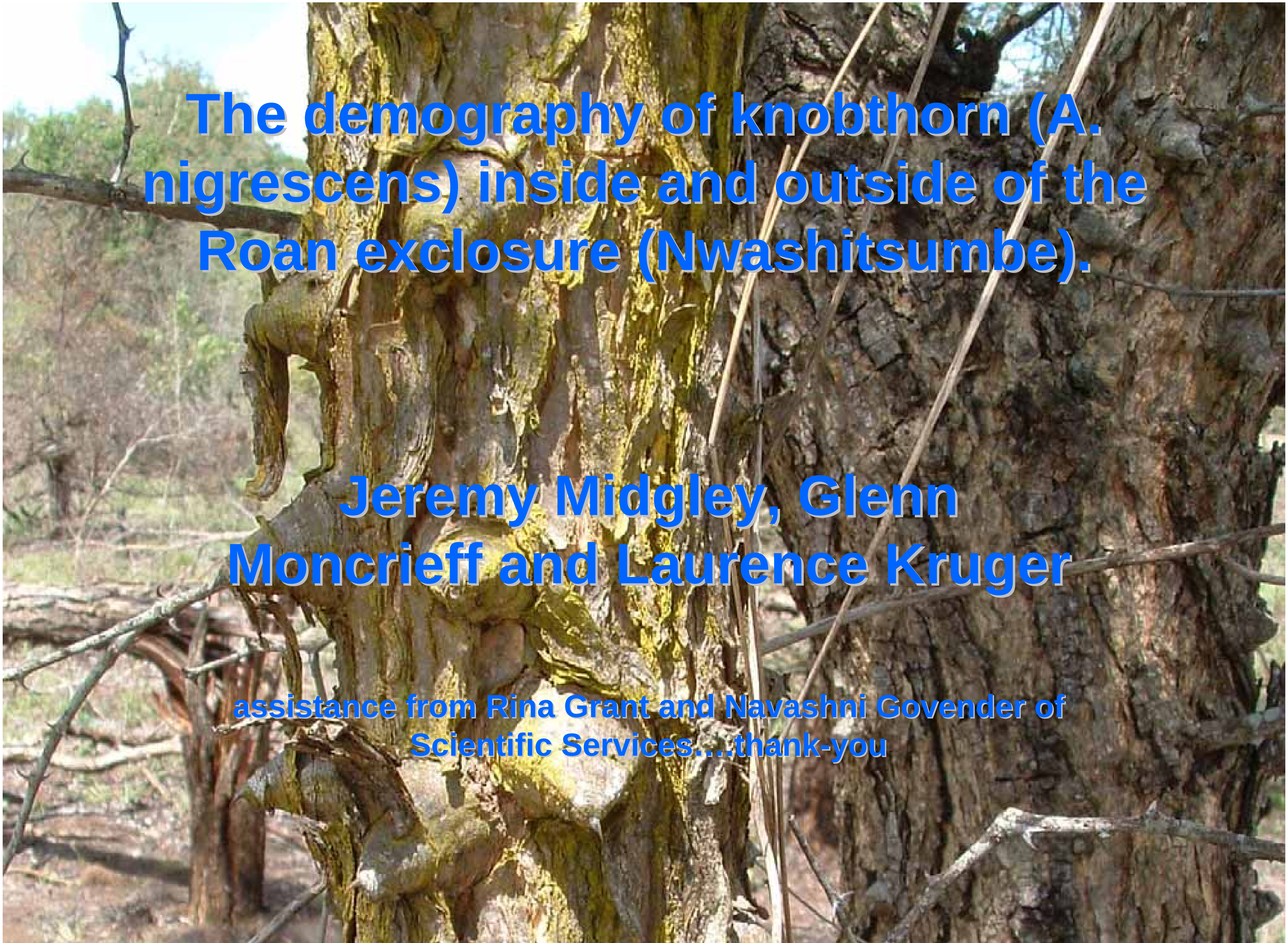

The demography of knobthorn (A. nigrescens) inside and outside of the Roan exclosure (Nwashitsumbe).

Jeremy Midgley, Glenn Moncrieff and Laurence Kruger

assistance from Rina Grant and Navashni Govender of Scientific Services….thank-you

The problem; what are the determinants of woody plant dynamics?

Is it elephants?

Is it fire (and if so…what about fire)?

Is it fire and elephants?

Is it grazers (influence on fire)?

Is it other browsers (impala etc. on recruitment)?

Is it fire???

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EFFECTS OF FOUR DECADES OF FIRE MANIPULATION ON WOODY VEGETATION STRUCTURE IN SAVANNA

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Abstract. The amount of carbon stored in savannas represents a significant uncertainty in global carbon budgets, primarily because fire causes actual biomass to differ from potential biomass. We analyzed the structural response of woody plants to long-term experimental burning in savannas. The experiment uses a randomized block design to examine fire exclusion and the season and frequency of burn in 192 7-ha experimental plots located in four different savanna ecosystems. Although previous studies would lead us to expect tree density to respond to the fire regime, our results, obtained from four different savanna ecosystems, suggest that the density of woody individuals was unresponsive to fire. The relative dominance of small trees was, however, highly responsive to fire regime. The observed shift in the structure of tree populations has potentially large impacts on the carbon balance. However, the response of tree biomass to fire of the different savannas studied were different, making it difficult to generalize about the extent to which fire can be used to manipulate carbon sequestration in savannas. This study provides evidence that savannas are demographically resilient to fire, but structurally responsive.

Key words: *carbon sequestration; fire; long-term ecological research; savanna.*

Herbivores were not excluded from plots and no consideration of their role!

Is it elephants?

