

Elephant impact on vegetation and habitats: are there indirect consequences for other ungulate species

The Team

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Issues

- Changes in vegetation structure
- Changes in species composition
- Changes in habitat structure
- Effects on other herbivore species?

Some ideas in the Tsavo story

Habitat change between late 60s and early 80s

- *Acacia tortilis* > 1 m decline by 65%, but saplings remain in high density
 - Baobad were extinct by 1974, 20 years after the first recorded damage
 - *Sterculia* spp. were also heavily impacted
 - *Commiphora* spp. reduced from 90/ha to 5/ha
- *Commiphora*-dominated thicket turned into grasslands with scattered trees over more than 4400 km²

Ungulate community changed also

Browsers: Lesser kudu ↓ 90%, gerenuk ↓ 80%; giraffe ↓ 40%

Grazers: Zebra, oryx and Grant's gazelle ↑

later, at low elephant densities : reverse pattern for grazers

Mana Pools NP - 1994



Communal Land

FENCE
(1968)

National Park



Selective herbivory - plant species

- Addo - geophytes and dwarf succulent shrubs 43% reduction in endemics (Moolman & Cowling 1994) and continuing loss of endemic species (Lombard et al 2001)
- Amboseli >50% loss of plant species?
- Chobe - no species lost but mostly loss of tall trees (*Acacia* sp & *Combretum* sp); 70% of all trees within 2 km from the river showed browsing scars; Increase in shrub species (e.g. *Caparis tomentosa*); Overall woodlands declined and shrublands increased, mostly within 8 km from the river (Skarpe et al 2004)
- Mana Pools escarpment woodlands – no woody species lost but 50% fewer canopy tree species in impacted woodland (Cumming et al 1994)

Elephant & Vegetation and habitat change

• Biodiversity

- patrimonial plant species
- habitats for endemics (plants & animals)

• Ecosystem functions

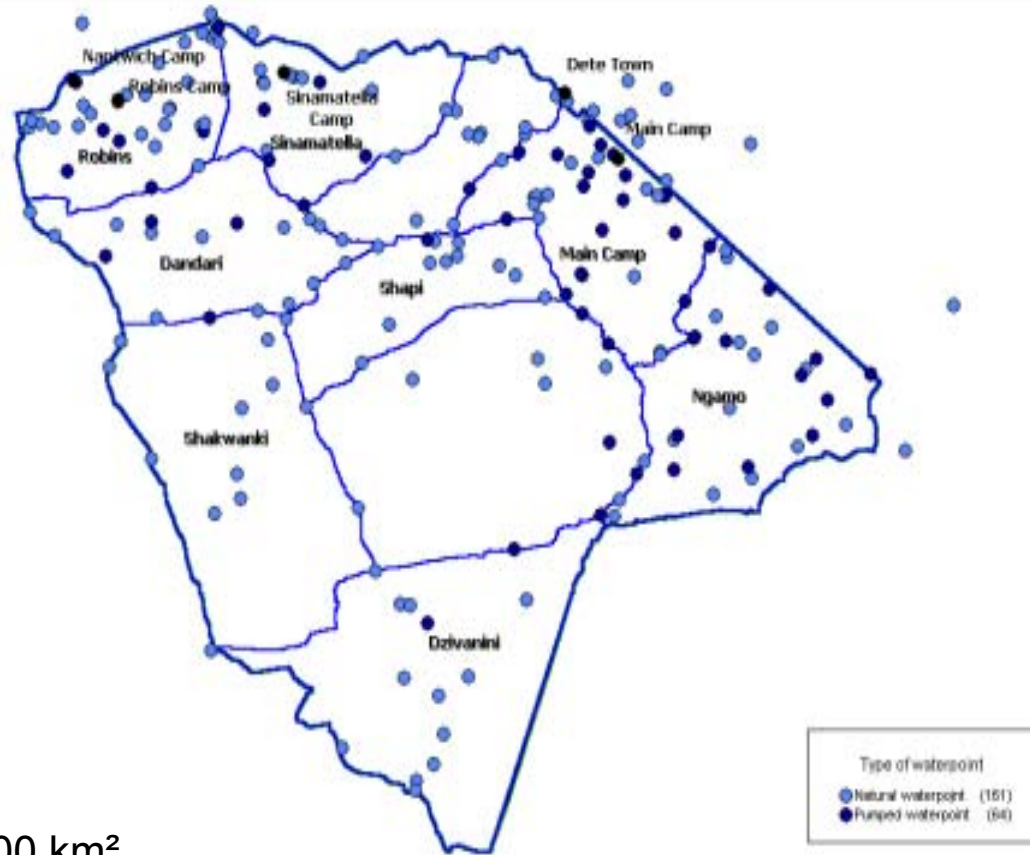
- primary production
- nutrient uptakes & cycles

• Habitat for other herbivore species

- resource access
- predation risk



What can Hwange National Park bring to the debate?

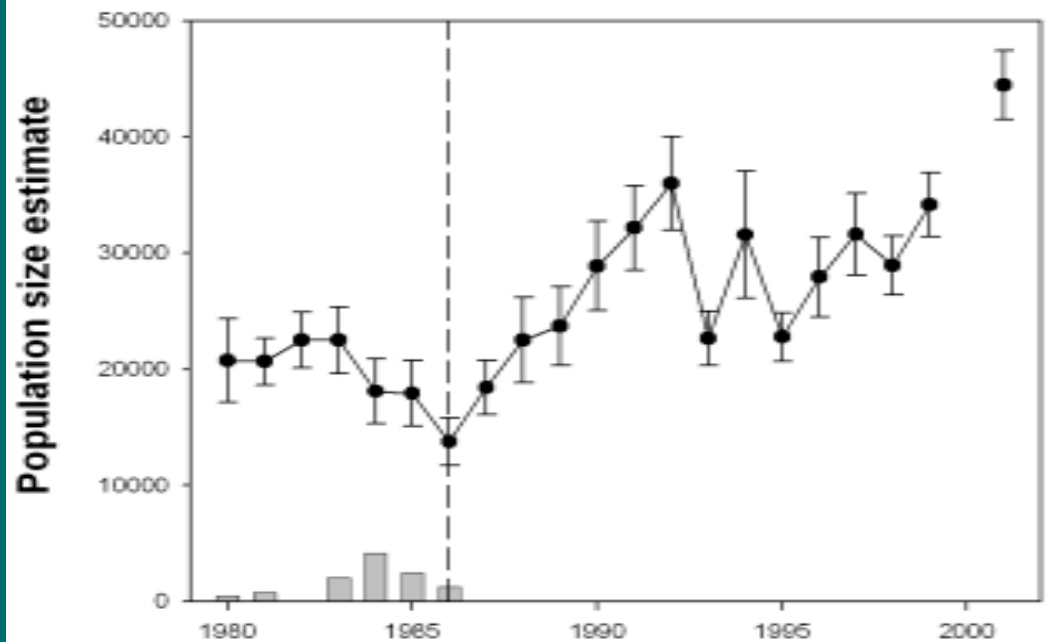
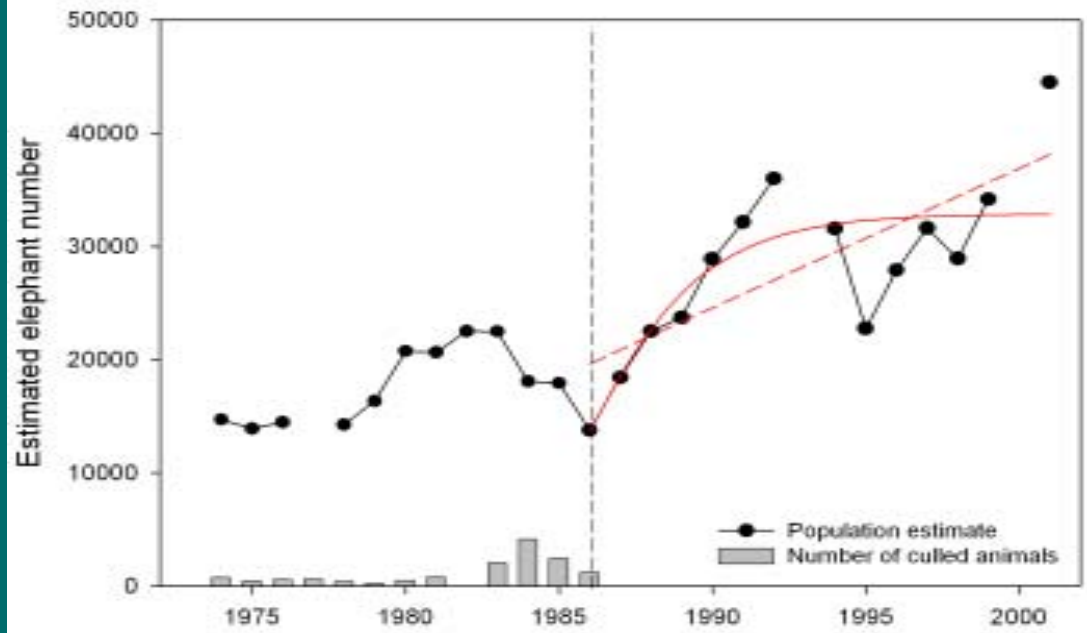


- Singular elephant situation
- Data on damage (comparison)
- Ecosystem functioning (ongoing + to come)
- Exploration of indirect effects (competition for water, habitat use)

