How fire regimes interact with other forms of ecosystem disturbance and modification

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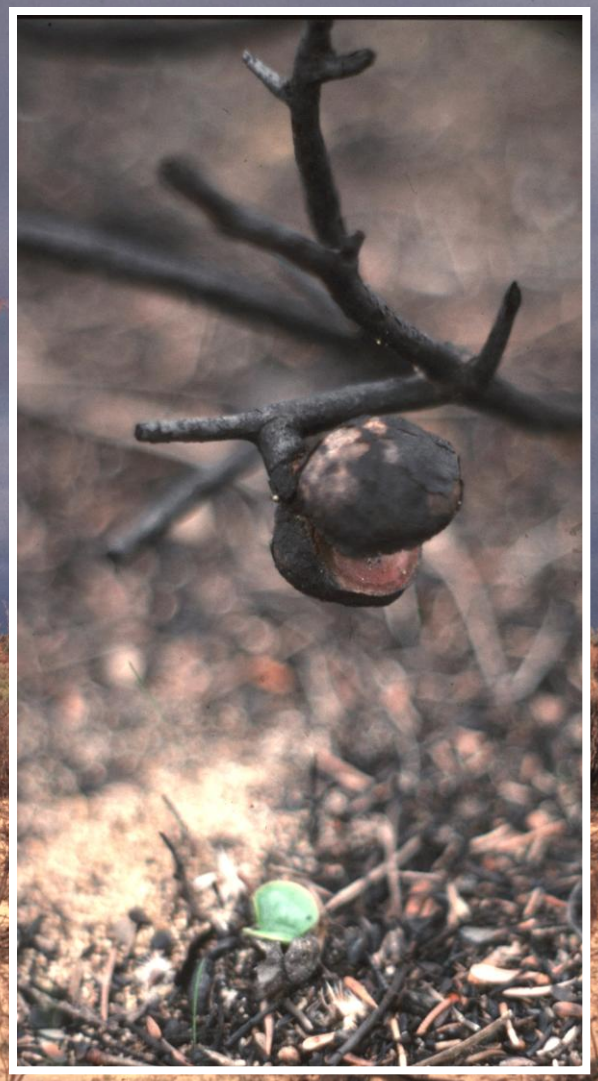
Outline

- Disturbances and ecosystem modification
- Fire and invasive plant species
- Fire and ecosystem fragmentation
- Fire and grazing
- Alternative states for ecosystems

Disturbances

- Any discrete event that causes change in ecosystem components
- Small-scale: e.g. animal diggings
- Large-scale: e.g. storms



Ecosystem effects of fire

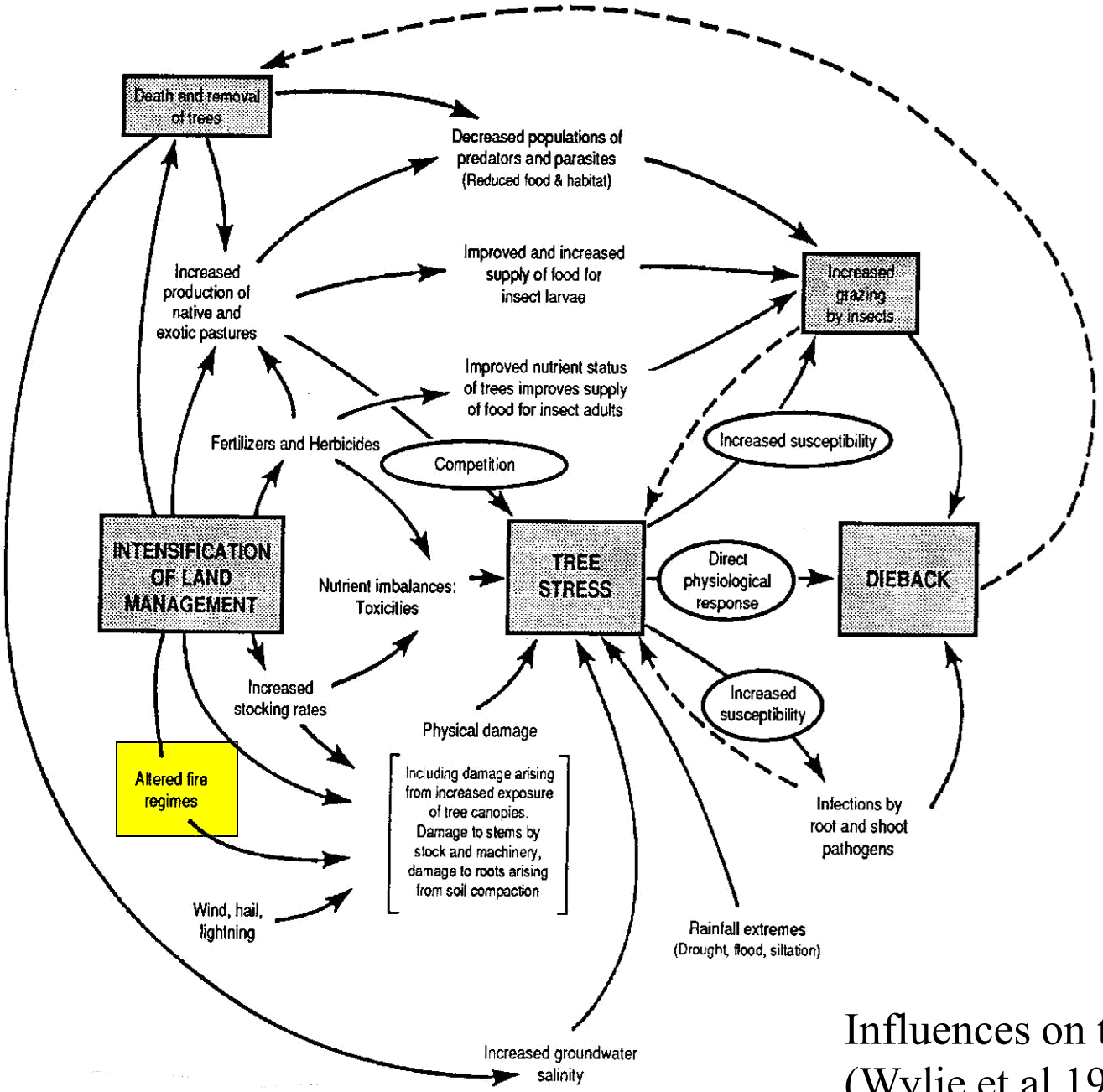
- "While many studies have examined the effects of one, or occasionally several fires, on plant and animal communities in the forest, the basis for predicting longer term effects of different fire regimes is limited" (McCaw & Burrows 1989)

- Fire regimes
  - frequency, size, intensity, season

Flammable Australia

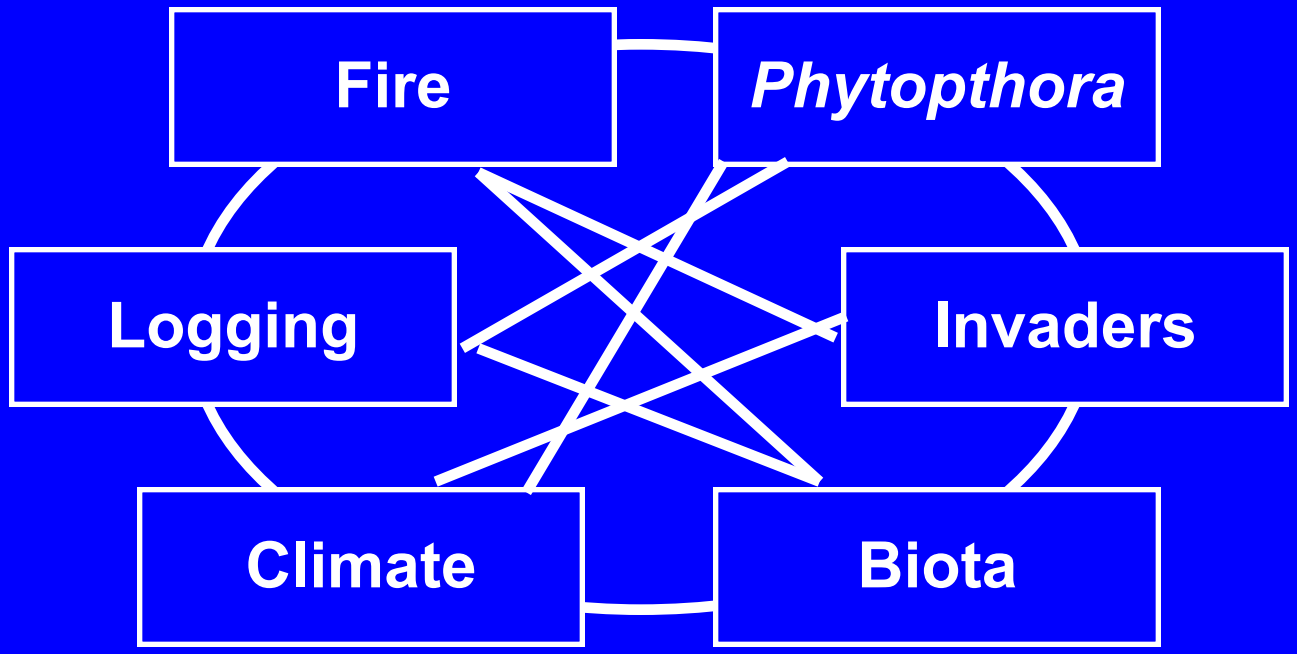
The Fire Regimes and Biodiversity of a Continent