Journal of Tropical Ecology

The utilisation of large savanna trees by elephant in southern Kruger National Park

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Abstract

Elephant are believed to be one of the main ecological drivers in the conversion of savanna woodlands to grassland. We assessed the impacts of elephant on large trees (≥5 m in height) in the southern section of the Kruger National Park. Tree dimensions and utilisation by elephant were recorded for 3082 individual trees across 22 transects (average length of 3 km and 10 m wide). Sixty per cent of the trees exhibited elephant utilisation and 4% were dead as a direct result of elephant foraging behaviour. Each height class of tree was utilised in proportion to abundance. However, the size of the tree and the species influenced the intensity of utilisation and foraging approach. *Sclerocarya birrea* was actively selected for and experienced the highest proportional utilisation (75% of all trees). Interestingly, the proportion of large trees that were utilised and pushed over increased with distance from permanent water, a result which has implications for the provision of water in the KNP. We conclude that mortality is likely to be driven by a combination of factors including fire, drought and disease, rather than the actions of elephant alone. Further investigation is also required regarding the role of senescence and episodic mortality.

The real problem in KNP…None or few experiments to properly determine…Fire versus herbivory versus fire+herbivory

Ideally a long-term, large-plot factorial experiment, herbivore-rich versus herbivore-poor landscapes etc.

Control (no fire or herbivores)

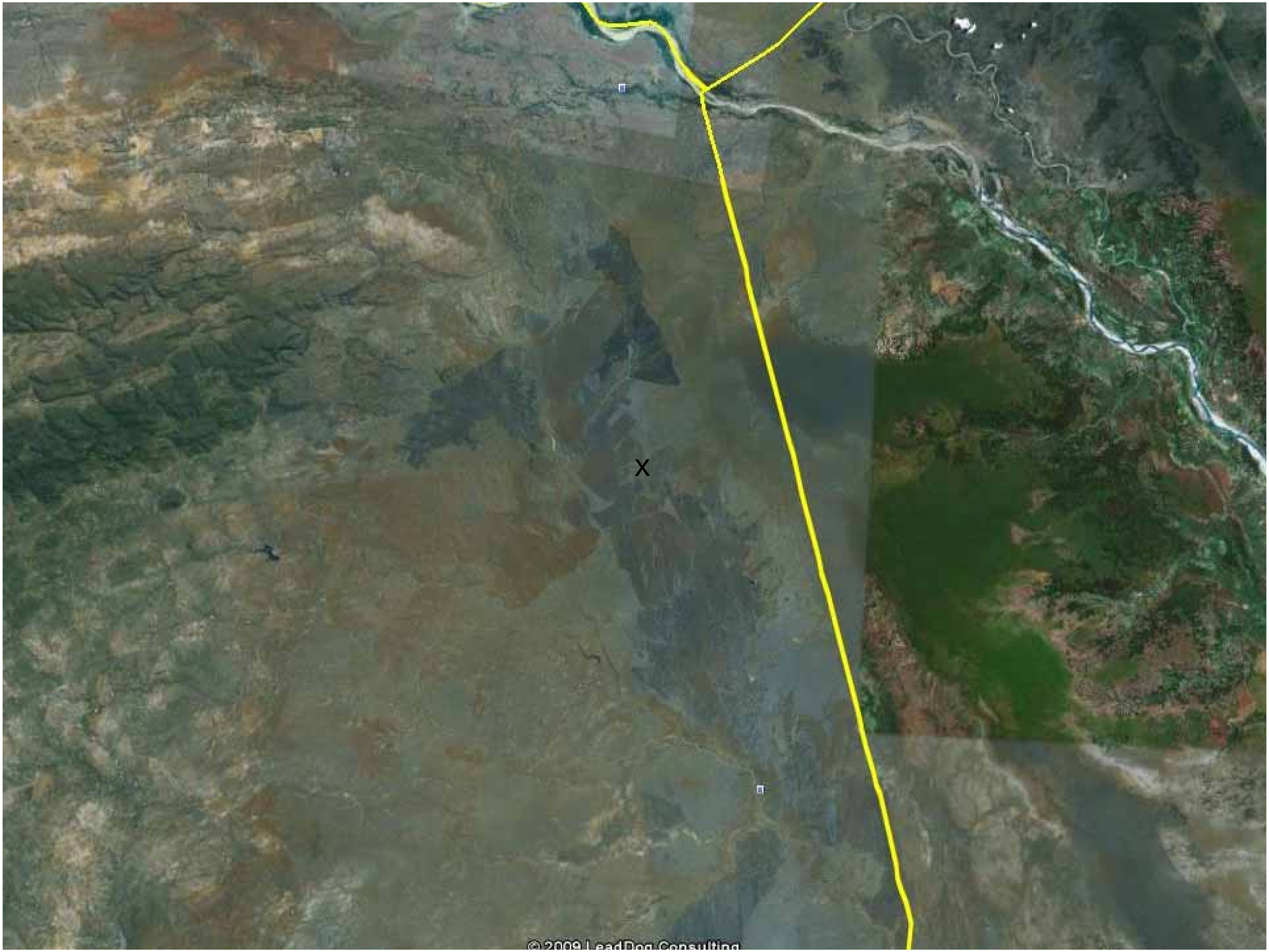
Fire (frequency, intensity)

Herbivory (which herbivores)

Fire+ herbivory

= millions of $$$'s

Fortunately, there are some exclosures in KNP.


