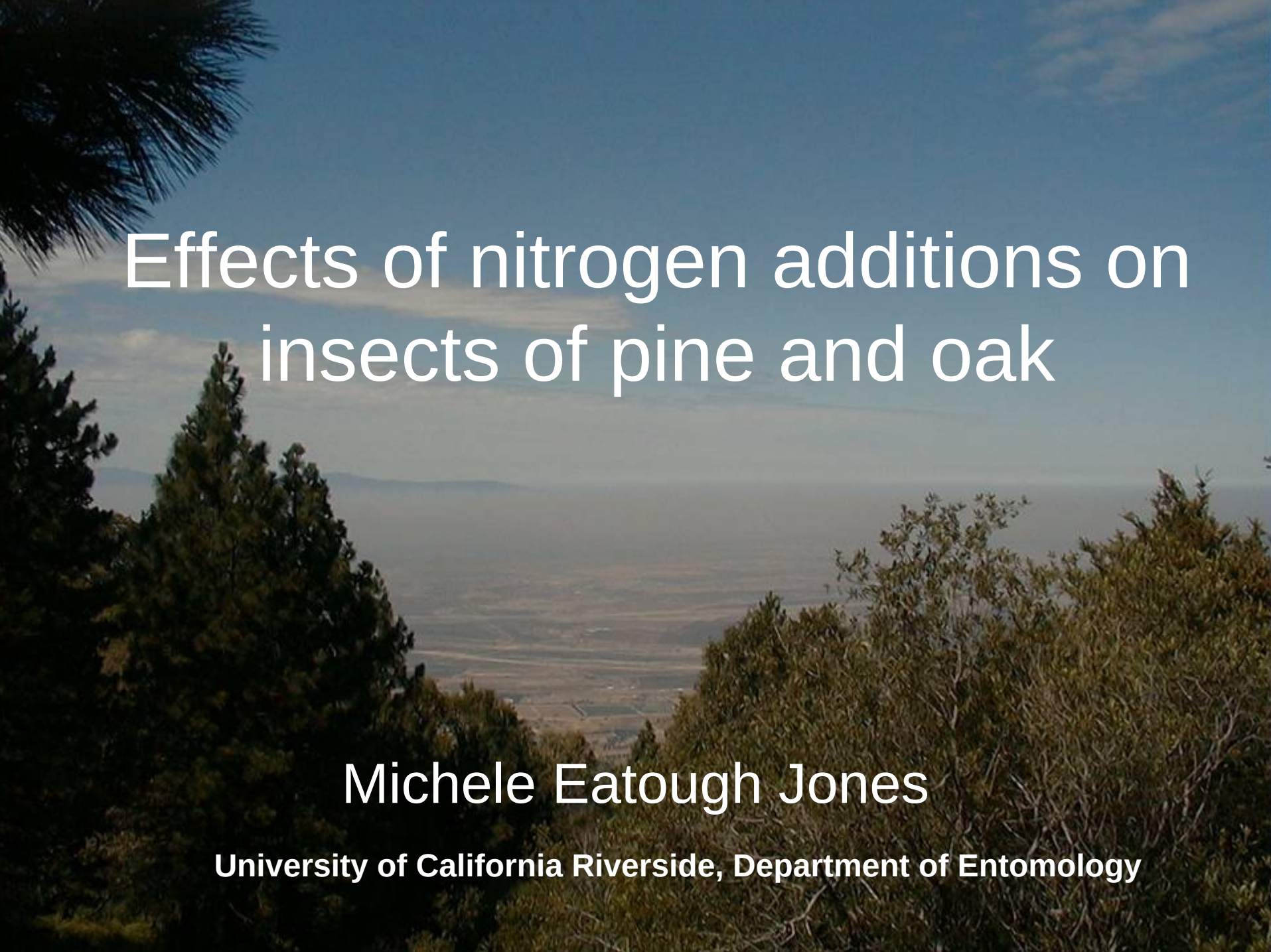
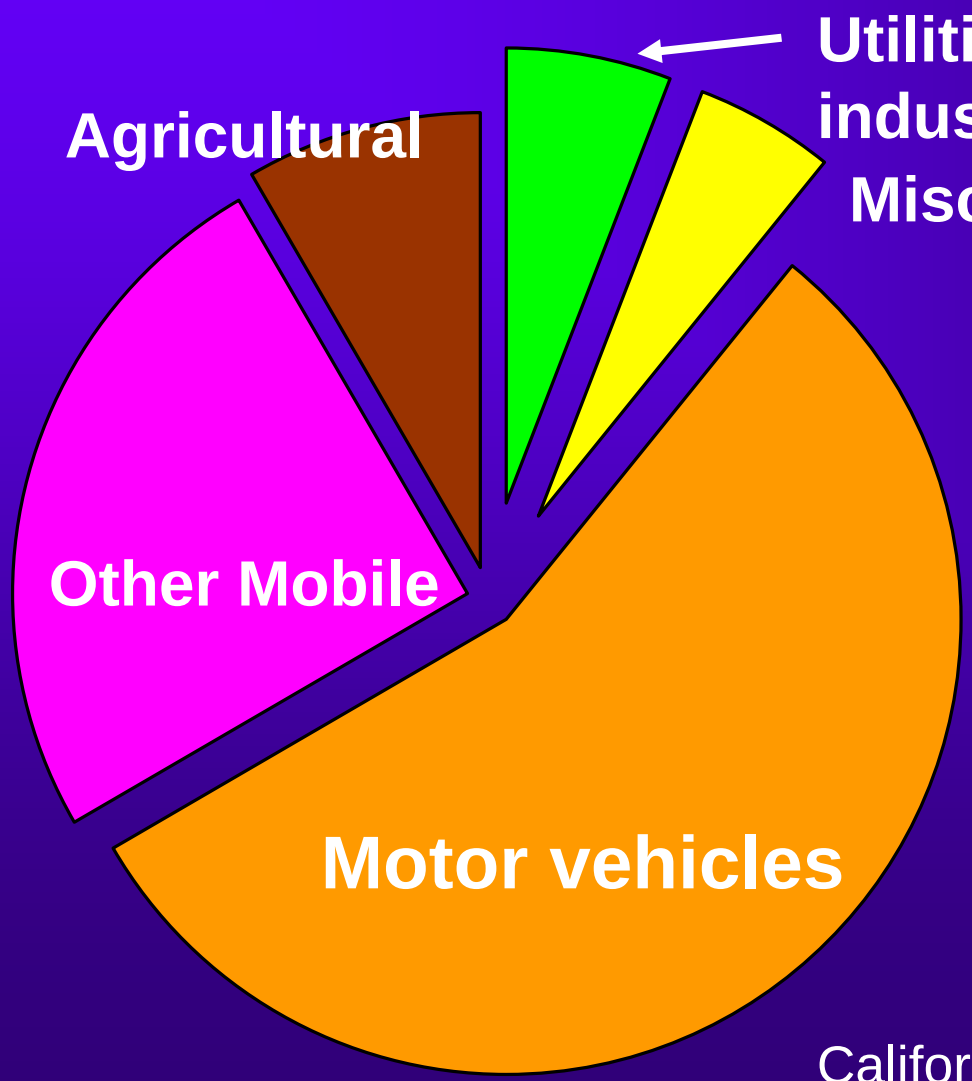


