Too much of a good thing:

Restoration of native biodiversity following soil nitrogen enrichment

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Outline

1. Human alterations to the nitrogen cycle
   - Local and regional
2. Impacts on natural ecosystems
   - Vegetation composition
   - Soil microbial community composition
3. Restoration strategies


Californiacoastline.org

Local processes

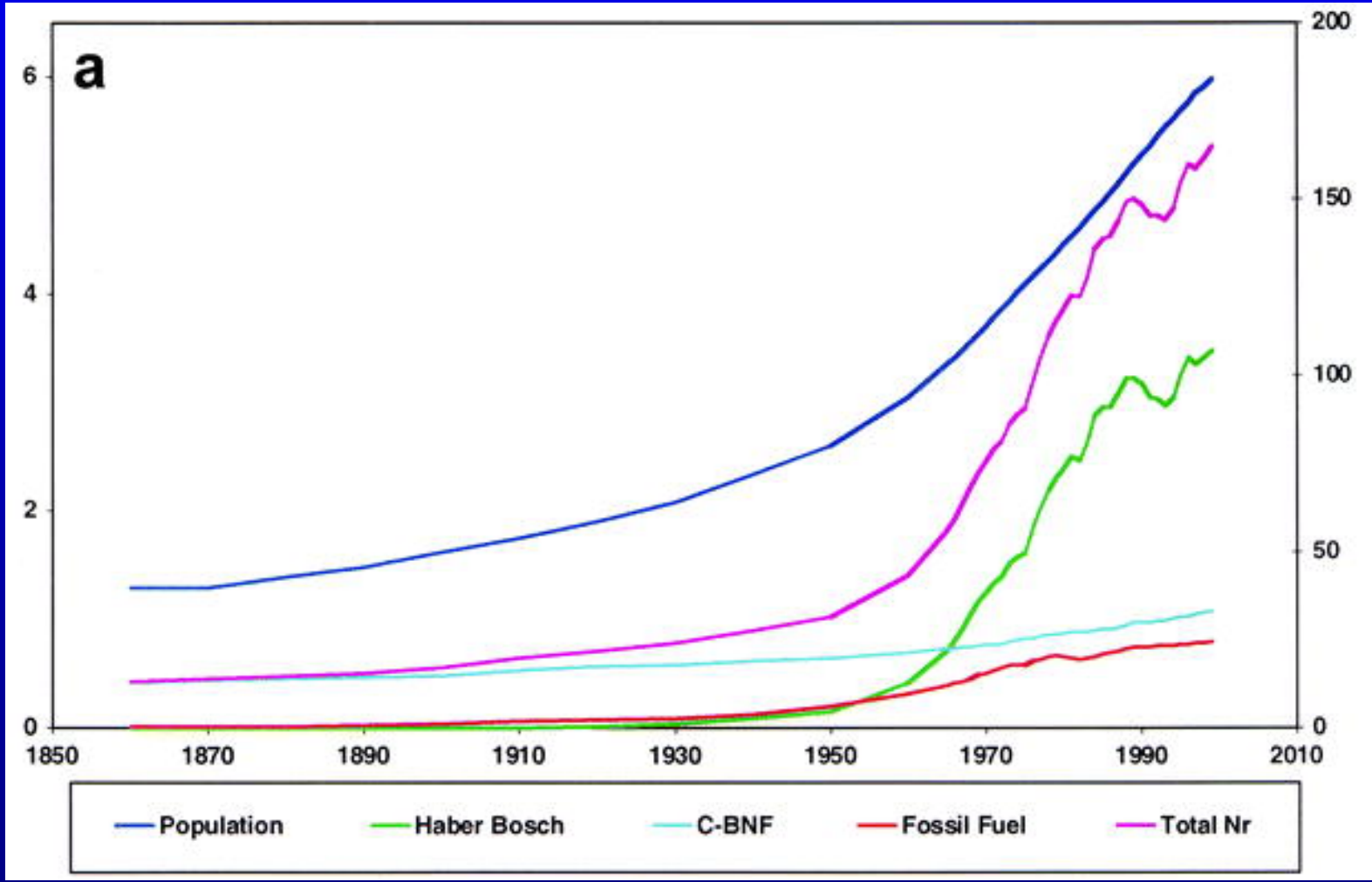
Fertilization and agriculture

Invasion by N-fixing shrubs

Regional processes

Atmospheric N deposition

Human alteration of the N cycle



From Galloway et al. 2003, *Bioscience*

Genista monspessulana, Cytisus scoparius, Ulex europea (French broom, scotch broom, gorse)

