Population performance indicators as functions of PAN and PAM in black rhinoceros (*D. b. michaeli*)

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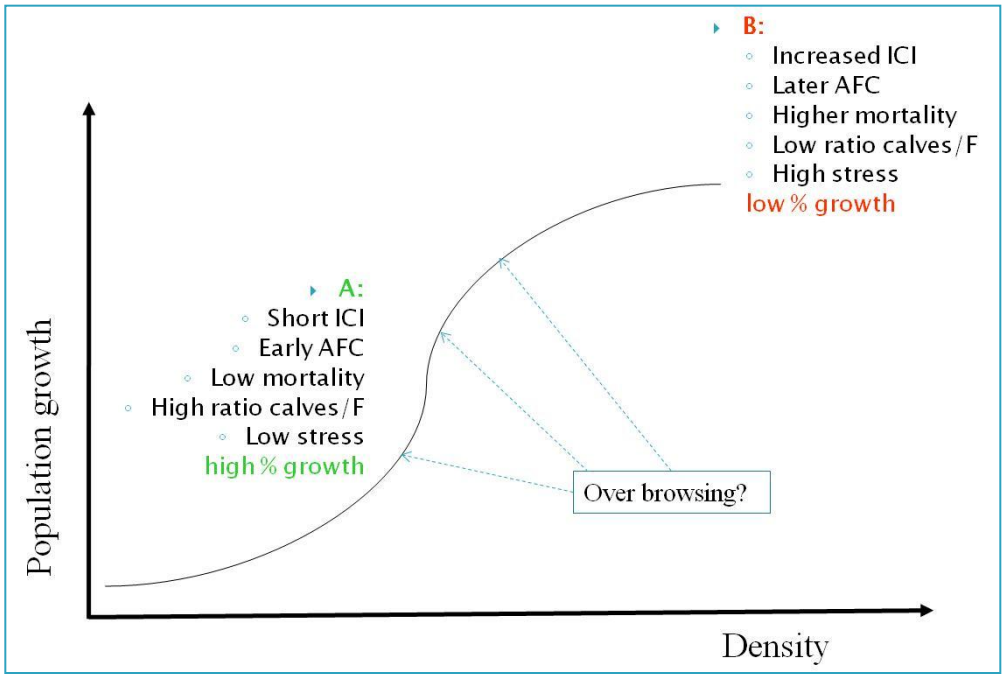
The big story

Is there density dependence effect in black rhino population performance?



If yes;

Can the effects be detected from reproductive and stress hormones in the dung?

If no;

Can PAN and PAM and Tree cover explain population performance?

Can quality of diet explain the observed performance?

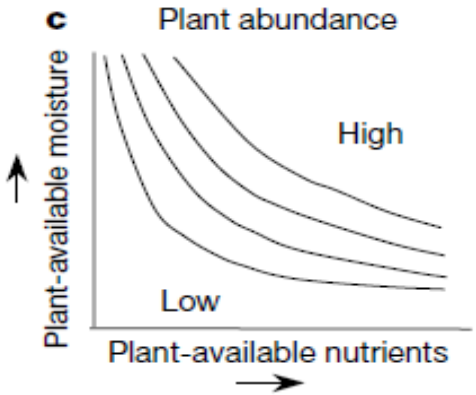
Introduction

If no;

Can PAN and PAM and Tree Cover explain population performance?

There is bottom-up control of population performance of mega herbivores via forage quality and quantity as functions of PAN & PAM.

Increases in PAN increase both plant quality and quantity; increases in PAM decrease quality but increase quantity of plants (Olff *et. al*. 2002)



