RESILIENCE AND RECOVERY IN CHALK GRASSLAND COMMUNITIES FOLLOWING SEVERE DISTURBANCE BY MILITARY VEHICLES

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PHYSICAL AGENTS OF DISTURBANCE IN NATURAL SYSTEMS

- ‘NATURAL’ FIRE, WIND, WATER MOTION

- ‘HUMAN – NATURE INTERFACE’

  Industrial development civil engineering construction
  mining and quarrying
  agriculture and forestry
  military training

EXTREME PHYSICAL DISTURBANCE

MINING AND QUARRYING

Require restoration of a functioning ecosystem on raw substrates e.g. calcareous grassland

RESPONSE TO EPISODIC PHYSICAL DISTURBANCE

- Natural recovery following military training
- Variable intensity through time and space

SPONTANEOUS ECOLOGICAL RESTORATION

SALISBURY PLAIN TRAINING AREA

CHALK GRASSLAND AND MESOTROPHIC GRASSLAND

Regular disturbance, a range of military vehicles including tanks. Military presence > 100 years

38,000 ha total 20,000 ha (SSSI)

CALCAREOUS GRASSLANDS

A BIOTOPE WITH HIGH EUROPEAN CONSERVATION IMPORTANCE

Underlying Cretaceous chalk deposits
Grazed by sheep and cattle (also rabbits and deer) for 1,600 years
30-40 plant species per square metre

AIM – BASIC QUESTIONS

- What is the rate of spontaneous recovery from disturbance?
  = RESILIENCE of ecosystem components

- RESISTANCE to disturbance – What is the magnitude of the initial change?

- CONVERGENCE – direction of recovery to pre-disturbance state (or to another state)?

METHOD - SITE SELECTION

- Historical aerial photographs 9 dates
  1945 – 1995 CHRONOSEQUENCE

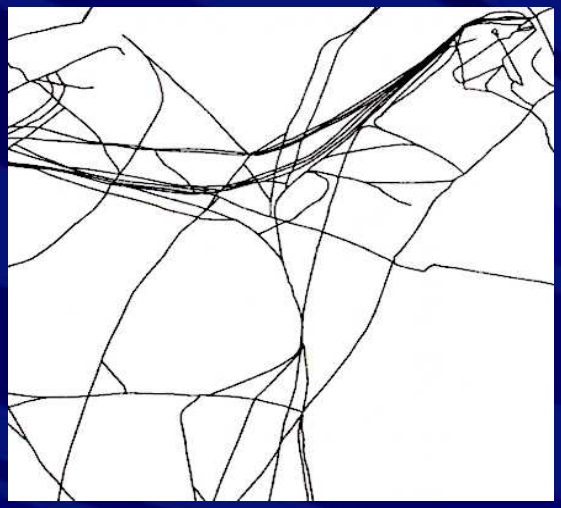
- 6 random tetrads 2 km x 2 km

- 53 Chalk grassland sites (CG3)
  29 Mesotrophic grassland sites (MG1)

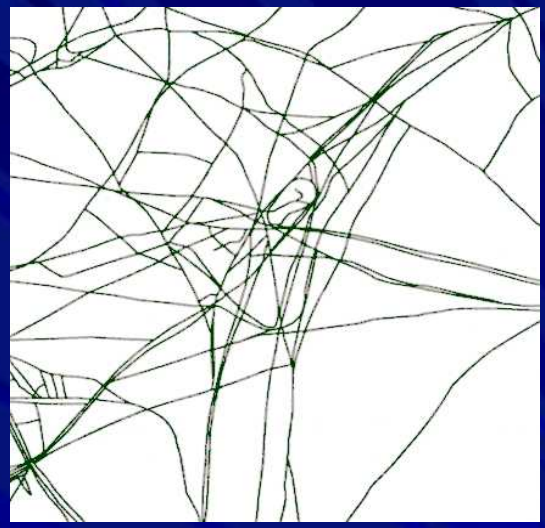
- 5 vegetation samples in disturbed areas
  5 vegetation samples in closest adjacent undisturbed area