Lupinus arboreus (yellow bush lupine)

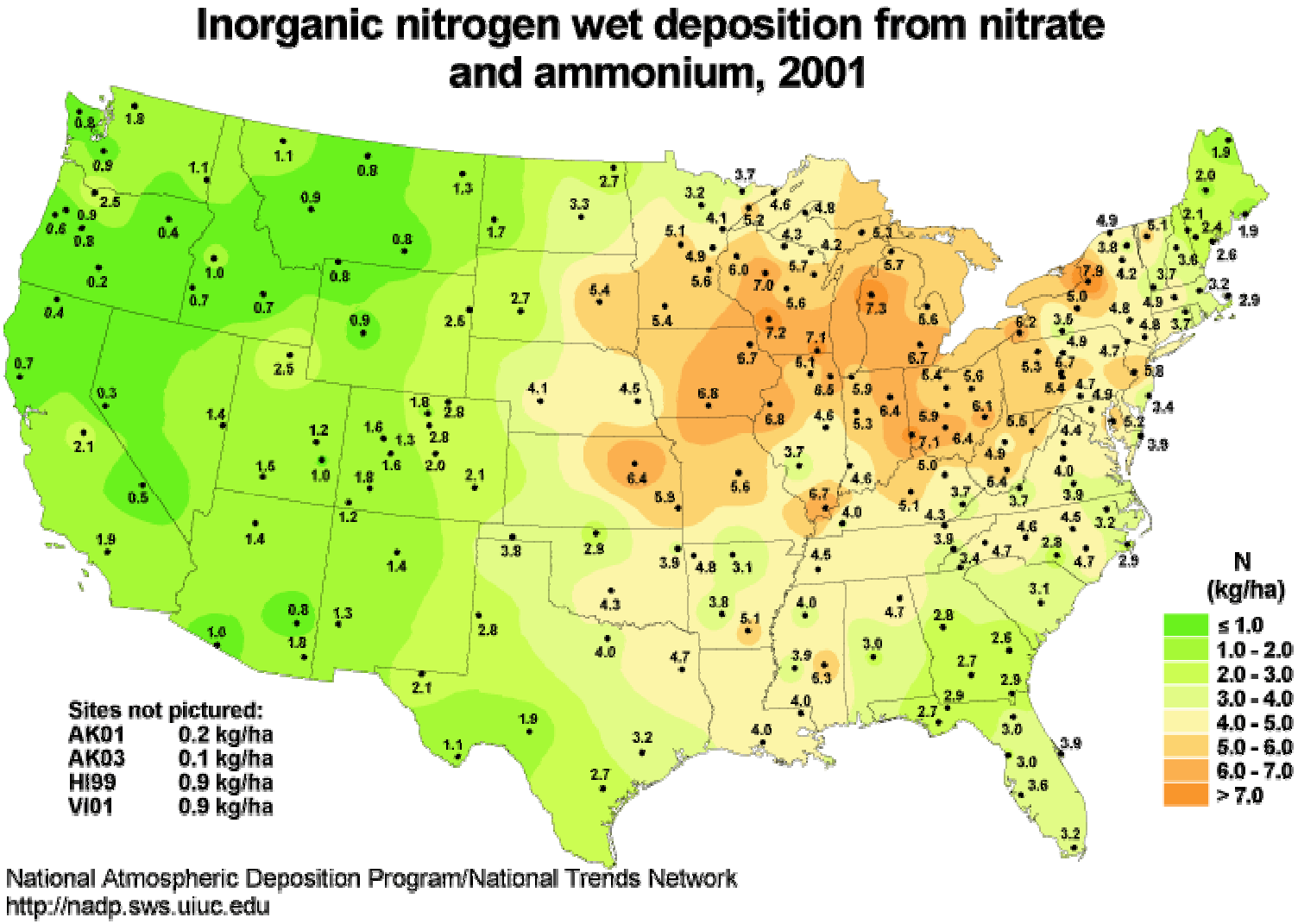
Local processes

- Fertilization
- Invasion by N-fixing shrubs
- Livestock

