The effect of different land-use practices on rangeland condition, herbaceous and seed bank composition – implications for land degradation and biodiversity management in semi-arid western rangelands of Southern Africa

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NW DACE

Scientific Technical Support Services

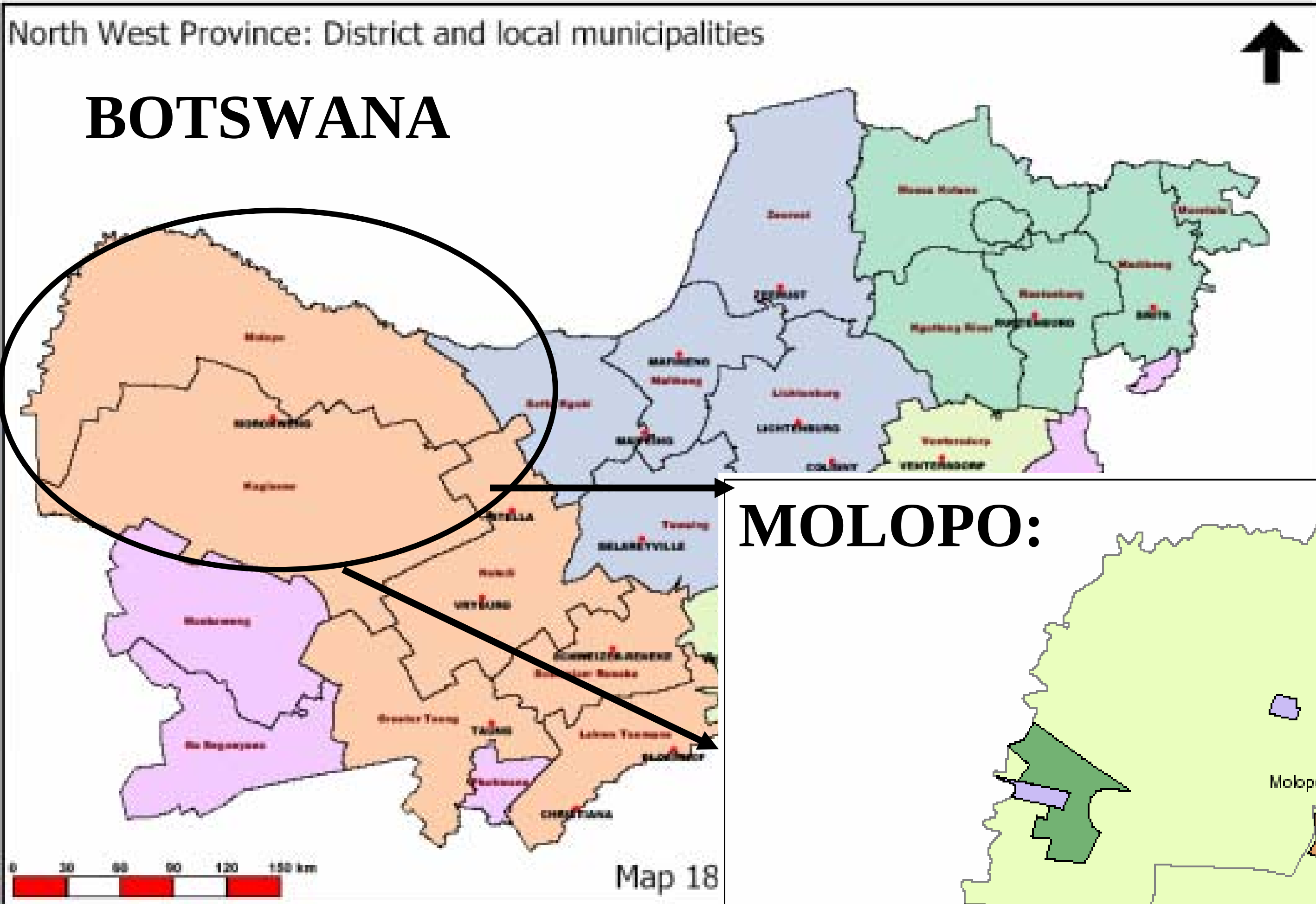
INTRODUCTION

- Rangeland degradation
- Global Environmental Facility Desert Margins Program (GEF-DMP)
- Some indicators of rangeland condition: classification of herbaceous species according to the ecological rangeland condition concept, changes in botanical composition, bush density as an indicator of bush encroachment, bare soil and the composition of herbaceous species according to their life-form (annual, perennial etc.).

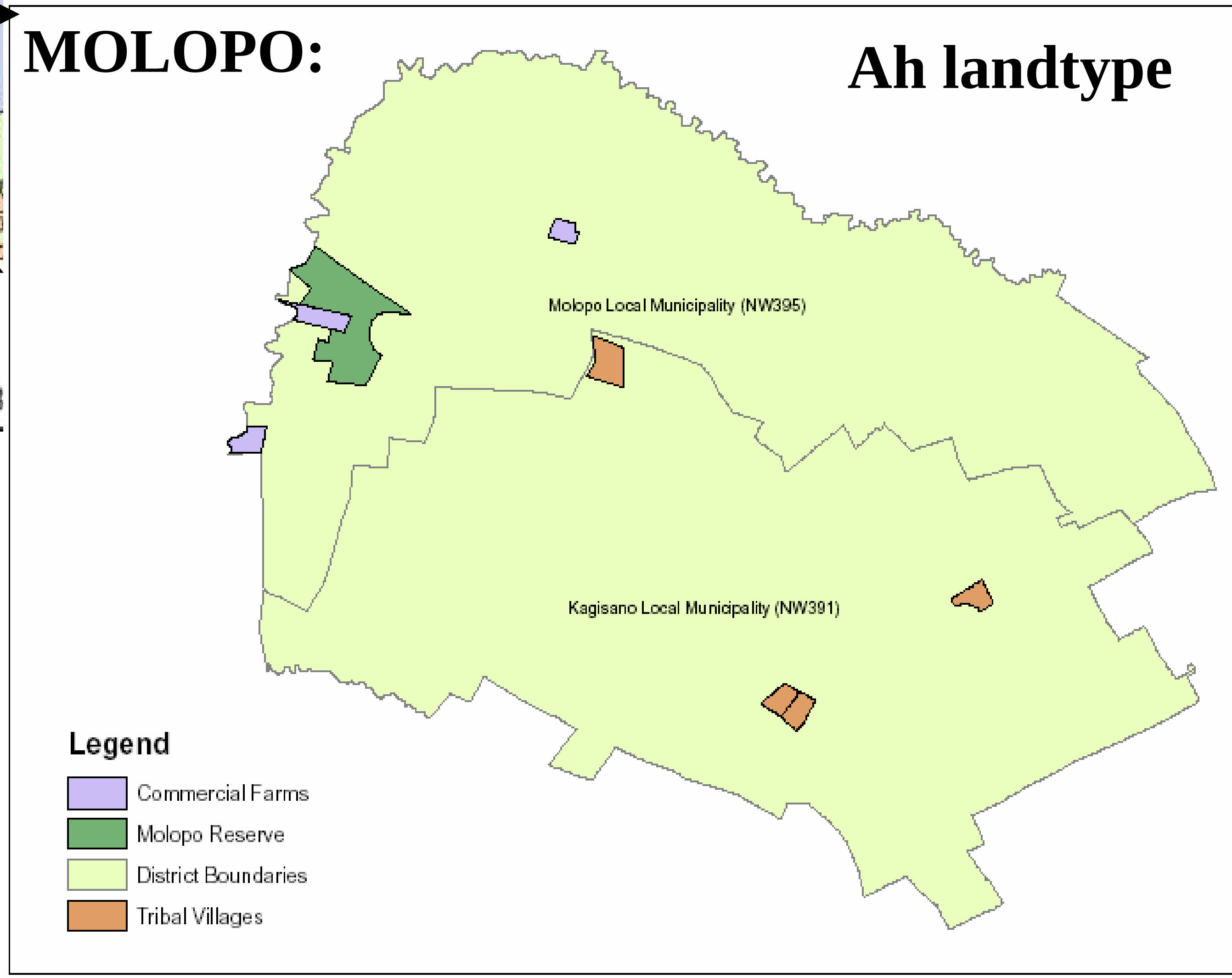
AIM

Present herbaceous composition differences between Commercial ("conservation farmer")-, Tribal and Reserve land uses, with special reference to degradation and diversity patterns within and between land uses, as a basis for understanding degradation and where possible, isolating indicators of degradation and diversity.