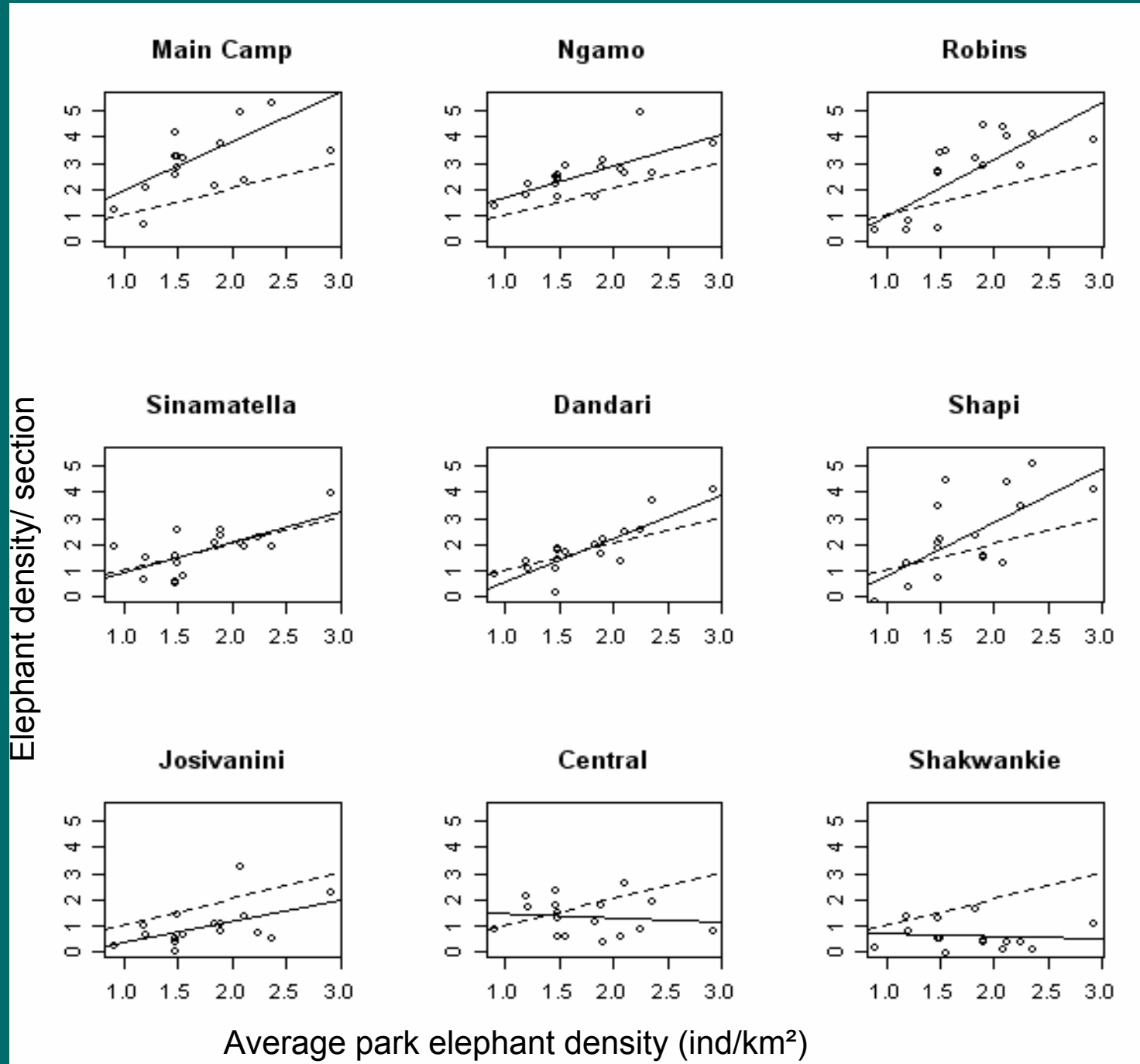
~15000 km²

570-620 mm annual rainfall
average

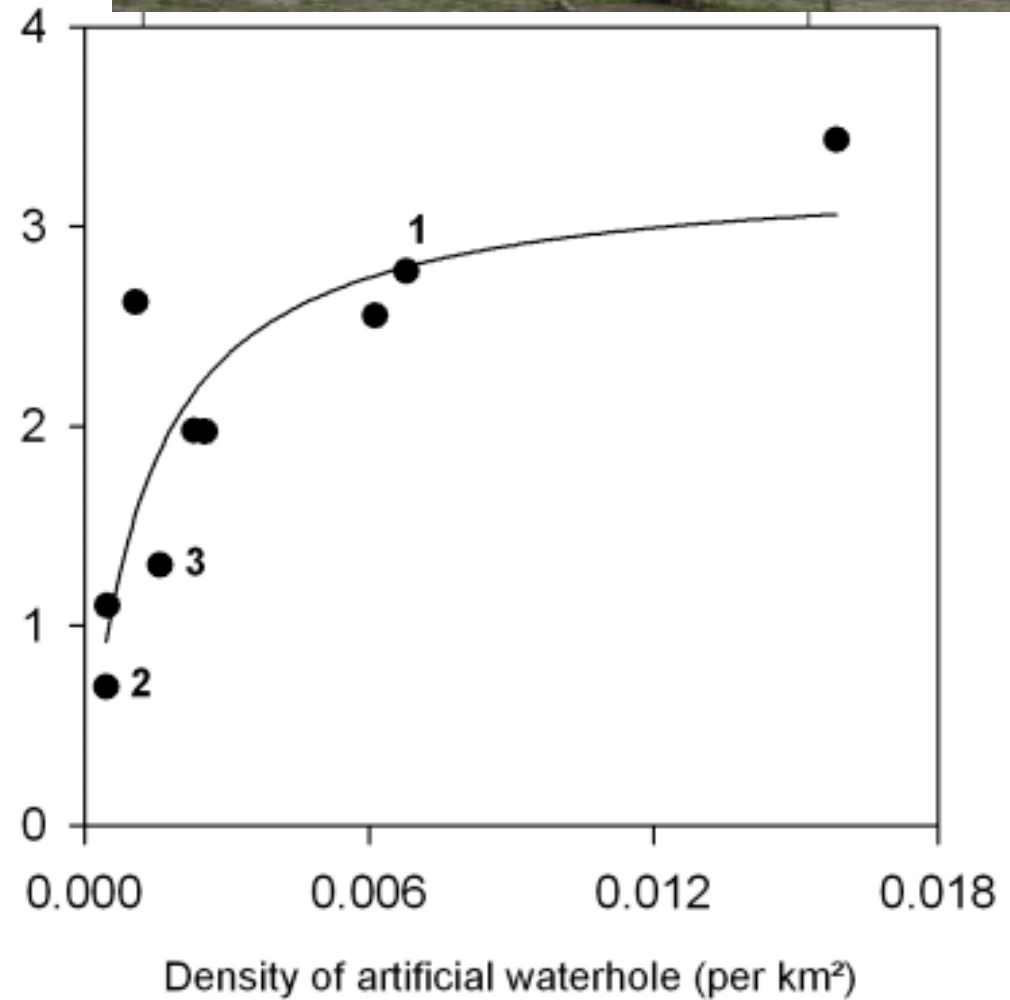
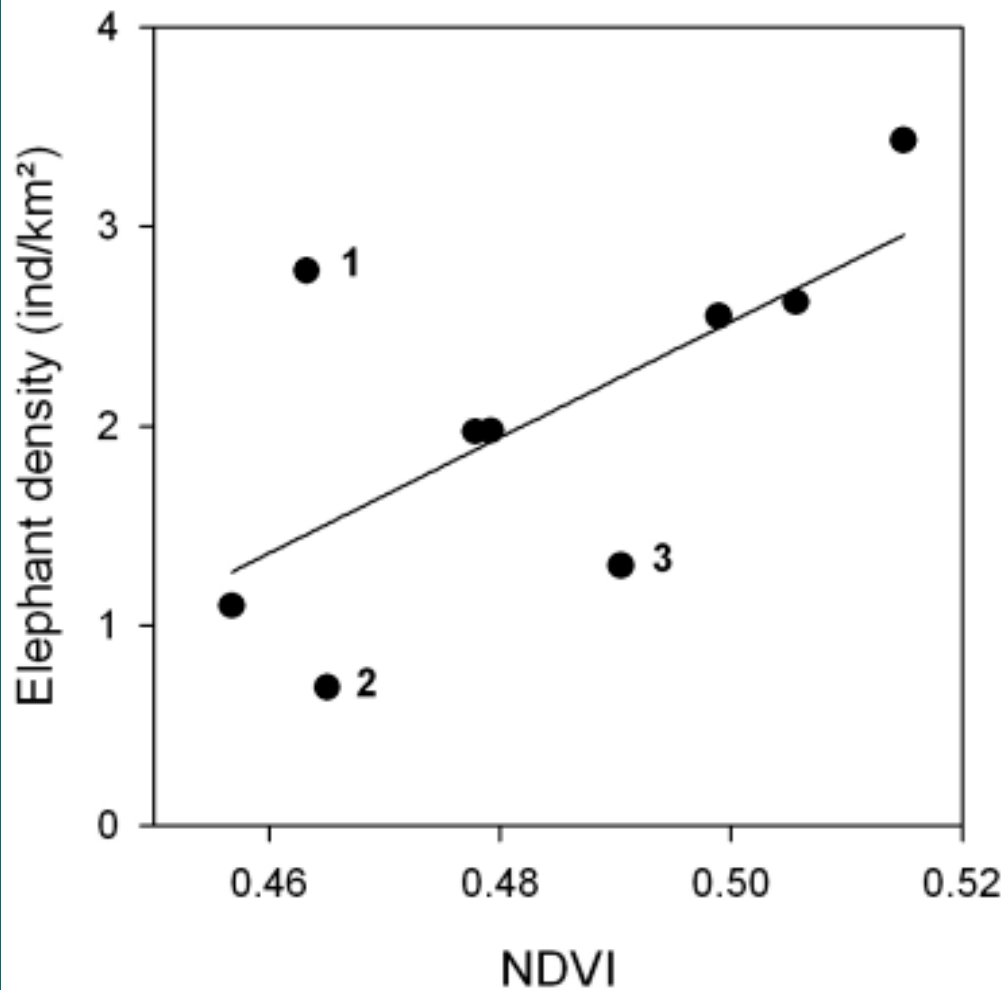
400-650 geographical range in AR