Associate Ecologist (LUC) - Dr Rachel Hirst who did all the hard work

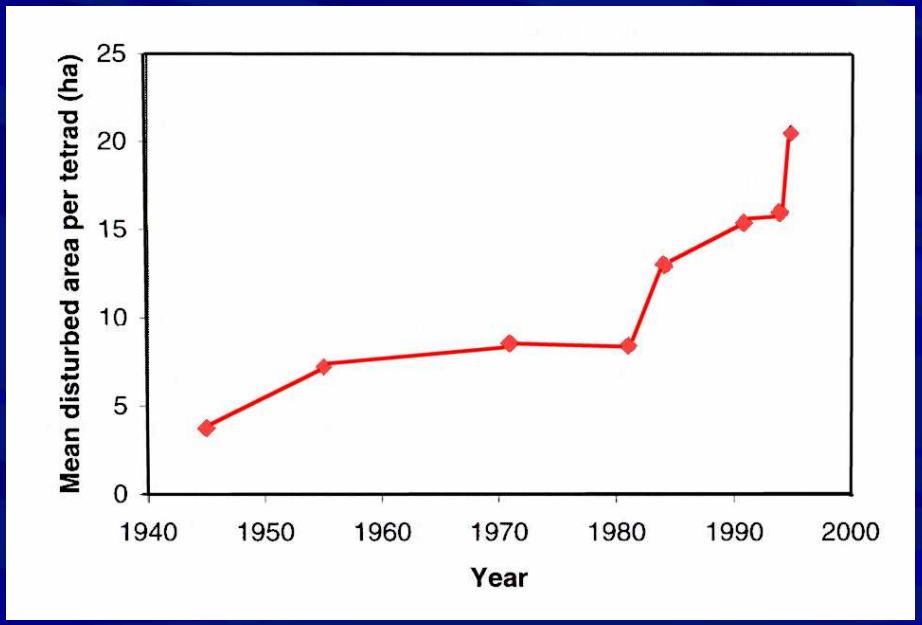
TRACK NETWORK



1955



1995



TRACK NETWORKS OF EXPOSED CHALK

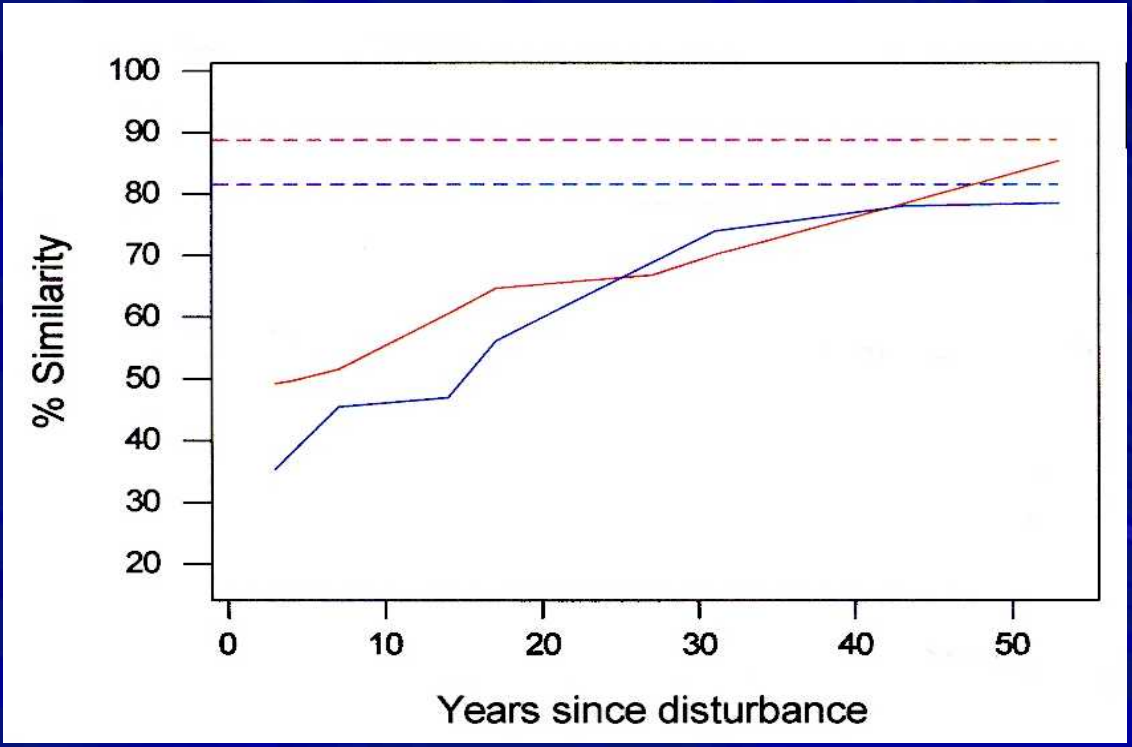
SINGLE TANK PASS NO EXPOSED CHALK

ADD APPROX. 30% TO INCLUDE LESSER DIS-TURBANCE

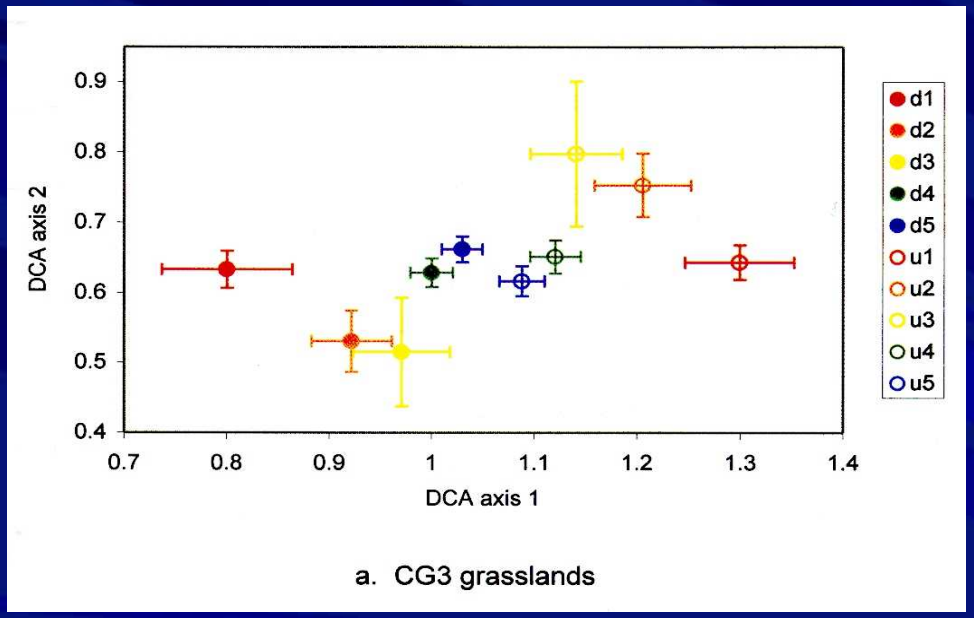
