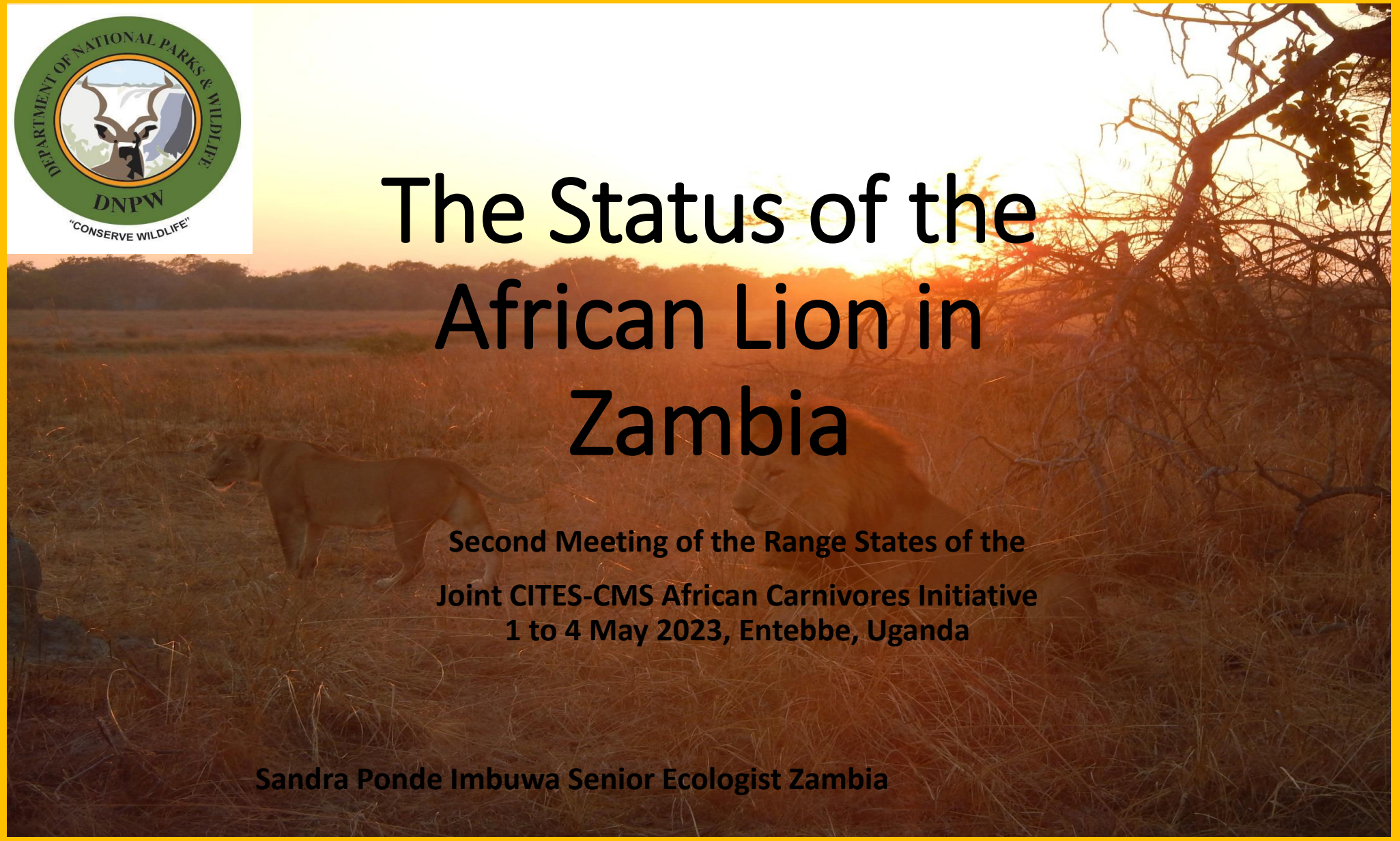


The Status of the African Lion in Zambia

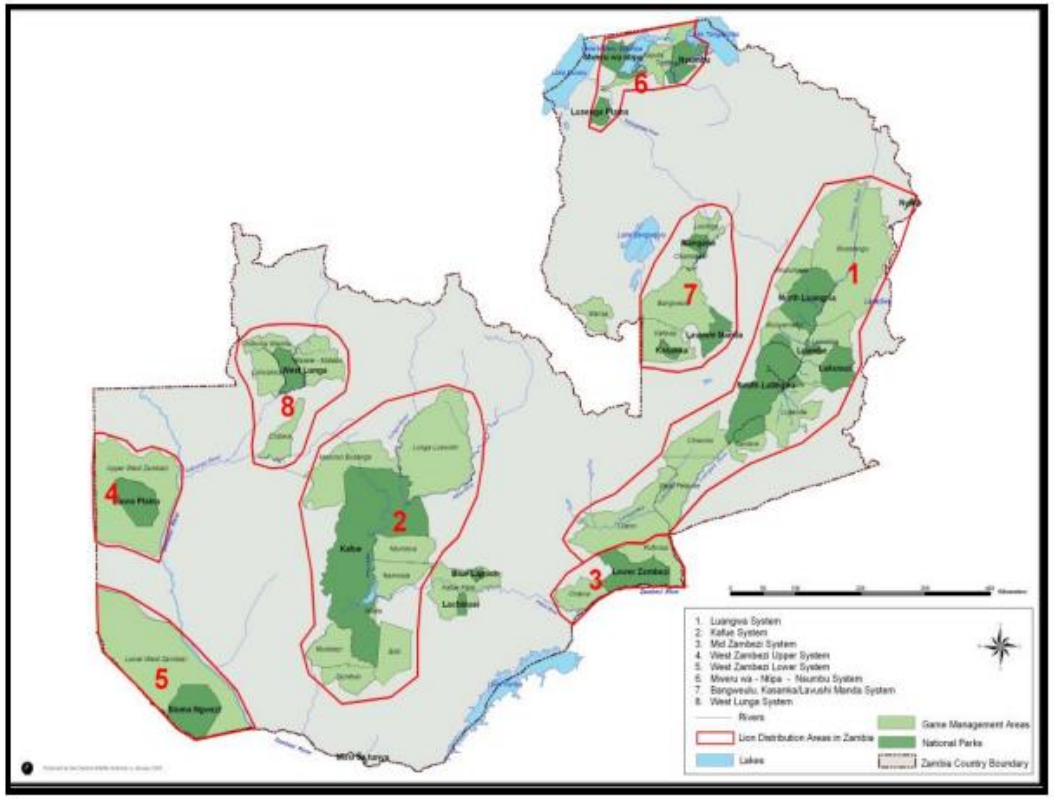
Second Meeting of the Range States of the

Joint CITES-CMS African Carnivores Initiative
1 to 4 May 2023, Entebbe, Uganda

Sandra Ponde Imbuwa Senior Ecologist Zambia

Distribution of the African lion in Zambia

The total estimated lion range in Zambia stands at 148,000 km^2, representing about a 63 % of Zambia's protected area network (230,000 km^2).



