tried?**  | **Comments** | **Willing to try**  |
| Increased human presence (grazing) |  |  |  |
| Light and sound distractions  |  |  |  |
| Relocating cattle to lower-risk areas |  |  |  |
| Higher thorn walls  |  |  |  |
| Trained guard dogs |  |  |  |
| Human night patrols |  |  |  |
| Reinforced enclosures (using metal walls and roofing) |  |  |  |

Would you be open to adjusting your husbandry practices if it would better safeguard your cattle?

* yes
* maybe
* no

What’s the biggest limiting factor in changing husbandry practices?

* Price of equipment
* maintenance
* labour
* other\_\_\_\_\_\_\_\_

Please explain and estimate the approximate cost and maintenance fees:

Protecting cattle in pens: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Disease prevention: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Veterinary expenses: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Do you shift grazing locations? How often do you graze in the same location? Explain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Wildlife & depredation**

Is there a change in the amount of wildlife seen?

* yes
* no

Animals (photos will be used to help identify)

Wildcats: leopard rusty spotted cat jungle cat fishing cat

Primates: grey langur macaque loris

Deer: spotted deer barking deer sambar mouse deer

Bear: yes no

Elephant: yes no

Small mammals: pangolin hare giant squirrel

Other species: jackal wild boar other:\_\_\_\_\_\_\_\_

What are the issues you encounter raising cattle in this landscape? (monkeys, elephants, leopards)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Do wildlife sightings around your farm or the community make you feel concerned for your safety, or the safety of your cattle? Please explain:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Do you see more or less leopards (or signs of leopard) than 3 years ago?

* many more
* more
* same
* fewer
* many fewer

Have there been any losses of cattle at this farm within the last 3 years?

* yes, \_\_\_\_\_\_ cattle lost
* no

If yes, please describe the incidents and the time of year most incidents occurred, if possible:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What was the cause of cattle loss? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* don’t know
* disease, ~ \_\_\_\_%
* wandering off, ~\_\_\_\_%
* snake bite, ~\_\_\_\_\_ %
* theft, ~ \_\_\_\_ %
* leopard predation, ~ \_\_\_\_%

IF leopard predation, how did you know this was a leopard? What were the signs?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is number of cattle lost to leopard predation more or less than 3 years ago (new government)?

* more now
* less now
* same
* don’t know

What is your course of action when an animal is killed? (allow them to answer first)

* Report to DWC
* Report to police
* Ignore
* Move cattle to new location

What if you lose multiple cattle? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If cattle are lost to predation, what is the biggest cost for you (direct, indirect)?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If predation occurs, which animals are most often lost?

* Strong/healthy animals
* Older/weaker animals
* Pregnant animals
* Calves

Have you noticed any patterns in these losses in terms of time and season?

1. time
* always night
* always daytime
* mostly night
* mostly day
* no pattern
* other\_\_\_\_\_\_\_\_\_\_\_\_\_\_
1. season
* mostly wet season
* mostly dry season
* all year round
* other \_\_\_\_\_\_\_\_\_\_\_

Have you had any successes on your farm in safeguarding your cattle? If so, what was the method and how long has it been implemented for?

Have you had less sightings of leopards since these measures were implemented?

* yes
* no
* don’t know

What is the approximate cost to you (Rs) of

1. Loss of 1 female calf \_\_\_\_\_\_\_ Rs
2. Loss of 1 pregnant cow \_\_\_\_\_\_\_\_\_ Rs
3. Loss of 1 lactating cow \_\_\_\_\_\_\_\_\_ Rs
4. Loss of 1 male stud \_\_\_\_\_\_\_\_\_\_\_ Rs

How much does the loss of cattle to leopards worry you?

* very much
* some
* not much
* not at all

Do you feel the government should play a role in facilitating cattle rearing in this landscape?

* yes
* no
* don’t know/maybe

If yes, could you suggest how? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Have you benefitted from any tourism or development projects focused on the leopard?

* yes
* no
1. **Importance of conservation**

Is Sri Lankan wildlife (elephants, primates, leopards, amphibians, birds) important to you?

 Elephants

* yes
* somewhat
* no

 Deer

* yes
* somewhat
* no

 Primates

* yes
* somewhat
* no

 Leopards

* yes
* somewhat
* no

 Reptiles and amphibians

* yes
* somewhat
* no

 Birds

* yes
* somewhat
* no

Do you think there are too many/too few/the right amount of wildlife in this area?

 Elephant

* too many
* too few
* right amount

 Deer

* too many
* too few
* right amount

 Primates

* too many
* too few
* right amount

 Leopards

* too many
* too few
* right amount

 Reptiles and amphibians

* too many
* too few
* right amount

 Birds

* too many
* too few
* right amount
1. **Views of leopard ecology and awareness of economic importance**

Do you know that the Sri Lankan leopard is endangered, and a very important species for the larger ecosystems they live in?

* yes
* no

Do you know you graze your cattle very close to a national park where leopards and other animals live?