Effects of nitrogen additions on insects of pine and oak

Michele Eatough Jones

University of California Riverside, Department of Entomology

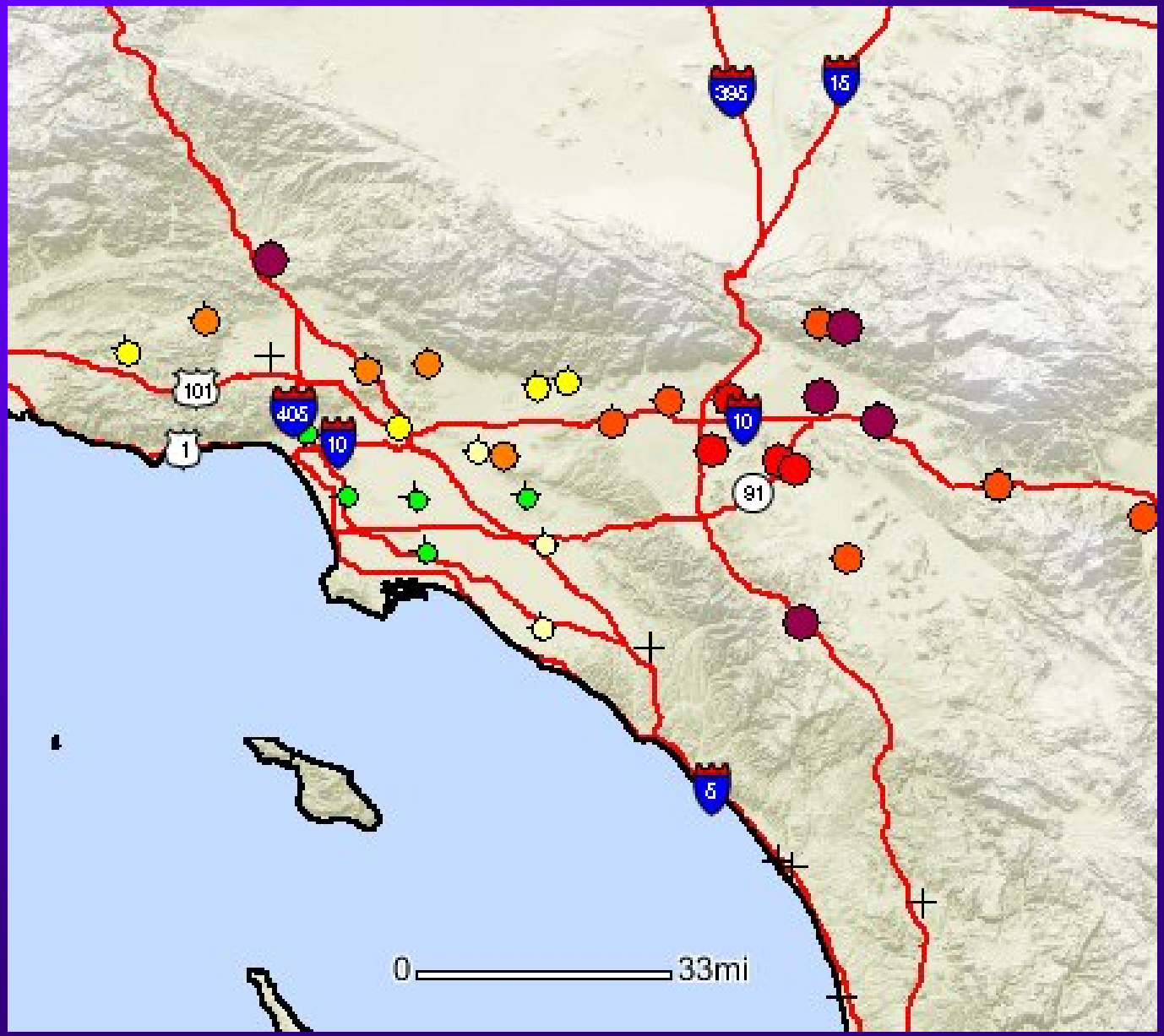
Sources of Atmospheric N in S. California



Total Emissions: 1204 tons/day

California Air Resources Board, 2003

Ozone: July 2003



California Air Resources Board

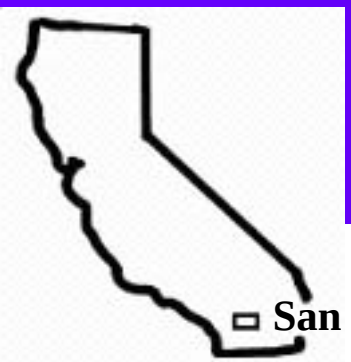
- **High nitrogen inputs**
  - **Increase plant growth**
  - **Increase nutrient status of foliage**
- **Ozone**
  - **Decrease plant growth rates**
  - **Change patterns of carbon allocation**