- Widely distributed across the country, mainly in wildlife protected areas (NPs GMAs)
- 63% of our total surface area of conserved land is a home range of the lion
- Long-term studies being implemented in 1, 2 and 3 conserved areas
- Latest estimates are from the 2011 survey
- however, due to the difficulty in surveying these apex species, Zambia has focused on long-term intensive studies to inform management of the African lion

Long-term Intensive Studies

- Rarity
- Cost vs benefit
- Planned extrapolation
- Effective surveys only evaluate trends
- Understanding drivers of trends observed requires more intensive work
- Rates and consequences of human-induced change
- Calibration and verification

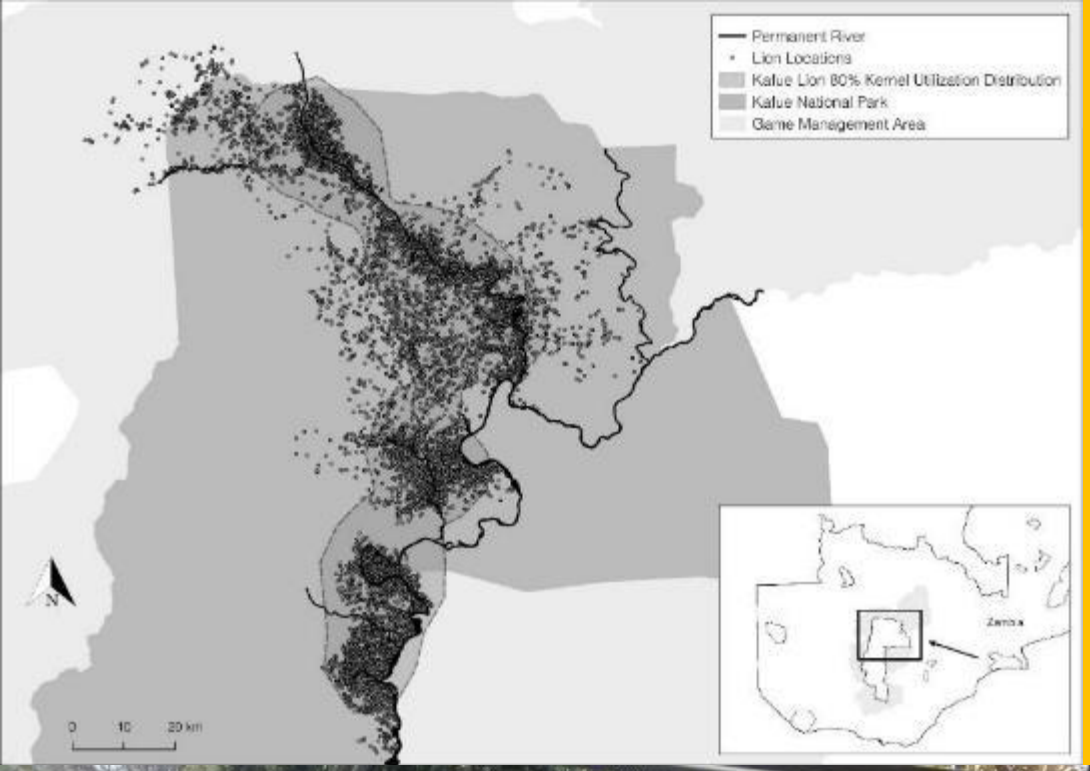
Long-term Intensive Lion Studies in Zambia

- Luangwa 2008-Present
- Kafue 2012-Present

Population characteristics (sex, age, age class) for Luangwa and Kafue lions for 2022, derived from intensive studies of 397 known individuals (most known age) from 72 groups, comprised of 41 prides (groups of breeding females and their offspring), and 31 coalitions (groups of territorial breeding or nomadic males) across nearly 20,000 km2 of South Luangwa, Kafue, and Luambe National Parks and adjoining Game Management Areas (GMAs).

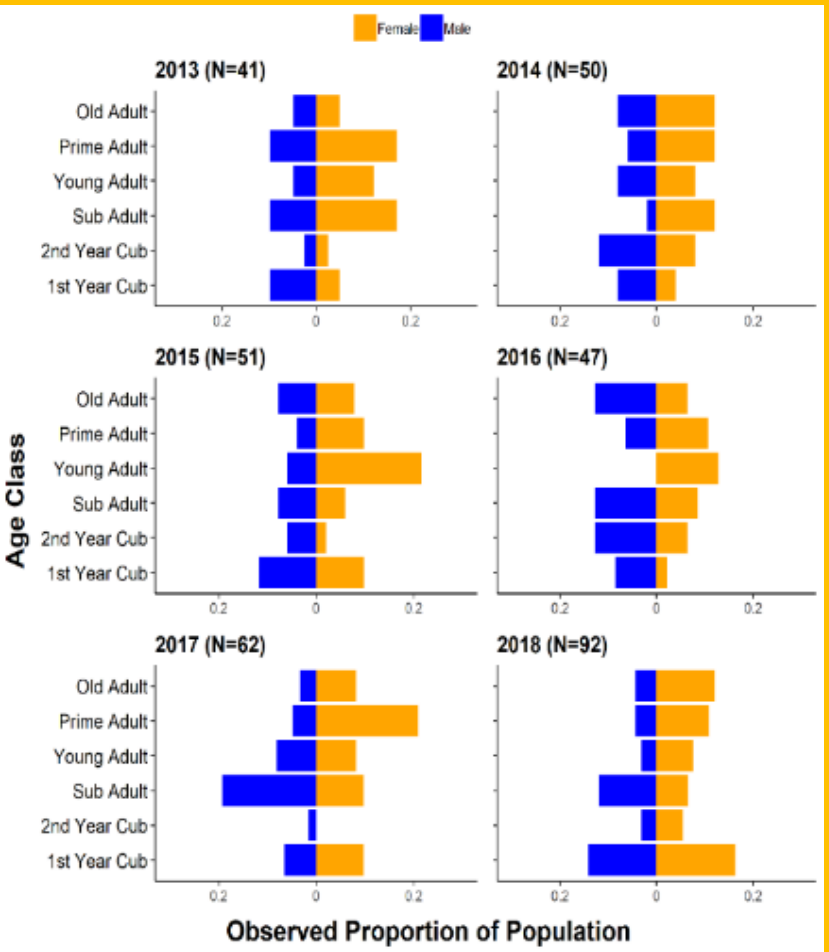
Some of the longest-running and most comprehensive lion studies in the region

Demographic Impacts of Prey Depletion: Kafue Lion Demography



Vinks, M.A., S. Creel, P. Schuette, M.S. Becker, E.Rosenblatt, K.Young-Overton, C. Sanguinetti, K. Banda, B.Goodheart, X. Stevens, C.Chifunte, Neil Midlane, and C. Simukonda. 2021. **Demographic response of an apex predator in response to long-term declines in prey abundance.** Ecological Applications.

