Acacia demographics in Hluhluwe iMfolozi Park: do major events define dynamic savannas?

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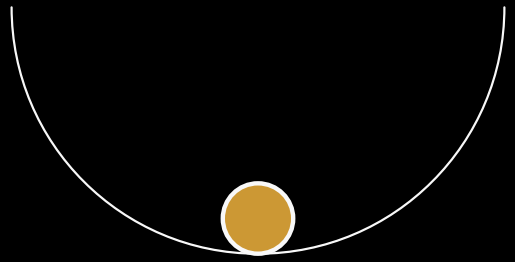
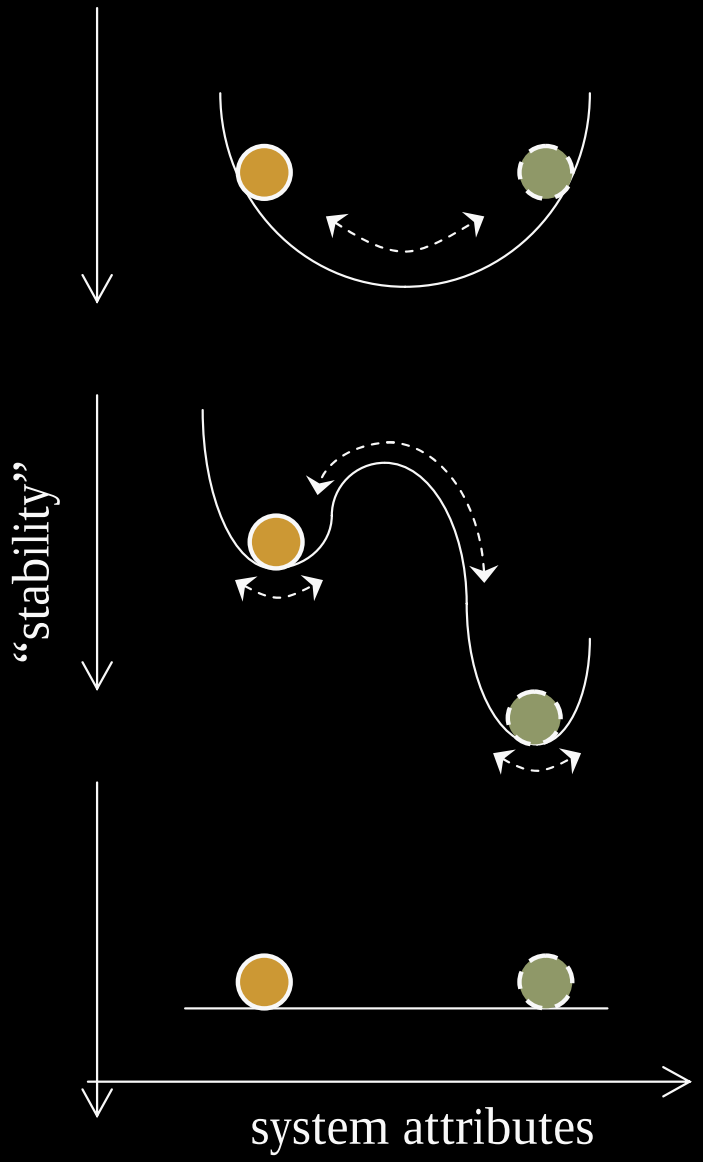
Stable coexistence...

- Savanna question – coexistence of trees and grasses
  - for a long time, mechanisms describing stable coexistence dominated
  - in some sense, Walter's water niche-differentiation hypothesis belongs to this category



...or change & variability?

- In fact, disturbance & non-equilibrium hypotheses are more realistic
  - but disturbance & non-equilibrium can mean different things...
  - variable determinants: climate, fire, herbivory



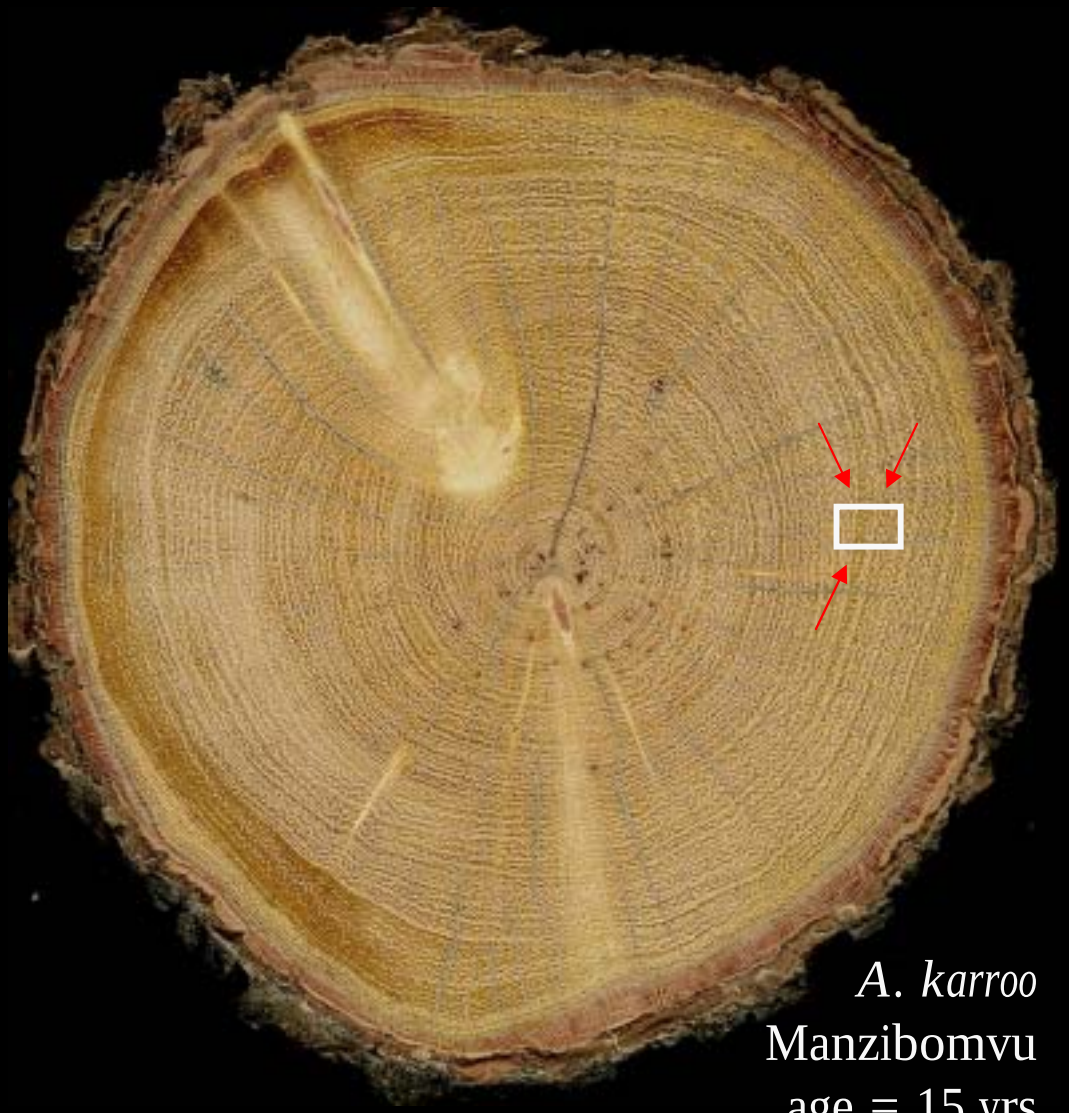
Dynamic, but how?

- basically, necessitates long-term ecological work
  - but HiP lacking a solid, continuous long-term record
- visually, adult *Acacia* appear to occur in patchy, even aged stands
- can we look at population structure of adult *Acacia* for fingerprints of history + demographic processes?

