Does mega-herbivory limit tree recruitment?

Results and implications of a herbivore exclusion experiment in Hluhluwe iMfolozi

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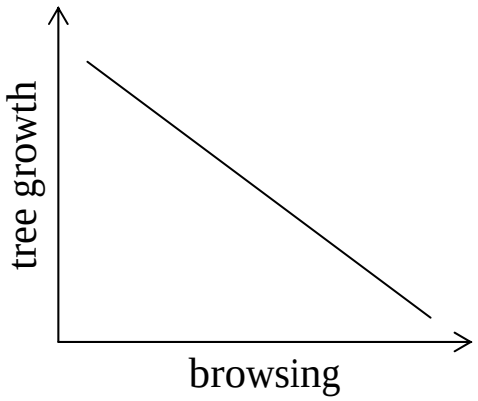
Introduction

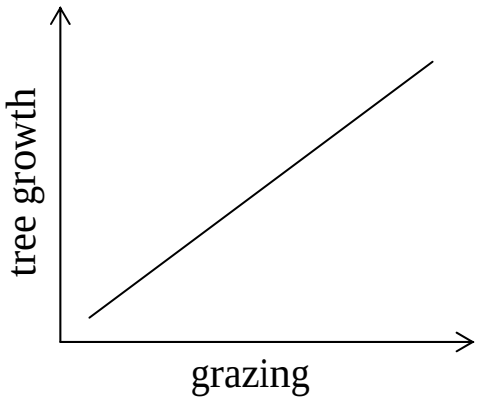
- What prevents the emergence of new large trees into a savanna system?
- Basic limitations of fire on recruitment of trees from juvenile (small) to adult (large) life stages
  - e.g. Higgins *et al*. 2001
- What about herbivory?
  - Especially in an African context, where native herbivores are still a part of the system

Browsing?



- Browsing acts directly on the tree layer
  - Particularly on small trees (Roques *et al*. 2001)
  - Browsers may regulate shrub and tree dynamics in savanna landscapes (Augustine & McNaughton 2004, Prins & van der Jeugd 1993)

Grazing?



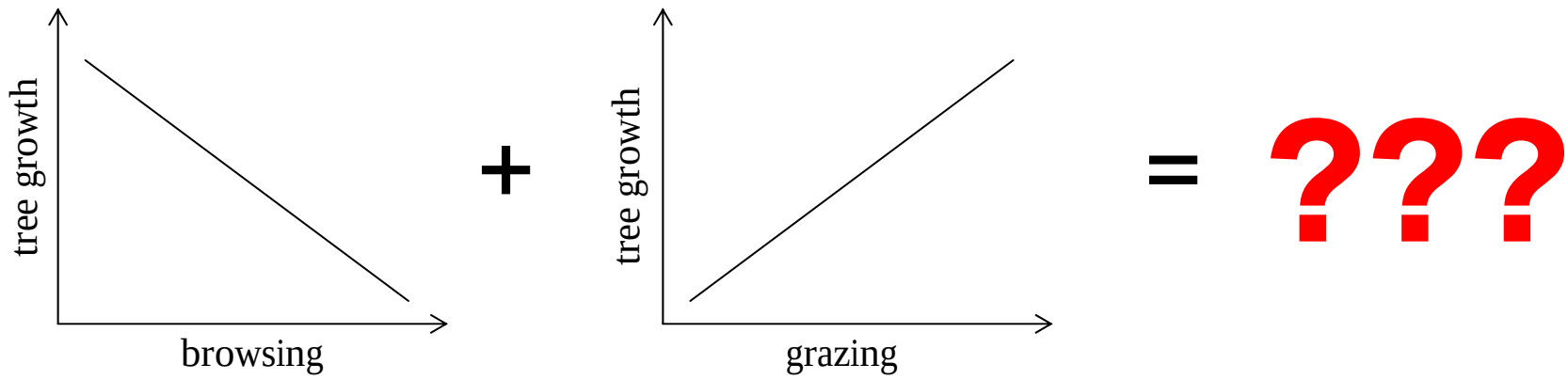
- Grazing by mega-herbivores is a major consumer of grass biomass
  - "Competes" directly with fire for fuel
  - Contributes to patchiness in the fuel layer → fires spread less easily
  - Less competition from grasses?

