ENVIRONMENTAL INFORMATICS

IS MORE THAN

DATA MANAGEMENT

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INFORMATICS HIERARCHY

DATA

→ INFORMATION

→ UNDERSTANDING

→ DECISIONS

INFORMATICS HIERARCHY

DATA

→ Storage and dissemination

→ **INFORMATION**

Statistical assessment

→ **UNDERSTANDING**

Theoretical modelling

→ **DECISION SUPPORT**

Alternative scenarios

INFORMATICS IS TRANS-DISCIPLINARY

- STATISTICS
  - New paradigms for increasingly voluminous data
- MODELLING
  - Accommodating spatial & temporal variability
- DECISION SUPPORT
  - Allowing for uncertainty

SCARCE SKILLS!!

ILLUSTRATED FROM PERSONAL EXPERIENCE

Entering the computer age

From notebook & pencil through Land Rovers

to computerized data collection & modelling

POPULATION DYNAMICS
Kudu in Kruger

Neither over-abundant nor rare

What limits population expansion?

What restricts population shrinkage?

POPULATION DYNAMICS
Kudu in Kruger

DATA:

Annual registration of survival and births

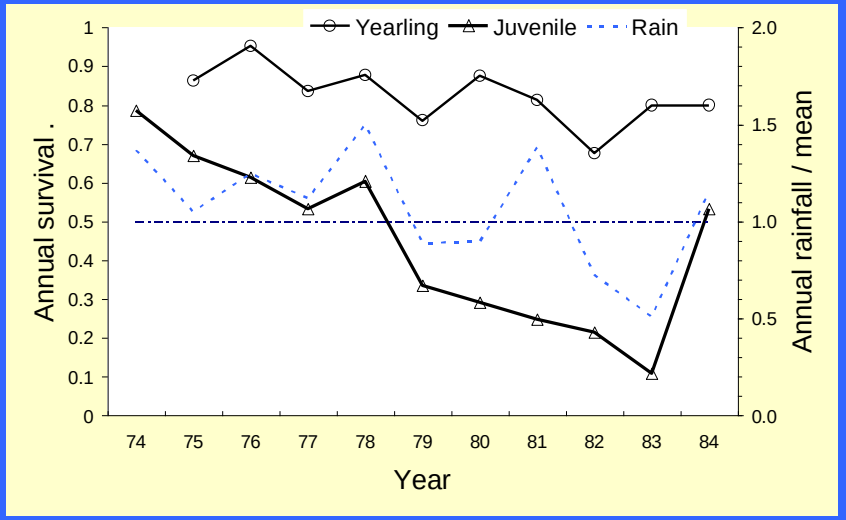
(recognisable from stripes)

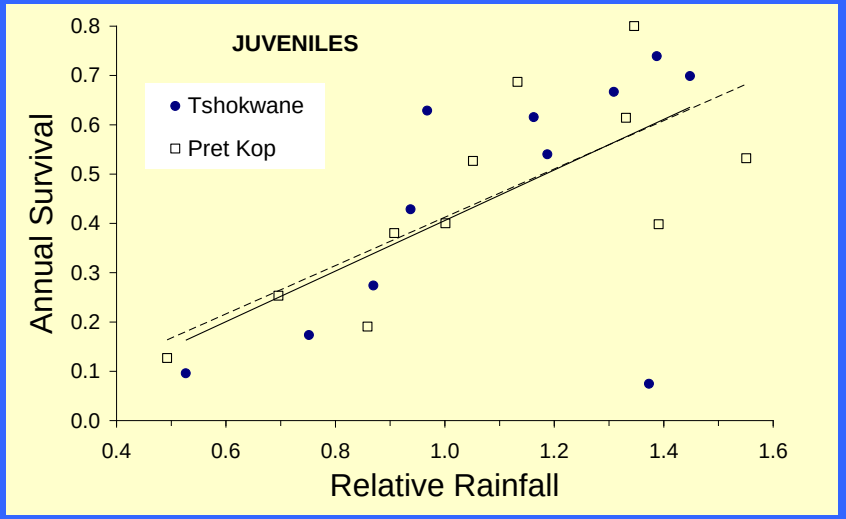
POPULATION DYNAMICS
Kudu in Kruger

INFORMATION:

Time trends in survival
& rainfall

Regression relationships

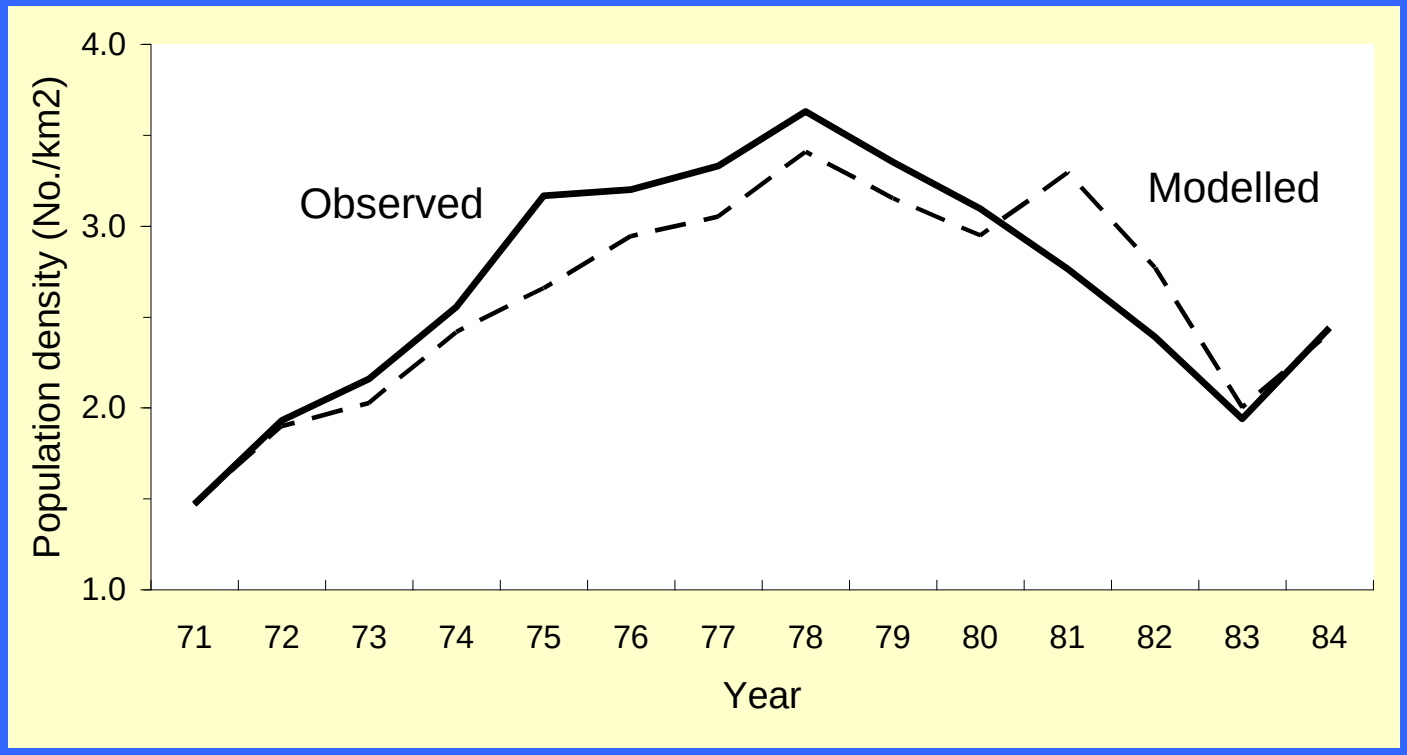




POPULATION DYNAMICS
Kudu in Kruger

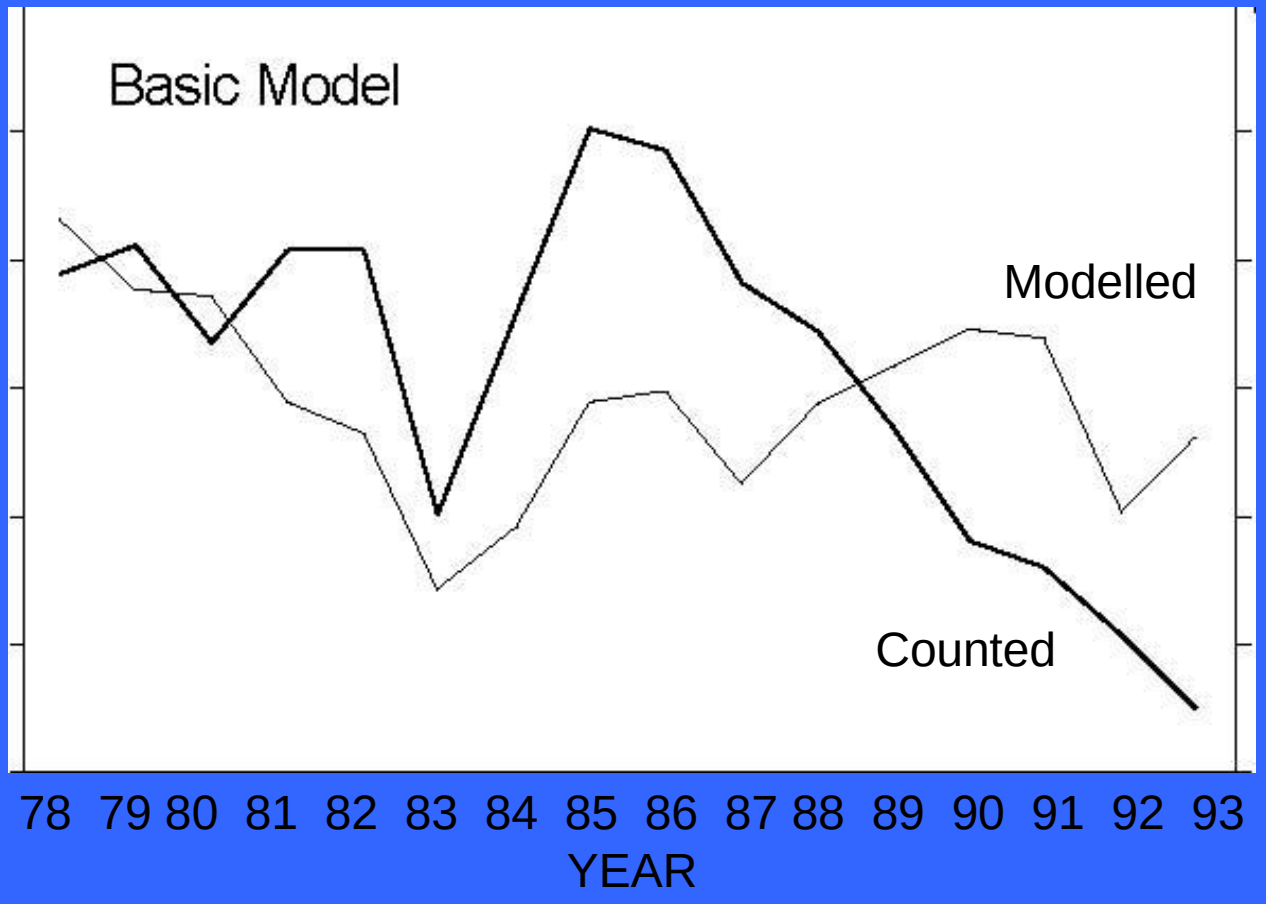
MODEL: *Replication*

Survival = f (Rainfall / Biomass)



POPULATION DYNAMICS
Kudu in Kruger

MODEL: *Projection, whole park*



DECLINING POPULATIONS
Rarer antelope in Kruger

DATA

Monitoring for interpreting natural changes

→ Annual aerial surveys 1977-1996

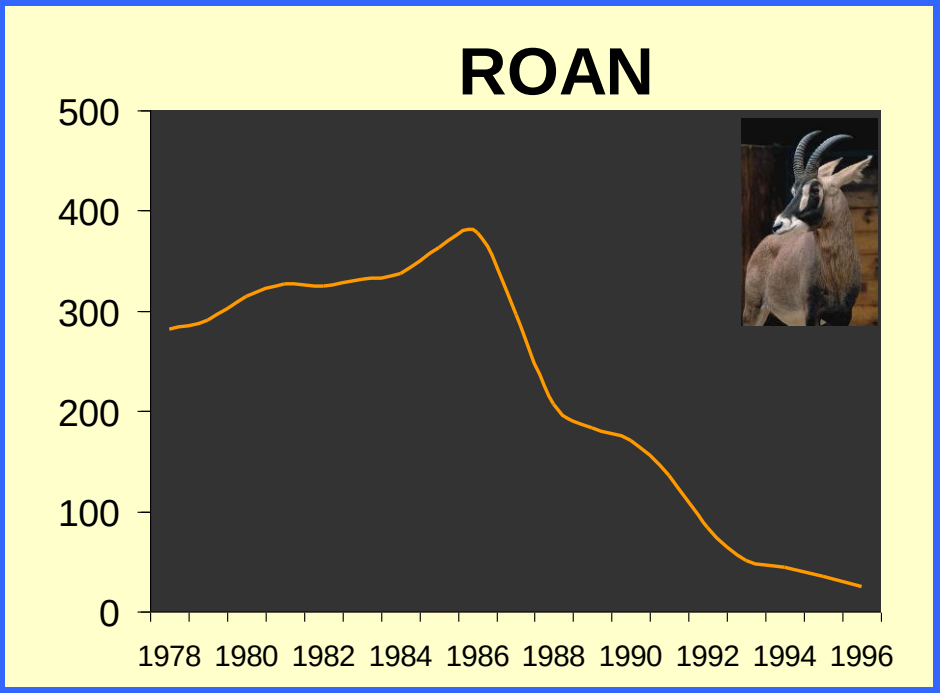
- Total counts of all large herbivores
- Sex and age structure of samples
- Daily rainfall records