CAMBRIDGE



Influences on tree dieback (Wylie et al 1992)

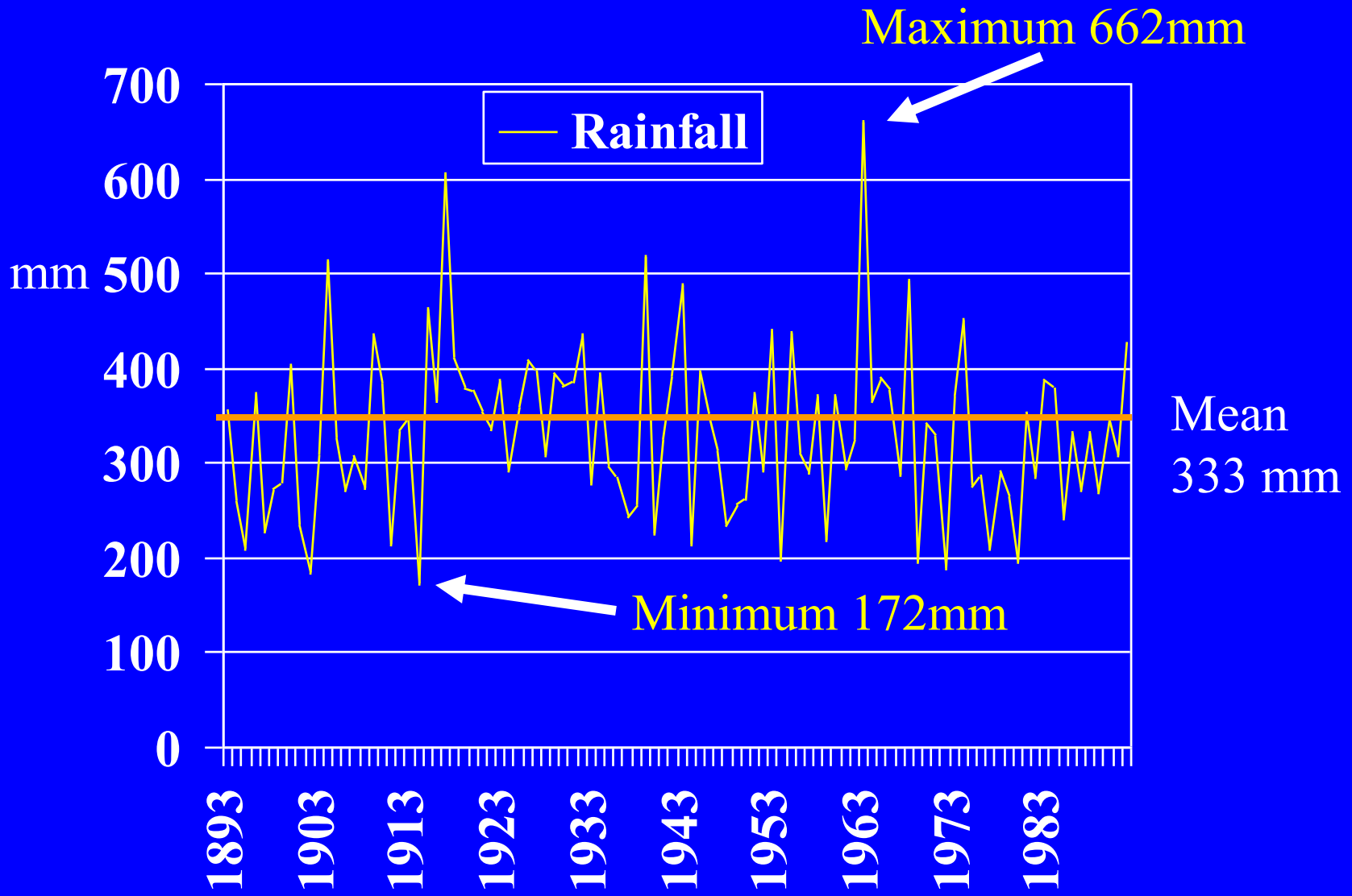
ECWEE!



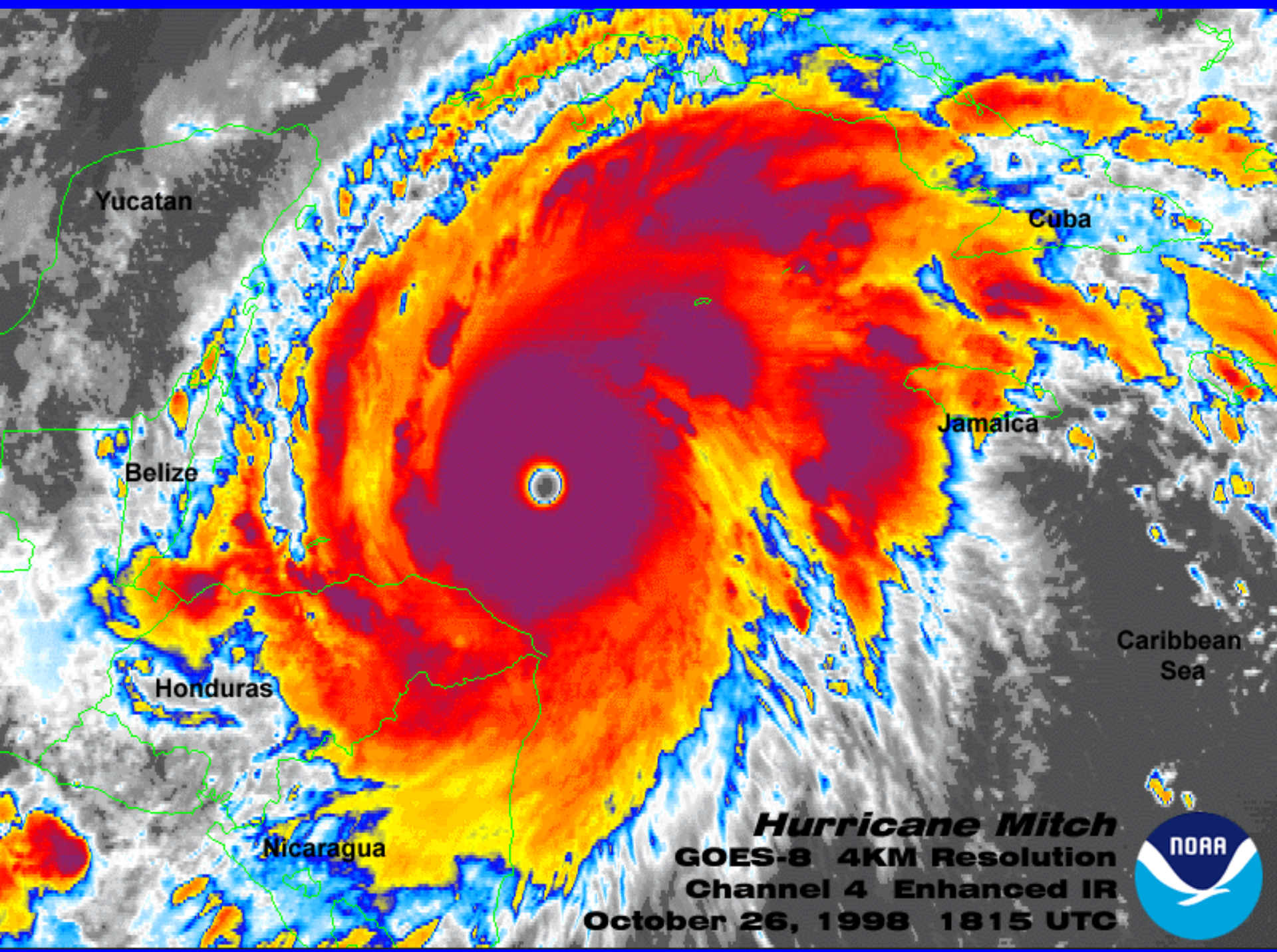
Localised disturbances

- Animal diggings
  - Native mammals
  - Pigs, rabbits, blackbirds
- Ant nests
- Small scale erosion, waterflow
- Individual tree deaths

Woylies create significant small-scale disturbance and alter ecosystem processes


Maximum 662mm
Rainfall
700
600
mm 500
400
300
200
100
0
Minimum 172mm
Mean
333 mm
1893
1903
1913
1923
1933
1943
1953
1963
1973
1983

Storms
Cyclones
Tornados
Hailstorms
Frosts
Flooding
Drought
Etc….