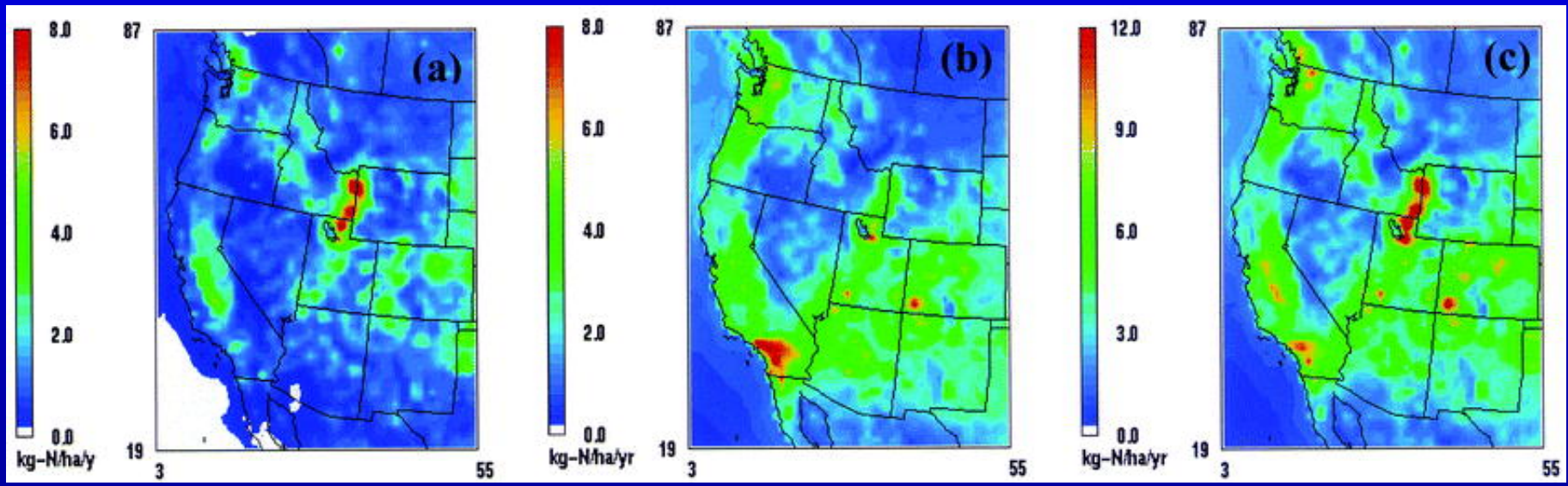
Regional processes

- Atmospheric N deposition

Atmospheric nitrogen deposition



Atmospheric nitrogen deposition



NH_4-N NO_3-N Total N