Effects on Ponderosa Pine

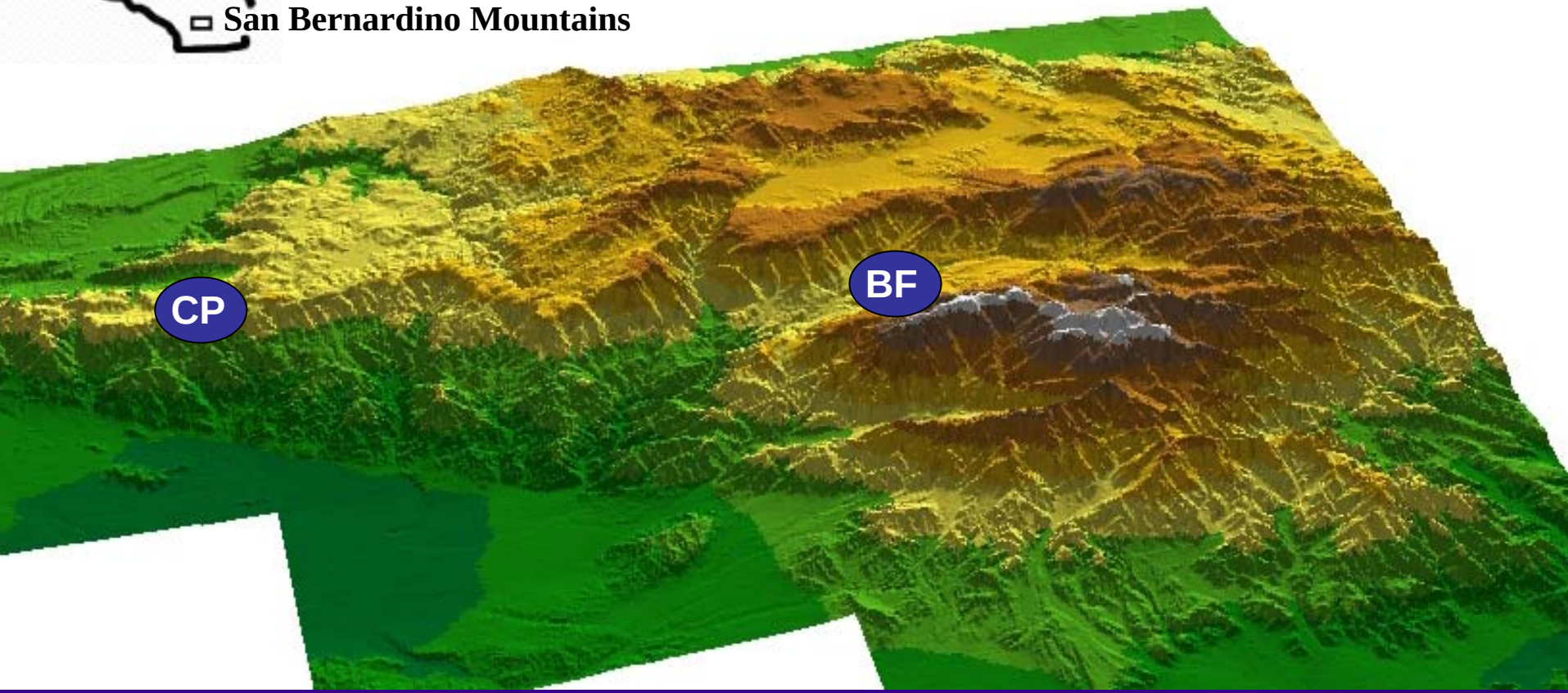
- Extremely ozone sensitive
  - decreased growth
  - decreased root mass
  - needle loss
- Increased foliar nitrogen

