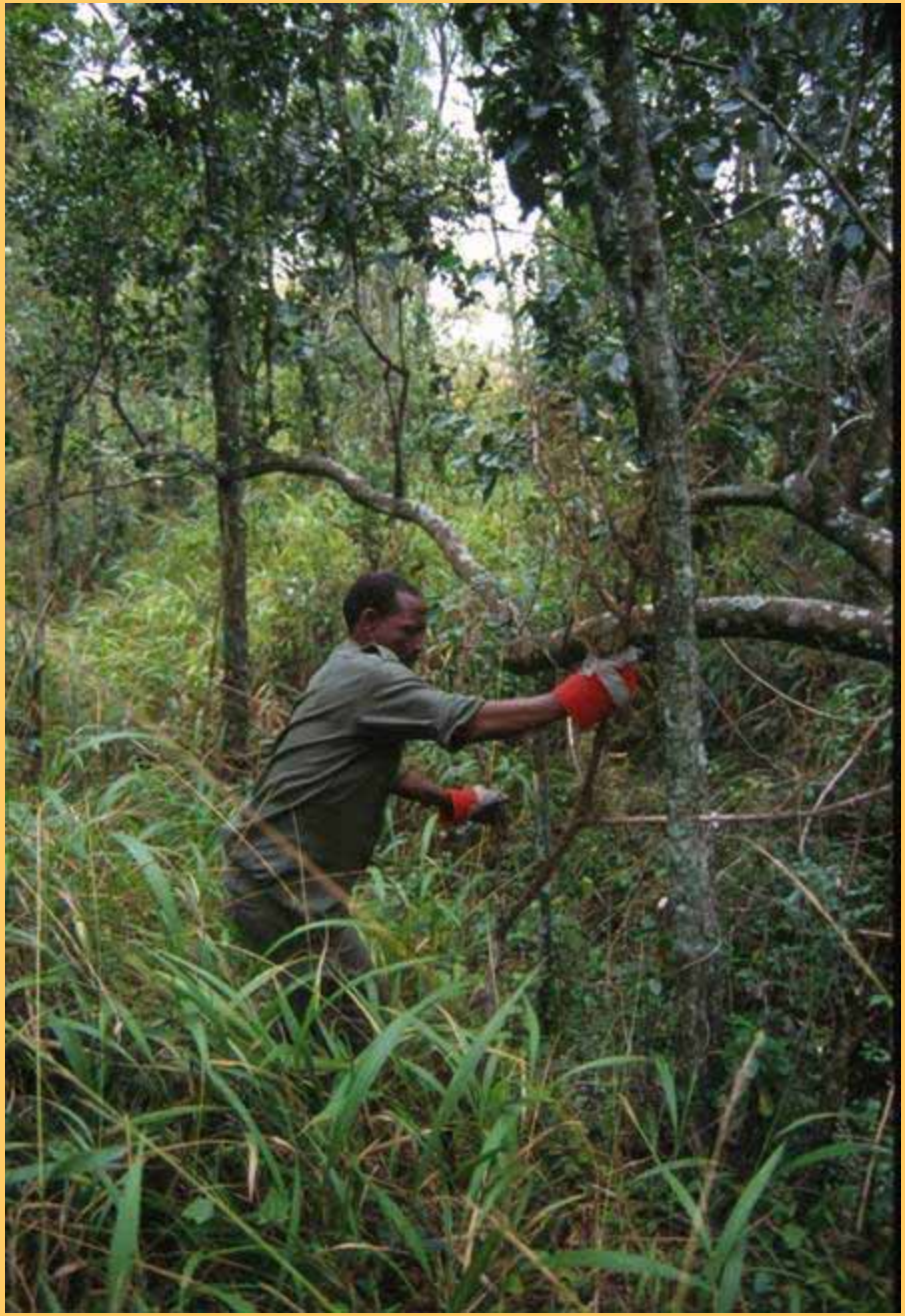
Lessons for ecology, conservation and society from the Serengeti

Anthony R.E. Sinclair
Centre for Biodiversity Research
University of British Columbia, Canada

THANK YOU

Dr. Simon Mduma
Head of TAWIRI &
the Serengeti
Biodiversity Progam

The Macaulay Institute
Frankfurt Zoological Society
NSERC, Canada
National Geographic Society
Wildlife Conservation Society



THE TEAM

Simon Mduma
Stephen Makacha
Ally Nkwabi
John Mchetto
Anne Sinclair
John Fryxell
Ray Hilborn
Roy Turkington
Kris Metzger
and indirectly

Markus Borner
Simon Thirgood
and many others

THE WORLD PROBLEM

Species are being lost at unprecedented rates.

How much can we lose before the ecosystems in which we live become unsustainable?

Species exist within a matrix of other species and are subject to the effects of their environment

We must understand how the whole system behaves- lack of understanding could lead to surprise, inappropriate management, or even system collapse

THE NEED

- therefore, one must understand important properties of ecosystems to apply

  - effective management

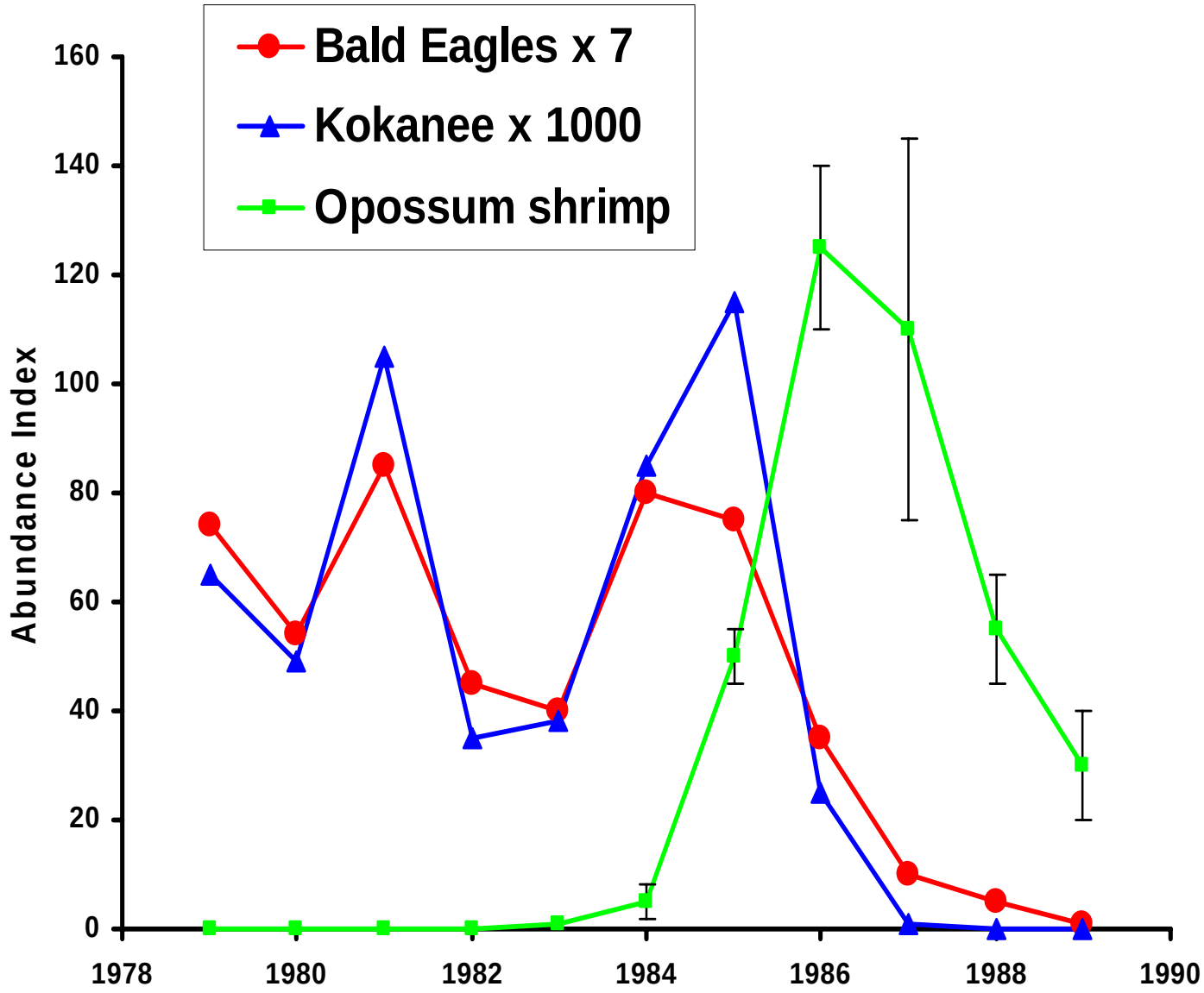
  - effective conservation

Changes in Ecosystems can lead to unexpected outcomes

Flathead Lake, Montana

Opossum shrimp added to provide extra food for
Kokanee Salmon
Bald eagles

Flathead lake, Montana

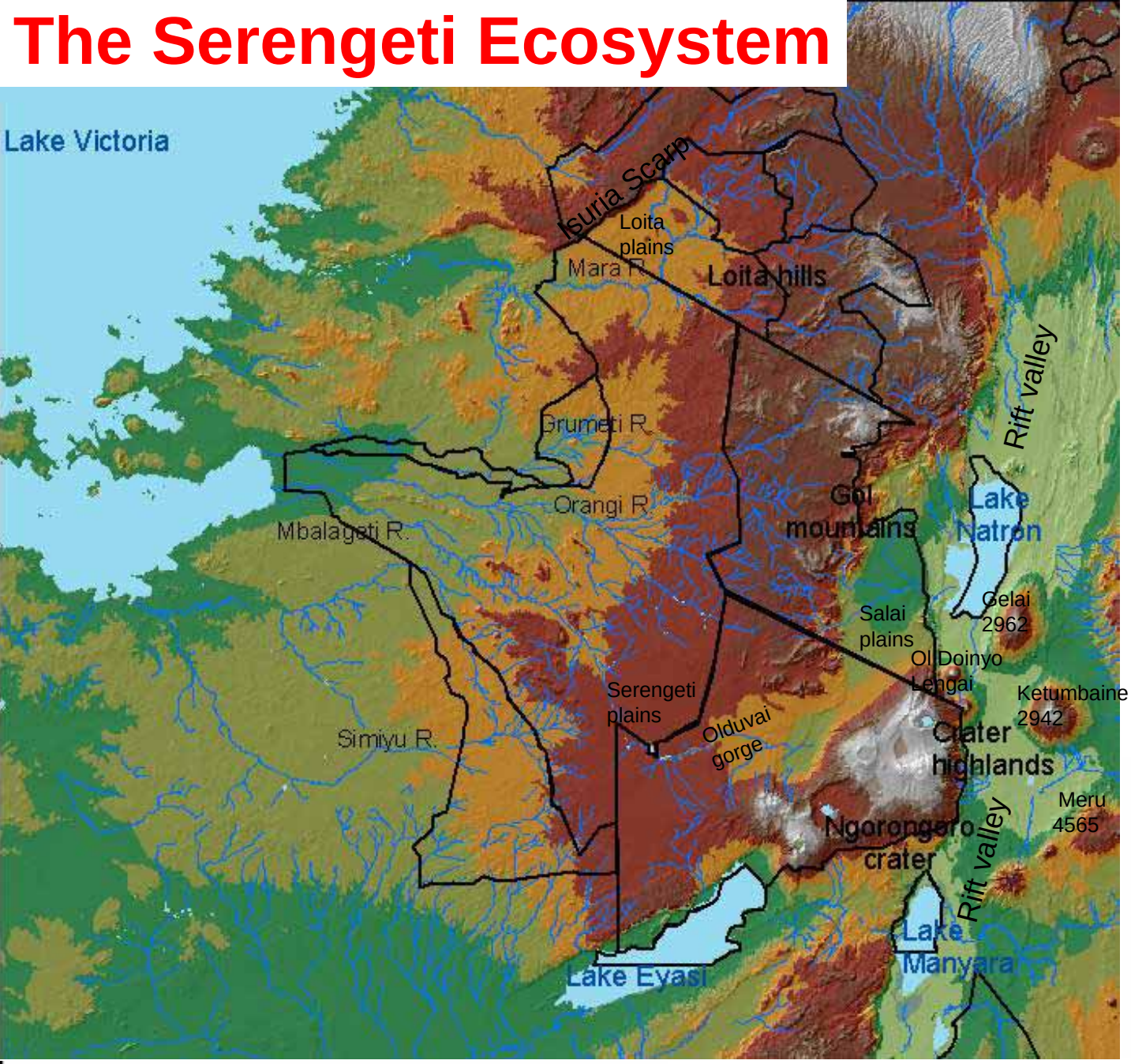


Spencer et al. 1991 BioScience

Unexpected events occur because of complex interactions.

