Data from: Ecological consequences of large herbivore exclusion in an African savanna: 12 years of data from the UHURU experiment

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Data Descriptors

There are 13 files that provide location, rainfall, habitat, vegetation, and animal data from the

UHURU experiment. There are several column headings that identify the scale and location of

sampling, appearing in many of the 13 datasets that follow.

Label	Attribute	Definition
Survey/Census	Survey or Census number	Numeric
Year	Year of sampling	2008–2019
Month	Month of sampling	Month
Site	Plot location	North (dry), Central (intermediate), South (wet)
Block	Replicate	Numeric (1–3)
Treatment	Experimental treatment type (definitions refer to the excluded LMH species)	OPEN = open plots; MEGA = megaherbivore; MESO = meso- and megaherbivore; TOTAL = all LMH excluded; OUT = near to, but outside, experimental plots (rarely used)
Plot	Unique plot identifiers	Comprises site, block, and treatment

Rebar/Section	Identity of the rebar stake within the central grid	Alphanumeric ID of rebar stakes (49 per plot). "Section" denotes the grid cell immediately below and to the right of a stake (e.g., 1A denotes the grid cell bounded by stakes 1A, 1B, 2A, and 2B).
Species	Species	Species of plant or animal. Some species are identified only to genus/morphospecies.

1. PLOT COORDINATES

A. Data set file

Identity: PLOT_COORDINATES.csv

Size: 4 KB

Format: CSV

Contents: Includes the name and location of all experimental plots. There are 81 lines of data, with each record providing location data for the axes of each plot.

B. Variable information

Column	Attribute	Definition
3-6	Coordinates	Columns 3 and 4 are UTM coordinates, columns 5 and 6 are decimal degree coordinates.

C. Data anomalies: None.

2. RAINFALL DATA

A. Data set file

Identity: RAINFALL_2008-2019.csv

Size: 263 KB

Contents: Daily data for each rain gauge.

B. Variable information

Column	Attribute	Definition
1	Date	Date in form of day-month-year.
2–13	Daily rainfall (mm)	Daily rain gauge readings at each block. "man" denotes manual rain gauges used early in the project, while "aut" denotes automatic rain gauges that were installed beginning in 2010.
14-16	Averages (mm)	Average rainfall across gauges at a given site.

C. Data anomalies: NA denotes days on which no data were recorded by a given gauge due to equipment failure. No gauges recorded data from the South site from 26 May 2011 to 30 May 2011, and no gauges recorded data for the Central site from 9 December 2015 to 31 December 2015 and 9 October 2016 to 23 October 2016, and therefore data is missing for these dates. No gauges recorded data for the North site from 9 December 2015 to 31 December 2015, but data from a nearby long-term hydrology study was substituted for those dates (Caylor et al. 2017).

3. VEGETATION DATA – PIN-FRAME SURVEYS

A. Data set file

Identity: UNDERSTORY_PIN_2008-2019.csv

Size: 29.1 MB

Contents: Understory pinhit vegetation data recorded within each of the smaller quadrats (0.25 m²) in each of 20 semiannual surveys from October 2008 to March 2019.

B. Variable information

Column	Attribute	Definition
9	Bare ground	Number of pins with bare ground and no vegetation
10:331	Species names	Genus and species of plant recorded in understory vegetation surveys

C. Data anomalies: Two surveys were performed per year, except for 2015, 2016, and 2019; only one survey was performed for each of those years. Notes on taxonomy, including changes across the 20 surveys, are recorded in rows 2-4. Row 2 (Notes) indicates the name that a plant was assigned during each of the 20 surveys. Row 3 (Changes) provides details on name changes, including lumping, splitting, and new identifications. Row 4 (SKS#) provides the voucher number matching each species to a specimen used to confirm identification by botanists at the National Museums of Kenya in conjunction with DNA barcoding (Gill et al. 2019). Taxonomic identities are considered provisional if labeled as morphospecies, as genus with "sp.", or as "unknown." Identifications of morphospecies are pending ongoing taxonomic investigation and DNA barcoding. Taxa are recorded as NA in surveys for which those taxa were not recognized. We include all 20 surveys conducted from 2008-2019 to facilitate tracking of nomenclatural updates that have been guided by detailed botanical investigations and DNA barcoding over this period (cf. Kartzinel et al. 2014). For Surveys 1-14, trees (e.g., *Acacia* spp., *Boscia angustifolia*) and other overstory species (e.g., *Opuntia stricta*, *Euphorbia* spp.) were not counted. Starting in Survey 15, seedlings and saplings of these species were included in the surveys as components of

the understory. For Surveys 1-14, these species are listed as NA. Elsewhere throughout the data set, NA indicates data that are missing or suffered from transcription errors.