CHANGES IN VEGETATION COMMUNITIES THROUGH THE TIME SERIES

Percentage similarity between disturbed and undisturbed samples (based on Sørenson's Similarity Index)

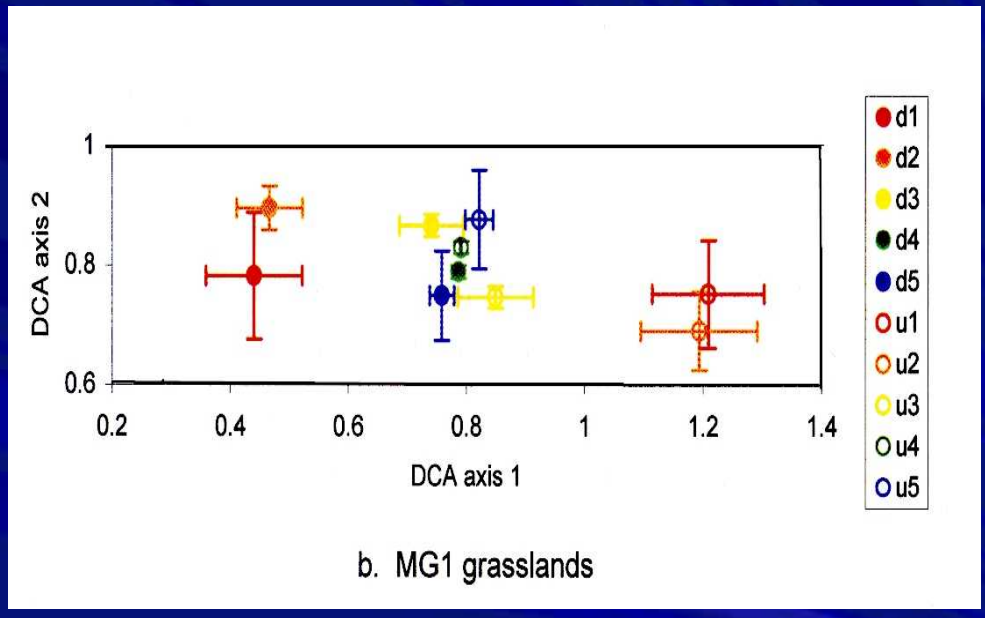
Solid red = CG3 community
Solid blue = MG1 community
Dotted = maximum similarity within undisturbed vegetation