- **Sites were selected on grounds of rangeland condition/“health”, not from the specific objectives of the respective land uses.**



- **Commercial land use: 3 replicates**
- **Reserve land use - 3**
- **Tribal land uses - 3**



- **Degradation gradient within each replicate**:

- relative good and relative poor rangeland condition sites

-benchmark exclosures

- sites representative of management system

MATERIAL AND METHODS

1. ***HERBACEOUS COMPOSITION:***
- **Descending point, nearest-plant method , PSION monitor until 98% of the variance has been explained**

2. ***HERBACEOUS PRODUCTION:***
- **Dry weight rank method – (T'mannetjie & Haydock)**

3. ***HERBACEOUS QUALITY:***
- **Quality analysis for crude protein, metabolisable energy (ME), digestibility, minerals (phosphorus, magnesium and calcium), neutral detergent fibre (NDF) and acid detergent fibre (ADF).**

4. ***SEEDBANK STUDIES:***
- **Samples up to 50mm collected in "open areas" as well as samples taken from beneath dominant woody component – mixtures kept apart**

5. ***SOIL:***
- **Sampled from the open herbaceous and dominant woody component : topsoil (5-25 cm) & sub-soil strata (50-75cm)**

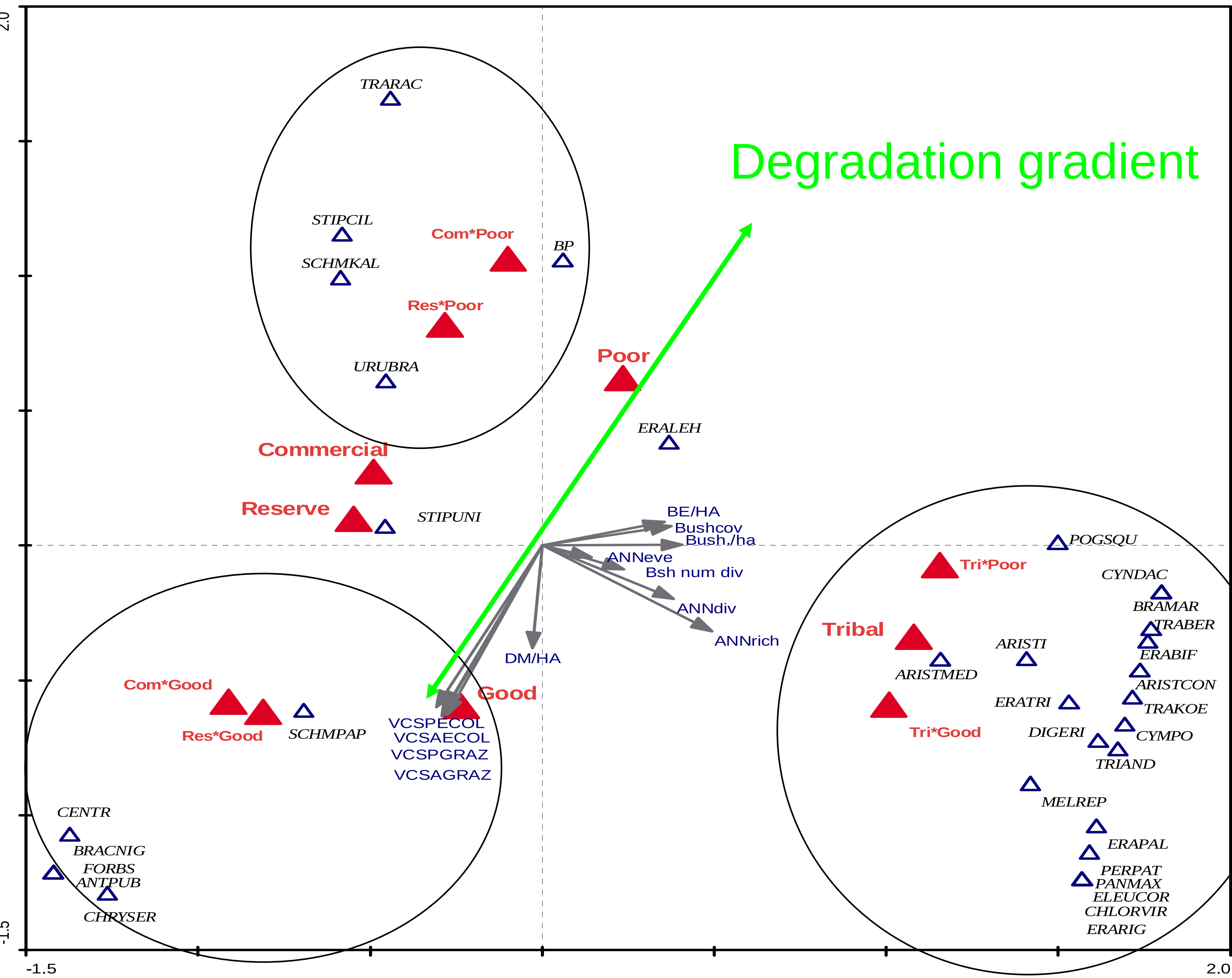
6. ***WOODY COMPONENT:***
- **Bush density and woody species composition: TE/ha, number of individuals per species/ha and area coverage per species/ha**
- **Woody structural form**

7. ***ANT SURVEYS:*** **Sampled in 54 grids (sub-replicates) of 15 pitfalls each**