X
© 2009 LeadDog Consulting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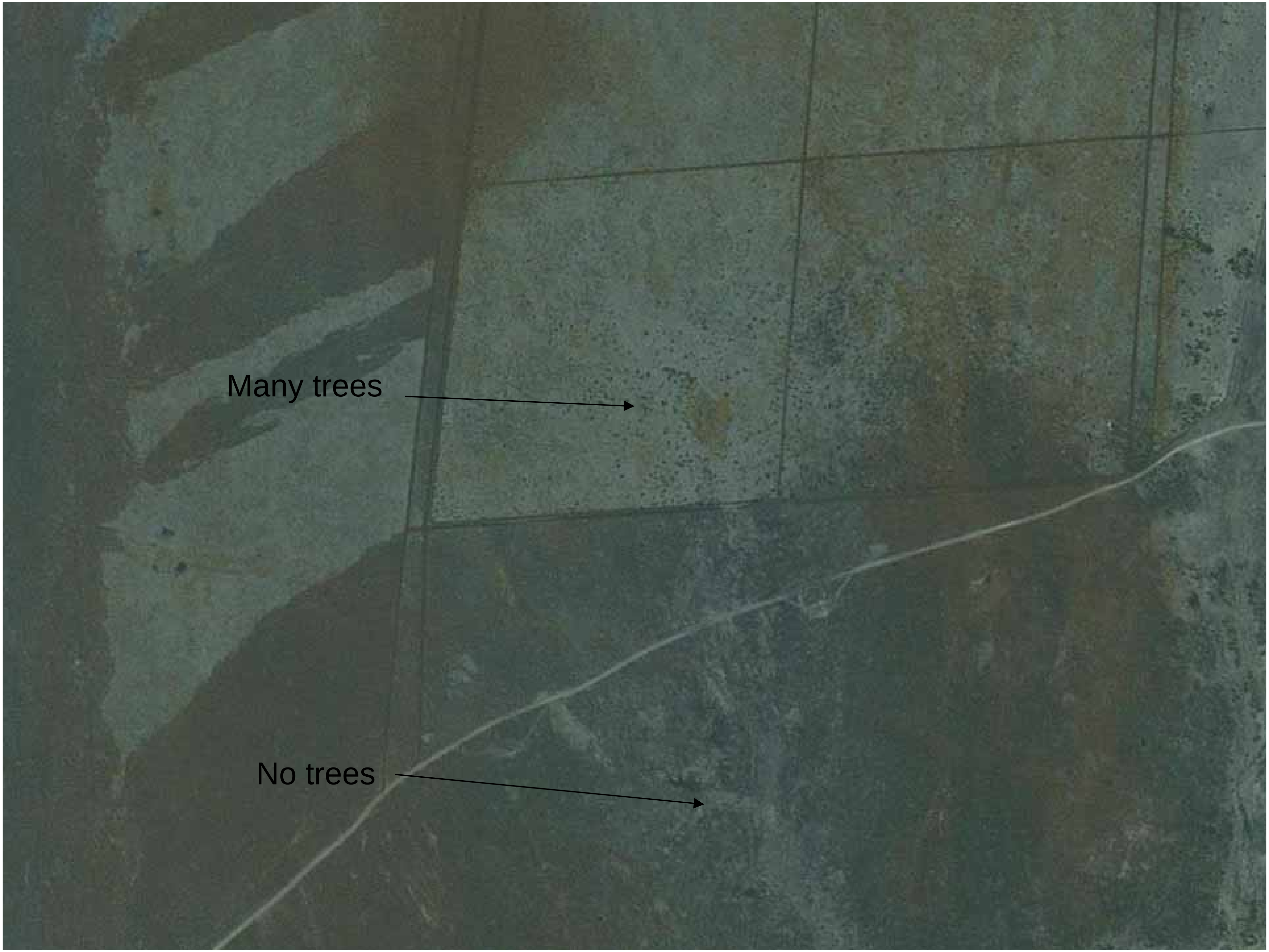
22°46'41.54" S 31°15'30.53" E
elev 1268 ft
Eye alt 13.96 mi
Google