4. VEGETATION DATA – SMALL (0.25 m^2) QUADRATS

A. Data set file

Identity: UNDERSTORY_SMQUAD_2008-2019.csv

Size: 28.7 MB

Contents: Understory vegetation data recorded in small quadrats (0.25 m²) at each rebar stake during 20 semiannual surveys from October 2008 to March 2019.

B. Variable information

Column	Attribute	Definition
9	Bare ground	Percent cover
10:331	Species names	Genus and species of plant recorded in understory vegetation surveys

C. Data anomalies: Two surveys were performed per year, except for 2015, 2016, and 2019; only one survey was performed for each of those years. Notes on taxonomy, including changes across the 20 surveys, are recorded in rows 2-4. Row 2 (Notes) indicates the name that a plant was assigned during each of the 20 surveys. Row 3 (Changes) provides details on name changes, including lumping, splitting, and new identifications. Row 4 (SKS#) provides the voucher number matching each species to a specimen used to confirm identification by botanists at the National Museums of Kenya in conjunction with DNA barcoding (Gill et al. 2019). Taxonomic identities are considered provisional if labeled as morphospecies, as genus with "sp.", or as "unknown." Identifications of morphospecies are pending ongoing taxonomic investigation and

DNA barcoding. Taxa are recorded as NA in surveys for which those taxa were not recognized. We include all 20 surveys conducted from 2008-2019 to facilitate tracking of nomenclatural updates that have been guided by detailed botanical investigations and DNA barcoding over this period (cf. Kartzinel et al. 2014). For Surveys 1-14, trees (e.g., *Acacia* spp., *Boscia angustifolia*) and other overstory species (e.g., *Opuntia stricta*, *Euphorbia* spp.) were not counted. Starting in Survey 15, seedlings and saplings of these species were included in the surveys as components of the understory. For Surveys 1-14, these species are listed as NA. Elsewhere throughout the data set, NA indicates data that are missing or suffered from transcription errors. For surveys 1-14, data are binary presence/absence data (values = 0 or 1), and surveys 15-20 include percent cover data.

5. VEGETATION DATA – LARGE (1 m^2) QUADRATS

A. Data set file

Identity: UNDERSTORY_LGQUAD_2008-2019.csv

Size: 28.7 MB

Contents: Understory vegetation data recorded in large quadrats (1 m²) at each rebar during 20 semiannual surveys from October 2008 to March 2019.

B. Variable information

Column	Attribute	Definition
9	Bare ground	Percent cover
10:331	Species names	Genus and species of plant recorded in understory vegetation surveys

C. Data anomalies: Two surveys were performed per year, except for 2015, 2016, and 2019; only one survey was performed for each of those years. Notes on taxonomy, including changes across the 20 surveys, are recorded in rows 2-4. Row 2 (Notes) indicates the name that a plant was assigned during each of the 20 surveys. Row 3 (Changes) provides details on name changes, including lumping, splitting, and new identifications. Row 4 (SKS#) provides the voucher number matching each species to a specimen used to confirm identification by botanists at the National Museums of Kenya in conjunction with DNA barcoding (Gill et al. 2019). Taxonomic identities are considered provisional if labeled as morphospecies, as genus with "sp.", or as "unknown." Identifications of morphospecies are pending ongoing taxonomic investigation and DNA barcoding. Taxa are recorded as NA in surveys for which those taxa were not recognized. We include all 20 surveys conducted from 2008-2019 to facilitate tracking of nomenclatural updates that have been guided by detailed botanical investigations and DNA barcoding over this period (cf. Kartzinel et al. 2014). For Surveys 1-14, trees (e.g., *Acacia* spp. and *Boscia angustifolia*) and other overstory species (e.g., *Opuntia stricta* and *Euphorbia* sp.) were not counted. Starting in Survey 15, seedlings and saplings of these species were included in the surveys as components of the understory. For Surveys 1-14, these species are listed as NA. Elsewhere throughout the data set, NA indicates data that are missing or suffered from transcription errors. For surveys 1-14, data are binary presence/absence data (values = 0 or 1), and surveys 15-20 include percent cover data.