RESULTS:
2004-2006

SPECIES COMPOSITIONAL PATTERNS

2004 : A CCA ordination triplot



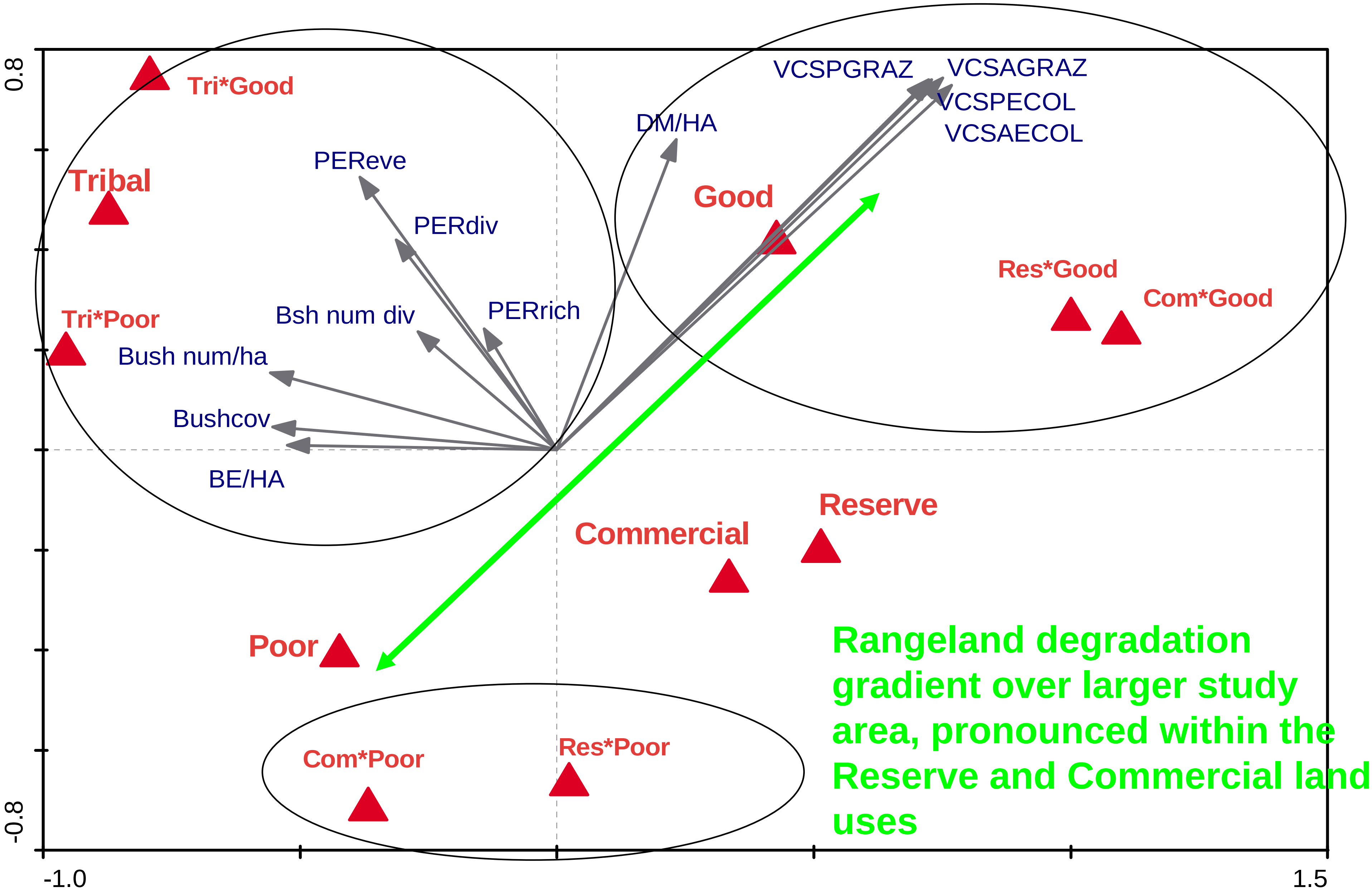
•*Species environment relation explained:*

98.4%

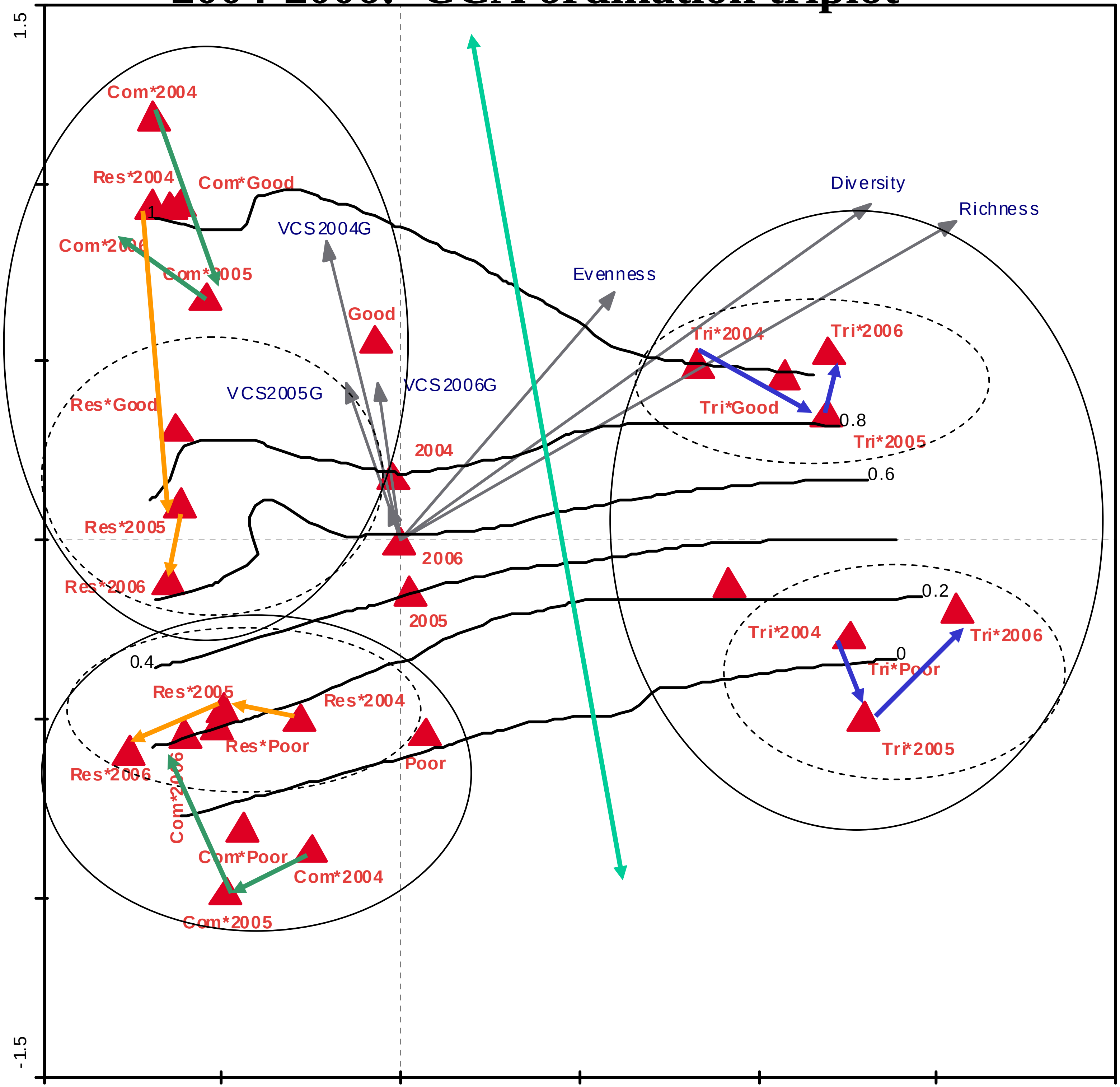
Monte Carlo Test:

P < 0.05

2004: A CCA biplot



2004-2006: CCA ordination triplot

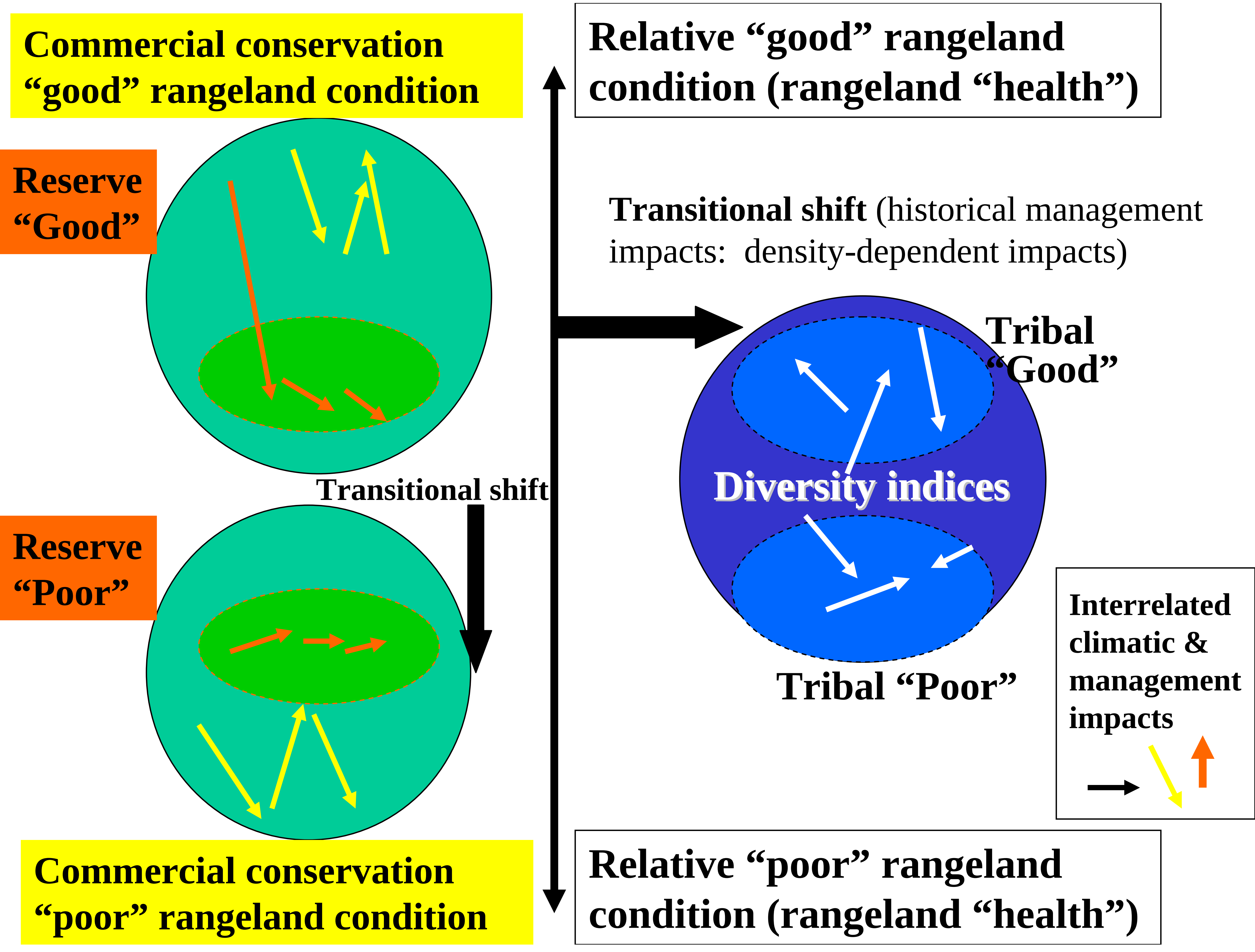


•*Species environ. relation explained:*

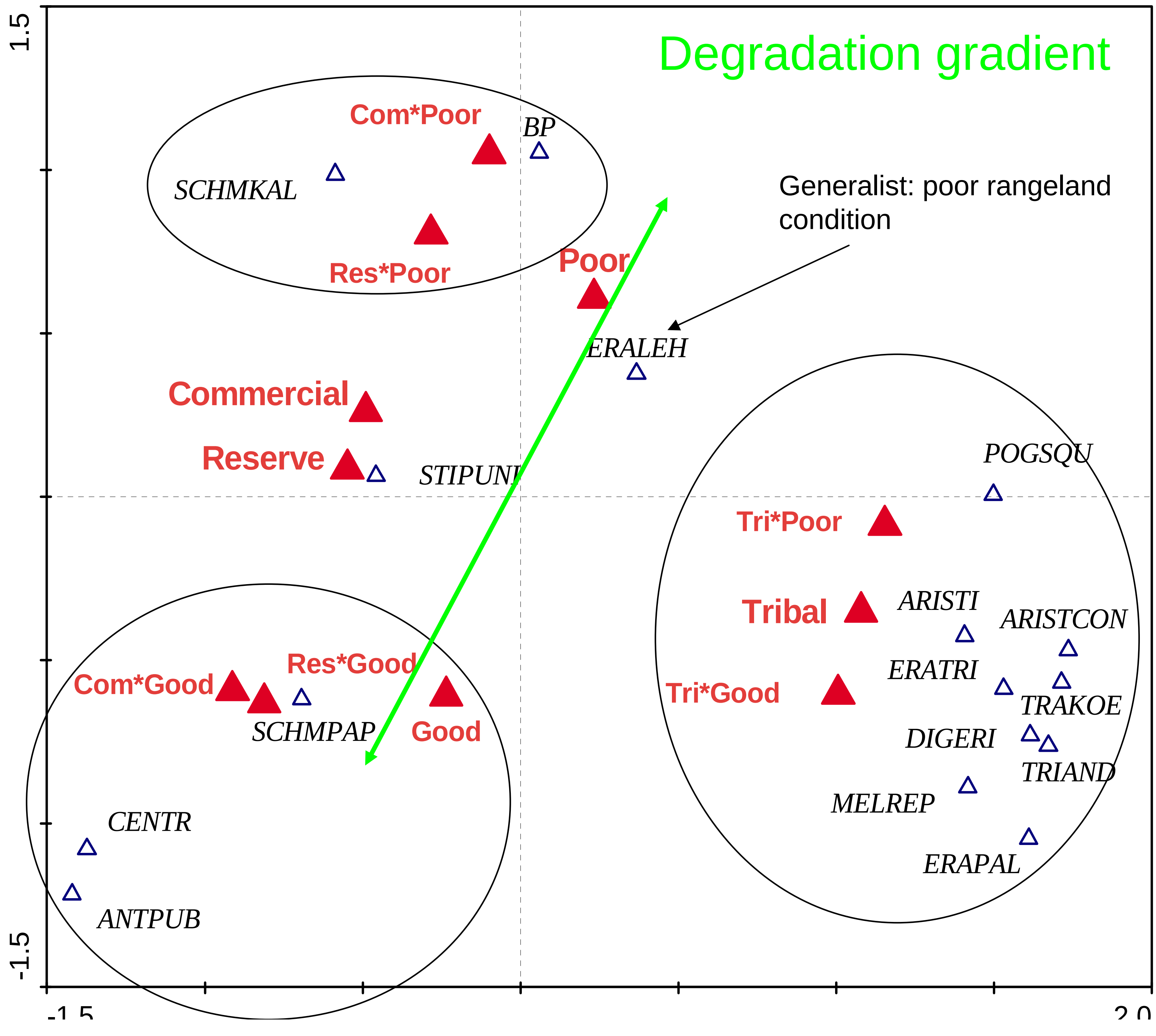
83.0%

Monte Carlo Test:

P < 0.05


Commercial conservation "good" rangeland condition
Relative "good" rangeland condition (rangeland "health")
Reserve "Good"
Transitional shift (historical management impacts: density-dependent impacts)
Tribal "Good"
Diversity indices
Transitional shift
Reserve "Poor"
Tribal "Poor"
Interrelated climatic & management impacts
Commercial conservation "poor" rangeland condition
Relative "poor" rangeland condition (rangeland "health")