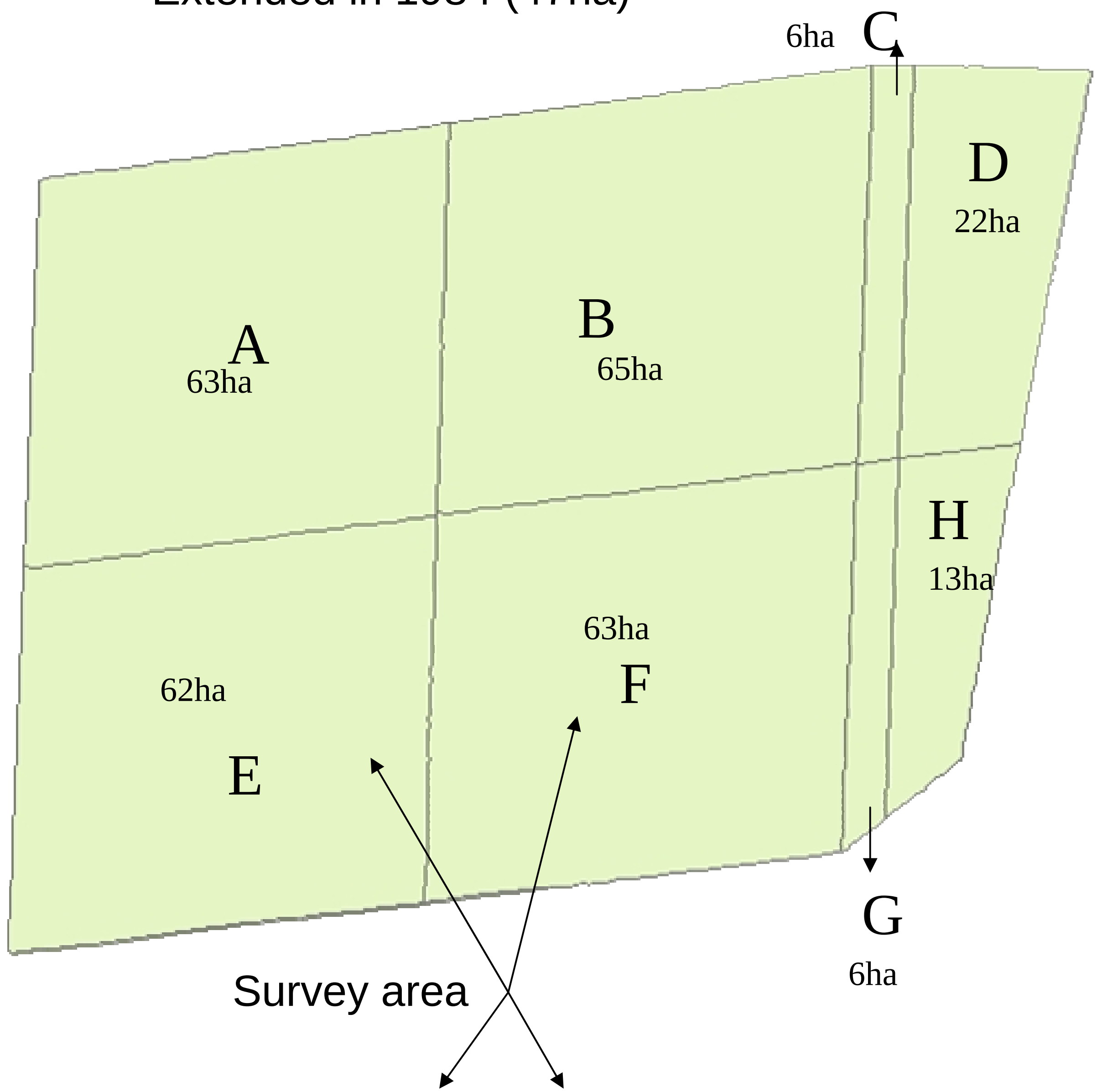

Many trees
No trees


Trees

Nwashitsumbe Roan Camp

Established in 1976 (253ha)

Extended in 1984 (47ha)



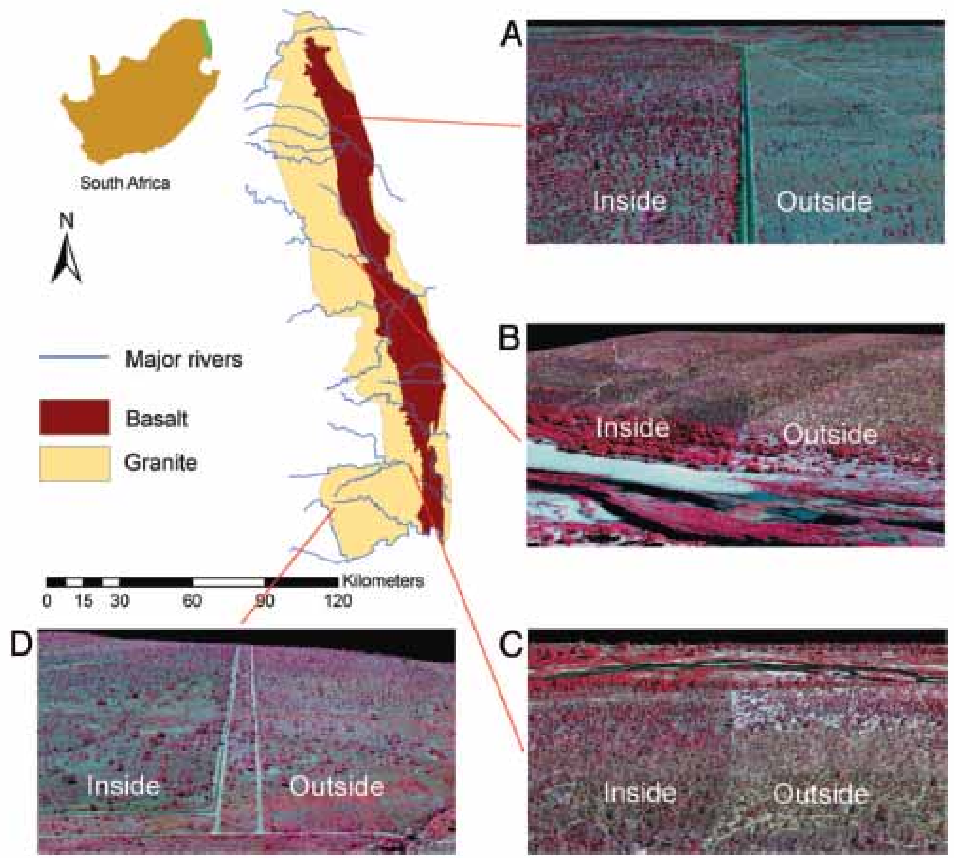
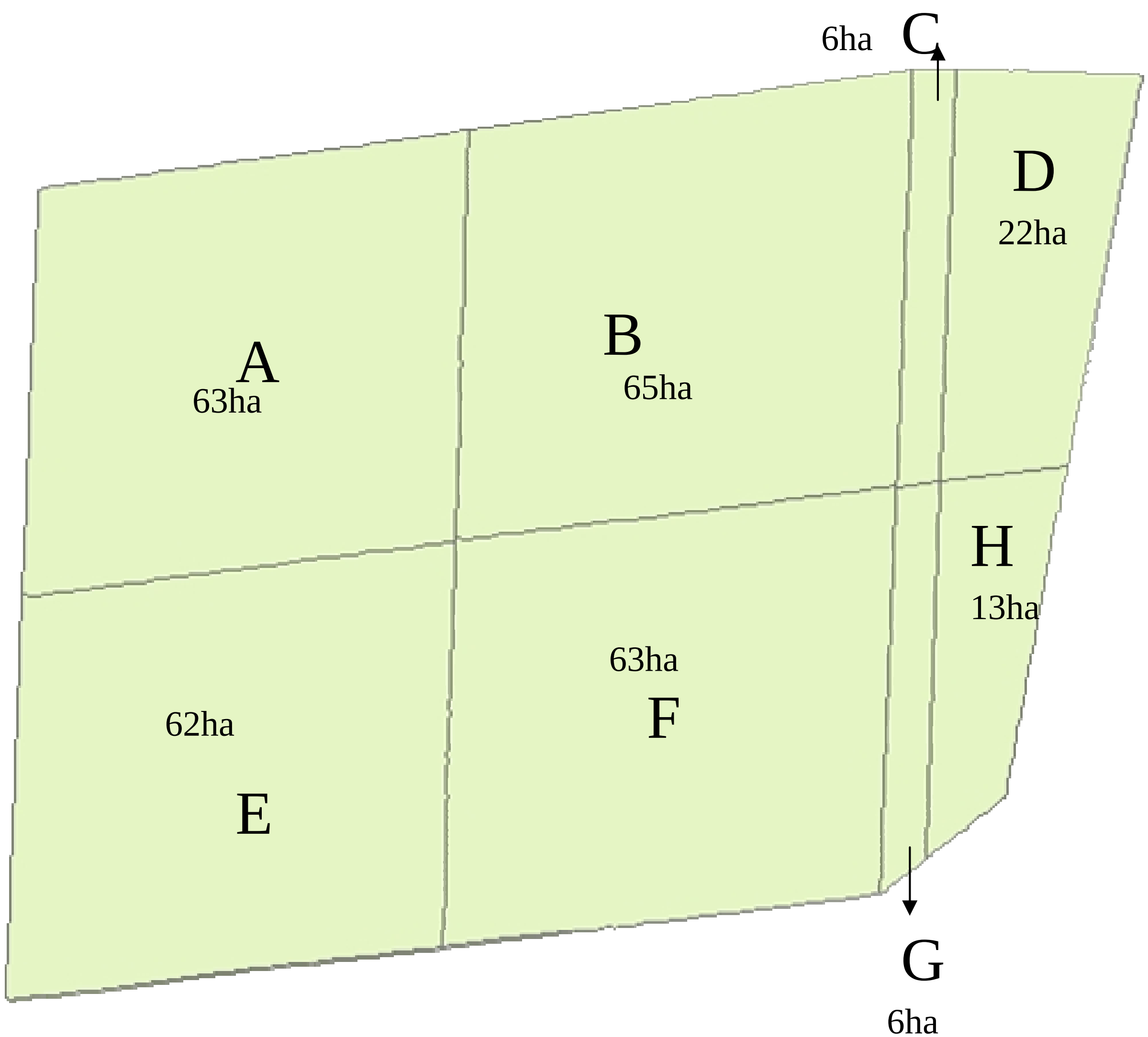


