Effects of Nitrogen Deposition on Vegetation-Type Conversion in Riversidean Sage Scrub

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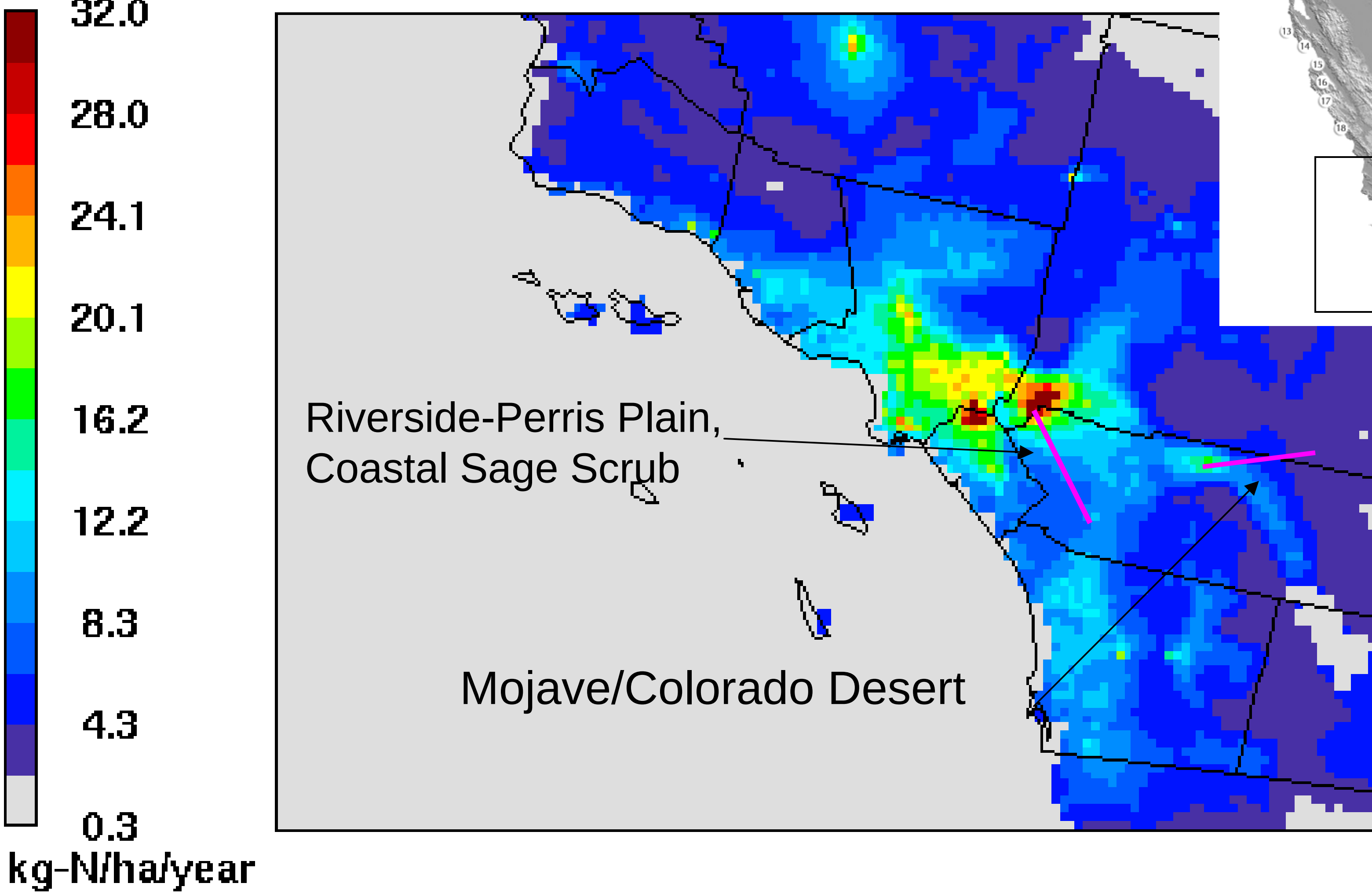
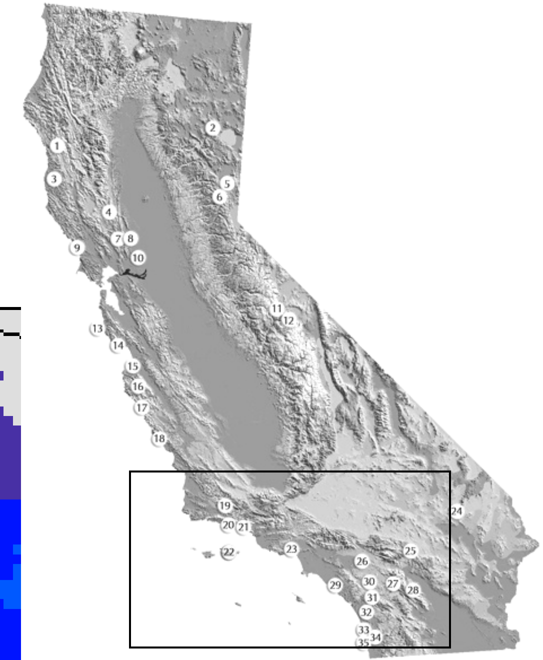
Tonnesen et al 2007