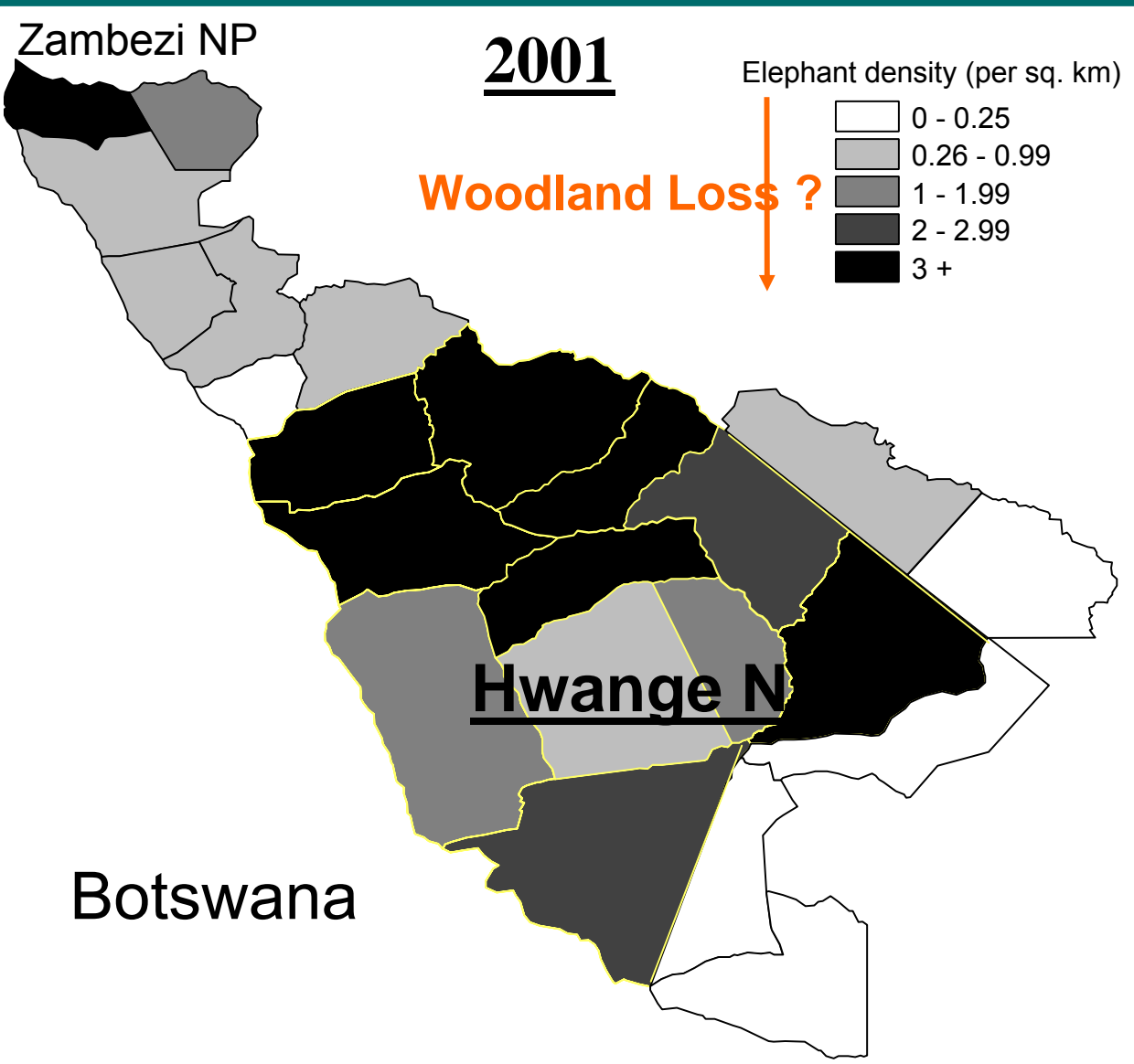
The dynamics is heterogeneous in space and time



Weakly coupled with NDVI,
strongly (limiting?) with surface water



Today we are mapping changes (72/73 – 82/83 - 98)

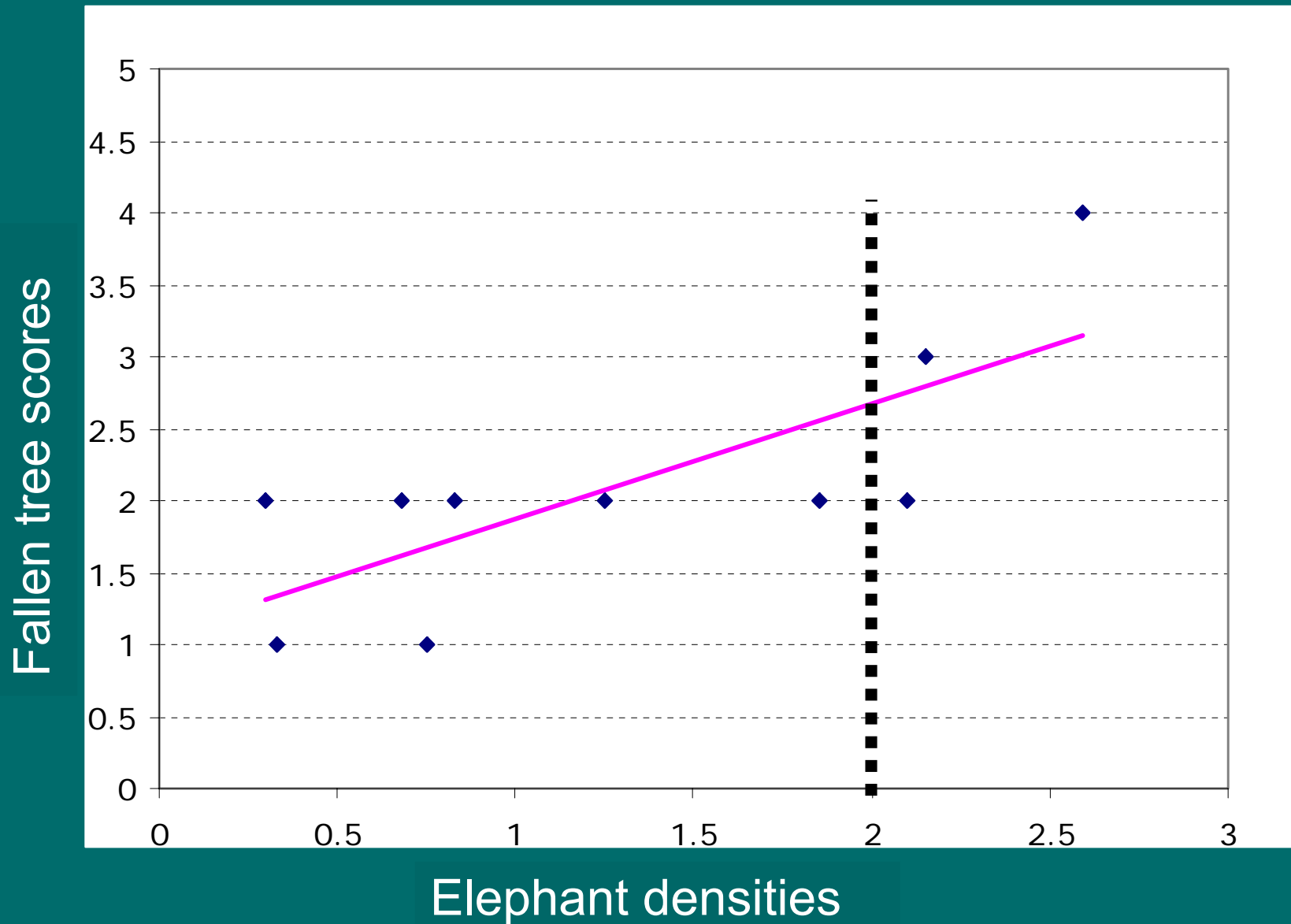


. % Woodland/Bushland/Grassland same 1980 – 1994, but spatial distribution changed (partly in relation to elephant densities)