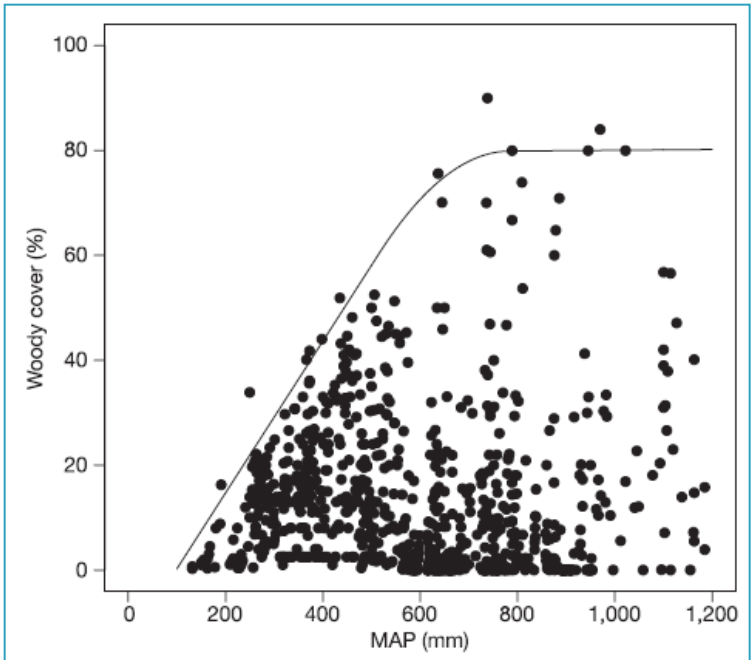
Graph reproduced for educational purposes from Olff *et. al*. 2002|Nature|Vol 415| 901-914

Intro.. Cont'd: PAN-PAM vs woody habitat

The described PAN-PAM and effects generally hold for grazing material (grasses and herbs)

Quantity of woody habitat positively is dependent on Frequency in precipitation of 200-700mm pa (PAM) and negatively dependent on PAN.

The quality of woody habitat is less dependent on PAN but is determined by combination of other biotic and abiotic factors.



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Intro.. Cont'd: PAN-PAM: Grazers vs browsers

PAN and PAM in predicting population performance of browsers versus grazers would show converse relationship

PAN and PAM in predicting population performance of browsing vs grazing hindgut fermenter may also show converse relationship

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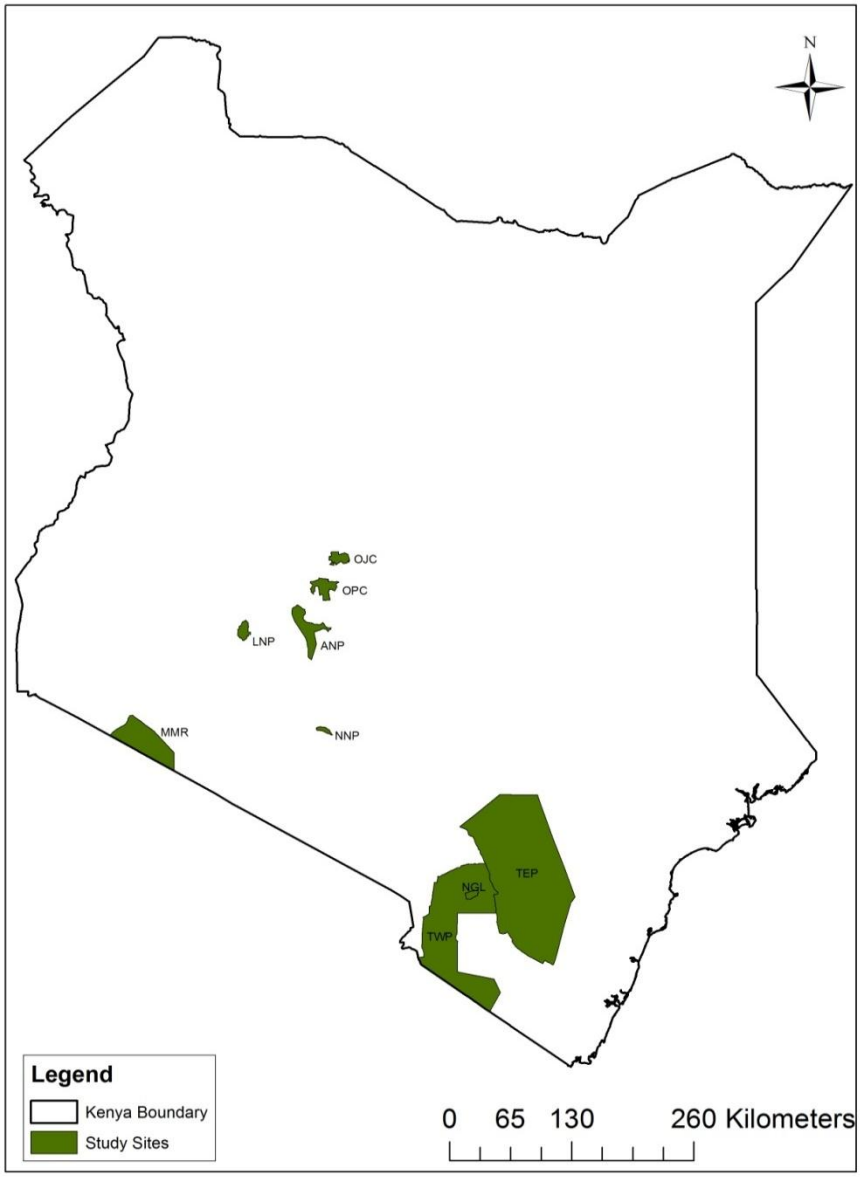
Study animal, areas and hypotheses

