



**The Great Grevy's Rally:  
The Need, Methods, Findings, Implications and Next Steps**

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**The Need.** In the 1970s there were over 15,000 Grevy's zebras in Kenya. They were typically seen in Samburu and Marsabit counties and herds sometimes numbered into the thousands. By the late 1980s numbers had dropped into the 4000s and by the early 2000s only about 2000 Grevy's zebras were counted (1). Aerial counts and 'Sight-Resight' analyses since then have produced population size estimates of up to 2500 individuals. But these studies were fraught with problems. The most recent national aerial survey sighted many fewer Grevy's zebras than expected and had to apply an average ground count correction factor to the data. This generated an estimate of over 2500, the largest estimate of the past few decades (2). The first national census of population size using a 'Sight-Resight' variant of the standard 'Mark-Recapture' analysis in which nature's 'natural barcodes' provided the 'marks', thus avoiding having to capture and mark individuals, ended up mostly relying on site-specific counts. With a small team it proved difficult to sustain the necessary sampling from day to day to insure sufficient resightings (3). As a result, the actual number of Grevy's zebras in Kenya today remains somewhat vague, with estimates ranging from 2100 – 2500.

Counting Grevy's zebra has always posed a challenge. Historically, they have usually been counted from the air, but detecting them can be problematic as they like to shade under trees in the heat of the day. To get a better estimate, the Kenya Wildlife Service's Grevy's Zebra Technical Committee recommended carrying out a 'Sight-Resight' analysis by amassing a large number of volunteers to drive throughout the Grevy's zebra's range, taking pictures on two successive days and then using the newly developed IBEIS software (4,5) to identify and match individual zebras based on 'hotspots' created by each individual's unique stripe patterns. In this way the problem of past counts and censuses could be overcome yielding a more accurate estimate of population size both nationally and by counties and ecologically relevant regions. Critically, the health of Grevy's zebra populations can also be determined from these photos by providing age structure data and by estimating the fraction of females breeding every year, or alternatively, by estimating the inter-birth interval of the average female. These methods provide an important breakthrough for Grevy's zebra conservation. And the reliance on public participation increases effort and awareness, both important factors in conserving the species.

**The Methods.** Performing the census required a herculean effort since Grevy's zebras range over 25,000 km<sup>2</sup>. It was solved by involving the general public. The area was divided into 45 blocks and teams comprised of over 350 members of the public that included conservancy members, rangers and scouts from conservancies, National Parks and Reserves, government officials from the counties as well as KWS and academic scientists. These volunteers spent two consecutive days between January 30 – 31, 2016 driving around each counting block photographing as many Grevy's zebras as possible when they were moving or facing right. Moreover, each photograph included data on the date, time of day and geolocation, which pinpoints their location in space and time. Moreover, they will help determine ranging patterns in the future.

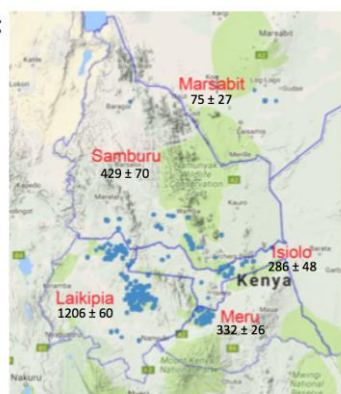
Being the first time that the IBEIS software has been tested on such a large dataset, it was done by experts in USA. In future these analyses can be done in Kenya. The IBEIS team processed the images (4,5), identifying unique individuals seen on days 1 and 2 as well as the number seen on day 1 that were resighted on day 2. Because over 40,000 images had to be analyzed, new computer algorithms had to be developed to handle such 'big data'.

From these three values, population size estimates could be computed. Over 4,000 photographs were then reviewed to assign ages and sexes to individuals so that age structures and inter-birth intervals and fractions of females breeding per year could be computed.

**The Findings.** Over 40,000 images were taken. 15,246 images were crisp and clear and had Grevy's zebras facing in the right direction. Those photos generated 16,866 images of individual zebras and the IBEIS hotspotter analysis yielded 1,942 uniquely identified and named individuals. 1,387 unique individuals were seen on day 1 [S1], another 1,408 unique individuals were seen on day 2 [S2] and 868 individuals seen on day 2 were resightings of individuals seen on day 1 [R]. Using

Population Sizes:  
County

Fig. 1.