Methods

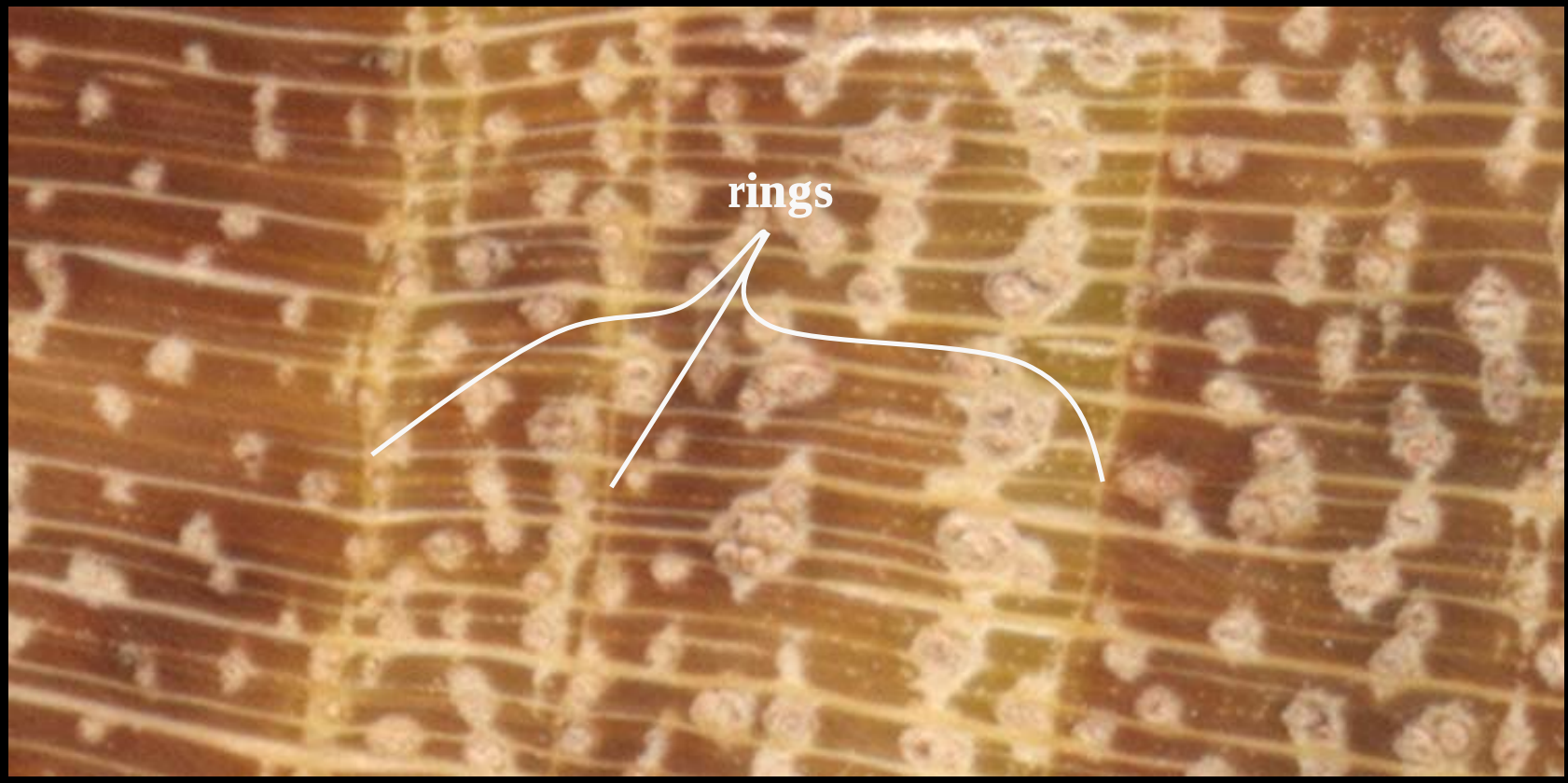
- using dendrochronology to analyze a spatially-explicit age-structure for 3 species of *Acacia*
  - Hluhluwe: *A. karroo* & *A. nilotica*
  - iMfolozi: *A nigrescens*

- some *Acacia* form approx. annual growth rings related to rainfall seasonality + variability