Demographic Impacts of Prey Depletion: Kafue Lion Demography 2013-2018



Results

- 170 Individuals from 16 prides and 16 coalitions from 2013-2018
- Density 3.4/100 km2 (2.79-4.23)
- 2nd Year Cubs smallest proportion of population

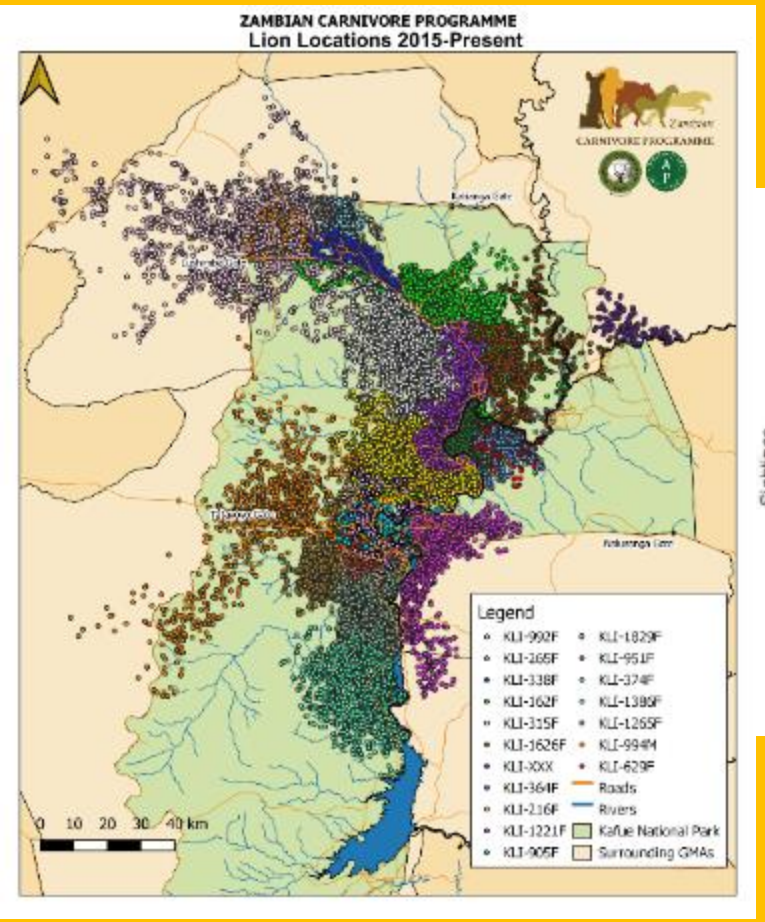
Vinks, M.A., S. Creel, P. Schuette, M.S. Becker, E.Rosenblatt, K.Young-Overton, C. Sanguinetti, K. Banda, B.Goodheart, X. Stevens, C.Chifunte, Neil Midlane, and C. Simukonda. 2021. **Demographic response of an apex predator in response to long-term declines in prey abundance.** Ecological Applications.

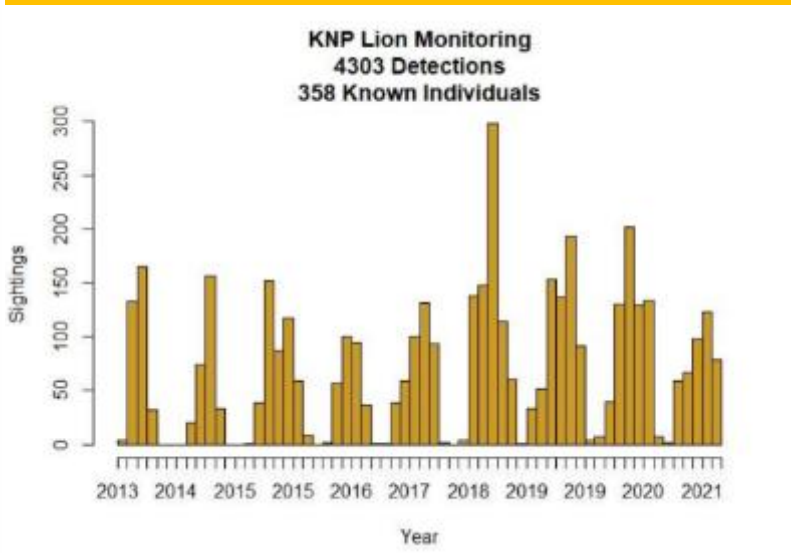
Demographic Impacts of Prey Depletion: Kafue Lion Demography 2013-2018

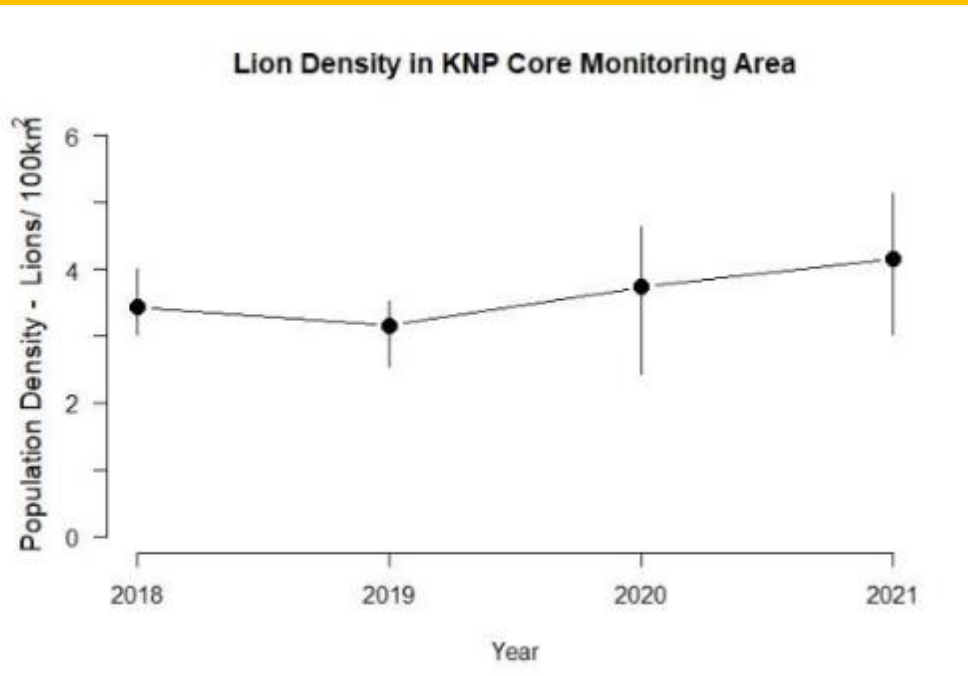
Summary

- Depleted preybase resulting in low densities of lions
- Survival comparable to other systems, reproduction low
- Life history theory predicts prioritizing survival over reproduction

Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021







Creel et al. (In Prep) **Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021**.

Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021

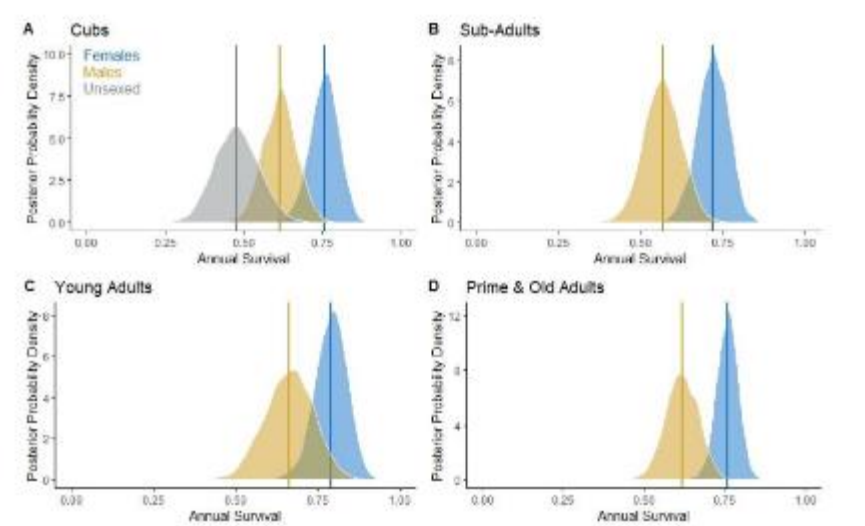
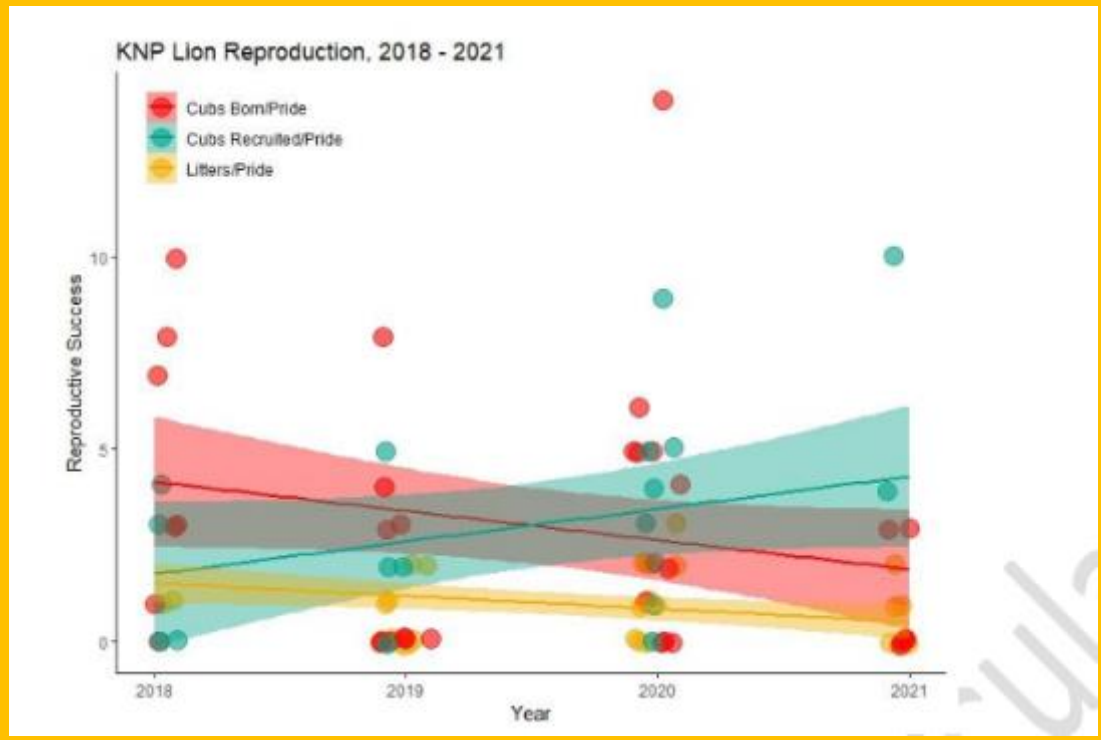


Figure 2. Estimates of annual survival (ϕ) for Kafue lions, 2013 – 2022, from a Bayesian Cormack-Jolly-Seber model fit to 4303 detections of 358 known individuals shown in Figure 1. As is typical of protected lion populations, survival is lower for cubs (0 – 1 years old) and sub-adults (2 – 3 years old) than among adults (ages 4+), and lower among males than among females. Vinks et al. (2020) emphasized that survival rates of KNP lions for 2013 – 2018 were quite high, even though lion density was quite low. With the addition of data from 2019 – 2021, **estimates of annual survival have tended to increase for sub-adult and young adult males, but have tended to decrease for females of all age classes and for prime-aged and old males** (see also Table 1 & Figure 3). These data come from 37 female prides and 32 male coalitions distributed over an area of > 8,000 km^2 shown in Figure 5.



Creel et al. (In Prep) **Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021**.

Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021

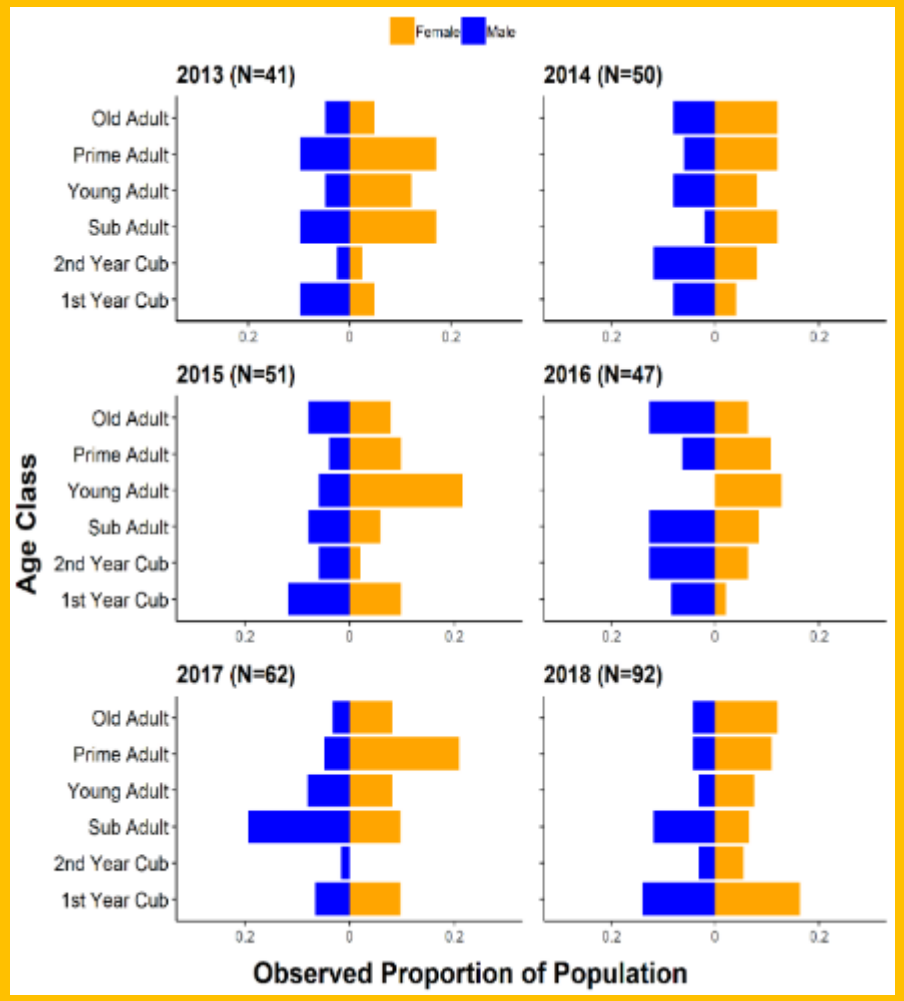
Conclusions

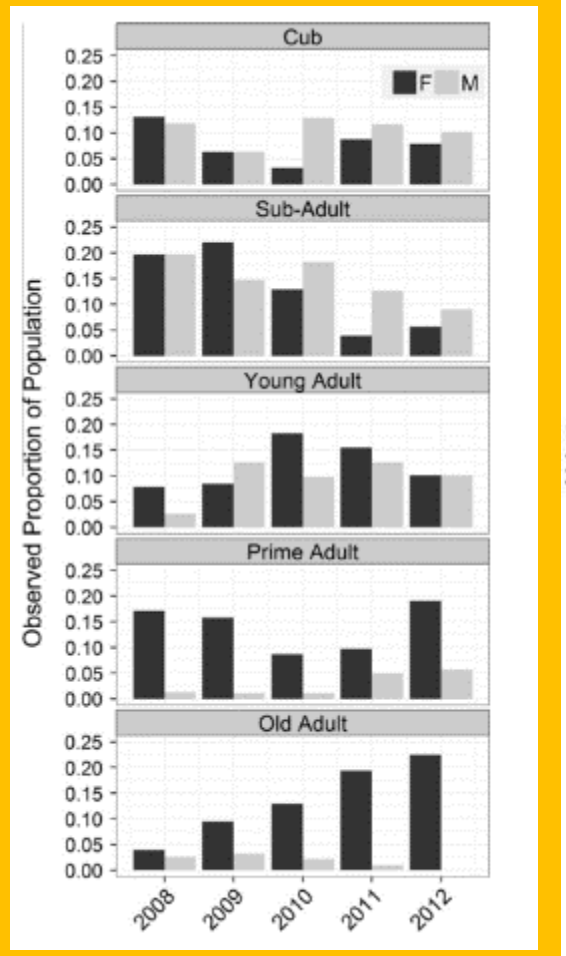
- No significant change in density
- Variability but no significant changes in survival
- Significant increase in cub recruitment
- Sustained large scale protection and recovery efforts needed to see significant

Creel et al. (In Prep) **Patterns of African lion survival, reproduction and population density in the Greater Kafue Ecosystem, Zambia, 2013 – 2021**.

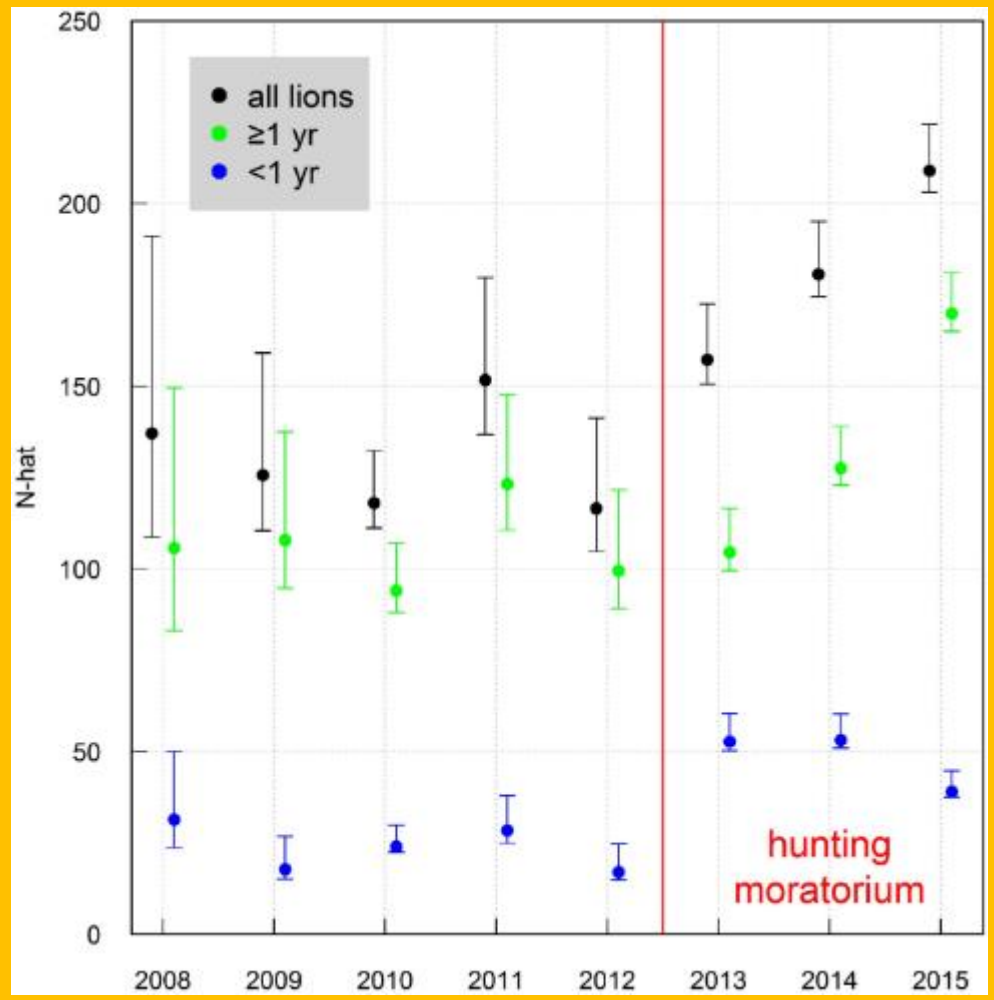
Ability to Detect Different Drivers of Population Dynamics between Kafue and Luangwa

Bushmeat Poaching & Prey Depletion
(Vinks et al. 2020, Creel et al. In Prep)