We therefore studied black rhino as a browsing large hindgut fermenter in 7 Kenyan savanna populations with varying PAN & PAM.

3# performance indicators AFC, ICI & %FC selected because they are influenced by browse quality and quantity; & were statistical reliable over the selected period of study.

H_0: PAN and PAM & interaction between them does not affect age at first calving (AFC), average inter-calving interval (ICI) nor yearly percentage of females calving (%FC).

H_0: AFC, ICI and %FC are not functions of Tree cover.



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Methods

Age at First Calving: difference in years between the date of birth of an adult female and the date of birth of her first calf. Only females with ±1year of birth date accuracies were considered

Average Inter-Calving Interval (ICI): averaged by dividing the duration in years between the date of birth of first calf and date of birth of the last calf as at end of 2010, by the female's total number of calves. Only females with ≥ 2 calves were considered

Yearly Percentage of females calving (%FC): the proportion of number of calves born in year "*t* " to the number of live adult females (≥ 7years) in year "*t*". The year to year high variations in %FC due to black rhino's long gestation period of 1.25-1.30 yrs was averaged using a 3-year moving average.

Methods... Cont'd

PAN: total of exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) by atomic absorption and flame photometry at 20cm depth (me/100g).

Source: Kenya Soils Survey and ISRIC

PAM: (Log_{10} RAIN/PET) in [mm day^{-1}] (monthly)

PET = Potential Evapo-Transpiration by Blaney-Criddle formula

$PET_o = p \cdot (0.46 \cdot T_{mean} + 8)$ (Blaney *et al.*, 1942a)

Source: Raster files; 4-km resolution;
(http://www.cpc.ncep.noaa.gov/products/fews/AFR_CLIM/afr_clim.shtml)

Tree Cover: percentage cover

Source: Hansel et. al., 2003

Analyses:

- Hawth's Tools for ArcMap9.3.1© and ArcMap™ for raster files
- Curve estimation procedure - tested for linear, logarithmic, inverse, power, S-shape and exponential relationships
- Generalized Estimating Equation approach

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Results

The black rhino study areas could be distinguished based on differential values for PAN and PAM (Fig.1)