From Fenn et al. 2003, *Bioscience*

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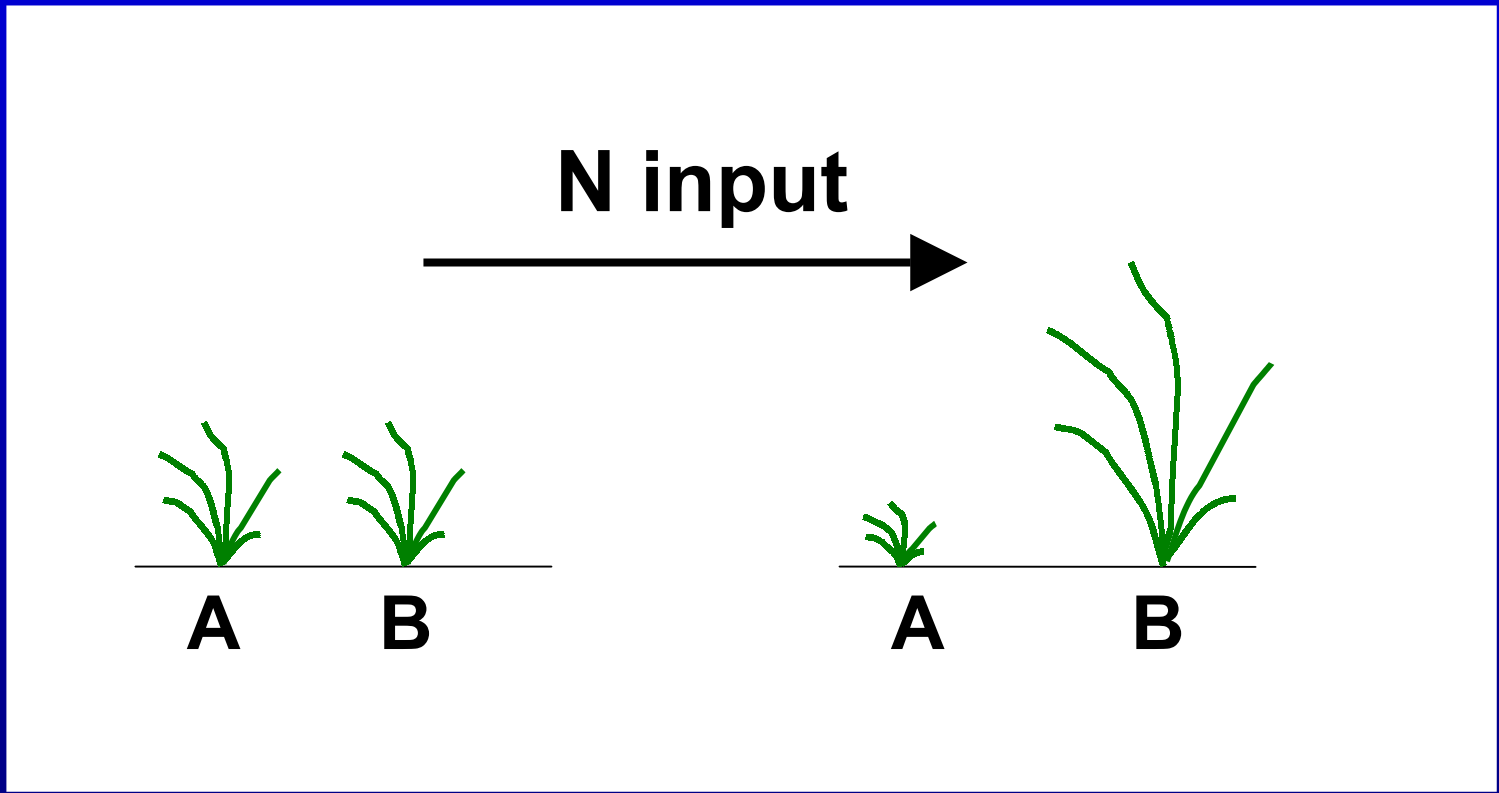
N inputs favor faster-growing species – often exotics!!