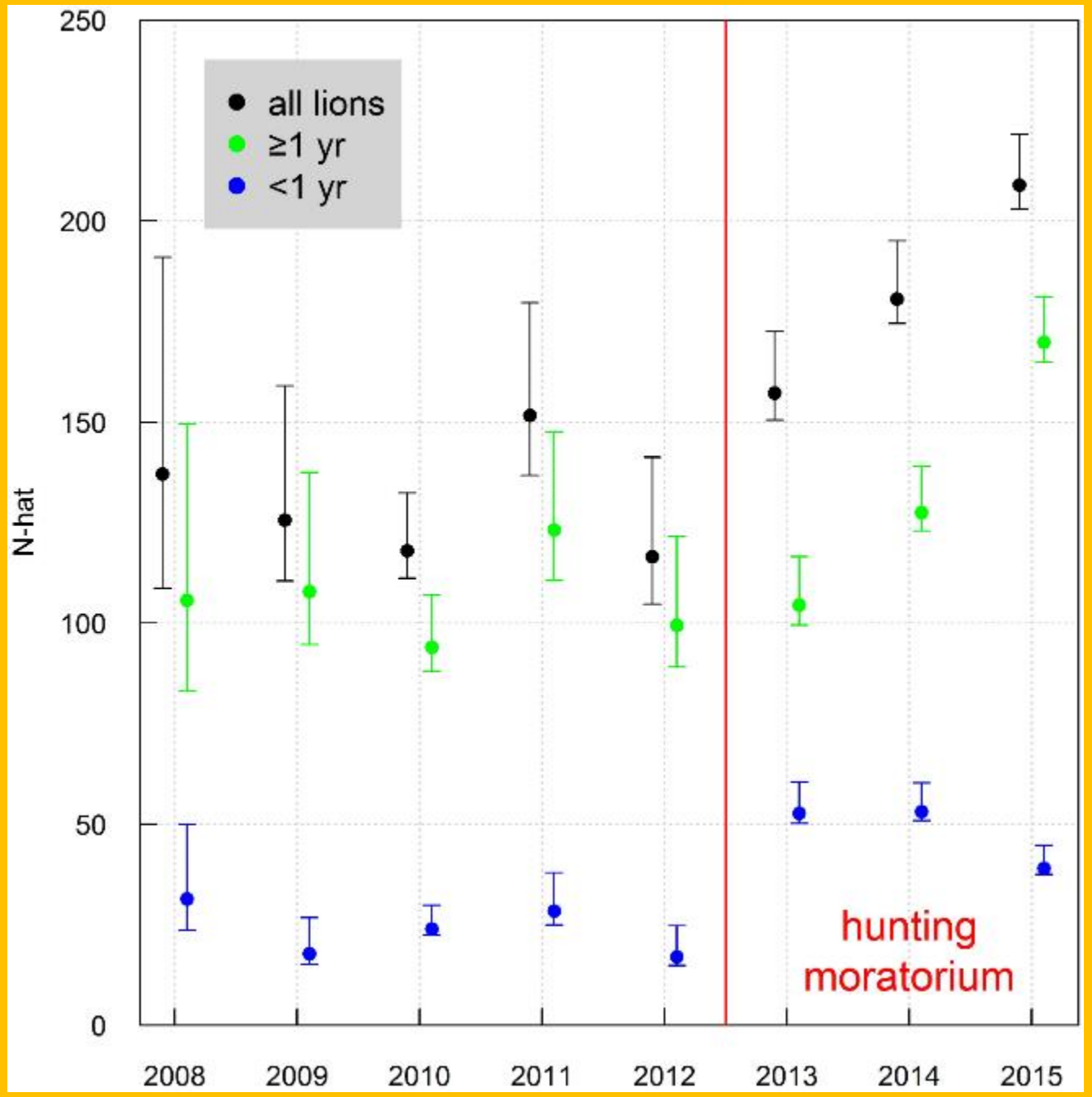


Trophy Hunting (Rosenblatt et al. 2014, Mweetwa et al. 2018)



LION in Luangwa Valley

CJS model fit to individual Detection histories



Mweetwa et al. 2018 PloS One

Genetic tools for monitoring lions

Göran Spong & Laura Bertola

Genetic samples to date:

- ~400 DNPW from lions, leopards, and cheetah
- ~250 WCP-DNPW seizures from lions, leopards, and cheetah

<u>Lions</u>

- >1000 baseline samples
- From Angola, Benin, Botswana, Cameroon, Central African Republic, Chad, Mozambique, Namibia, Nigeria, Tanzania, Senegal, Sudan, Zambia.
  More incoming and combined panel based on pan-african variation. Two markers for Indian lions also validated and optional on chip.

<u>Leopards</u>

- Baseline nearing 1000
- Bulk of samples from Mozambique, South Africa, Tanzania, and Zambia.
  But panel ascertained on global variation.

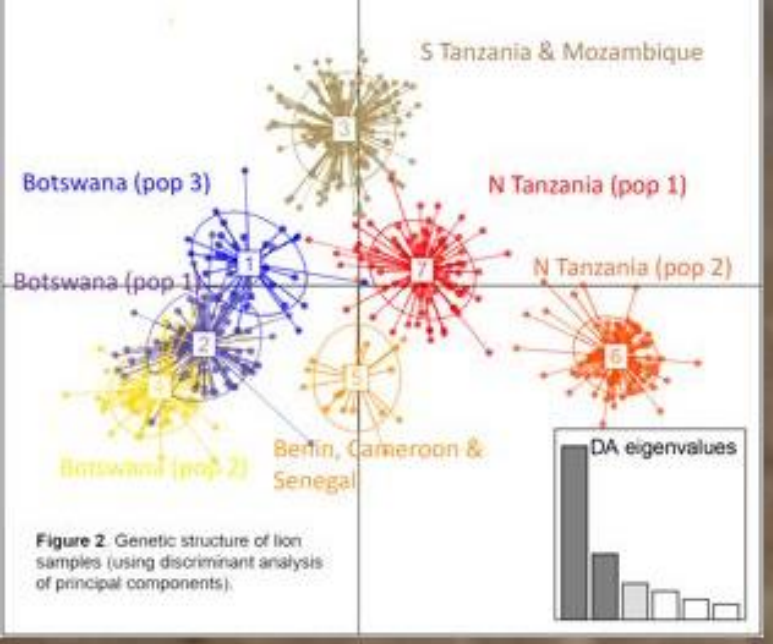


Figure 2. Genetic structure of lion samples (using discriminant analysis of principal components).

SNP Chips

- Allows for surveying without observing animals
- SNP Chip takes markers with most explanatory power for provenance
- Allows for high-quality genetic data from low-quality samples (i.e. scat)

Genetic tools for monitoring

- Confirm presences/distribution
- Identify genetic signature specific for a region/country/protected area → Forensics, trace source population of confiscated samples
- Identify individuals
  → Population estimates (e.g. CMR)
  → Identify home ranges

Methods to Estimate Abundance

- Direct Estimate
  - All individuals Detected: $p = 1$
    - Complete census
    - Census on Sample plot
  - Some individuals not detected: $\hat{N} = \frac{C}{\hat{p}}$
    - **Individual ID**
      - Phenotypic Mark Recapture
      - Genetic Mark Recapture
      - Pedigree Reconstruction
      - Monitoring
      - Camera Grid
      - Integrated Population Model
    - **No Individual ID**
      - Space-to-event & Time-to-event
      - N-mixture
      - Transect
        - Distance Sampling
        - Double Observer
        - Sightability GLM
- Index
  - Call-up
  - Spoor count

Ground-Based Herbivore Surveys

- Surveys since 2012
- 2-3 times/year (cold dry/hot dry)
- 5 ecosystems (Luangwa, Kafue, Liuwa, West Lunga, Nsumbu)
- Established roads, seasonal roads, off-road
- Vehicle and foot
- Across gradients of protection
- All herbivores aside from hippo

Why ground-based surveys

- Low-tech (binos, range finder, compass, positive mental attitude)
- Relatively cheap
- Inclusive
- Data-rich
- Density & Distribution
- Ecological and Anthropogenic Drivers
- Relationship between lions and prey
- Depletion of Large Prey

Biodivers Conserv
https://doi.org/10.1007/s10531-018-1529-7

CrossMark

ORIGINAL PAPER

Boots on the ground: in defense of low-tech, inexpensive, and robust survey methods for Africa's under-funded protected areas