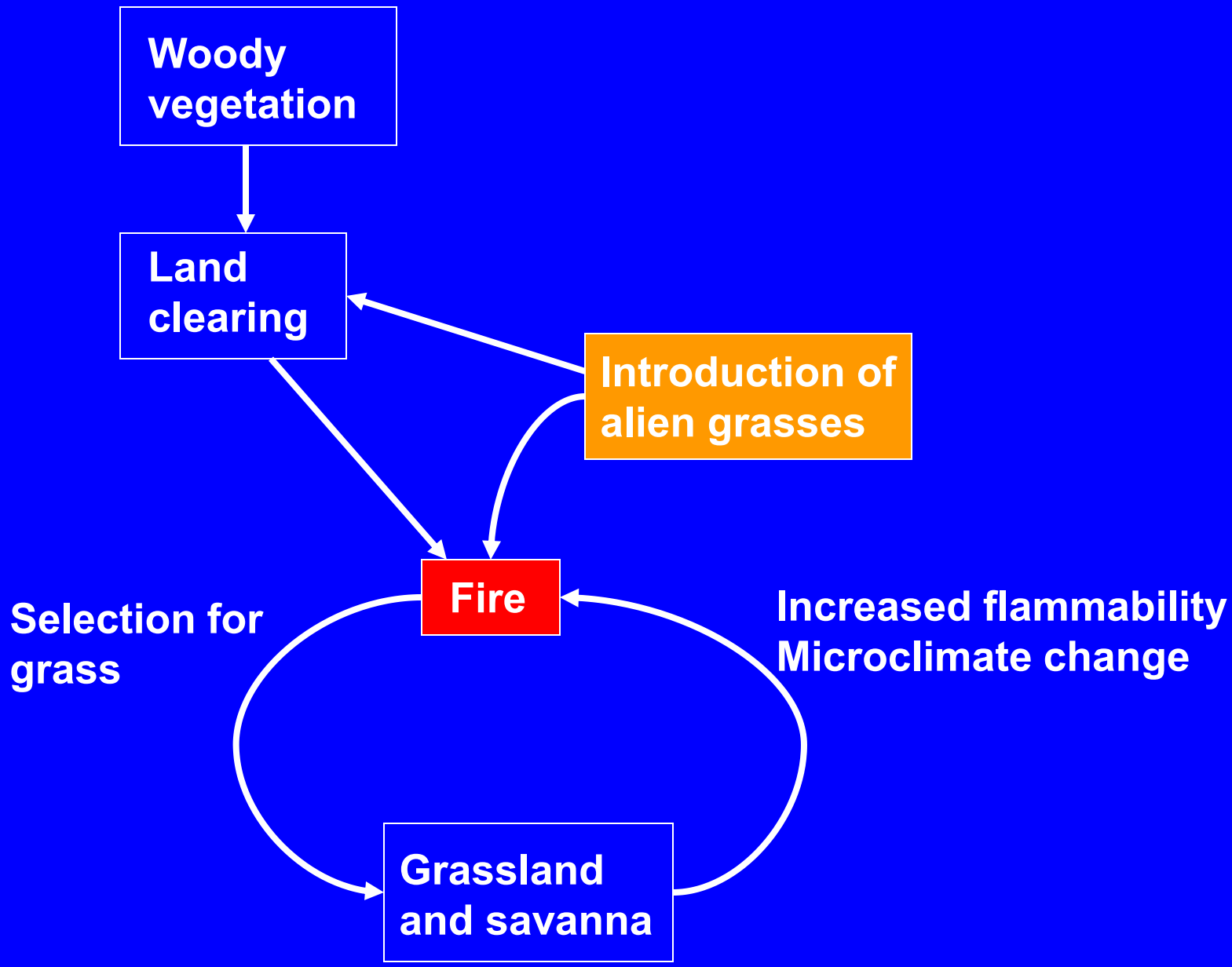

Yucatan
Cuba
Jamaica
Belize
Caribbean
Sea
Honduras
Nicaragua
Hurricane Mitch
GOES-8 4KM Resolution
Channel 4 Enhanced IR
October 26, 1998 1815 UTC
NOAA

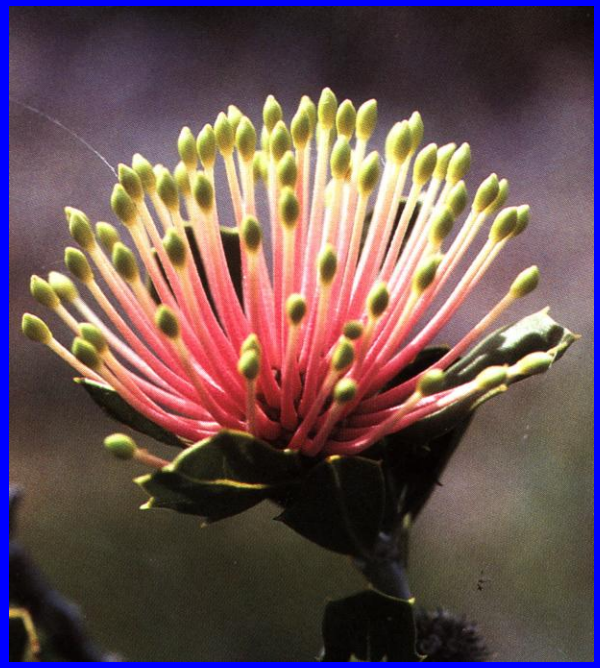
Tropical cyclones

- 13 cyclones passed over Perth last century
- Return time of 2 to 15 years
- Cyclone Bruno 1982: 200-250 mm rainfall in 48hrs
- Cyclone Albi 1978: little rain but 360 fires totaling 110,000 ha

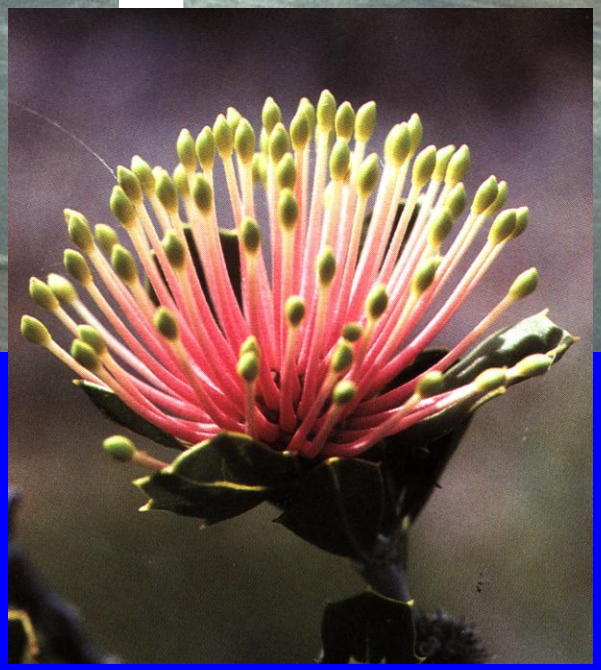
Ecosystem modifications

- Harvesting
- Clearing
- Mining
- Grazing
- Disease
- Invasive plants and animals


Woody vegetation
Land clearing
Introduction of alien grasses
Fire
Selection for grass
Increased flammability
Microclimate change
Grassland and savanna



Banksia cuneata



Banksia cuneata

Banksia cuneata

- Seed production - OK
- Seed release following fire
- Seed predation - minimal
- Germination - 5%
- Survival - 0.1%

(Lamont et al 1991)