DRY N DEPOSITION

CMAQ SIMULATION 2002 TOTAL





Objectives

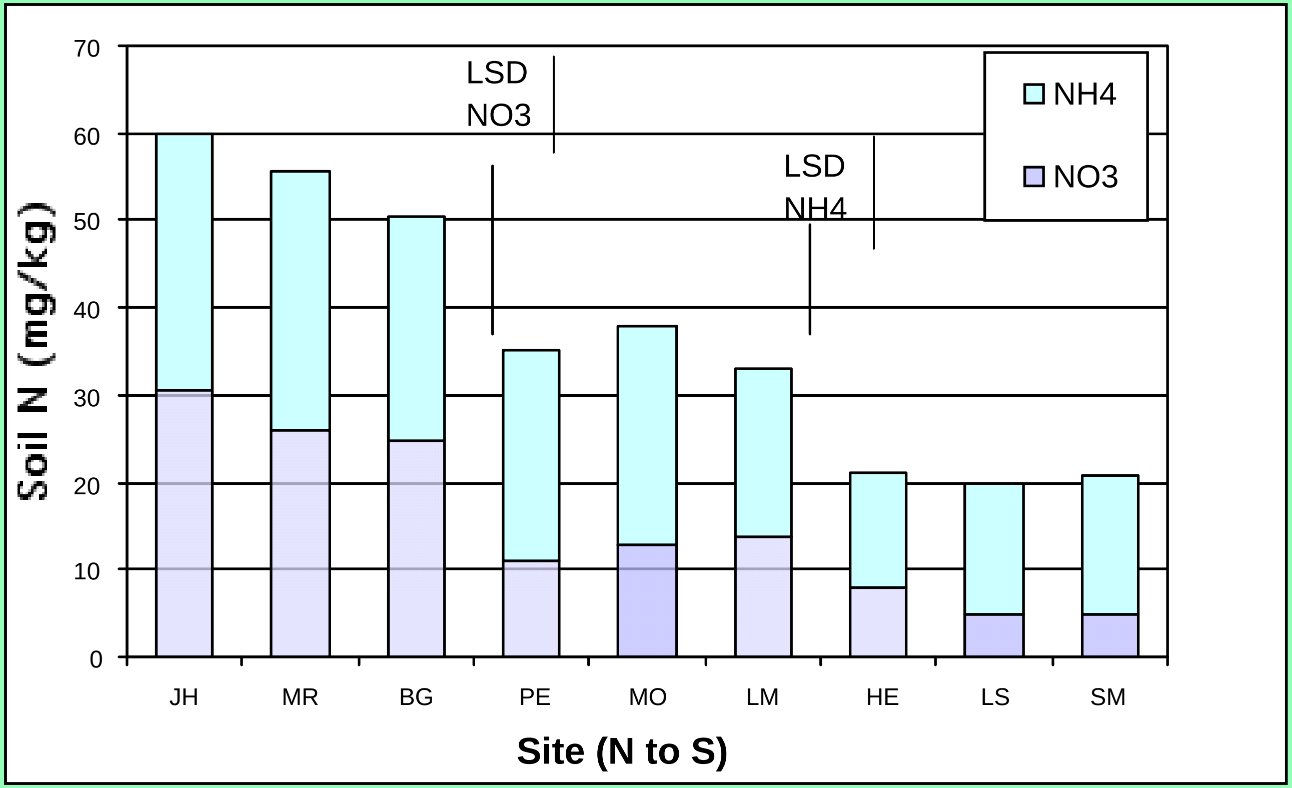
1. Observe responses of native and invasive vegetation along a N deposition gradient in coastal sage scrub.

2. Test responses of native and invasive plants to N fertilization in a site with low N deposition.

3. Determine the critical load of N deposition that causes undesirable negative effects.

Coastal sage scrub vegetation receives up to 30 kg N ha^{-1} yr^{-1} mainly as dry deposition; frequent fire, loss of native diversity, exotic annual grass invasion

Soil N gradient from north to south in the Riverside-Perris Plain



Observe responses of native and invasive vegetation along N deposition gradients in coastal sage scrub (CSS)

- Seven sites with CSS on north-facing slopes
- No fire or grazing in last 10 years, same soil type
- Prior to 10 years ago, sites dominated by exotic annual grass had frequent fires
- Vegetation sampled in May 2003 in three, 1-ha plots
- Herbaceous cover estimated in 50, 0.5 X 0.5 m quadrats in each ha
- Shrub cover measured in 250 m of line transects per ha
- Soil N measured during dry season

Nitrogen Critical Load

- A critical load for nitrogen is that amount of N deposition above which there are negative impacts on an ecosystem
- Impacts may be measured as changes in

  organisms (e.g., loss of native species,

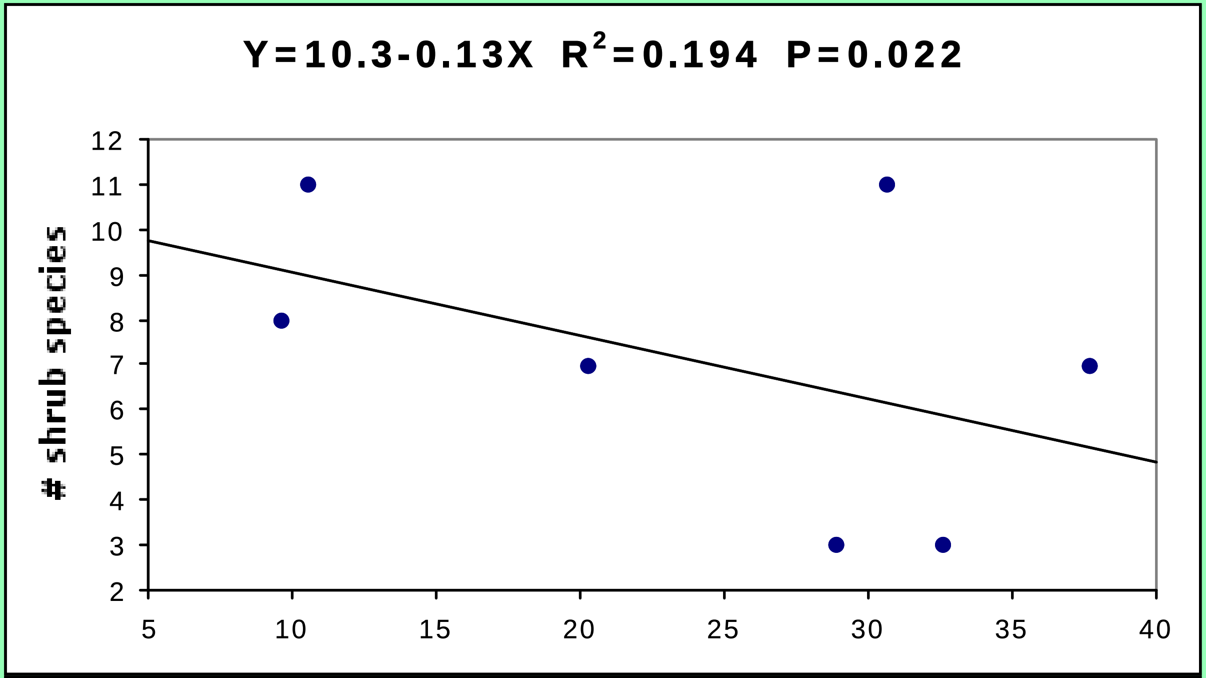
  increase in invasive species)