MULTIVARIATE ANALYSIS OF PLANT COMMUNITY CHANGES
DETRENDED CORRESPONDENCE ANALYSIS (DCA)



a. CG3 grasslands

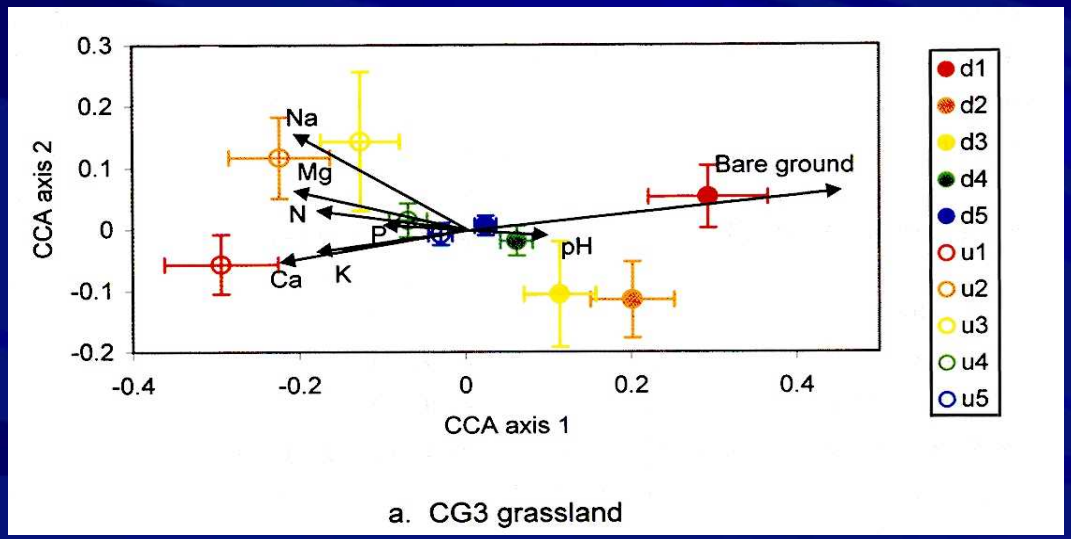


b. MG1 grasslands

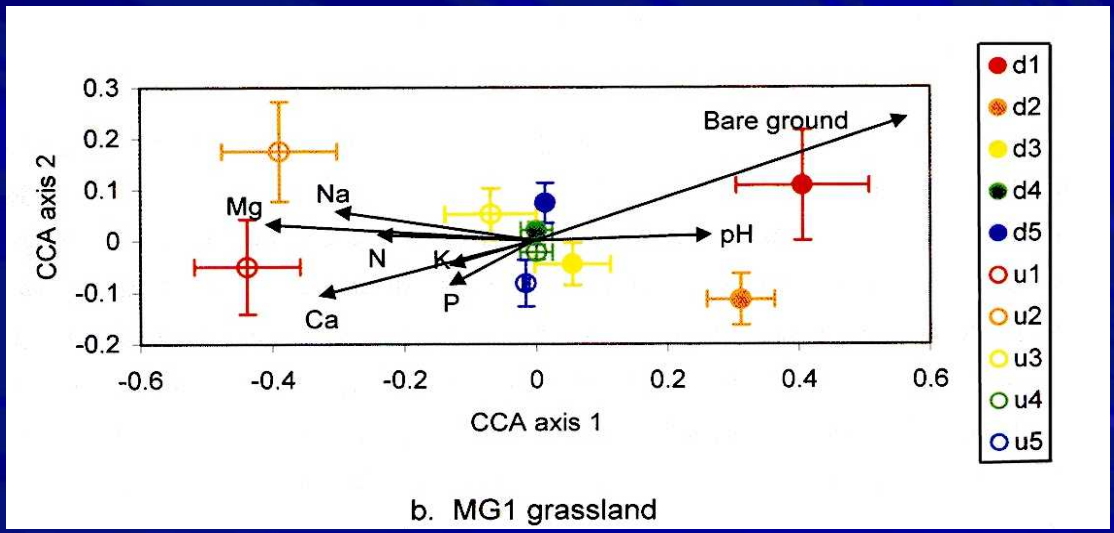
Bars show standard error of the mean along the two axes displayed

CANONICAL CORRESPONDENCE ANALYSIS (CCA)