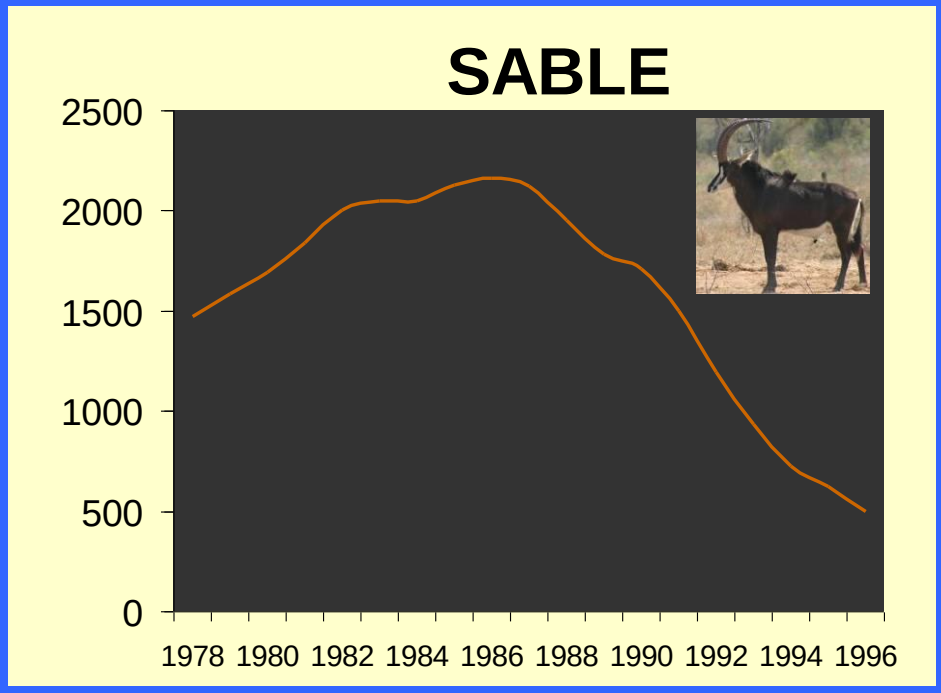
DECLINING POPULATIONS
Rarer antelope in Kruger