  soils (e.g., decreased pH, elevated N),

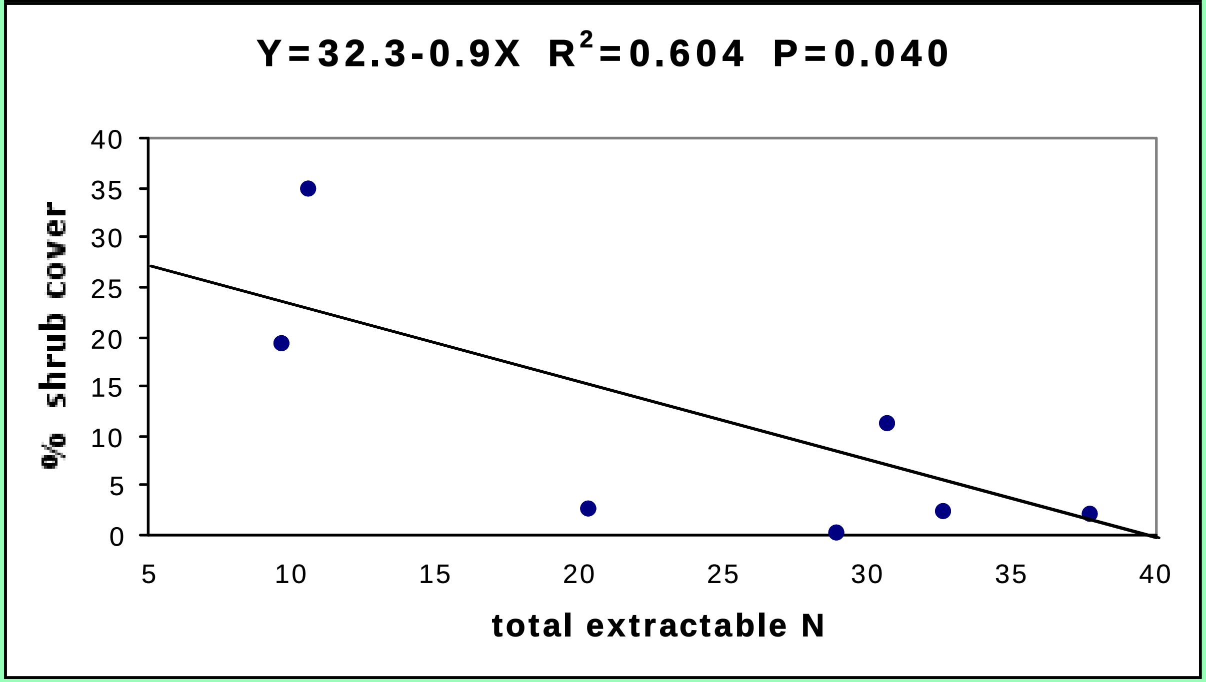
  biogeocycling rates (e.g., increased N in run-off, mineralization).

Box Springs Mt. with high N deposition dominated by exotic annual grasses (*Bromus* spp.)

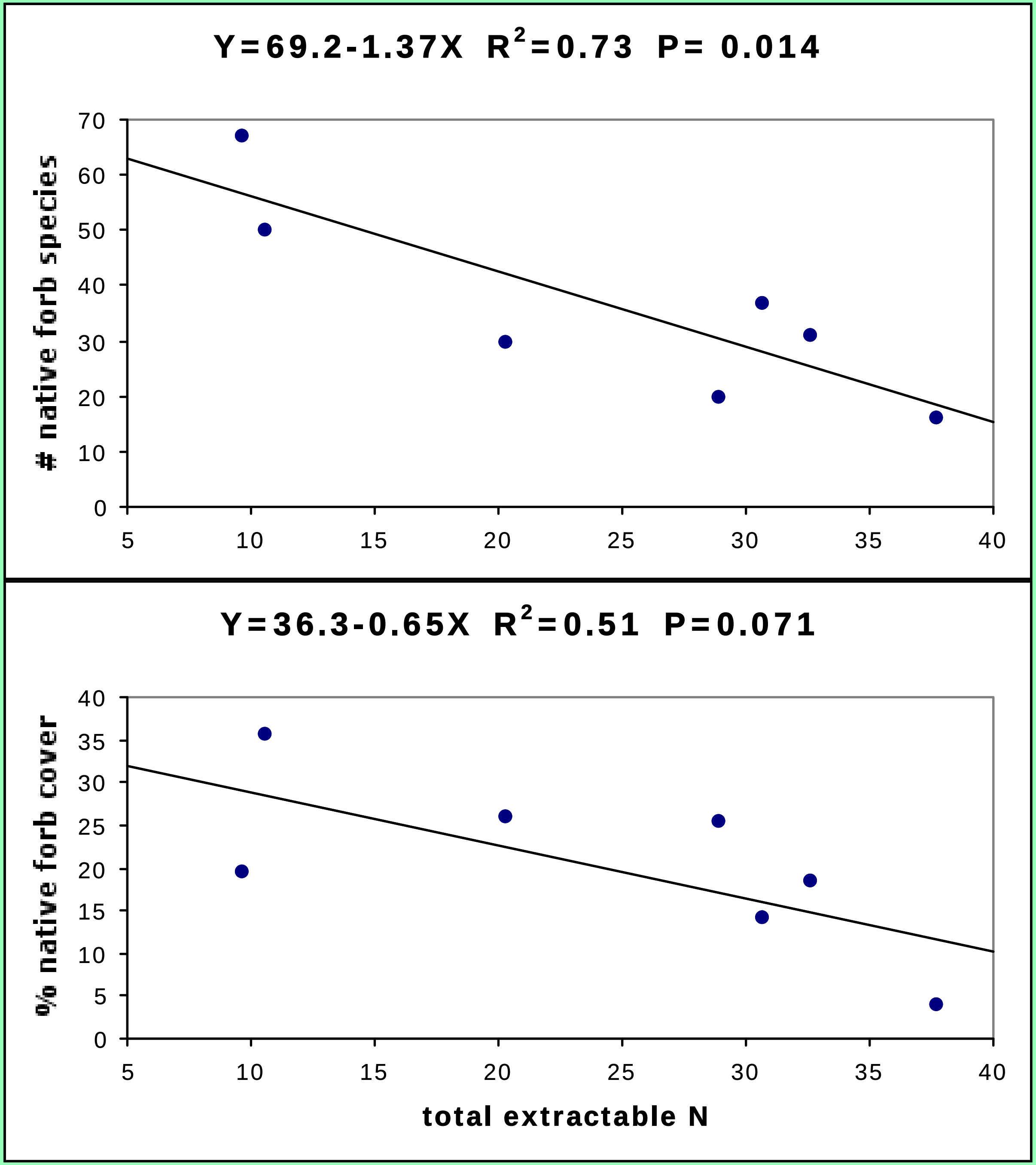
Lopez Canyon with low N deposition dominated by native forbs and shrubs