Including soil chemical variables, time, bare ground, grazing intensity

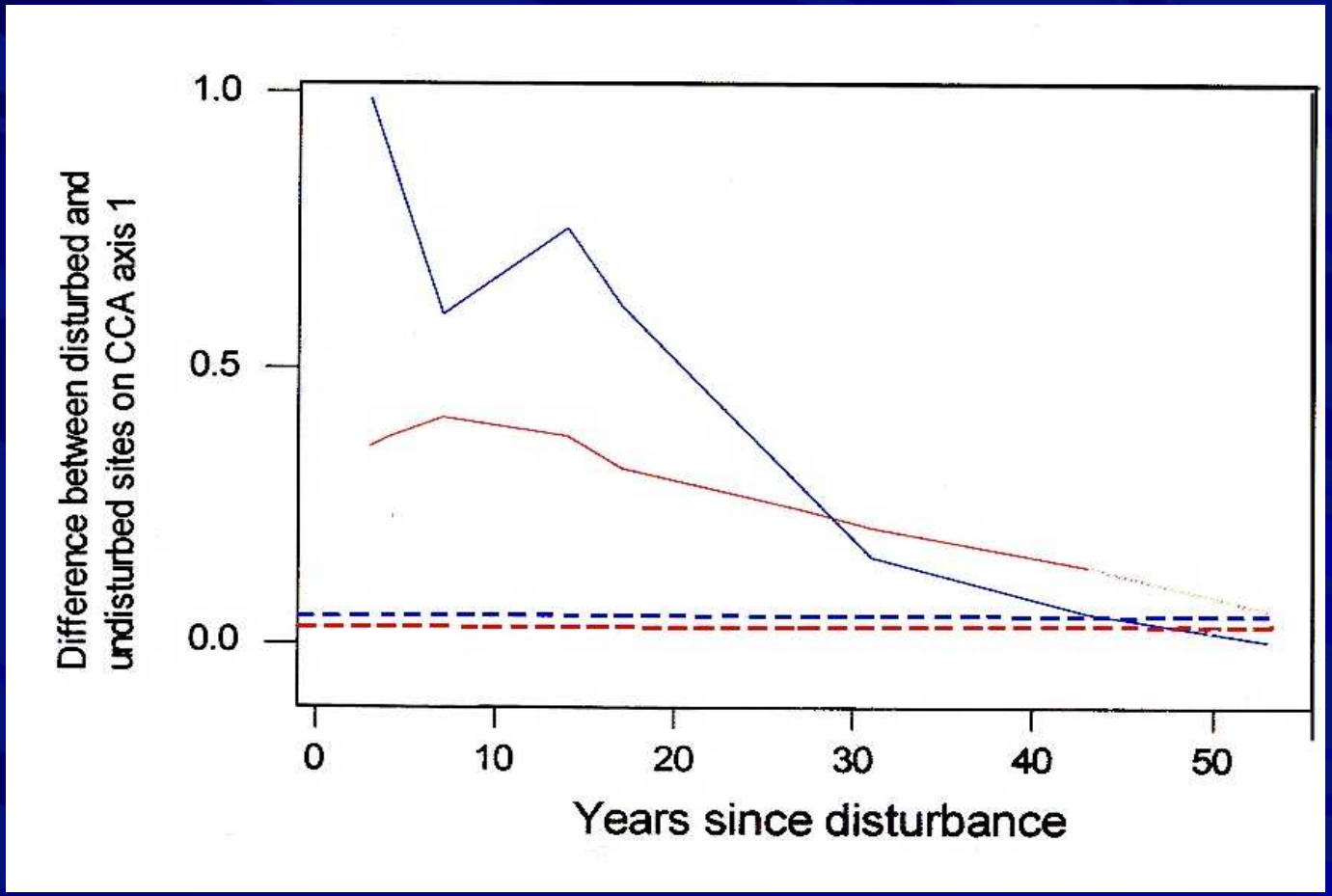


a. CG3 grassland



b. MG1 grassland

THE DIFFERENCE OVER TIME BETWEEN THE POSITION OF DISTURBED AND UNDISTURBED SITES ON CCA AXIS 1



Solid red = CG3 community

Solid blue = MG1 community

Dashed lines = mean difference between pairs of undisturbed reference sites

SIGNIFICANCE OF DIFFERENCE BETWEEN PERCENTAGE COVER OF SPECIES CLASSES (PAIRED T TESTS) CG3 GRASSLAND

SPECIES TYPE	YEARS SINCE DISTURBANCE			
	14-17	27-31	43	53
Perennial grasses	uu			dd
Perennial forbs			d	d
Annual forbs	dd		d	

u = undisturbed > disturbed
d = disturbed > undisturbed

TYPICAL UNDISTURBED CG3 GRASSLAND

RECENTLY DISTURBED (TANK TRACK) WITH ANNUAL AND PERENNIAL FORBES e.g. *DAUCUS CAROTA, MELILOTUS ALTISSIMUS*

SIGNIFICANCE OF DIFFERENCE BETWEEN SOIL CHEMICAL PROPERTIES (PAIRED T TESTS)