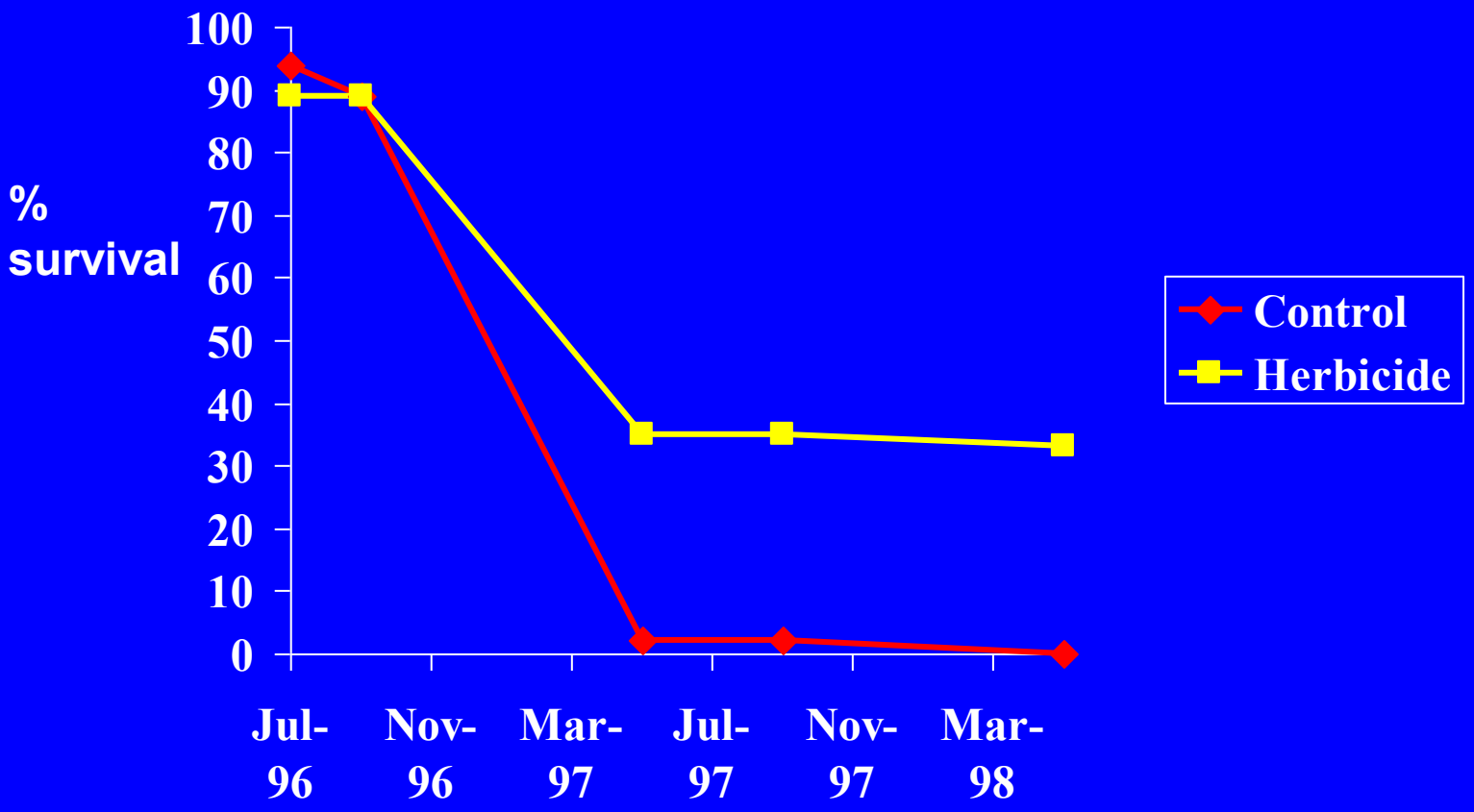
Banksia cuneata survival

- Regenerates after fire
- Dependent on summer rainfall?
- Impact of weed competition
  - Seedlings unable to survive first summer in presence of introduced grasses and forbs
- Therefore need fire coupled with weed control

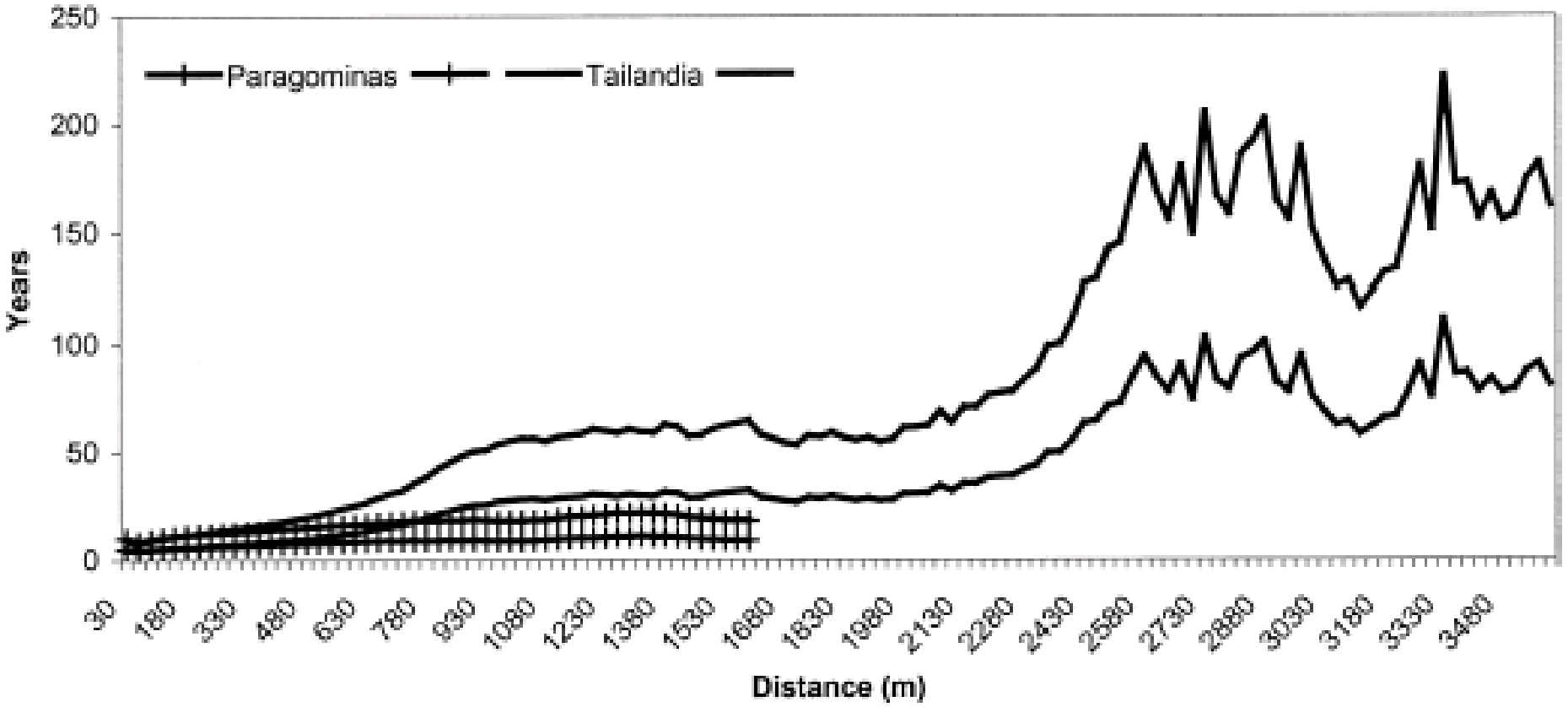
Biomass of non-native species (gm^{-2})