- From rangelands, cattle grazing often leads to bush encroachment (e.g. Roques *et al*. 2001)

Browsing v. grazing

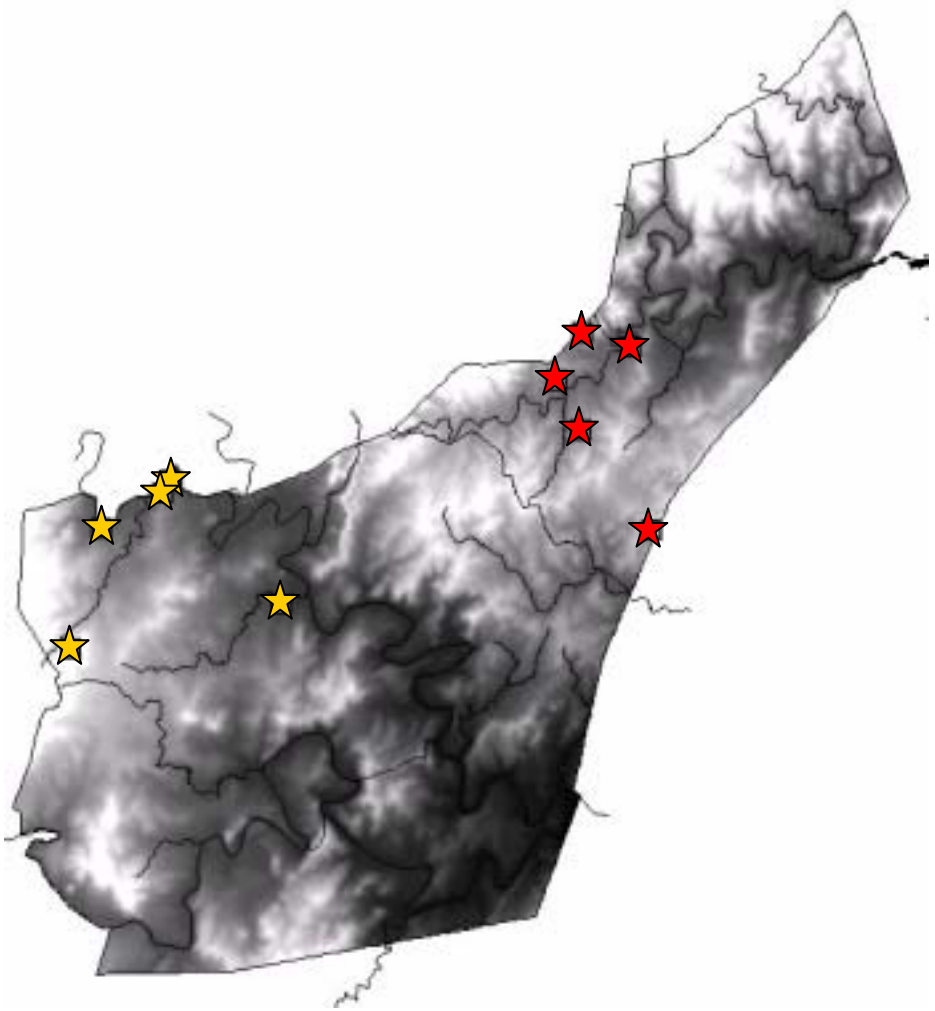
- Both grazers and browsers present in native assemblages of African herbivores

- How does mega-herbivory affect tree growth in African savannas?
  - In which circumstances is browsing the major driver?
  - In which circumstances does grazing and its effect on grass?