CCA biplot "Key" species responsive to axes using inclusion rules



CCA ordination axes

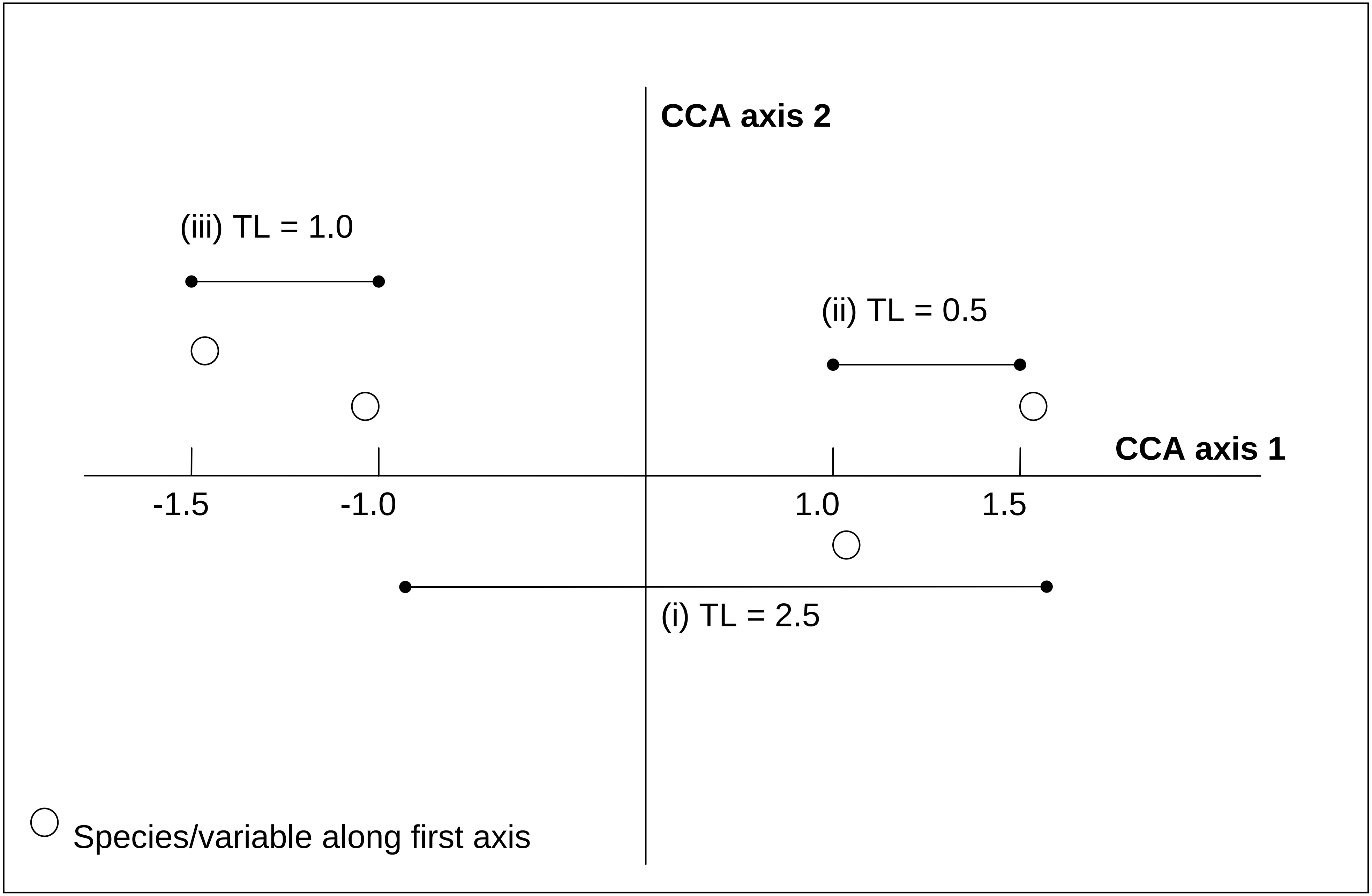


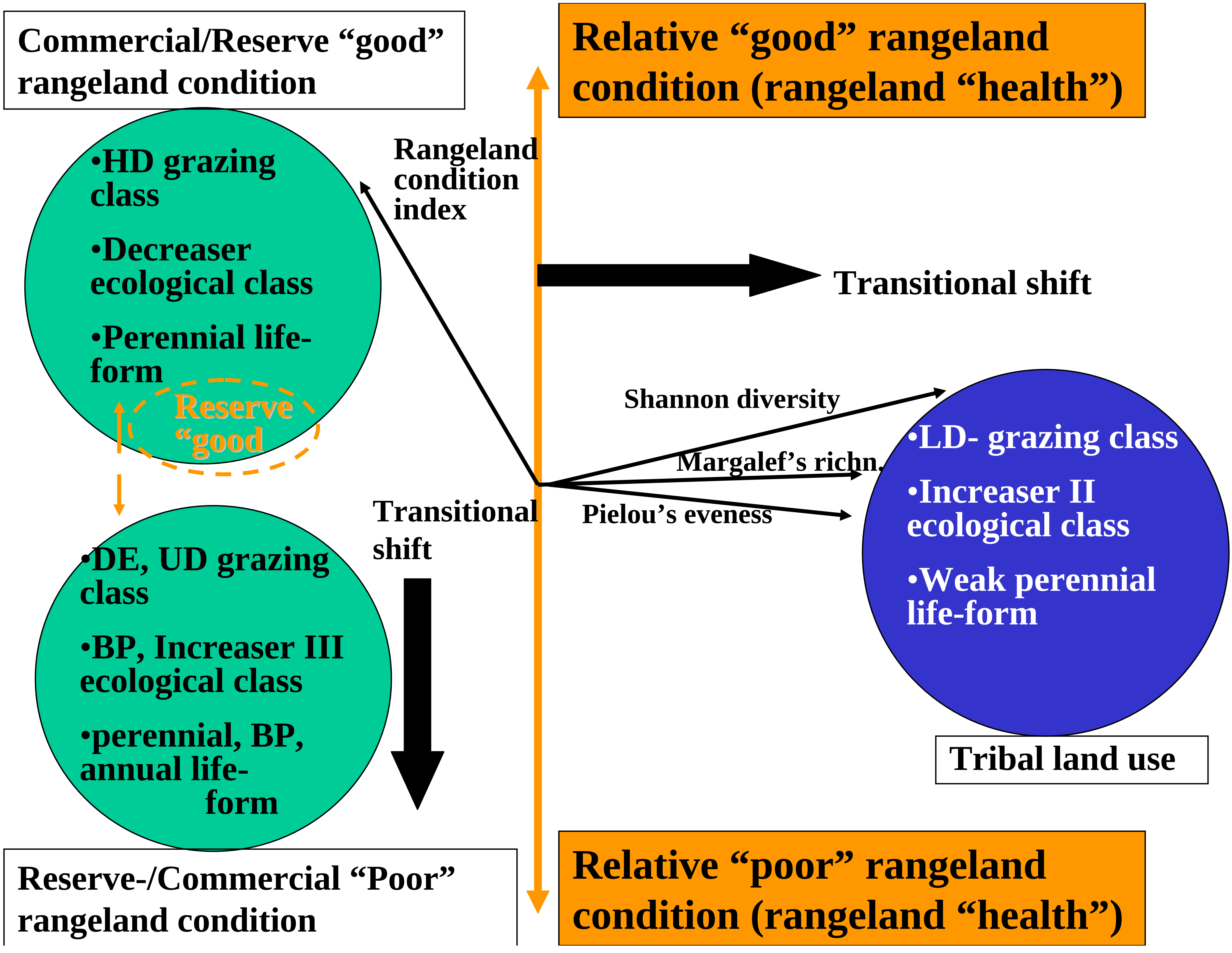
Fig. Calculation of the Total length (TL) of eigenvalue ranges for species/variables along the first CCA axis, for the purpose of calculating the Index Score (IS).

D.1 Key assessment matrix before further seperation/refinement of CCA axis 2

AX1	**Tribal**	**Commercial/Reserve**	**AX2: Commercial/Reserve in bold; underline shared by both land uses**	**Poor**
ARIST CON	10.0	0.0	<u>BP</u>	0.0
TRA KOE	9.9	0.1	***SCHM KAL***	0.3
TRI AND	9.8	0.2	<u>*ERA LEH*</u>	3.0
DIG ERI	9.6	0.4	***STIP UNI***	4.4
ERA PAL	9.6	0.4	*POG SQU*	4.6
ERA TRI	9.3	0.7	*ARI STI*	6.5
POG SQU	9.2	0.8	*ARIST CON*	6.7
MEL REP	9.0	1.0	*TRA KOE*	7.1
ARI STI	9.0	1.0	*ERA TRI*	7.2
ERA LEH	5.7	4.3	***SCHM PAP***	7.4
BP	4.7	5.3	*DIG ERI*	7.8
STIP UNI	3.1	6.9	*TRI AND*	8.0
SCHM KAL	2.6	7.4	*MEL REP*	8.6
SCHM PAP	2.3	7.7	*ERA PAL*	9.3
CEN TR	0.2	9.8	***CEN TR***	9.4
ANT PUB	0.0	10.0	***ANT PUB***	10.0
				Good