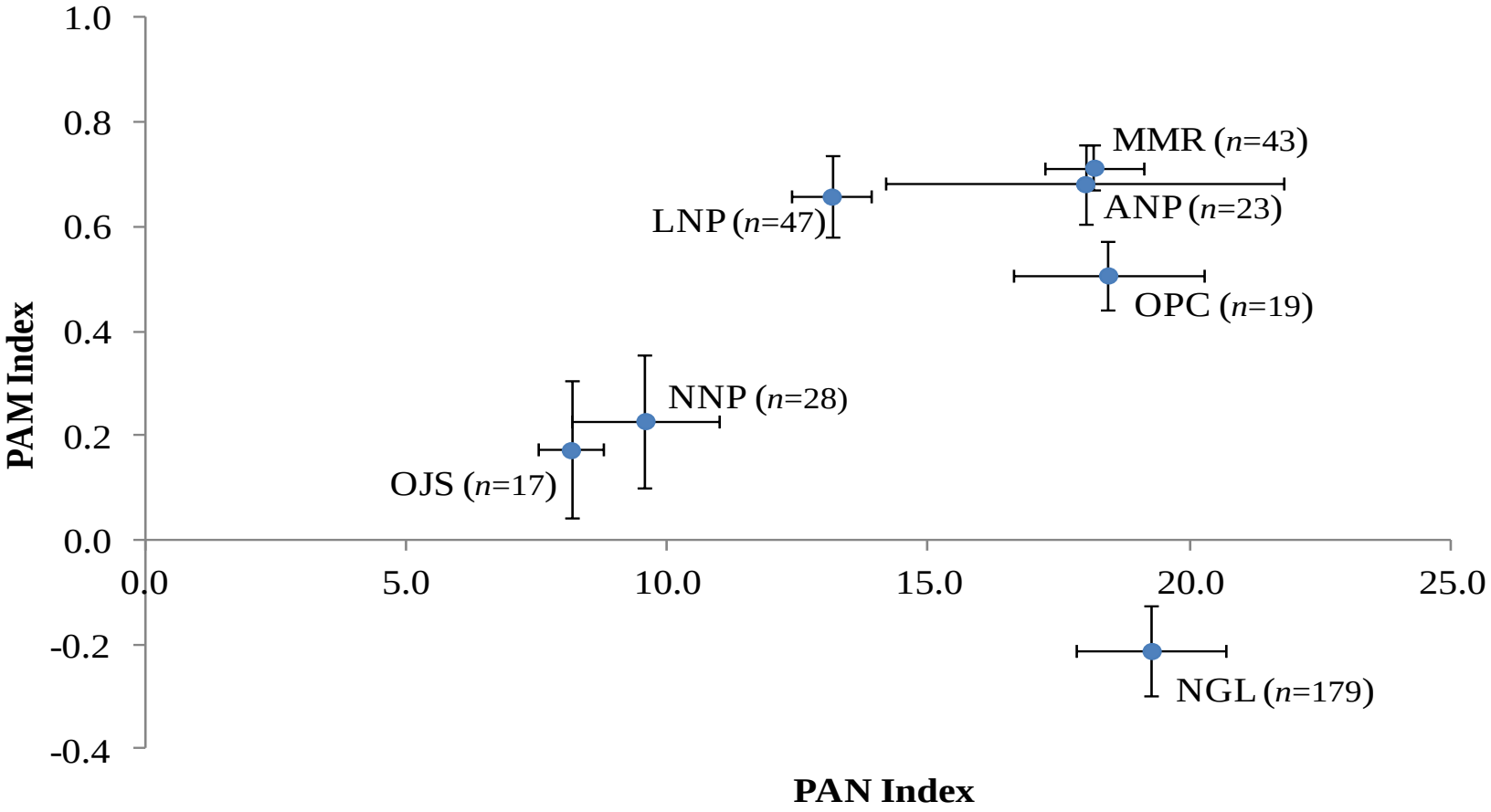


Fig. 1: Study areas on a plane of PAN ±SE error bars (sum of exchangeable cations=me/100g) and PAM ±SE error bars ($(Log_{10}[RAIN/PET])$=mm day^{-1}). (*n*= sample size for PAN. ANP=Aberdares NP; LNP=Lake Nakuru NP; MMR=Masai Mara NR; NNP=Nairobi NP; NGL=Ngulia Rhino Sanctuary; OJS=Ol Jogi Pyramid; OPC=Ol Pejeta Conservancy)

Results... Cont'd

%FC increased at low PAN with high PAM but decreased at high PAN with high PAM, whereas low PAM did not significantly affect %FC in low or high PAN (Fig. 2)