INFORMATION

Annual reports → Population trends

➔ ***TPCs surpassed***





DIAGNOSIS

POTENTIAL CAUSES

Poaching
Disease
Drought
Habitat change
Competition
Predation
Mis-management

MANAGEMENT OPTIONS

If merely ***drought***, don't intervene

MANAGEMENT OPTIONS

If merely drought, don’t intervene

If ***climate shift***, mitigate

MANAGEMENT OPTIONS

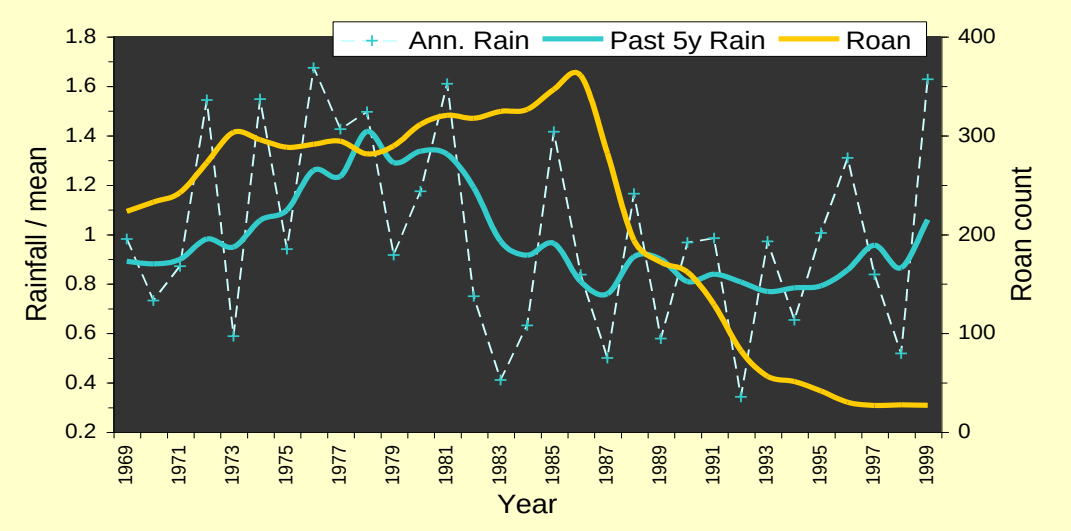
If merely drought, don’t intervene

If climatic shift, mitigate

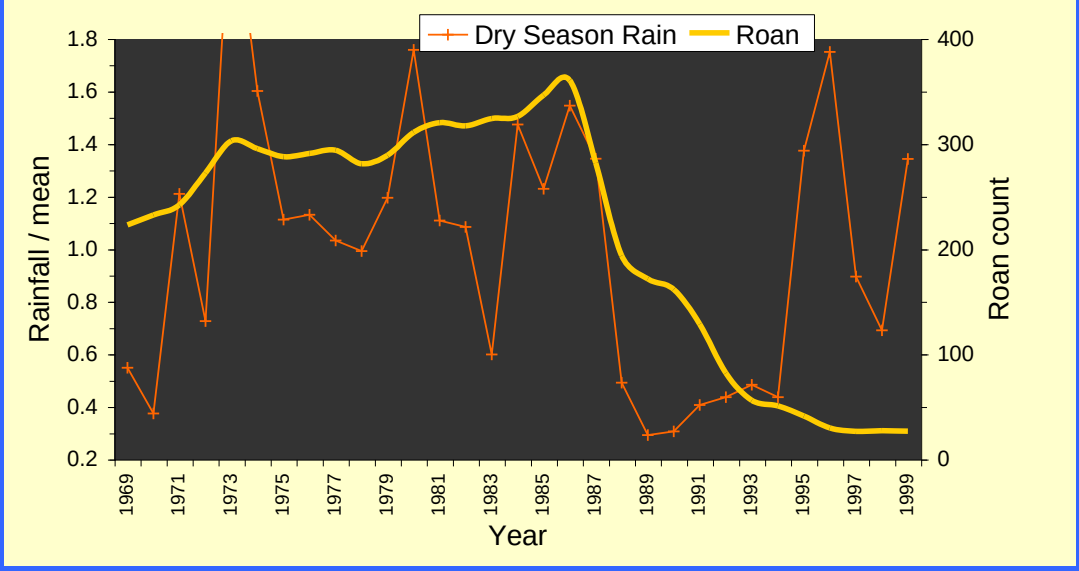
If ***mis-management***, rectify

RAINFALL TRENDS

Annual



Dry season



INFERENCE FROM REGRESSION RELATIONSHIPS

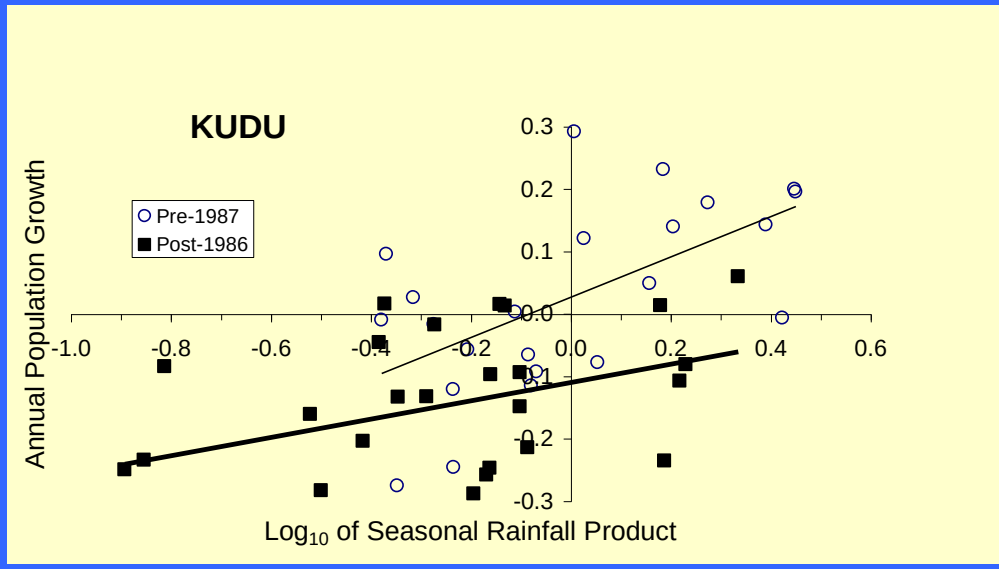
Table 1 Regression statistics

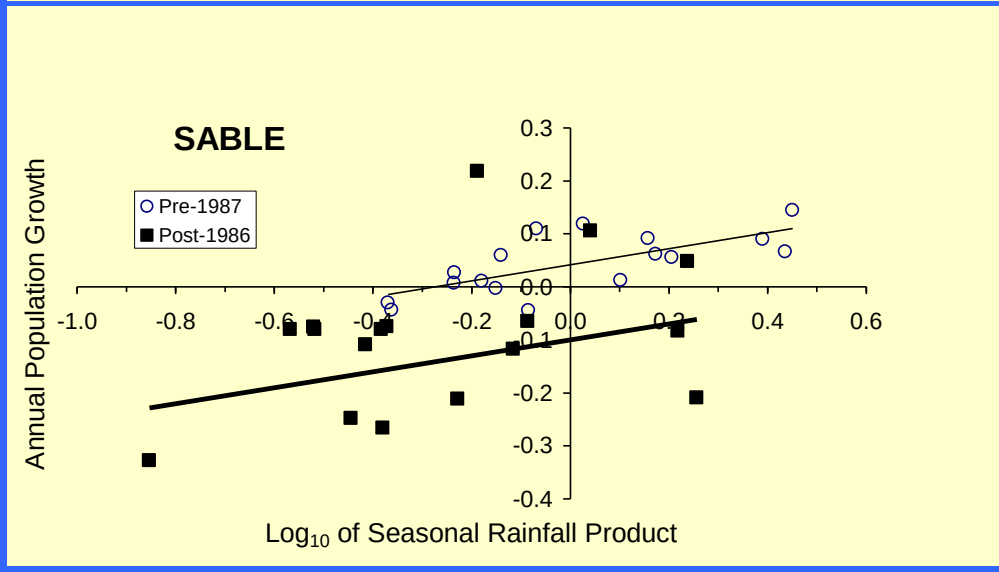
Species	N	Regression statistics					
		Relative abundance		Wet season rainfall		Dry season rainfall	
		Slope	P	Slope	P	Slope	P
a) *Stabilizing*							
Zebra	67	**-0.048**	**0.020**	**0.070**	**0.031**	**0.054**	**0.020**
Wildebeest	67	(0.002)	-	(-0.007)	-	**0.171**	**0.0003**
Impala	67	**-0.087**	**0.019**	**0.169**	**0.034**	0.044	0.397
Giraffe	49	-0.031	0.131	0.046	0.338	(-0.006)	-
b) *Declining*							
Kudu	67	-0.058	0.090	**0.163**	**0.029**	**0.198**	**0.0005**
Waterbuck	35	**-0.174**	**0.045**	**0.283**	**0.022**	**0.287**	**0.001**
Warthog	49	-0.033	0.342	**0.423**	**0.002**	**0.281**	**0.002**
Sable	35	-0.021	0.405	0.045	0.666	**0.173**	**0.020**
Eland	19	**-0.302**	**0.010**	(-0.143)	-	**0.173**	**0.026**
Tsessebe	18	(0.161)	-	0.023	0.135	0.019	0.096
Roan	18	(+)	-	0.043	0.813	0.047	0.719

INFERENCE FROM KUDU MODEL

Not merely
low rainfall

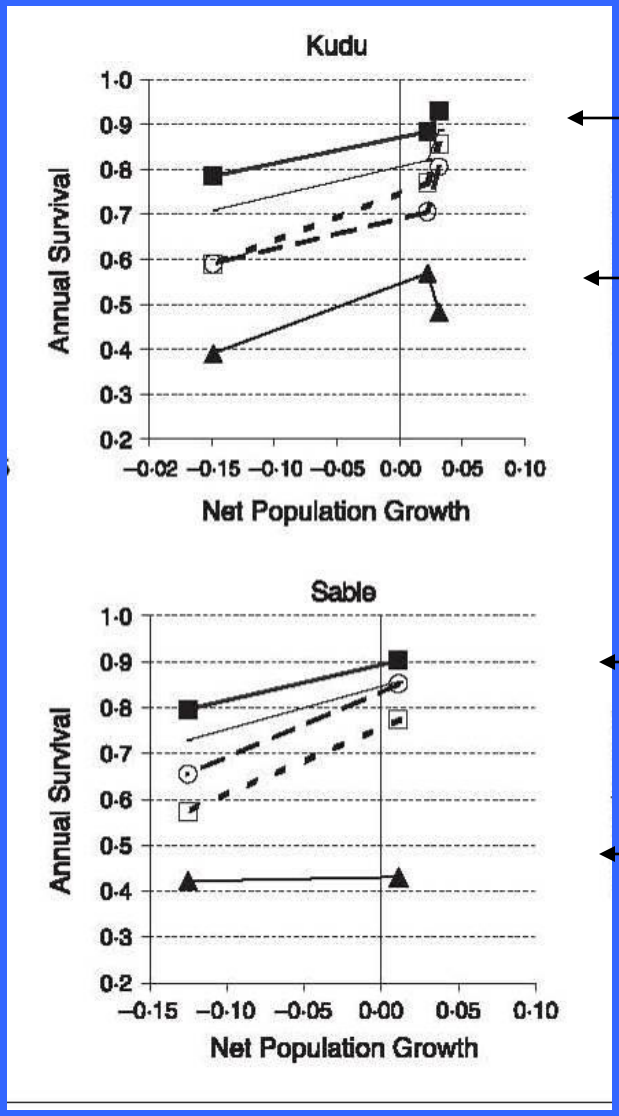
Regime shift
after 1986





INFERENCE FROM DEMOGRAPHY

Altered trend was associated with reduced ***adult survival*** in all cases



Adult segments

juveniles

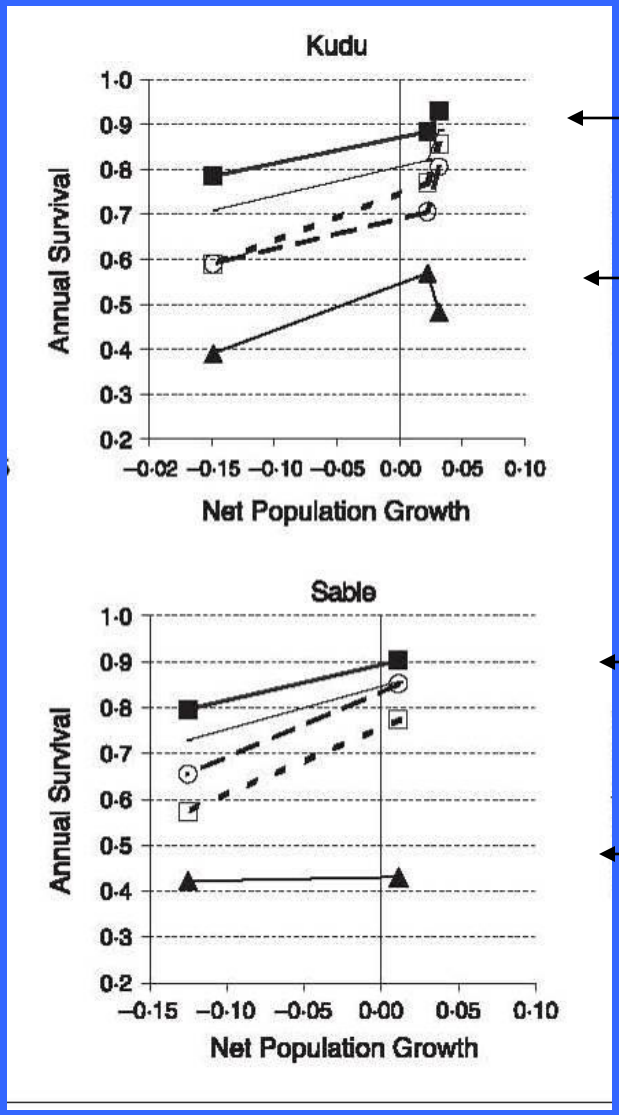
Adult segments

juveniles

INFERENCE FROM DEMOGRAPHY

Altered trend was associated with reduced ***adult Survival***

Predation?