6. VEGETATION DATA – VERTICAL VEGETATION STRUCTURE

A. Data set file

Identity: VERTICAL_VEGETATION_2016-2018.csv

Size: 3.8 MB

Contents: Annual surveys of vertical vegetation taken at the 49 stakes in each plot.

B. Variable information

Column	Attribute	Definition
8	Voucher Number	Specimen number for identification at National Museums of Kenya
9	Stem	Stem (1) or non-stem (0; e.g., leaf, flower)
10	Height	Height at which plant touched tree pole (cm)

C. Data anomalies: Three vertical vegetation surveys were performed between December 2016 and December 2018. A partial survey in October 2017 (Survey 1B) includes only the South plots. During Surveys 1-2, *Achyranthes aspera* was identified to subspecies, but in Survey 3 it was identified only to species. During data curation for this publication, several species names were updated from those that have been used in previous studies from UHURU: an unknown *Eragrostis* species was identified as *Eragrostis cylindriflora*, an unknown Malvaceae was identified as *Hibiscus sparseaculeatus*, an unknown *Pavonia* species was identified as *Pavonia patens*, and an unknown *Pollichia* species was identified as *Atriplex semibaccata*. *Sida alba* was changed to *Sida ovata*, *Abutilon mauritianum* was changed to *Pavonia burchellii*, and *Cyathula cylindrica* was changed to *Cyathula orthacantha*. All instances of *Cyathula orthacantha* associated with Voucher # RRH_13_040 as described in Gill et al. (2019) were changed to *Pupalia lappacea*. Nomenclatural updates (cf. Kartzinel et al. 2014) have been guided by detailed botanical investigations of voucher specimens at the National Museums of Kenya as well as DNA barcoding, and are consistent with changes made in the understory, tree census, and tree survey datasets.

7. VEGETATION DATA – LONGITUDINAL TREE SURVEYS

A. Data set file

Identity: TREE_SURVEYS_2009-2019.csv

Size: 1.3 MB

Contents: Annual tree surveys and measurements for each plot (2009–2019).

B. Variable information

Column	Attribute	Definition
9	Tag Number	Current tag number that identifies a tree.
10	Dead	Whether the tree is dead (Y = Yes; N = No).
11	Height	Tree height (m).
12	Length	Length of canopy extent (m).
13	Width	Length of canopy perpendicular to first measurement (m).
14	Circumference	Circumference of tree (cm).
15	Number of stems	Number of stems at ground level.

C. Data anomalies: Re-measuring tree heights and circumferences can be imprecise due to factors including variability in how high on the stem the calipers or measuring tape was placed or the inadvertent measurement of the wrong basal stem on a tagged tree. Nonetheless, tree heights and diameters can change dramatically from year to year, due to damage by elephants, drought,

etc. We scrutinized data and identified all trees with changes in height or circumference greater than three standard deviations between any two consecutive surveys to identify and correct inadvertent miscalculations, transcription errors, or other verifiable mistakes; otherwise, we assumed measurements to be accurate, even when differing markedly between successive years. No tree survey was conducted in 2018. Some trees and plots were inadvertently measured twice in the same year—these values can be used to estimate measurement error. Many additional trees were tagged in 2012 following the same monitoring protocol as the other trees, but some of these additional trees were not monitored after 2015; these trees are denoted by a tree tag number beginning with "JM".

8. VEGETATION DATA – TREE CENSUS SUMMARY

A. Data set file

Identity: TREE_CENSUS_SUMMARY.csv

Size: 259 KB

Contents: Summary spreadsheet at the plot level showing number of individuals of each species in each size class in each year per plot (2009-2019).

