2011

Dietary Ecology of the Endangered Grevy's Zebra, Equus grevyi, in Historic and Modern Laikipia

Susan Olszewski
University of Puget Sound, solszewski@pugetsound.edu

Dietary Ecology of the Endangered Grevy's Zebra *Equus grevyi* in Historic and Modern Laikipia, Kenya

Susin Olszewski*, Professor Kena Fox-Dobbs
University of Puget Sound, Tacoma, WA 98416

ABSTRACT

The Grevy's zebra, *Equus grevyi,* a highly endangered equid, has undergone the most dramatic reduction in population of any African mammal (Nelson & Williams 2003). Over the last 100 years, Kenya has undergone many changes in land use practice and policy that have lead to high densities of people and livestock in close proximity to wildlife (Flury 1988). Recent studies suggest these increases in human population and livestock pressure in overgrazed areas have negatively shifted the diet of this the Grevy's zebra from hypergrazer to mixed browser. Interestingly, the plains zebra, *Equus burchelli,* a co-occurring equid whose diet is also chiefly composed of grasses, has maintained a stable population in spite of these pressures (Kleine & Fox-Dobbs, 2010). Using stable isotope analysis, this study examines changes in zebra diet over the last century in conjunction with changes in land management in Kenya. It is expected that intensification of land use and livestock presence over time have contributed to a decline in the proportion of grass that makes up the zebra's diet.

BACKGROUND

STUDY LOCATIONS

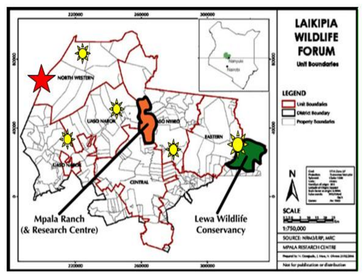

Figure 1. Map of Laikipia region of Kenya with modern and historic sampling sites. The Lewa Wildlife Conservancy, shaded green, was previously sampled for zebras under no livestock pressure. The Mpala Research Centre, shaded orange, was previously sampled for zebras under some managed livestock. The red star indicates the approximate location of the Westgate community land outside of Lewa Wildlife Conservancy, where samples were taken from zebras under heavy, unmanaged livestock pressure. Yellow stars indicate approximate locations of historical sampling sites. Map modified courtesy of the Mpala Research Center.

(a)

(b)

Figure 2. Grevy's zebra (a) and plains zebra (b) on the Mpala Research Centre. In Laikipia, grevy's and plains zebras co-occur. However, the population of plains zebra has remained stable over the last century whereas the Grevy's population has declined.

Historic zebra Grevy's and plains zebras were among the 23,151 specimens collected during Theodore Roosevelt's 1909 expedition to Africa. The expedition was cosponsored by the newly formed Smithsonian Museum of Natural History.

Table 1. Summary of Grevy's and plains zebra samples.

Species	Number of Individuals	Year
Equus grevyi	31	2006-2010
Equus burchelli	5	2006-2010
Equus grevyi	12	1908-1911
Equus burchelli	13	1909-1911

*each individual subsampled 3 times along the length of the hair.

MATERIALS & METHODS

I. Collection of modern Grevy's zebra hair in collaboration with Dr. Siva Sundaresan (grevy's n=31) and historic samples from the Smithsonian Museum of Natural History (Grevy's n=36, plains n=15).
II. Subsampling and weighing of hairs into base, middle, and tip samples.
III. Analysis of samples at the University of California Santa Cruz Stable Isotope Lab.

PART I. How were resources partitioned among co-occurring equids 100 years ago versus today?