Adult segments

juveniles

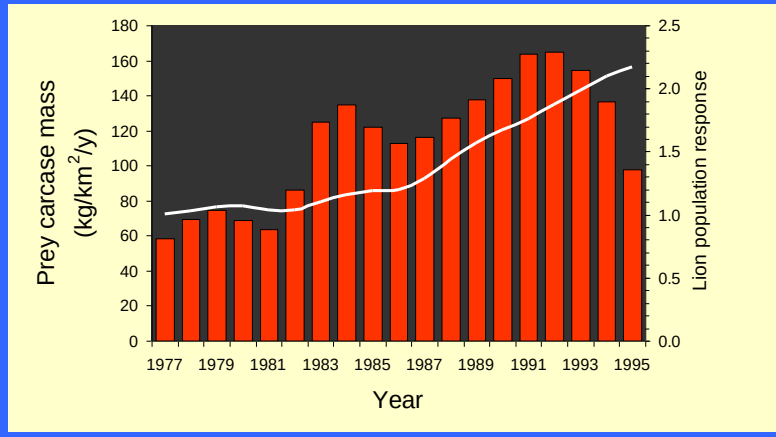
Adult segments

juveniles

INCORPORATE PROXY MEASURES INTO MODEL

PREDATION:

Food availability as indexed by prey carcasses produced annually



HABITAT CHANGE:

Indexed by prior rainfall conditions

MODEL COMPARISON

Model selection statistics

supported by relative Akaike distances and corresponding relative likelihoods

Species	Current Abundance + Rainfall only		Prior Rainfall		Past Predator Food	
	ΔAICc	Relative likelihood	ΔAICc	Relative likelihood	ΔAICc	Relative likelihood
Kudu	8.8	0.012	6.7	0.035	**0**	**1.000**
Waterbuck	**1.1**	**0.568**	**0.1**	**0.932**	**0**	**1.000**
Warthog	**0**	**1.000**	1.5	0.461	2.1	0.353
Sable	11.7	0.003	**1.21**	**0.546**	**0**	**1.000**
Tsessebe	4.1	0.129	**0**	**1.000**	**0.5**	**0.787**
Roan	8.8	0.012	**1.0**	**0.607**	**0**	**1.000**

WHAT CAUSED INCREASED PREY AVAILABILITY?

MANAGEMENT INTERVENTIONS:

More waterpoints → more zebra

Culling suspended → more buffalo

→ more widespread lions

→ elevated risk of predation

→ accentuated drought impact

SHIFTING PREY SELECTION

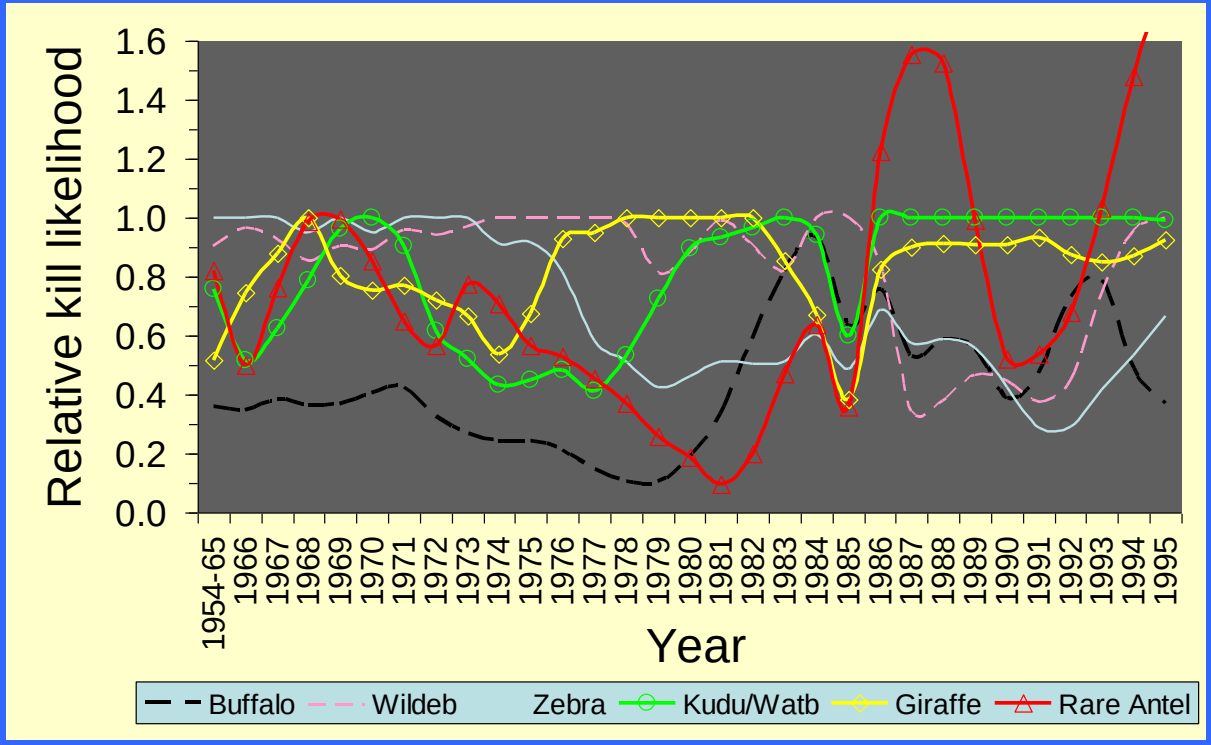
DATA

- 49,453 found carcass records spanning 1954-1995
- 94% ascribed to predator kills
- Lions were responsible for 55%

SHIFTING PREY SELECTION

INFORMATION

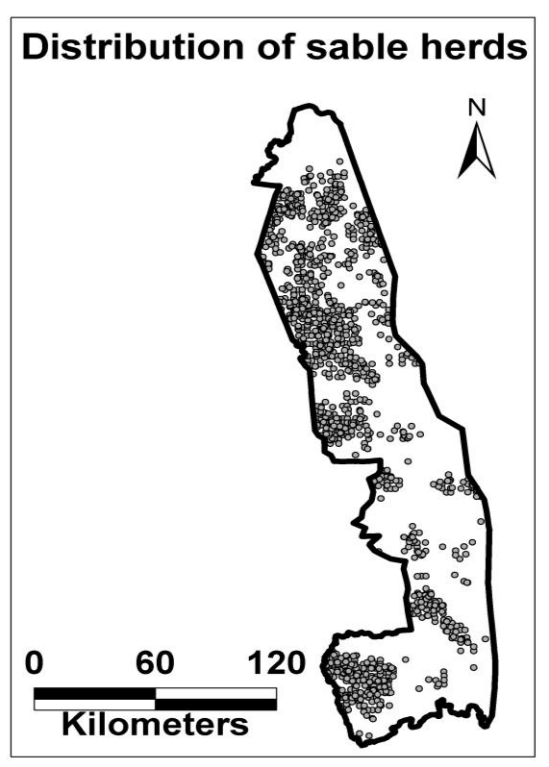
Increased selection for alternative prey species was synchronous with the population declines