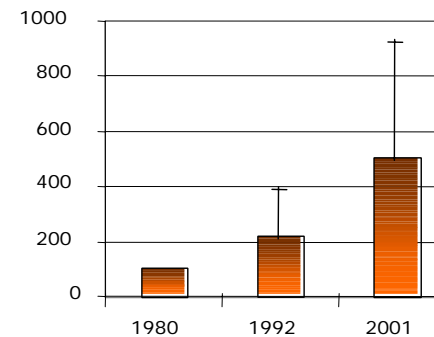
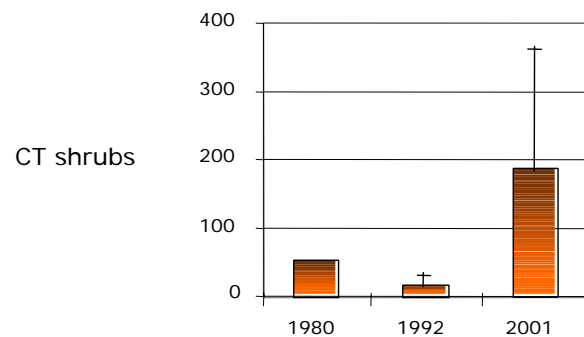
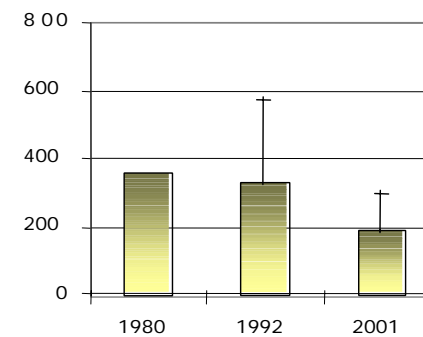
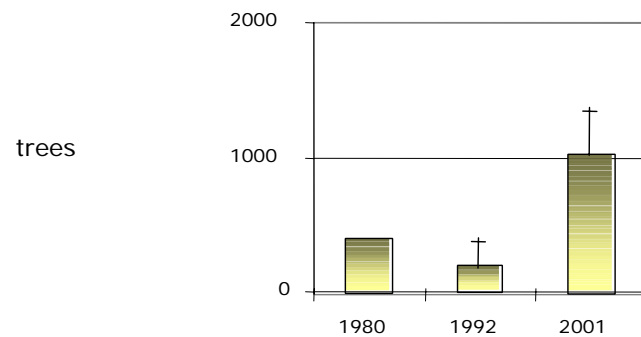
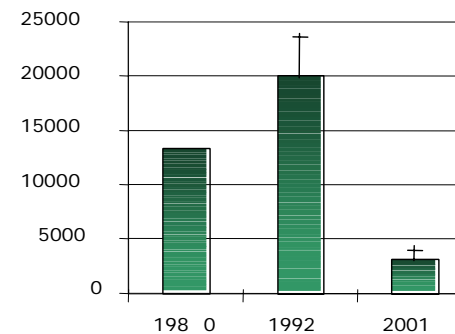
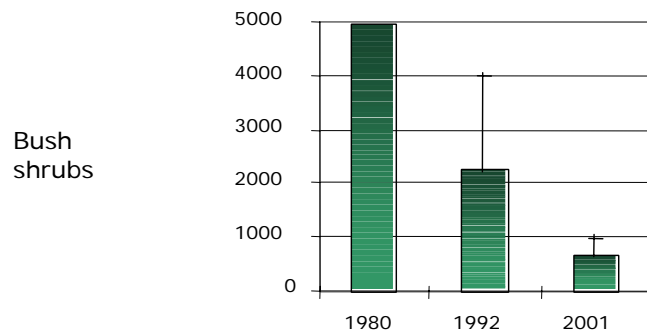
. First analyses on 8x8 km NDVI show no decreasing trend of primary production besides that related to rain

. Concern is the loss of nutrient pumps with the loss of mature trees in the Kalahari sands

Hwange National Park – early 80s (Cumming unpublished)

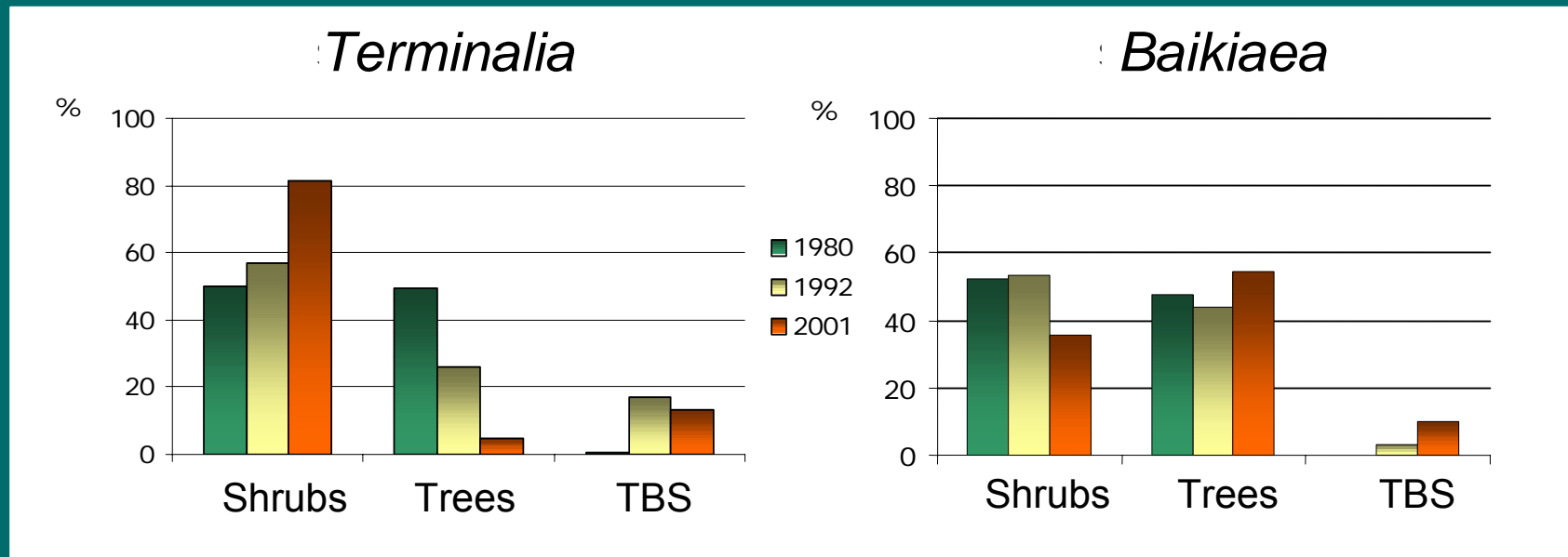


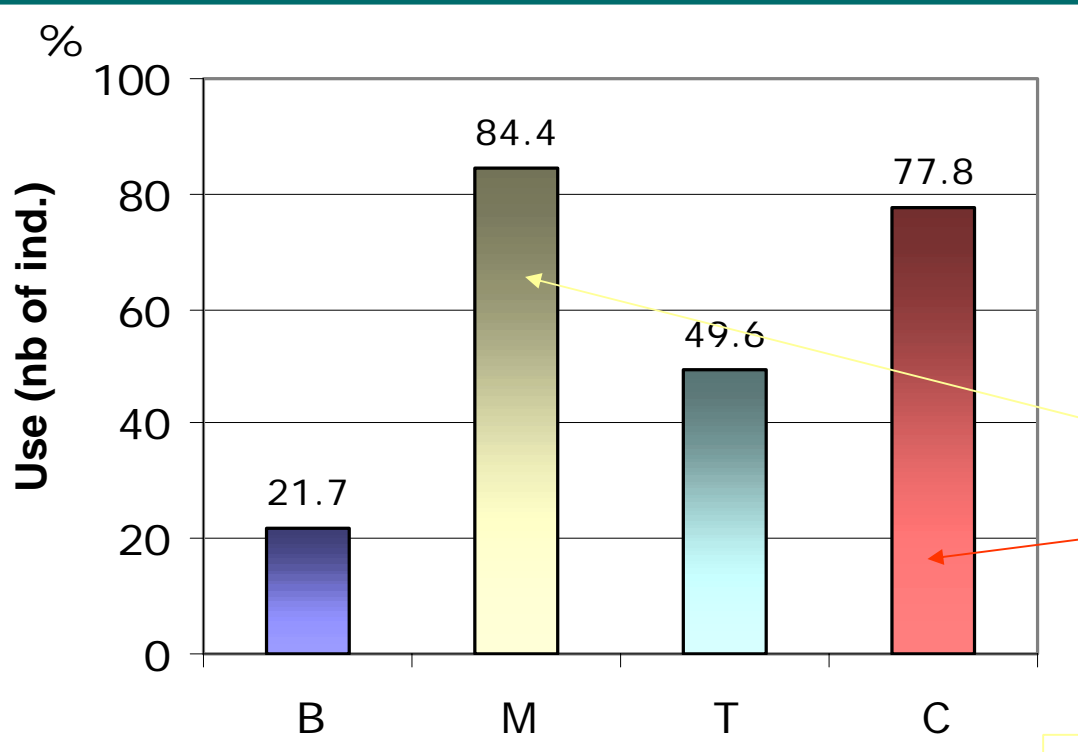
| Density (/ha) | Site Bc | | Site Tc |
|---------------|---------|-------|---------|
| Density | 1980 | 5 416 | 13 761 |
| Total ind | 1992 | 2 473 | 20 552 |
| | 2001 | 1 870 | 3 736 |



Elephants
15000
32000
45000
(Max values)