Reserve		Roadverge	
Unburned	Burned	Unburned	Burned
0.03	0.66	0.66	974.4

Survival, *Eucalyptus salmonophloia*

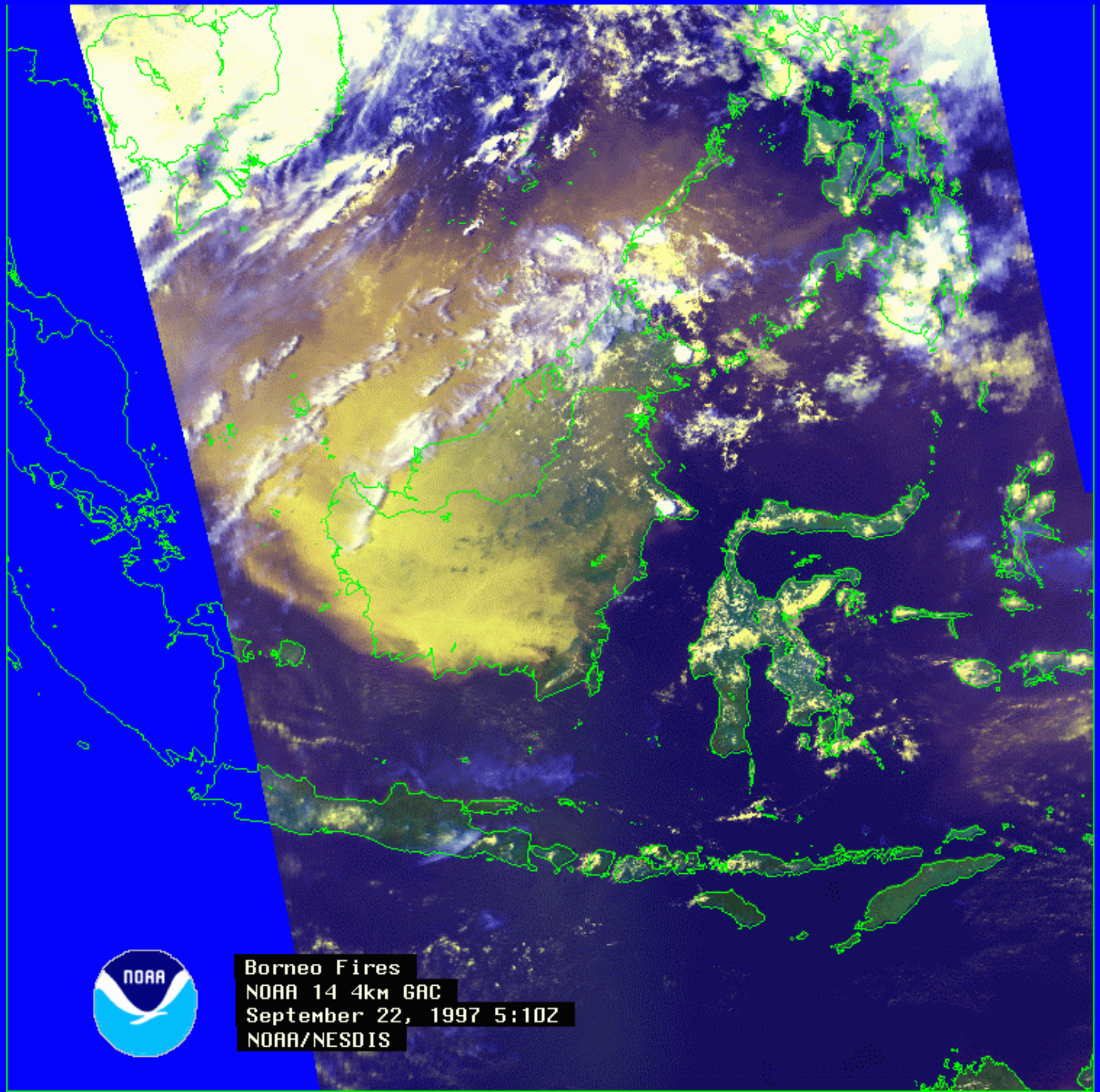


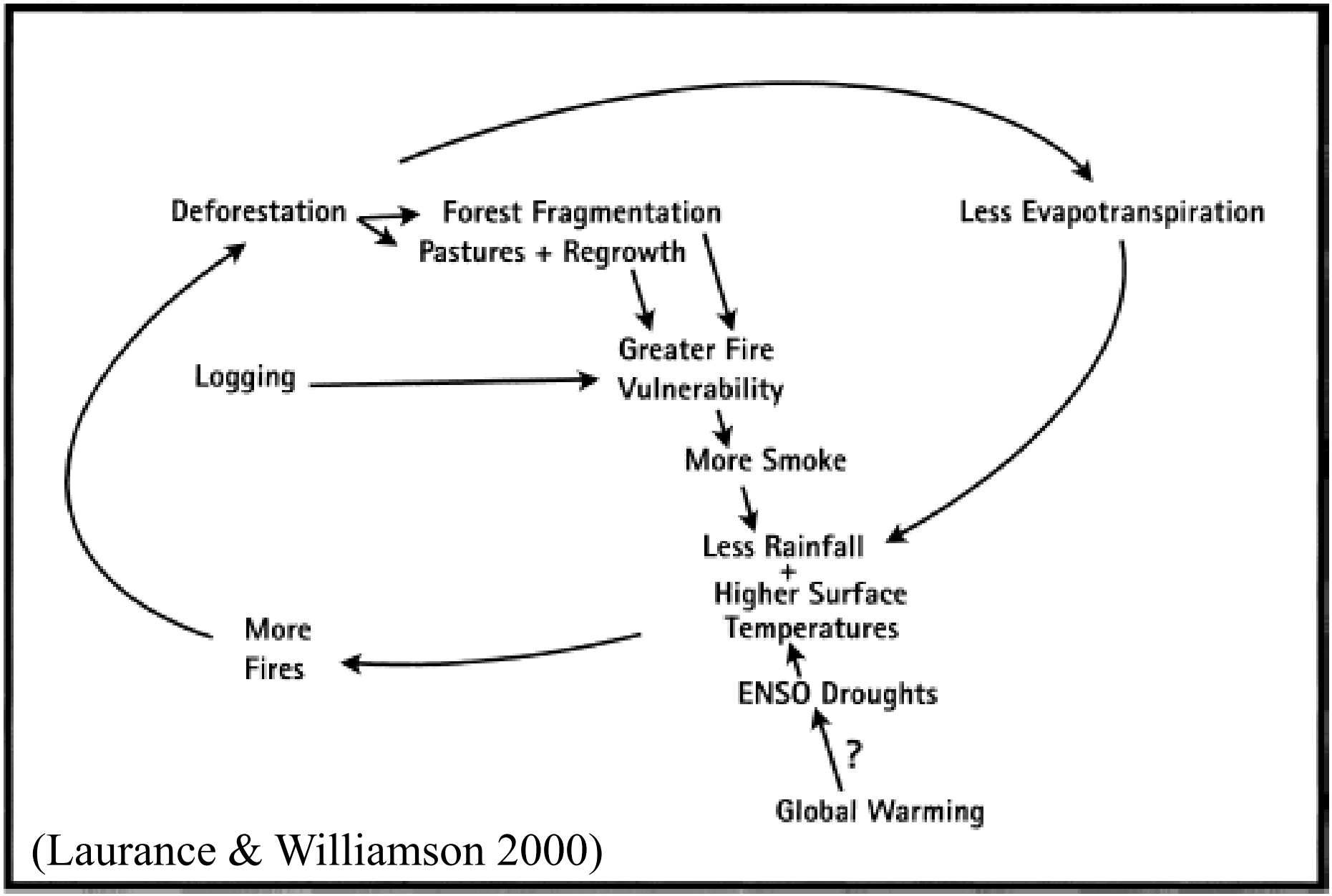
Fire and fragmentation in Amazon rainforests



Fires from adjacent lands extend large distances into forest fragments

(Cochrane, 2000)


Borneo Fires
NOAA 14 4km GAC
September 22, 1997 5:10Z
NOAA/NESDIS

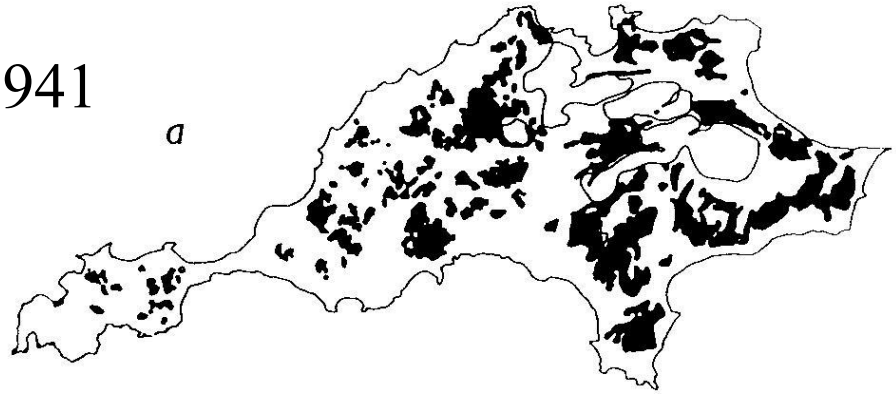


(Laurance & Williamson 2000)