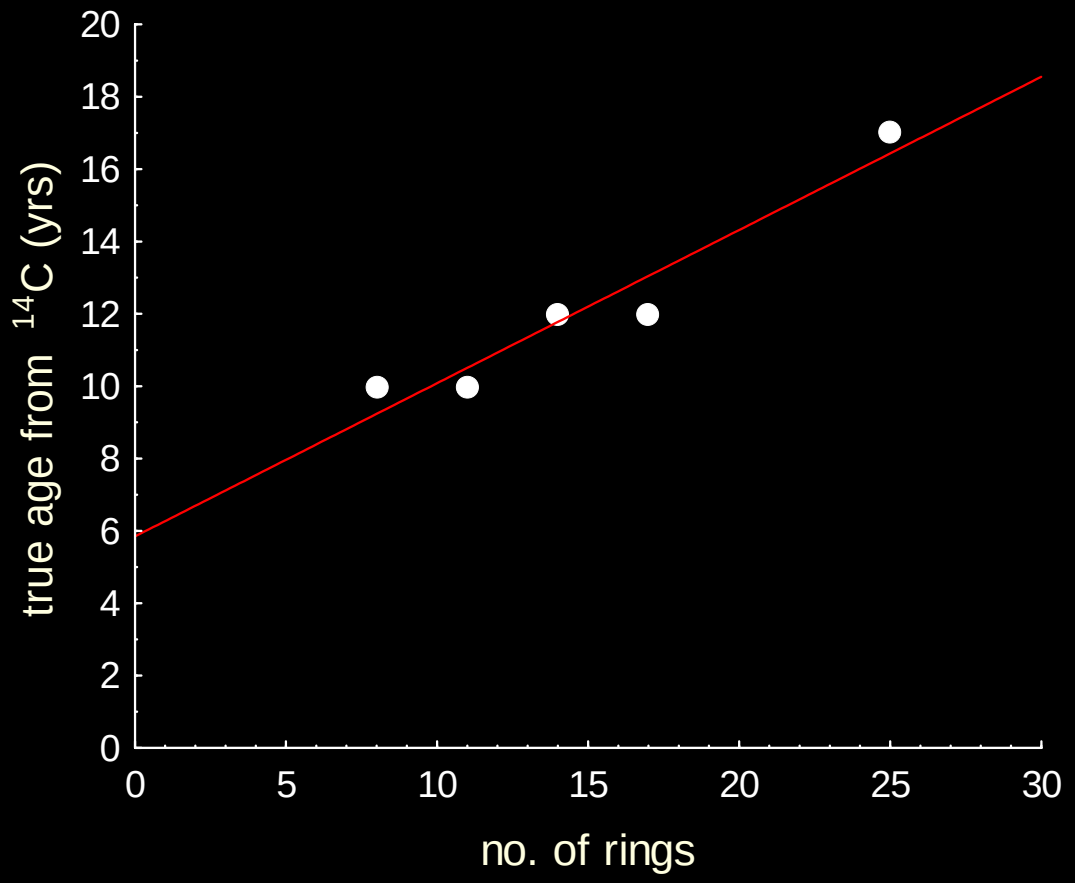


A. karroo
Manzibomvu
age = 15 yrs

Methods



A. karroo: age v. ring count

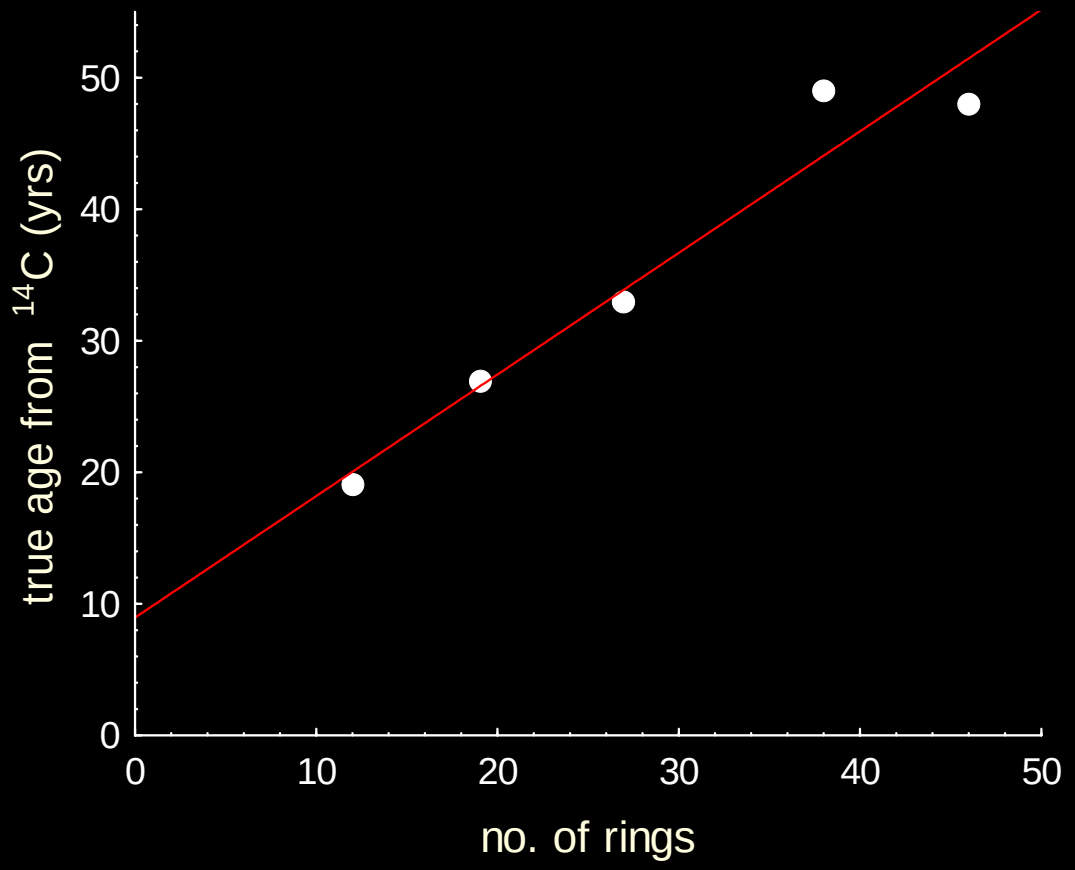


r^2=0.930

p=0.0081

age = 5.85 + 0.42*rings

A. nilotica: age v. ring count



r^2=0.944

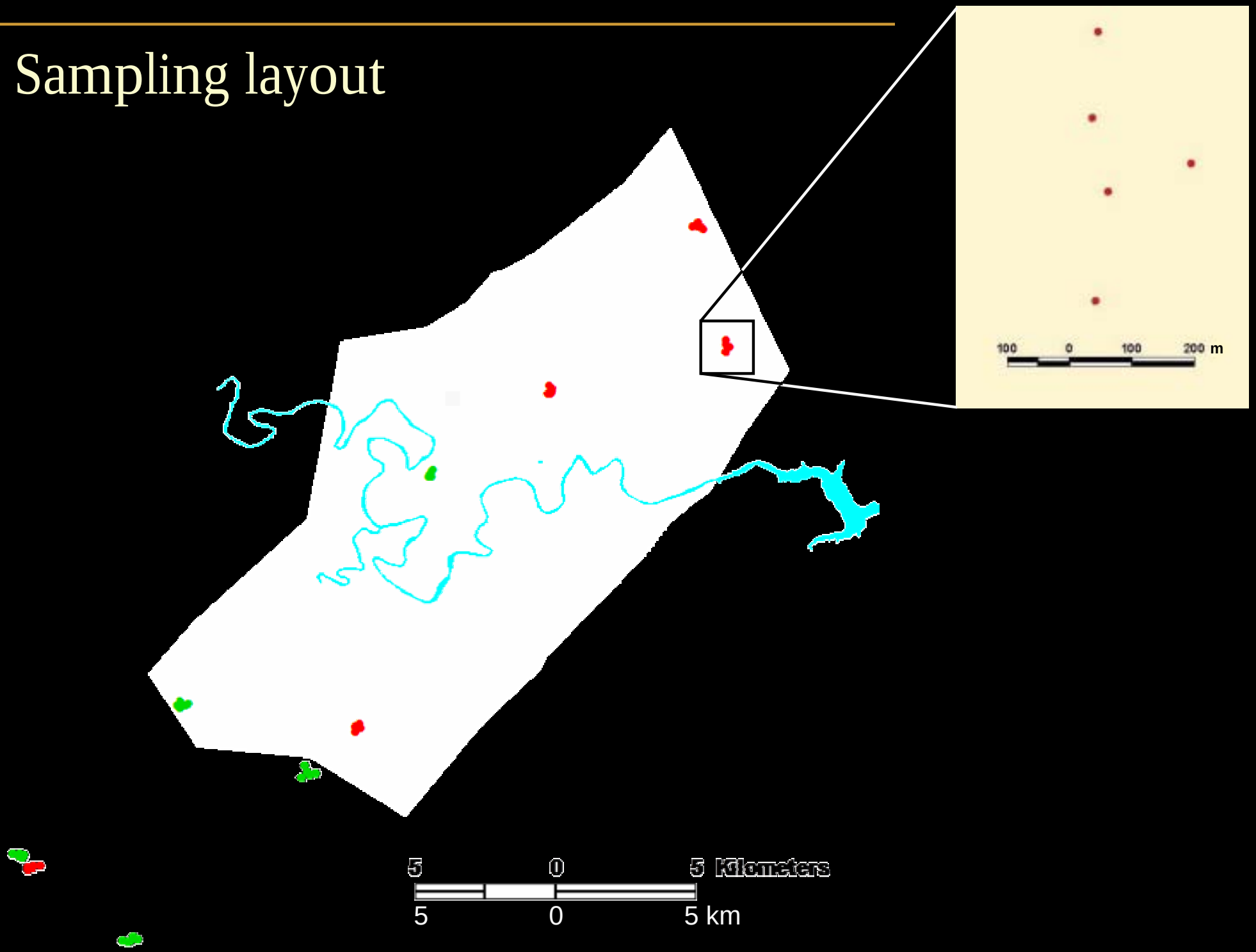
p=0.0057

age = 8.95 + 0.92*rings

Method

- Adult =
  - 3.5m tall (WT's fire ht) OR
  - reproductive = pods or large canopy