Fig. 1. Airborne 3-D imaging of the 4 herbivore treatments across the KNP in South Africa. (*A*) Long-term basalt (Nwashitsumbe). (*B*) Short-term granite (Letaba). (*C*) Short-term granite (Nkuhlu). (*D*) Long-term granite (Hlangwine). A map of the park is shown in the upper left, with the 2 major geologic substrates and river systems. Each zoom image shows a portion of each large-scale treatment area, with color-infrared spectroscopy highlighting vegetation canopies (red) and dry/senescent vegetation and bare soil (blue to gray) overlain on the 3-D structure of each woody plant at a spatial resolution of 56 cm.

Asner *et al.* 2009 PNAS

- Inside: plenty of grass, intense infrequent fire (?), but no browsers.

- Outside: grazers (less grass) and browsers, especially elephants.



Fire History

1976 – Feb – whole camp
1978 – June – E
1979 – Nov – F
1980 – July – B
1981 – July – F
1982 – July – A
1984 – Apr – E
1985 – Apr – B,D,H,C,G
1985 – June – F
1985 – Sept – A
1986 – Jan – E
1987 – Mar – A
1988 – May - C,G,H
1988 – Jun – F
1989 – May – D,G
1990 – May – C,E,H
1990 – Oct – A
1991 – June – C,D
1994 – June – C, G
1997 – May – C, G
1998 – Sept – A
1999 – Sept - E
2001 – May – C, G
2002 – May - A

Fire summary

	inter-fire period (years)	
Block E	Block F	Outside
2	3	3- 4 (van Wilgen et al 2000)
6	2	
2	4	
4	3	
9	14	