Number of native shrub species in 3 ha in each of seven sites vs. extractable N (NH_4^+ plus NO_3^-), µg/g

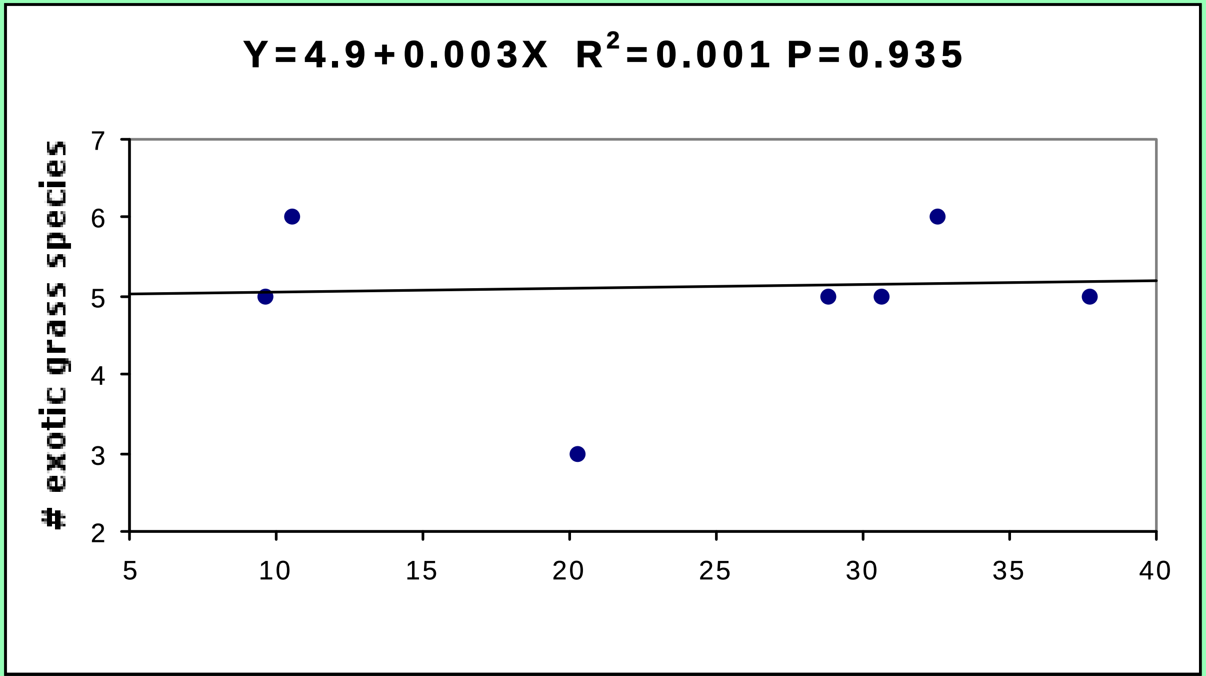


% shrub cover vs. extractable N (NH_4^+ plus NO_3^-), µg/g

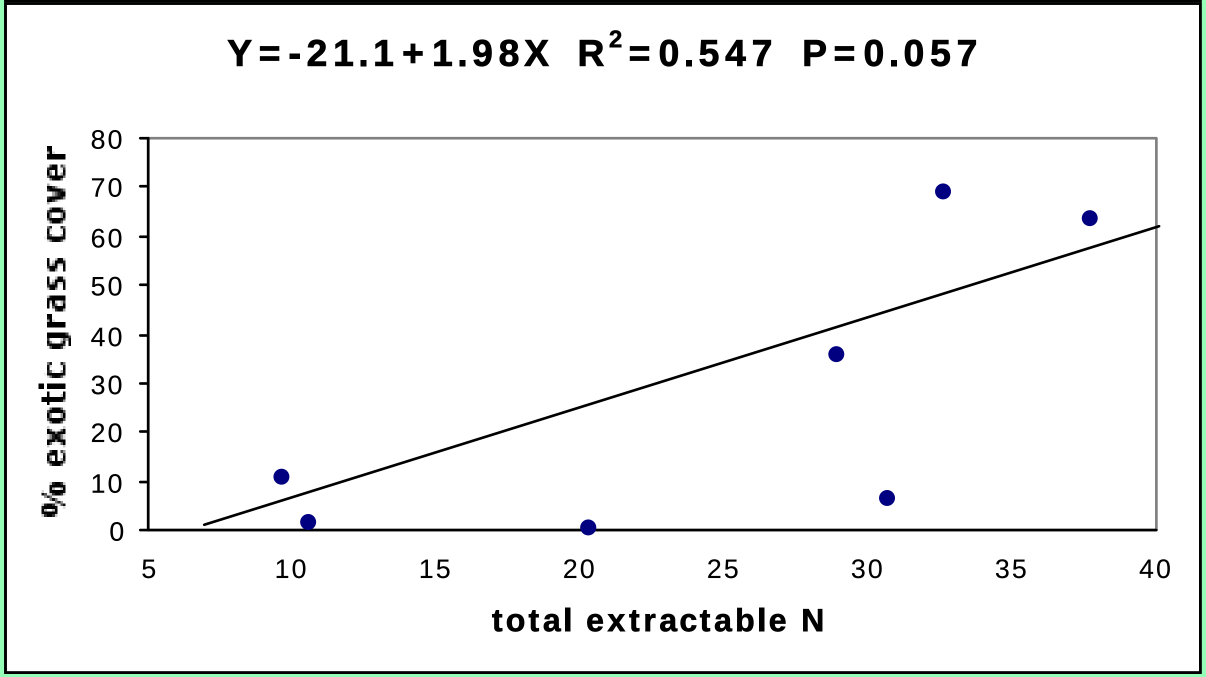


Number of native forb species in 3 ha in each of seven sites vs. extractable N (NH_4^+ plus NO_3^-), μg/g

% forb cover vs. extractable N (NH_4^+ plus NO_3^-), μg/g



Number of exotic grass species in 3 ha in each of seven sites vs. extractable N (NH_4^+ plus NO_3^-), μg/g



% exotic grass cover vs. extractable N (NH_4^+ plus NO_3^-), μg/g

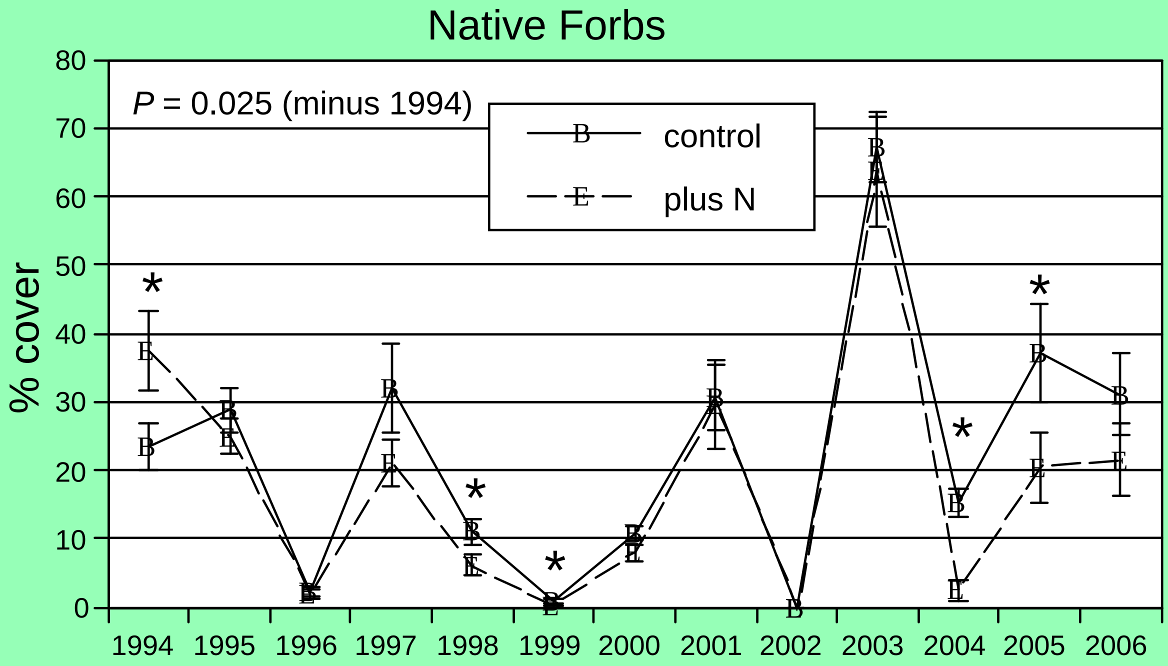
Critical Load of N based on loss of native diversity is 11 kg N/ha

