

PROGRAM B - Project 4.2 ("Multi-scale analysis of patterns in ecological processes in relation to fire regimes")

→ An Imagery Based Method to Chart Fire Driven Dynamics of Semi-Arid Grasslands

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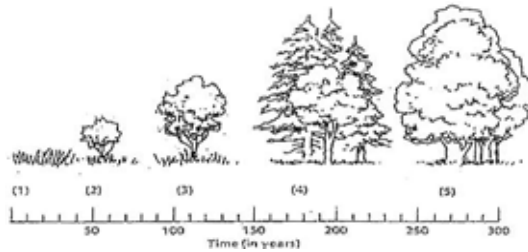
Rangeland Monitoring and Measures of Ecological Function

- Initially succession based: range condition ratings (1950s)
- Landscape Functional Analysis (1990s)
- Science Based Land Management (2000s)

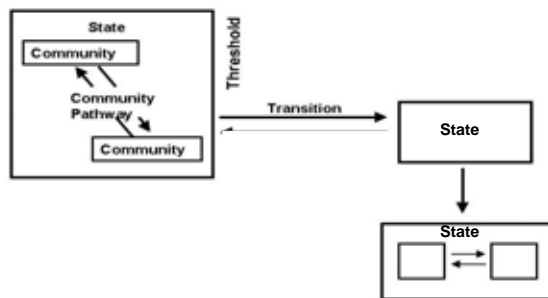
"An integrated framework for organizing, synthesizing, and applying our growing knowledge of ecosystems to facilitate development of flexible, multi-objective assessment, monitoring, and management systems for arid and semi-arid ecosystems"

Ecological Concepts of Dynamics

Succession



State and Transition



Remote Sensing

Advantages

- Scalable
- Rapid
- Repeatable
- Sophistication

Disadvantages

- Need to establish processing protocol
- Need to be related to processes on the ground (e.g. net primary productivity)

Objectives

- What is a useful state space?
- How may you relate the state space to on-ground processes?
- How would you use time series of image data to construct the different ecological “phases”?
- How would you define threshold events amongst interacting drivers?
- How may you do all this with off-the-shelf statistical procedures?