Paul Schuette[1,2] · Ngawo Namukonde[3] · Matthew S. Becker[2,4] · Fred G.R. Watson[5] · Scott Creel[4] · Clive Chifunte[6] · Wigganson Matandiko[4] · Paul Millhouser[7] · Elias Rosenblatt[2,8] · Carolyn Sanguinetti[2]

Prey Depletion Dynamics

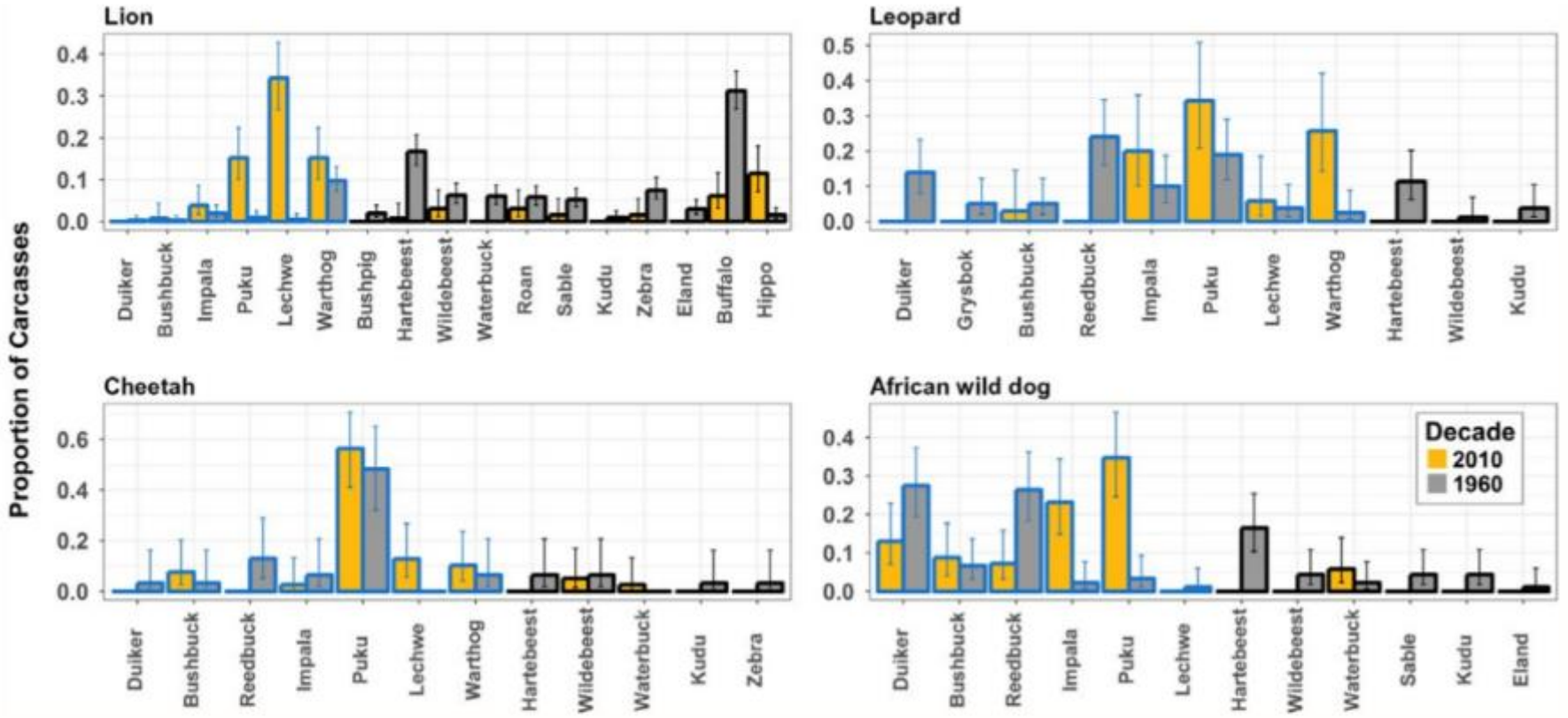


FIGURE 1 Changes over the last half-century in the proportion that each ungulate species formed in the diet of each large carnivore. In each panel, prey species are arranged from smallest (left) to largest (right). Bars show the proportion of a carnivore's diet comprised by each prey species and whiskers show 95% binomial confidence limits using the Wilson method (so that nonoverlapping whiskers denote differences at $\alpha = 0.05$). Bar fill identifies data from the 1960s and the 2010s. Bar outline colour identifies prey species that are smaller or larger than median body mass within the KNP ungulate guild

- Large Herbivores such as buffalo have dropped out of lion diets over time
- This is due to declines in abundance of the larger herbivores (not changes in prey preference by lions)

Smaller-bodied Herbivores

Larger-bodied Herbivores

Niche Compression and Prey Homogenization

- Poaching depletes the large prey for lions and hyenas
- All species focusing on a much more narrow suite of prey species in the small to mid size range

Creel, S., W. Matandiko, P.Schuette, E.Rosenblatt, C. Sanguinetti, K.Banda, M.Vinks and M.S.Becker. 2018. **Changes in large carnivore diets over the past half-century reveal depletion of large prey.** Journal of Applied Ecology

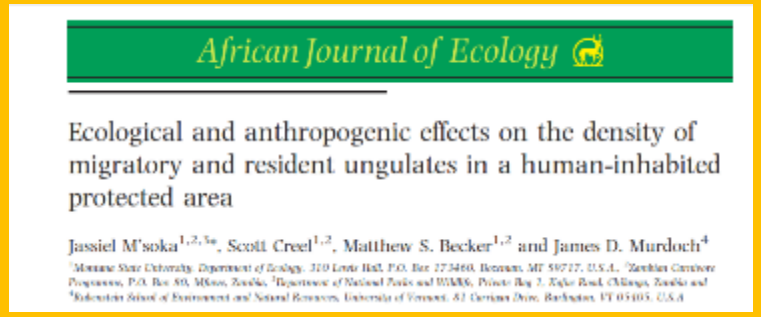
Niche Compression and Prey Homogenization

Consequences

- Hunting energetics
- Group Size
- Interspecific competition
- Snaring susceptibility

Topics

- Bushmeat poaching impacts
- Evaluation of trophy hunting bans
- Differing dynamics of migratory/resident species and the impacts of development and protection gradients


African Journal of Ecology

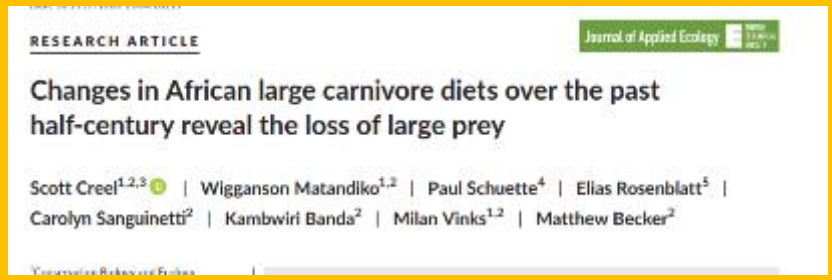
Ecological and anthropogenic effects on the density of migratory and resident ungulates in a human-inhabited protected area