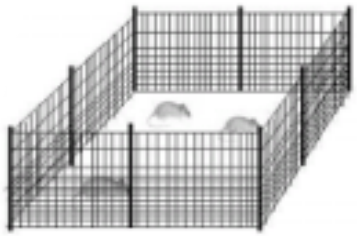
The Experiment

- Two parks
  - Hluhluwe GR
    - cooler in summer
    - wetter
    - fire more frequent
    - fewer herbivores
  - iMfolozi GR
    - hotter
    - drier
    - fire less frequent
    - more herbivores



The Experiment

Highest herbivory → **Lowest herbivory**

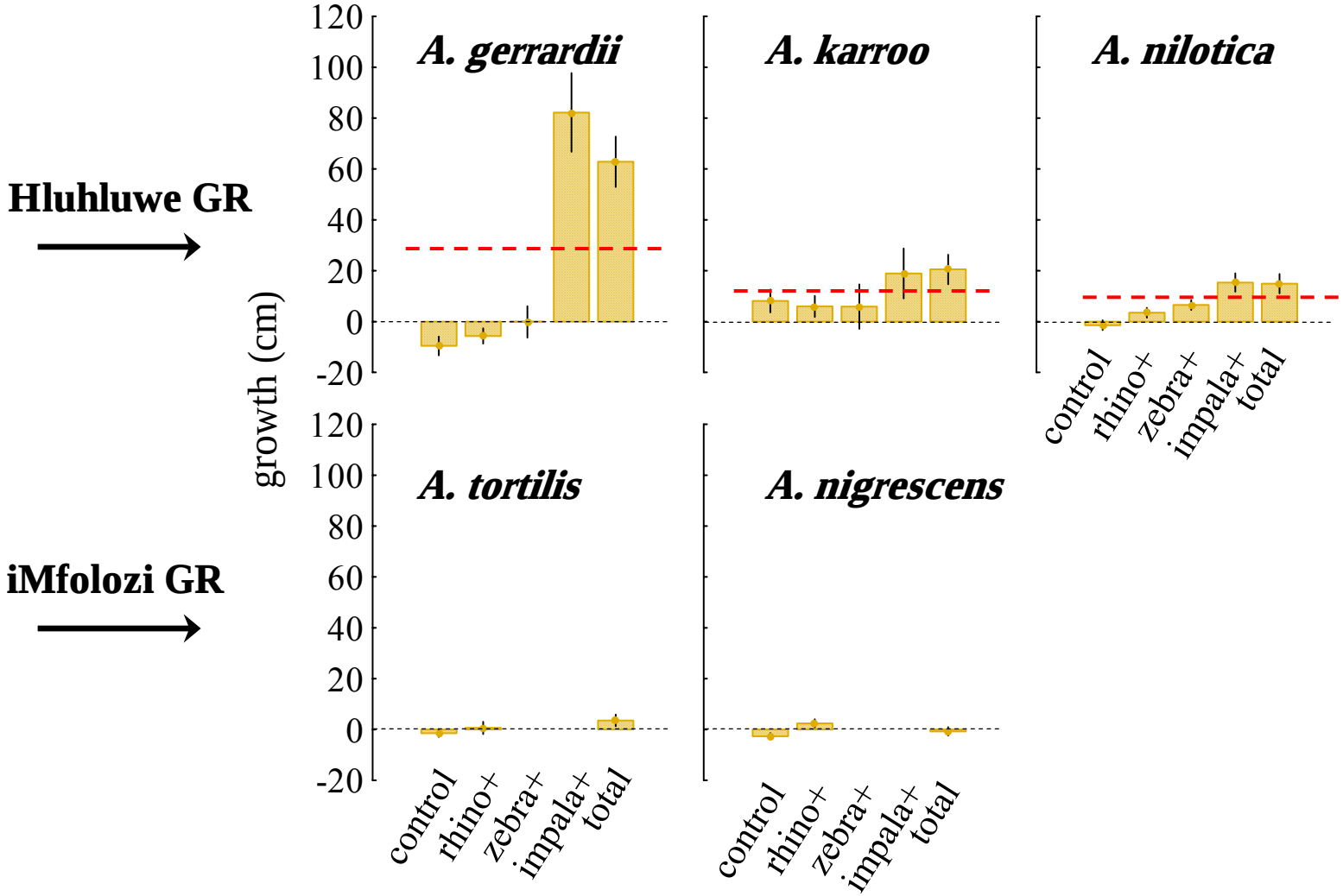


None = Control (Co)