Sampling layout



Hypotheses

- Landscape pattern =
  - various demographic/life history stages

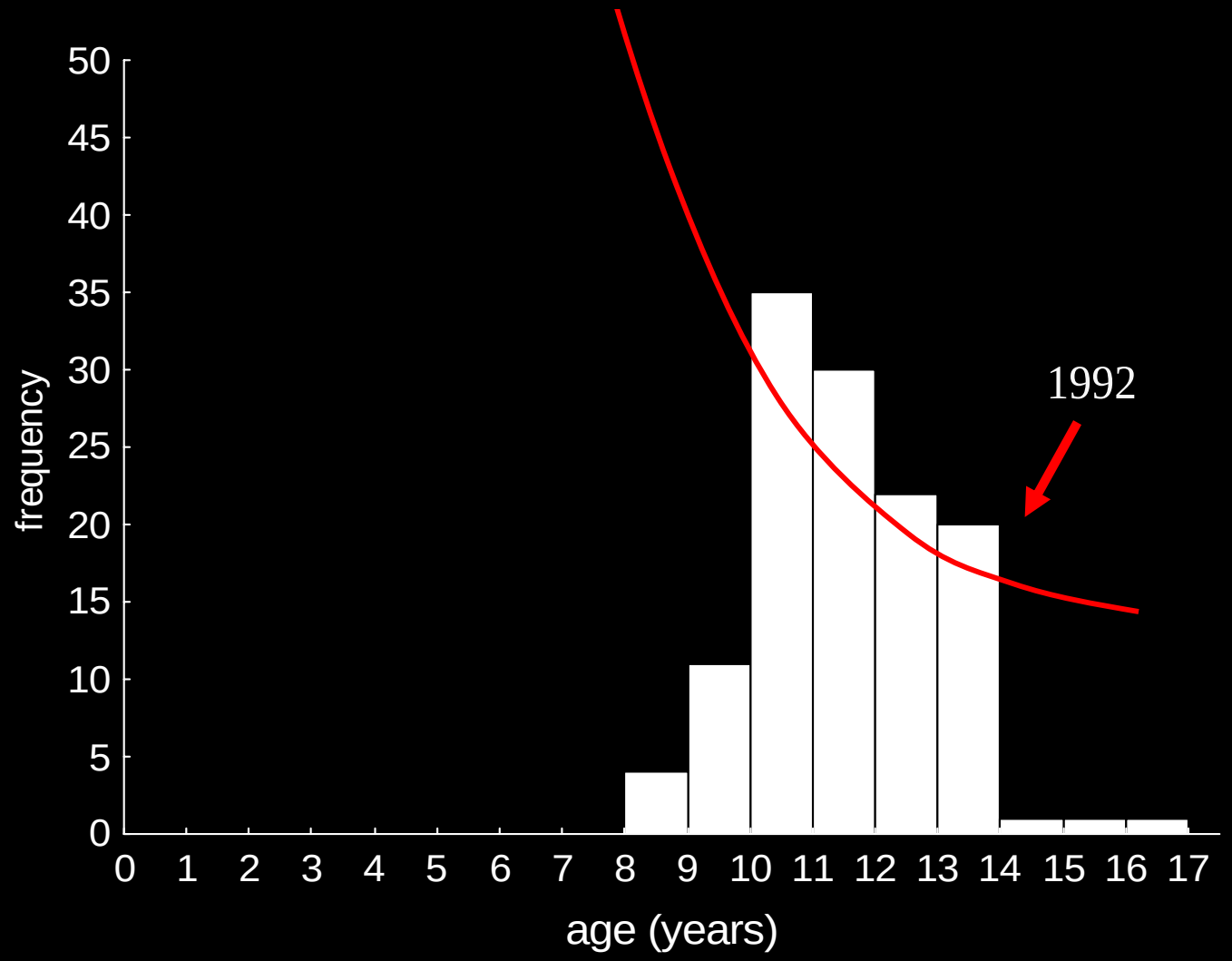
    +
  - their relation to biotic & abiotic environmental variability
- Result?
  - Landscape-wide cohort?
    - = climatic or herbivore population crash event
  - Localized cohorts?
    - = local event, e.g. fire or change in herbivore use patterns
  - Variable-scale heterogeneity?
    - = driver variability at multiple scales, e.g. fire
    - = interactions of landscape scale event w/ landscape heterogeneity
  - J-shaped age class distribution?
    - = continuous recruitment

Hypotheses: *A. karroo*

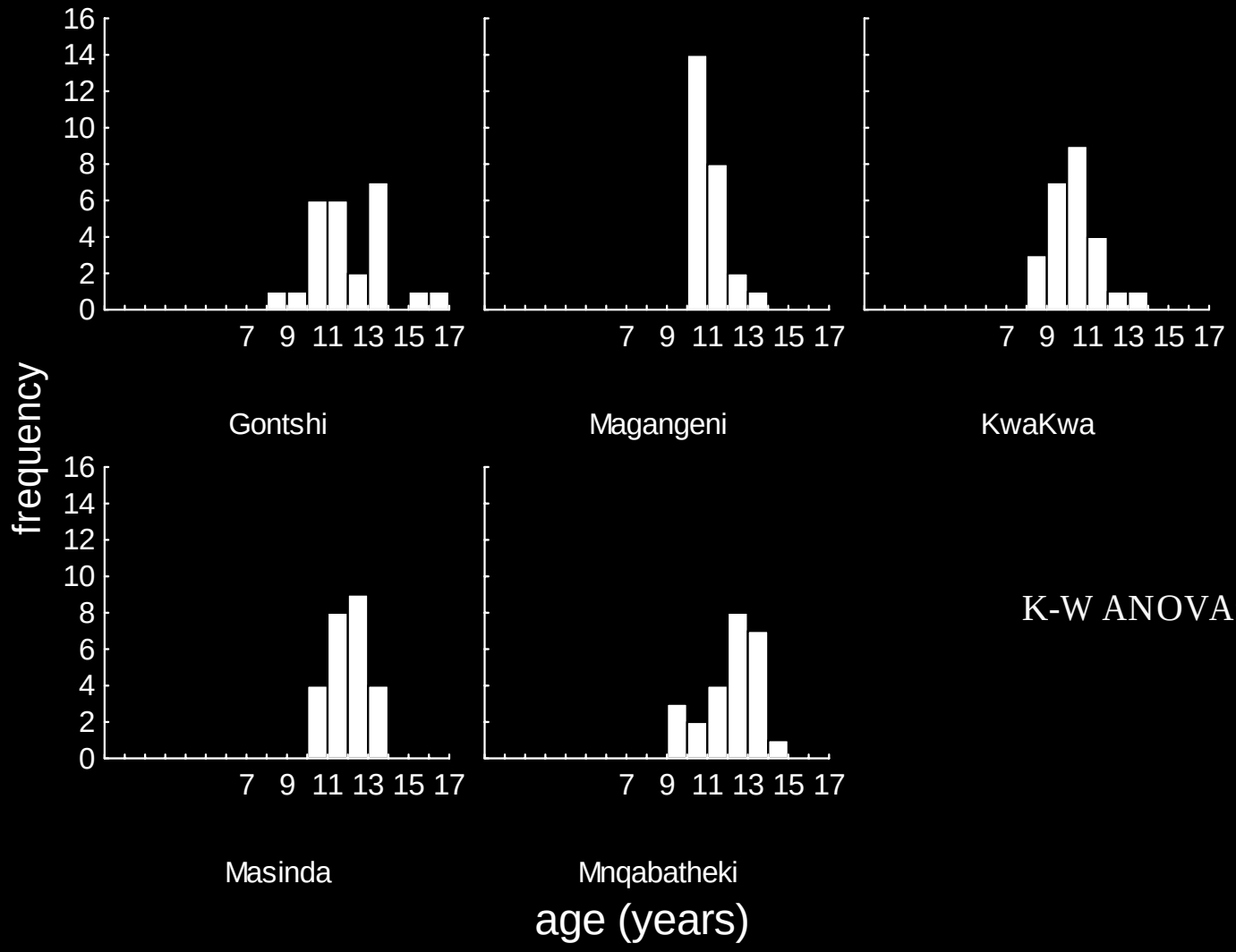
- demographic bottleneck = escaping the ‘fire trap’ = growing from a sapling to a young adult tree
- landscape pattern should be related to landscape fire patterns
- fire is heterogeneous at multiple scales = small to large areas may escape burning