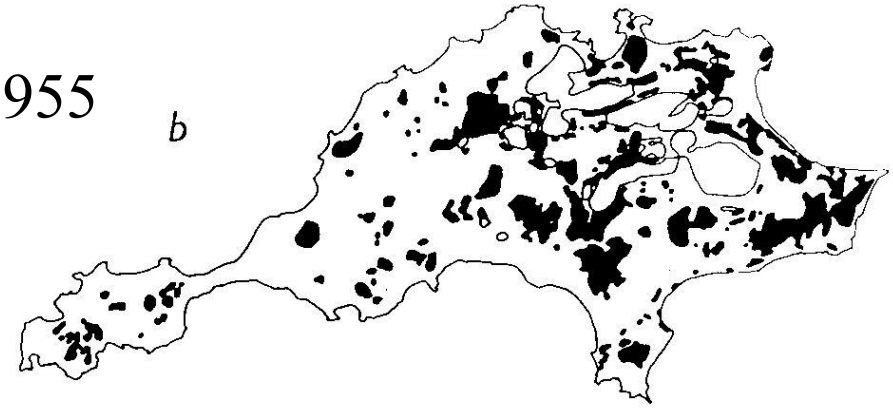
Fire and grazing on Rottnest Island

Rottnest 1939

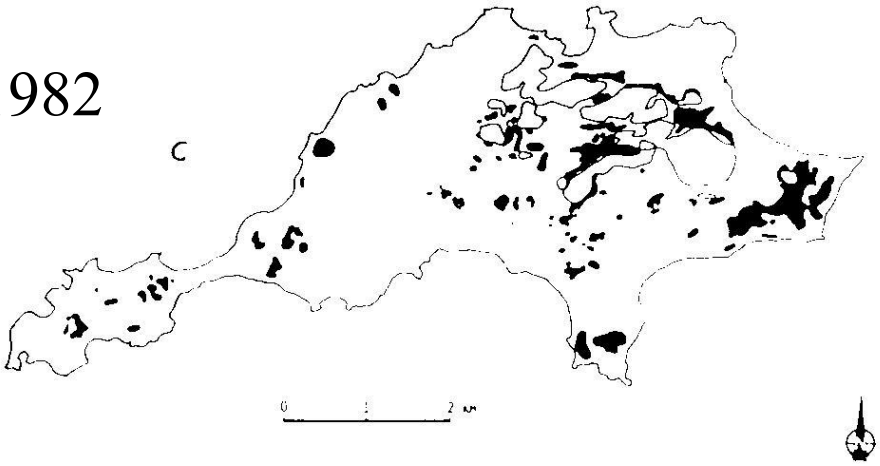
1941

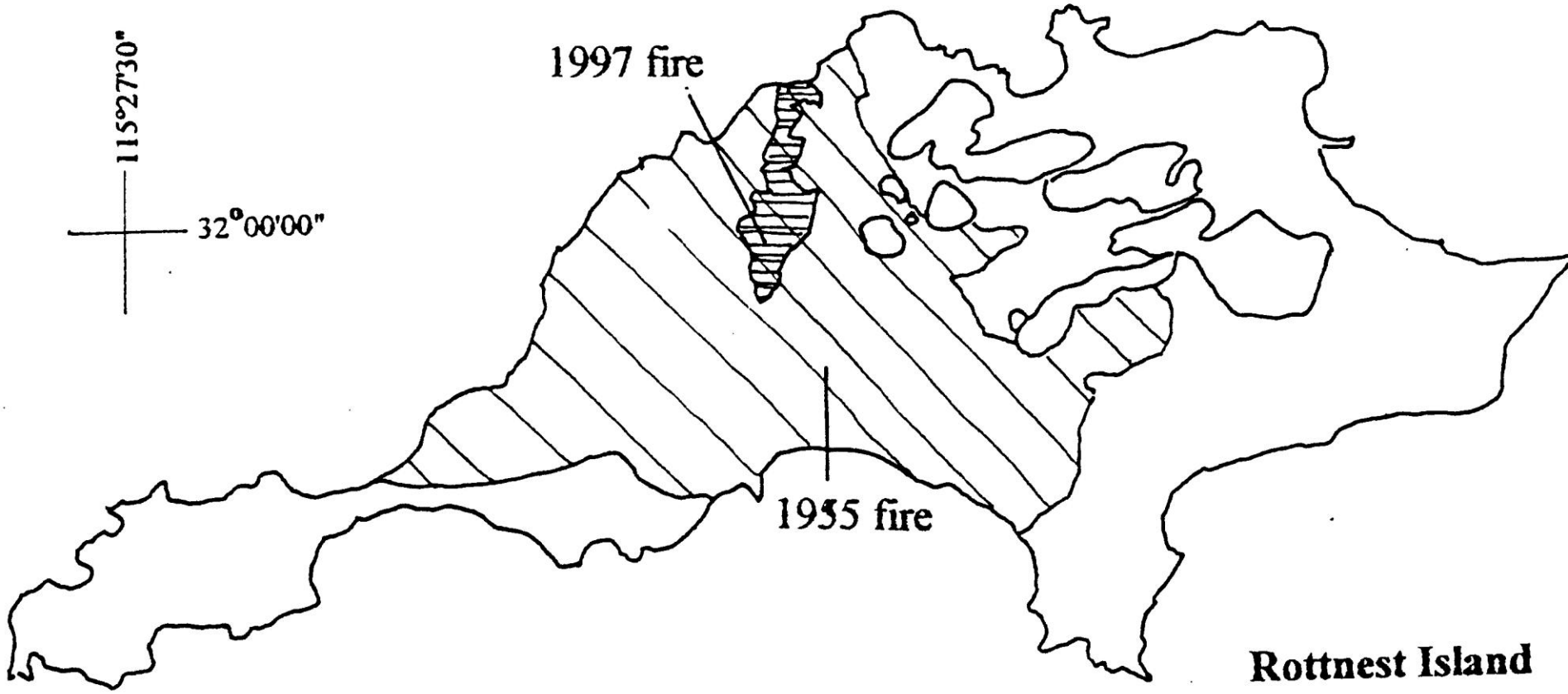


1955



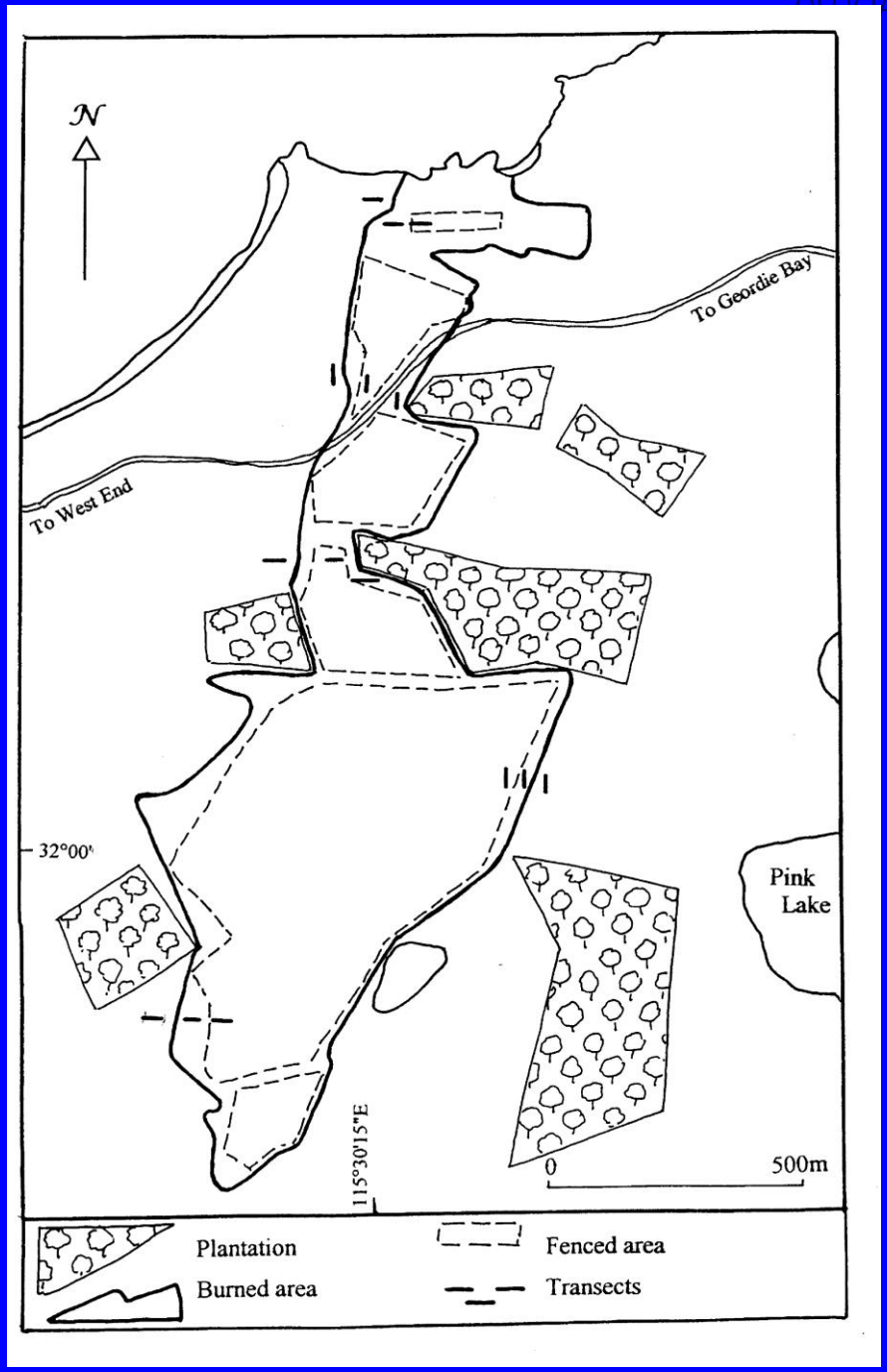
1982




115°27'30"
32°00'00"
1997 fire
1955 fire
Rottnest Island

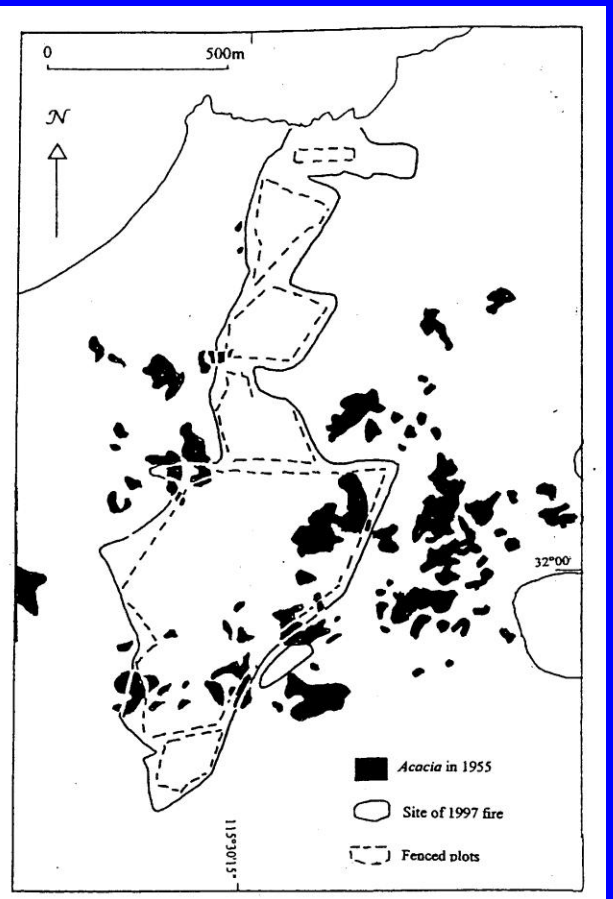

#12
17/4


12
11/25/57

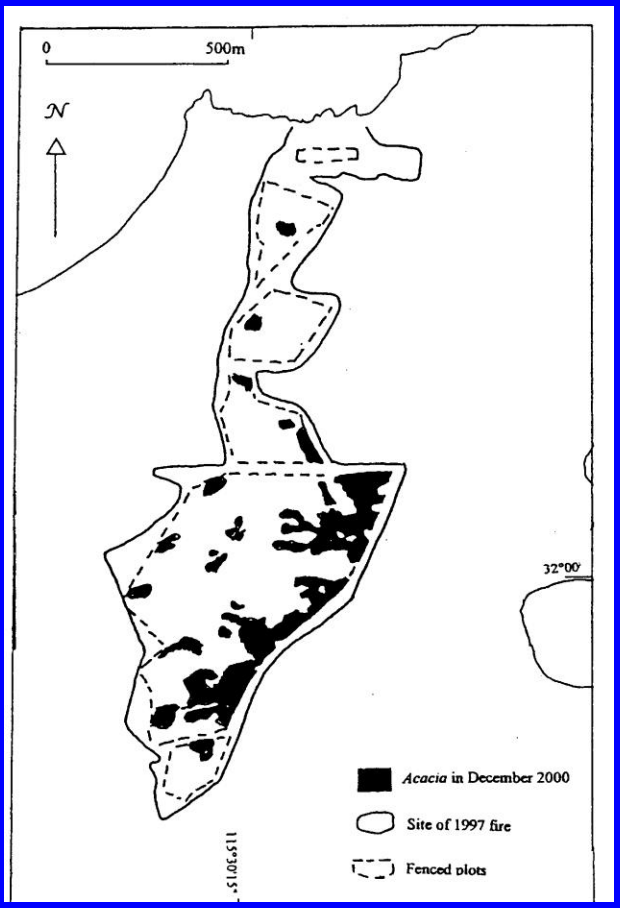


1997 fire area, Rottnest Island

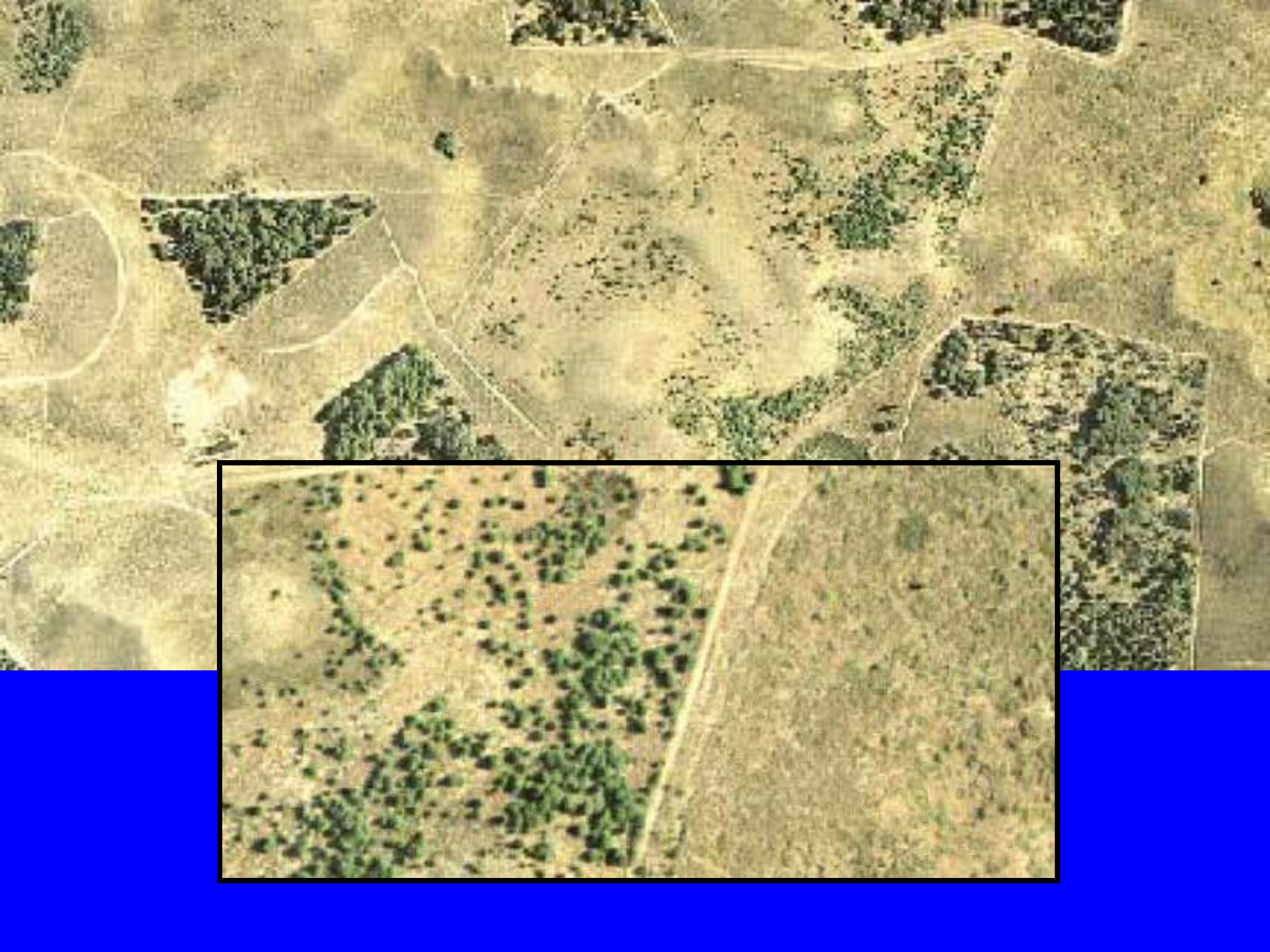