B. Variable information

Column	Attribute	Definition
8–14	Size classes	Trees per size class per subplot
15	Total	Total trees per species per subplot

C. Data anomalies: No census was conducted in 2011 or 2015. No data are available for N1MESO and N3OPEN in 2019. Some data were missing for S2MESO and S3MESO in 2016, S3MESO in 2017, and C1TOTAL and C3TOTAL in 2019 (so summarized data may be meaningfully undercounted in these plots in these years). *Euphorbia* spp. were present but not recorded in 2009; *Opuntia* spp. were present but not recorded until 2012. Otherwise, when tree species are not listed in a year, this indicates that the tree species was not present in that year.

9. VEGETATION DATA – TREE CENSUS DETAILED

A. Data set file

Identity: TREE_CENSUS_DETAILED.csv

Size: 2.7 MB

Contents: Spreadsheet showing the data for each 10×10 m sampled section of each plot (2009-2019).

B. Variable information

Column	Attribute	Definition
9-15	Size classes	The number of trees for the corresponding species in each size class
16	Total	The total number of trees measured.

C. Data anomalies: No census was conducted in 2011 or 2015. No data are available for N1MESO and N3OPEN in 2019. Some data were missing for S2MESO and S3MESO in 2016, S3MESO in 2017, and C1TOTAL and C3TOTAL in 2019 (so summarized data may be meaningfully undercounted in these plots in these years). *Euphorbia* spp. were present but not

recorded in 2009; *Opuntia* spp. were present but not recorded until 2012. Otherwise, when tree

species are not listed in a year, this indicates that the tree species was not present in that year. In

some sections in some years, two rows for the same species were inadvertently recorded with

different numbers of trees. We recommend that data users average these entries to account for

these data errors.

10. VEGETATION DATA - FLOWER AND FRUIT PHENOLOGY

A. Data set file

Identity: PHENOLOGY_2012-2019.csv

Size: 1.2 MB

Contents: Spreadsheet detailing the presence of flowers and fruit on species of plants at each

site of the UHURU experiment.

B. Variable information

Column	Attribute	Definition
4	Flower or fruit	Whether the observation represents flowers or fruits
5-7	Presence at sites	Presence of flowers or fruits during the month and year denoted by the row (1: present, 0: absent or missing from site)

C. Data anomalies: June and December 2012 data quantified numbers of flowers and fruits for a

small subset of plant species. From August 2013, monthly phenology data were collected. These

data include a broader range of species than 2012 data, but only specify whether a species was

flowering (not fruiting) in a given site. From January 2017, the data include the presence of both

flowers and fruits (separately) for each species in each site. Zeros may indicate either that no flowers or fruits were present, or that the species itself was not present or not detected in a plot; analyses based on absence of flowering/fruiting should therefore be conducted with caution.

11. VEGETATION DATA - *ACACIA* SEED RAINFALL

A. Data set file

Identity: ACACIA_SEED_RAIN_2016-2019.csv

Size: 83 KB

Contents: Seed rain from *Acacia etbaica* and *Acacia mellifera* across the rainfall gradient from December 2016 to October 2019.

B. Variable information

Column	Attribute	Definition
2	Tree ID	Unique identifier for each tree, including species and ID number (AE = *Acacia etbaica*; AM = *Acacia mellifera*)
3	Species	*Acacia* tree species (*Acacia_etbaica* or *Acacia_mellifera*)
4	Height class	Trees divided into categories based on height (2-3 m, 3-4 m, or >4 m)
6	Weight	Weight of seeds caught in net underneath tree canopy (g; marked as "not checked" if tree was not checked in a given week)

C. Data anomalies: Missing data are indicated by NA.

12. ANIMAL DATA – DUNG SURVEYS

A. Data set file

Identity: DUNG_SURVEYS.csv

Size: 532 KB

Contents: Dung count survey data, 2009–2019

B. Variable information

Column	Attribute	Definition
9	Line	Transect line number (corresponding with the tree census and small mammal trapping grid)
10-40	Source of dung	Species of origin and age (old vs. new dung assessed by color).

C. Data anomalies: Dung of several species pairs cannot be differentiated reliably in the field. These include hares (*Lepus* cf. *L. capensis* and *L.* cf. *L. saxatilis*; Kartzinel et al. 2019), plains and Grevy's zebra (*Equus quagga* and *E. grevyi*), African buffalo (*Syncerus caffer*) and domestic cattle (*Bos indicus*). We made no effort to differentiate predator dung (rare) according to species; instead, we lumped them within three size classes: large, medium, and small. A transcription error occurred when recording block number in the Central plots during the January 2011 survey. As a result, Block 2 and Block 3 are coded as NA to reflect the uncertainty. No data are available for the Central and South sites for Survey 19.

