

# Recovery, Resilience and Stability in Piosphere Systems in the Kruger National Park

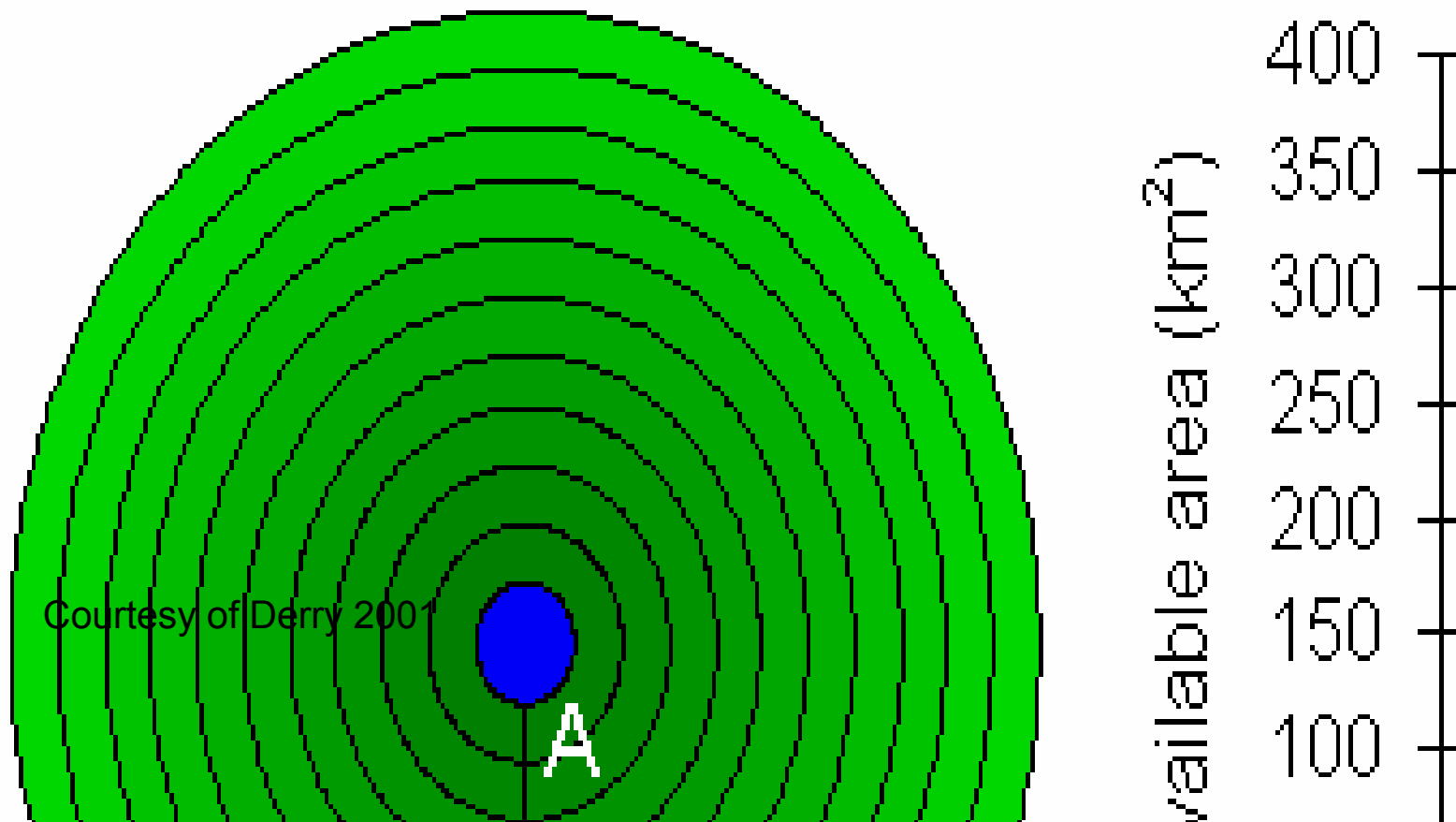


By Kate Matchett, Kevin Kirkman, Craig Morris, Mike Peel

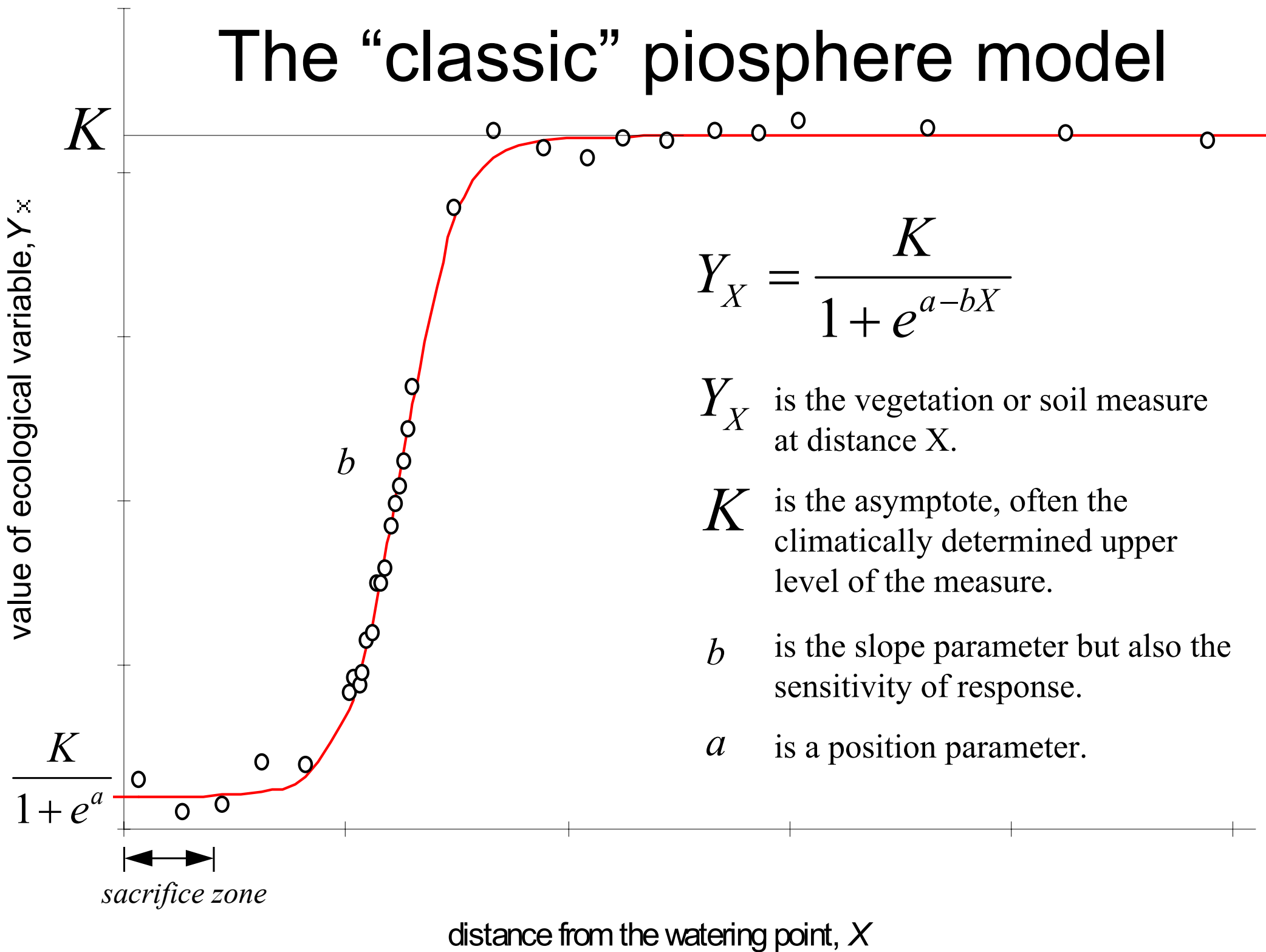


# Introduction

- Radial movements of ungulates to & from H<sub>2</sub>O-source → grad. increasing utilization with decreasing dist. from H<sub>2</sub>O → “piosphere”
- Model system → study plant-animal interactions



# The “classic” piosphere model



# Aims & Objectives

Focus to resurvey herbivore utilization gradients around artificial waterholes described in an earlier study (Thrash 1990).