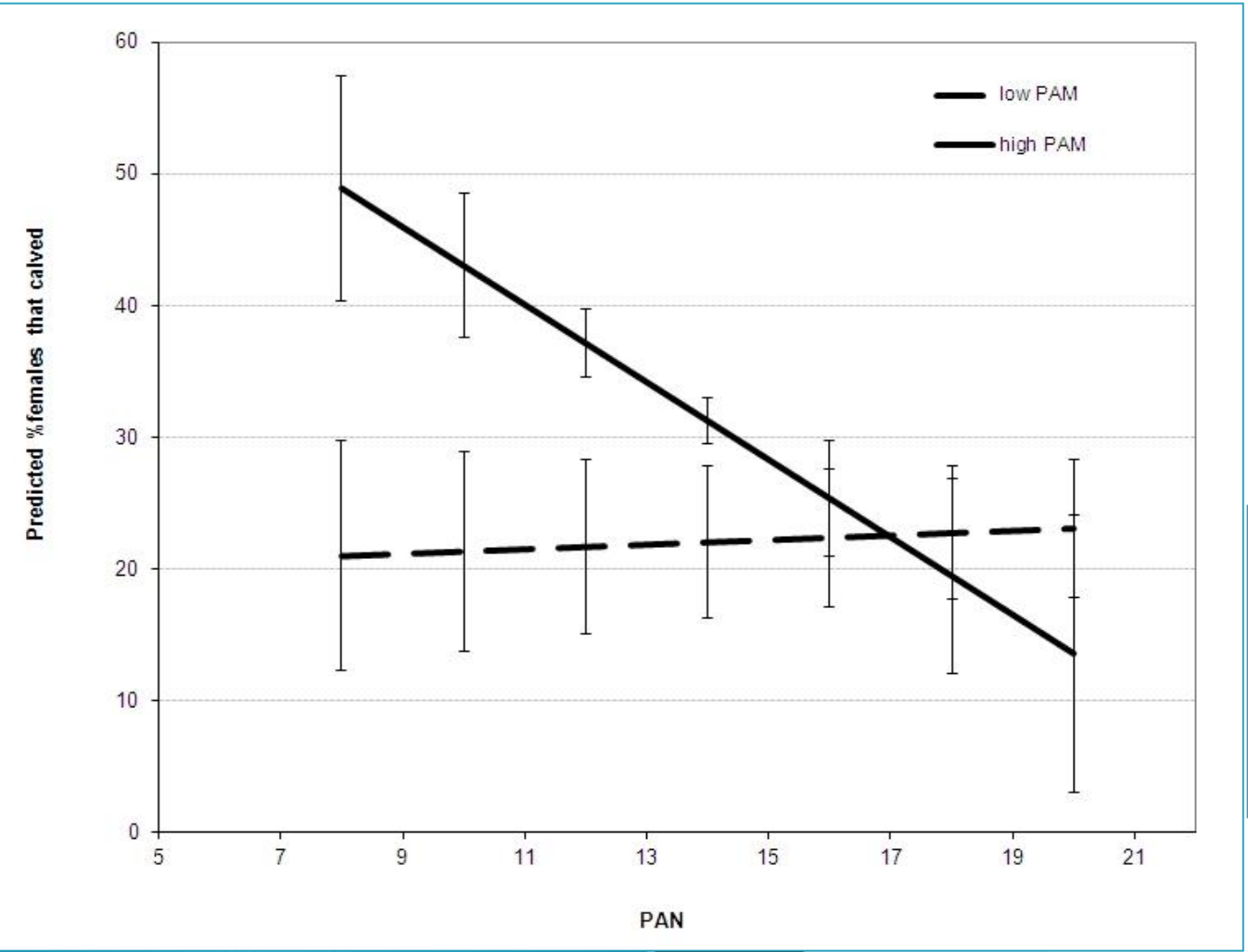
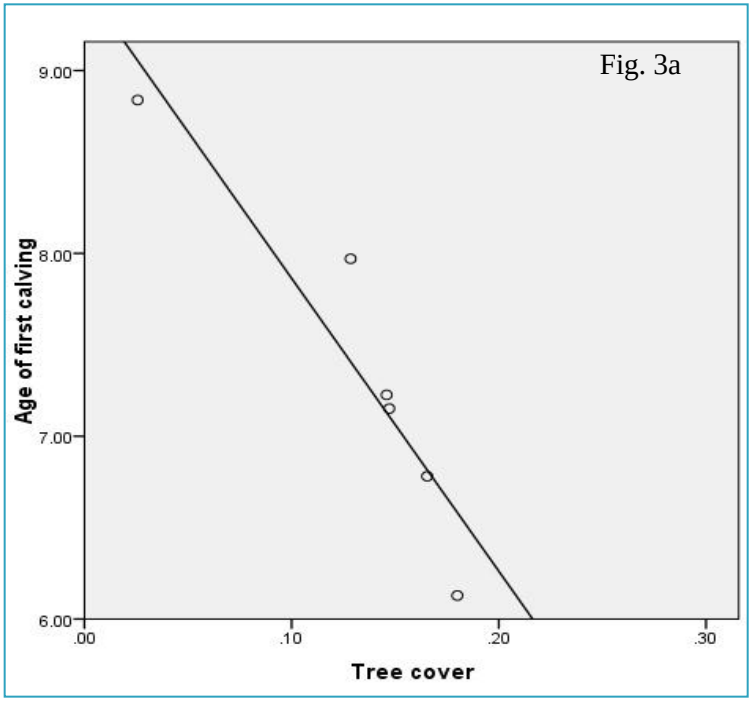