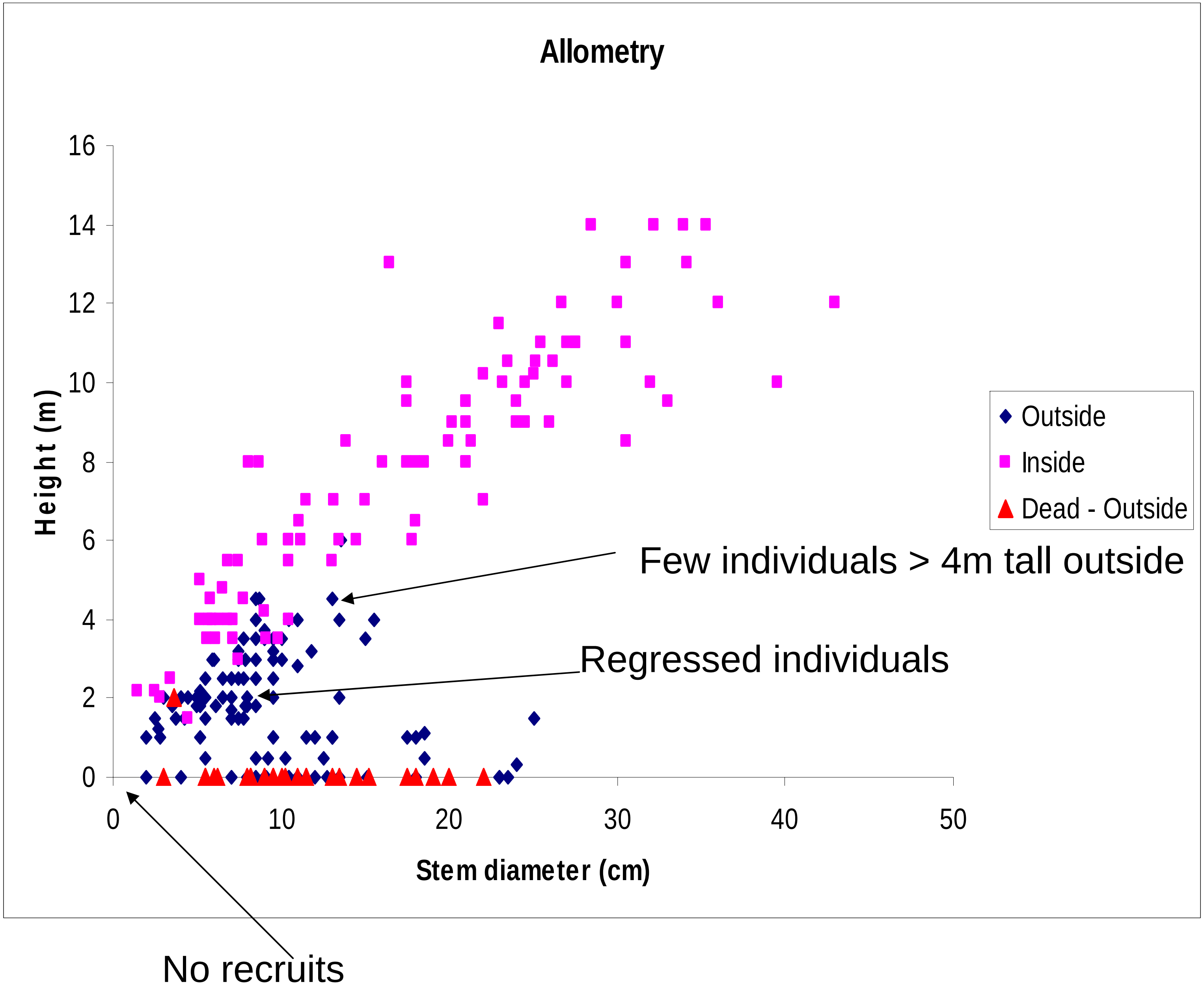
Grass height (n= 50)

inside	outside
52.3 (24.1) cm	31.3 (32.8) cm

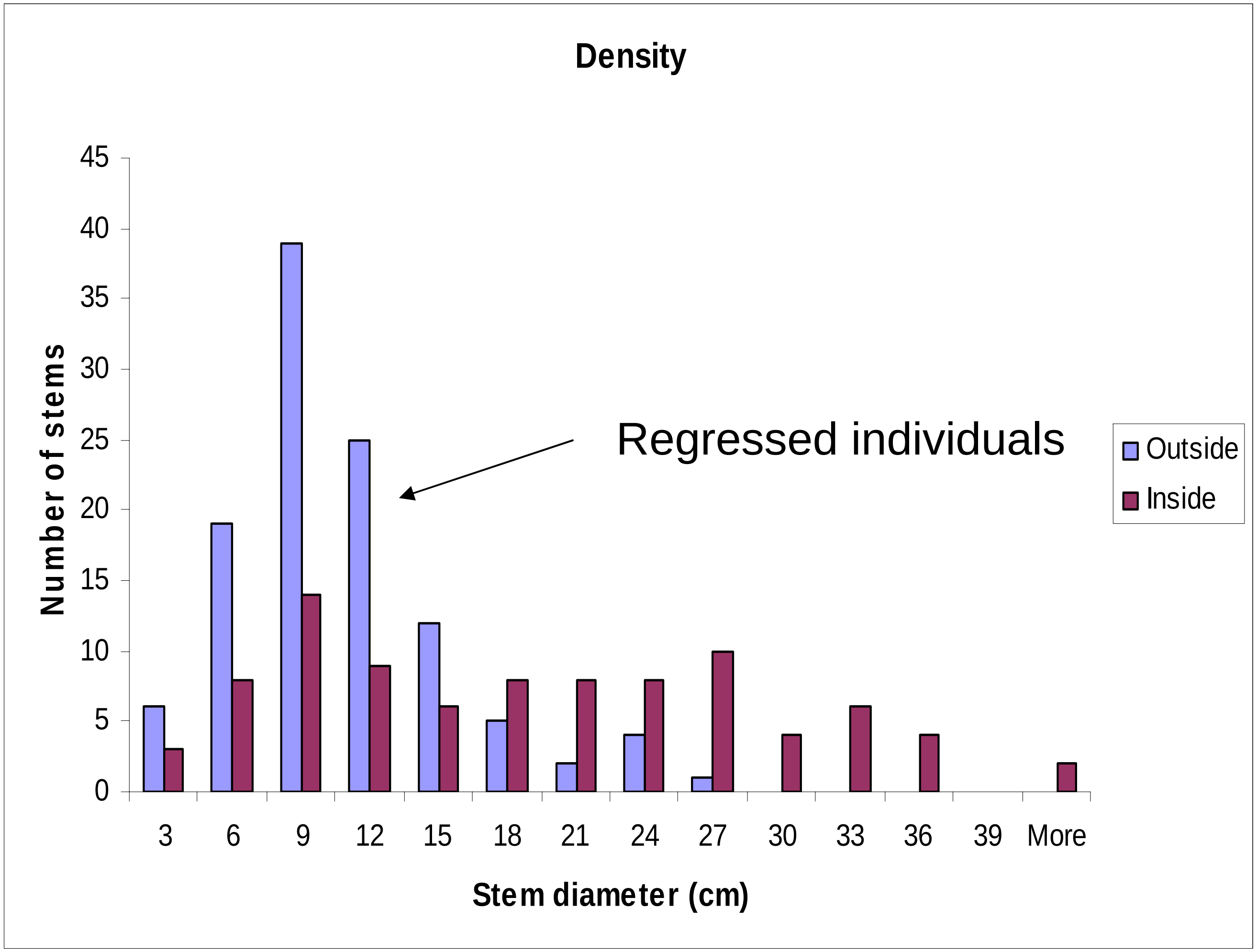
= Fuel-wise: hotter fires inside the exclosure.