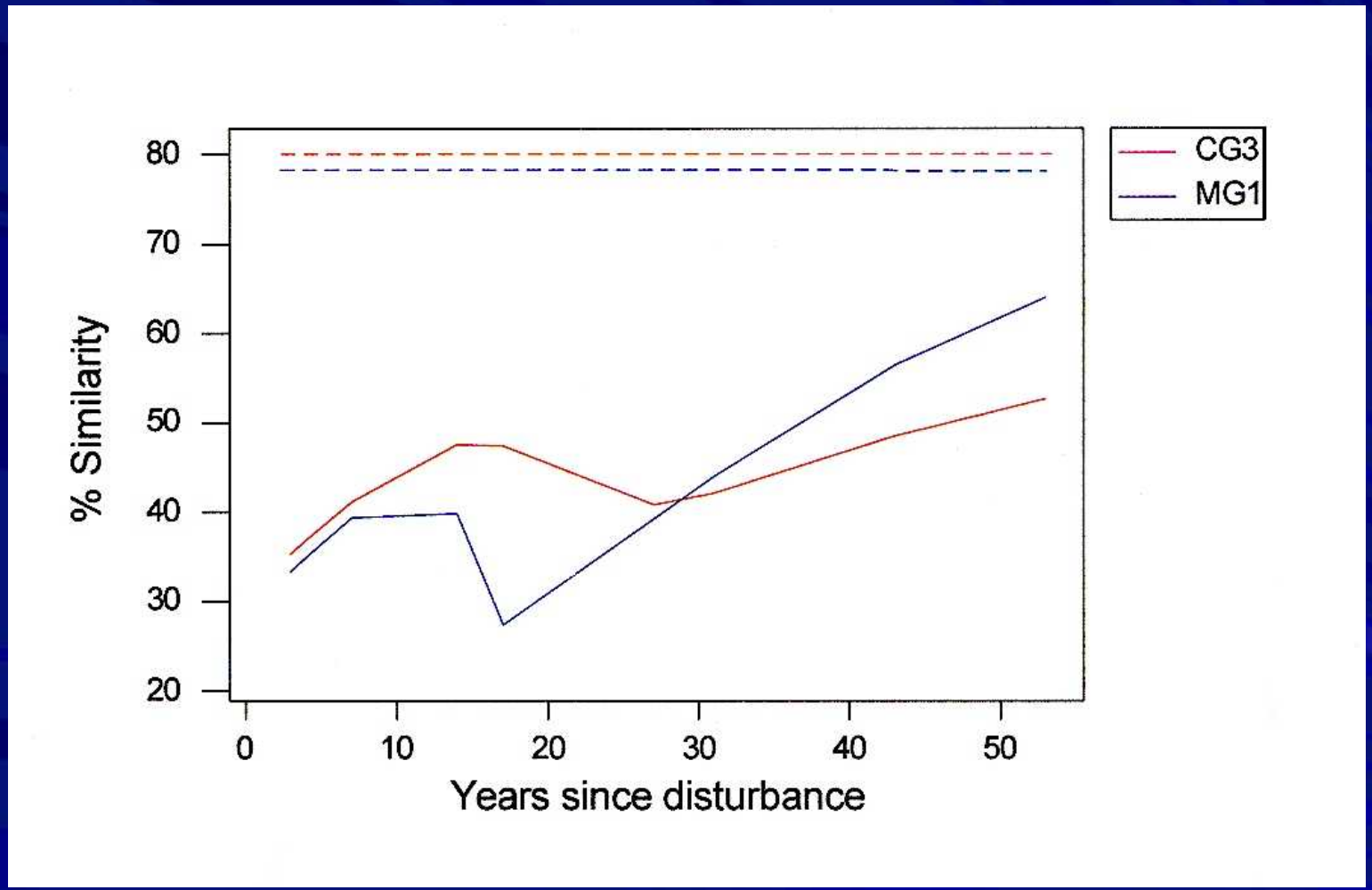
CG3 GRASSLAND

SOIL PROPERTY	YEARS SINCE DISTURBANCE			
	14-17	27-31	43	53
Mg*	uu	uu		
Ca*	uu			
N (total organic)	uuu		uu	
P (extractable)	uu			