western pine beetle
Dendroctonus brevicomis

mountain pine beetle
D. ponderosae



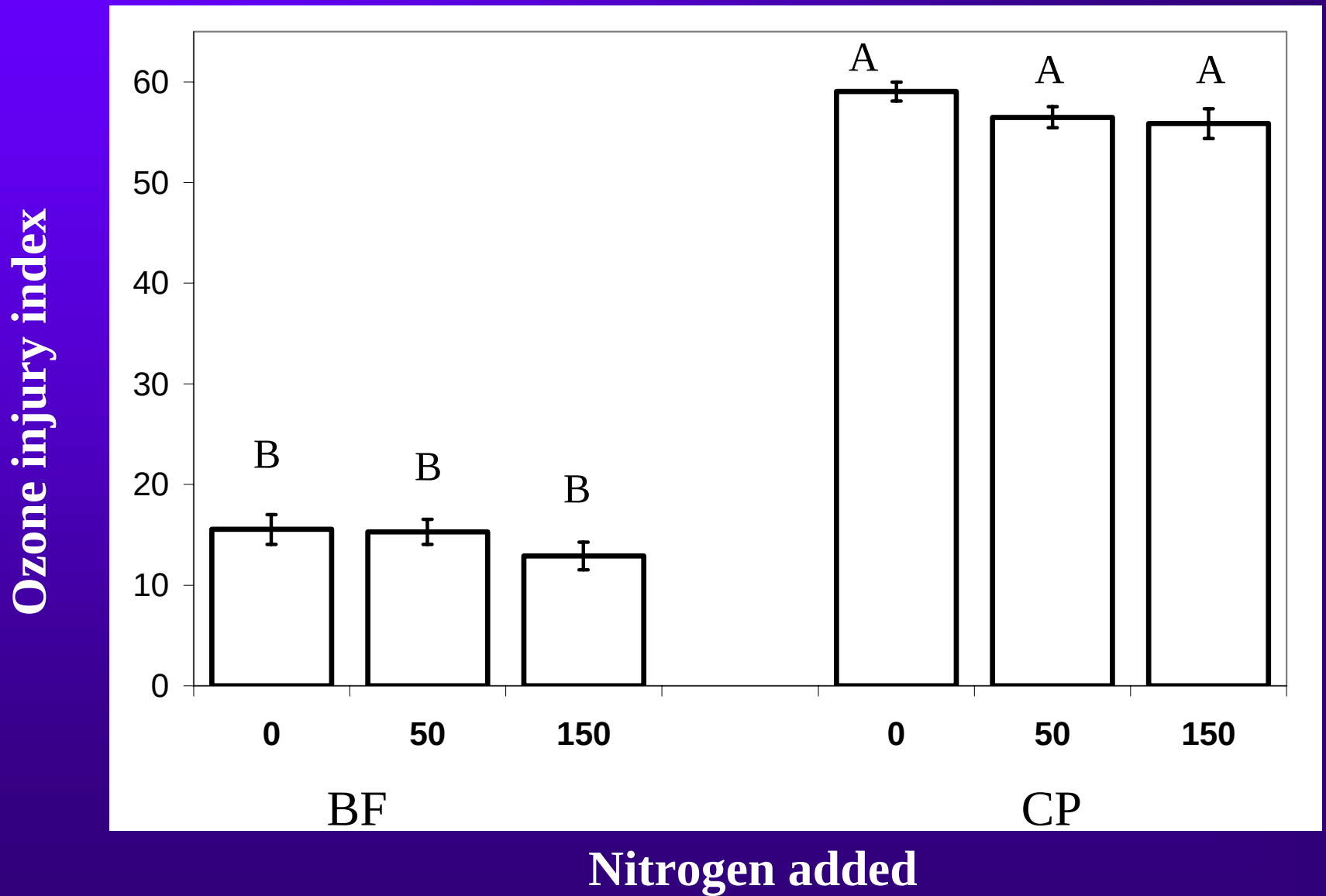
San Bernardino Mountains

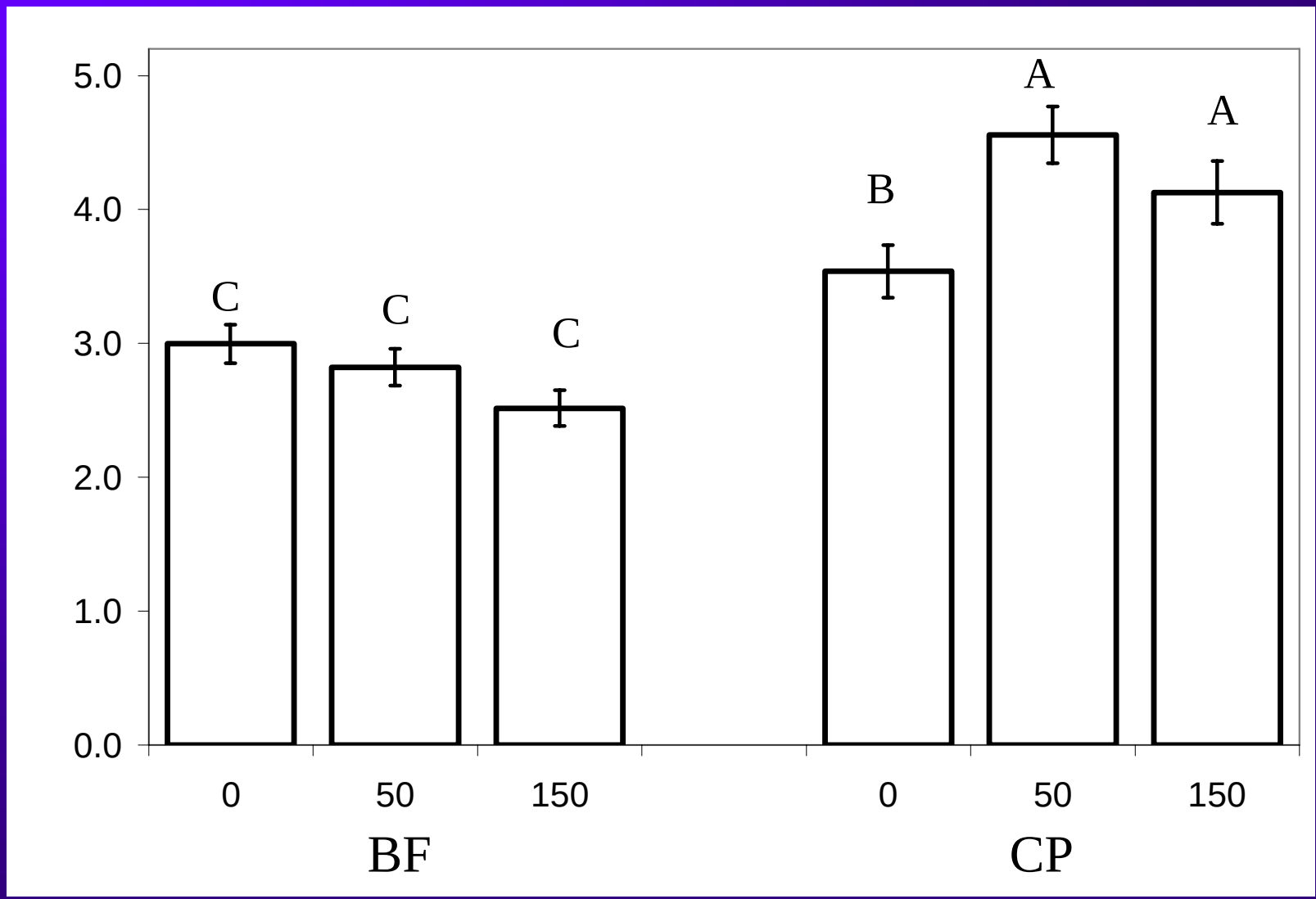


Map courtesy of the Atmospheric Deposition Group
USDA Pacific Southwest Research Station

	BF	CP
Ozone, summer peak (ppb)	91.3	101.6
N deposition: under pine kg/ha/yr	18	194
stand total	8	82
Elevation (m)	1900	1600
Annual precipitation (mm)	534	994