Illustrated by events in Serengeti, Tanzania

The Serengeti Ecosystem



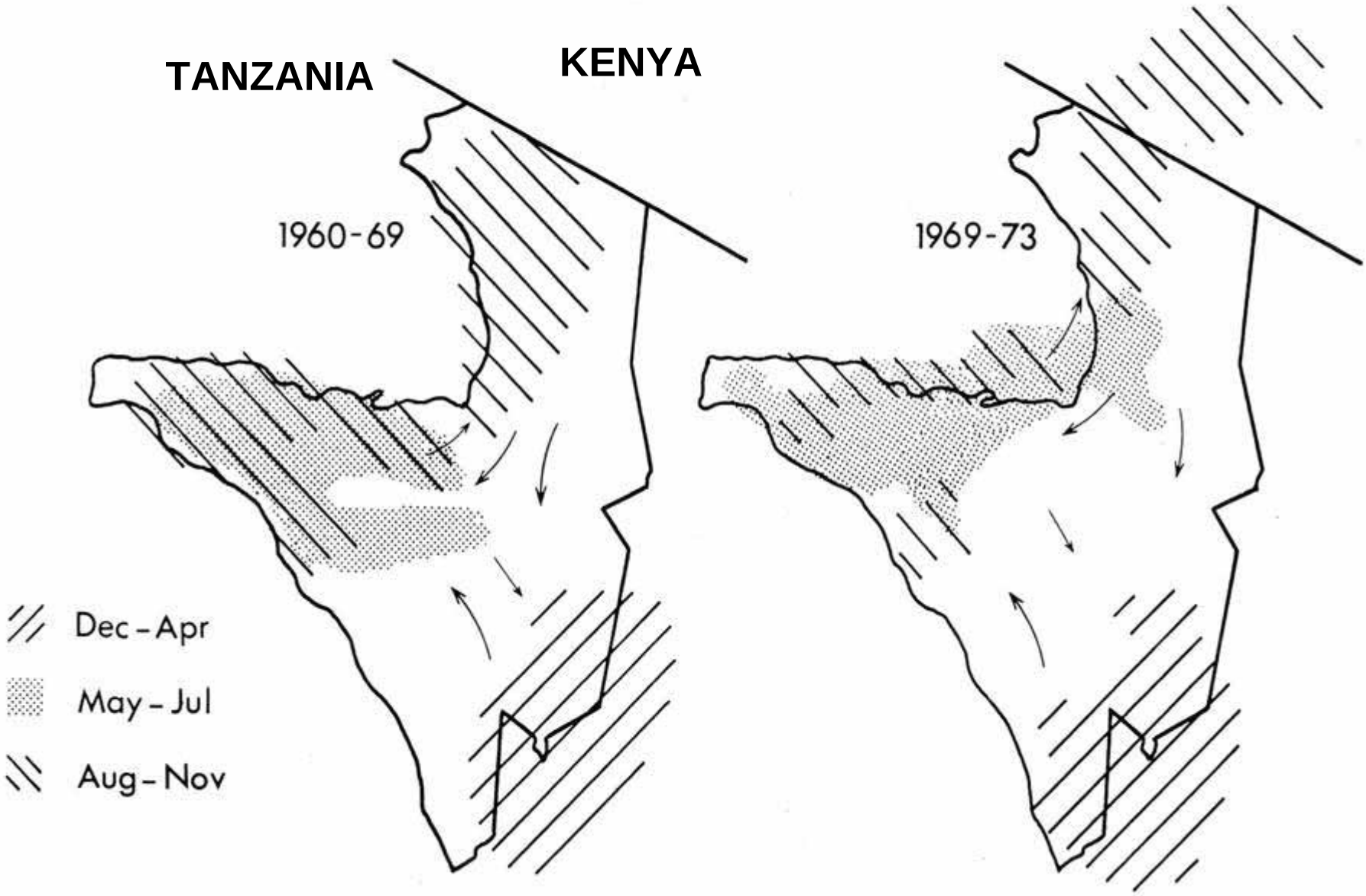
From Grant Hopcraft

SERENGETI IS COMPOSED OF TREELESS PLAINS


..AND SAVANNA WOODLANDS

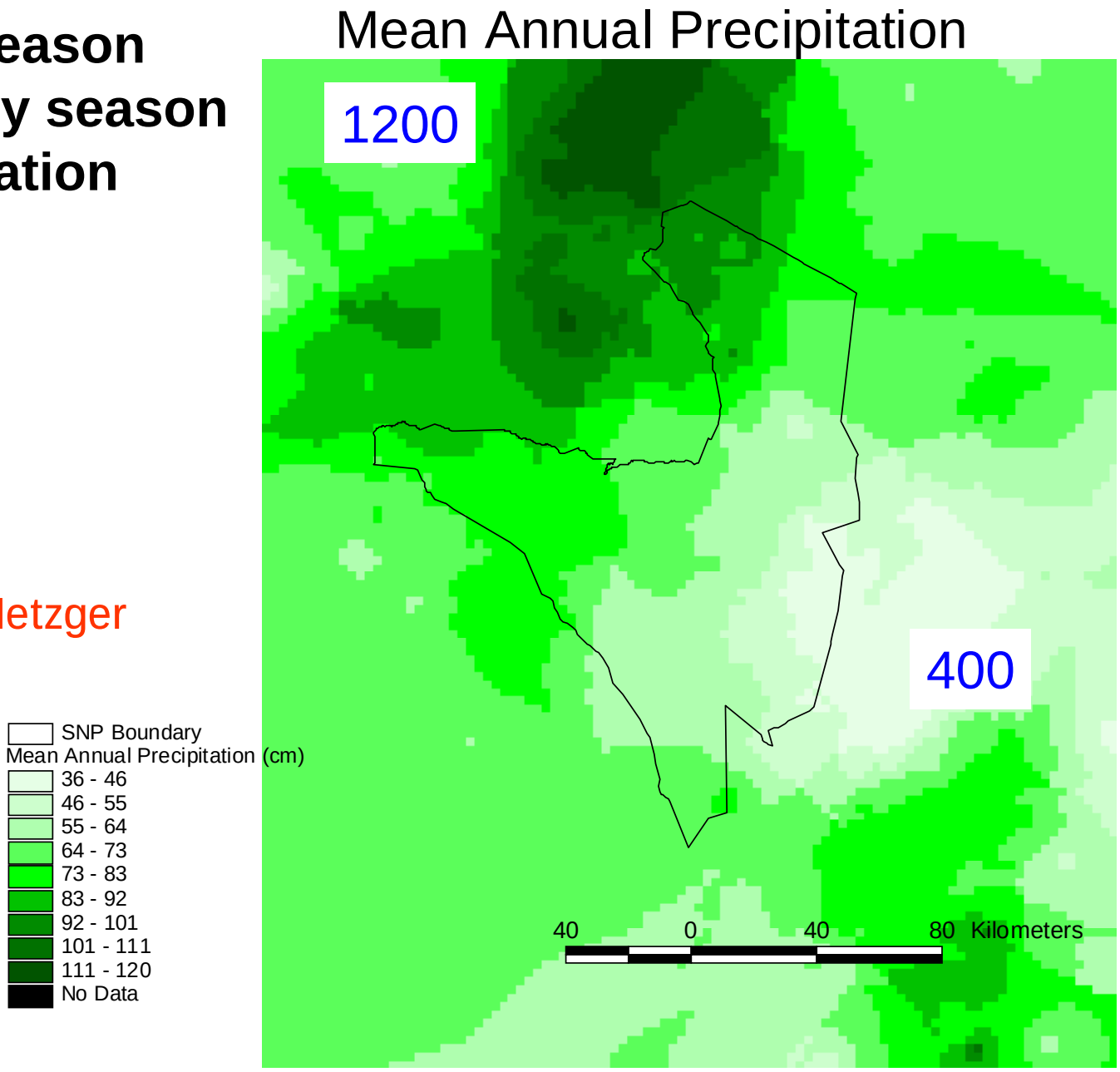

Wildebeest is the dominant species

Wildebeest migration patterns

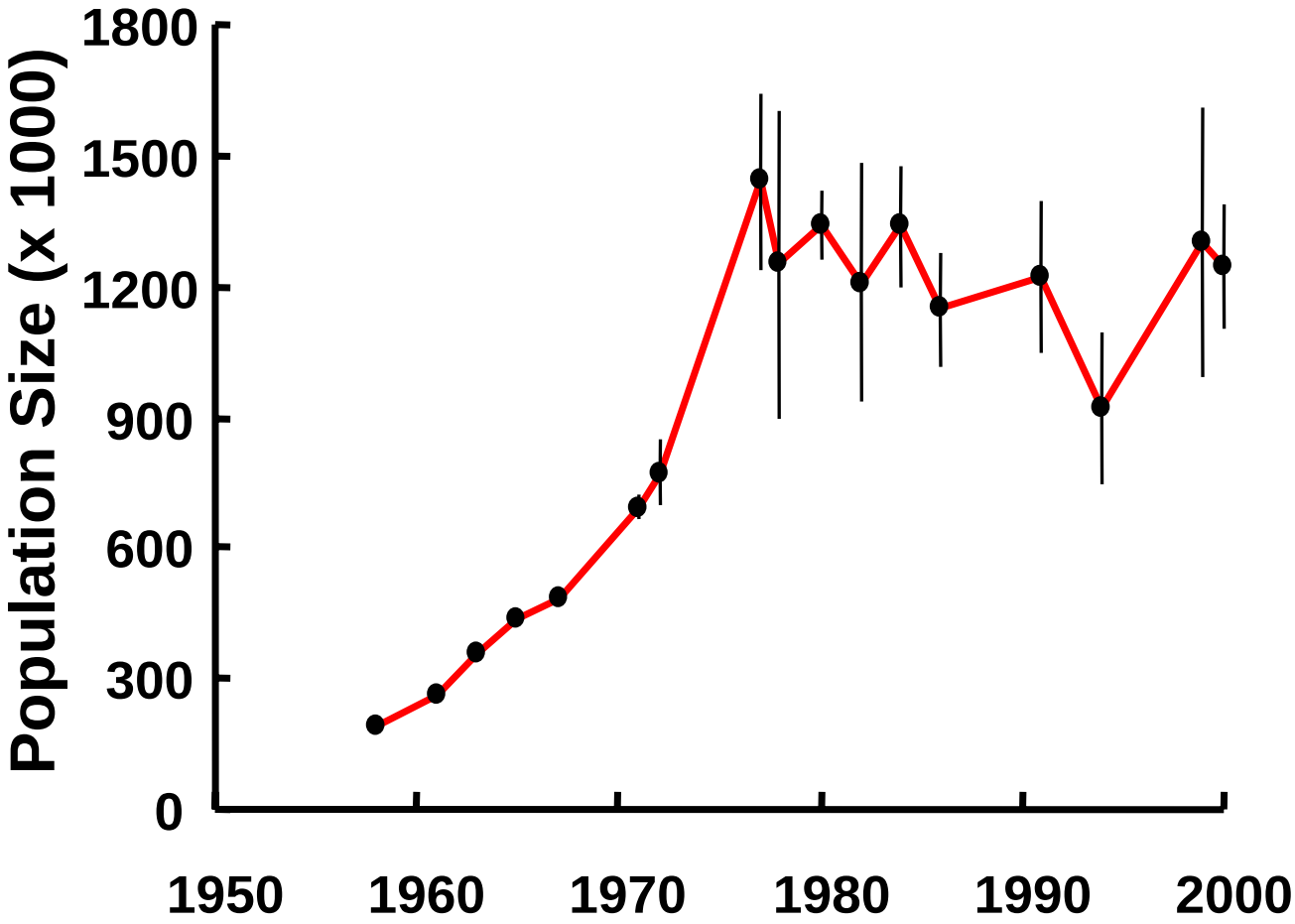


The reason for dry season migration

Kris Metzger



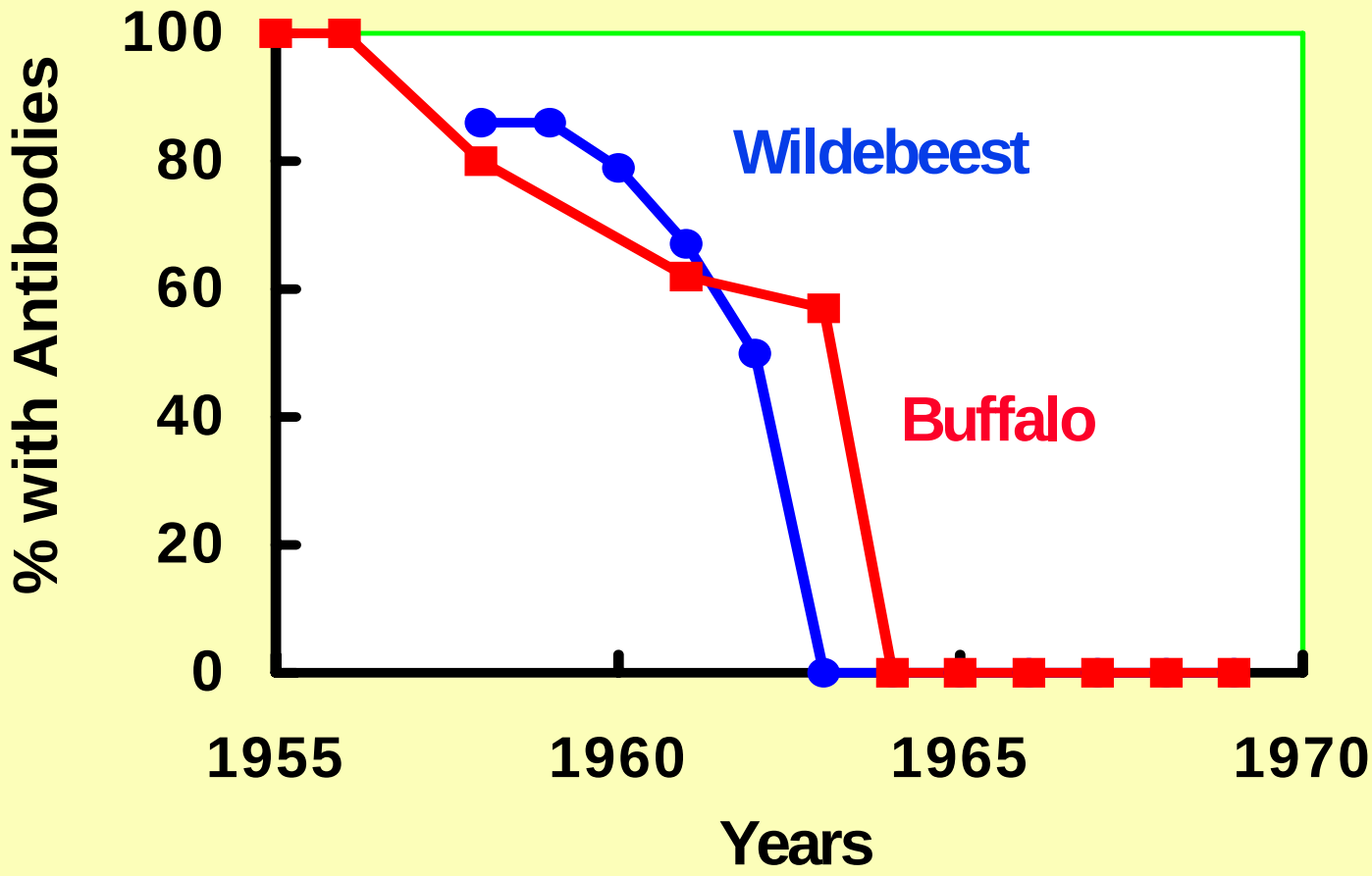
Serengeti Wildebeest Population outbreak – the event that changed everything – to understand it we must go back a century



The Great Rinderpest

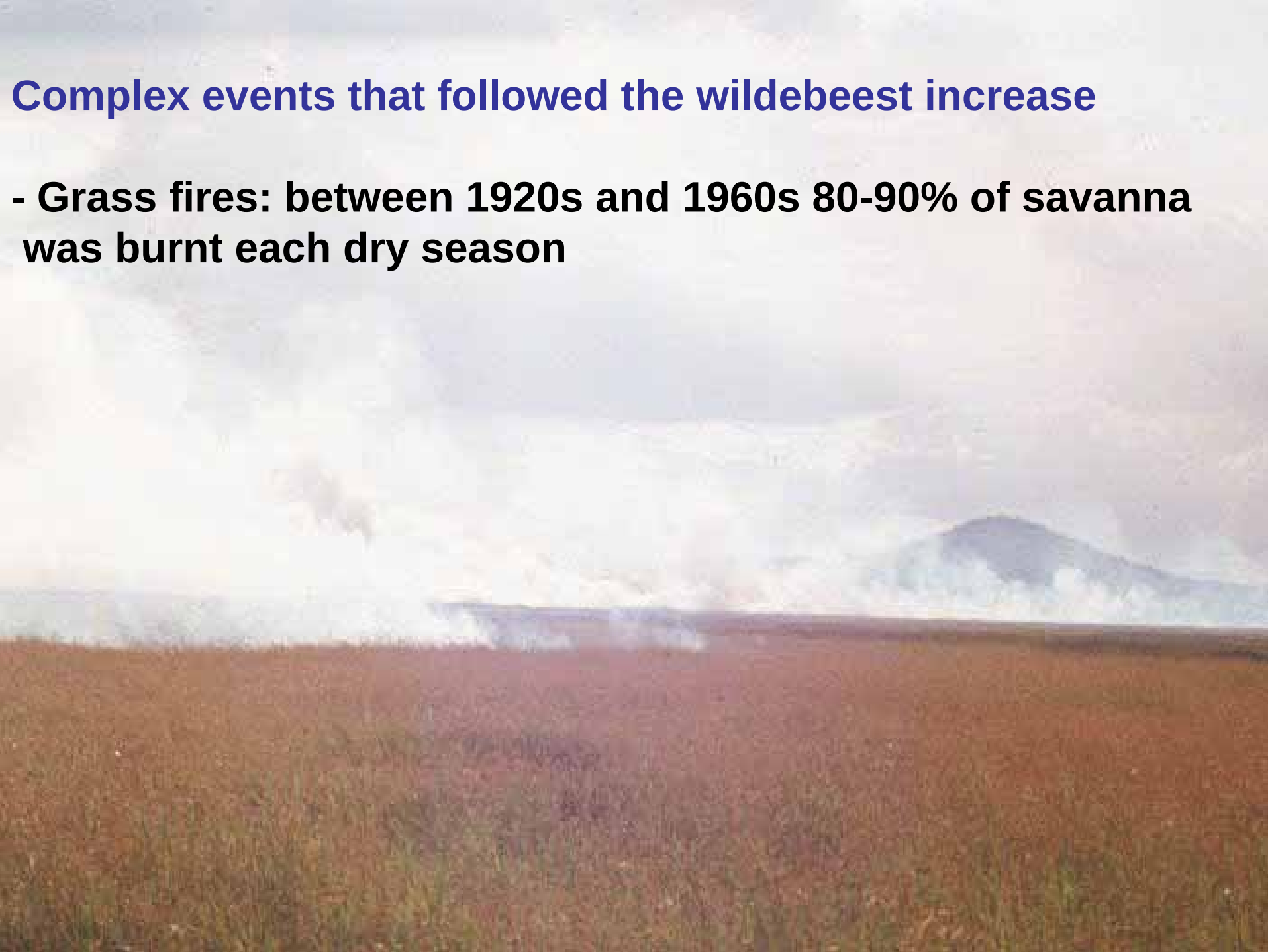
- **The Epizootic of 1889**
- **Ethiopia to Cape by 1896**
- **Die-off of cattle and other ruminants 95%**
- **These include African buffalo**
- **Wildebeest yearling disease present up to 1963**
- **THIS IS THE PERTURBATION THAT UNDERLIES OUR UNDERSTANDING OF THIS SYSTEM**