Different responses of age/growth classes to changes in elephant densities





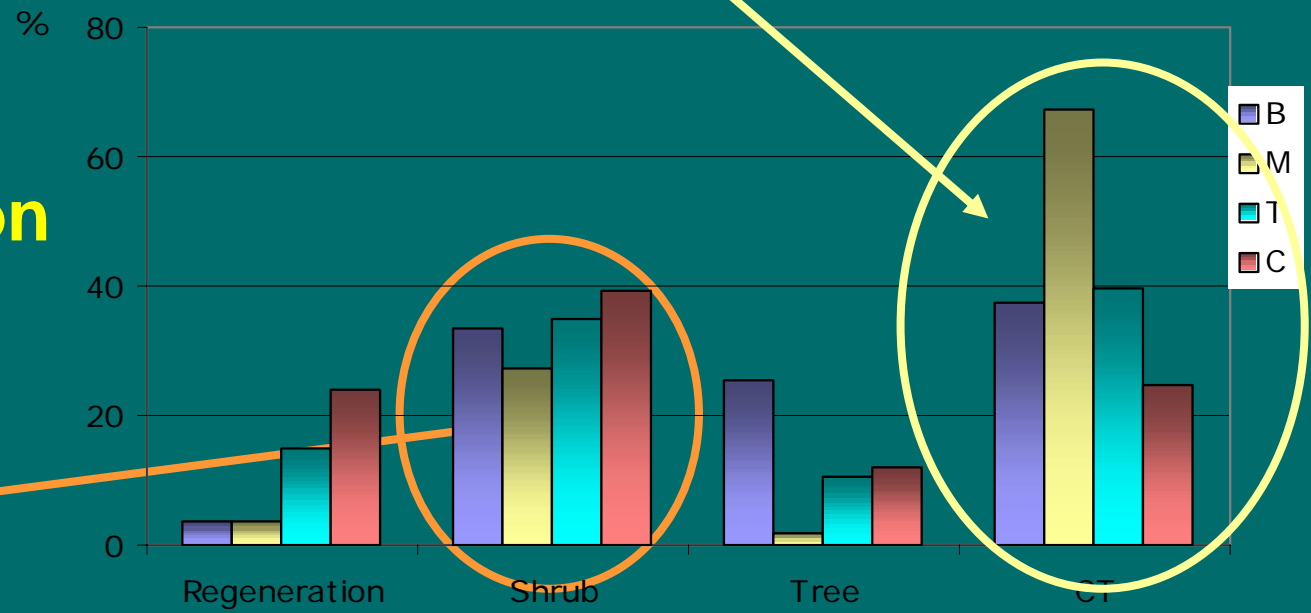
Proportion of woody plant individuals used differed between habitat types

Mopane & Combretum
More used

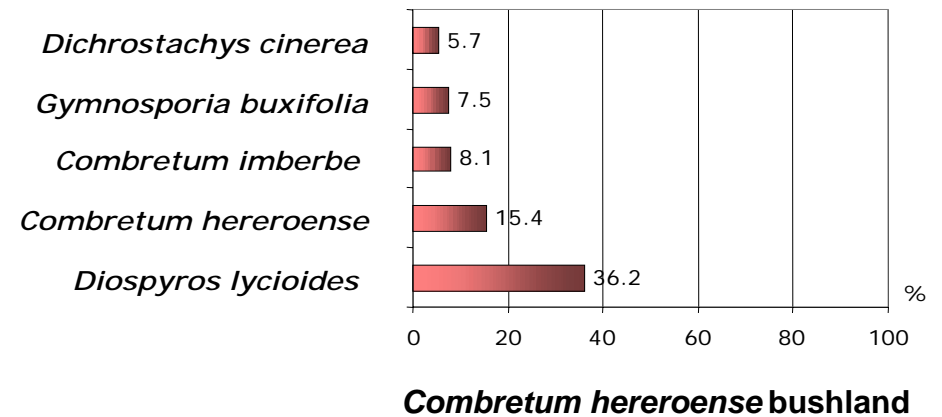
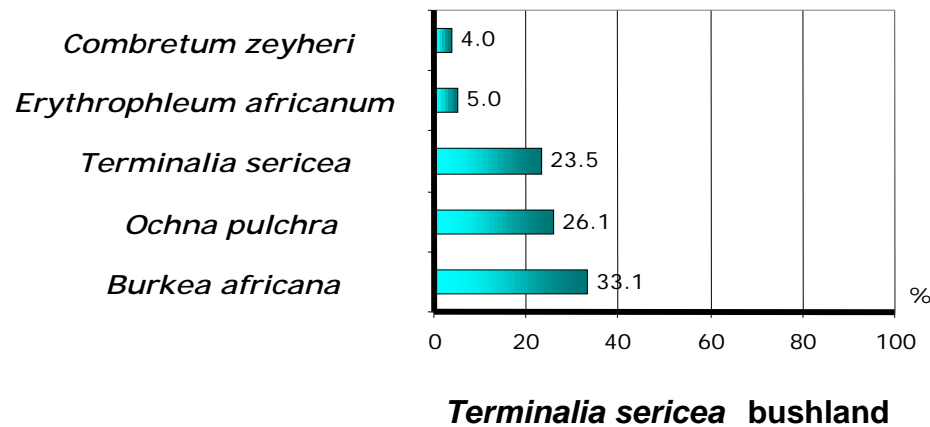
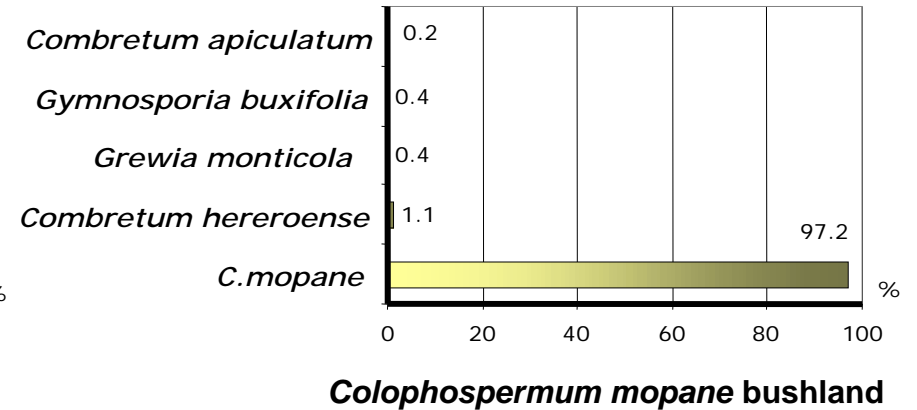
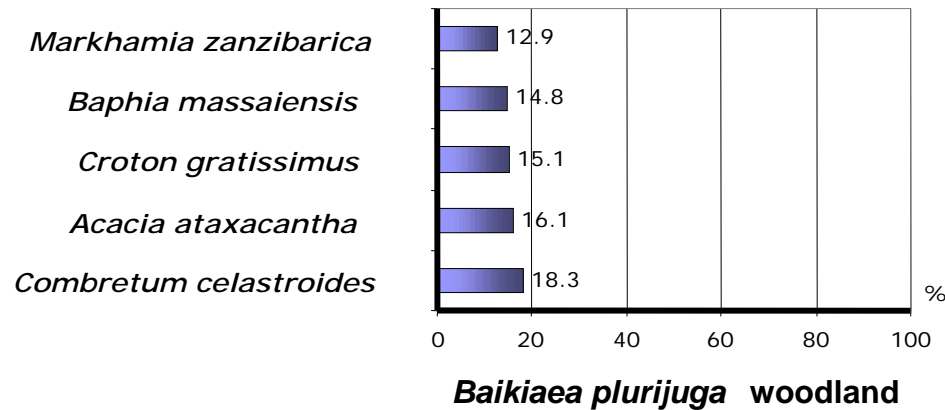
Converted trees

The use varies with the vegetation classes

Bush



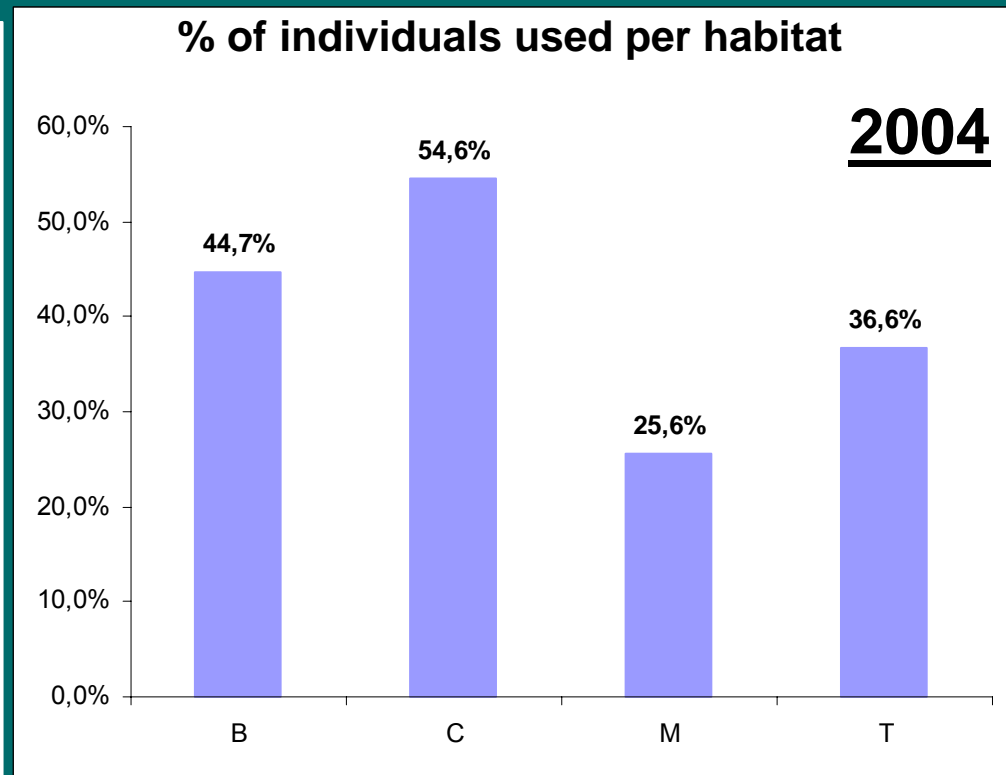
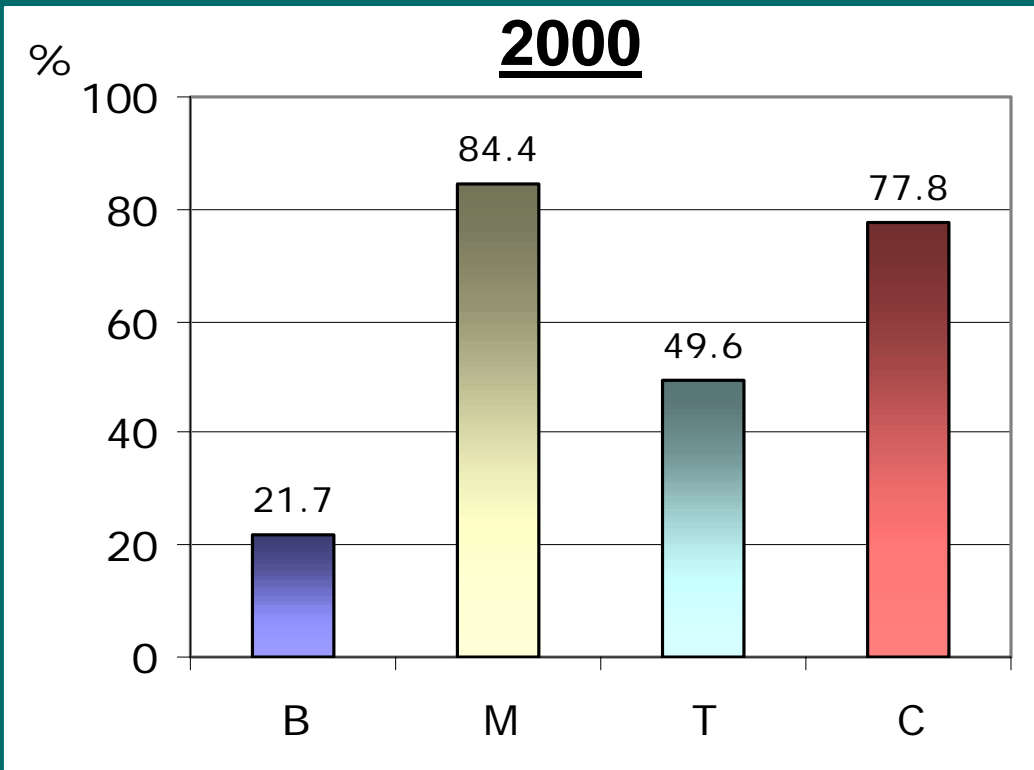
Contrasted effects on species in different vegetation (habitat) types