Document recovery around closed waterholes ( $\pm 50\%$  sites) and change (spacio-temporal) around open sites

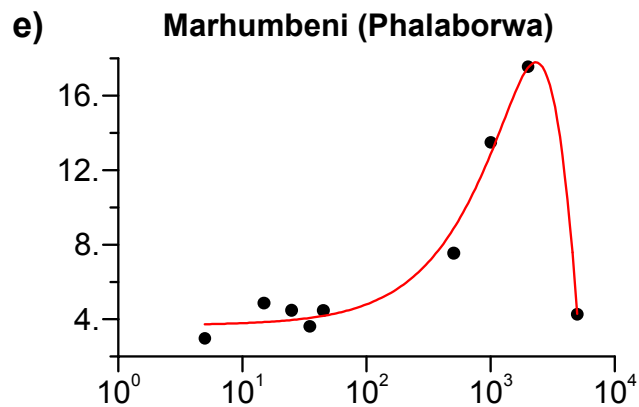
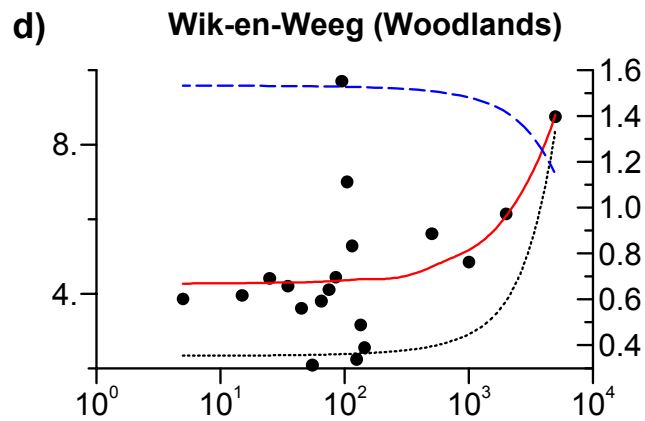
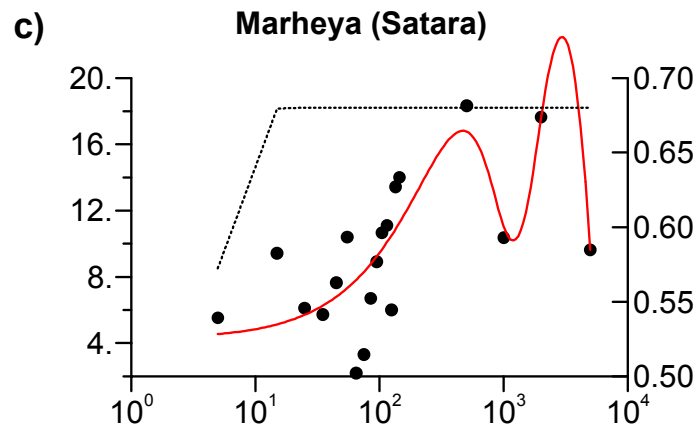
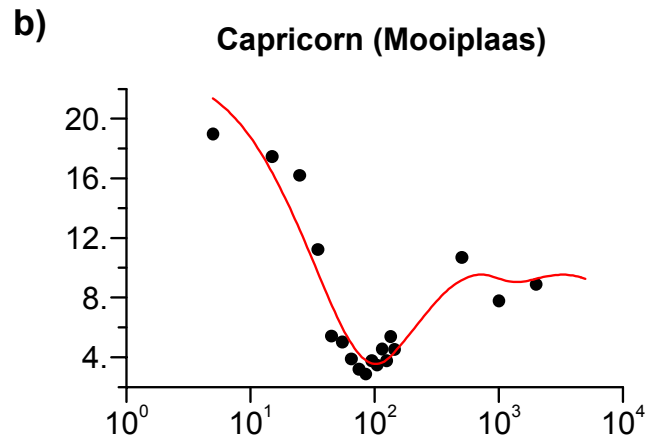
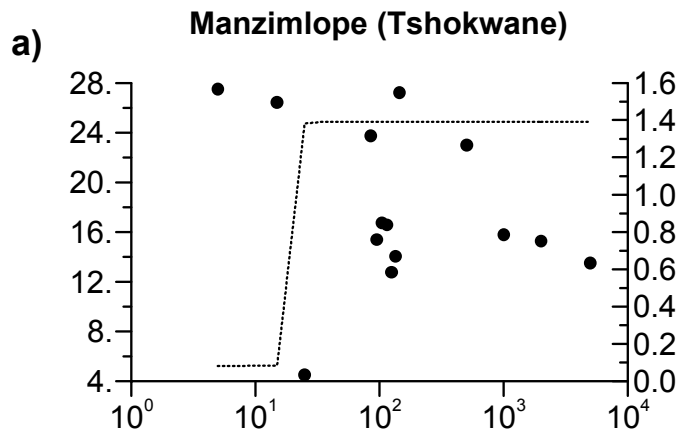
Consideration of a range of environmental/managerial parameters (rainfall, soil type, fire history, etc.)