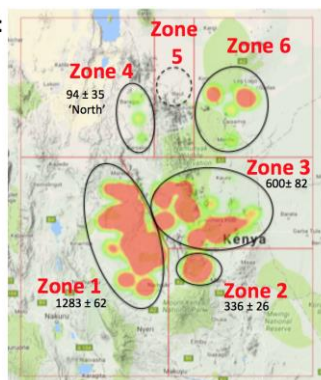


the above values for S1, S2 and R, population sizes (N) for the nation and each county and their respective 95% confidence intervals (CI) could be estimated using the following Lincoln-Peterson formulae (6) :

$$N_{\text{estimate}} = S1 \cdot S2 / R; CI = N_{\text{estimate}} \pm 1.96 \sqrt{((S1^2 * S2[S2 - R]) / R^2)}.$$

Population Sizes:  
Ecological  
Regions

Fig. 2



From these data, three major findings emerge. First, this approach estimated that Kenya's total Grevy's zebra population consists of 2250 individuals ranging from a low of 2157 and a high of 2343 individuals. When additional counts from small areas, areas outside of the Grevy's zebra's historical range or areas that were inaccessible or too dangerous to survey during the census period are added to the total, the

estimate of the size of the national population rises to 2350. Given the tight confidence intervals the number of Grevy's zebras in Kenya ranges from a low of 3175 to 3343.

The population sizes and confidence intervals of individual counties and biological zones based on likely movement corridors are shown in the figures 1 and 2 respectively. What is most interesting is that Laikipia county, once considered a refuge, is now home to the largest population of Grevy's zebras in

Kenya. We recognise, however, that in Marsabit County and Samburu County North, we did not have enough teams to cover the vast areas that Grevy's zebra inhabit in these regions, and as a result, it is likely that these populations are somewhat larger than estimated.

Second, the demographic state of the national population and most counties are

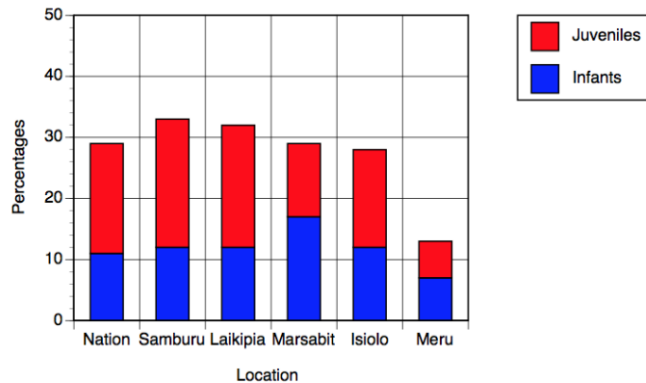


Figure 3. Proportion of foals and juveniles

healthy. When the percentage of infants and juveniles approaches 30% of the total, populations appear stable and tend to sustain themselves because there are sufficient recruits to replace adults that die. As figure 3 shows, only Meru County's Grevy's zebras do not approach this critical threshold, whereas both Samburu and Laikipia counties surpass it.

Third, the fraction of females giving birth per year is high, or its inverse, the inter-birth interval is low. Both also indicate that the reproductive potential of a population is strong and steady. Although equids have a postpartum estrus and in theory can give birth every year, most growing populations typically achieve a birth fraction of .5 or display an inter-birth interval of 2 years. Populations with steady reproductive output have birth fractions close to .3 and inter-birth intervals close to 3 years. As figure 4 shows, all but the Meru population is reproductively steady.