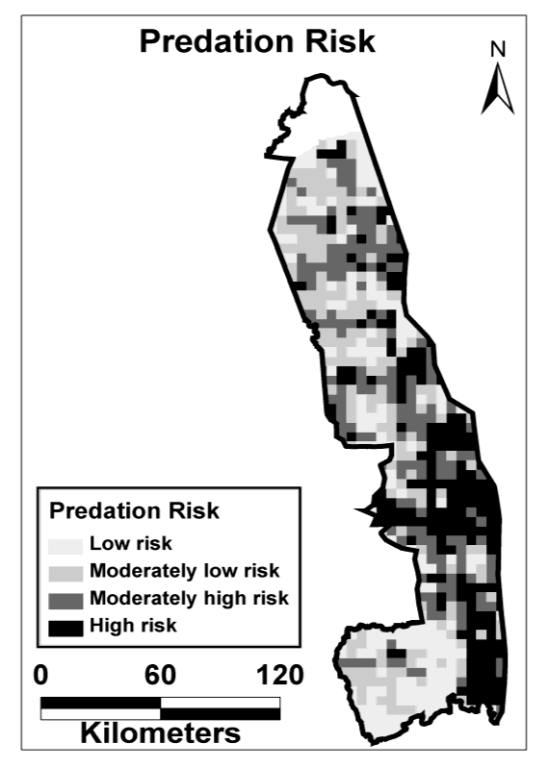


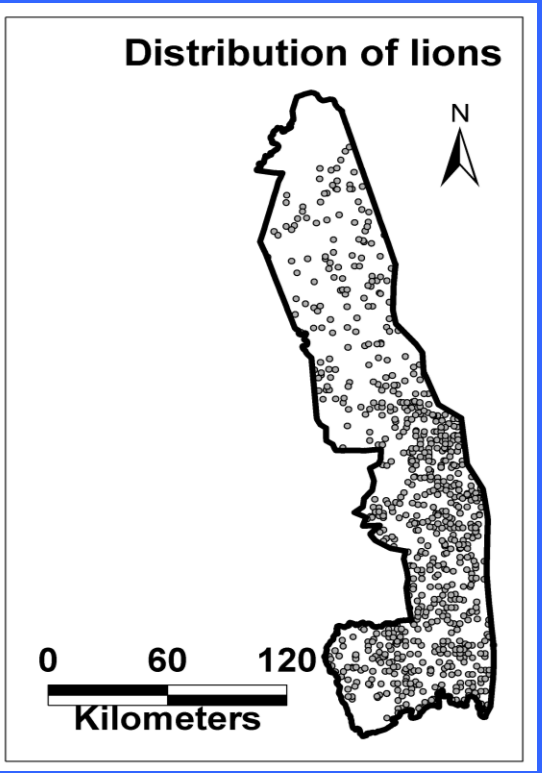
SHIFTING PREY SELECTION

MODEL

Rare antelope species occupied spatial refuges of lower predation risk in north & west of Kruger Park







MOVEMENT STUDIES

Comparative space use patterns

DATA:

GPS-GSM collars on

- 8 sable herds
- 10 zebra herds
- 8 wildebeest herds
- 4 buffalo herds
- 3 lion prides

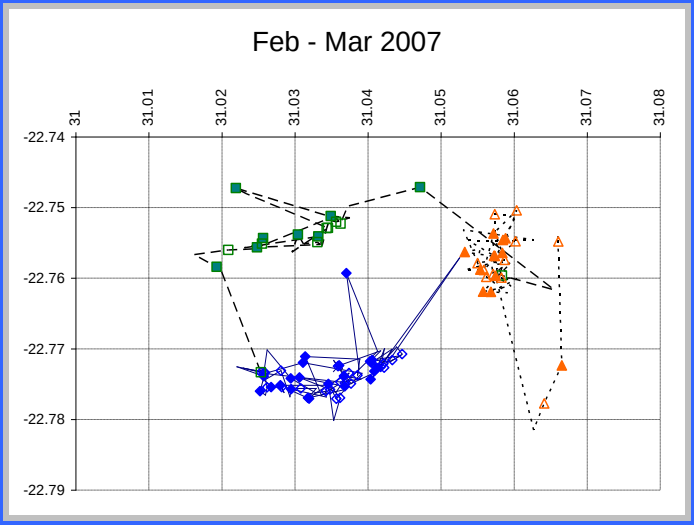
Hourly locations → >100,000 records annually

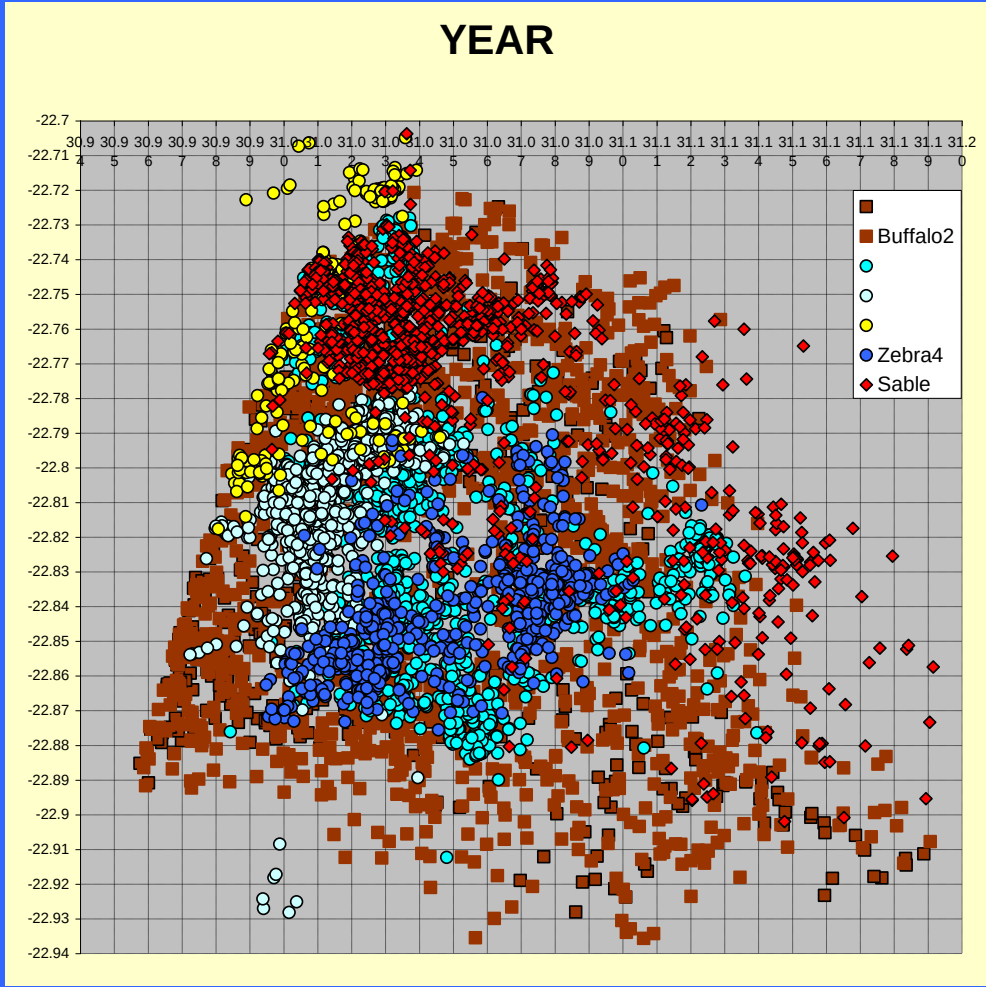
MOVEMENT STUDIES

Comparative space use patterns

Broad scale overlap

Fine scale distinctions





OVERVIEW

SANParks gathered a voluminous data set

- Total area counts covering 15+ species over 20 years
- Demographic structure over 12 years
- Carcass records spanning 40+ years
- Daily rainfall records from 35 stations

