The dynamics of *Acacia mellifera*, implications for bush encroachment management.

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Hypotheses:

1. *En masse* seed production occurs in only excellent rainfall years

2. Vigorously growing climax grasses can outcompete seedlings (reduce vigour; increase mortality)

3. Fire is effective at an early stage of establishment in preventing the transition, ineffective as a control measure with established shrubs

4. Browsing by small herbivores may significantly thin establishing thickets
Potential bush encroachment initiation events very rare

Fire (preventor) and excess water (promoter) main drivers

= transition 3 events if 3 years are required
FIRES IN NAMIBIA SINCE 2000
Study site

Highland Savanna
Methodology

Fire Control

Chi square

Competition/browsing

Soil water potential (gypsum blocks)

1/4 clipped

Soil nutrients

X 4 ("climax" veld)
Results: Seed production
Percentage of trees with fruits and rainfall from 1998 to 2003

- **% of trees with fruits per plot**: 0.00%, 10.00%, 20.00%, 30.00%, 40.00%, 50.00%
- **Rainfall (mm)**: 0, 200, 400, 600, 800, 1000

The chart shows a significant variation in the percentage of trees with fruits and the corresponding rainfall amounts over the years from 1998 to 2003.
Pods / tree in relation to rainfall

$y = 0.0504x - 12.169$

$R^2 = 0.9052$
Available seeds per tree after pre-dispersal predation for 2001 and 2002

Seeds in 2001 and 2002 per labelled tree

- Nonviable: 173.9 seeds in 2001, 5.3 seeds in 2002
- Available: 20.3 seeds in 2001, 5.3 seeds in 2002
- Predated: 3.4 seeds in 2002
Results: competition
Results: competition (*A. pubescens* unclipped)

Stem diameter = 3.6248mm + 0.00389*distance(cm)  
$r = 0.0601$
Results: competition (*A. pubescens* clipped)

Stem diameter = 3.6838mm + 0.00052*distance(cm)

\[ r = 0.009 \]
Results: competition (S. pappaphoroides unclipped)

Stem diameter = 4.0083mm + 0.00688*distance(cm)

$r = 0.076$
Results: competition (*S. pappaphoroides* clipped)

Stem diameter = 4.5732mm + 0.0162*distance(cm)

\[ r = -0.1572 \]
Results: competition (*A. pubescens*)
Results: competition (*S. pappaphoroides*)

![Diagram showing stem diameter data for 2009](chart.png)
Results: different grasses provide different competitive effects?

Plot of Means (unweighted)
VAR9 Main Effect
F(1,647)=38.32; p<.0000

STEM DIAMETER 2009 (MM)

3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4

A. pubescens  S. pappaphoroides

BIOTA
Results: competition

- Soil moisture
- Soil nutrients
- Root distribution and architecture
- “minor” perennials
Results fire
Results: fire + seedlings

P = 0.0000
Results fire

- 98% alive
- 3% dead
Results browsing: seedlings

Survival Feb 2008 – June 2009
Survival in controls significantly lower (64%) versus exclosures (84%) (p < 0.001) (Chi square analysis).

21% of seedlings in control confirmed browsed by hare and 21% of these died.

Seedling mortality through browsing by hares likely to be much higher than this.

Recently, 12% of 292 surviving seedlings in the controls browsed by hares within ±40 days!!! This suggests that a very high proportion could be browsed in 2009 (study ongoing).

Browsing appears to increase in the dry season.
• cumulative increase in the number of browsed saplings (stem diameters = 7.2 mm; SD 2.14 cm) from 15% (2007) to 36% (2008) (n = 60). Suggests possibly ALL saplings are browsed between recruitment events. Measurements will be repeated in 2009.

• 18% mortality of saplings through the year NOT ascribed to browsing by hares (WATER STRESS?).

• Hare browsing appears to not negatively affect saplings of such a large size (≥8 years).

• Browsing MAY PROMOTE growth at this stage.
Conclusion

- Hypotheses:
  - Generally true, situation more complex excellent rainfall years
  - Not convincing! Subtle reduction of vigour?
  - Fire is effective at an early stage of establishment ineffective as a control measure with established shrubs
  - Browsing by small herbivores may significantly thin out establishing thickets

Major driver!
Thins thickets out!
## Adaptive and Preventative Management

<table>
<thead>
<tr>
<th>Dynamics</th>
<th>Management</th>
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<tbody>
<tr>
<td>1. Infrequent establishment (fruit production, short-term seed banks)</td>
<td>Monitor</td>
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<tr>
<td>2. Grass competition generally “weak”</td>
<td>Monitor; maintain a healthy sward for..</td>
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<td>3. Fire effective in killing seedlings and saplings</td>
<td>Fire, Should be used where seedlings and saplings are present</td>
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<td>4. Hares and other small browsers could significantly thin out establishing thickets</td>
<td>Maintain healthy populations of small browsers (habitat, reduced poaching)</td>
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<td>5. Saplings and mature trees are drought sensitive and prone to fungal infections</td>
<td>Use these opportunistically to reduce costs of, for example, arboricides</td>
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<td>6. Slow growing</td>
<td>Fire may be effective for longer periods</td>
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