Variables  $\rightarrow$  **herbaceous plant composition**, structure (DPM) & **basal cover**, woody composition & structure (horizontal & vertical), indicators of soil fertility (N, P, pH, organic C), **soil infiltration & compaction**, **LFA**,

# Herbaceous Basal Cover

- Increased (4 – 60 %) between 1990 and 2006 at all study sites & all piosphere zones identified in 1990 ( $p \leq 0.05$ )
- No difference btwn open/closed sites → unchanged herbivore utilization patterns?
- No difference btwn granitic/basaltic sites
- Increase in BC & regional patterns of increase best explained by MAP & fire history (1 – 3 yr window)

- Regression analysis → range of biologically plausible models from the linear, exponential & logistic families → selection using AIC
- Descriptive tool
- Limited use for prediction → high temporal variability
- Highly variable response → maximum and minimum BC occurring at different distance-from-water at each site

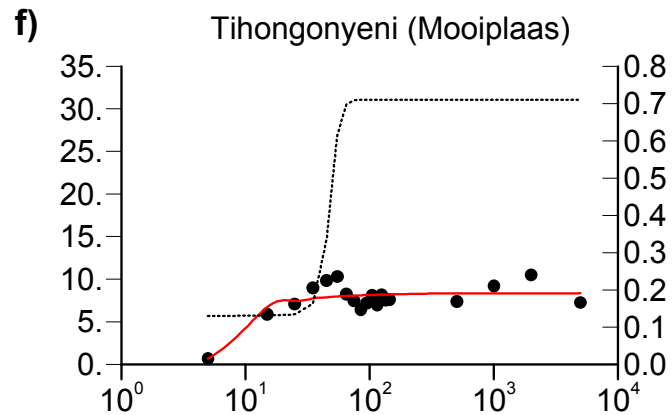
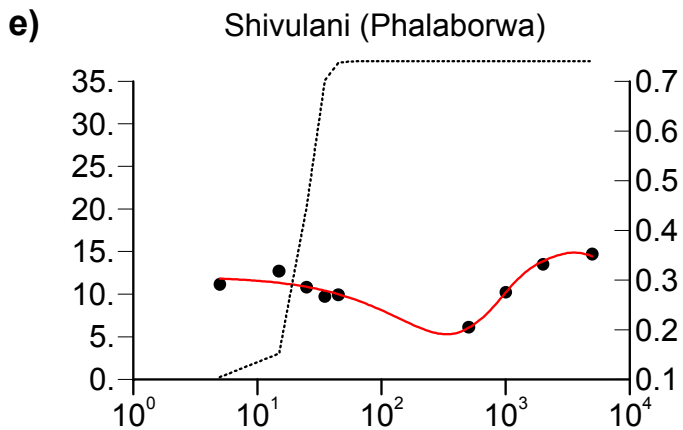
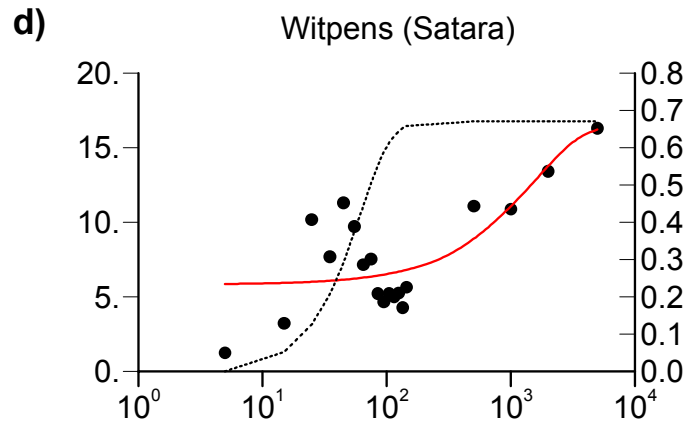
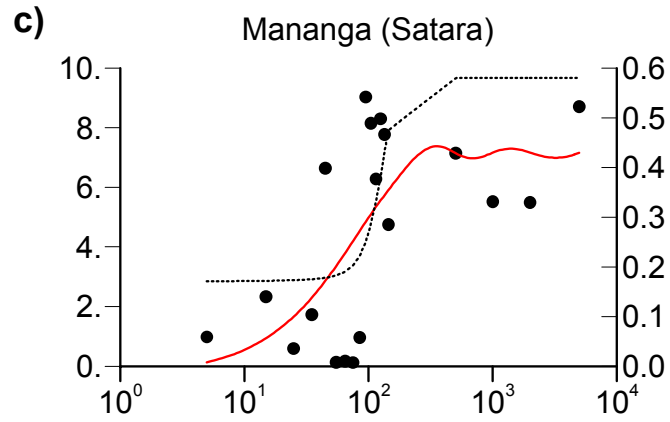
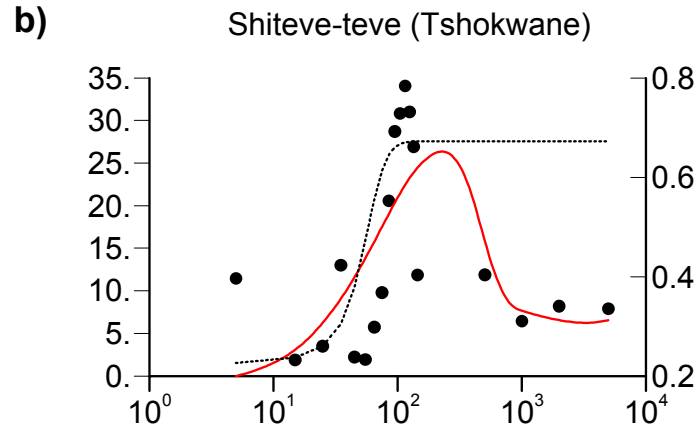
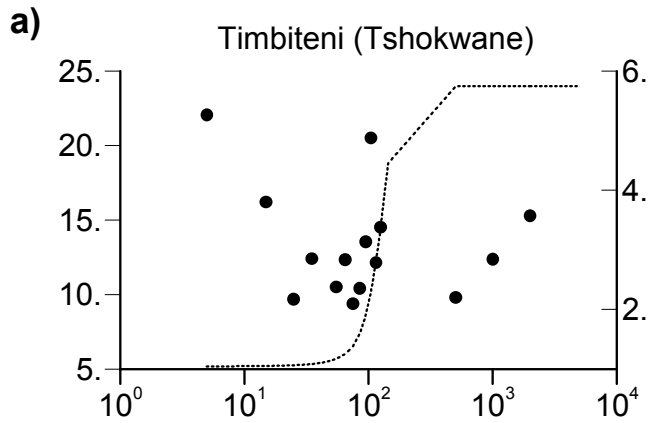