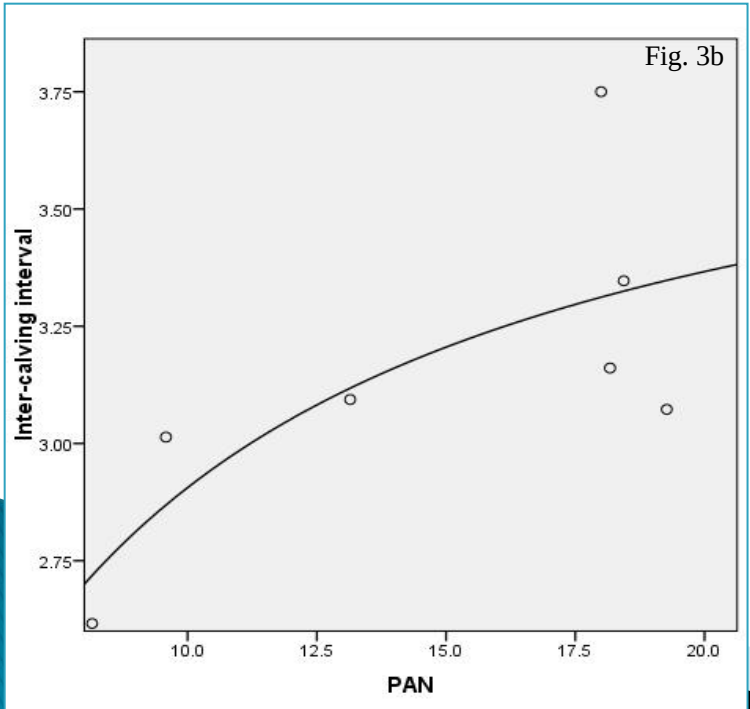