OVERVIEW

INFORMATION EXTRACTED

Descriptive population trends only

Neither assessed *statistically*, nor *modelled*

→ ***Lack of capacity***

OVERVIEW

STATISTICAL ASSESSMENT

Enabled through my collaboration with post-doctoral statistical ecologist

(Dr Joseph Ogutu)

→ ***Model selection statistics using information theory***

OVERVIEW

INTERPRETIVE MODELLING

Not rainfall alone

Additional effect of shifting predation

Habitat change?

Scenario modelling could have avoided adverse waterpoint consequences

OVERVIEW

Have now established what caused population declines of the rarer antelope species

– *15+ years after the problem arose!*

But only 85% confident

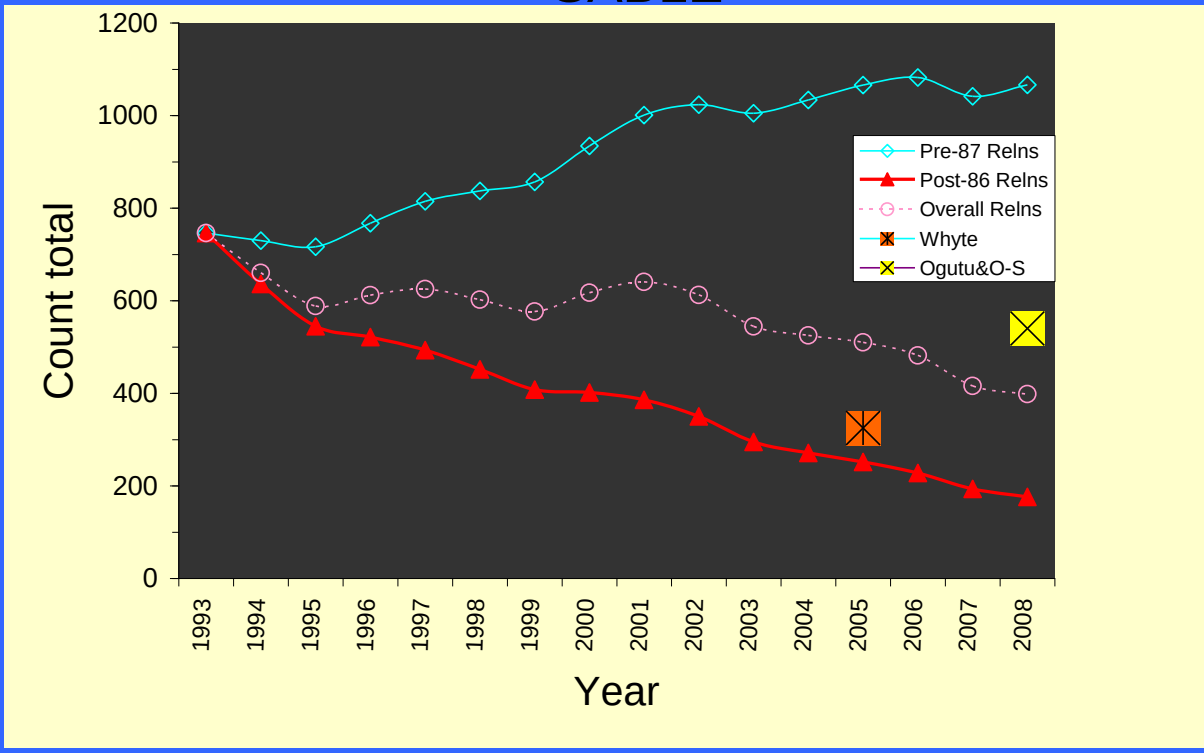
Cannot exclude ***habitat deterioration*** because data on *vegetation composition* change are lacking

OVERVIEW

Populations of the rarer antelope species have not recovered

Model projections:

May be too late to intervene – herd sizes are very small



OVERVIEW

SANParks lacks

- Human capacity to apply the full informatics hierarchy
- Financial capacity to maintain the monitoring effort

→ ***Inadequate data to interpret recent population trends***

MICROCOSM OF SAEON'S CHALLENGE

CENTRAL ISSUE

How to reliably distinguish ***human influences*** from ***climatic causes***

But inter-twined

Human transformation of landscapes and ecosystems is disrupting the capacity of the biota to cope with climatic variation

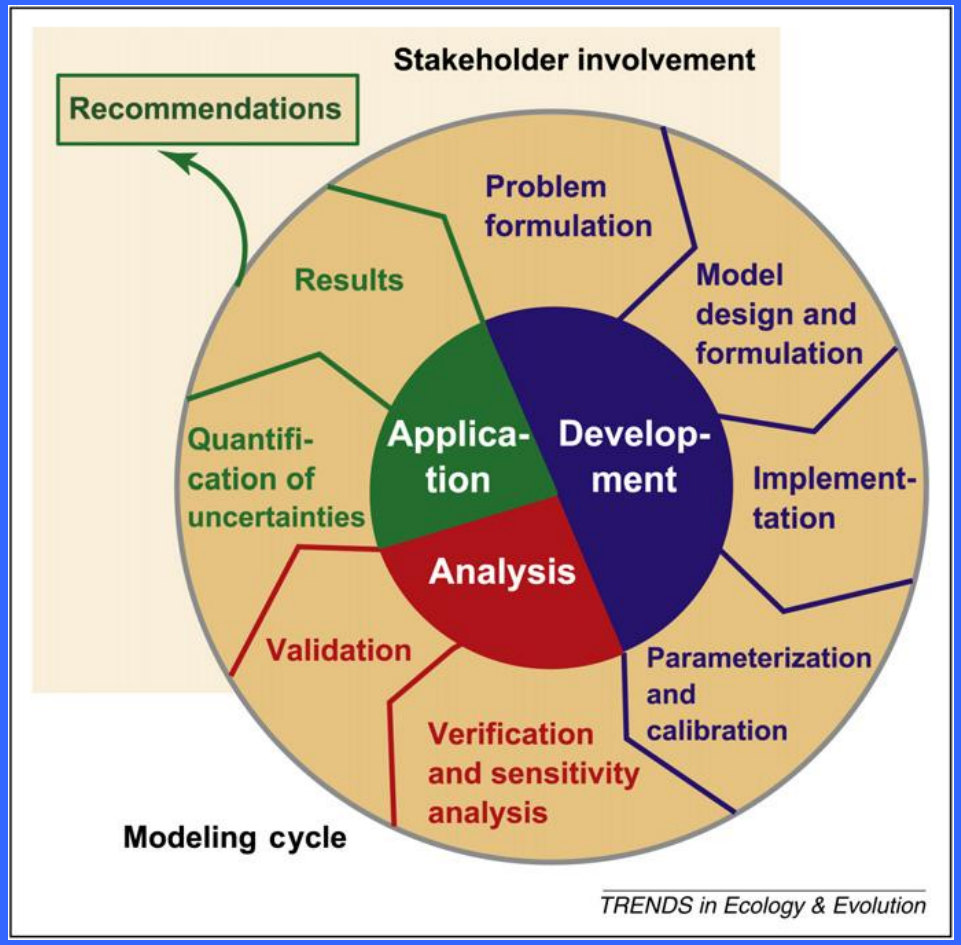
Ecological models supporting environmental decision making: a strategy for the future