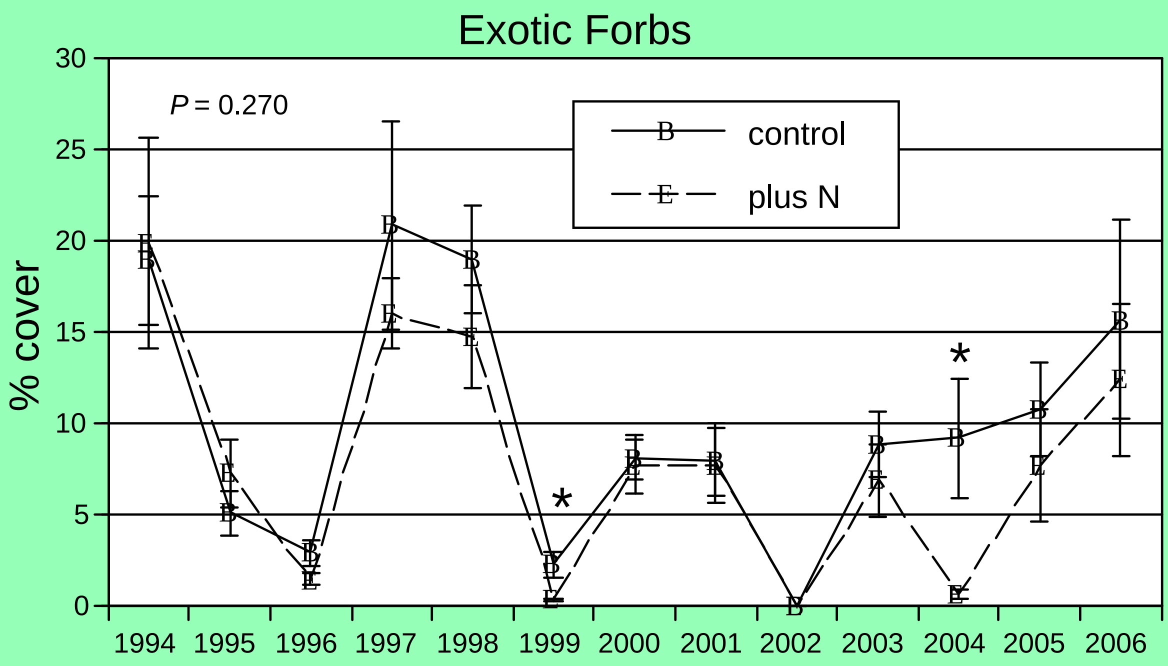
	% cover			no. per 3 ha	µg g^{-1}	kg N ha^{-1} yr^{-1}
Site	Exotic grass	Native forb	Shrub	Native forb	soil N	N deposition[1]
Jurupa Hills	63.5	4.0	2.2	16	37.7	19.6
Box Springs	69.2	18.5	2.4	31	32.6	14.7
Botanic Garden	36.0	25.4	0.2	20	28.9	13.4
Lake Perris	0.5	26.1	2.8	30	20.3	11.1
Mott Reserve	6.7	14.3	11.2	37	30.6	11.1
Lopez Canyon	11.1	19.6	19.3	67	9.6	9.0
Tucalota Hills	1.5	35.7	35.0	50	10.5	8.7

N fertilization experiment in coastal sage scrub

- Low N deposition site near Lake Skinner
- NH_4NO_3 fertilized at 60 kg $ha^{-1}yr^{-1}$ since 1994
- Ten fertilized, ten control, 5 x 5 m plots
- Vegetation sampled yearly for % cover, species composition

Coastal sage scrub (CSS) vegetation was fertilized yearly with 60 kg/ha/yr of N following the 1993 wildfire near Lake Skinner, an area of low N deposition