Incidence of Rinderpest in Serengeti



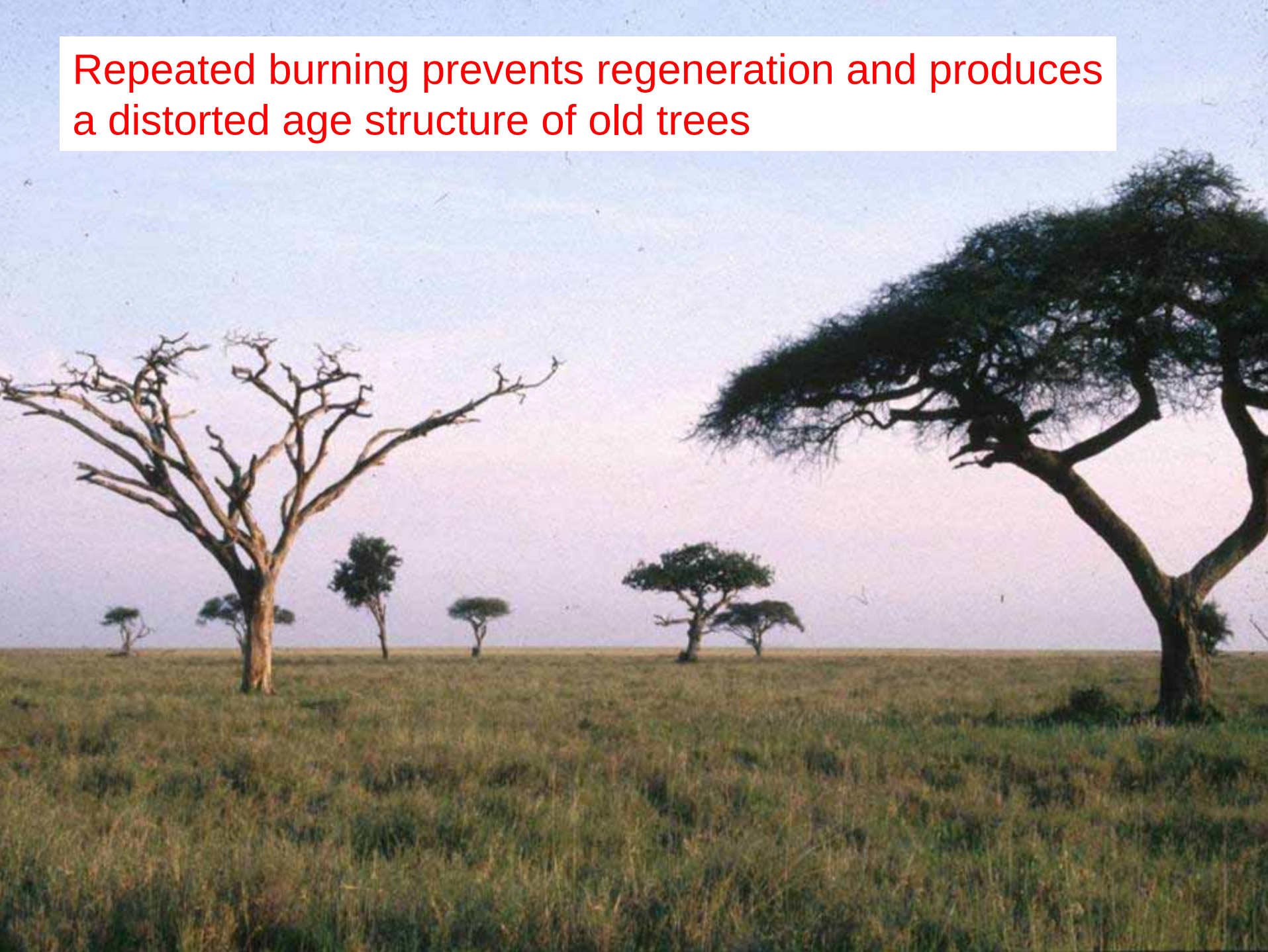
Complex events that followed the wildebeest increase

- Grass fires: between 1920s and 1960s 80-90% of savanna was burnt each dry season

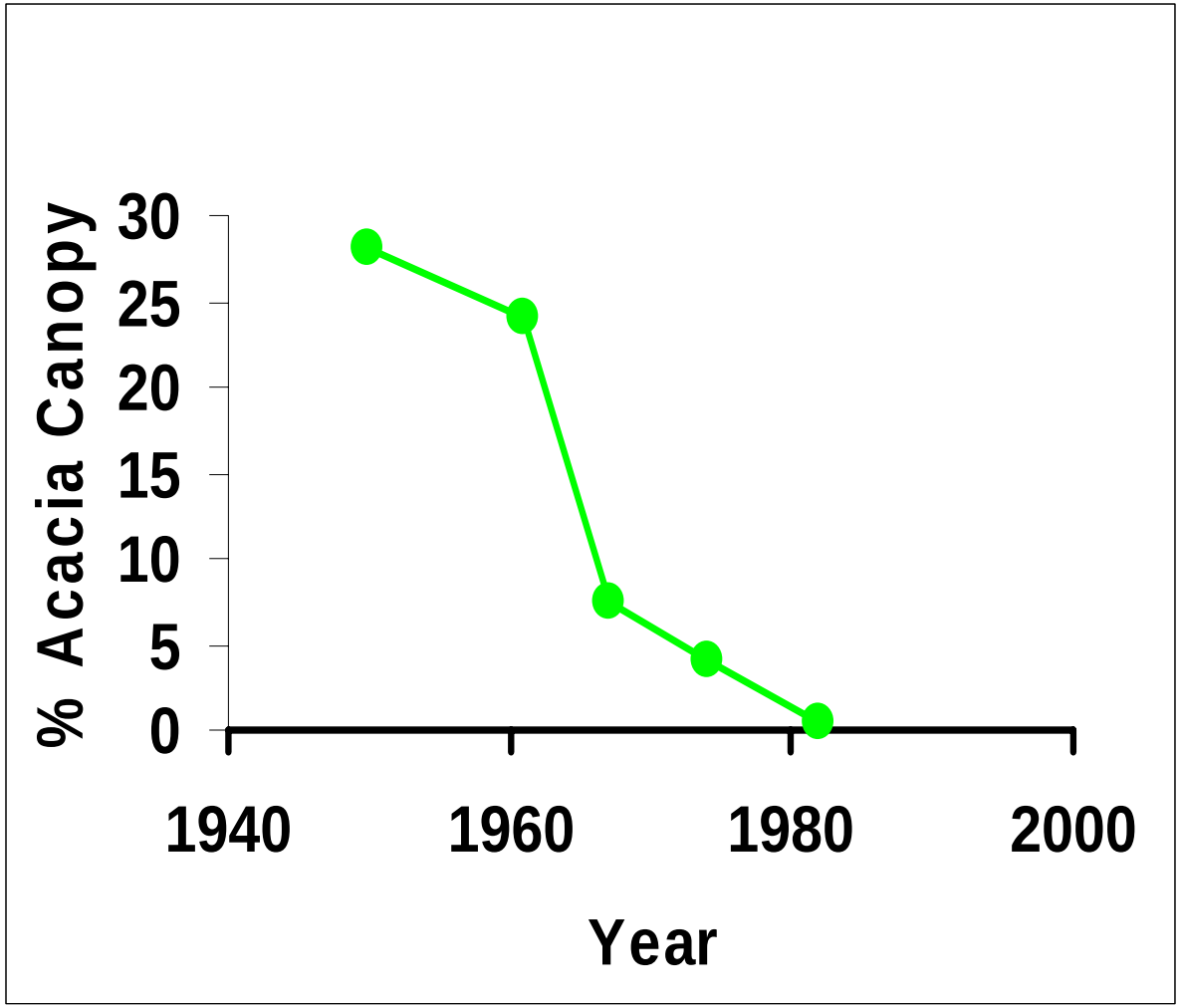



Grass fires prevent tree regeneration below 2 m height

Repeated burning prevents regeneration and produces a distorted age structure of old trees



% Acacia tree canopy cover drops rapidly in the 1960s



H.Dublin 1986

Northern Serengeti, Mara triangle 1944

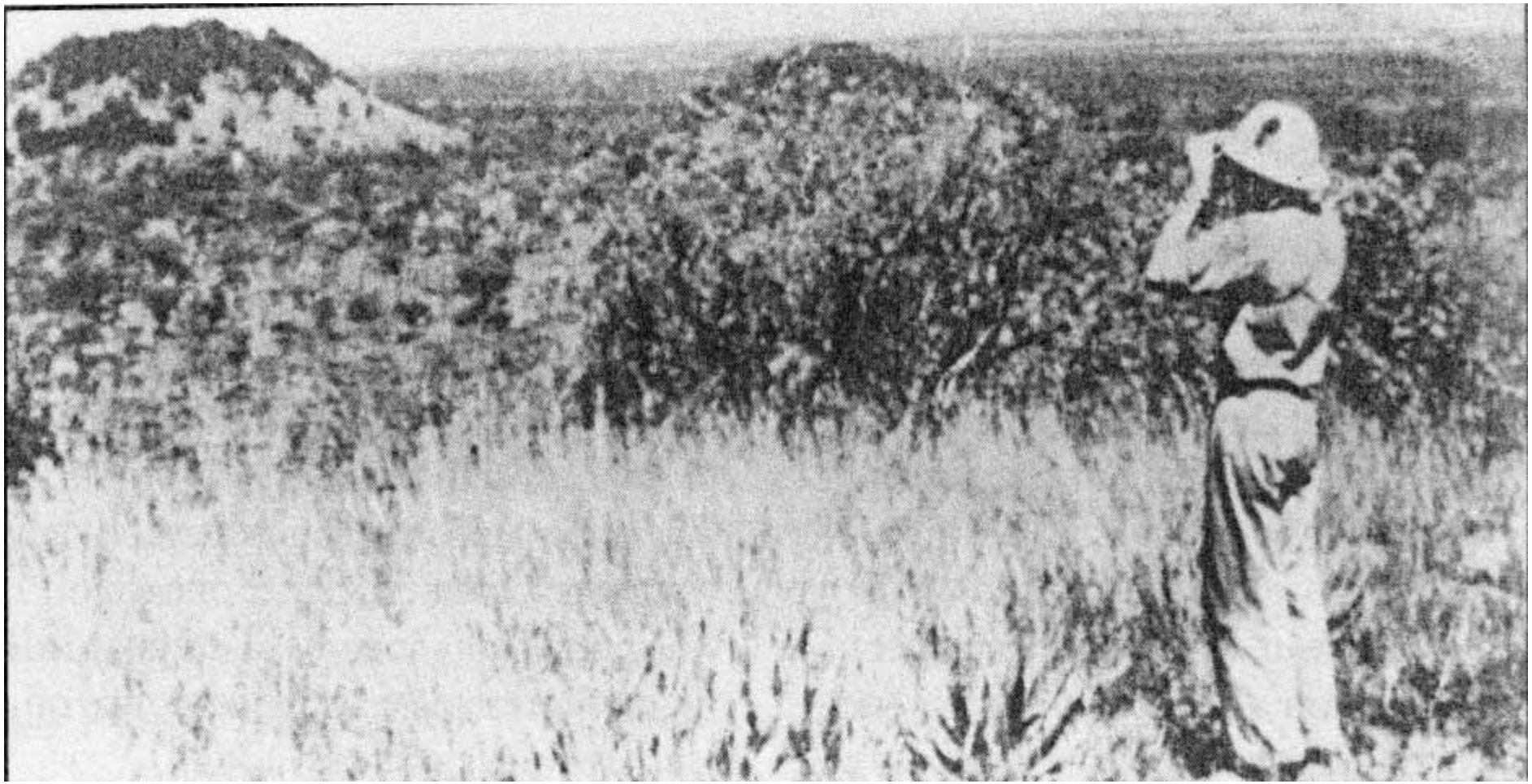
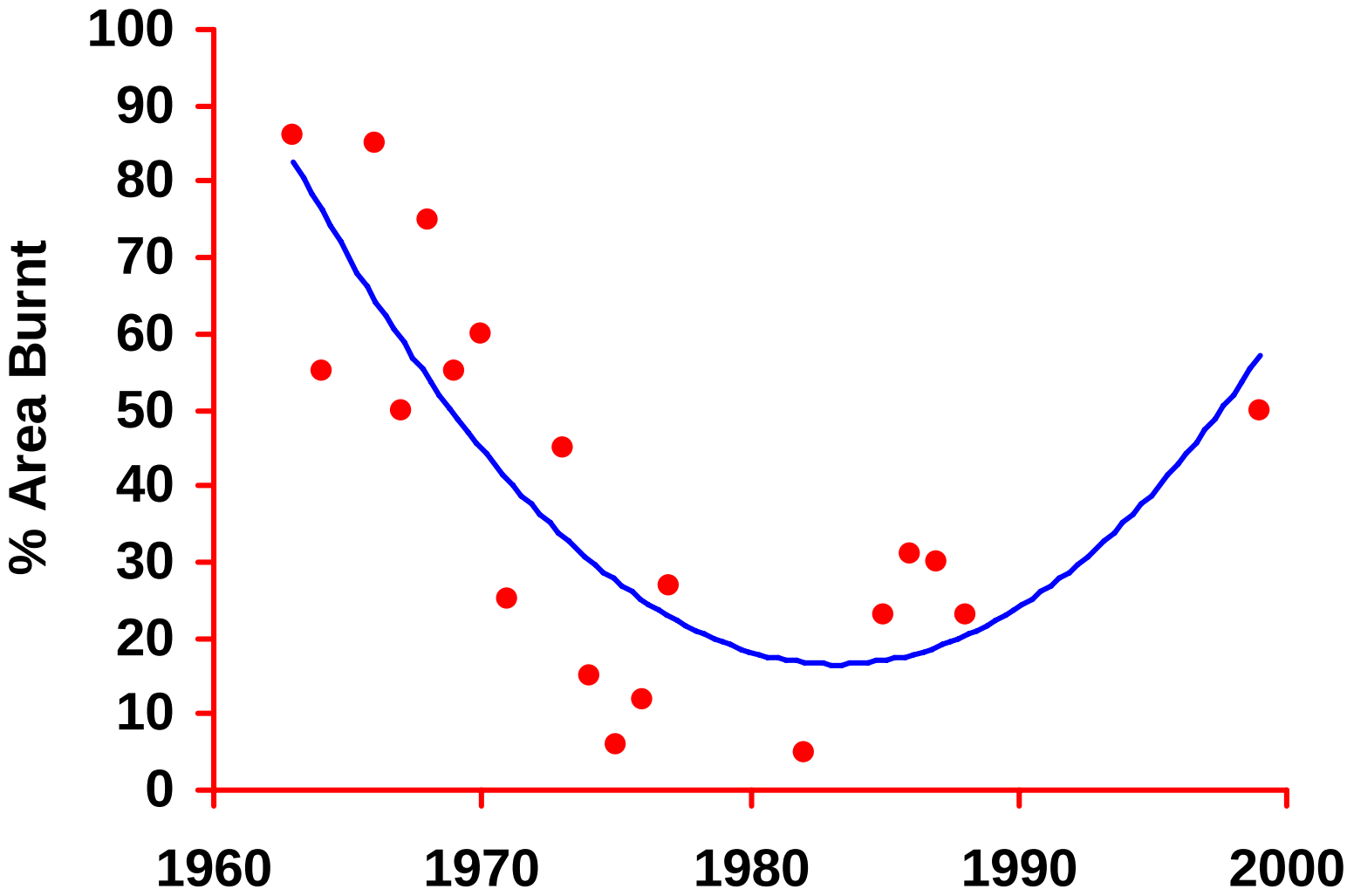