4 years after, new visit & new insights

| | B | C | M | T |
|------------|----------|----------|-----------|----------|
| Trees | 357±44 | 501±117 | 128±67 | 544±130 |
| Shrubs/TBS | 1077±455 | 1299±190 | 1261±393 | 1363±262 |
| Saplings | 528±125 | 443±259 | 3200±1943 | 915±81 |



Revisiting old plots from Drew Conybeare (1980s -90/91- 2000)

- With regards to Bushland Trees less than 2km from Water, long term trends showed a marked decline in tree density for all but one species (pulchra) particularly after 1992.
- Tree density was generally higher in plots lying more than 2.5 m from the water source than in those lying less than 2 km from the water i.e. tree density increased in proportion to distance from the water points.
- . Overall densities individuals were fairly stable.
- Causes of changes in vegetation density included rainfall, frost, fire, elephants and the effect of wind. Fire was not a contributing factor. Elephants were found to be the biggest factor in terms of biomass loss accounting for 28% of the loss (38% of the estimated browse annual production – twigs & leaves)
- Frost damage was much more intense on shrubs than on woodlands, particularly in 1980 when frost damage was severe.
- Shrub density tended to stabilise in plots close to water as opposed to those far away from the water where it increased.

For particular plant species

Changes in Shrub density : 1980 = 2002

BUSHLAND SHRUB DENSITY GROUPED PLOTS 1980 - 2002

≤ 2 km from water

> 2 km from water

Year

Year

| Species | 1980 | 1994 | 1992 | 2002 | % Ch | 1980 | 1994 | 1992 | 2002 | % Ch |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Acacia ataxacantha | 242 | 242 | 362 | 145 | -40% | 48 | 28 | 184 | 218 | 350% |
| A. fleckii | 40 | 20 | 60 | 20 | -50% | 182 | 216 | 104 | 256 | 33% |
| Balanites plurijuga | 2676 | 2600 | 510 | 2100 | -18% | 1710 | 1093 | 2280 | 1840 | 7% |
| Baphia massaiensis | 1035 | 1270 | 1855 | 3480 | 236% | 4869 | 5300 | 5240 | 3800 | -22% |
| Bauhinia petersiana | 630 | 430 | 405 | 100 | -84% | 1877 | 1532 | 920 | 216 | -88% |
| Burkea africana | 60 | 60 | 100 | 70 | -22% | 377 | 360 | 272 | 96 | -76% |
| Canthium hullense | 0 | 0 | 0 | 0 | | 320 | 120 | 40 | 0 | -100% |
| Combretum collinum | 485 | 410 | 275 | 275 | -43% | 656 | 916 | 640 | 400 | -38% |
| C. psidioides | 200 | 205 | 125 | 270 | -28% | 690 | 720 | 422 | 600 | 2% |
| C. zeyheri | 255 | 260 | 240 | 145 | -43% | 743 | 920 | 440 | 8 | -99% |
| Commiphora angolensis | 60 | 35 | 60 | 0 | -100% | 88 | 48 | 24 | 0 | -100% |
| Crataegus griffithii | 25 | 25 | 25 | 0 | -100% | 0 | 0 | 0 | 0 | |
| C. pseudopulchellus | 2000 | 1875 | 7450 | 5100 | 155% | 1742 | 2313 | 6240 | 2560 | 47% |
| Dichrostachys cinerea | 10 | 0 | 10 | 60 | 500% | 81 | 48 | 55 | 138 | 68% |
| Erythrophloeum africanum | 60 | 118 | 68 | 38 | -61% | 380 | 240 | 260 | 0 | -100% |
| Grewia avellana | 0 | 0 | 0 | 0 | | 0 | 24 | 40 | 32 | |
| G. flavescens | 60 | 10 | 30 | 10 | -83% | 138 | 64 | 200 | 72 | -47% |
| Lonchocarpus nelsii | 10 | 0 | 10 | 40 | 300% | 0 | 0 | 0 | 0 | |
| Ochna cinnabarina | 0 | 0 | 0 | 0 | | 18 | 8 | 0 | 0 | -100% |
| O. pulchra | 700 | 700 | 773 | 487 | -38% | 1135 | 1135 | 272 | 120 | -89% |
| Pterocarpus angolensis | 0 | 0 | 0 | 0 | | 18 | 32 | 0 | 24 | 30% |
| Rhus tanuinervis | 25 | 0 | 25 | 0 | -100% | 104 | 16 | 55 | 8 | -92% |
| Terminalia sericea | 1208 | 833 | 700 | 509 | -58% | 890 | 904 | 550 | 608 | -32% |
| Vitex mombasana | 30 | 30 | 30 | 60 | 100% | 0 | 0 | 0 | 0 | |
| All species | 10078 | 10540 | 13100 | 12914 | 28% | 15959 | 16980 | 18270 | 11058 | -31% |

- Frequency dependent predation
 - negative: when plant rare ⑦ *Risk*
 - Positive: when plant abundant
- Absolute preference
 - Absent from elephant landscapes*