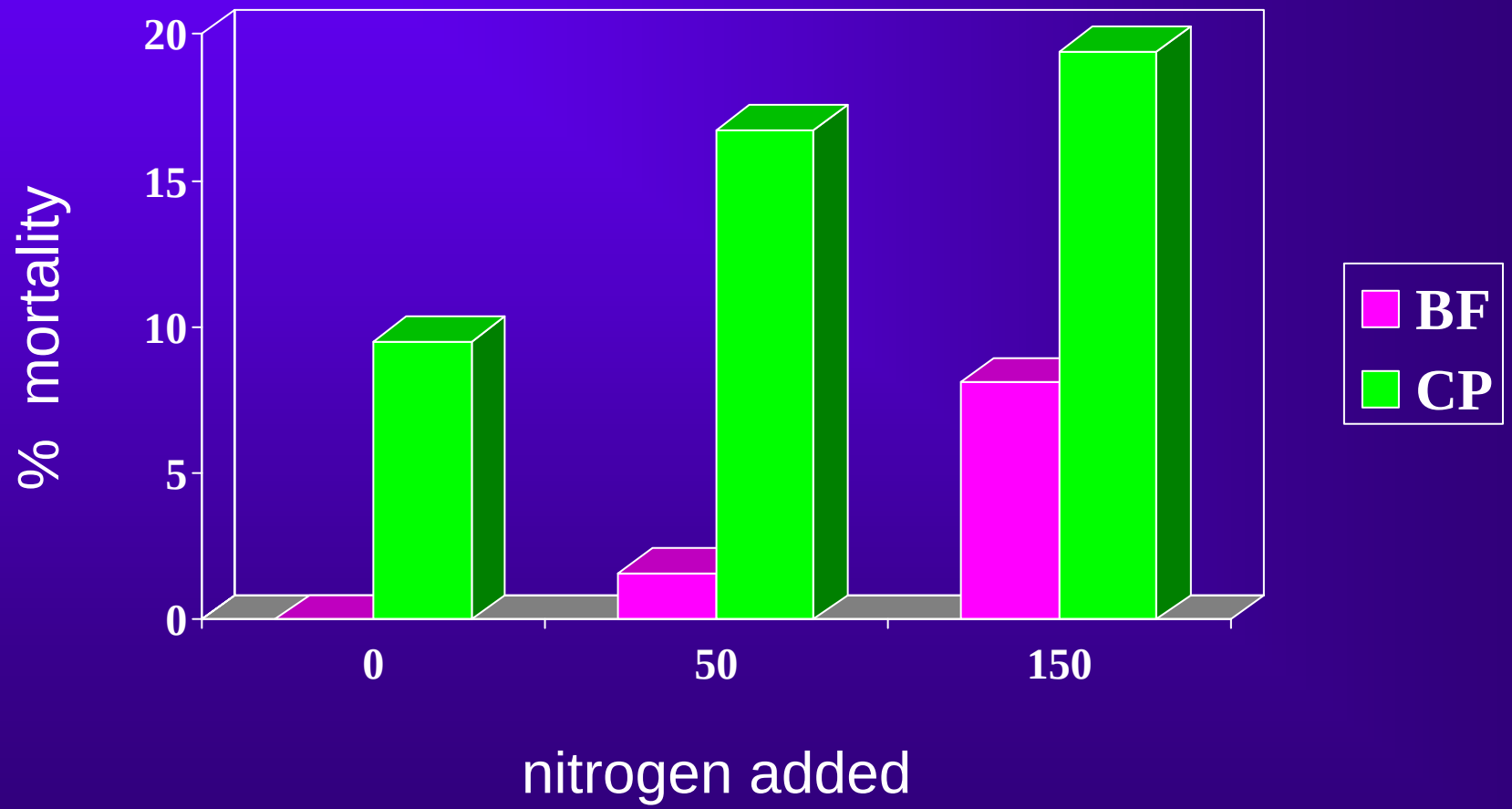
N added kg/ha/yr	Total estimated N BF Low pollution	CP High pollution
0	8	82
50	58	132
150	158	232


Ozone injury index
60
50
40
30
20
10
0
B
B
B
A
A
A
0
50
150
0
50
150
BF
CP
Nitrogen added

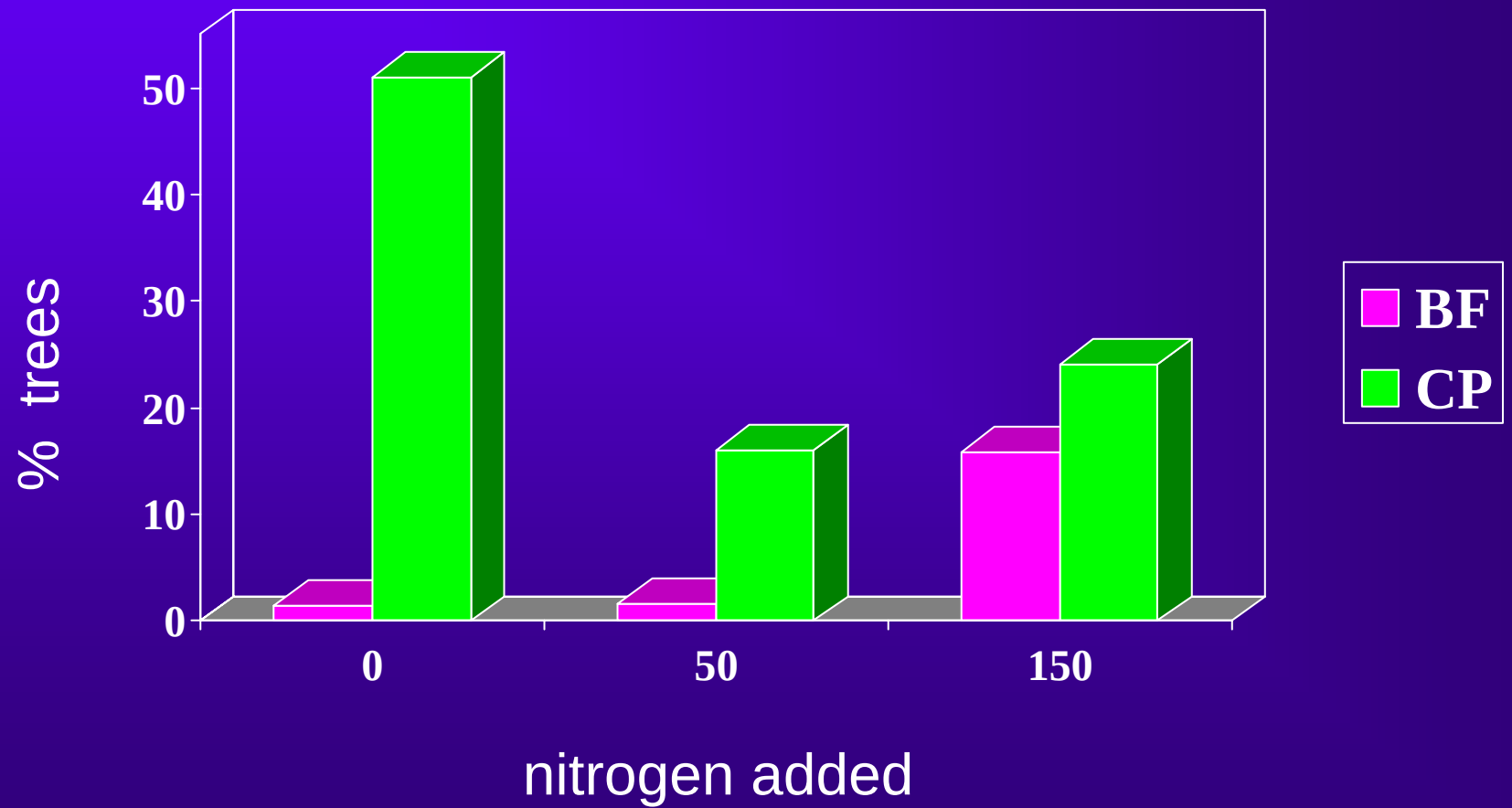

Radial growth (cm/yr)
5.0
4.0
3.0
2.0
1.0
0.0
C
C
C
B
A
A
0
50
150
0
50
150
BF
CP
Nitrogen added