Photo Syd Downey

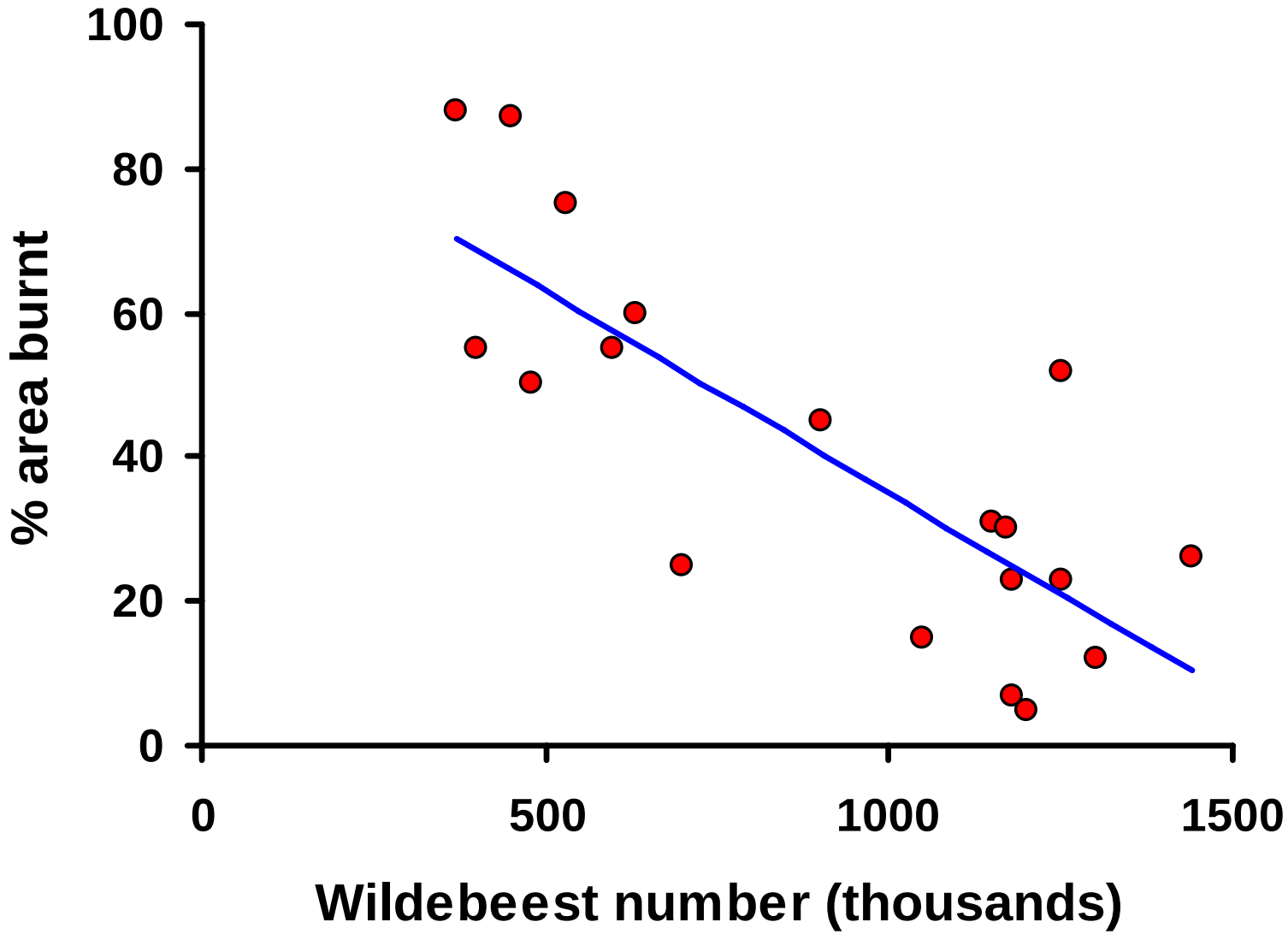

1983


Wildebeest grazing reduces grass fuel and area burnt

SERENGETI AREA BURNT IN DRY SEASON



Increase in wildebeest causes decrease in burning



Complex interactions of wildebeest and the environment

The extent of grass fires is determined by the degree of grazing imposed by wildebeest

….this had consequences on savanna trees

Savanna

1980

1986

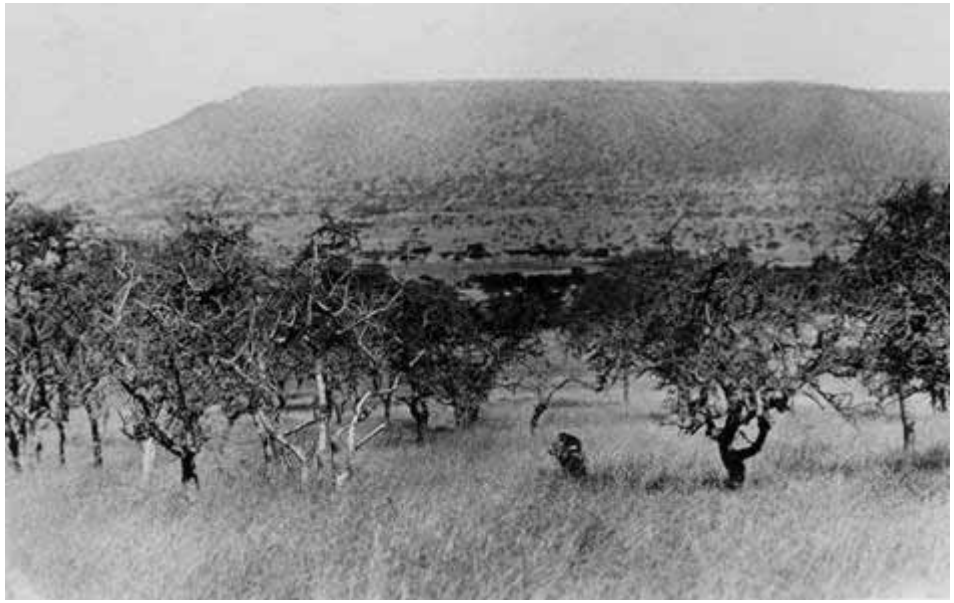
1991

2003

Martin and Osa Johnson 1928

Osa Johnson filming from plane 1933

NYARABORO FROM EMAKAT



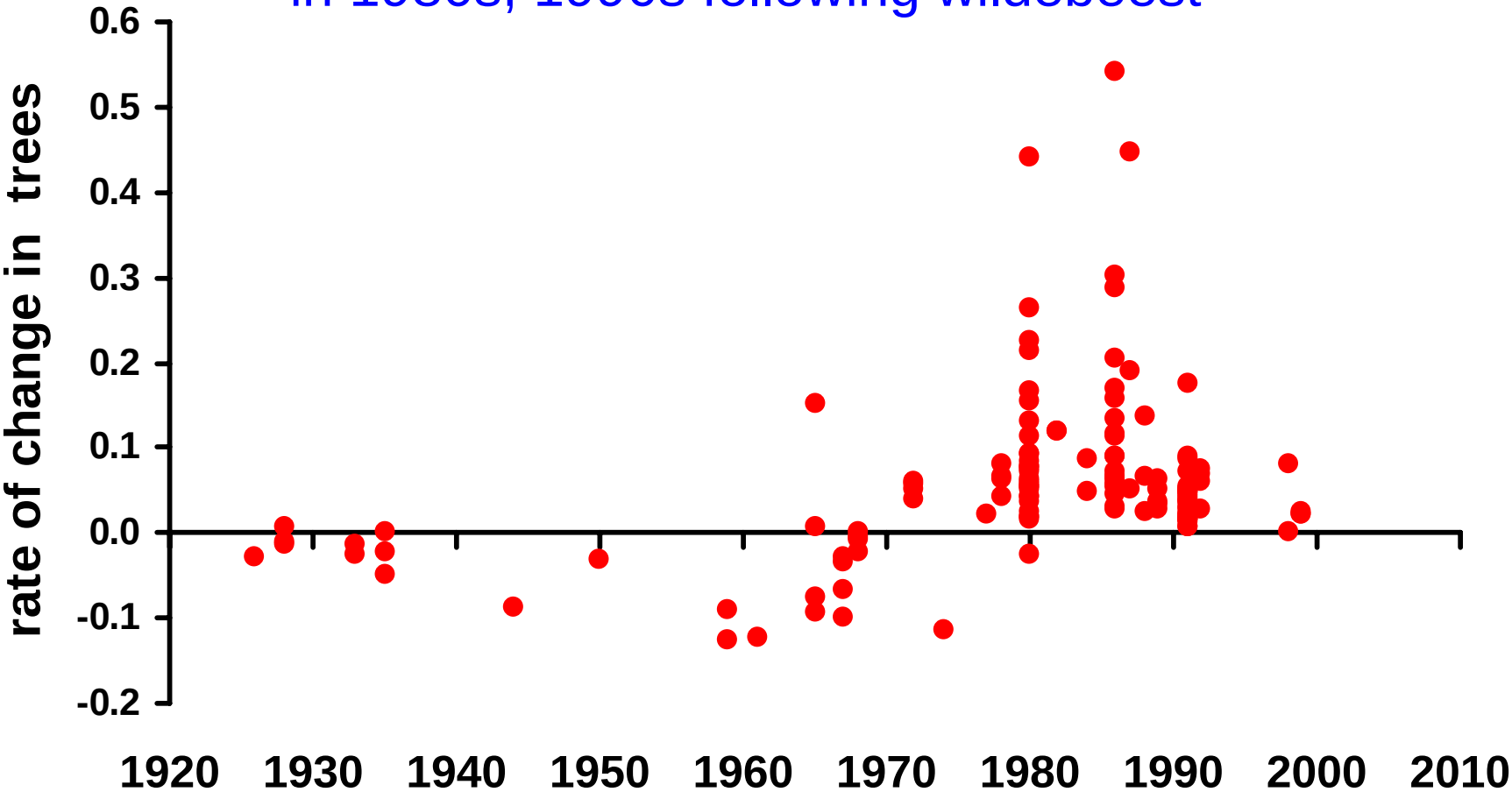
1928

1982

2003

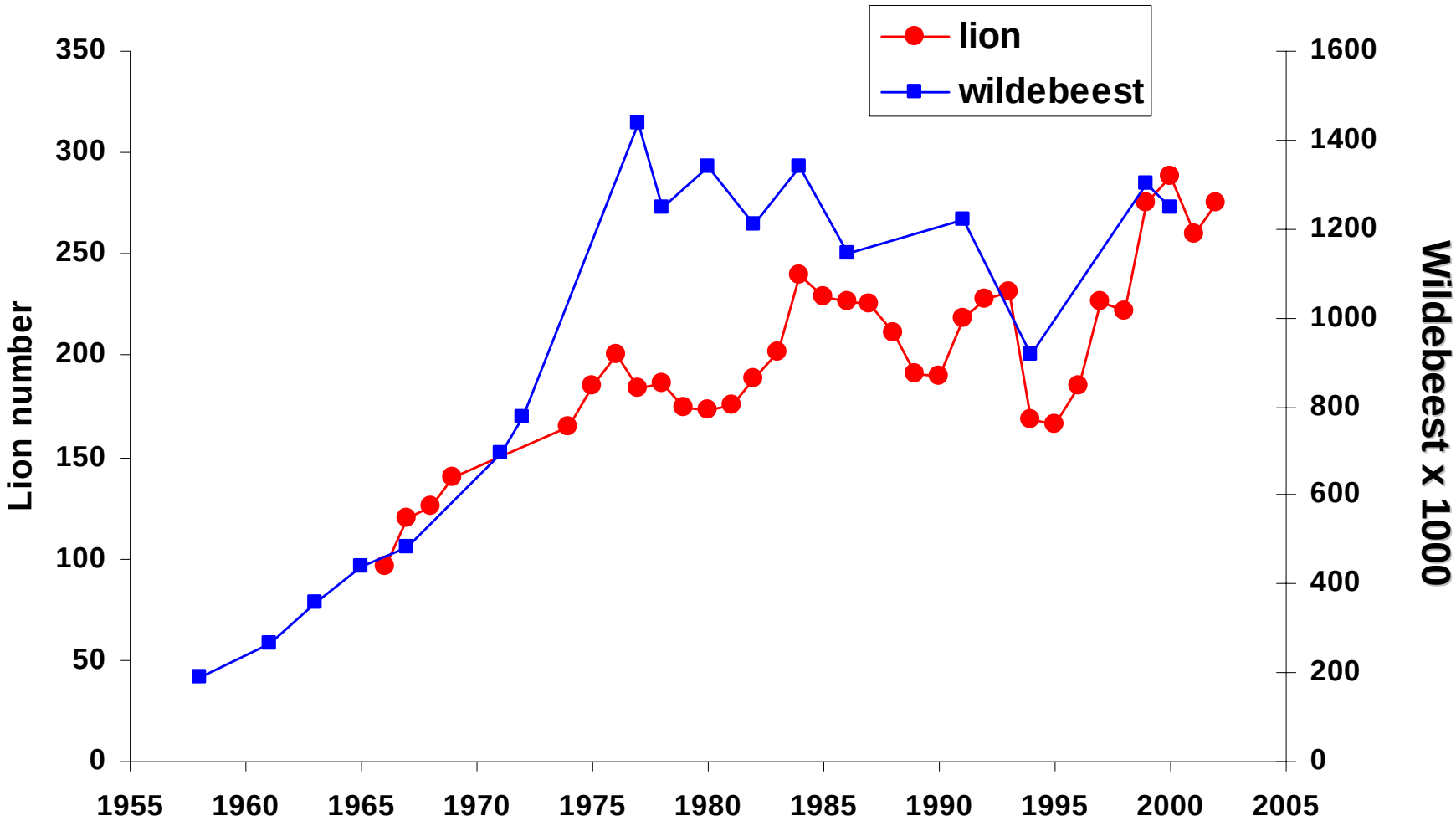
SERENGETI TREE DENSITY

Instantaneous rate of change in tree density
negative 1920s-1960s, then increases rapidly
in 1980s, 1990s following wildebeest