Rhino and larger (Rh+)

All = Exclosure (Ex)

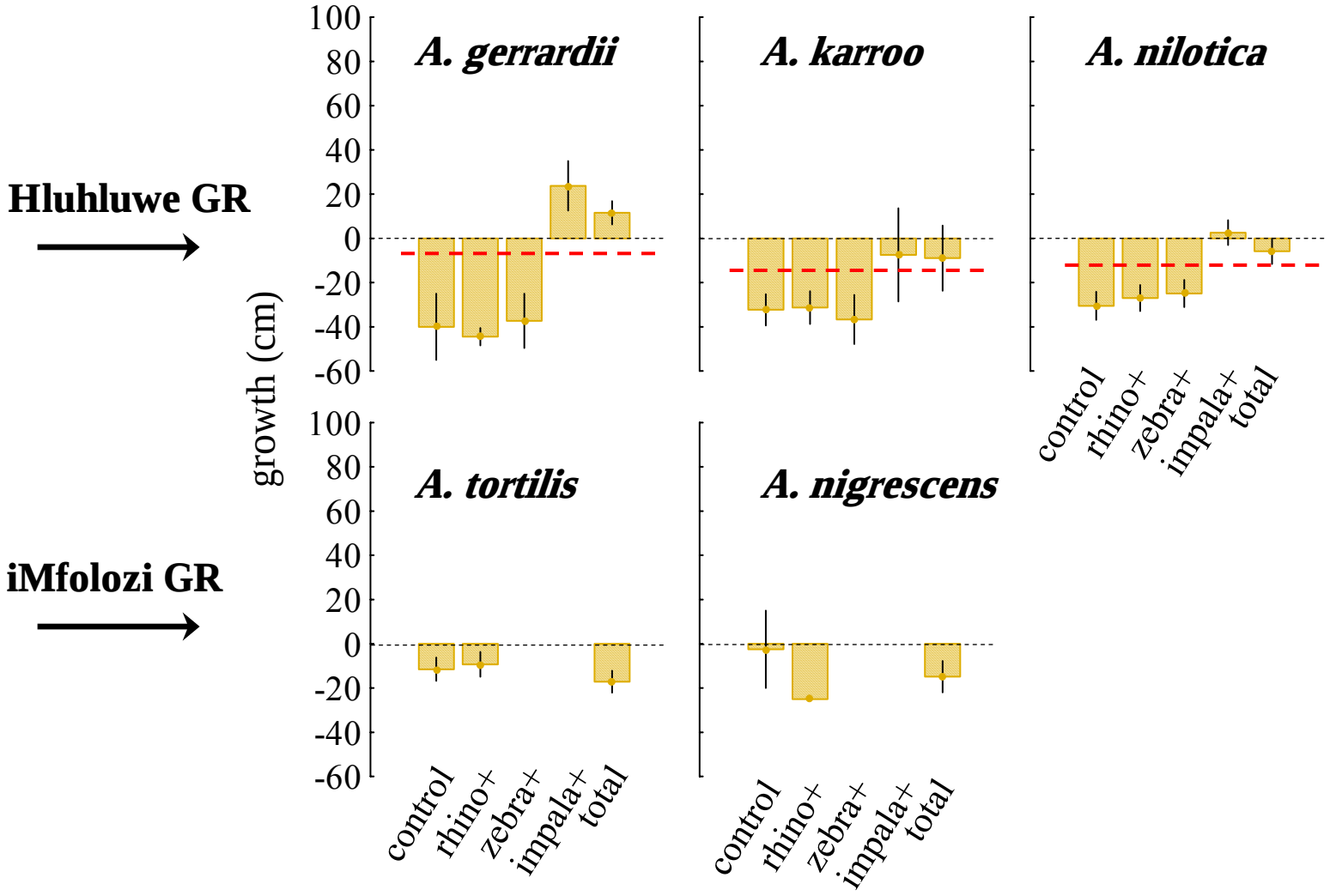
Height growth of small trees (ht<50cm)