Local Process – Community response to invasion

Regional process: Community response to Atmospheric N deposition

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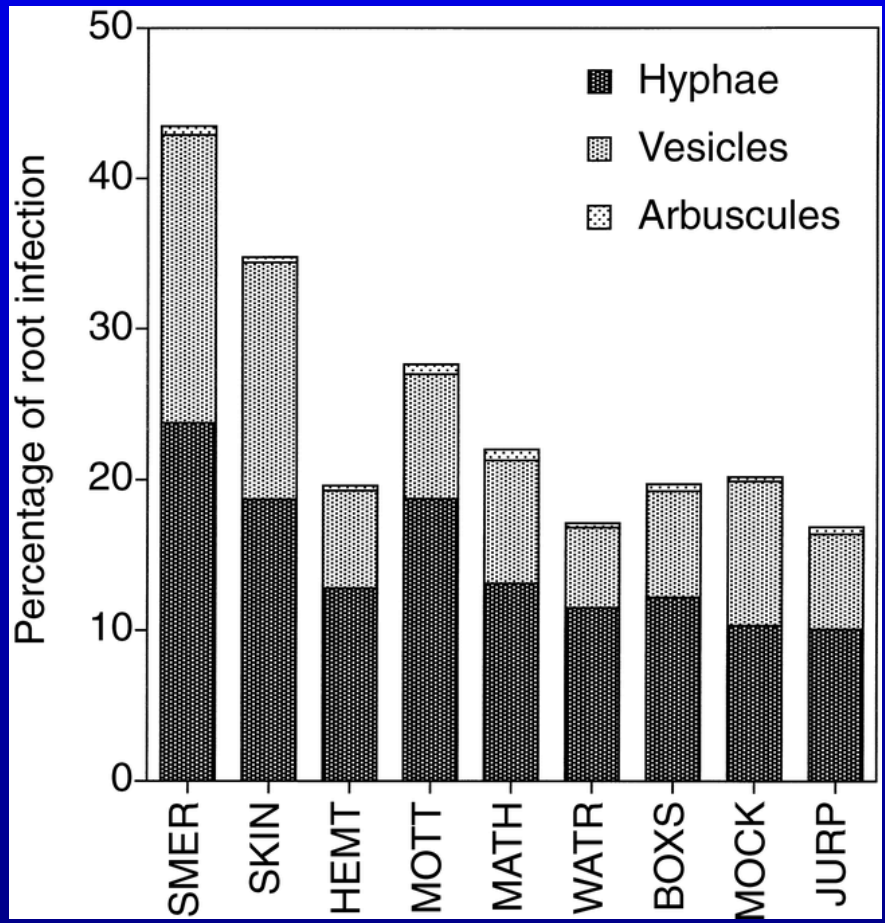
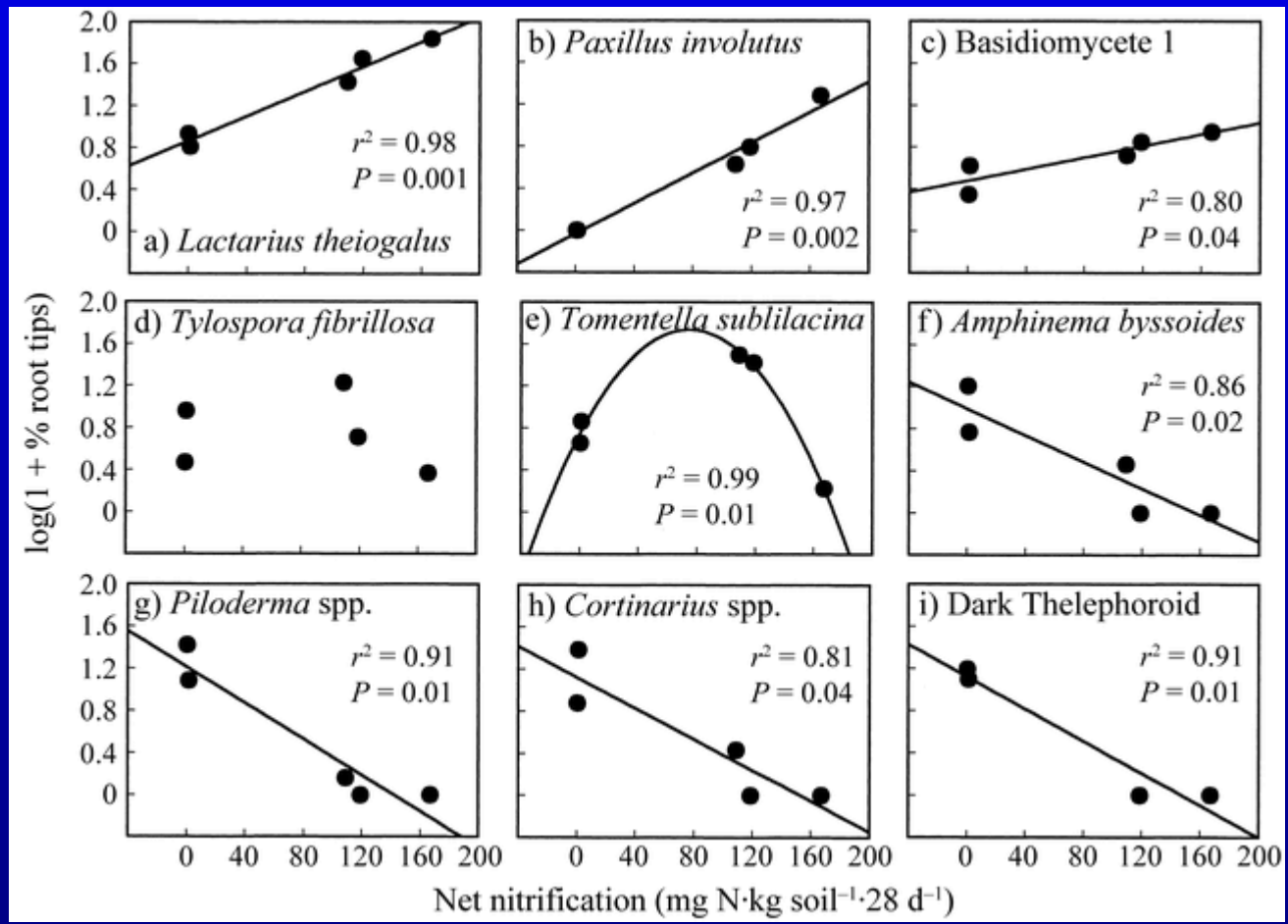
N deposition reduces arbuscular mycorrhizal infection rates…