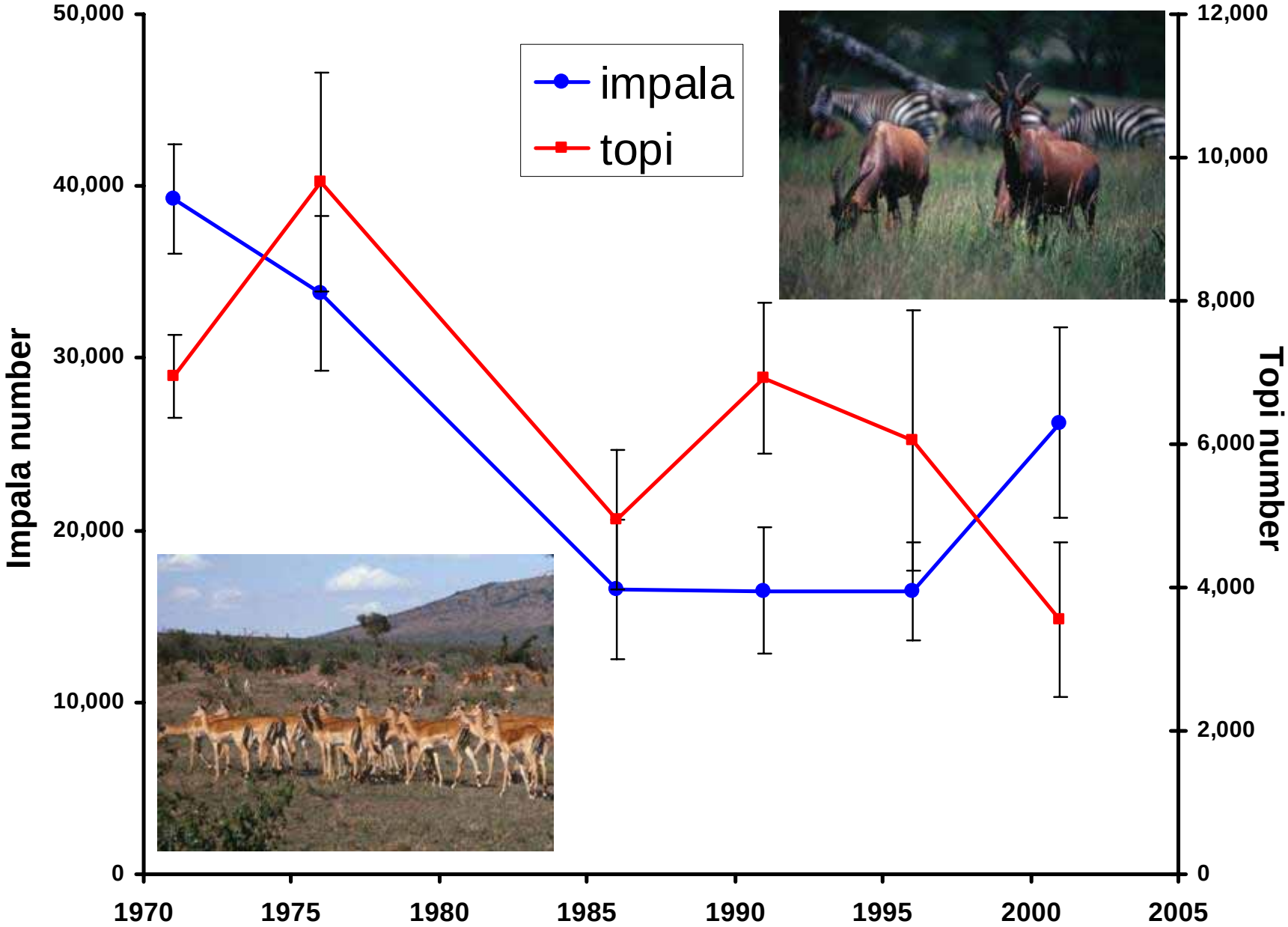
Lions use thickets to capture prey
- more thicket improves success

Serengeti woodland lion numbers increase in the 1990s



Lion data from C. Packer

Decrease in most resident prey



Disturbance and multiple states

Ecosystems are continually being disturbed

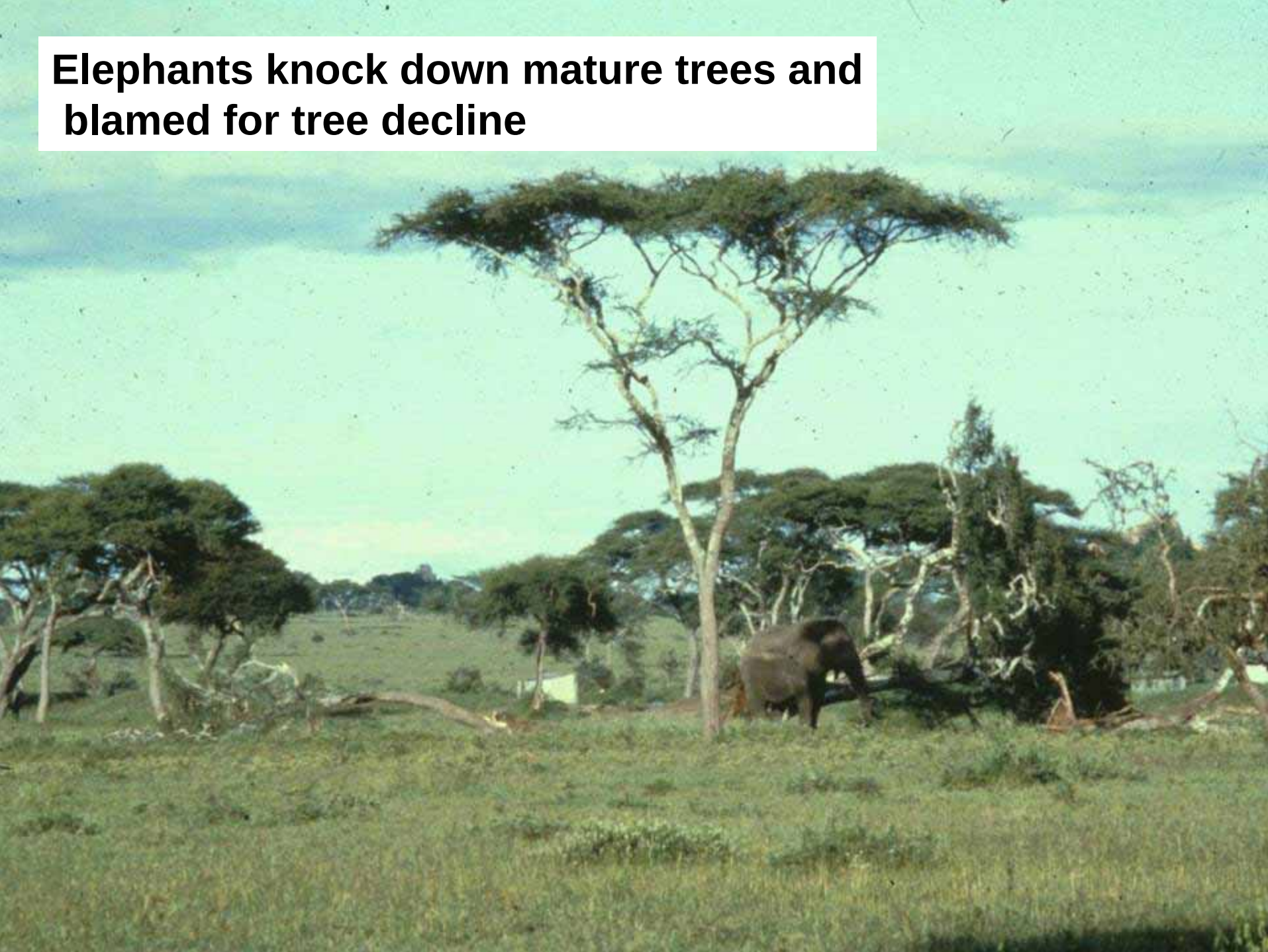
weather events
human harvesting
invasions of species
predation

Disturbance can cause a change of state

Disturbance changes ecosystems – which do not always return to the original state afterwards

The role of elephants in Serengeti

Elephants knock down mature trees and blamed for tree decline

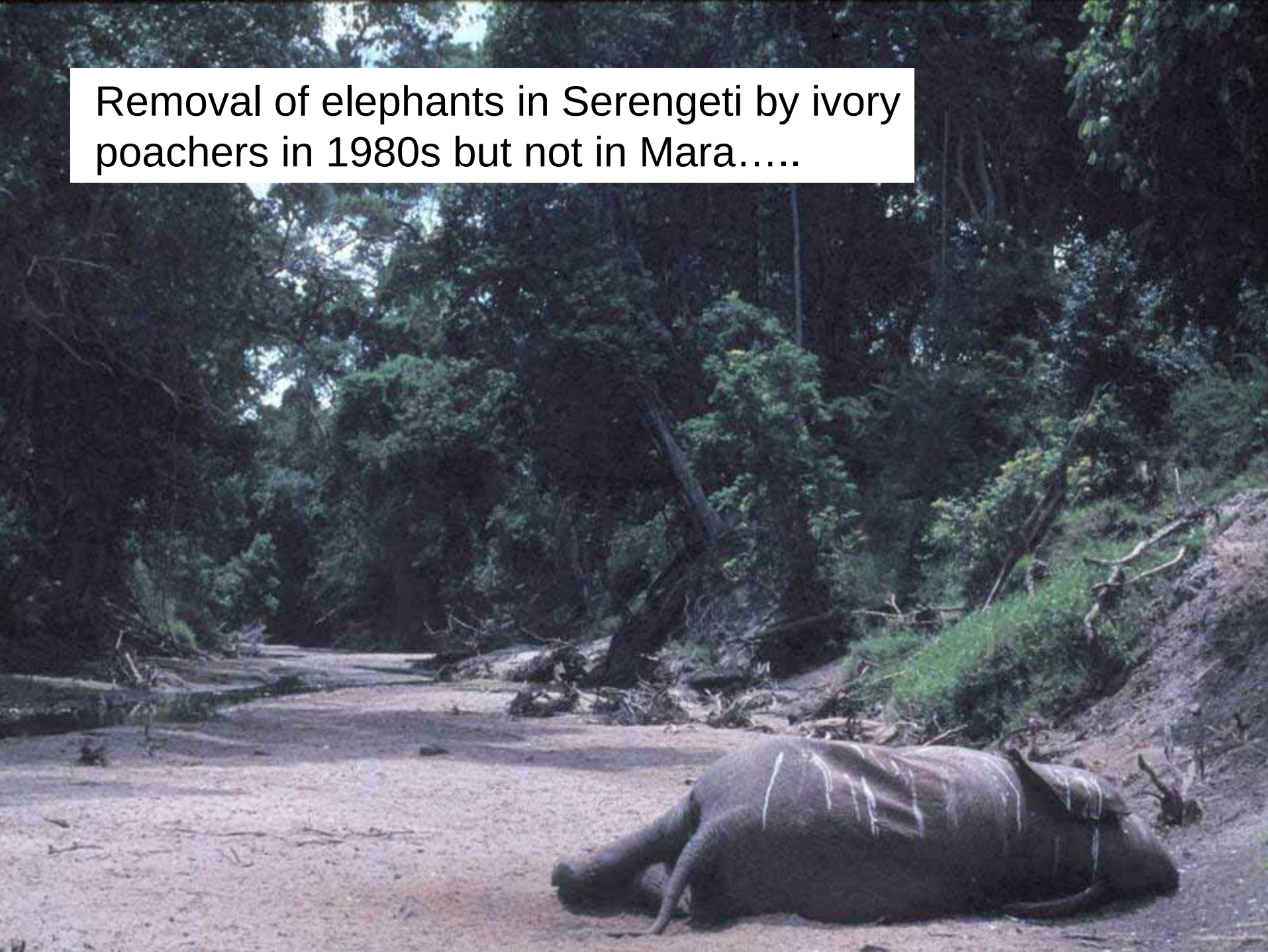


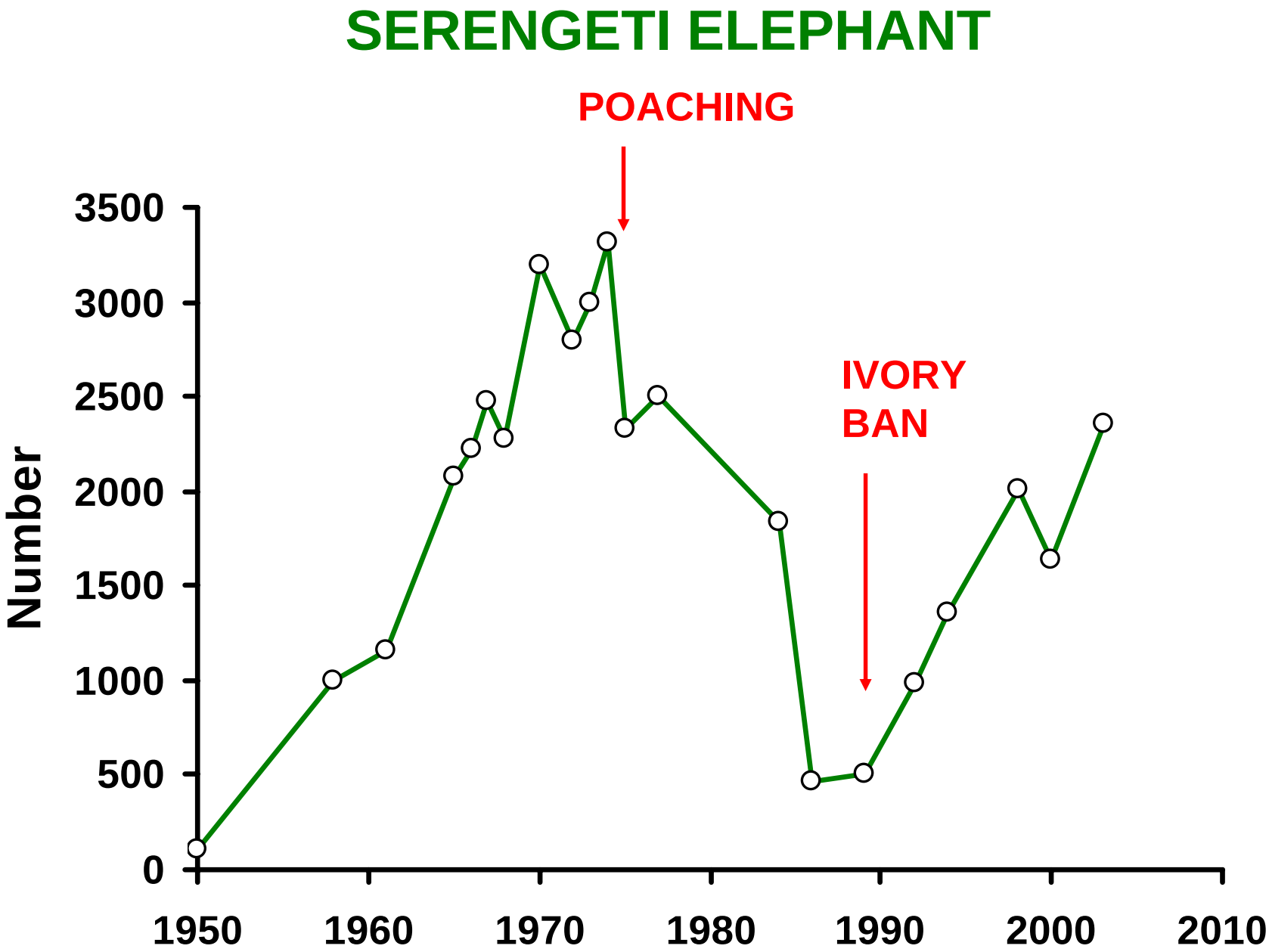
Trees and elephant predation

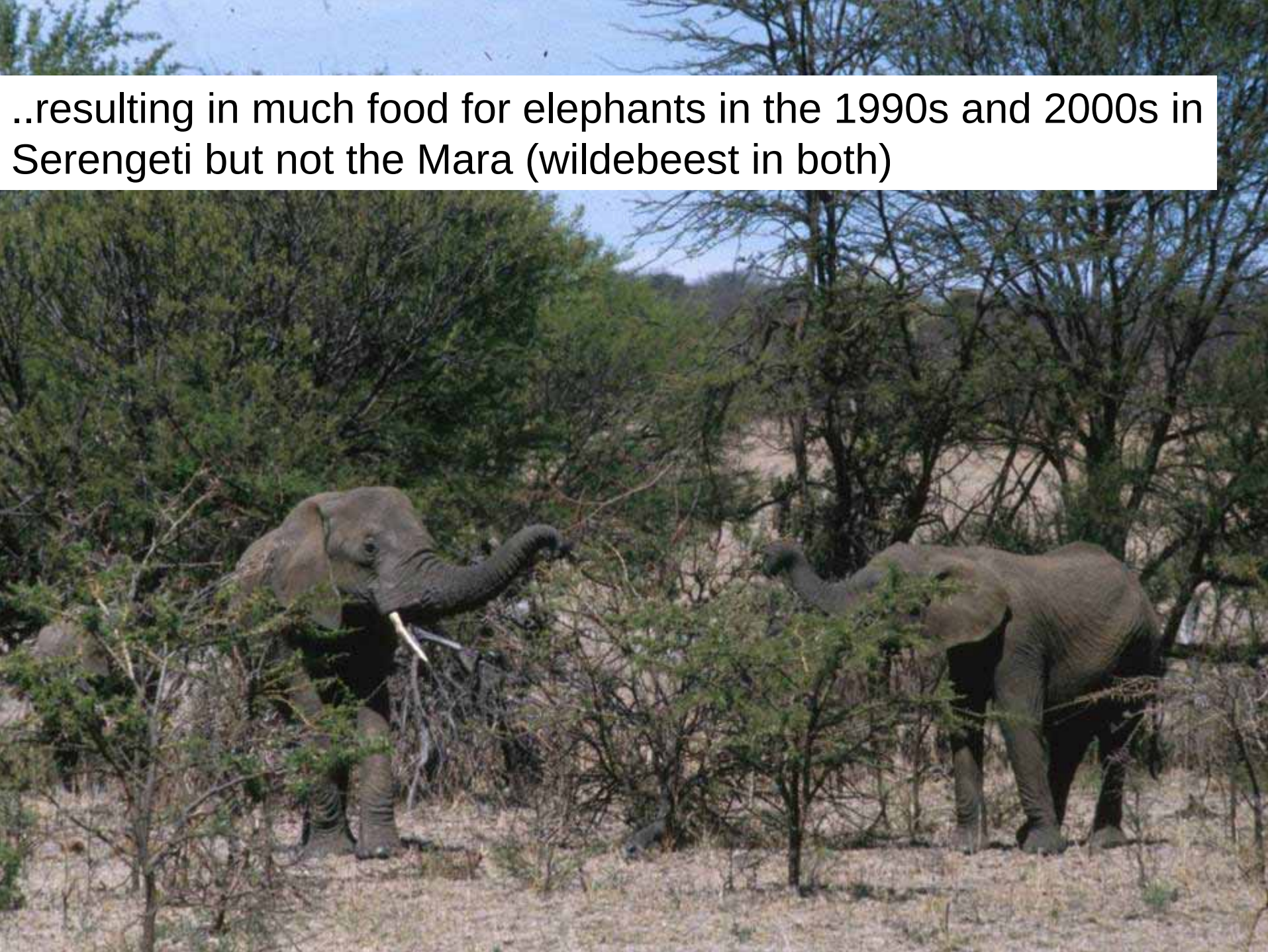
1970s – fire rather than elephant shown to be the cause of decline (Norton-Griffiths work in 1970s)