Hluhluwe: *A. gerrardii* $p<0.0001$, co=rh+=z+<im+=ex *A. karroo* $p=0.33$ *A. nilotica* $p=0.0006$, co<z+=im+=ex

iMfolozi: *A tortilis* $p=0.18$ *A. nigrescens* $p=0.047$, co<rh+

Height growth of saplings (50cm<ht<150cm)



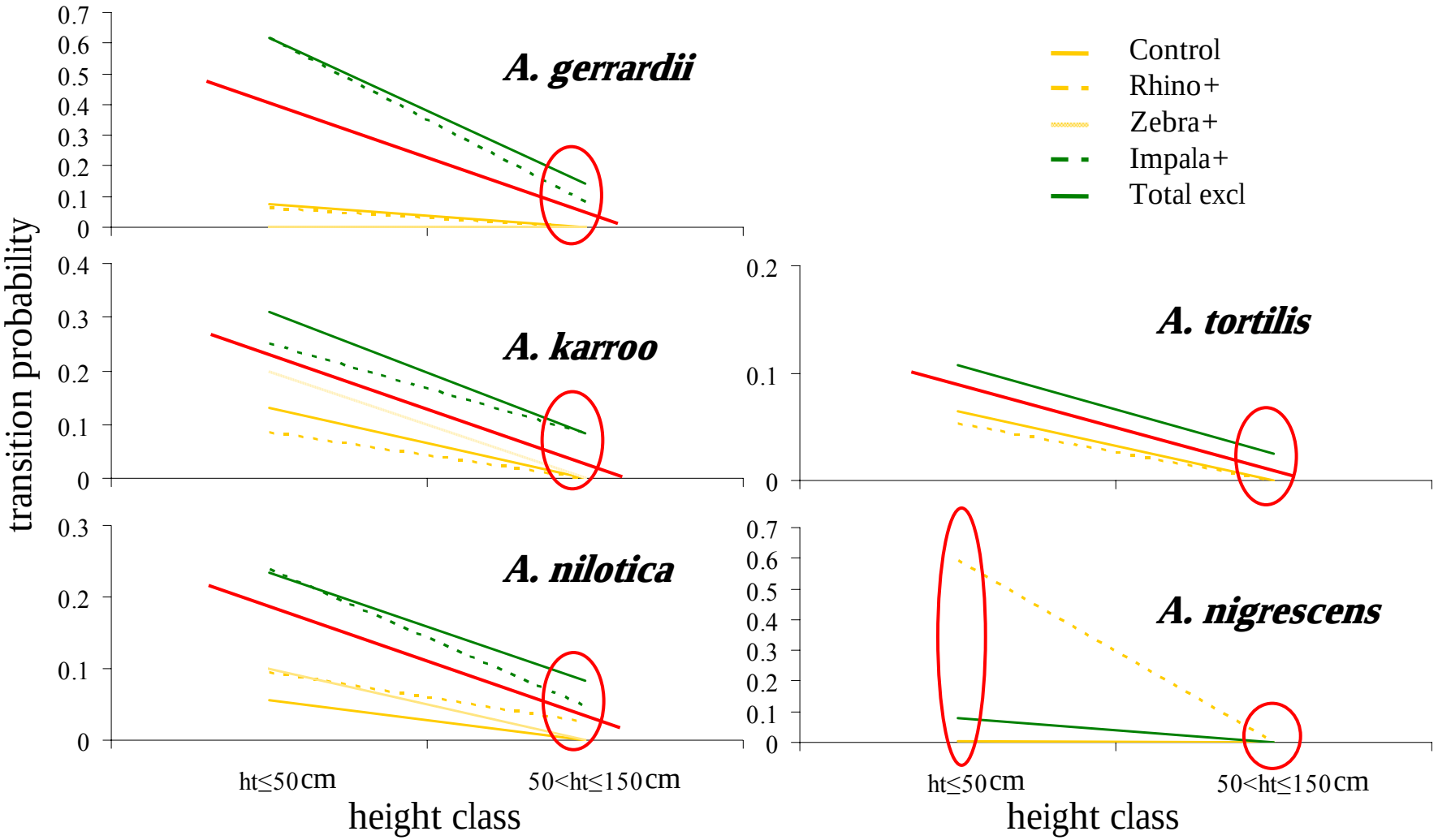
Hluhluwe: *A. gerrardii* $p<0.0001$, rh+=z+<im+=ex *A. karroo* $p=0.60$ *A. nilotica* $p<0.0001$, co=rh+=z+<im+=ex