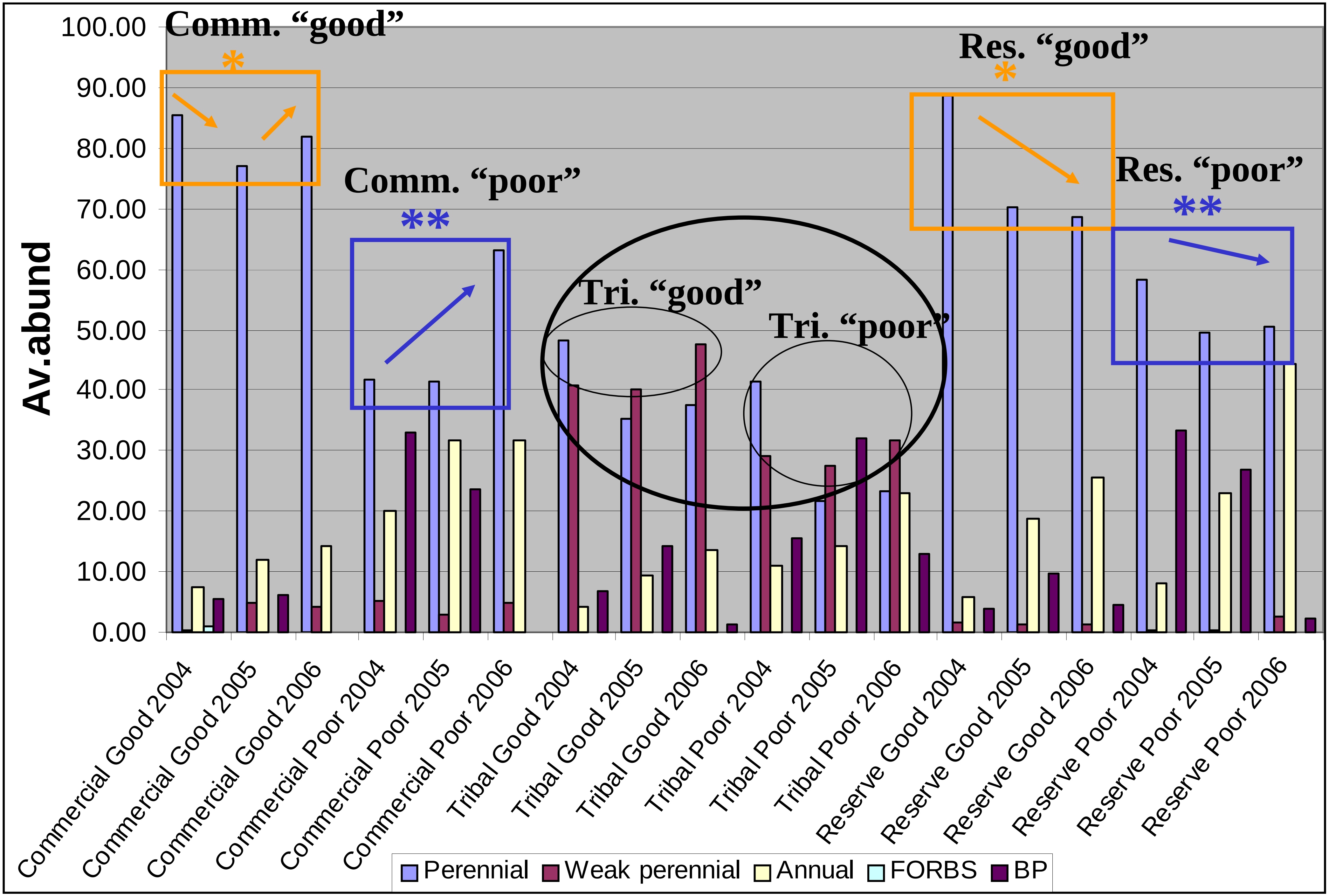
RESULTS:

- **GRAZING CLASSIFICATION:**
  palatability
- **ECOLOGICAL CLASSIFICATION:**
  functional/successional stage
- **LIFE-FORM:**
  rangeland condition/"health"



Commercial/Reserve "good" rangeland condition
Relative "good" rangeland condition (rangeland "health")
•HD grazing class
•Decreaser ecological class
•Perennial life-form
Reserve "good"
Rangeland condition index
Transitional shift
Shannon diversity
Margalef's richn.
Pielou's eveness
•LD- grazing class
•Increaser II ecological class
•Weak perennial life-form
Tribal land use
•DE, UD grazing class
•BP, Increaser III ecological class
•perennial, BP, annual life-form
Transitional shift
Reserve-/Commercial "Poor" rangeland condition
Relative "poor" rangeland condition (rangeland "health")