1942

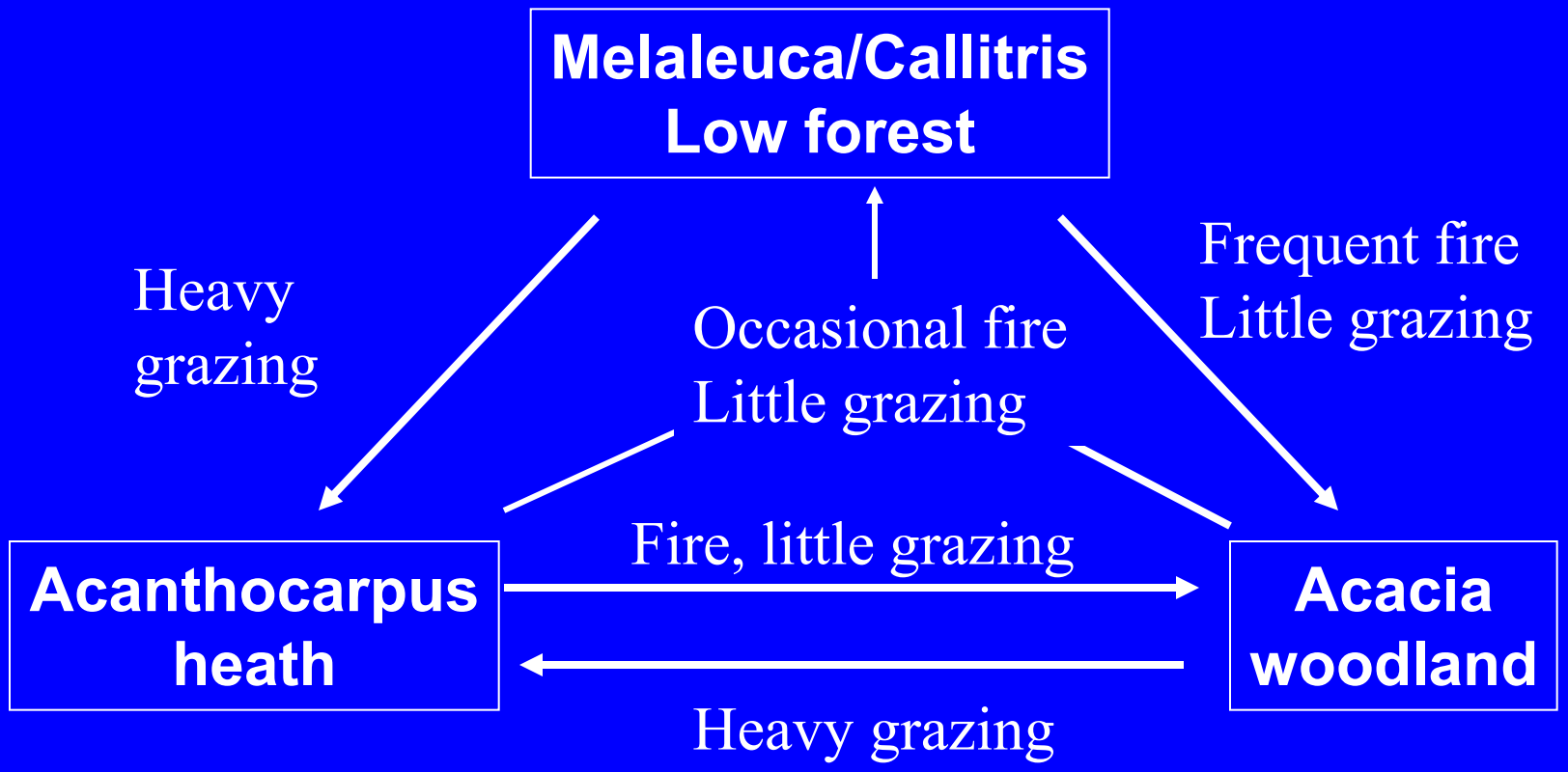


1955



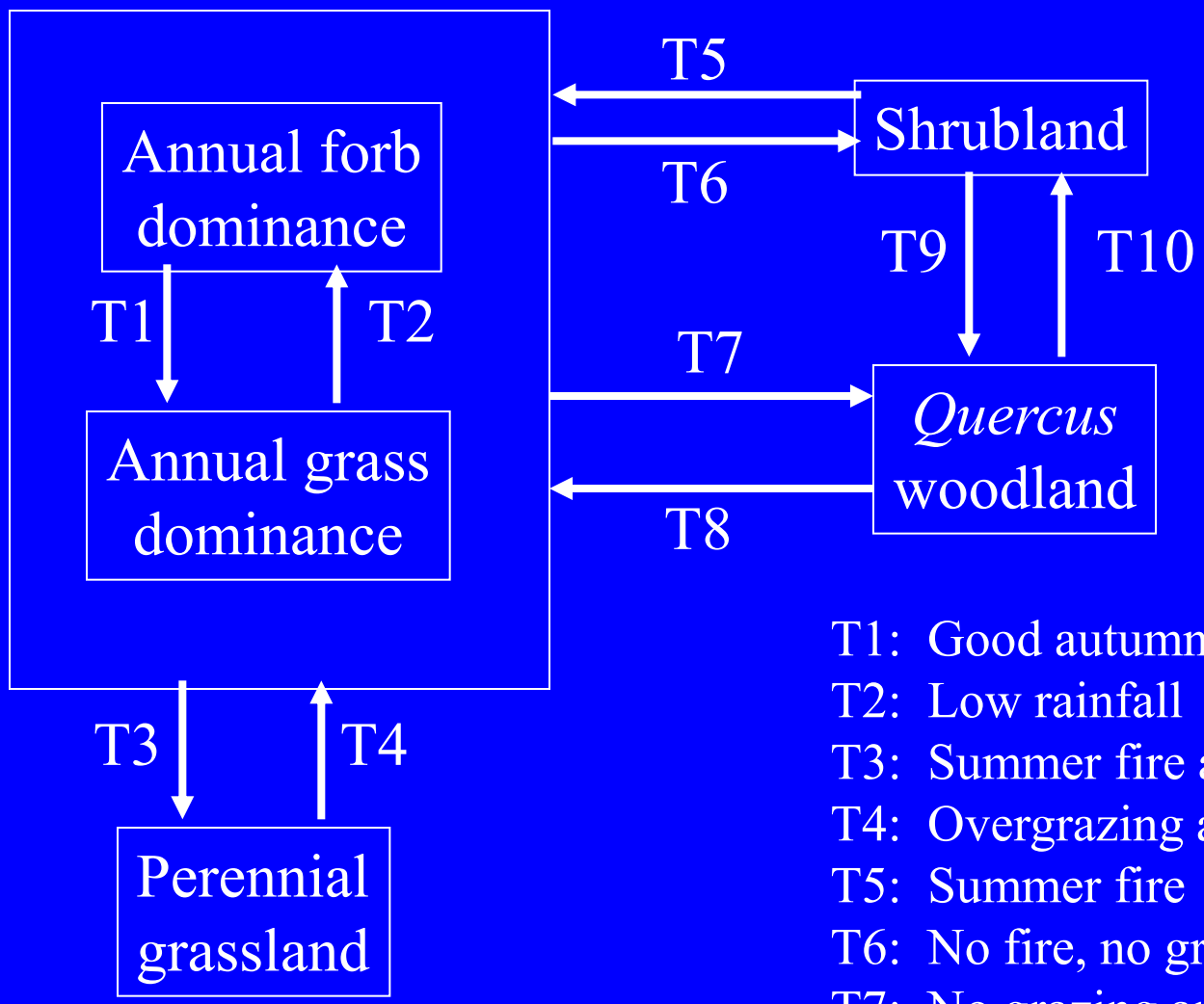
2000





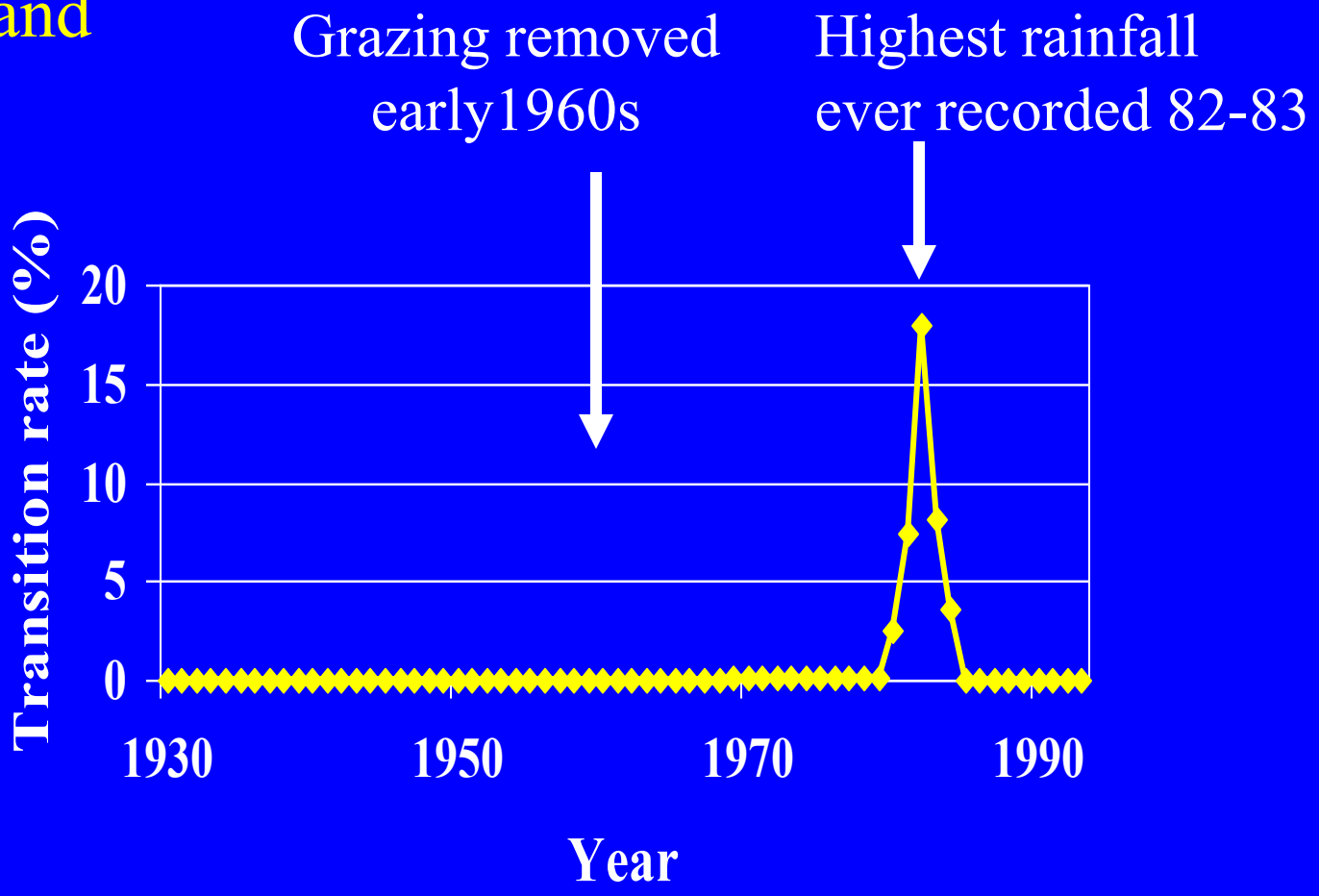
Alternative stable states in Rottnest vegetation

Alternative stable states model



T1: Good autumn/winter rain
T2: Low rainfall
T3: Summer fire and/or spring grazing
T4: Overgrazing and drought
T5: Summer fire
T6: No fire, no grazing, high rainfall
T7: No grazing and high rainfall
T8: Drought or fire and/or grazing
T9: No fire and no grazing (gradual)
T10: Fire

Transition from annual grassland to shrubland



Conclusions

- Fire is one of many influences on ecosystems
- Fire management = weed management in some cases
- Fire effects will be different in fragmented and modified ecosystems
- Fire can interact with other disturbances and modifications to create different ecosystem states
- Consider fire in the broader context of ecosystem dynamics