Elephant play another role by feeding on seedlings

Dublin observed elephants removing almost all seedlings
- They hold the system in a grassland state


Removal of elephants in Serengeti by ivory poachers in 1980s but not in Mara…..

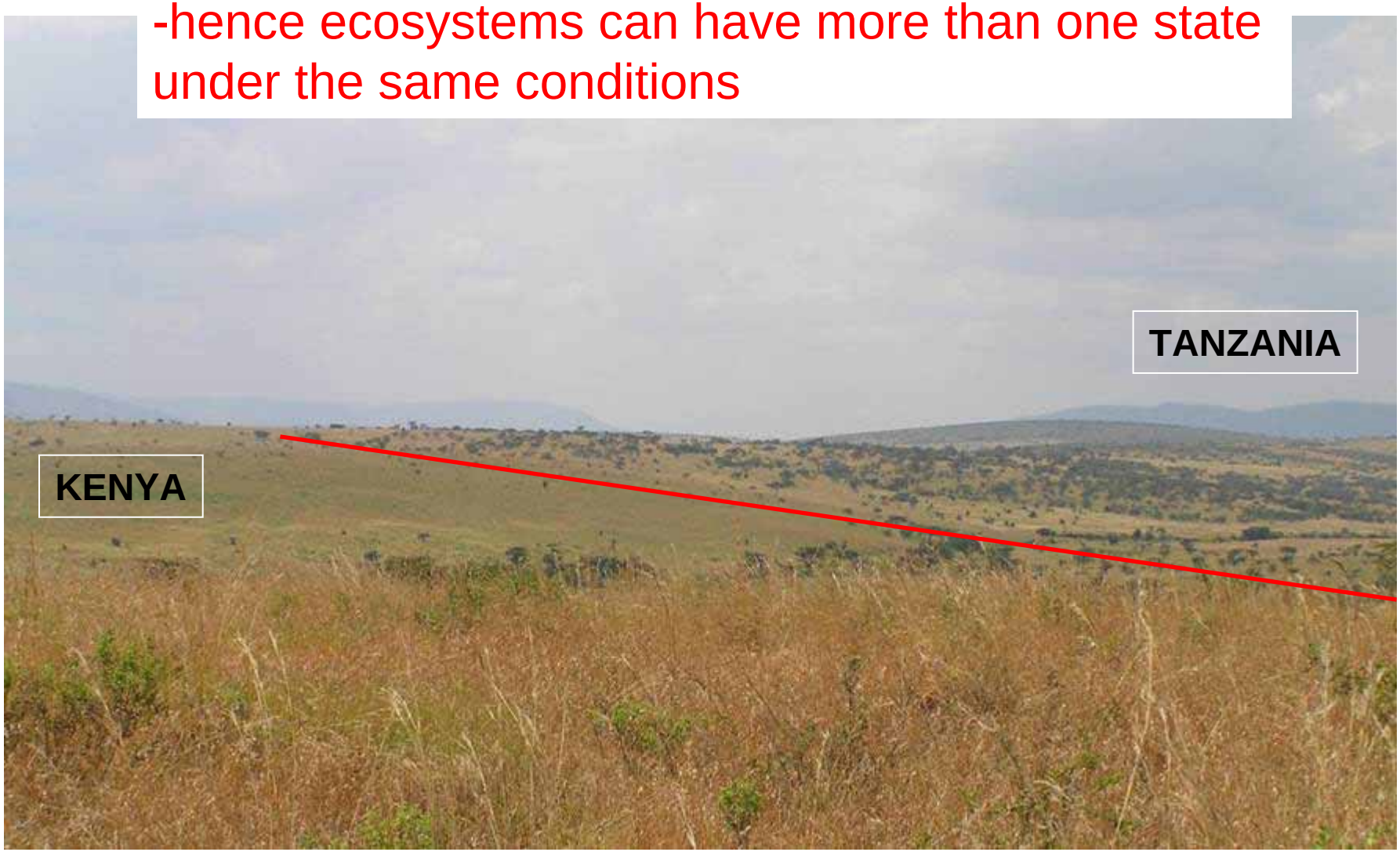

SERENGETI ELEPHANT
POACHING
IVORY
BAN
Number
3500
3000
2500
2000
1500
1000
500
0
1950
1960
1970
1980
1990
2000
2010



..resulting in much food for elephants in the 1990s and 2000s in Serengeti but not the Mara (wildebeest in both)

SERENGETI - MARA 2005

-hence ecosystems can have more than one state under the same conditions



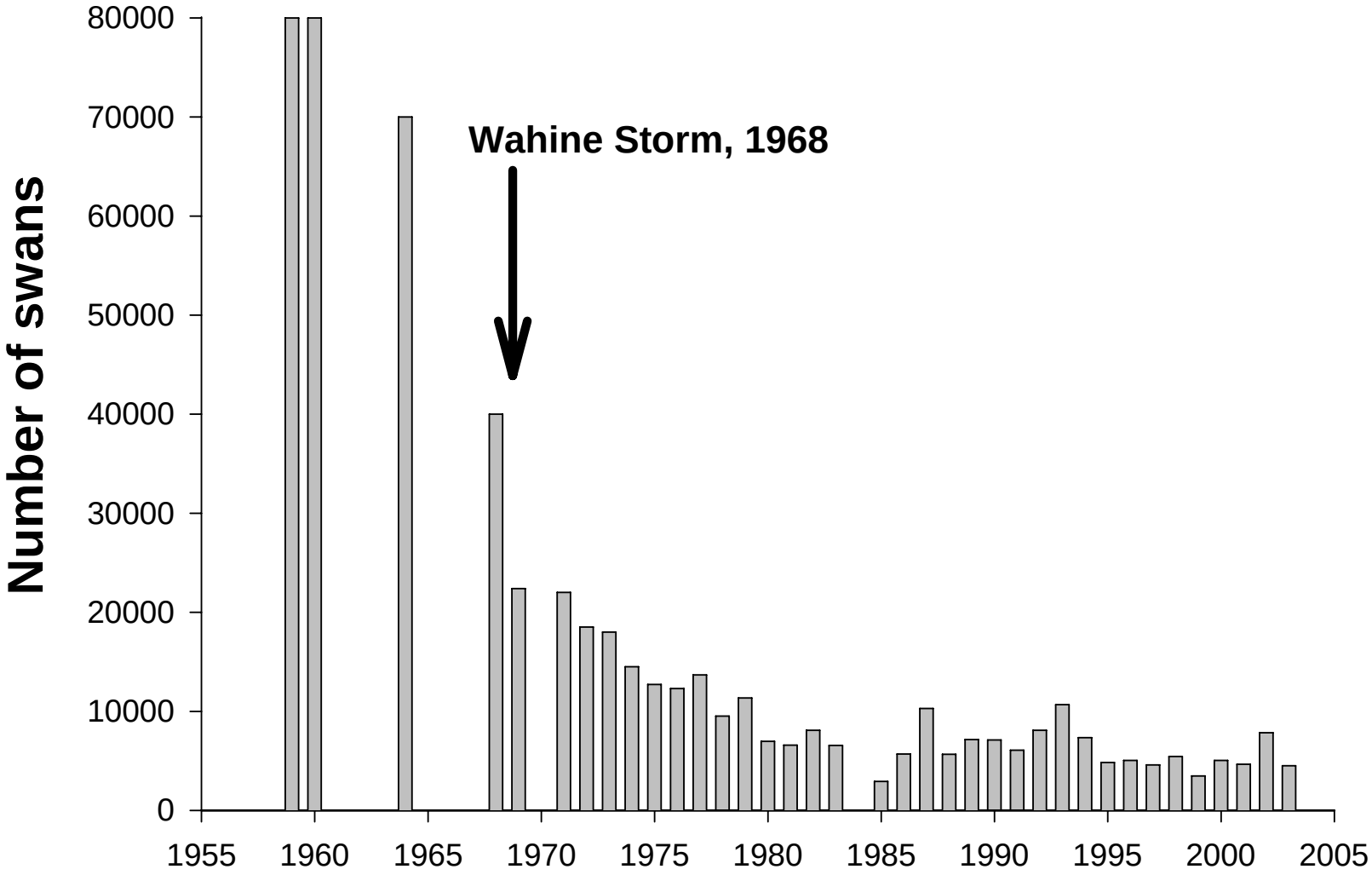

Tibetan yak


20 9 2005

Tibetan grasslands near Naqu

MONGOLIA – Brandt's vole outbreaks

CHANGE IN STATE:
swans on Lake Ellesmere, New Zealand



Disturbance and Ecosystem Processes

What goes wrong if we ignore ecosystems? Their processes for ecosystem functioning

For example

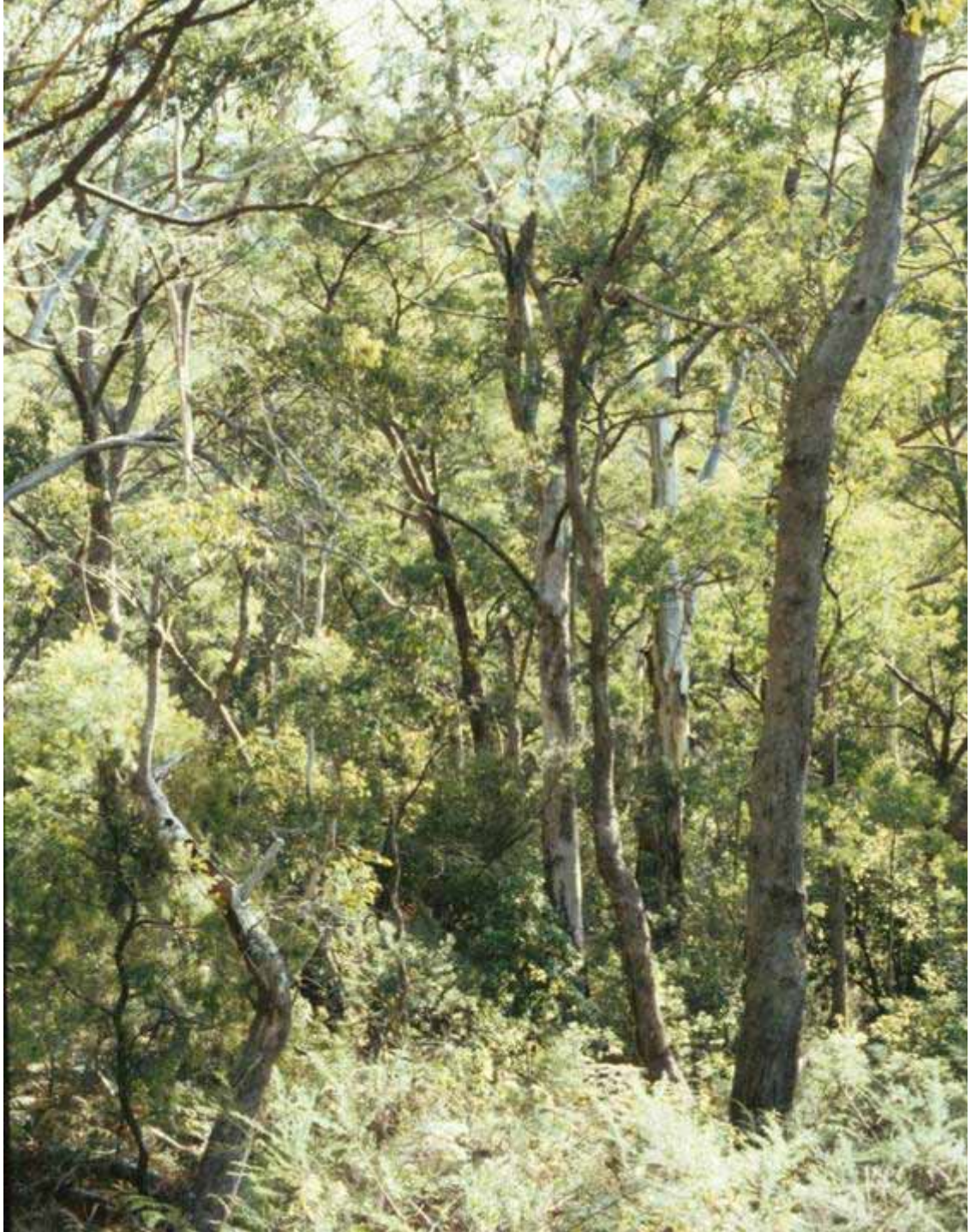
- **Hydrology, flux and storage**
- **Biodiversity and Stability (resilience)**