- 2 sites
- 3 levels of N
- 60 trees

Tree Mortality



Trees with beetle activity



Stepwise logistic regression

			Wald's χ^2	p
Mortality	BF	N added	4.55	0.03
	CP			
Activity	BF	N added	12.16	<0.01
	CP	Growth	8.28	<0.01
		Ozone injury	4.47	0.03

Summary

- **Low pollution site**:
  - Nitrogen additions
    - increased tree mortality
    - increased beetle activity
- **High pollution site**:
  - Higher tree mortality & beetle activity
  - Activity high on control plots
    - lower growth rate
    - slightly higher ozone injury

Effects on vegetation

- California black oak
  - Moderately ozone sensitive
    - decreased growth
    - increased litterfall
  - Increased foliar nitrogen

Methods

Foliage collected 4 times per year 1998-2000

10 samples/treatment

Insects identified to family and morphospecies

samples pooled by tree for all 3 years

Community Structure Analysis

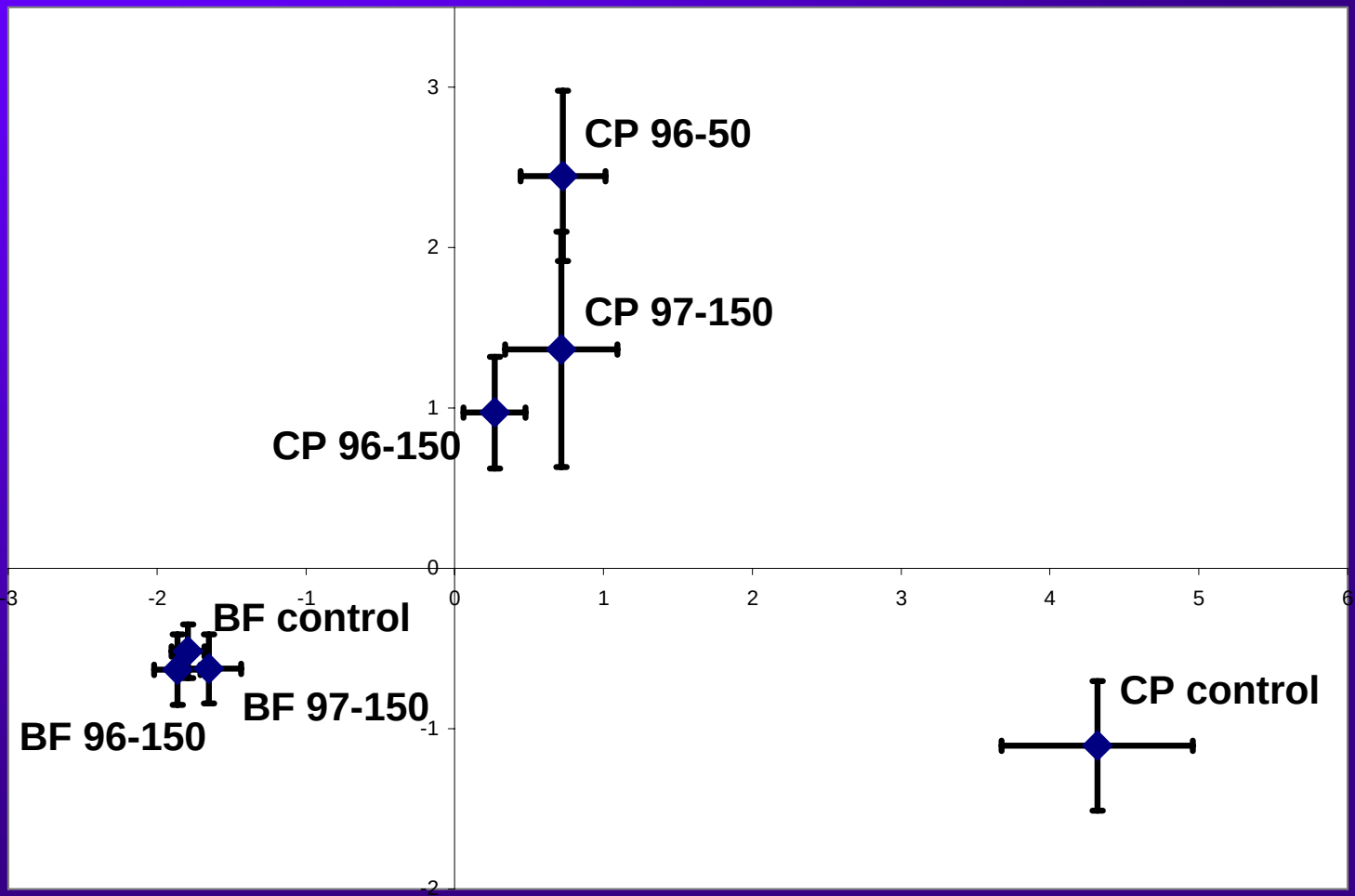
- Discriminant Function Analysis

  Most abundant herbivore taxa were represented individually

  Less abundant taxa grouped by family or feeding guild

  Each axis on DF graphs is a combination of all herbivore groups

Oak herbivore communities



catkin beetles

λ=1.3

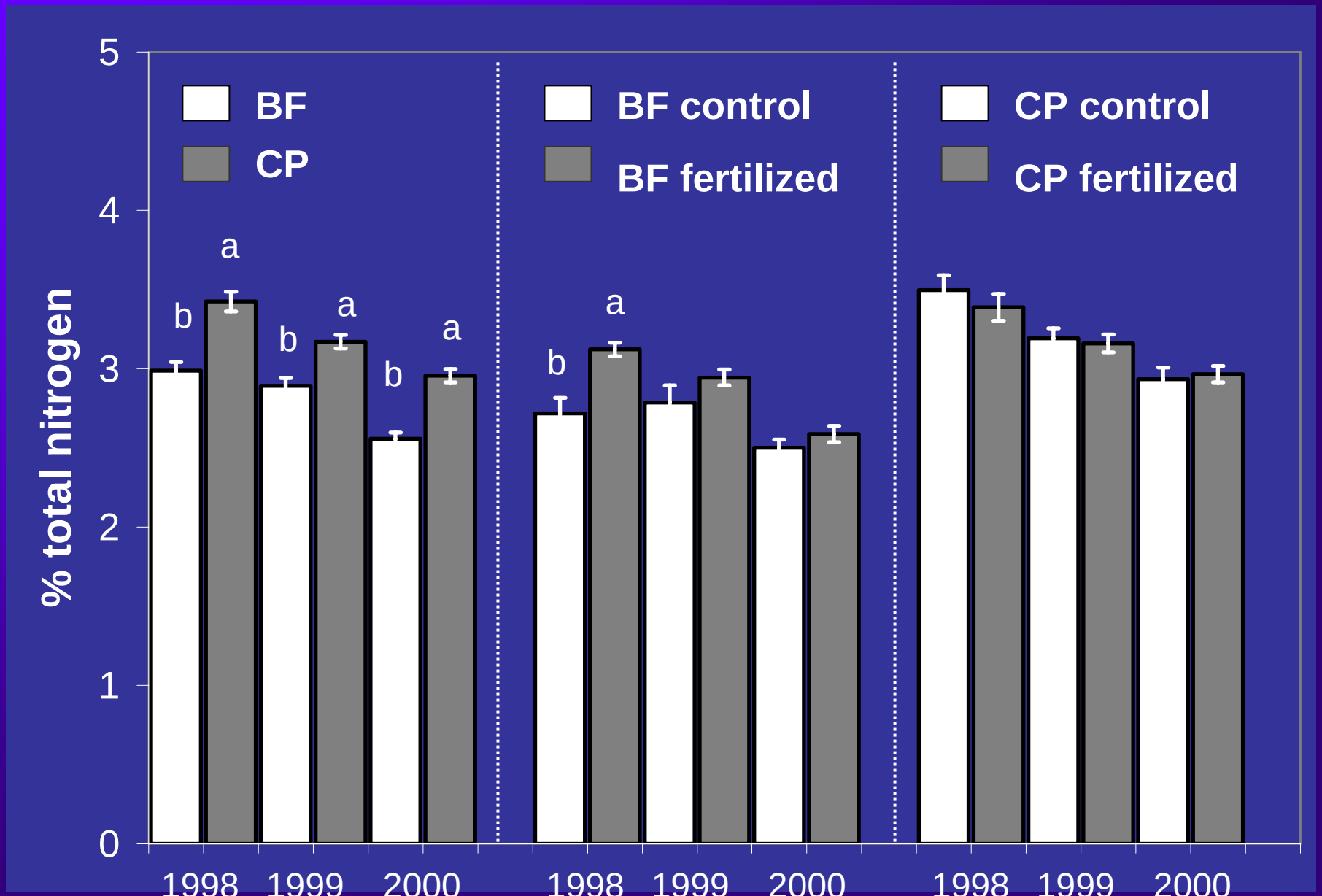
λ=5.4

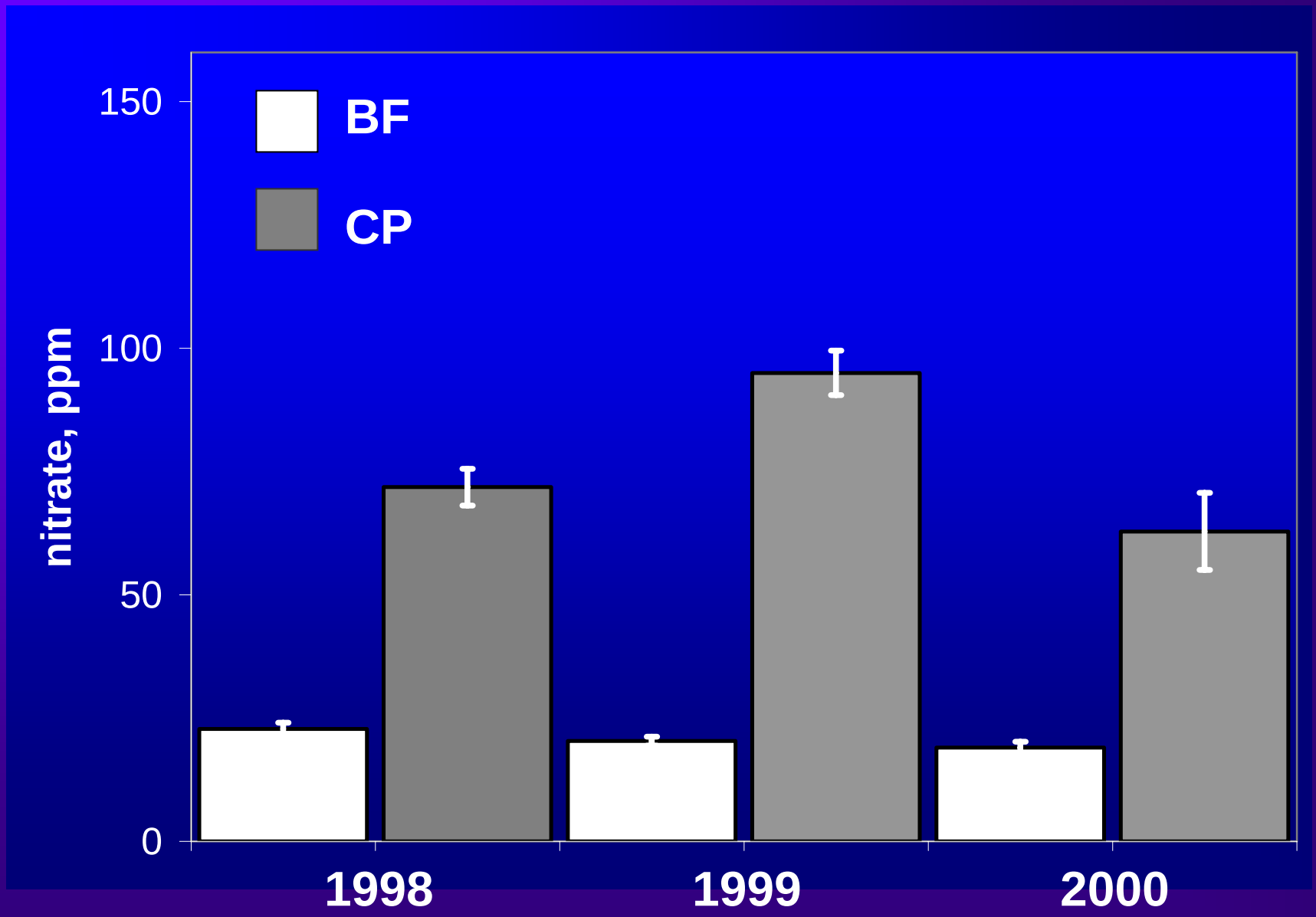
other rollers, mobile sucking, fruittree leafroller plutellids