Egerton-Warburton and Allen 2000
Ecological Applications

…and shifts ectomycorrhizal community composition



Lilleskov et al. 2002, *Ecology*

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Restoration strategies

Local processes

1. Remove source of input
2. Reduce N levels
    - C addition
    - Mowing and biomass removal
3. Overcome seed limitation of natives

Remove source of input, BUT…

After removal of N-fixing shrubs, the legacy of high N levels may remain

Restoration strategies

Local processes

1. Remove source of input
2. Reduce N levels
    - C addition
    - Mowing and biomass removal
3. Overcome seed limitation of natives

Addition of carbon

- High C:N ratio: e.g. sawdust, sucrose, mulch

- Mechanism: (1) C stimulates growth of microbial populations
  (2) Microbial populations immobilize N
  (3) Plant-available N is decreased

- Outcome: Favors slower-growing natives over faster-growing exotics

Examples of carbon addition

McLendon and Redente 1992

Zink and Allen 1998

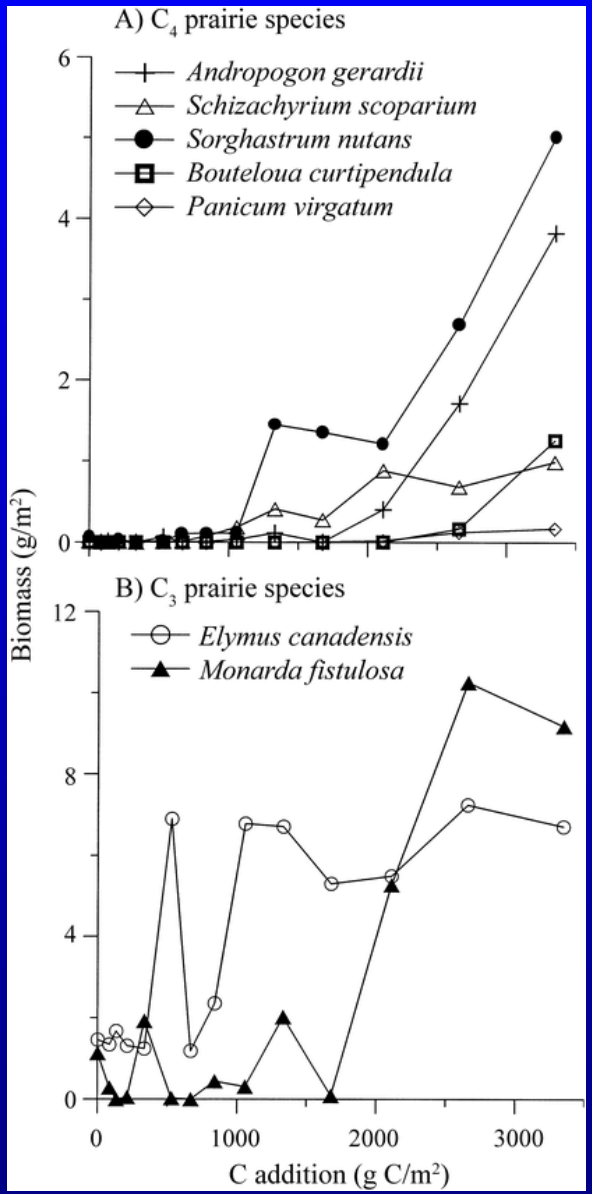
Reever Morghan and Seastedt 1999

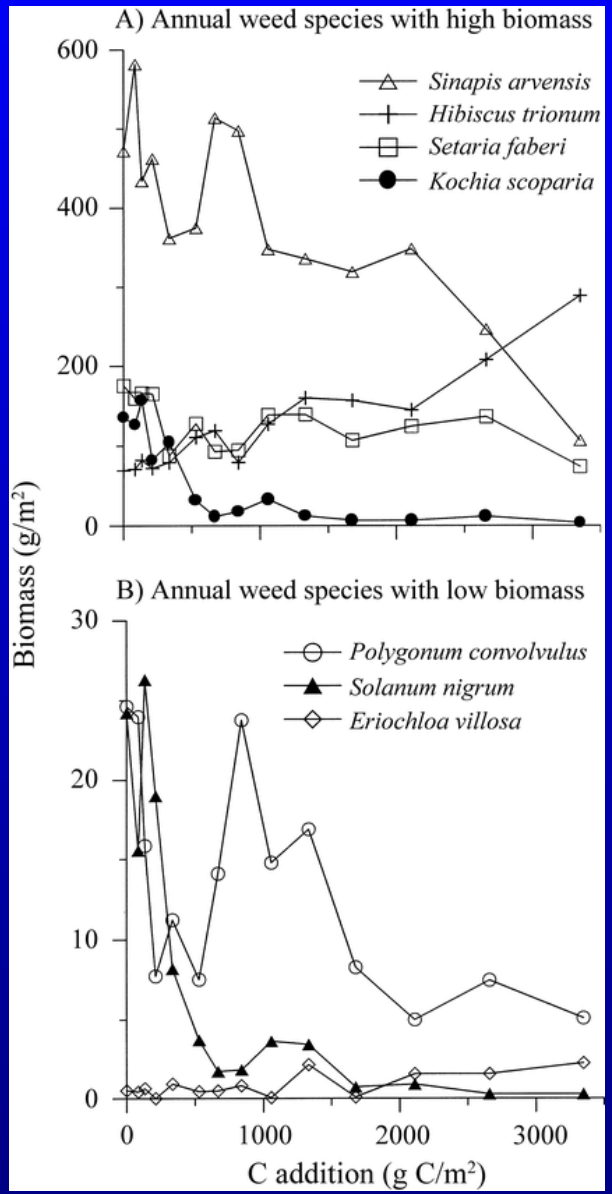
Alpert and Maron 2000

Paschke et al. 2002

Blumenthal et al. 2003

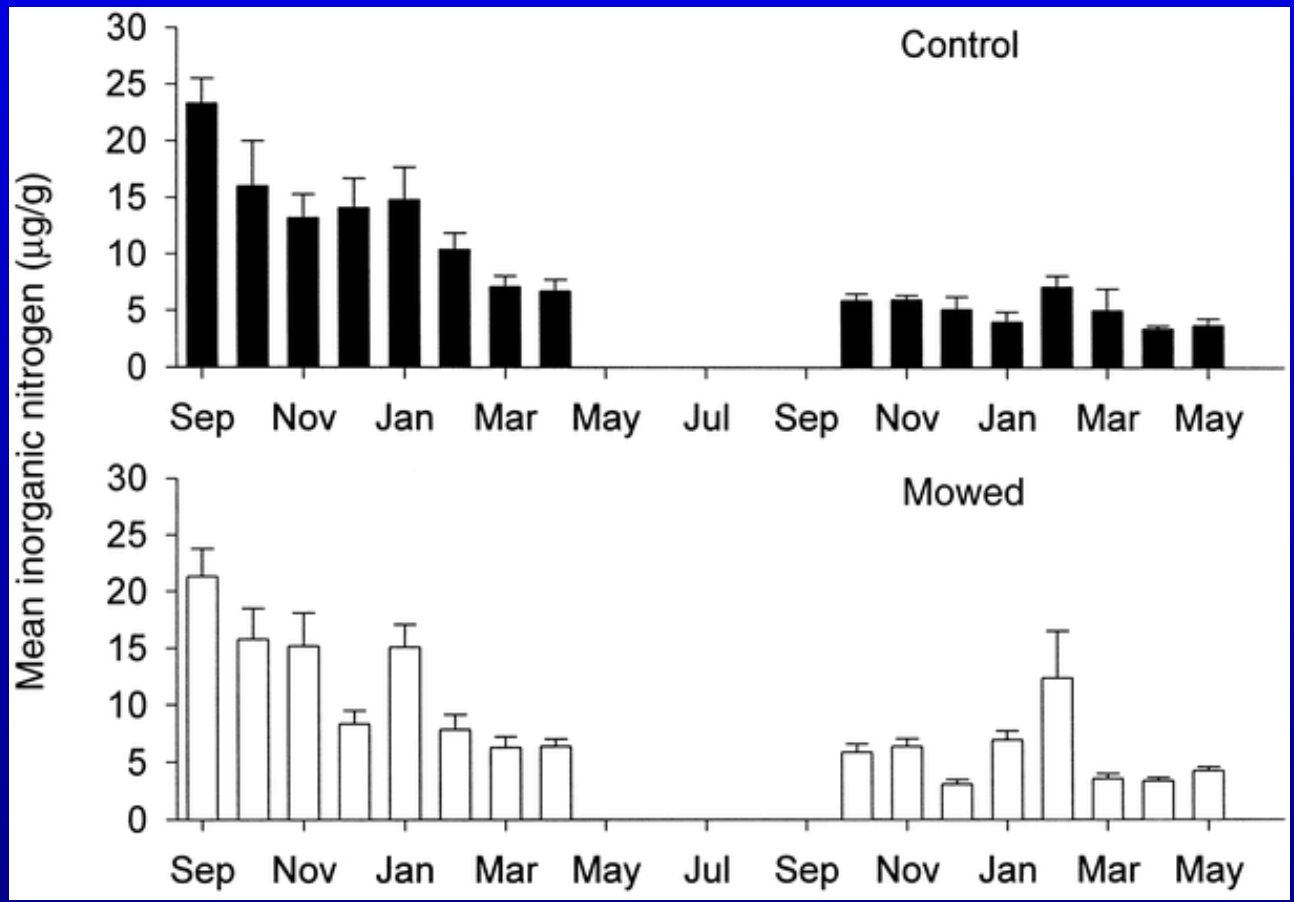
Corbin and D'Antonio, *in review*





Blumenthal et al., 2003
Ecol. Appl.

Mowing and removal of biomass



Maron and Jefferies 2001, *Ecol. Appl.*

Restoration strategies

Local processes

1. Remove source of input
2. Reduce N levels
    - C addition
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Restoration strategies

Local processes

1. Remove source of input
2. Reduce N levels – C addition, mowing
3. Overcome seed limitation

Regional processes

1. Chronic inputs difficult to stop
2. Even protected ecosystems vulnerable
3. How to restore soil microbial communities?

Conclusions

- Human alteration of the N cycle can have dramatic impacts on natural ecosystems
- Successful strategies exist for local processes
- Regional processes more daunting
- Southern CA ecosystems particularly threatened