13. ANIMAL DATA – SMALL MAMMAL SURVEYS

A. Data set file

Identity: SMALL_MAMMALS_2009-2019.csv

Size: 2.7 MB

Contents: Small mammal captures during capture periods 1–63 (May 2009 – December 2019).

B. Variable information

Column	Attribute	Definition
10	Night	Trap night (per site per survey)
11	Species	Acke = *Acomys kempi* = Kemp's spiny mouse Acpe = *Acomys percivali* = Percival's spiny mouse Aehi = *Aethomys hindei* = Hinde's rock rat Arna = *Arvicanthis nairobae* = Nairobi grass rat Arni = *Arvicanthis niloticus* = African grass rat Crel = *Crocidura elgonius* = Elgon shrew Crgr = *Crocidura gracilipes* = Peter's musk shrew Croc = *Crocidura* spp. = white-toothed shrews Dend = *Dendromus* spp. = climbing mice Elru = *Elephantulus rufescens* = rufous elephant shrew Geni = Gerbiliscus nigricaudus = black-tailed gerbil Gero = *Gerbilliscus robustus* = fringe-tailed gerbil Grdo = *Grammomys dolichurus* = woodland thicket rat Grmi = *Graphiurus microtis* = small-eared dormouse Mana = *Mastomys natalensis* = Natal multi-mammate rat NA = used for traps that were closed but empty as well as traps that were missing or damaged; also used for plots in which no animals were caught that night Rara = *Rattus rattus* = black rat Same = *Saccostomus mearnsi* = northern pouched mouse Stpa = *Steatomys parvus* = tiny fat mouse Taha = *Taterillus harringtoni* = Harrington's tateril Uarvi = *Arvicanthis* spp. = grass rats Umus = *Mus* spp. = pygmy mice Unkn = unknown Zehi = *Zelatomys hildegardeae* = Hildegarde's broad-headed stink mouse
12	Capture	C = capture; R = recapture

13	Sex	F = female; M = male
14	Condition	L = lactating N = none (no reproductive condition) P = pregnant PL = pregnant and lactating S = scrotal
15	Age	A = adult; S = subadult; J = juvenile
16	Left hind foot	Length of left hind foot (mm)
17	Left tag	Tag number at survey
18	Original tag	Original tag number. Particularly useful for cross-referencing with left_tag column when a tag was missing or replaced
19	ID	Individual identifier
20	Marks	Number of paint marks left on animals without ear tags
21	Weight	Weight (g)

22	Notes	Indicate areas where individual identifications or measurement interpretations require caution. In particular, this column indicates if ID tags were lost or replaced, or if an individual escaped during evaluation. The condition of some individual captures could be consequential, such as individuals captured dead or with broken limbs. Also may indicate when a non-small mammal species is caught, such as a bird, squirrel, or dwarf mongoose.

C. Data anomalies: NA indicates no data. Based on mitochondrial DNA barcoding data, along with geographic range and morphological data, the species listed as *Mus sorella* (MUSO) on the original field data sheets is now identified as the tiny fat mouse, *Steatomys parvus* (STPA). Harrington's tateril (*Taterillus harringtoni*) was initially misclassified as juvenile fringe-tailed gerbil (*Gerbilliscus robustus*) but was identified in May 2011 via DNA barcoding (Goheen et al. 2013). We now differentiate between the two species based on hindfoot length (<34 mm for *T. harringtoni*), mass (<60 g for *T. harringtoni*), and tail (tufted for *T. harringtoni*). Mitochondrial DNA barcoding has also been used to confirm the presence of at least 3 *Mus* phylotypes in the plots that we cannot reliably distinguish in the field; all are listed as Umus (*Mus* spp.) in the dataset. Two *Crocidura* species (*C. elgonius* and *C. gracilipes*) are distinguished by size at maturity; *C. elgonius* are <7 g, and *C. gracilipes* are >7 g.