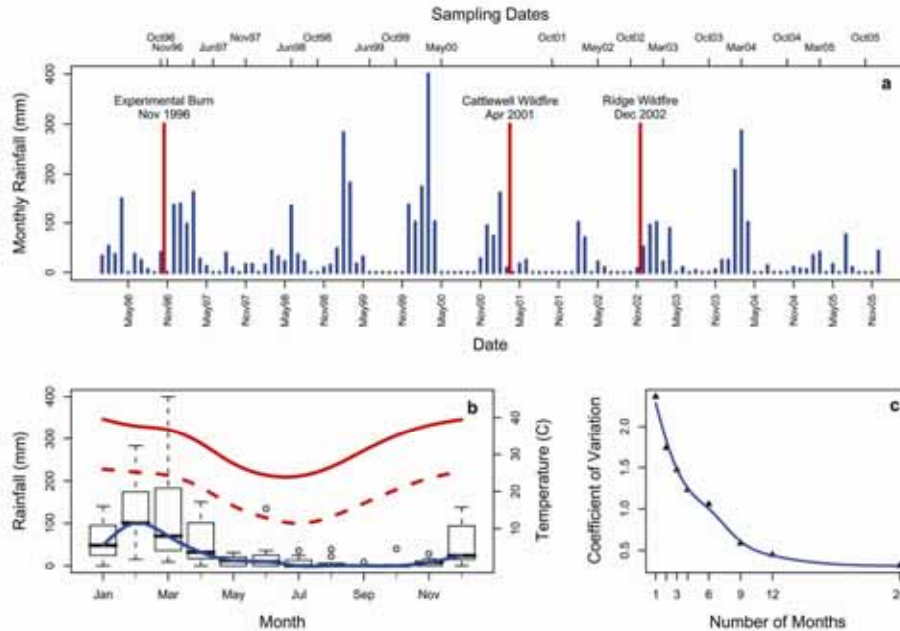


The Site

Themeda triandra (Forsk.) grasslands
Pilbara Region, NW Western Australia

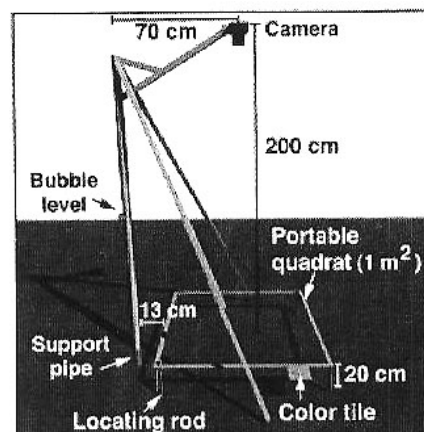


High Variability?



The Data

- *Themeda triandra* grasslands monitored since 1996 by Ecosystems Research Group, The University of Western Australia
- Images of 1m x 1m plots taken at the beginning and end of the summer period
- Environmental variables have also been recorded: rainfall, soil and ambient temperatures, and fire occurrence.



Dynamics?