Amelie Schmolke, Pernille Thorbek, Donald L. DeAngelis and Volker Grimm
UFZ, Helmholtz Centre for Environmental Research – UFZ, Department of Ecological Modelling, Permoserstr. 15, 04318 Leipzig, Germany
Syngenta, Environmental Safety, Jealott's Hill International Research Centre, Bracknell, Berkshire RG42 6EY, UK
USGS/Biological Resources Division and Department of Biology, University of Miami, PO Box 249118, Coral Gables, FL 33124, USA

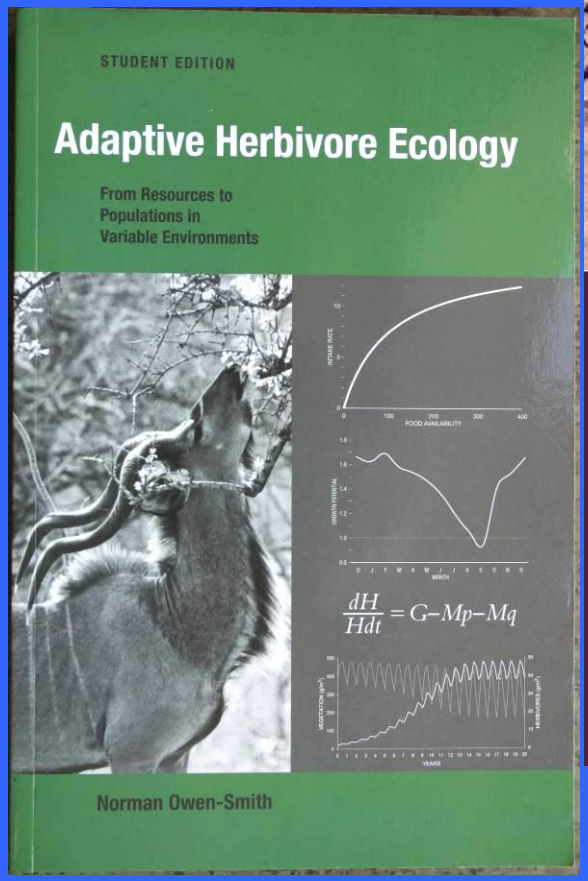
Trends in Ecology & Evolution 25:479-486, 2010

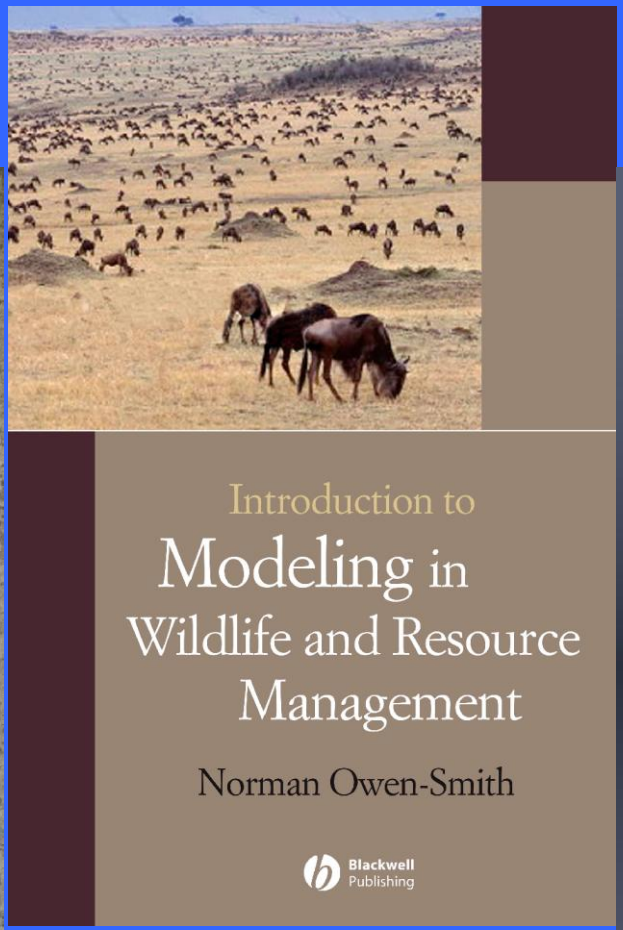
Transparent & Comprehensive Ecological Modelling Documentation

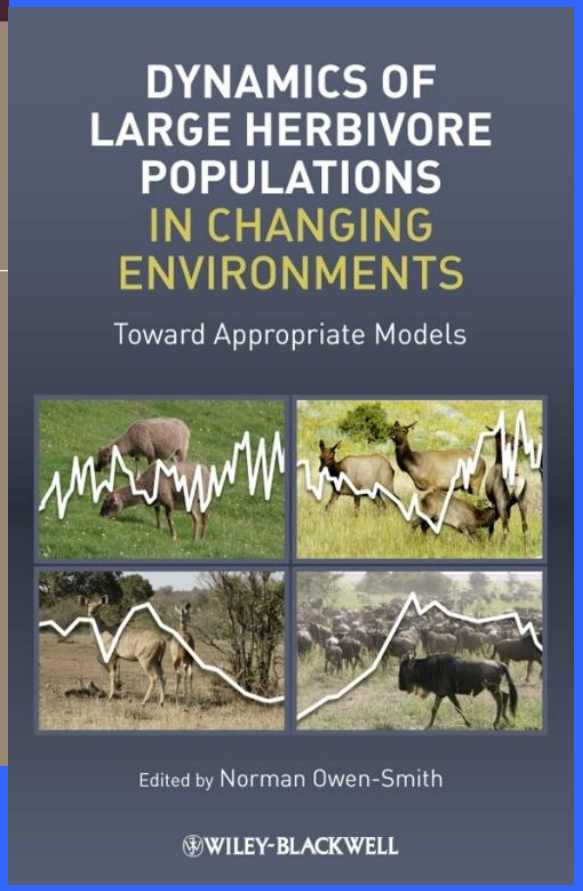
(TRACE)



MY CONTRIBUTION







WHY PRIORITISE THE UNIVERSE

WHEN OUR

EARTH SUPPORT SYSTEMS

ARE CRUMBLING?

SKA
SQUARE KILOMETRE ARRAY
www.skatelescope.org

WHAT'S NEEDED IS A
SAEON SUPPORT FACILITY

Environmental Informatics Institute
(or Centre of Excellence, or Unit)

Concentrating & fostering scarce skills needed to interpret voluminous data

Bio-informatics ***Epi-informatics***
Eco-informatics ***Enviro-informatics***

Trans-disciplinary,
supporting graduate courses in

data management statistical interpretation
theoretical modelling decision support systems