Jassiel M'soka, Scott Creel, Matthew S. Becker and James D. Murdoch


esa ECOSPHERE

Testing the effects of anthropogenic pressures on a diverse African herbivore community

Milan A. Vinks, Scott Creel, Paul Schuette, Elias Rosenblatt, Wigganson Matandiko, Carolyn Sanguinetti, Kambwiri Banda, Ben Goodheart, Matthew Becker, Clive Chifunte, and Chuma Simukonda


RESEARCH ARTICLE

Changes in African large carnivore diets over the past half-century reveal the loss of large prey

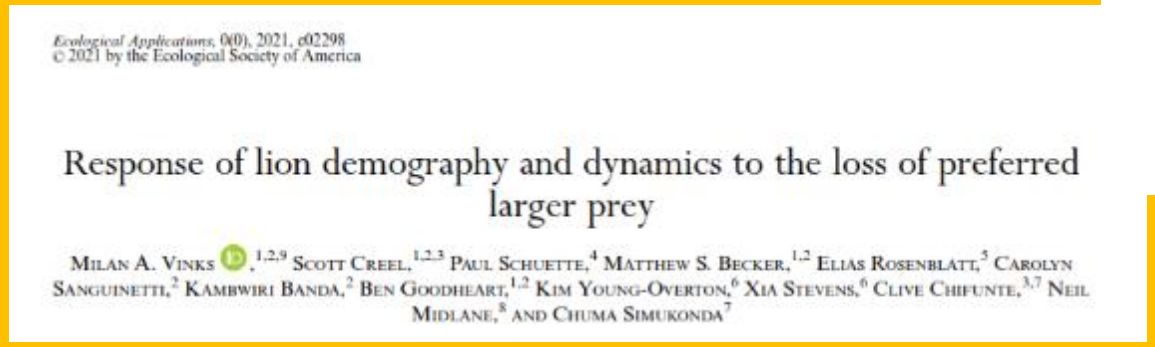
Scott Creel | Wigganson Matandiko | Paul Schuette | Elias Rosenblatt | Carolyn Sanguinetti | Kambwiri Banda | Milan Vinks | Matthew Becker


PLOS ONE

RESEARCH ARTICLE

Do protection gradients explain patterns in herbivore densities? An example with ungulates in Zambia's Luangwa Valley

Elias Rosenblatt, Scott Creel, Paul Schuette, Matthew S. Becker, David Christianson, Egil Dröge, Thandiwe Mweetwa, Henry Mwape, Johnathan Merkle, Jassiel M'soka, Jones Masonde, Twakundine Simpamba


Ecological Applications, 0(0), 2021, e02298
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Response of lion demography and dynamics to the loss of preferred larger prey

Milan A. Vinks, Scott Creel, Paul Schuette, Matthew S. Becker, Elias Rosenblatt, Carolyn Sanguinetti, Kambwiri Banda, Ben Goodheart, Kim Young-Overton, Xia Stevens, Clive Chifunte, Neil Midlane, and Chuma Simukonda

Biodivers Conserv
https://doi.org/10.1007/s10531-018-1529-7

ORIGINAL PAPER

Boots on the ground: in defense of low-tech, inexpensive, and robust survey methods for Africa's under-funded protected areas

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Received: 25 July 2017 / Revised: 19 February 2018 / Accepted: 23 February 2018

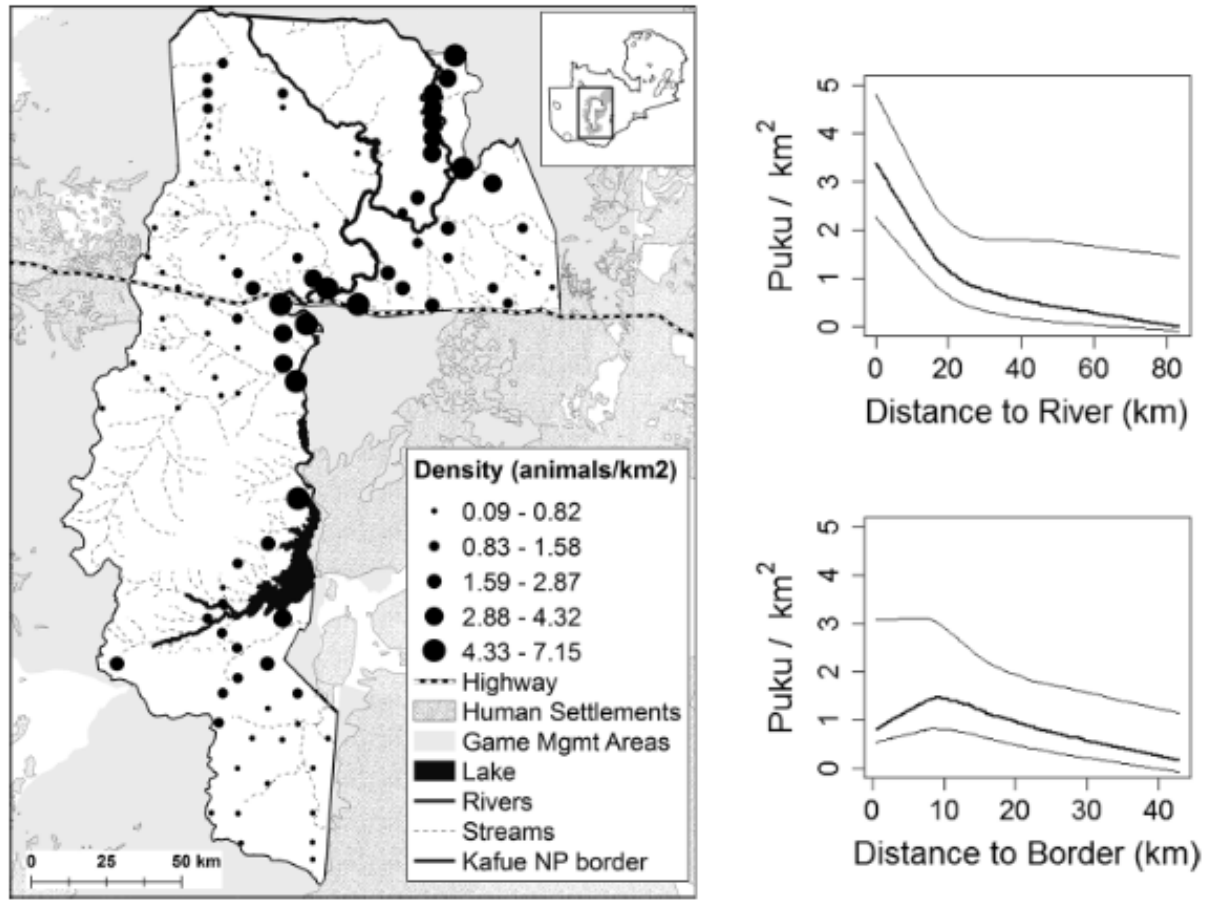

Fig.. 2 Estimated puku density (animals/km^2) at each surveyed transect using ground-based distance sampling methods in Kafue National Park, Zambia (left). Puku distributions were primarily influenced by distance to permanent rivers and distance to the park border. Densities are shown as animals/km^2 with 95% confidence intervals (right)