The use of panoramic photographs at waterholes

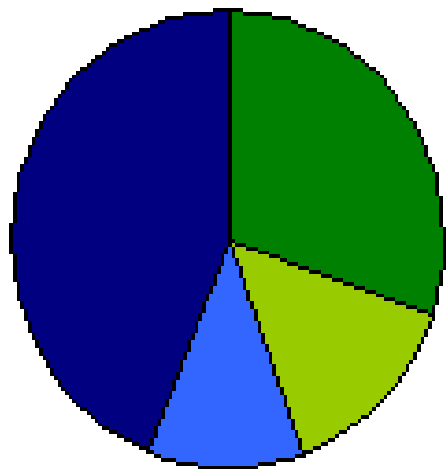


e.g. Caterpillar

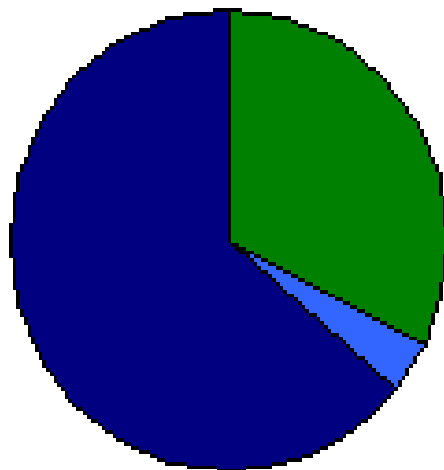




Waterhole



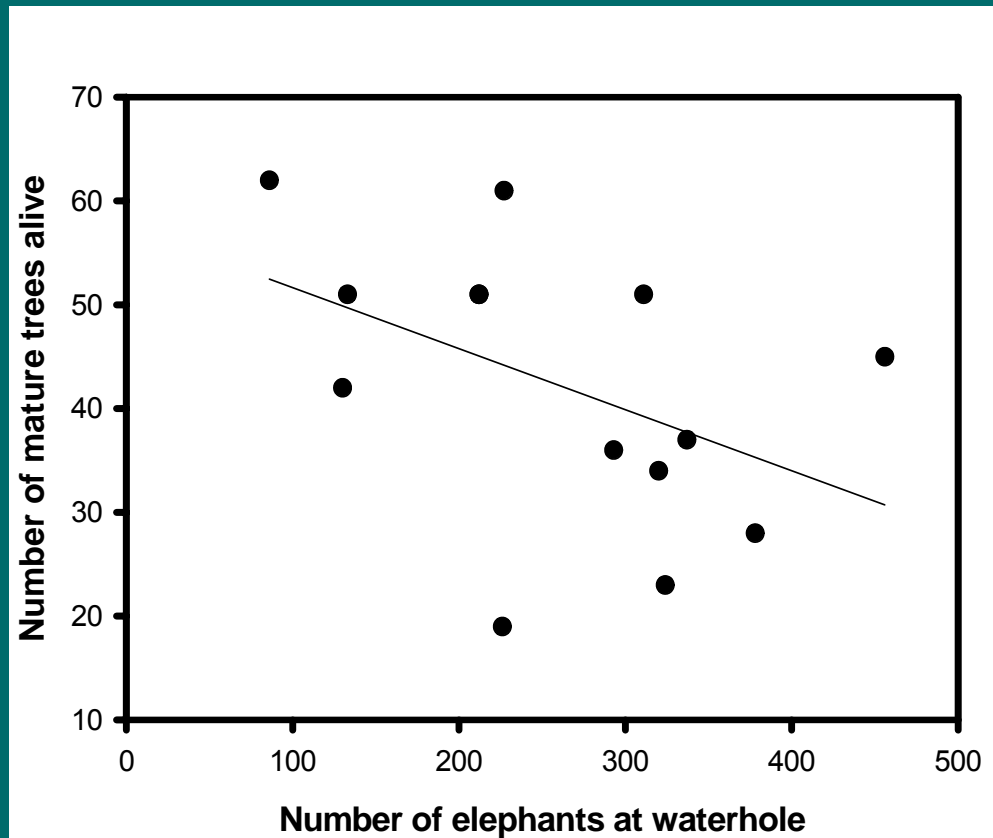
Bush



N=16 waterholes 1970 - 2005

Standing alive
Standing dead

Disappeared
Fallen dead

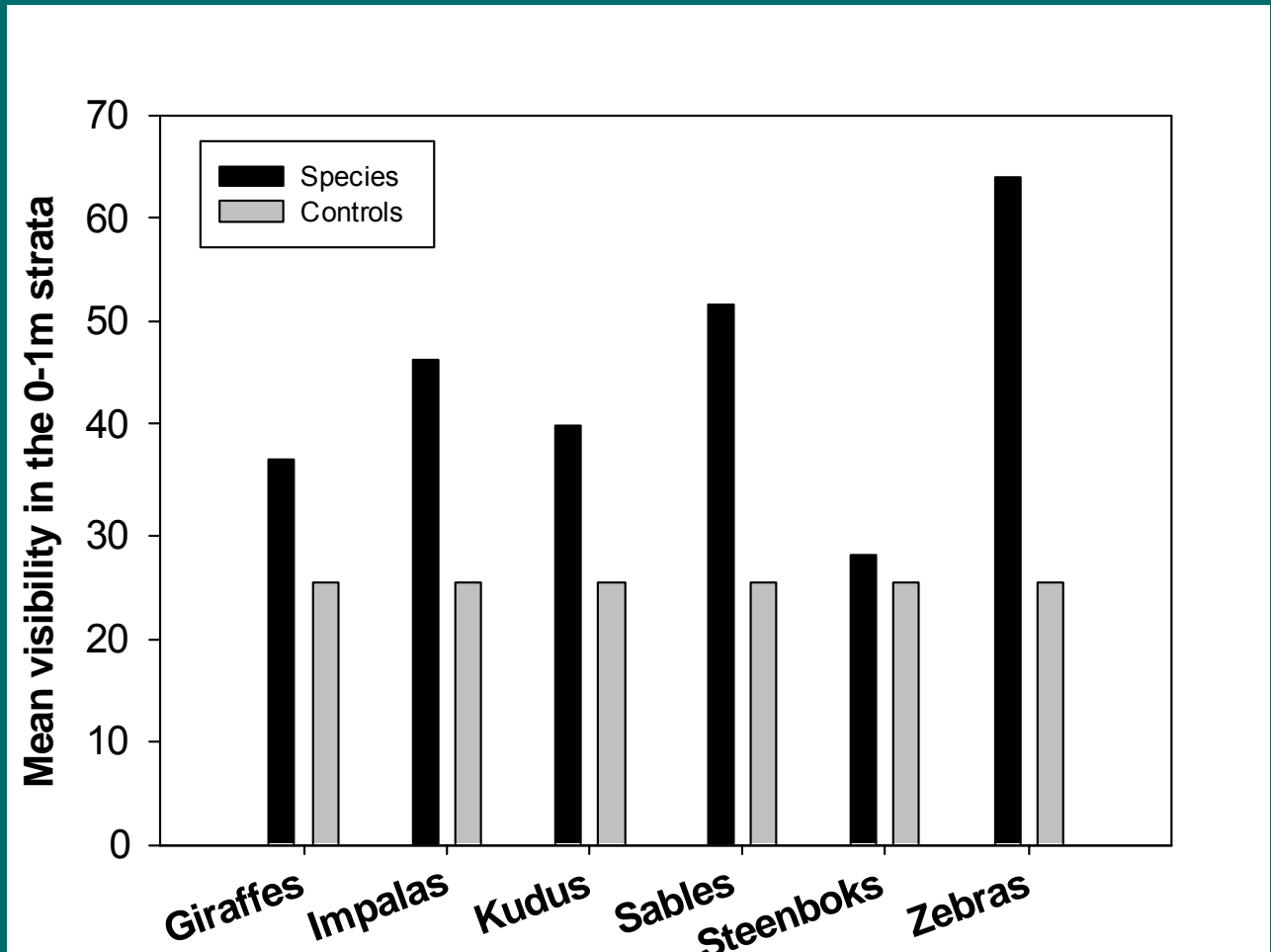


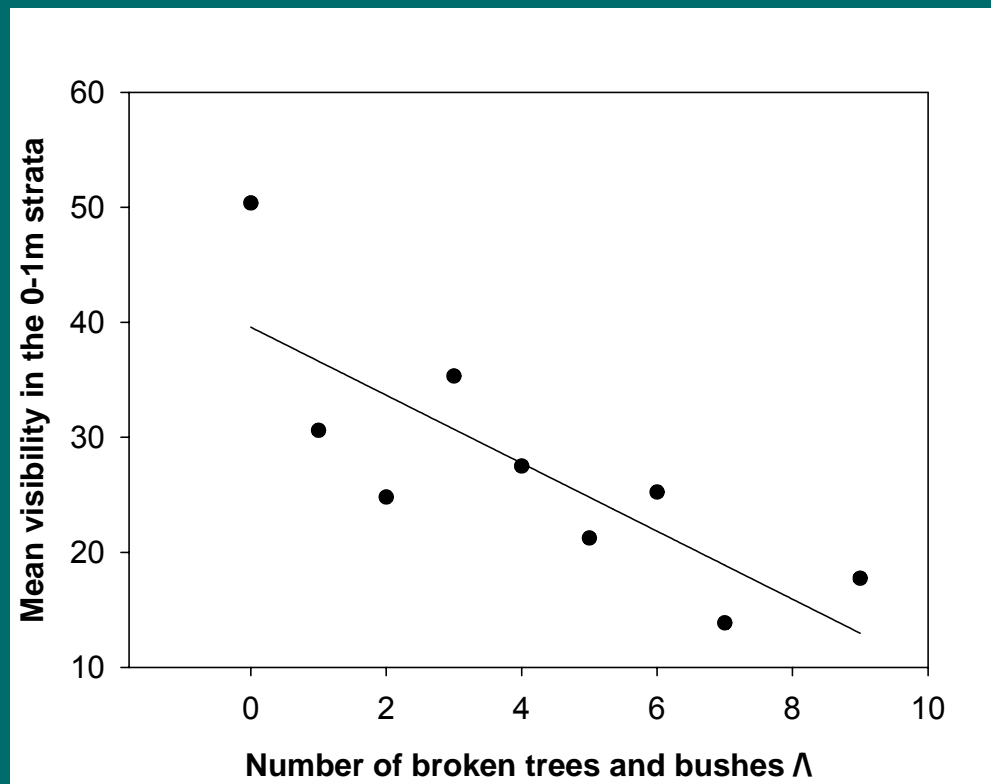
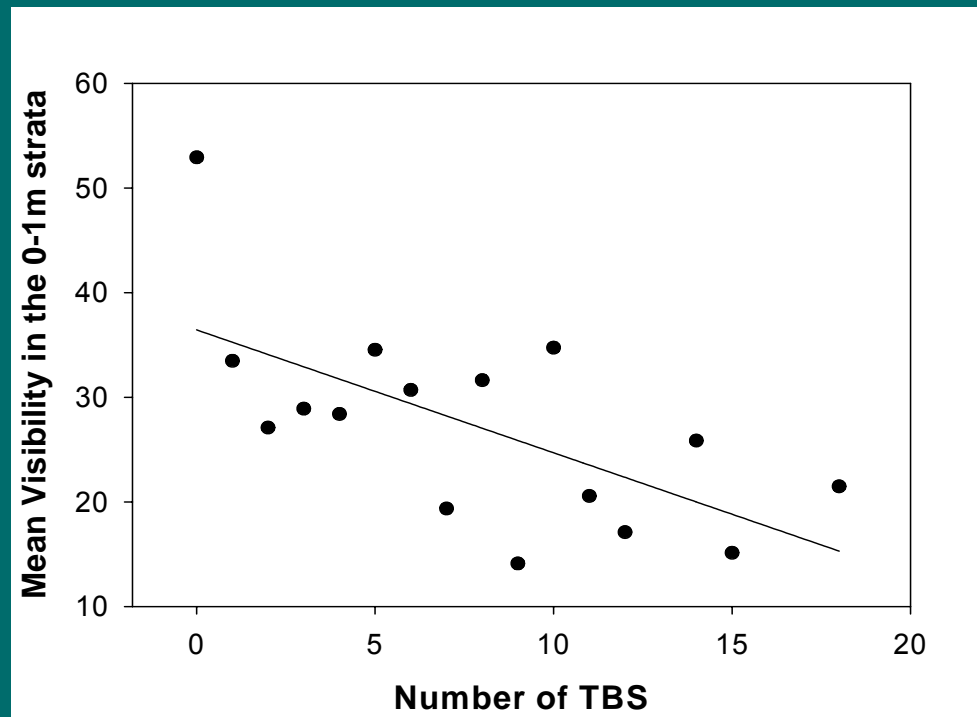
Secondary effects on animal species

- Chobe – increases in some species, none lost
- Amboseli – browsers lost
- Hwange – browsers & water dependent grazers declining (could be elephants?)
- Tsavo – browsers declining and grazers increasing
- Kruger – none lost (but high proportion of vertebrates depend on large trees?)