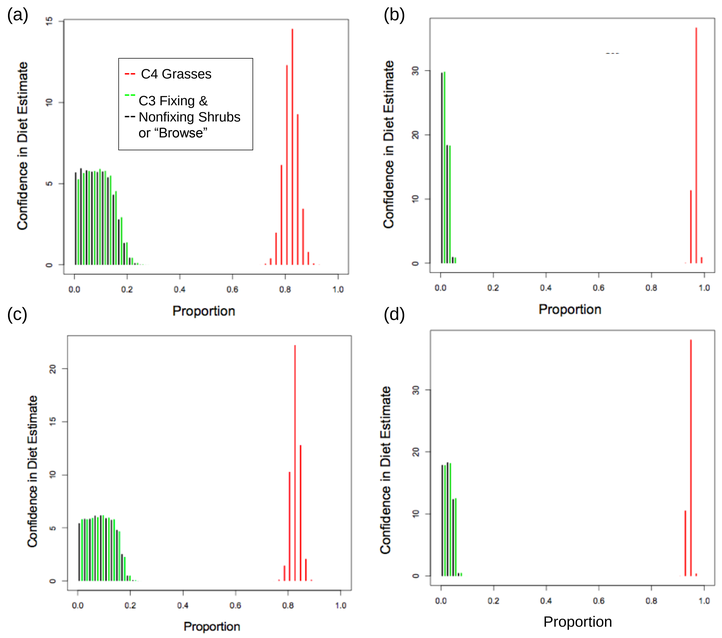

Figure 3. Proportions of C4 grasses, C3 fixing, and C3 non-fixing browse sources in historic Grevy's (a), historic plains (b), modern Grevy's (c), and modern plains (d) zebra diet. Based on raw geochemical data, historic Grevy's (n=36) and plains (n=39) zebras show significantly different proportions of C4 grasses in diet. Historic plains consume a greater proportion of grasses than Grevy's (1-way ANOVA, $F_{1,73}$=27.5, p=1.47x10^{-6}). Historic Grevy's have a mean $\delta^{13}C$ of -12.41±2.46, whereas historic plains show a mean of -10.26±0.63. Modern Grevy's also consume significantly more browse than modern plains (1-way ANOVA, $F_{1,70}$=4.83, p=0.0312). Diets historic and modern plains zebras did not differ significantly as both had high proportions of C4 consistent with a hypergrazer (1-way ANOVA, $F_{1,52}$=4.21, p>0.05). Proportions of C4 did not differ between modern and historic Grevy's (1-way ANOVA, $F_{1,91}$=1.07, p>0.05).

SUMMARY
•Historic Grevy's have a more variable diet containing higher proportions of browse than historic plains zebras
•Historic Grevy's and plains zebras exhibit similar resource partitioning comparable with modern zebras.

PART II. How does Grevy's diet vary across time and livestock pressure?

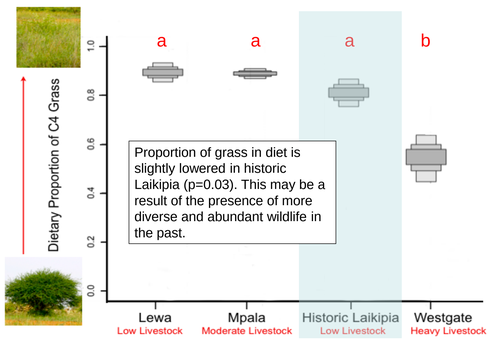

Figure 4. Mean proportion of C4 grasses in Grevy's zebra diet across locations of varied livestock pressure: Lewa (n=42), Mpala (n=39), historic Laikipia (n=36), and Westgate (n=16). Under low and moderate livestock pressure, grevy's eat almost entirely grass whereas under heavy livestock pressure, the dietary proportion of browse increases. Letters indicate statistical differences in grass proportion among individuals (1-way ANOVA).

SUMMARY
•Historic Grevy's diet is most similar to of modern zebras under low or moderate livestock pressure.
•Under heavy livestock pressures, Grevy's are mixed browser feeders.
•The lowered average proportion of grass in historic Laikipia zebras may be caused by competition with other large herbivores no longer present in Laikipia (e.g. rhinoceros).

PART III. How variable is individual Grevy's diet across location?

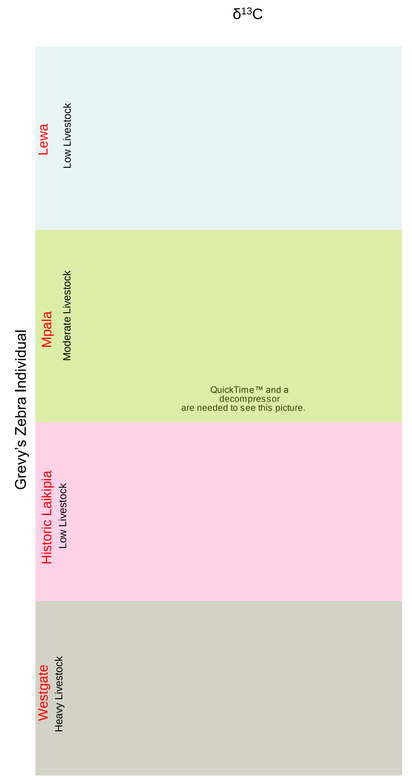

Figure 5. Variation within Grevy's zebra individual diet temporally and spatially. Diet within each individual is represented at three points in time as determined by subsection of hair: hair base represents average diet nearest to the time of capture, tip as the furthest back in time, and middle falling in between the two. Individual diet is most variable for zebras in Westgate (heavy livestock) and historic Laikipia (low livestock).

Factors that Influence Diet Variability
1. Competition with other herbivores
   - Cattle, goats, & sheep (Westgate)
   - Historic grazers (Laikipia)
   - Co-occuring equids (Lewa & Mpala)
2. Resource Availability
   - Climatic conditions (e.g. rainfall)

SUMMARY
•Individual diet is most variable in historic Laikipia and Westgate.
•Livestock conditions and and competition drive intra-individual variability in diet.
•Historically, Grevy's zebras competed with a more diverse and abundant grazer guild.

Conclusions

• Competition and resource availability influence diet variability at the population level and on an individual level.

•Historic zebras partition resources similarly to modern zebras, such that browse makes up a more significant proportion of Grevy's diet than plains diet.

Future Directions

•Investigate climatic conditions that affect resource availability.

•Correlate zebra diet records with spatial and seasonal changes in resource availability.

•Analyze fecal material to estimate short term diet variability.

Acknowledgements & Literature Cited

I would like to thank my faculty advisor, Kena Fox-Dobbs for her support and guidance. Funding provided by the University of Puget Sound and the Andrew W. Mellon Foundation.

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