- adult *A. karroo* landscape pattern = variable-scale heterogeneity

A. karroo: age class dist. for adults in park

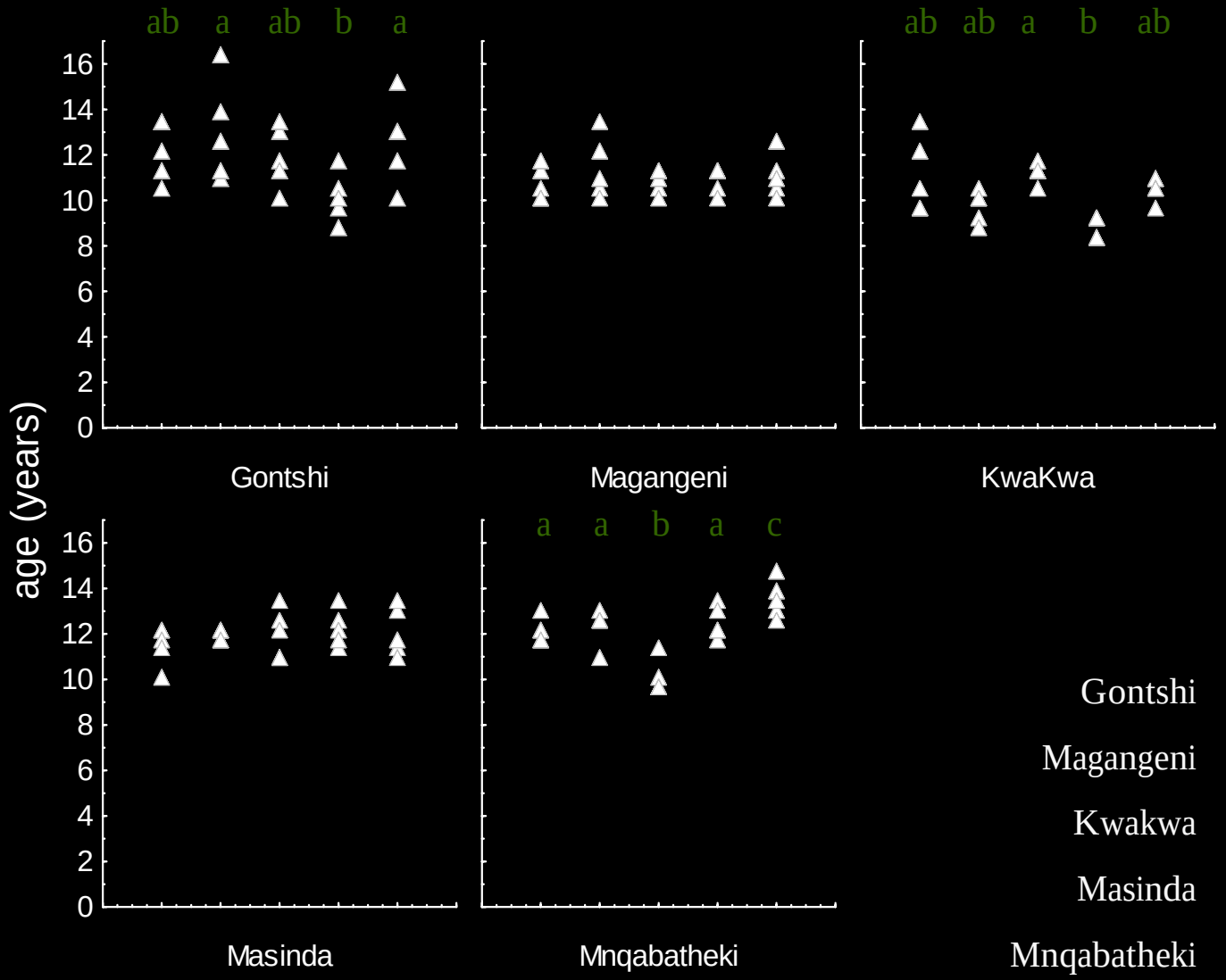


A. karroo: mean tree age by region



K-W ANOVA: H (4, 125) = 33.7;
$p < 0.0001$

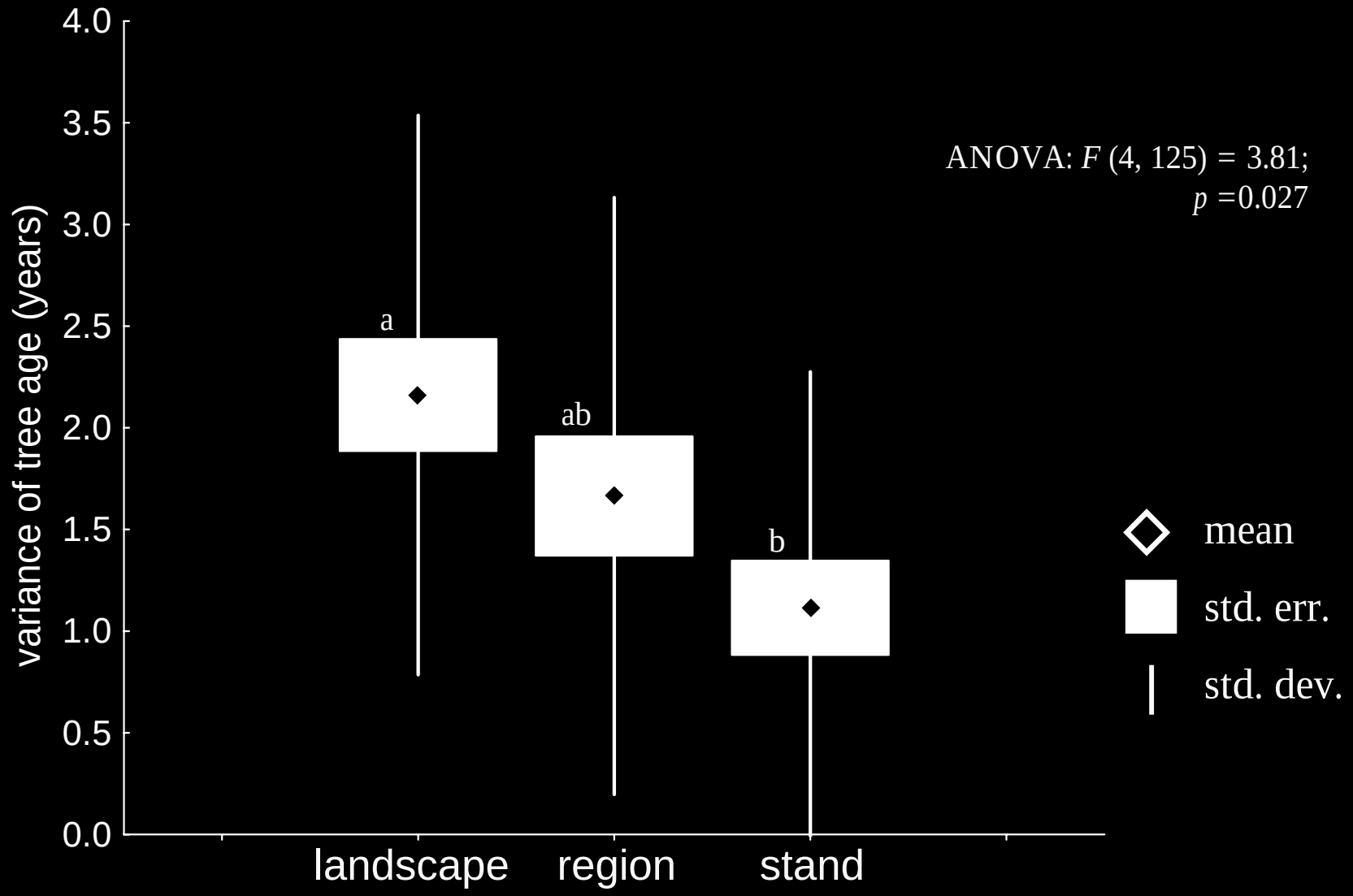
A. karroo: mean tree age by local x regional scale



ANOVA

Gontshi	$F = 2.32$; $p = 0.093$
Magangeni	$F = 0.43$; $p = 0.78$
Kwakwa	$H = 15.\ 5$; $p = 0.004$
Masinda	$F = 0.52$; $p = 0.72$
Mnqabatheki	$F = 15.3$; $p < 0.001$