Microhabitat characteristics in relation to elephant damage and responses from mesoherbivores

(Here the predation hypothesis)

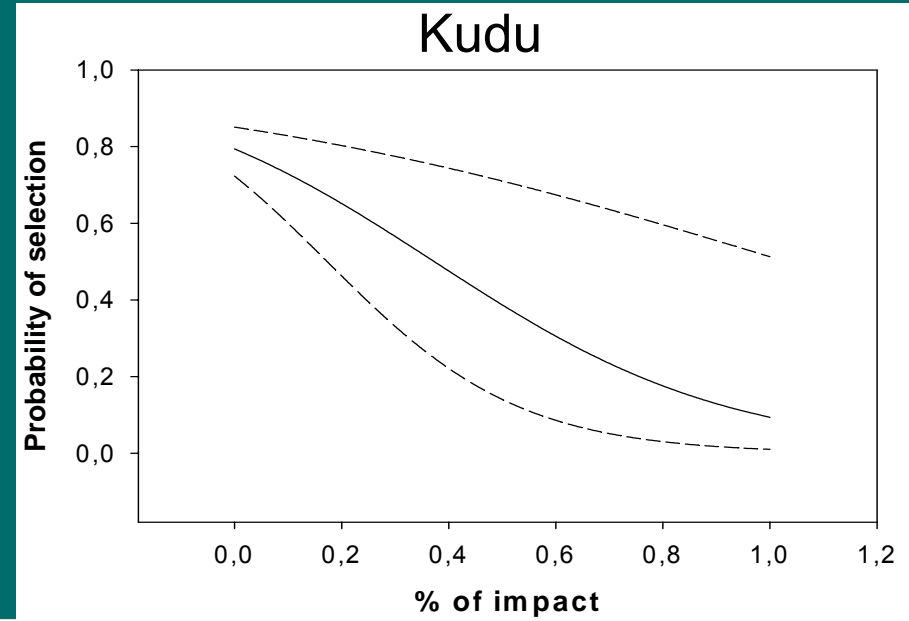






| | <i>Trees impacted</i> | <i>Bushes impacted</i> |
|----------|-----------------------|------------------------|
| Kudu | - | avoid |
| Steenbok | - | select |
| Giraffe | - | - |
| Impala | - | select |
| Sable | select | avoid |
| Zebra | select | avoid |

| | <u><i>Avoid</i></u> | <u><i>Select</i></u> |
|----------|---|---|
| Kudu | NS | NS |
| Steenbok | TBS & trees \wedge | broken bushes |
| Giraffe | NS | trees with broken branches |
| Impala | TBS & uprooted trees & trees \wedge | broken trees & bushes with broken branches |
| Sable | \wedge & broken bushes | trees with broken branches |
| Zebra | broken bushes | NS |



| | Global impact | Impacted trees | Impacted bushes | TBS | Broken A |
|----------|---------------|----------------|-----------------|-----|----------|
| Kudu | | | | | |
| Impala | | | | | |
| Steenbok | | | | | |
| Zebra | | | | | |
| Giraffe | | | | | |
| Sable | | | | | |

Negative effect
 Positive effect

Concluding points:

Is this going to be another manager's headache?

No...(few informed guesses at least, suggestions may be!?)

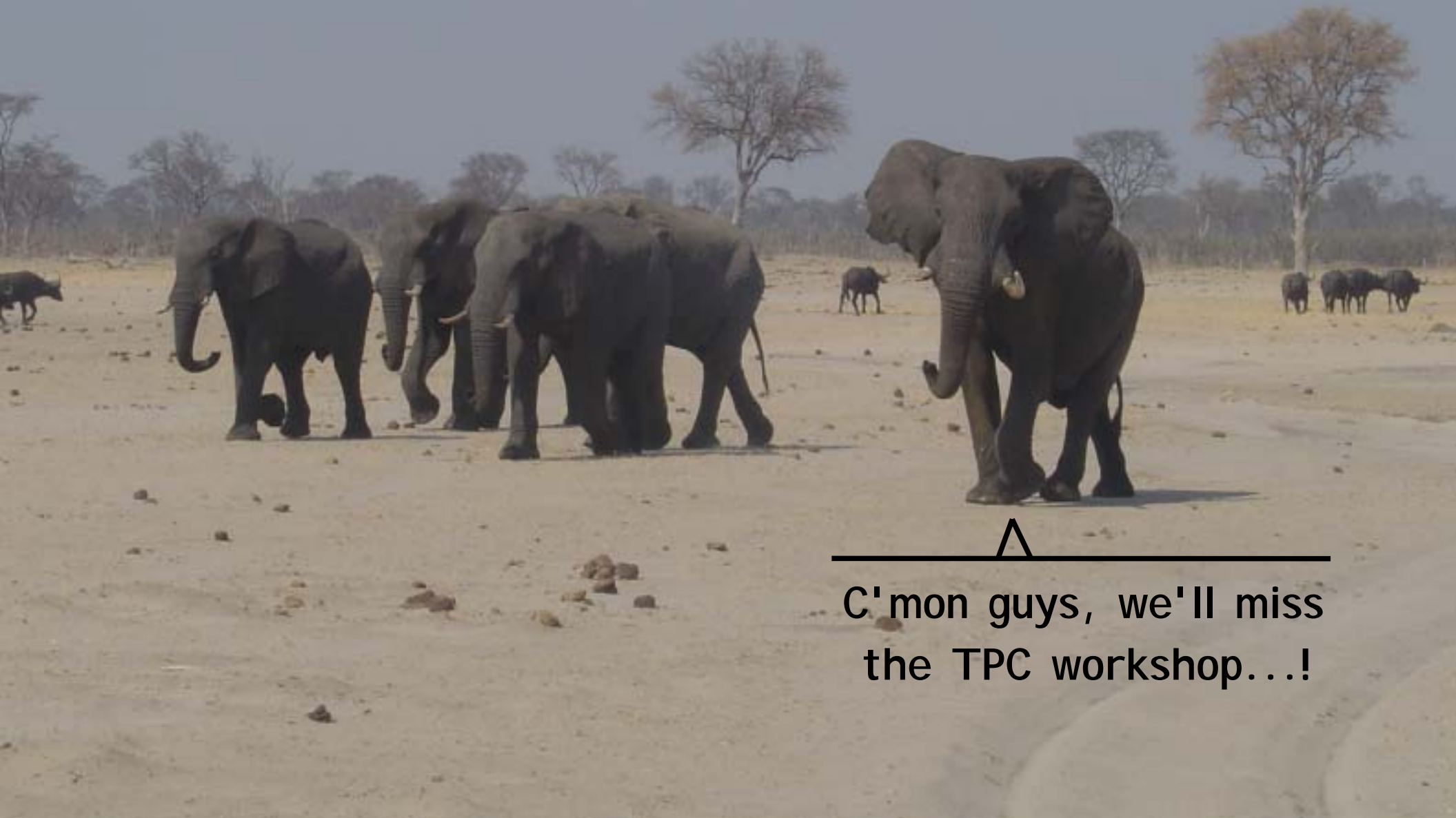
- TPC preferred plants, Dele $\rightarrow 0$
- TPC canopy cover loss Dele $\sim 1/\text{km}^2$
- TPC massive loss mature trees Dele $> 2/\text{km}^2$
- TPC control bush encroachment Dele $\sim 2/\text{km}^2$
(distance to water plays)
- Dele ~ 1.5 no overall change in vegetation type proportion
- Dele $\sim 2-2.5$ does not affect massively regeneration
- Dele > 2 already affects visibility (predation risk)
- Dele $\sim 2-2.5$ density dependent effects (interplay water-food)
- Dele $\sim 1-1.5$ when mesoherbivores decreased

But...

- Spatial heterogeneity
- Loss of mature trees and nutrient pumping
- Dele and competition for water
- (more research in fact!)



Thank you!



△
C'mon guys, we'll miss
the TPC workshop...!

The biomass of herbivore has doubled in Hwange since 1986,
mostly elephants (pop $\times 2.5$)

First analyses show no decreasing trend of primary production besides
that related to rain

Regeneration exist

In nutrient rich savannas, unlimited by water and with significant
graze share in elephant diet (e.g. Manyara), the fluctuations may
be compensatory

Some plant species will never coexist in elephant landscapes (refuges needed)

Bush encroachment may be stabilised by elephant