Saline upwelling in Western Australia

Biodiversity and stability

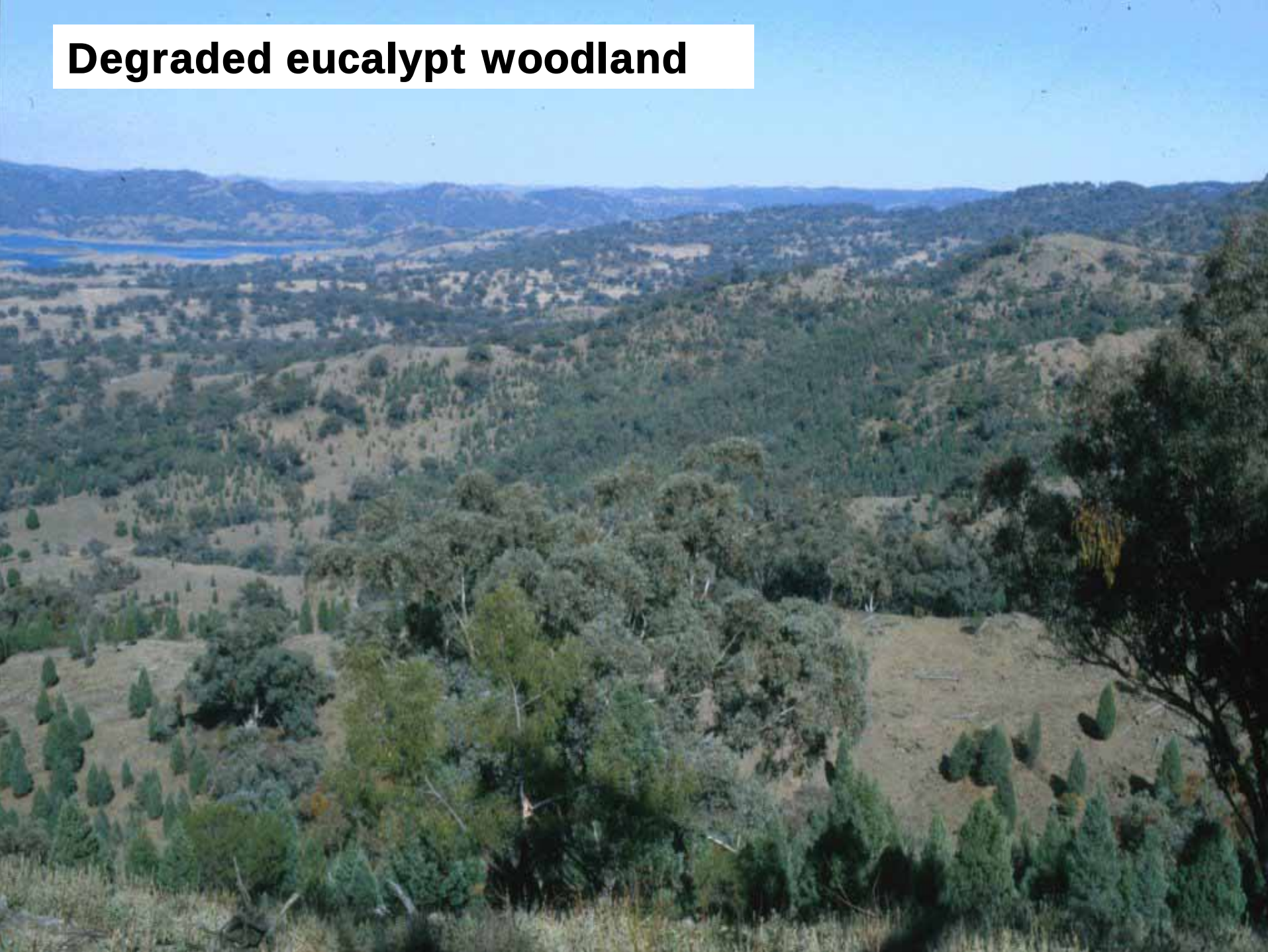
- **species diversity and community resilience**

e.g. Australian Eucalypt woodlands



Original closed eucalypt woodland

Degraded eucalypt woodland



Loss of bird diversity in Australian woodland

Noisy miners reduce or exclude…..

…white-plumed honeyeaters and other species in degraded Eucalypt woodland

Drawings Frank Knight

Psyllid outbreaks in isolated trees of farmland

Psyllid insect outbreaks cause dieback in exposed trees

-disruption of intact forest causes biodiversity loss and ecosystem disfunction

Eucalypt dieback – eastern Australia

Long time scales - The effects of history

Disturbance events take a long time

To understand ecosystems we must understand the long-term events. History is important

Rinderpest – the ecological event in 1889 that changed the course of human history in Africa.
It decimated human populations and allowed the colonization of Africa

The ecological effects are still seen in Serengeti today

Buffalo long-term change 1890-2003

Poaching

Observed

Reported

The Great Rinderpest epizootic

removed

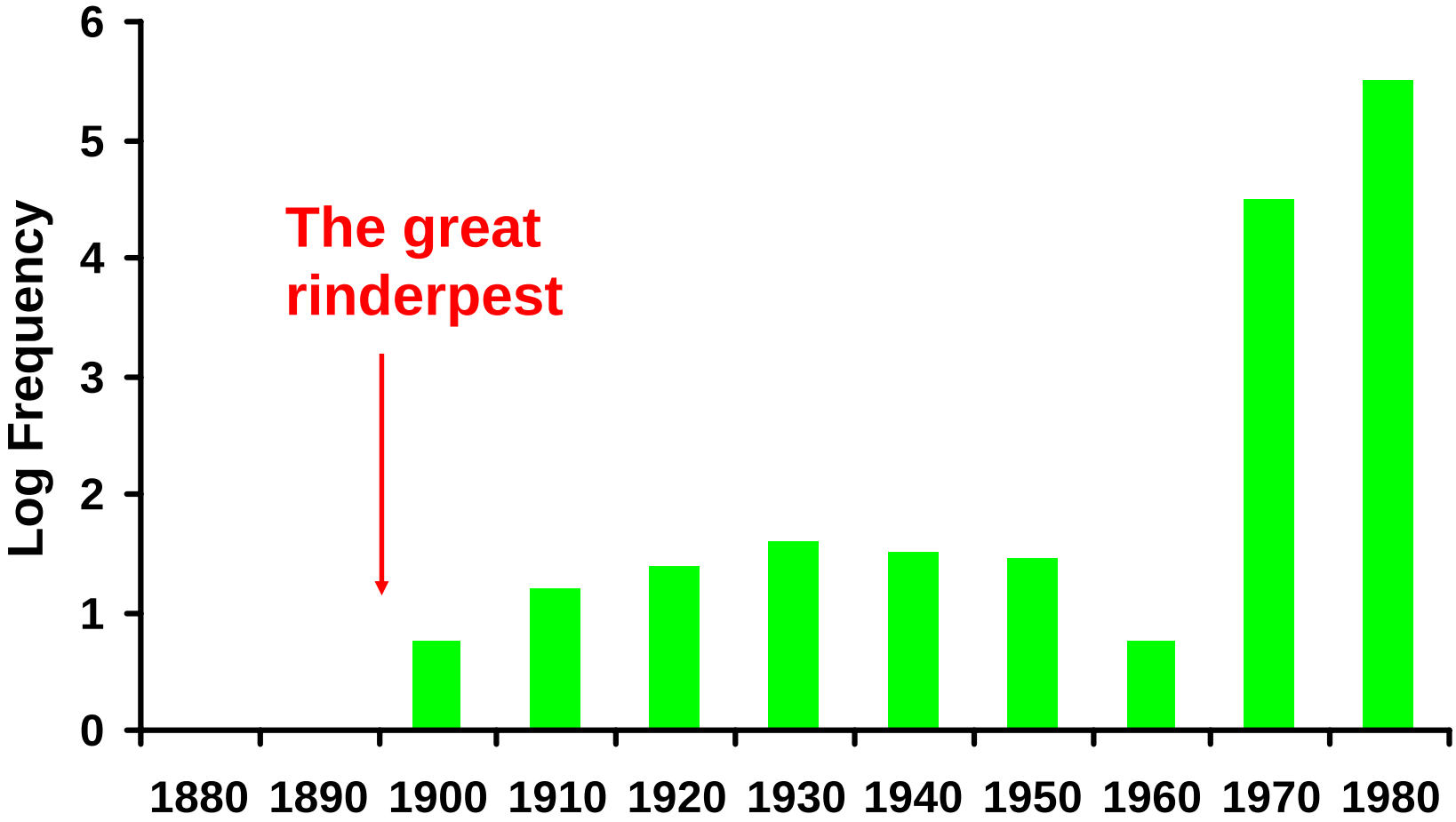
Number

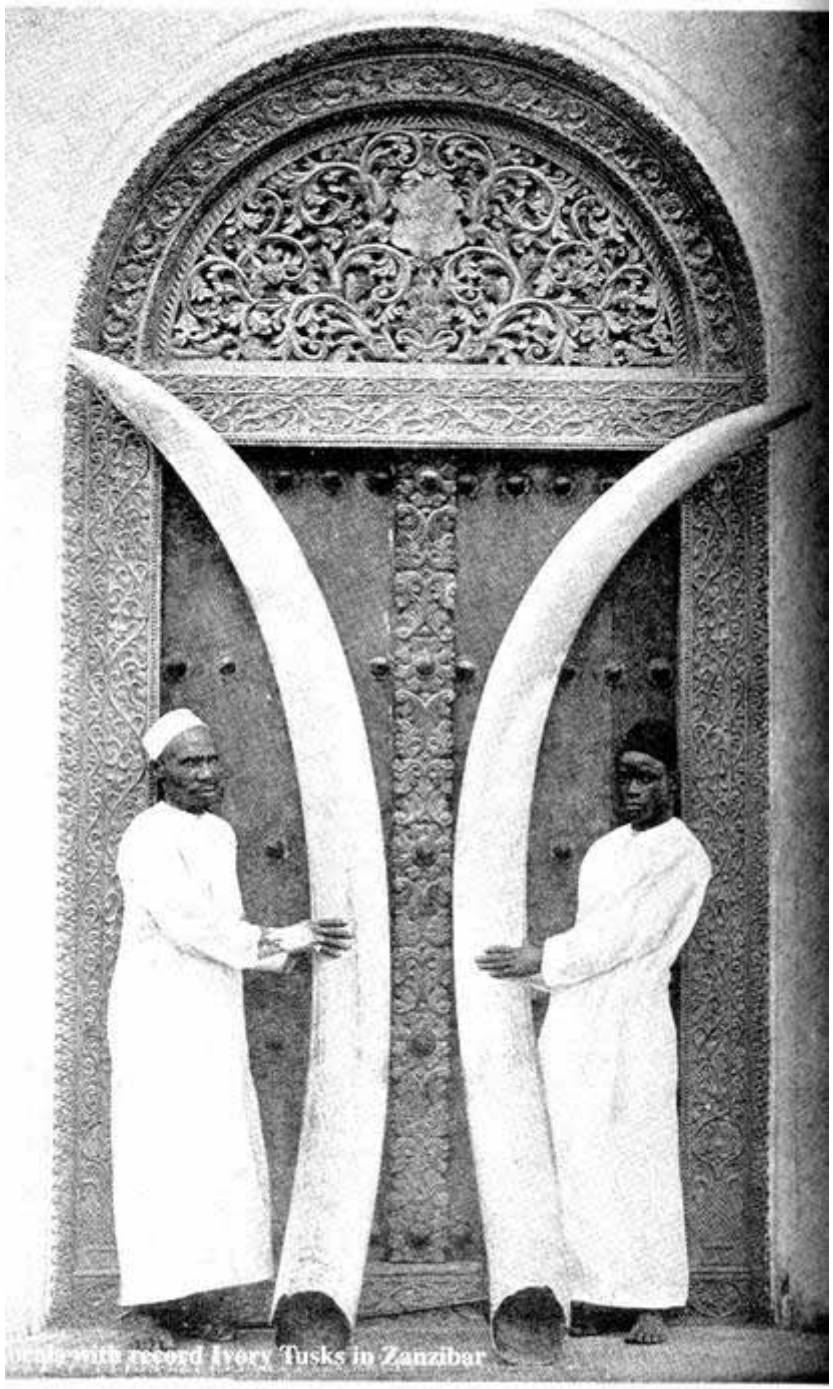
80000
70000
60000
50000
40000
30000
20000
10000
0