**Distance from Water (m)**

**Closed  
Waterholes**

**Basal Cover (%)**

Basal Cover (%)



Distance from Water (m)

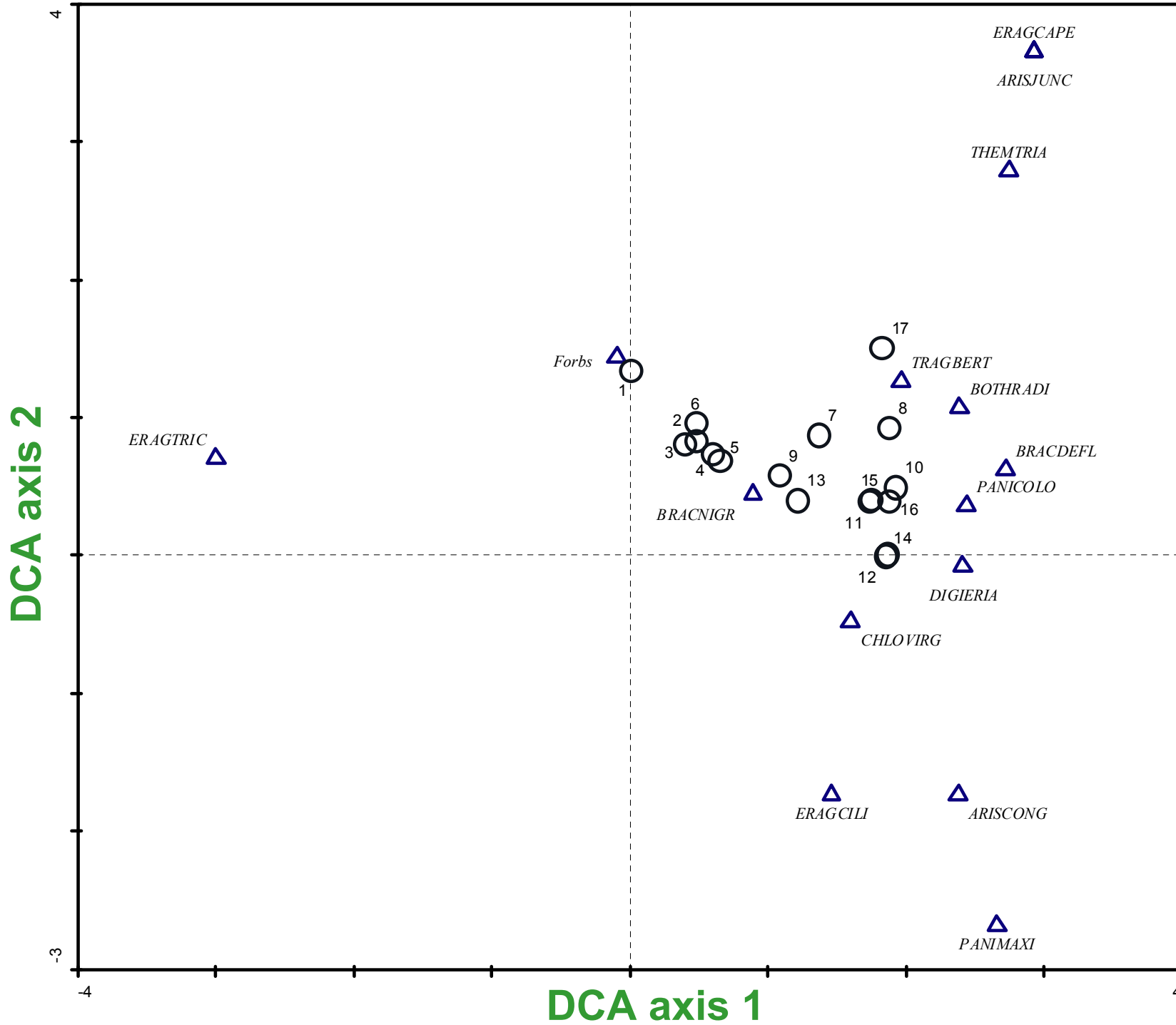
Open

# Herbaceous plant composition

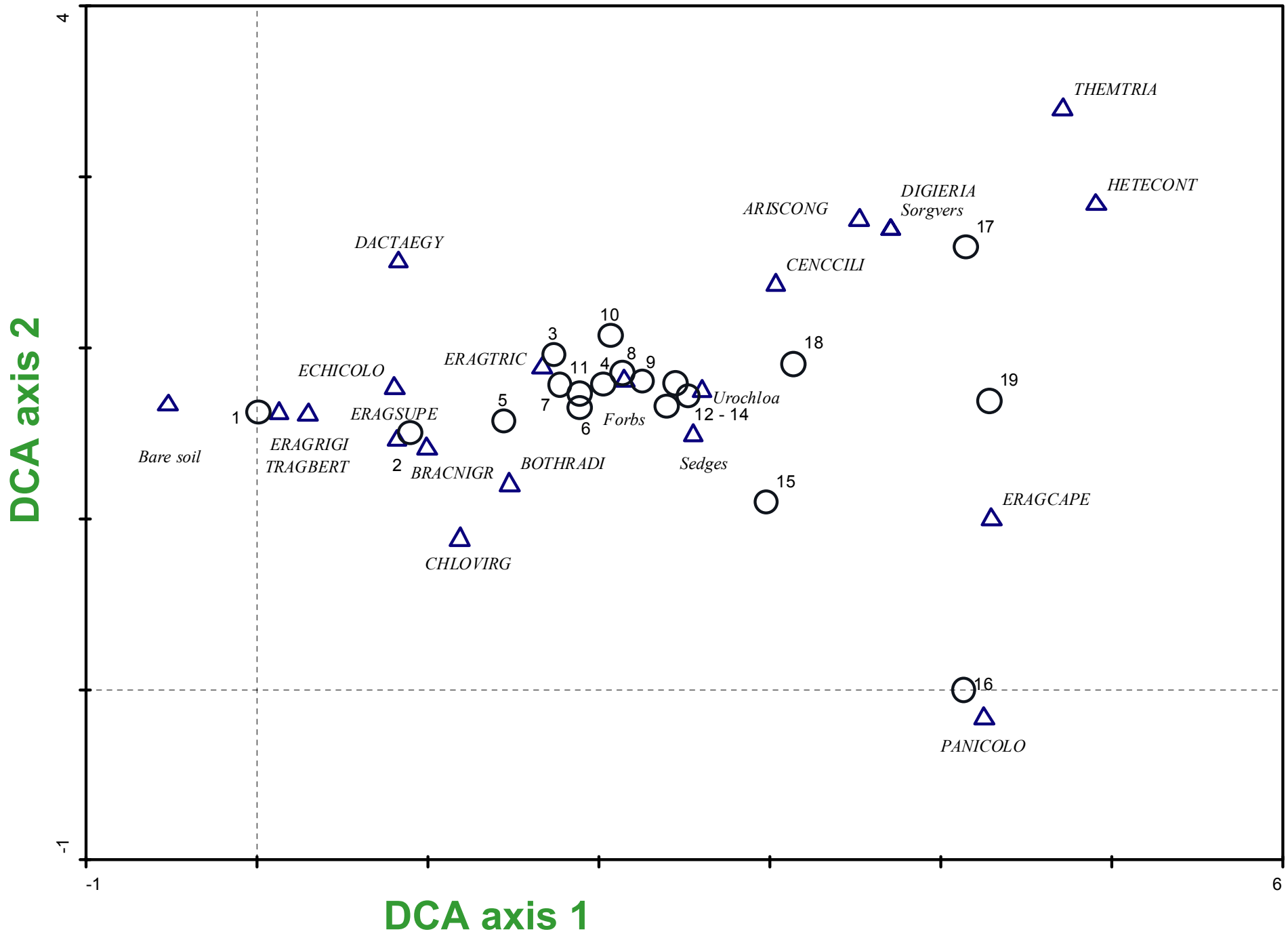
- Reanalysis of Thrash data
- DCA – axis 1 scores & dist from water
- Regression analysis – again, highly variable responses (btwn years/sites) & no generally applicable model
- 7/9 sites: sig. change in spp composition between years