A. karroo: age variance v. scale



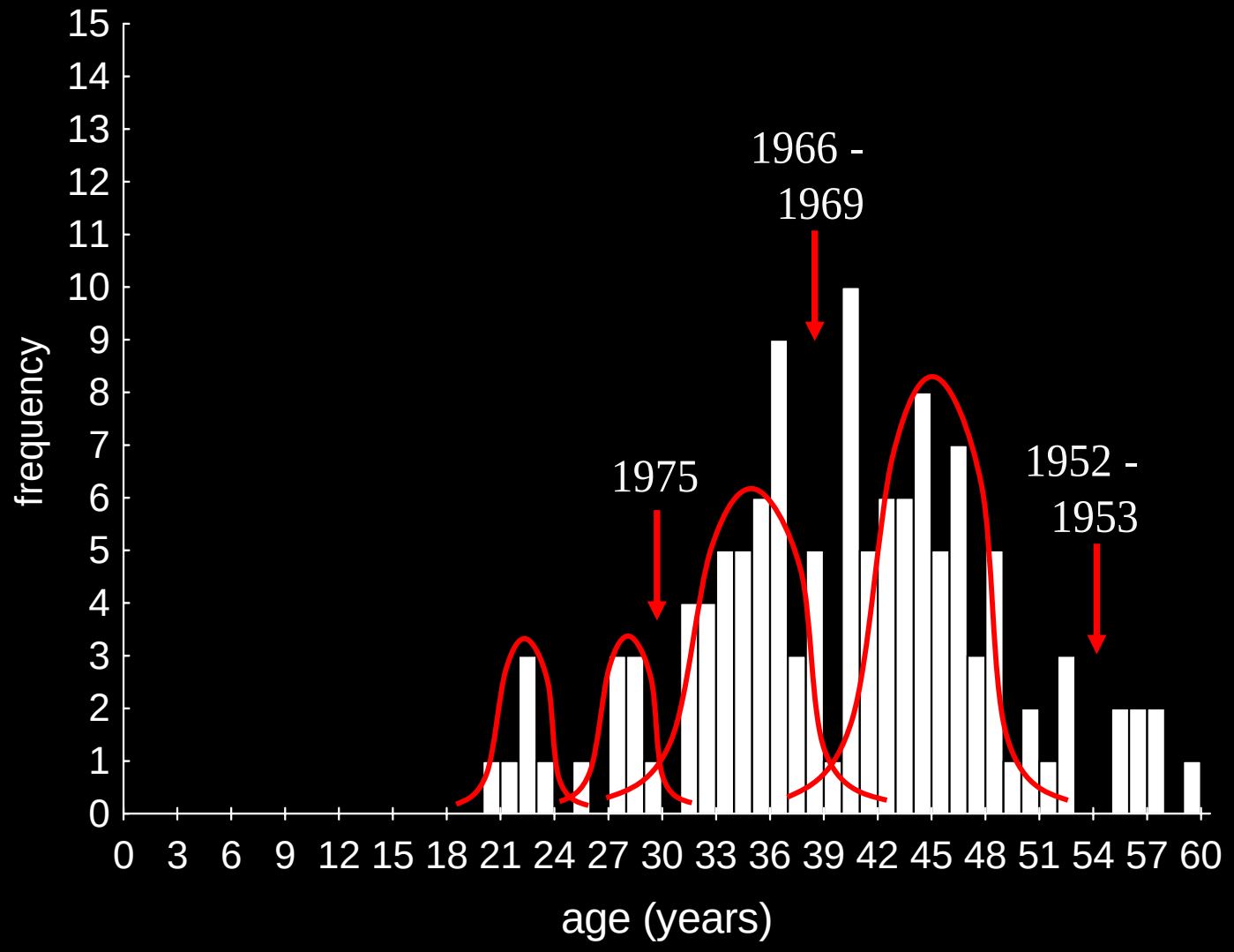
Summary: *A. karroo*

- whole-park ‘landscape’ scale
  - recruitment began in ~1992
  - continued for at least 4 years, possibly continuing even now
- structure at ‘regional’ scale
  - continuing recruitment in high-rainfall north of park
  - hill-side size cohorts occur
- structure at stand level
  - even-aged stands occur throughout park

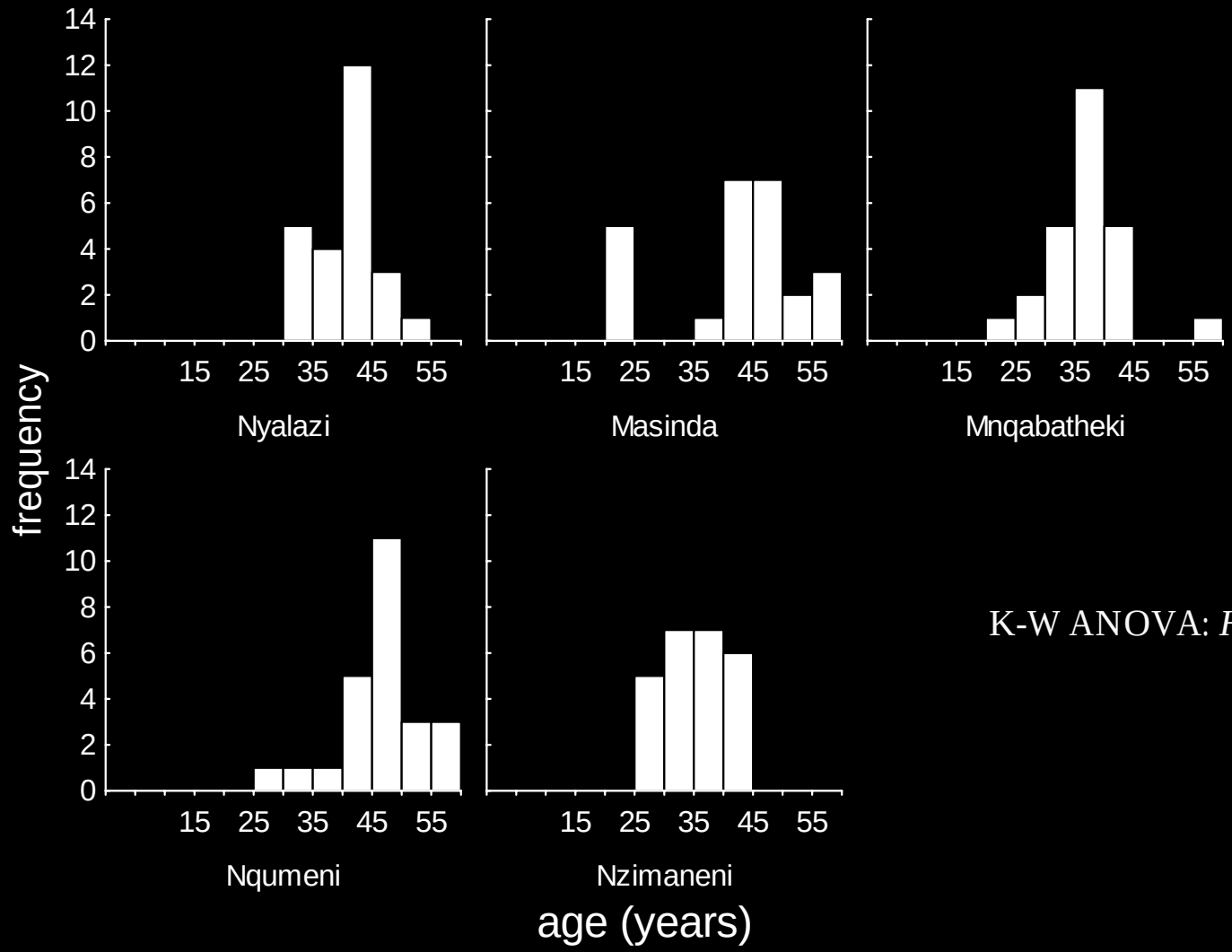
Hypotheses: *A. nilotica*

- no demographic model
- landscape-wide cohort?