Effect of fertilization on plant N

- Low pollution site:
  - Fertilization did not increase foliar N

- Why?
  - Water limitation
  - Litter layer and nitrogen cycling
  - Ozone drives site differences


% total nitrogen
5
4
3
2
1
0
BF
CP
BF control
BF fertilized
CP control
CP fertilized
b
a
b
a
b
a
b
a
1998
1999
2000
1998
1999
2000
1998
1999
2000


150
100
50
0
nitrate, ppm
BF
CP
1998
1999
2000

Herbivores that distinguished sites

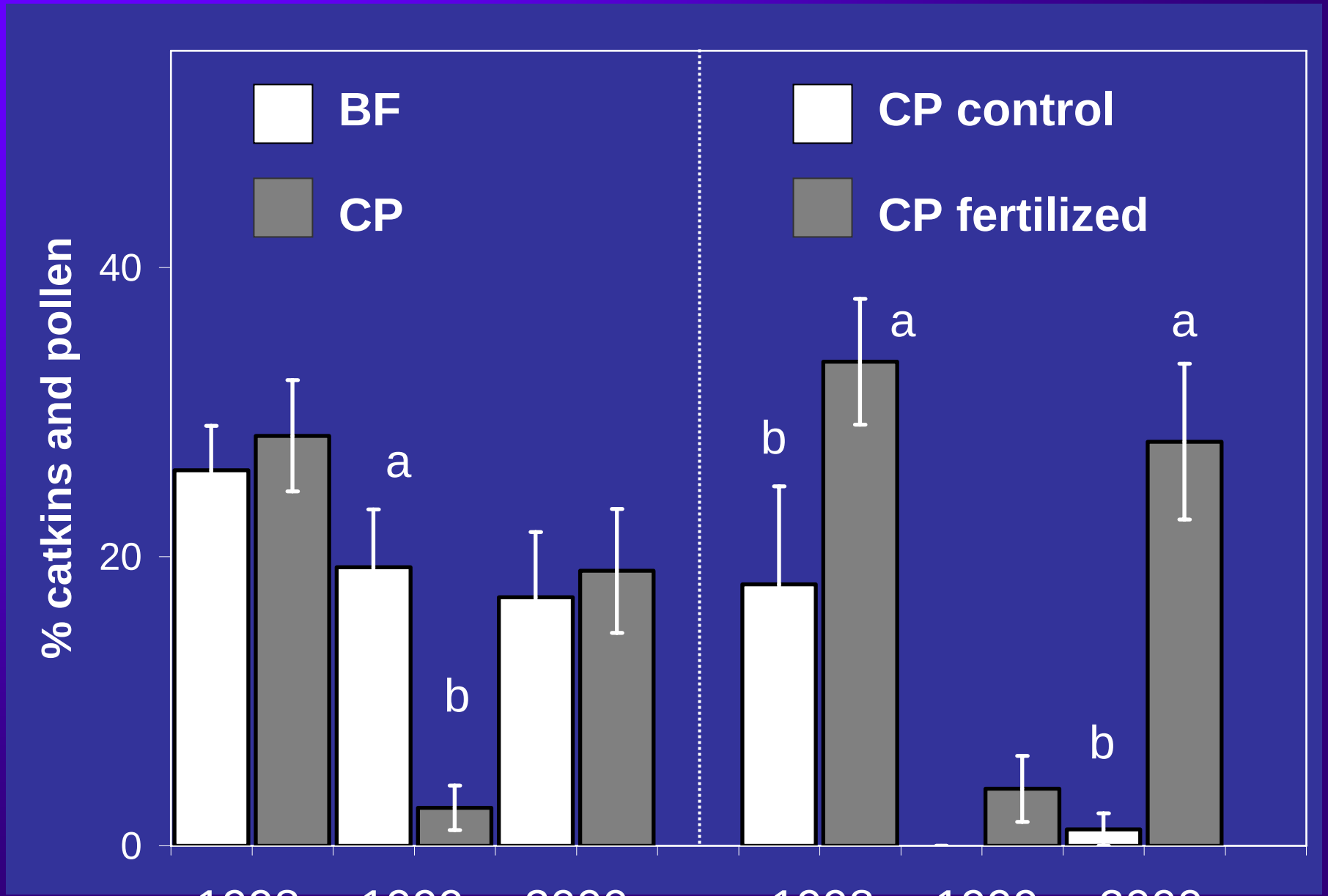
Associated plant characteristics

Pearson's correlation coefficients significant at $\alpha<0.05$

Fruittree leafroller	Plutellids	Mobile sucking
	Total N	
Nitrate	Nitrate	Nitrate

Why nitrate?

- Normally a feeding deterrent
- Other components of total N
  - soluble protein
  - amino acids


BF
CP
CP control
CP fertilized
% catkins and pollen
40
20
0
a
b
b
a
b
a
1998
1999
2000
1998
1999
2000

Pearson Correlation Coefficients

Catkin beetle with foliage variables

	r	P
% water	-0.15	0.26
Total N	0.25	0.05
% catkins & pollen	0.45	0.0005

Summary: Oak communities

- Differences between sites
  - Associated with plant nitrogen
- Low pollution site N response: NO
  - expected increased chewing herbivores
- High pollution site N response
  - higher pollen production
  - increased pollen-feeding beetles

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