- In general decrease in forb abundance overall, but esp. close to waterhole
- Capricorn: *Cenchrus ciliaris* increases ( $\pm 150$  % along most of the gradient)
- Increase in abundance of *Panicum coloratum*, *Dactyloctenium aegyptium* & *Urochloa mosambicensis* overall at most sites
- Definite increase in “Decreasers” spp (e.g. *Themeda triandra*, *Digitaria eriantha*) at closed sites, esp. btwn 500 – 5000 m.

# Witpens (Satara ) 1990 open



# Witpens (Satara) - 2006



| <b>Species</b>                      | <b>Negative linear</b>  | <b>Positive linear</b>           | <b>Peak 10 – 100 m</b>                            | <b>Peak 100 – 500 m</b> | <b>Peak 500 – 1000 m</b> | <b>Bimodal</b> | <b>Other</b> |
|-------------------------------------|---|----------------------------------|---|-------------------------|--------------------------|----------------|--------------|
| <i>Brachiaria nigropedata</i> 1990  |   | Tihongonyeni                     | Capricorn, Mananga, Manzimhlope, Marheya, Witpens |                         |                          |                |              |
| <i>Dactyloctenium aegyptum</i> 1990 |   |                                  | Tihongonyeni                                      |                         |                          | Timbiteni      |              |
| <i>Dactyloctenium aegyptum</i> 2006 | Mananga, Manzimhlope, Marheya, Marhumbeni, Shiteve-teve, Tihongonyeni |                                  |   |                         |                          |                |              |
| <i>Panicum coloratum</i> 2006       | Manzimhlope   |                                  |   | Capricorn, Witpens      | Marhumbeni               |                |              |
| <i>Tragus berteronianus</i> 1990    | Capricorn, Marheya  |                                  |   |                         |                          |                |              |
| <i>Tragus berteronianus</i> 2006    | Witpens   |                                  |   |                         |                          |                |              |
| <i>Themeda triandra</i> 1990        |   | Mananga, Witpens                 |   |                         |                          |                |              |
| <i>Themeda triandra</i> 2006        |   | Capricorn, Shiteve-teve, Witpens |   |                         |                          |                |              |
| <i>Urochloa mosambicensis</i> 2006  | Capricorn, Wik-en-Weeg  |                                  | Manzimhlope, Tihongonyeni                         | Marhumbeni, Shiteve-eve |                          |                | Marheya      |

# The Logistic Regression Model

- Universality as a biosphere model questioned
- Typical biosphere zonation not present at most sites (esp. 2006)
- Conclusion supported by other work (eg Derry & Morris *in prep*) → estimations of biosphere extent using logistic model on average twice that estimated using a 'best fit' model (exponential decay better)
- Purpose of modeling exercise – managerial, explanatory, prediction, etc.

# The future

- Include site pairs (open/closed) that incorporate a longer rainfall gradient
- Increase replication at regional/local (site) scales
- Catenal position
- Herbivore utilization pressure
- Distance to next nearest permanent waterhole
- Repeat sampling across a wider temporal scale → capture year-year variation → stability issues
- Prediction → model recovery (changes in sensitivity (slope) and extent (zonal boundaries), taking environmental/managerial predictors into account

# Acknowledgements

- **Andrew W. Mellon Foundation and the National Research Foundation – project funding**
- **Supervision: Kevin Kirkman, Craig Morris and Mike Peel**
- **KNP Project co-ordinator: Holger Eckhart**
- **Scientific Services staff: Nick Zambatis, Navashni Govender, Judith Kruger, Sandra MacFayden**