Oct
1996

Nov
1996

Mar
1997

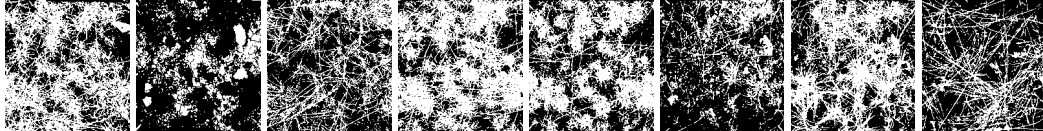
Jun
1997

Nov
1997

Jun
1998

Oct
1998

Jun
1999



Rain

Fire

Rain

Drought

Rain

Oct
1999

May
2000

Oct
2001

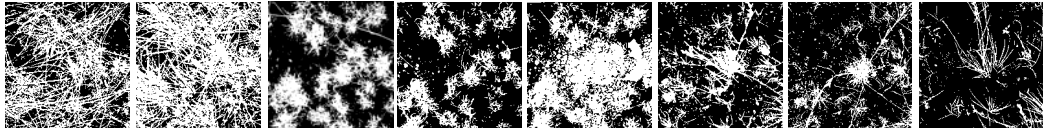
May
2002

Oct
2002

Mar
2003

Oct
2003

Mar
2004



Rain

Fire

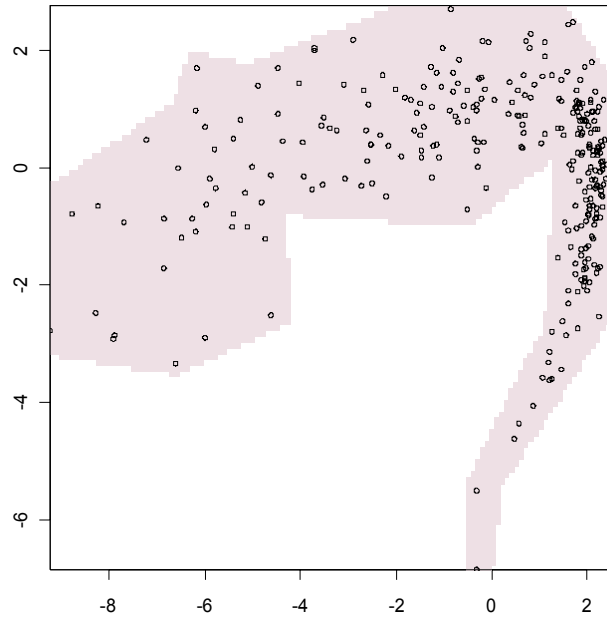
Drought

Rain

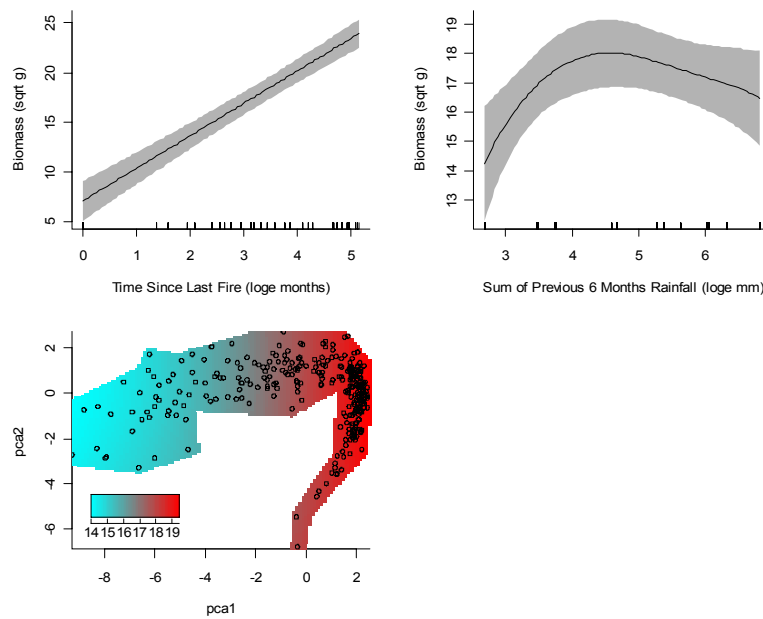
Image Metrics

White Fraction	The proportion of the image occupied by the "white" fraction of a binary black and white image.	
Number of Patches	Counts the number of discrete "white" patches	See Frohn (1998) for a discussion.
Twist Number	A measure of overall shape complexity. Calculated by counting the number of twists in the perimeter of a shape	Bogaert et al. (1999)
Effective Mesh Size	Associated with the probability of two locations belonging to the same patch, and determines the size of uniform patches that corresponds to that probability.	Jaeger (2000)
Box Counting Slope	Complex systems may display some form of multi-fractality, i.e. differently scaled regions may display different space filling properties. Slopes of the box counting plot are therefore used as separate metrics using box dimensions of 1, 2, 5, 10, 25, and 50 pixels in length.	Li (2000)
Contrast	Measures local variability of pixel values	Haralick et al. (1973)
Contagion	Based on the relative frequency of finding a pixel of one type next to a pixel of another type.	O'Neill et al. (1988); Li and Reynolds (1993)
Recursivity	Measures uniformity of pixel pair combinations. Designed to be independent of contrast and scaled to between 0 and 1.	Baraldi and Parmiggiani (1995)
Compactness	Counts the number of internal pixel edges contained in a shape, and expressed as a fraction of the number of internal edges contained in the most compact shape for the same number of pixels.	Bribiesca (1997)