iMfolozi: *A tortilis* $p=0.62$ *A. nigrescens* $p=0.65$

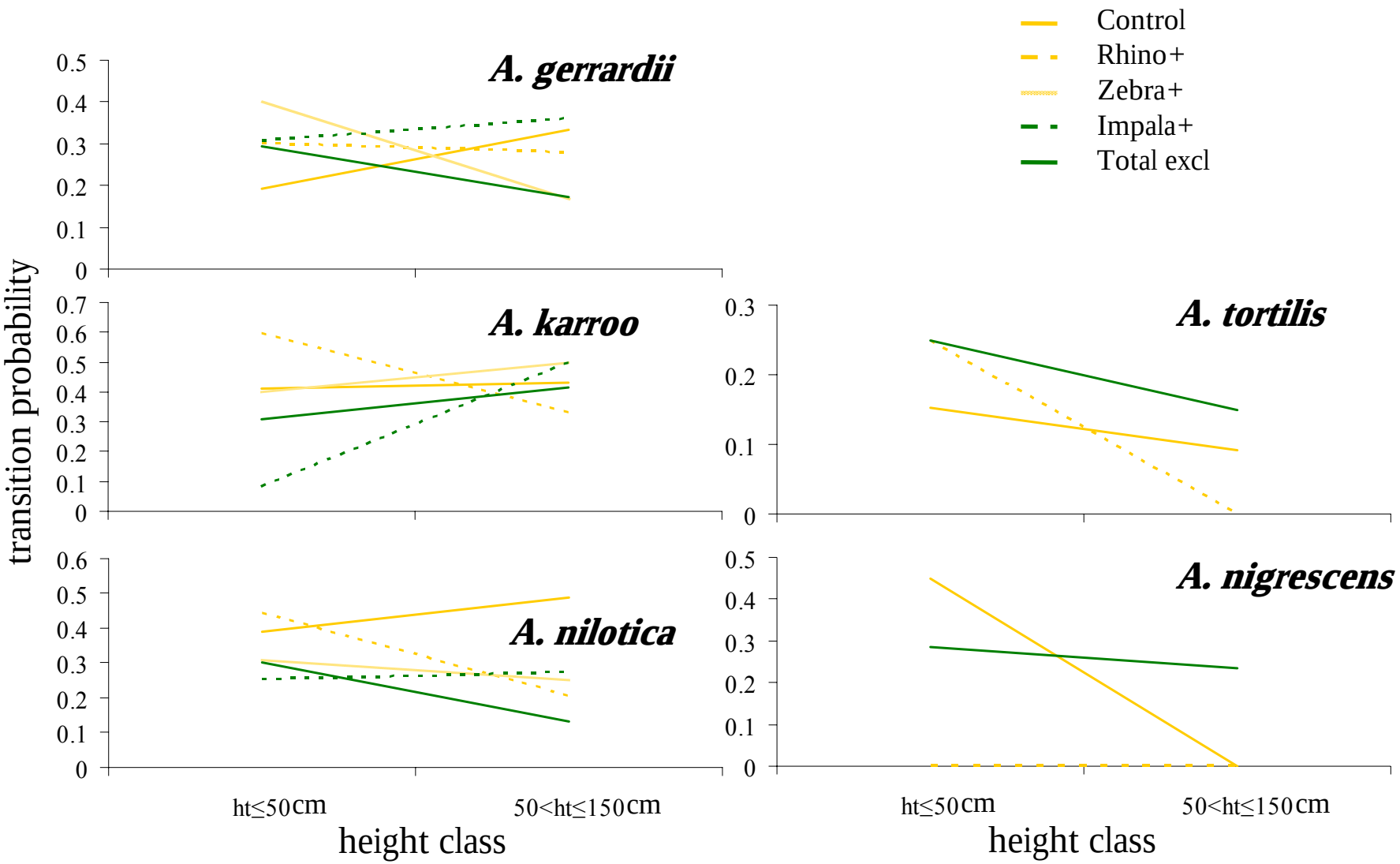
Proportion of trees growing into larger ht classes

- Do changes in growth translate into population growth?