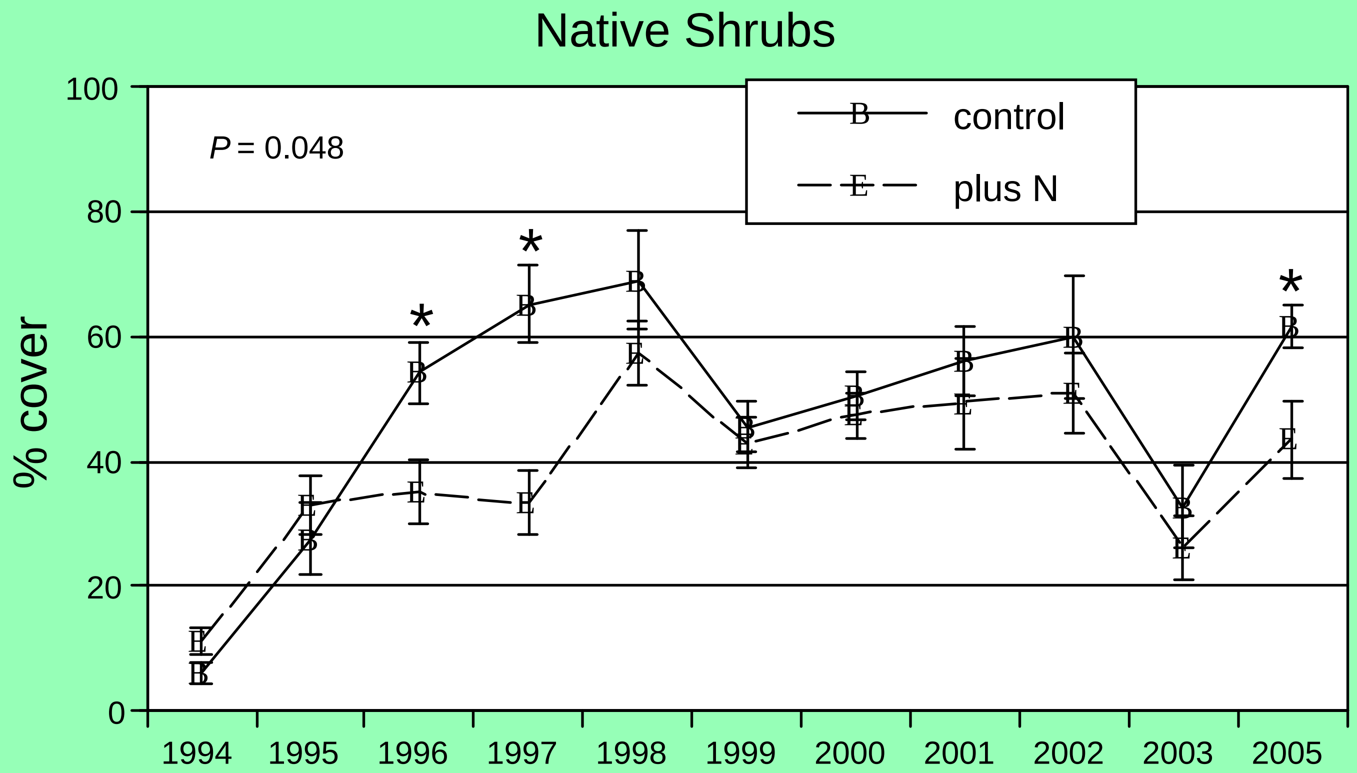




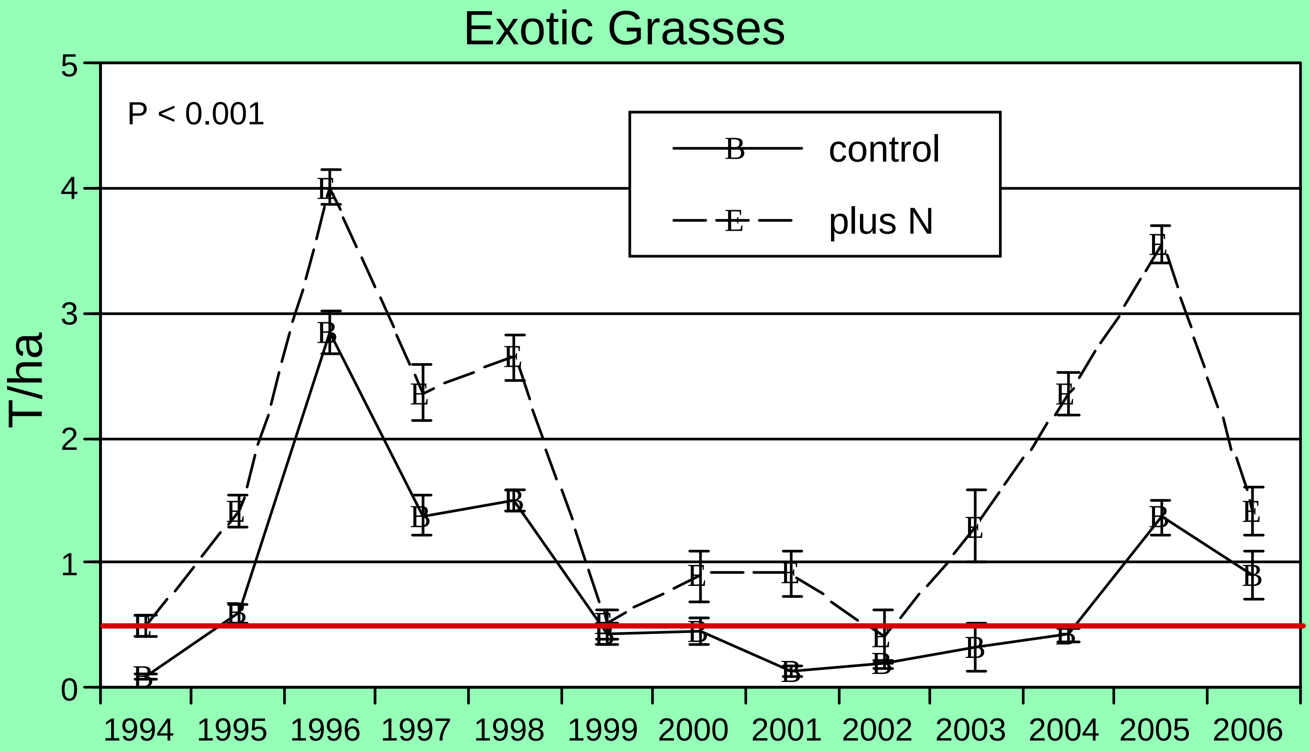
% cover of native forbs (69 spp.) and exotic forbs (*Erodium* spp.) for 13 seasons following the 1993 fire with and without N fertilization.