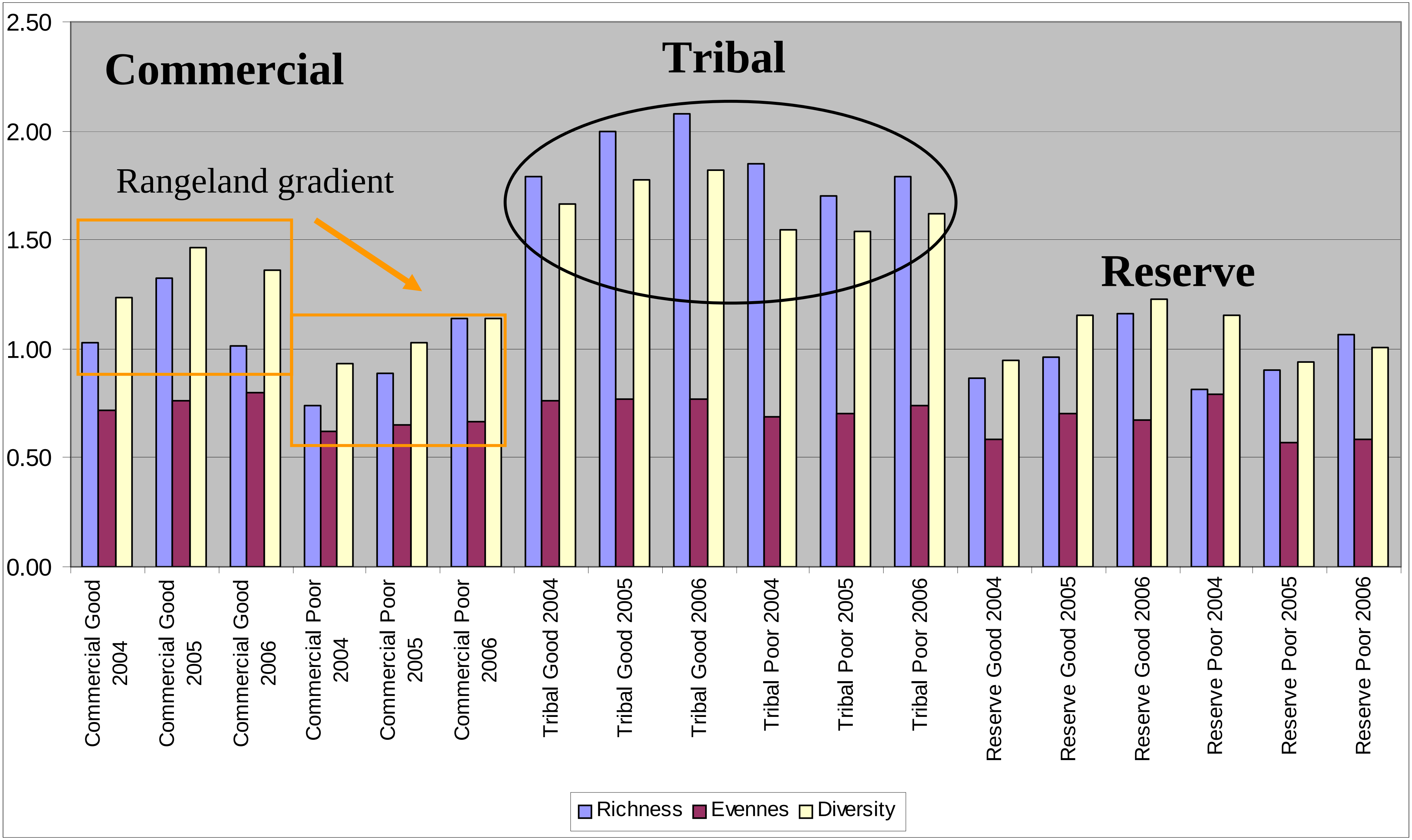
2004-2006: Life-form classification



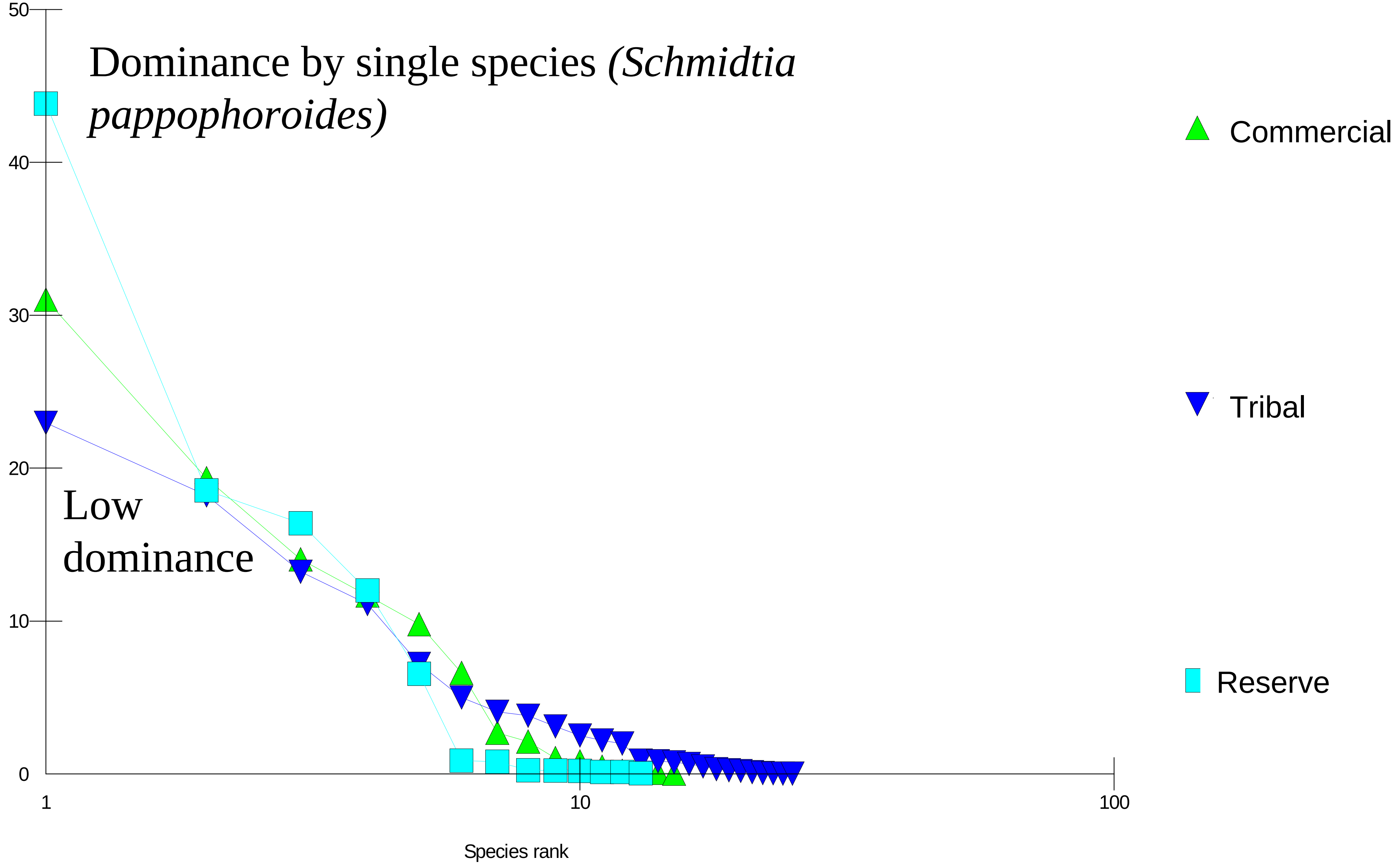
RESULTS:

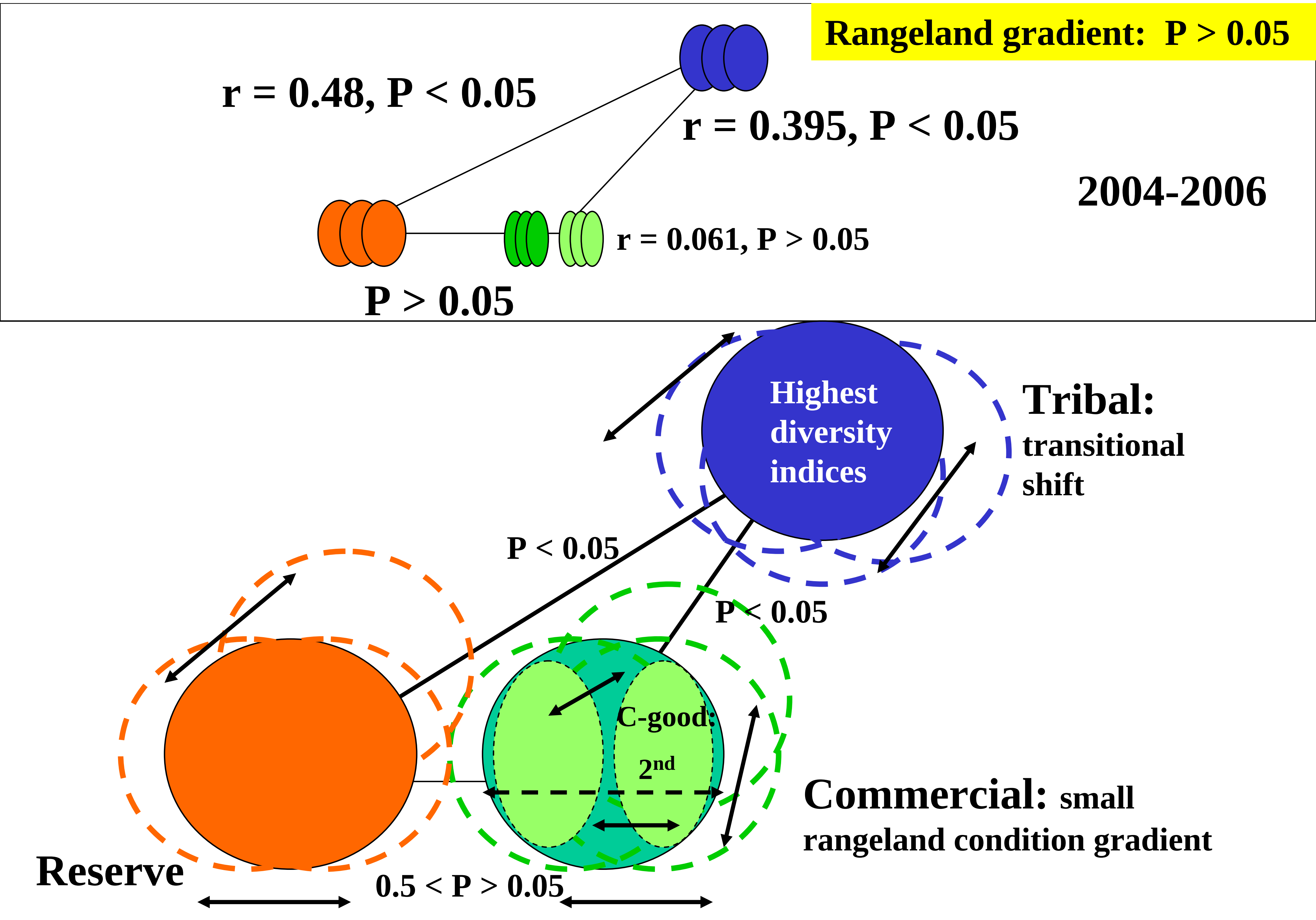
DIVERSITY PATTERNS

2004-2006: Average diversity indices



Species dominance plot



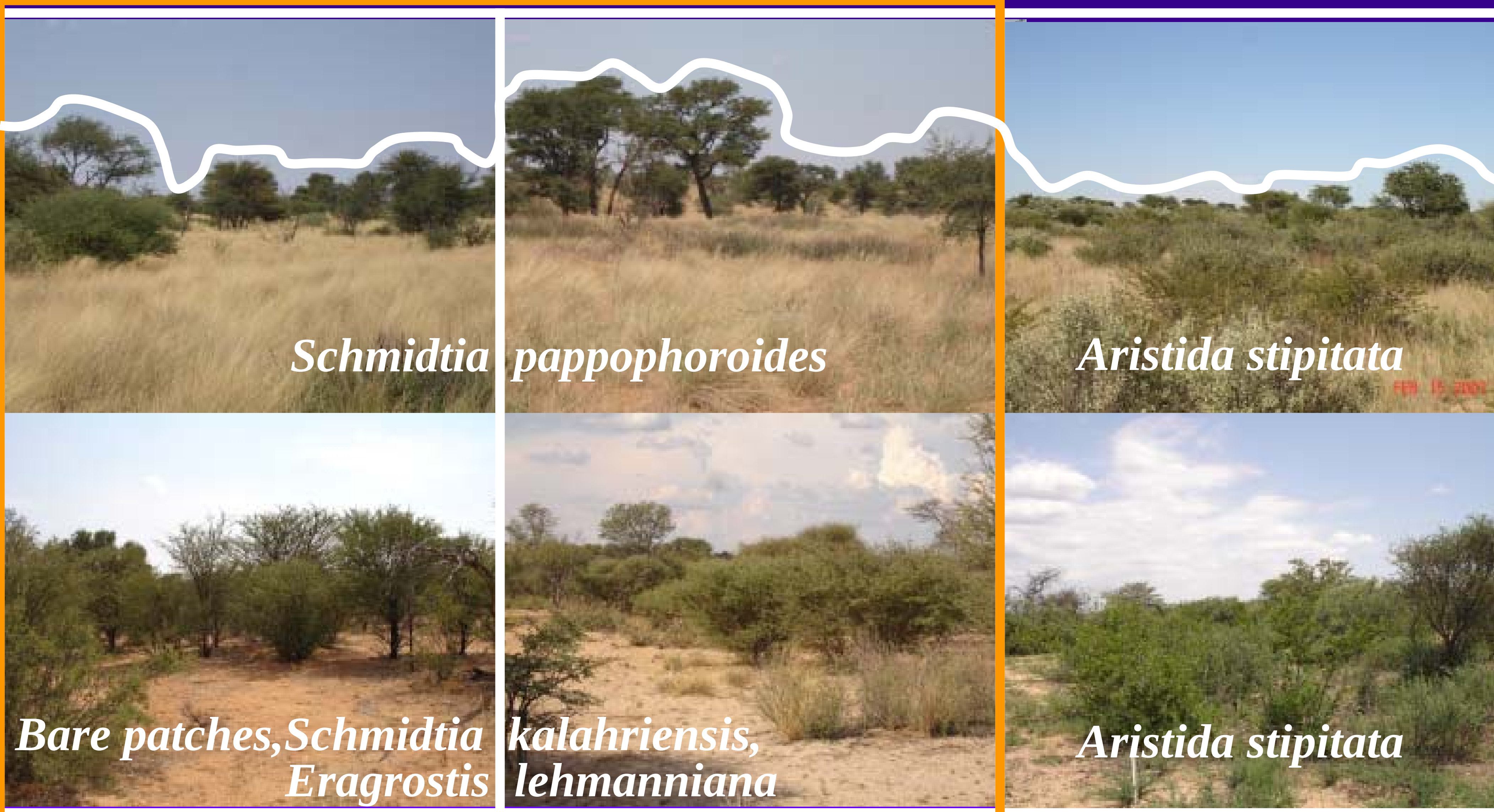

Rangeland gradient: P > 0.05
r = 0.48, P < 0.05
r = 0.395, P < 0.05
2004-2006
r = 0.061, P > 0.05
P > 0.05
Highest diversity indices
Tribal: transitional shift
P < 0.05
P < 0.05
C-good: 2nd
Commercial: small rangeland condition gradient
Reserve
0.5 < P > 0.05

Reserve: intermediate tree stratum structure/height

Commercial: high tree stratum

Tribal: low, dense tree stratum

Reserve-Good | **Commercial-Good** | **Tribal-Good**



Reserve-Poor | **Commercial-Poor** | **Tribal-Poor**

Molopo Pilot study outputs

ECOSYSTEM KNOWLEGDE BASE	COLLECT AND ARCHIVING DATA	DEVELOP & PROMOTE TECHNOLOGIES
MODELLING	**MONITORING/ METADATA**	**TECHNOLOGY PACKAGES, EXTENSION**
RESOURCES: AGRICULTURE, CONSERVATION, OTHER 1. Degradation 2. Rangeland "health" 3. Diversity patterns	1. Data management systems – METADATA - AGIS 2. Should be compatible between programmes 3. High quality, serve as dissemination 4. Monitoring trends	1. Production and rangeland condition norms. 2. Conservation and diversity technologies 3. Adaptive management tools, demonstrations, webbased packages, extension, spatial data etc.
Research, Conservation Scientific Services, ARC, NDA, Universities	Research, Conservation Scientific Services, GIS, AGIS – NDA, ARC	DFS, Conservation, Capacity Building, Policy & Planning, ARC, NDA, Research

CONCLUSION

- **Although rainfall events (non-equilibrium) are major driving factors of vegetation change in the Molopo, some management practices, irrespective of land use type, historically & currently do result in density-dependent processes (equilibrium), with the effect of degradation being masked by climatic events only up to a certain point, whereafter the system may reflect the longer-term degradation events due to losing its flexibility (resilience). If a shift towards a new domain has been reached, non-equilibrium events will not easily result in a transitional shift (flexibility) back.**
- **Events <u>time-delayed</u>, management impact observable later.**
- **In answer to the key objectives, this study found:**

1. <u>Degradation gradient</u> for the larger Molopo study area, including all land uses

2. A <u>transitional shift</u> in species composition for the entire Tribal land use, and Commercial/Reserve-Poor sites.

3. <u>Seed bank</u> composition studies corresponded with the herbaceous composition patterns.

4. <u>Diversity indices</u> associated with Tribal land use. Diversity patterns congruent between the herbaceous, woody and ant compositions.

5. Different <u>herbaceous patterns</u> at patch, paddock & landscape level.

6. Management impacts and rainfall showed <u>"time-delayed" responses</u> visible only at a later stage.

7. <u>State-and-transition models</u> may be most useful to describe vegetation dynamics pertaining to the Molopo rangelands – TPC's.

WAY FORWARD

- Include other spectra of land uses along rangeland degradation gradient, and refine gradient, including different parameters (also animal norms etc.)
- Link different management aspects, where available, to biophysical data in "expert decision-making" model.
- Ensure effective multidisciplinary and multisectoral linkages to strengthen capacity, expertise and resources


Meet the “people”