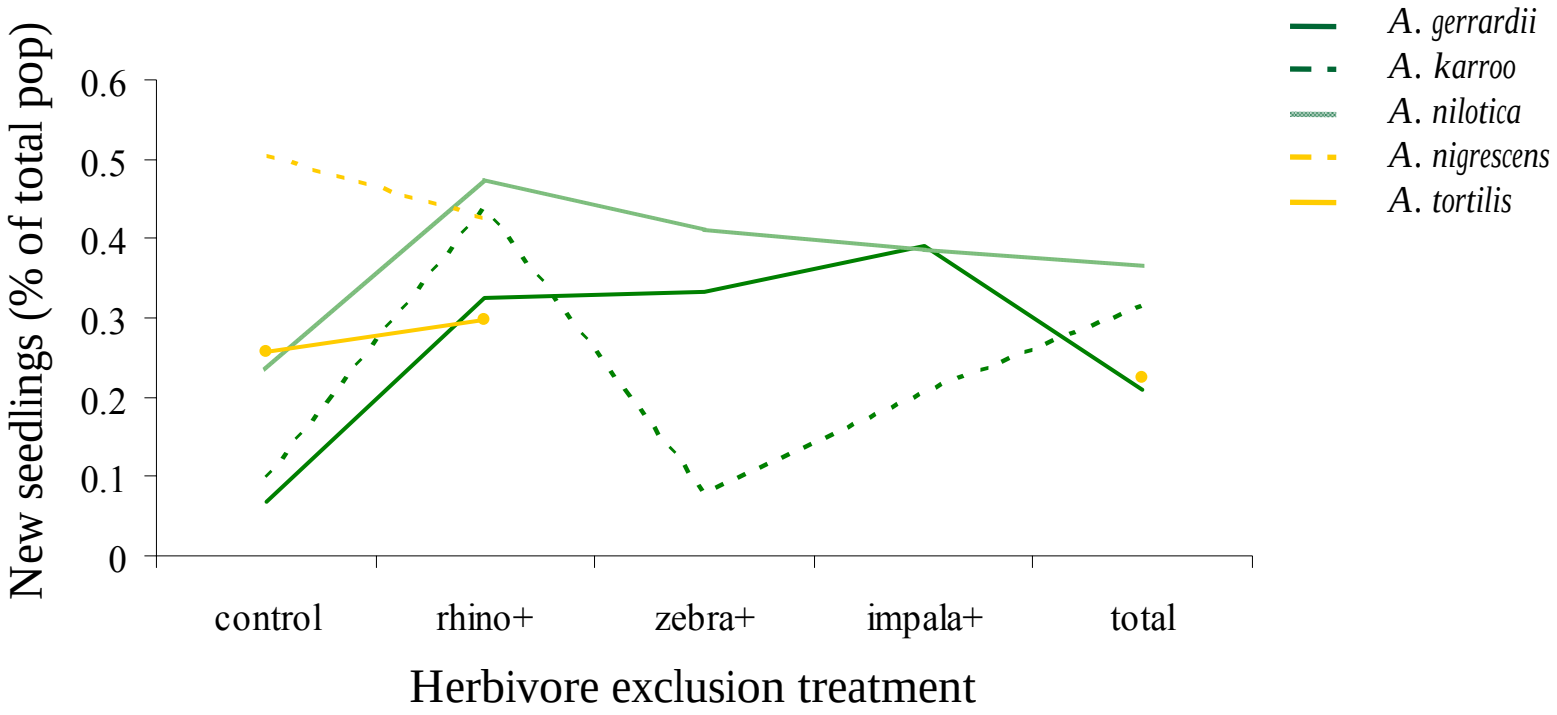
Proportion of trees growing into larger ht classes



Mortality


Control
Rhino+
Zebra+
Impala+
Total excl
A. gerrardii
A. karroo
A. tortilis
A. nilotica
A. nigrescens
transition probability
ht≤50cm
50<ht≤150cm
height class
ht≤50cm
50<ht≤150cm
height class

Seedling recruitment



Conclusions – what type of driver is herbivory?