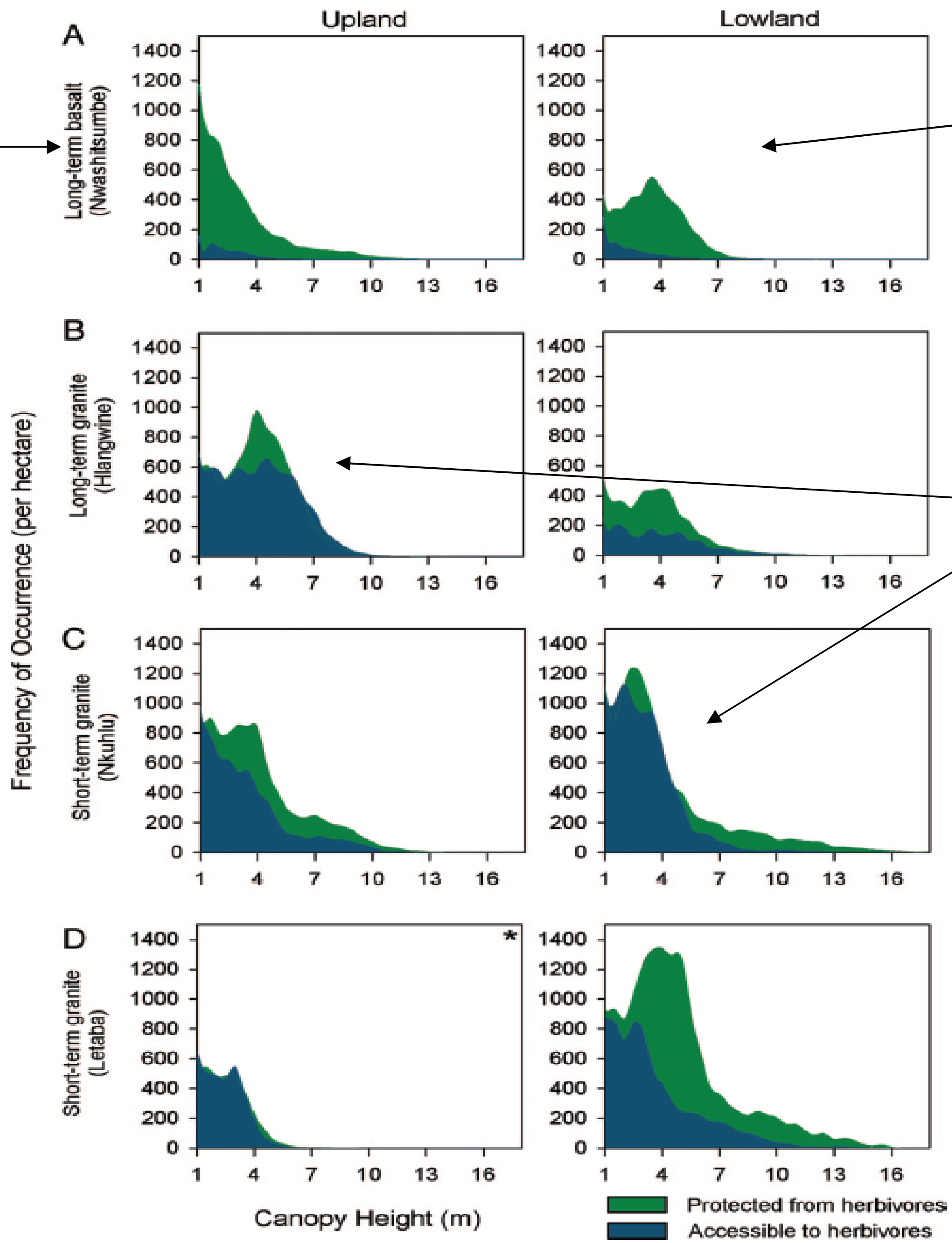
Methodology

- Simple transects measuring height, diameter and condition of knob-thorns.



Allometry
Height (m)
16
14
12
10
8
6
4
2
0
0
10
20
30
40
50
Stem diameter (cm)
Outside
Inside
Dead - Outside
Few individuals > 4m tall outside
Regressed individuals
No recruits


Density
Number of stems
45
40
35
30
25
20
15
10
5
0
3
6
9
12
15
18
21
24
27
30
33
36
39
More
Stem diameter (cm)
Regressed individuals
Outside
Inside