u = undisturbed
> disturbed

*extractable cations

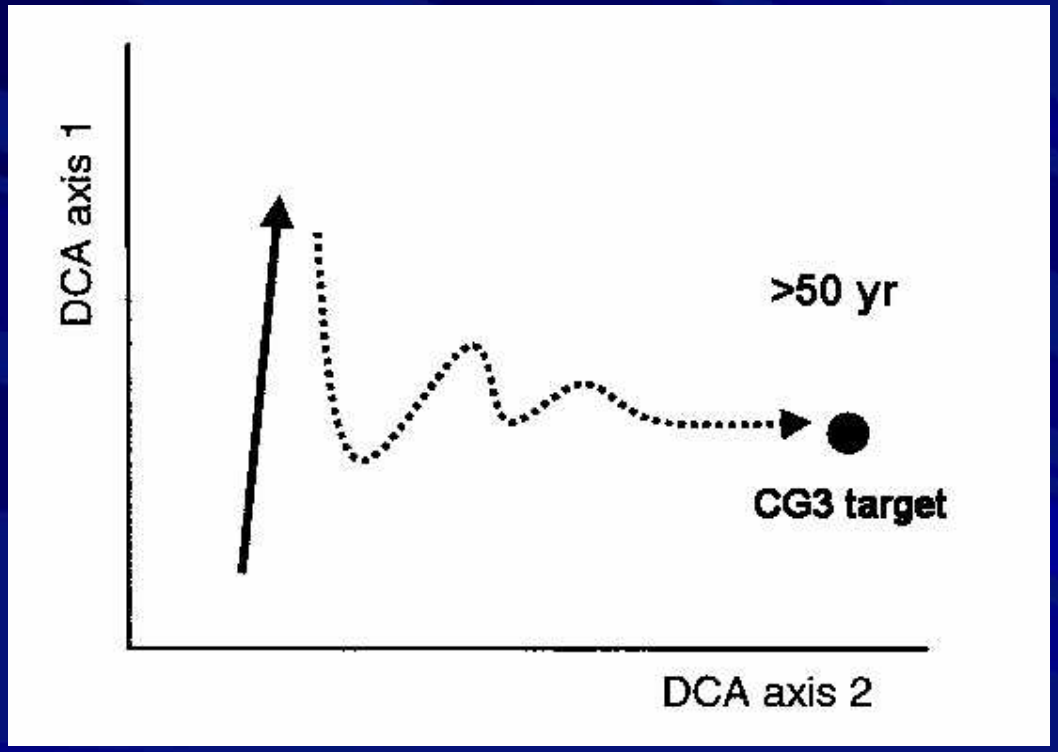
THE DIFFERENCE OVER TIME IN SEED BANK POPULATIONS BETWEEN DISTURBED AND UNDISTURBED SITES



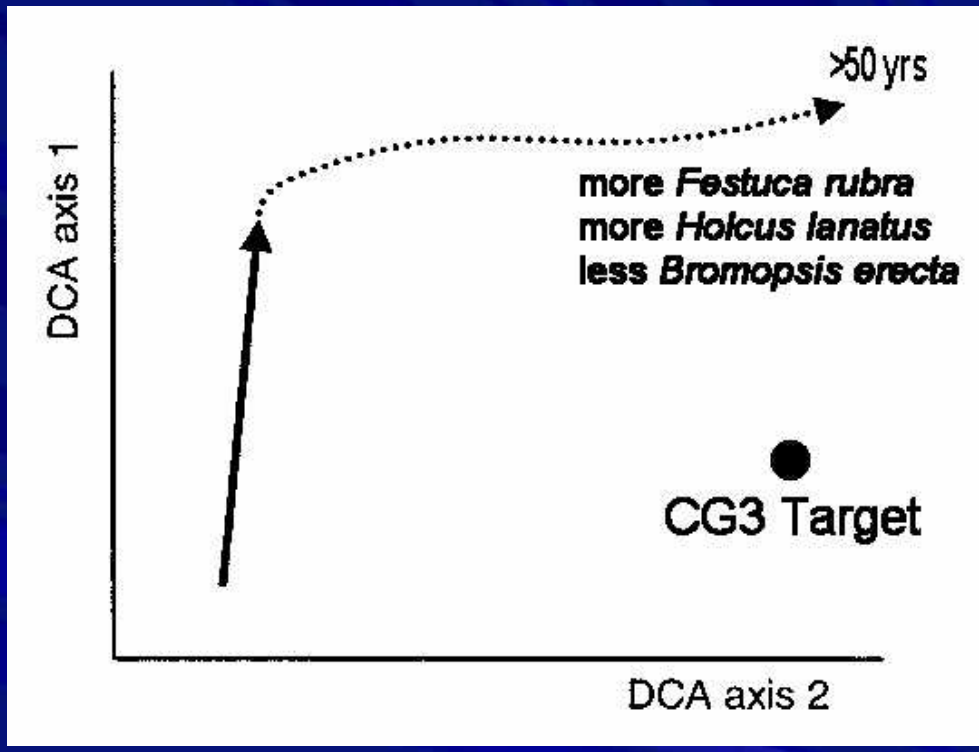
SUMMARY OF ESTIMATES OF RESILIENCE FOLLOWING PHYSICAL DISTURBANCE AND SPONTANEOUS RECOVERY

FACTOR	CALCAREOUS CG3	MESOTROPHIC MG1
VEGETATION COVER (n)	< 20 years	< 20 years
n + SURFACE SPECIES ASSEMBLAGE (v)	> 50 YEARS	> 30 YEARS
n + v + SOIL PROPERTIES (s)	> 50 YEARS	> 40 YEARS
n + v + s + SEED BANK POPULATION	> 50 YEARS	> 50 YEARS