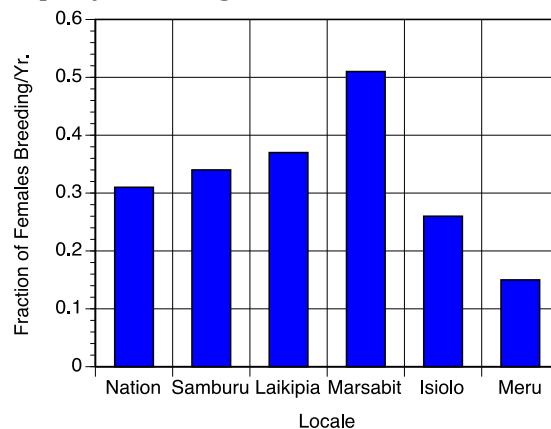


Fig. 4. Fraction of females giving birth

**The Implications and Next Steps.** The results of the first ever citizen science assisted 'Sight-Resight' census of an entire nation's population of an endangered species—in this case Kenya's iconic Grevy's zebra—are staggering. For the first time, the size of Kenya's Grevy's zebra population is known with high precision because the confidence intervals are small. That resightings on day 2 of animals seen on day 1 exceeded 60% is remarkable. Moreover, of the estimated number of individuals comprising the nation's population (2250), over 86% were actually seen, uniquely identified and named. These two outcomes demonstrate that engaged and committed volunteers driving extraordinary distances over rugged terrain can sight and resight a majority of the nation's population during two consecutive days with intensive effort. And the estimate emerging from

such committed volunteers produces precise estimates, a necessary requirement for framing effective conservation actions and policies.

Second, most of the populations reveal age structures with sufficient recruits (~30%) to indicate that they are sustaining themselves. Such high infant and juvenile survival levels may be the result of high levels of rainfall and high levels of vegetation productivity associated with 2015 and 2016 being El Nino years. Even if this is an atypical situation, Grevy's zebra survival demonstrates the potential for the species to increase quickly when released from competition. This is an adaptive life-history trait and suggests that Grevy's zebra populations can rebound from anthropogenic insults when given a chance.

Third, although the traditional heartland counties of Samburu and Isiolo are demographically strong because they are sustaining a large number of recruits, the sizes of populations residing in these counties are smaller today than they were three generations ago. Today Laikipia county has become the home to the largest population of Grevy's zebras in Kenya. Assessing the reasons for this county's growth can be instructive in highlighting key determinants that foster conservation success.

**Conservation Consequences.** The results of the Great Grevy's Rally reinforce the critical importance of access to grazing and water within a secure environment for Grevy's zebra. Historically, Laikipia County was not a natural part of Grevy's zebra range, However, today it is supporting over half of Kenya's Grevy's zebra population due its healthy rangelands. This tells us that the Grevy's zebra is a sensitive and reliable indicator of ecosystem health.

#### *Action 1: Restore Grasslands*

Loss of habitat due to overgrazing by livestock has long been recognised as the most critical threat facing the species, yet land degradation continues at an unprecedented rate. Although cattle migrate, most small stock (sheep and goats) stays locally resident throughout the year, continuously overgrazing plants, which has resulted in increasing bare ground and undesirable species like *Acacia reficiens*. The results of the Great Grevy's Rally are a clear reflection of this trend.

This underscores the critical need for the grazing patterns of all livestock types to be planned throughout the year to ensure recovery time for plants. Where this has been achieved, there are significant results to show for it. Scaling up sound rangeland management practices to restore grassland will enable Kenya's Grevy's zebra population to increase, whilst also having benefits for multiple wildlife species and community livelihoods.

#### *Action 2: Improve Water Access*

Limited access to water during the dry season is another major threat to Grevy's zebras, especially in water-scarce regions. Developing wildlife-dedicated access points at existing or planned water sources, ensures the needs of Grevy's zebra and other wildlife can be met, and reduces the potential for disease transmission between wild and domestic species.

*Action 3: Develop Wildlife-Friendly Infrastructure*

As Kenya moves towards securing much-needed development for its economy and its citizens, we call upon County Governments in Grevy's zebra range to ensure that wildlife needs are duly considered to ensure the continued protection of the country's natural heritage and to sustain functioning ecosystems (7). There are many global examples of progressive wildlife-friendly infrastructure developments that serve both conservation and development goals. Let Kenya lead the way for Africa in this regard.

*Action 4: Address High Lion Predation Rates in Meru County*

Often, species of high conservation value come into conflict. In some Grevy's zebra locations lion predation is extremely high and needs to be addressed. Lewa Wildlife Conservancy is in partnership with Kenya Wildlife Service to pilot options to reduce the reproduction of lions within the conservancy using reversible birth control techniques. This partnership demonstrates the role of adaptive management in conservation and the power of science in developing effective conservation policies.

*Action 5: Develop Local Capacity and Support Citizen Science Monitoring*

In order to achieve the above actions, local capacity must be built, and monitoring Grevy's zebra using citizen scientists must be continued so that we can assess the impact of conservation interventions over time.

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