P is repeated measures probability,
* is *P* = 0.05 by year.

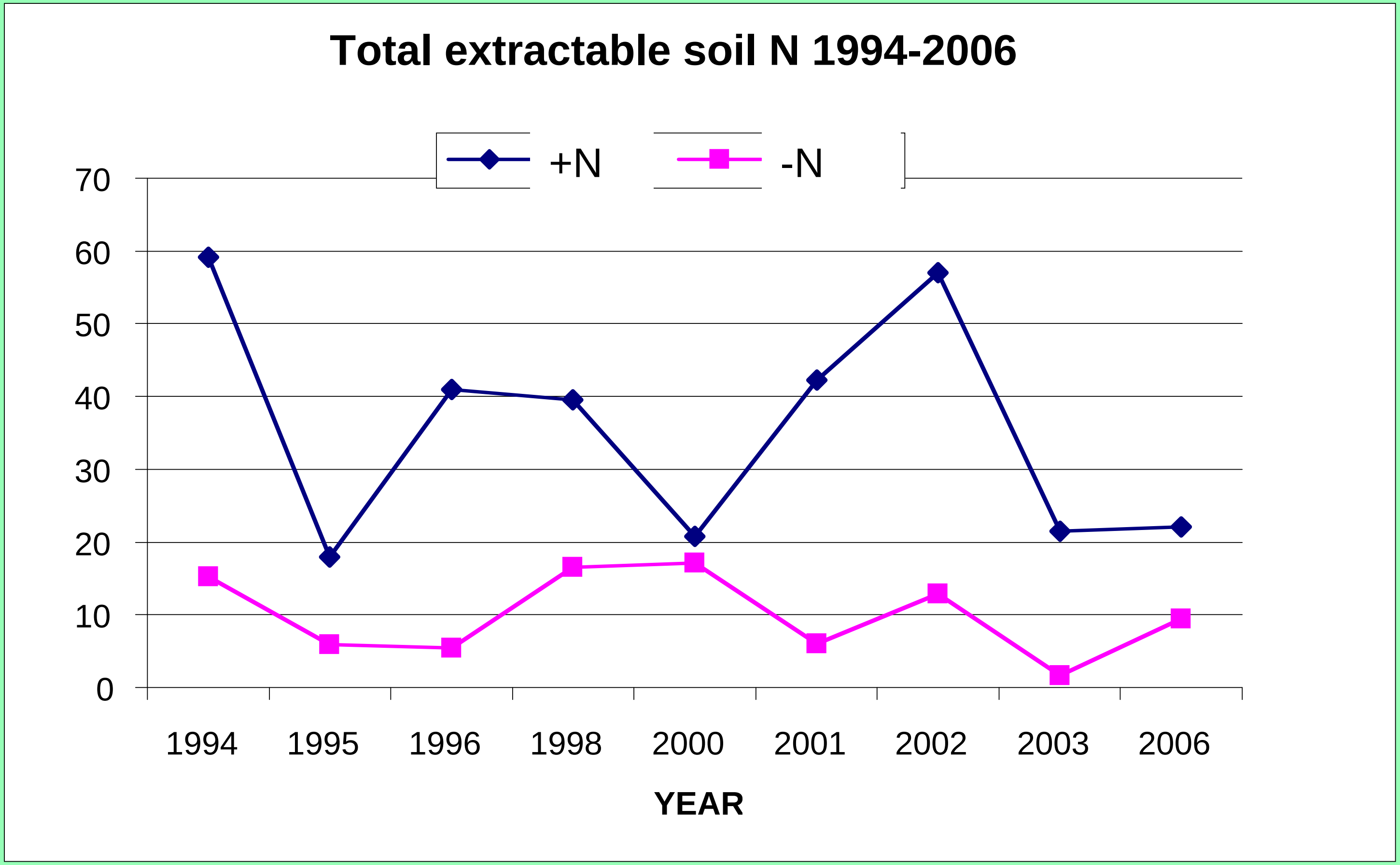
Percent cover of native shrubs from 1996 to 2005 with and without N fertilization of 60 kg/ha/yr following the 1993 fire