A. nilotica: age class dist. for adults in park

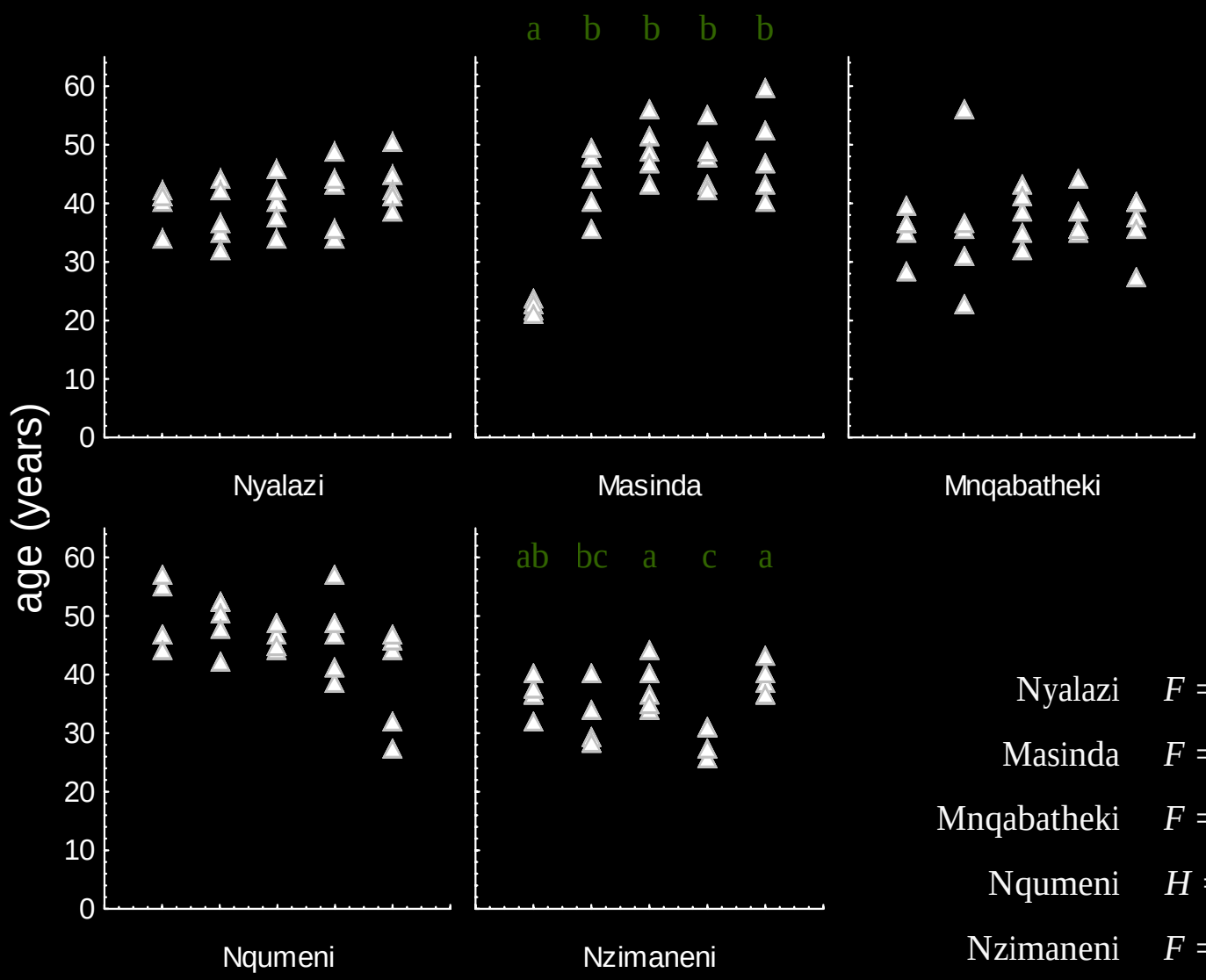


A. nilotica: mean tree age by region



K-W ANOVA: H (4, 125) = 38.9;
$p < 0.0001$

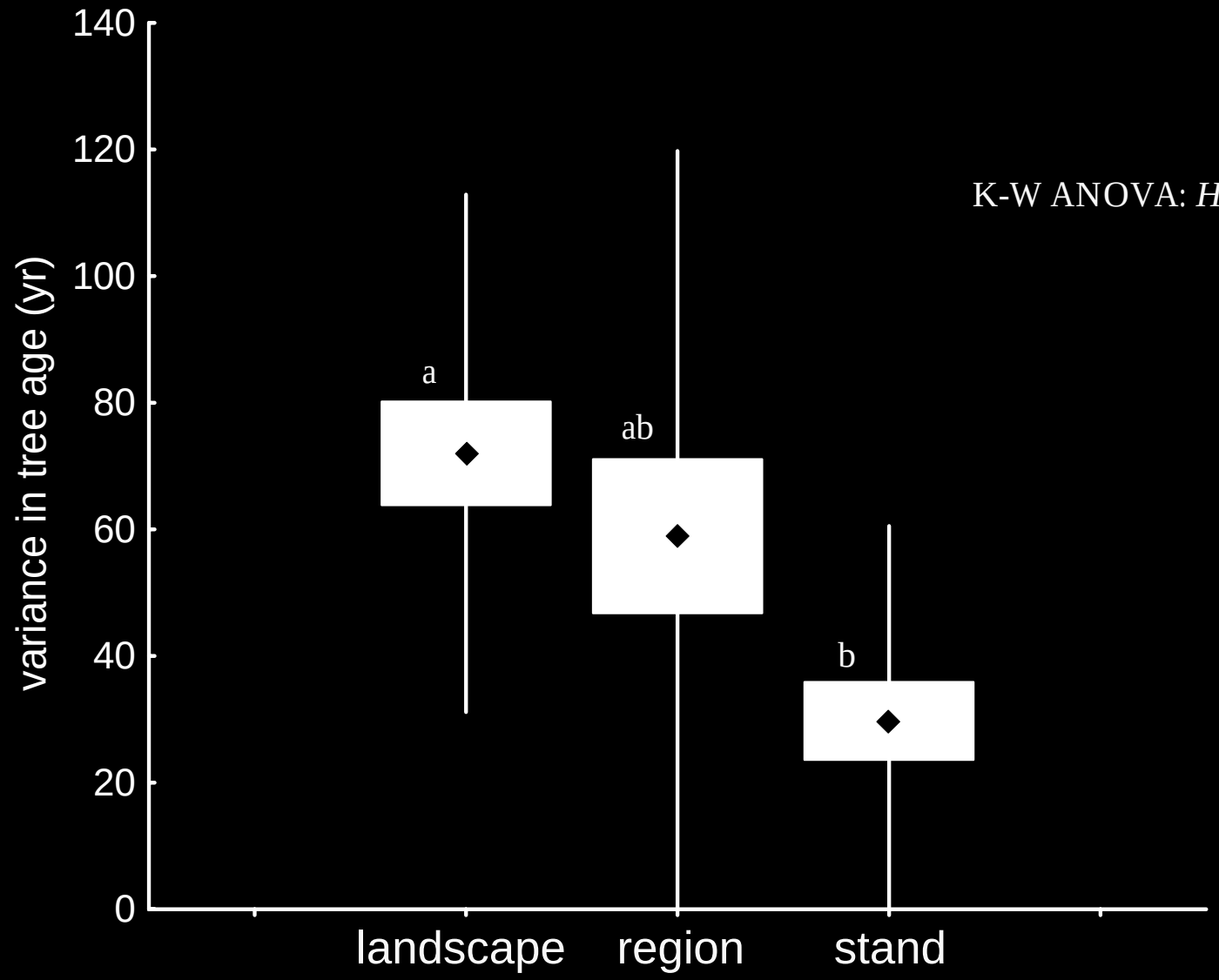
A. nilotica: mean tree age by local x medium scale



ANOVA

Nyalazi	$F = 0.89$; $p = 0.49$
Masinda	$F = 22.2$; $p < 0.0001$
Mnqabatheki	$F = 0.14$; $p = 0.96$
Nqumeni	$H = 6.16$; $p = 0.19$
Nzimaneni	$F = 6.40$; $p = 0.0017$