* yes
* no

Do you think that these protected national parks provide the best environment for leopards to live, across Sri Lanka?

* yes
* no

Do you think that leopards live outside of these protected national parks, and can live and reproduce in smaller forest patches?

* yes
* no

Do you think that leopards in Sri Lanka like to eat animals like deer, langurs, buffalo, hares and wild boar?

* yes
* no

Do you think that dairy cattle often have reduced defence instincts and may be easier for older or younger leopards to capture and eat?

* yes
* no

Do you know that leopards produce economic benefits both in this area and across Sri Lanka?

* yes
* no

Do you know that Yala National Park is the most visited national park in Sri Lanka?

* yes
* no

Do you know that Yala National Park generates over 600 million rupees each year?

* yes
* no

Are you aware that a nearby hotel has been giving out steel cattle enclosures as part of a program to market increased coexistence between cattle farmers and leopards in this area?

* yes
* no
1. **Attitude statements**

The following questions will be answered on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree)

+ The nature and wildlife of Sri Lanka is a national treasure and should be conserved

+ I respect leopards for their economic value they bring to the country through wildlife tourism

- My livelihood is more important than current leopard populations

+ It does not matter if a leopard kills a few of my cattle, they are wild animals just trying to survive

- At this farm we cannot tolerate leopards killing any cattle at any time

- I would be happier if there were fewer leopards around where I live and raise my cattle

- I do not want to kill leopards, but if they kill my cattle I might have to

+ I would like to communicate and work together with scientists, government staff and organizations to find a solution to this problem

Supplementary Material 2 Further information relating to the Exploratory Factor Analysis (EFA) method used during data analysis.

Exploratory Factor Analysis (EFA) is a form of dimension reduction when there are multiple variables measuring the same latent trait. Different dimensions (e.g. questions responses) are combined through a factor analysis approach to give a final (continuous) score for each respondent, that will be used in later regression modeling.

**Extracting Factors**

First, we calculated the correlation matrix for each round of EFA depending on the variable type, as follows:

* Pearson’s correlations for numeric data
* Polychoric correlations for ordered variables
* Tetrachoric correlations for dichotomous variables

We used a maximum likelihood factoring method due to its clearer interpretability. Maximum likelihood factoring method gives us the best estimate by maximising the empirical probability function. We used an oblique rotation when performing EFA as it allows for correlations to exist in the data, which it likely does when pertaining to social science data. We tested the two most commonly used and flexible rotations, ‘promax’ and ‘oblimin’, and found that the proportion of variance explained did not differ between rotations, for any factor used in this analysis. We chose to use the ‘promax’ oblique rotation.

We then produced a scree plot to determine the number of factors to use. The scree plot displays the factors and their eigenvalues using the correlation matrix. The number of factors that are strongly present in the data was determined visually at the point where the plot suddenly changes direction. When the eigenvalues indicated two factors be used, the decision to use two or one came down to the proportion of additional variance explained by including the second factor, the interpretability of each factor (i.e. can I understand and explain how and why these two factors are separate?) and the number of predictor variables the relatively small sample size allowed for (leaving a minimum of 10 observations per variable included). A general rule of thumb used was that each identified factor has at least 3 variables with high factor loadings (e.g. above 0.7), and that each variable loads highly on only one factor.

**Factor loadings and factor scores**

The output of EFA is a table of factor loadings. The loading of each item (e.g. each attitude statement, or each column used in EFA) represents the strength and directionality of the relationship between each item and the underlying factor, from -1 to 1. If all loadings are very similar to each other, we can calculate linear combinations of items and ignore their weights, through a simple sum or average. However this is rare in reality, and if loadings vary we want an index to reflect that each item has an unequal association with the factor. We did this by combining the items through calculating an index variable through an optimally-weighted linear combination called factor scores. Each item’s weight is its factor loading, so each item’s contribution to the factor score depends on how strongly it relates to the factor. We used Bartlett scores as opposed to Thurstone or Anderson-Rubin scores as this method uses maximum likelihood estimation to produce unbiased estimates of factor scores, and allows for correlations in the data which does exist in this context. Measurement error was not considered during this analysis due to sample size limitations. Factor scores were then created for each respondent, providing a continuous value of each latent phenomenon measured, relative to others surveyed, to be used in subsequent regression models.

R packages used

* psych (Revelle, 2018)
* polycor (Fox, 2016)
* GPArotation (Coen & Jennrich, 2005)

**References**

Coen, A.B. & Jennrich, R.I. (2005) Gradient Projection Algorithms and Software for Arbitrary Rotation Criteria in Factor Analysis. Http://www.stat.ucla.edu/research/gpa.

Fox, J. (2016) polycor: Polychoric and Polyserial Correlations. Https://cran.r-project.org/package=polycor.

Revelle, W. (2018) psych: Procedures for Personality and Psychological Research. Northwestern University, Evanston, Illinois. Https://cran.r-project.org/package=psych.