Fig. 2: Effect of PAN and PAM on the yearly percentage of females that calved (GEE statistics). The error bars indicate the 95% CI of the predicted values. The low value of PAM is -0.1 and the high value 0.6.

Results... Cont'd

AFC decreased with increase in Tree cover; ICI increased with increase in PAN and Tree cover – a seemingly contradictory result – (Figs. 3a, b & c).





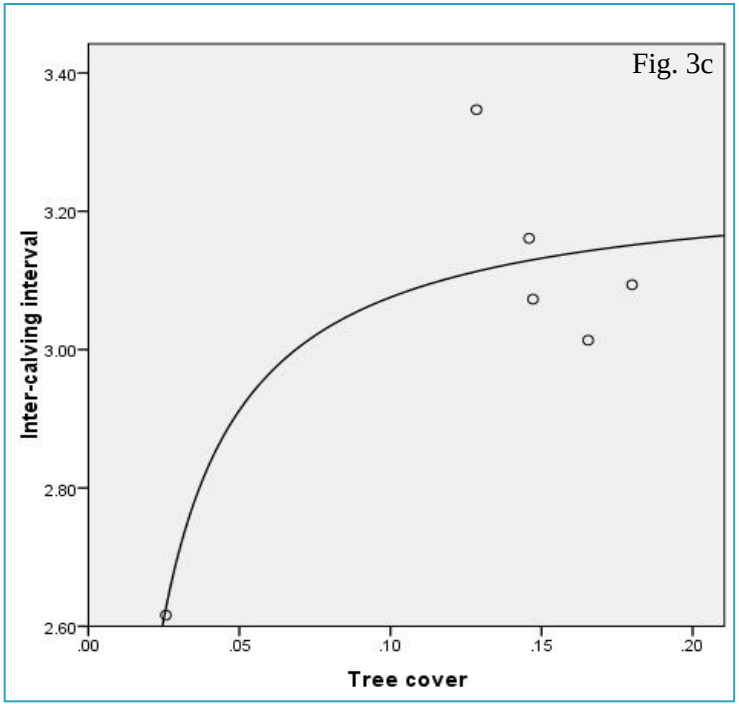


Fig. 3: (a) the effect of tree cover on AFC; **(b)** the effect of PAN on ICI and; **(c)** the effect of tree cover on the ICI.

Discussions

The results conformed to concepts on

- Forage abundance availability
- Digestive physiology and mechanisms of a hindgut fermenter
- Plant energy:nitrogen ratios
- Fast throughput
- Energy requirements in gestation, lactation

Conclusions

1. We reject hypotheses & identify %FC as best fitting function in predicting performance.

2. Areas of low PAN and high PAM yield maximum reproductive returns for black rhino; Areas of high PAM and high PAN yield low reproductive returns (Fig.4).

3. Tree cover alone is a less reliable indicator because its estimation methodology ignores foraging heights

4. We confirm reproduction dependency on energy

5. Study contributes to conservation of black rhino e.g. selection criteria for new areas.

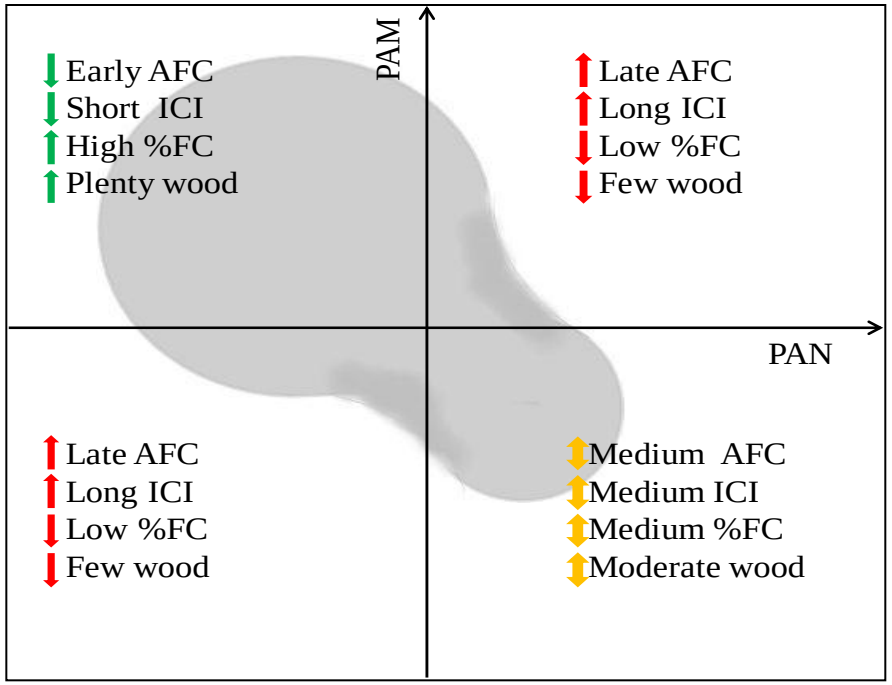


Fig. 4: An Illustration of black rhino population performance on PAN & PAM plane. The shaded area shows predicted areas of maximum reproductive return.

Disclaimer: These are preliminary findings and interpretations and are still subject to changes

.....Thank You.....

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Zoo D'Amneville – France
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