A. nilotica: age variance v. scale

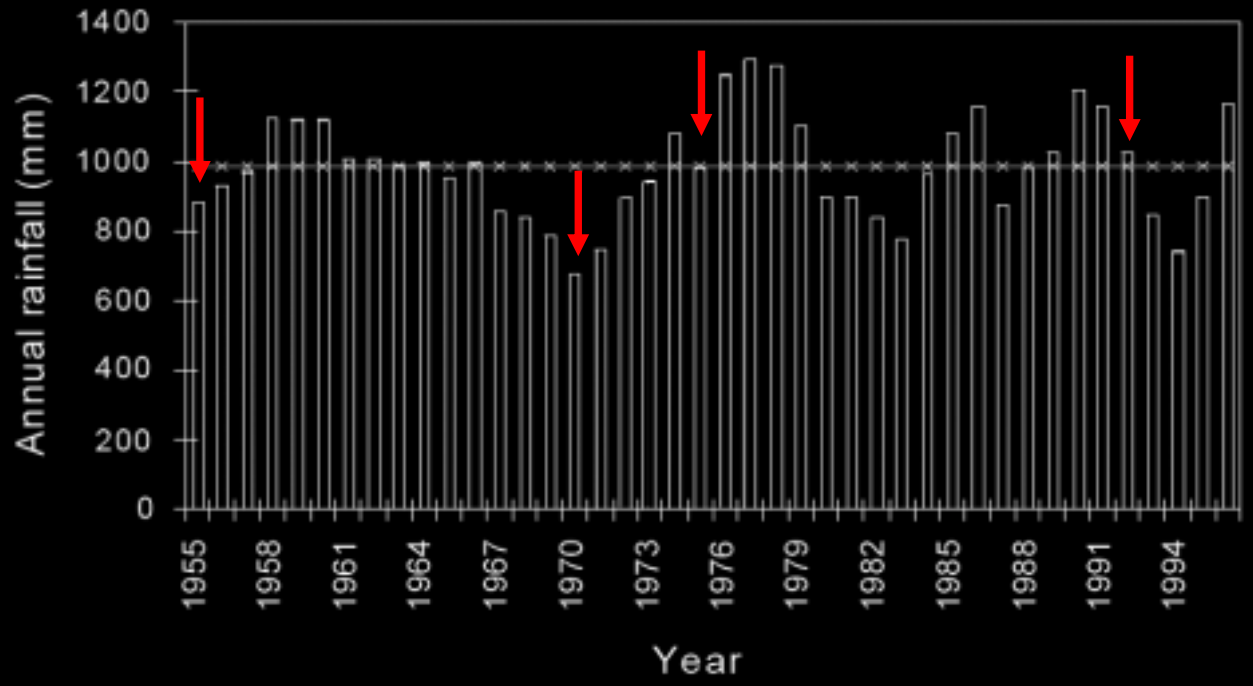


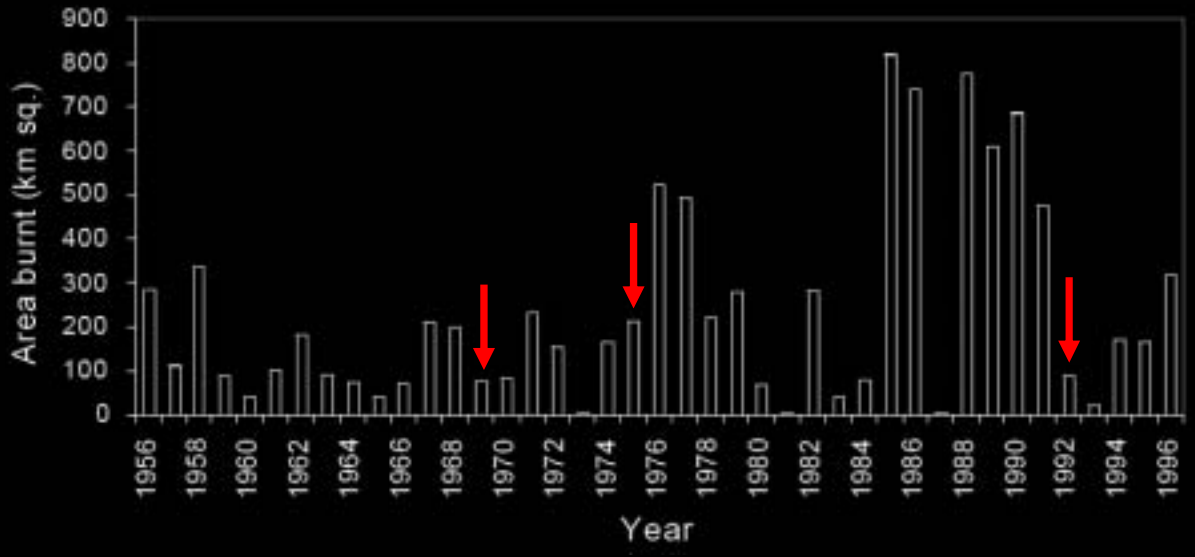
K-W ANOVA: H (4, 125) = 14.7;
p = 0.007

Summary: *A. nilotica*

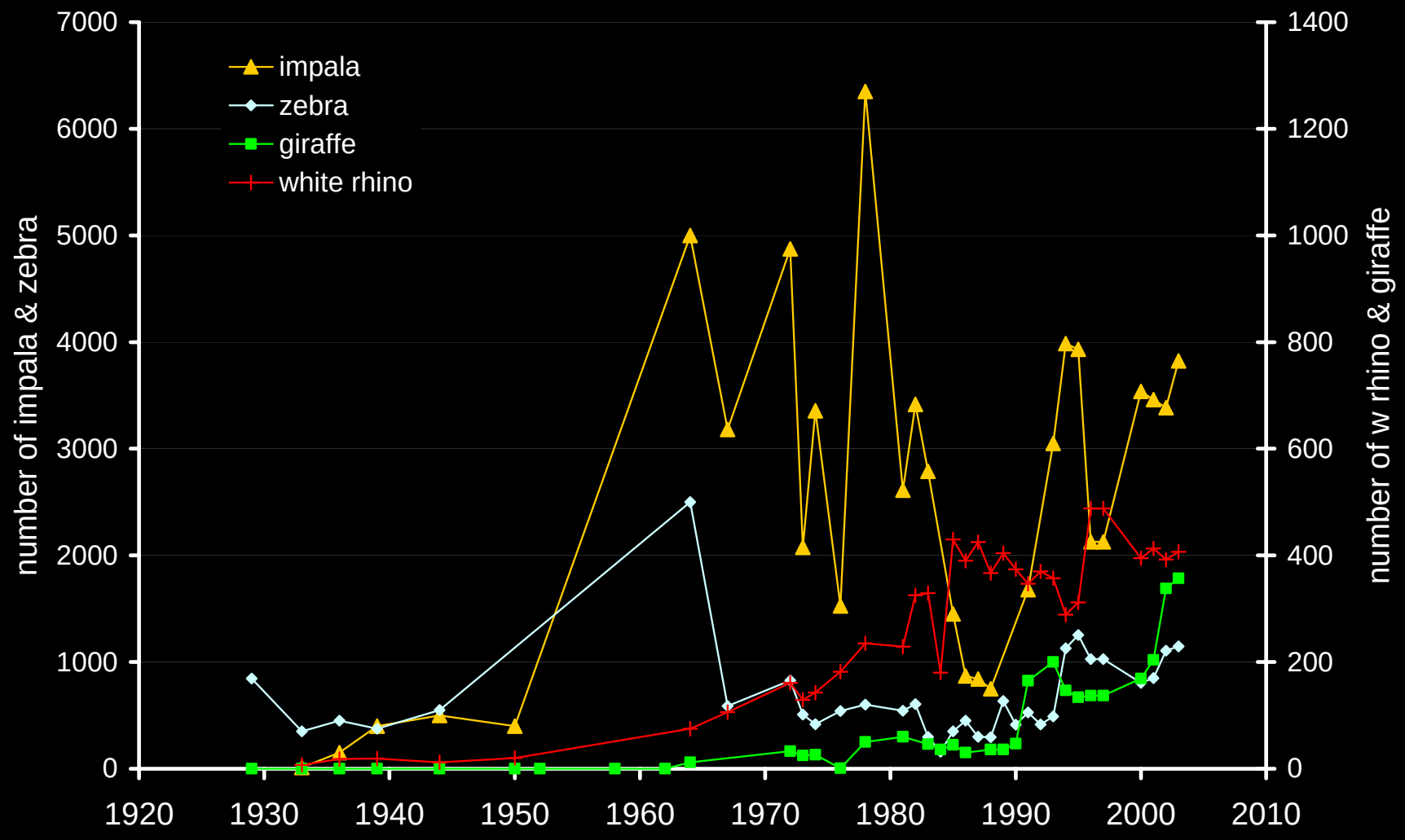
- whole-park ‘landscape’ scale
  - few younger adults ~20 years old & many older adults 30-60 years old
  - a longer-term recruitment episode or period of recruitment?
  - recruitment not continuous!
- structure at ‘regional’ scale
  - interactions between landscape-scale driver & landscape variation = ‘regional’ structure
- structure at stand level
  - even-aged stands occur throughout park

What drivers?





What drivers?



Conclusions

- Recruitment episodes are probably not brief events
  - Periods in time when recruitment is more likely
  - ... or when events on the local scale are more likely
  - Events are important on a local/stand scale

Conclusions

- Recruitment of adults is not continuous
- Species composition is not constant
  - Species attributes determine recruitment success under different cond.
  - Equilibrium resulting from shifting patch dynamic emerges only at scale larger than Hluhluwe iMfolozi Park?

    OR
  - Stability simply does not exist, even as a product of non-continuous processes?

Many thanks

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- ZLTP staff
- ...and others!