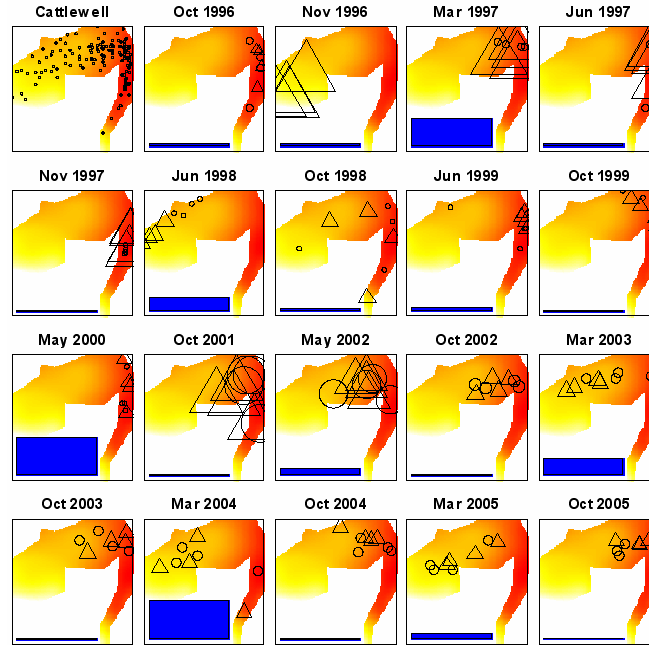
Principal Component State Space



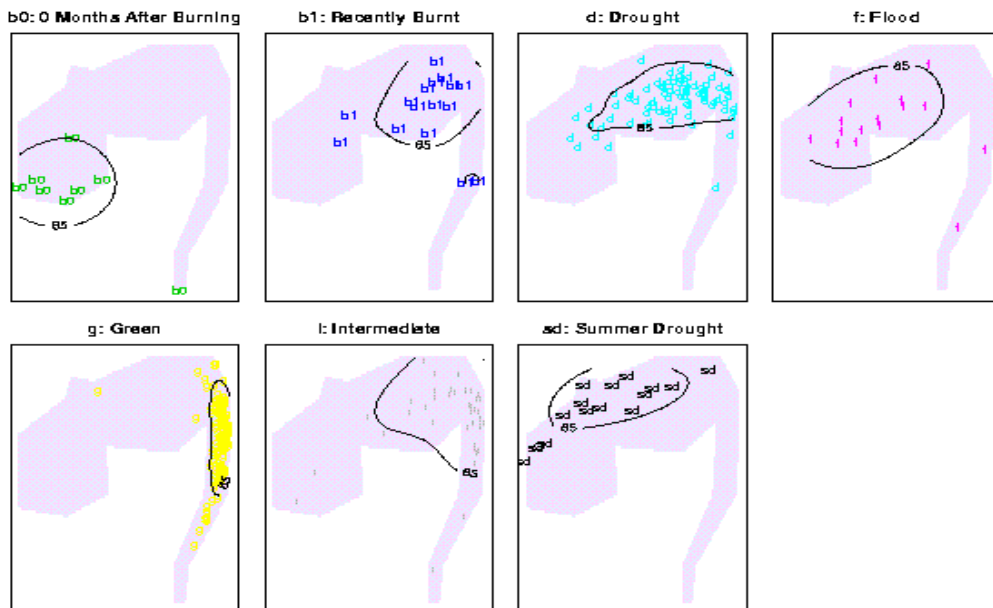
Biomass and the State Space



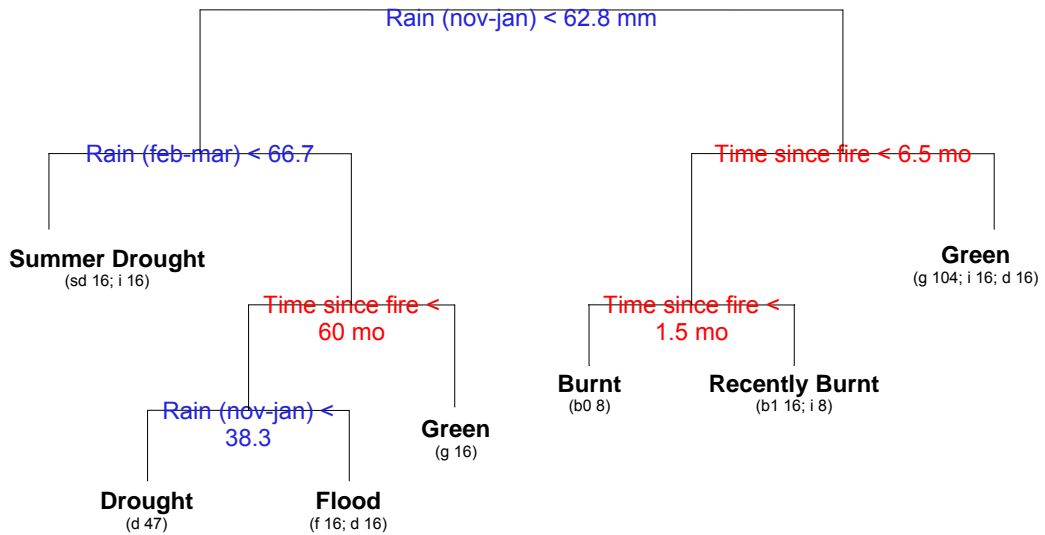
Cattlewell Site



Partitioning the State Space



Including More Information



A State-and-Transition Model!!