Large impact

Small impact

Lidar measurements of vegetation density

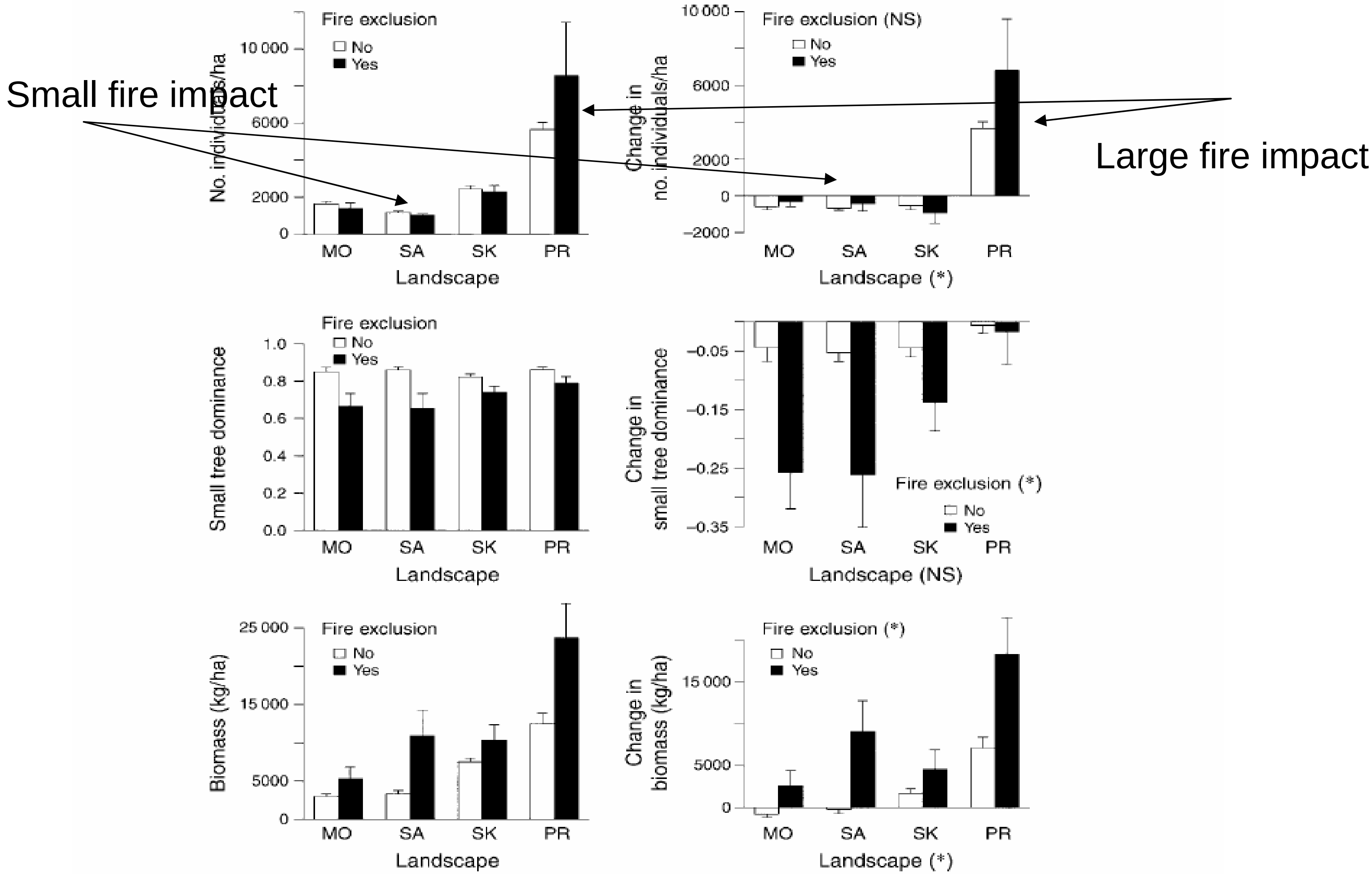


FIG. 1. The mean estimate at the second survey (left-hand panels) and mean change (right-hand panels) in the number of woody individuals, dominance of small trees (proportion of all trees <2 m height), and aboveground woody biomass after four decades in different landscapes (MO, Mopani; SA, Satara; SK, Skukuza; PR, Pretoriuskop). Open bars are plots that were burned in different seasons and at different frequencies; solid bars are fire-exclusion plots. Analysis of variance was used to test the effects of fire exclusion and landscape on the change response variables (right panels); factors that were not significant are indicated by NS; factors that were significant at $P < 0.05$ are indicated by an asterisk (see *Results* for details). The fire-exclusion plots on two strings were exposed to runaway wildfires (Pretoriuskop Fayi burned in 1991 and Mopani Tsende burned in 1968); these two strings are excluded from these analyses. Error bars indicate +SE.

Fire versus herbivores

- No exclosure (herbivore) impact at Hlangwine but strong impact at Nwashitsumbe (Asner et al. 2009).

In contrast,

- No fire impact in Mopani but strong impact at Pretoriuskop (Higgins et al. 2007).

- Fire and herbivory are n.b. in different areas and devastating to trees where both occur.

Summary

No seedlings (<1.5 cm diameter) inside or outside!!

Many (recently) dead individuals outside (27/140). No dead individuals inside.

Herbivory (elephants) much more n.b. than fire as determinant of trees, but apparently due to the interaction between fire and elephants. (Snapping and burning, bark stripping and burning cause mortality and not just repsrouting).

Impact of exclosures…why more trees?

More Additions:

Increase demographic transitions

(more shrubs become trees….role of elephant and non-elephant browsers and fire?),

But, no exclosure influence on recruitment (great unknown??).

Fewer Deletions:

Decrease demographic regressions

(fewer elephant/fire damaged trees regressing to resprouting shrubs),

Decrease in mortality (particularly due to elephants and fire).

Problem with exclosures

Unreplicated,

Undocumented (initial conditions, fire regime),

Need further work to determine exact demographic consequences. For example, many marula inside exclosure….fast growth rates=many transitions?

Issues of extrapolation (herbivory, fire, growth-rates).

Nevertheless of extreme value (need more).

Conclusions

- Knobthorns are in danger of extinction; in short term the almost total loss of reproductive adults, in longer term the slow decline of total population size.

- What causes knobthorn regeneration? (wet years?....often see small ones along roads).