1890
1910
1930
1950
1970
1990
2010

Data from Sinclair & Mduma

Acacia tree density 1880-1980

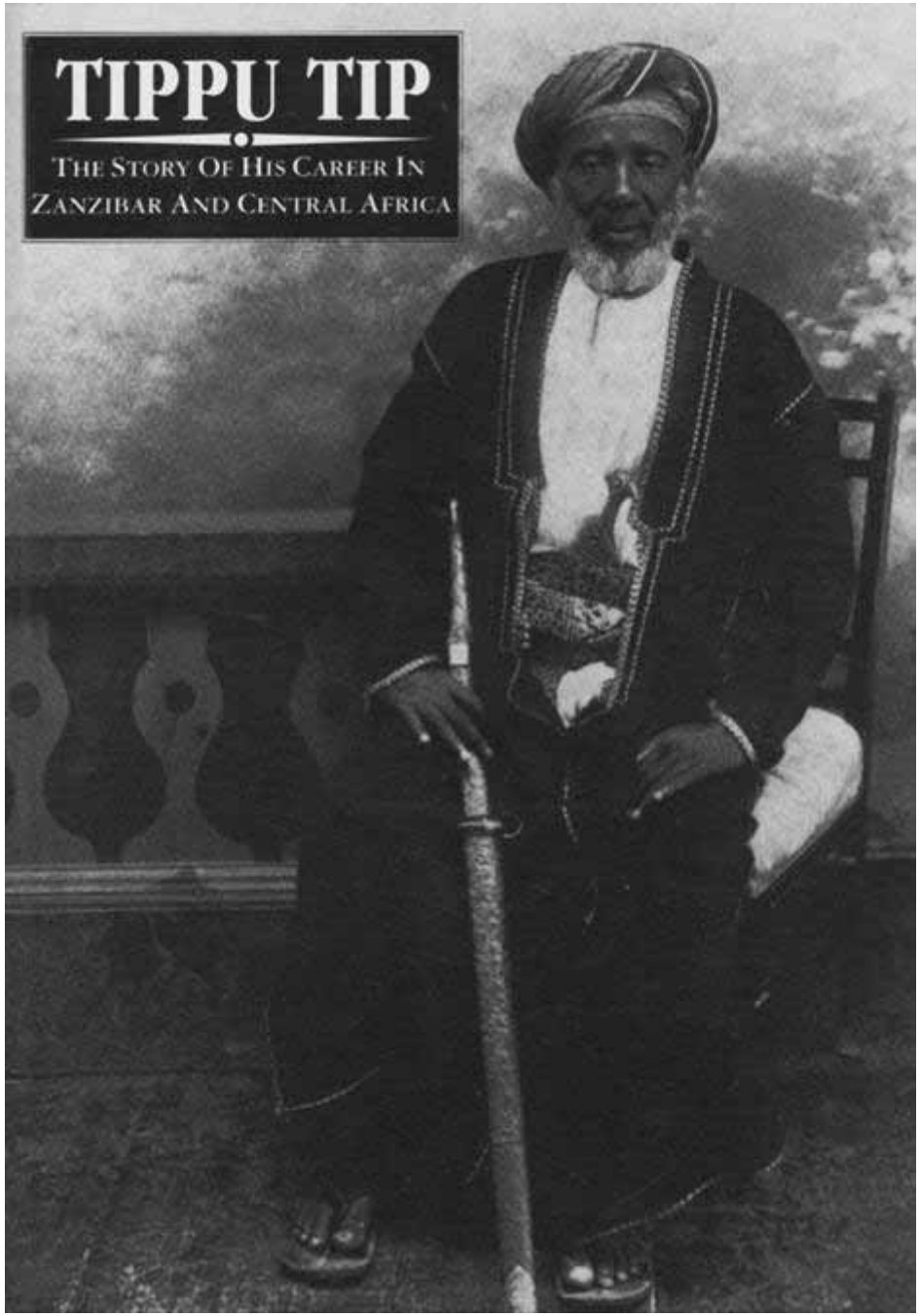




Disturbance and history

THE IVORY TRADE

1840s – 1890s

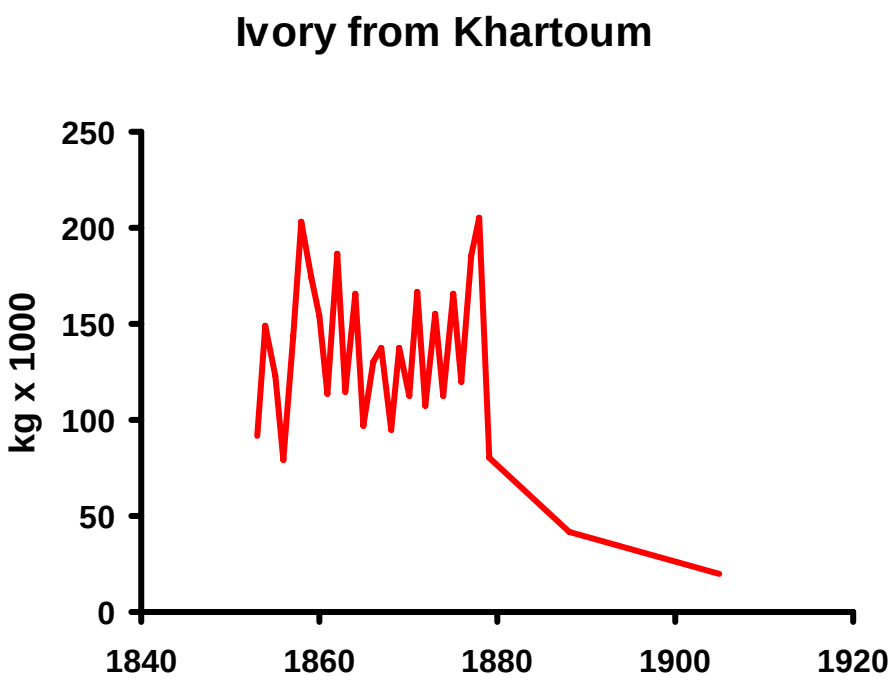


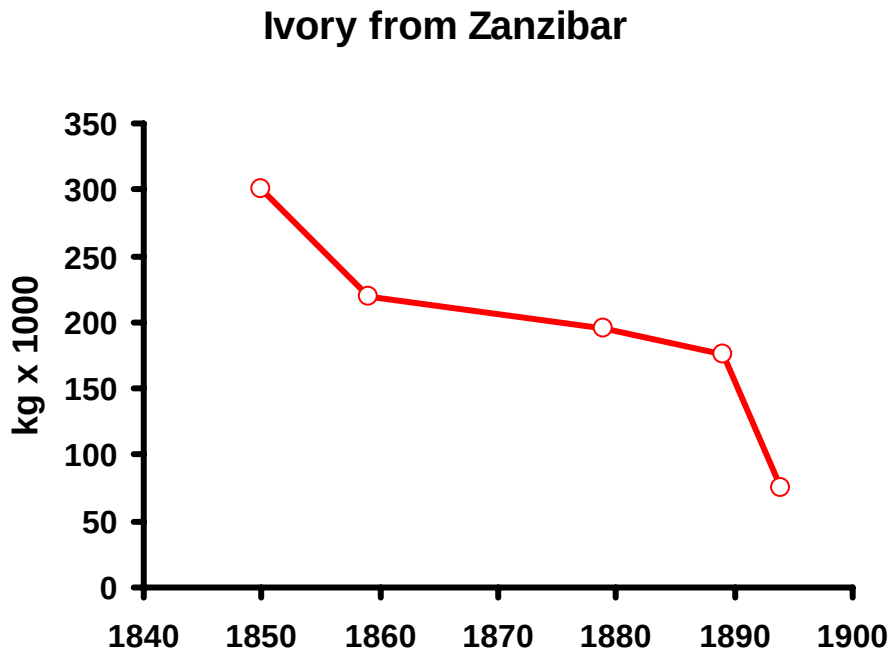
TIPPU TIP
The great slave trader of eastern Africa

- **1860s to 1890s**

Porters carrying Ivory

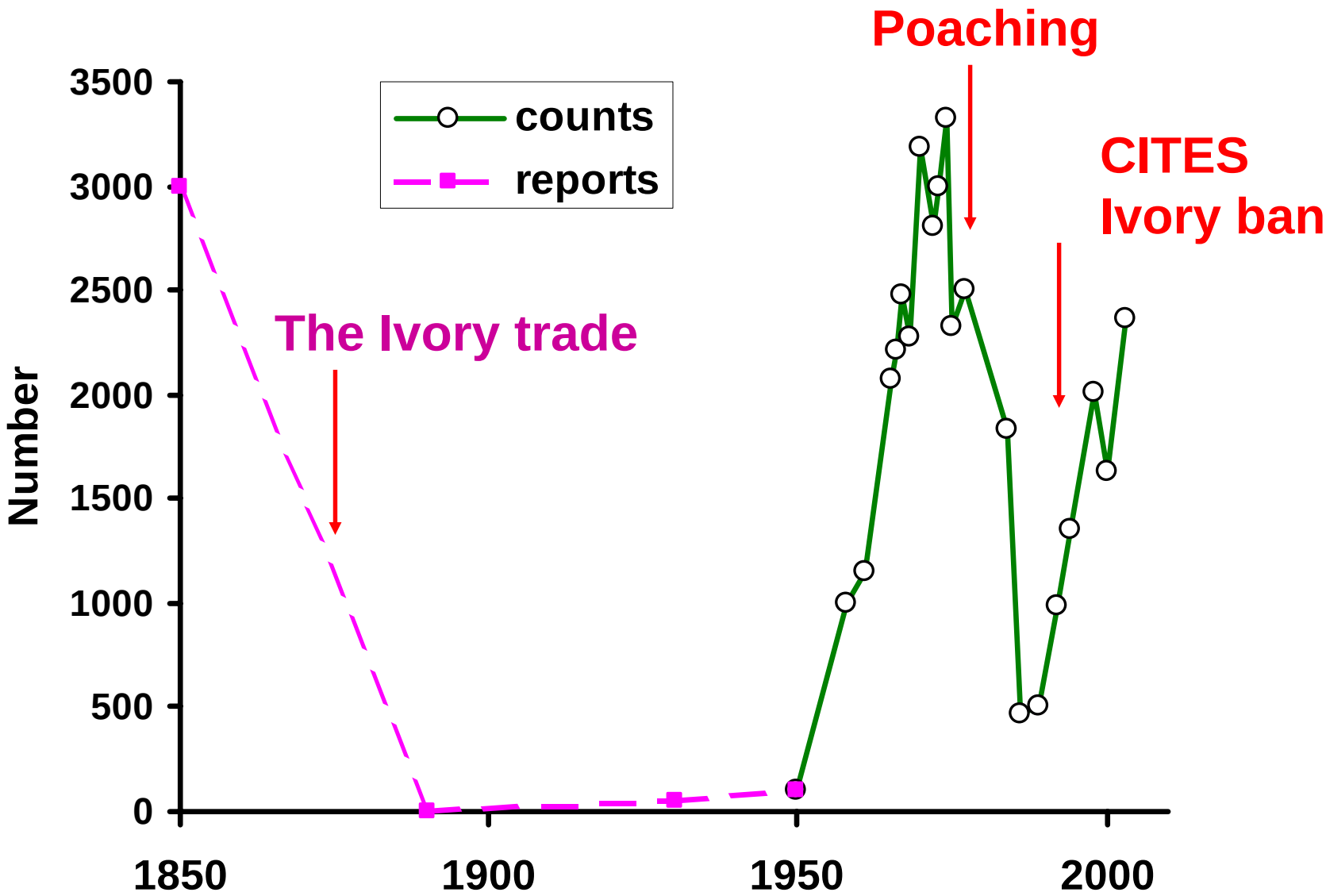
EAST AFRICAN IVORY EXPORTS





Data from C. Spinage 1973

SERENGETI ELEPHANT



The effects of history

Ivory hunting – affected the vegetation in Protected areas such as Tsavo (Kenya) and Chobe (Botswana), and altered the long-term course of conservation in Africa.

It also decimated human populations and prevented human advancement

Disturbance and history

Therefore,

- ecosystems are always changing,

- they do not return to the same state

- long-term consequences

- **e.g. Scotland**
- **e.g. New Zealand**

LESSONS FOR SOCIETY: THE FUNCTION OF MIGRATION

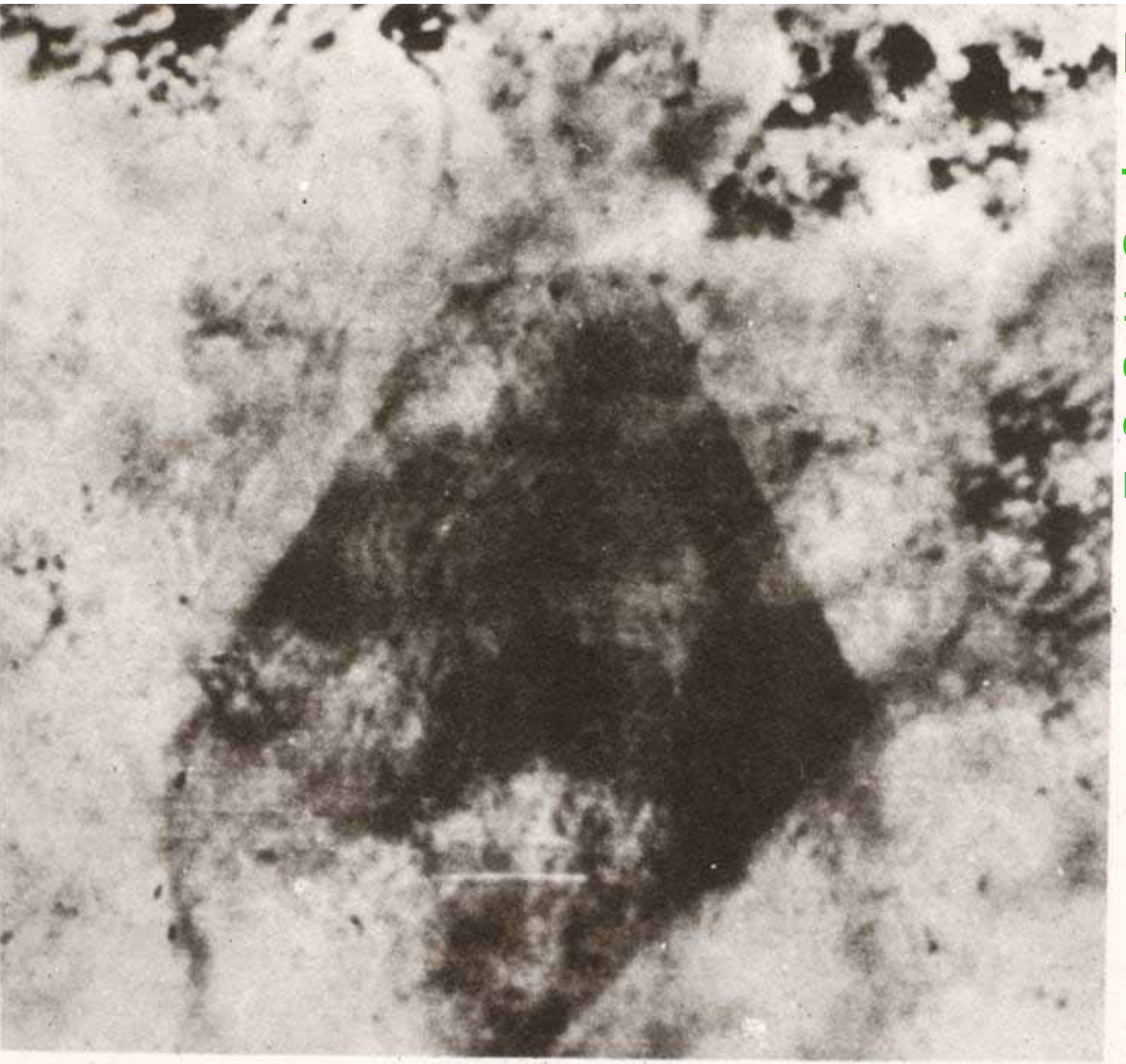
Migration allows use of ephemeral resources on the plains and so larger populations than if they were resident. This rule applies to all migrations


Traditional Human migrations in the Sahel follow rain
SAHEL

Boreholes have been sunk in the Sahel since the 1960s to present. Sedentary life style has resulted in overgrazing

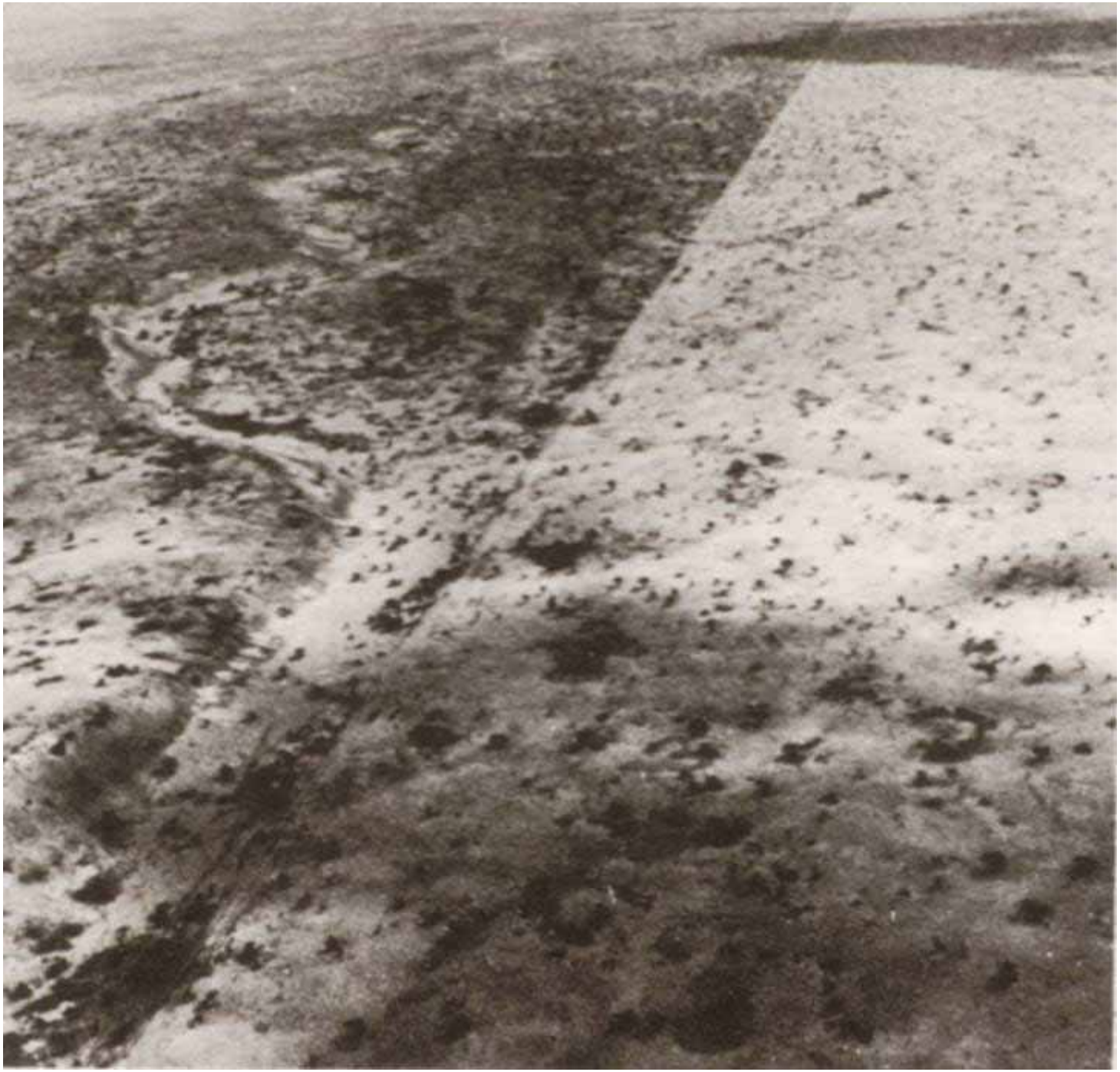
.. and repeated famines. MALI FAMINE 1973

Photo A. de Vos 1975



MALI –

The Green Polygon 1973 demonstrates overgrazing not drought



The ranch boundary

The role of Protected Areas

- The Green Polygon illustrates the need for baselines
- Protected Areas act as such ecological baselines to provide insight for human ecosystems
- BUT Ecosystems are continually evolving and do not return to where they began
- Protected areas will not stay as they are currently

Take home message

Conservation has to focus on ecosystems

- they are complex, have long time scales and multiple states
- they are subject to disturbance which can change state

- human disturbance can be monitored by reference to Protected Areas

- ecosystems are continually changing

Current protection strategy is not addressing this issue

- we need to find a new way to accommodate change