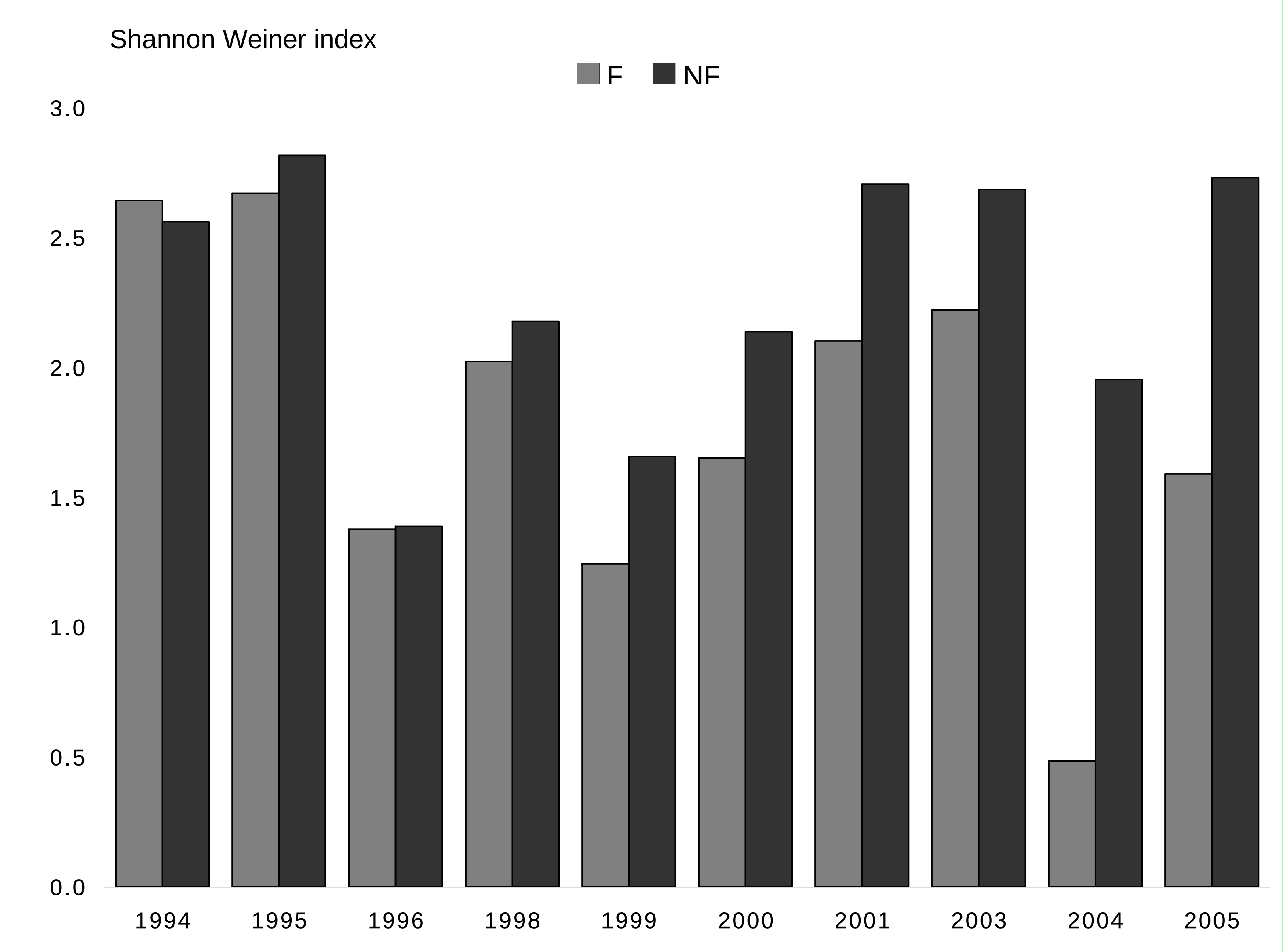
Biomass of grasses following the 1993 fire and N fertilization (60 kg/ha/yr). The threshold for fire is 0.5-1.0 T/ha of fine grass fuel (red line).



Soil N concentrations1994-2006



Diversity (H') changes with N fertilization in coastal sage scrub



Conclusions

- Exotic annual grasses had higher cover with increasing N on a deposition gradient, while native forbs and shrubs had lower cover and richness.
- Exotic grasses had increased biomass with N fertilization in most years, while native forbs responded negatively after 11 years with 60 kg N/ha/yr.
- Elevated exotic grass biomass above the threshold value of 0.5-1.0 T/ha may be responsible for the high incidence of fire in areas affected by N deposition, and fire causes rapid vegetation type conversion.
- A critical load of N based on diversity loss is 11 kg N/ha.