OUTCOME OF DISTURBANCE DEPICTED ON HYPOTHETICAL ORDINATION AXES

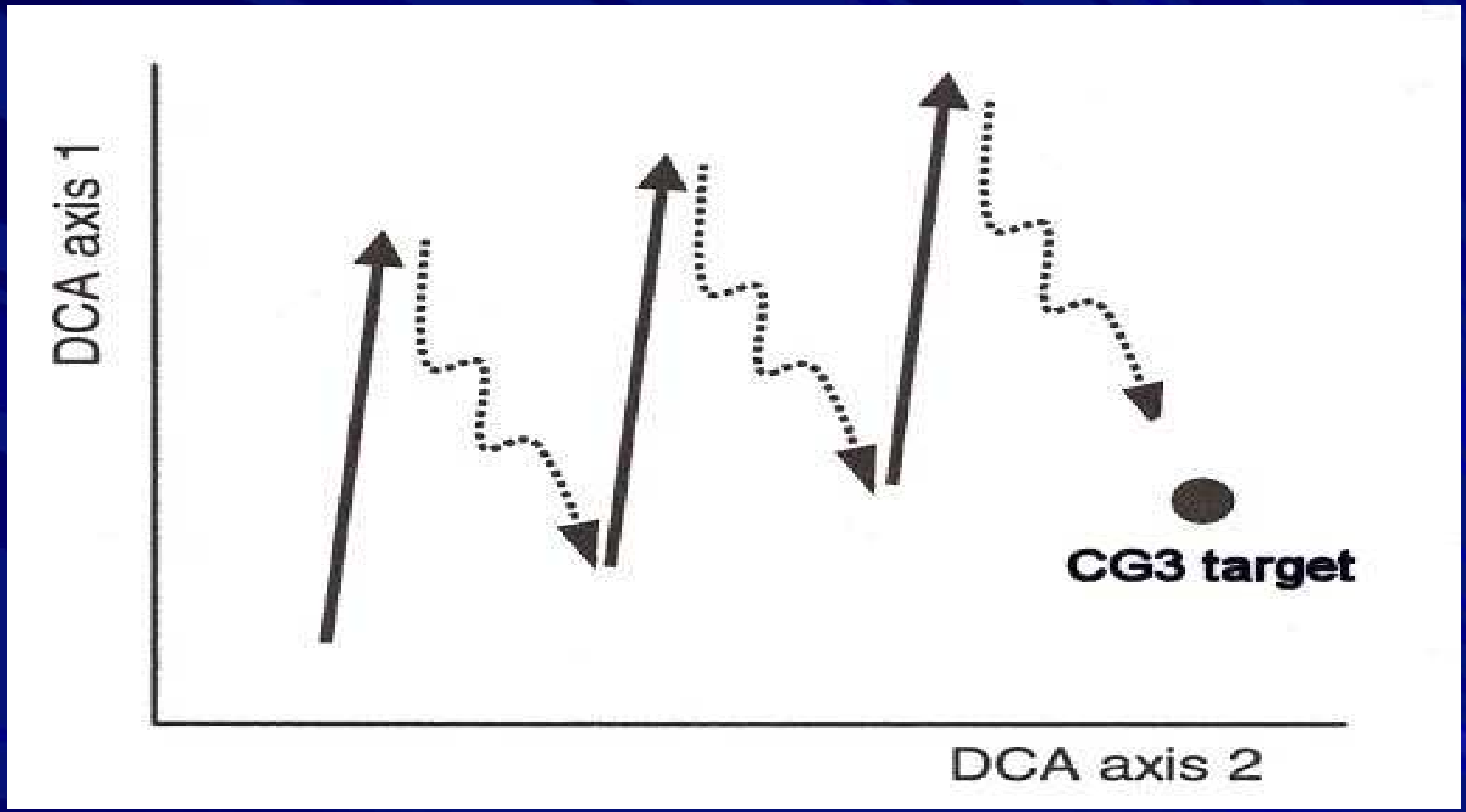


Trajectory towards target CG3 community



Trajectory towards new community type

OUTCOME OF DISTURBANCE DEPICTED ON HYPOTHETICAL ORDINATION AXES



Frequent severe disturbance
Dynamic species assemblage

CONCLUSIONS

- Ecological recovery is not keeping pace with the rate of creation of bare disturbed ground
- Different components of the chalk grassland ecosystem recover at varying rates
- Disturbed chalk grassland communities may not converge exactly towards the plant species structure of undisturbed communities