- Herbivory does not consistently impact mortality or recruitment
- Herbivory substantially affects tree growth

- Herbivory acts to suppress populations of small trees in a persistence life-stage = a demographic bottleneck!
- In certain circumstances, removal of herbivory results in the release of these individuals

Keystone species?

- In Hluhluwe, the exclusion of impala from heavily grazed areas seems to make the functional difference for tree growth

- Why would intense grazing result in suppressed tree population growth rather than bush encroachment?

control

total exclosure

Keystone species?

- In native assemblages of African mega-herbivores, some grazers *are* browsers
  - Mixed feeders are a rare phenomenon
  - Only impala and nyala in Hluhluwe iMfolozi NP
- Perhaps grazing lawns can occur with their peculiar structure and form because of the proliferation of mixed feeders in African savannas?

Keystone species?

- In iMfolozi, the signal is less clear
  - Only 3 herbivore exclusion treatments: control, rhino ex, total ex
- Even so, pattern not necessarily consistent with that found in the 5 Hluhluwe treatments
- Interaction with increasing grass growth as grazing decreases appears to be more important in regulating tree growth

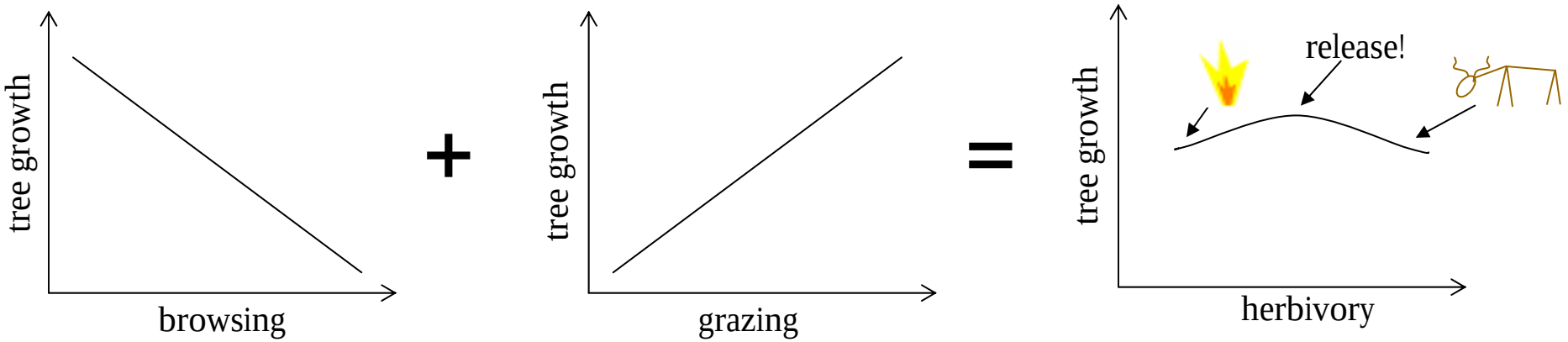
Thoboti

Fire / herbivore interaction

- Release from impala may be sufficient for Hluhluwe *Acacia*s to recruit
  - Fire-adapted so fire less of a problem?
- Release from grazing in iMfolozi results in increased fire intensity
  - Herbivore-adapted so fire more of a problem?
  - Recruitment may only occur when trees are relieved from both herbivory and fire → RAINFALL

Conclusions

- Influence of herbivory non-linear & interactive
  - Is the system is herbivore- or fire-dominated?
  - Species?
  - Temporal variation?



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