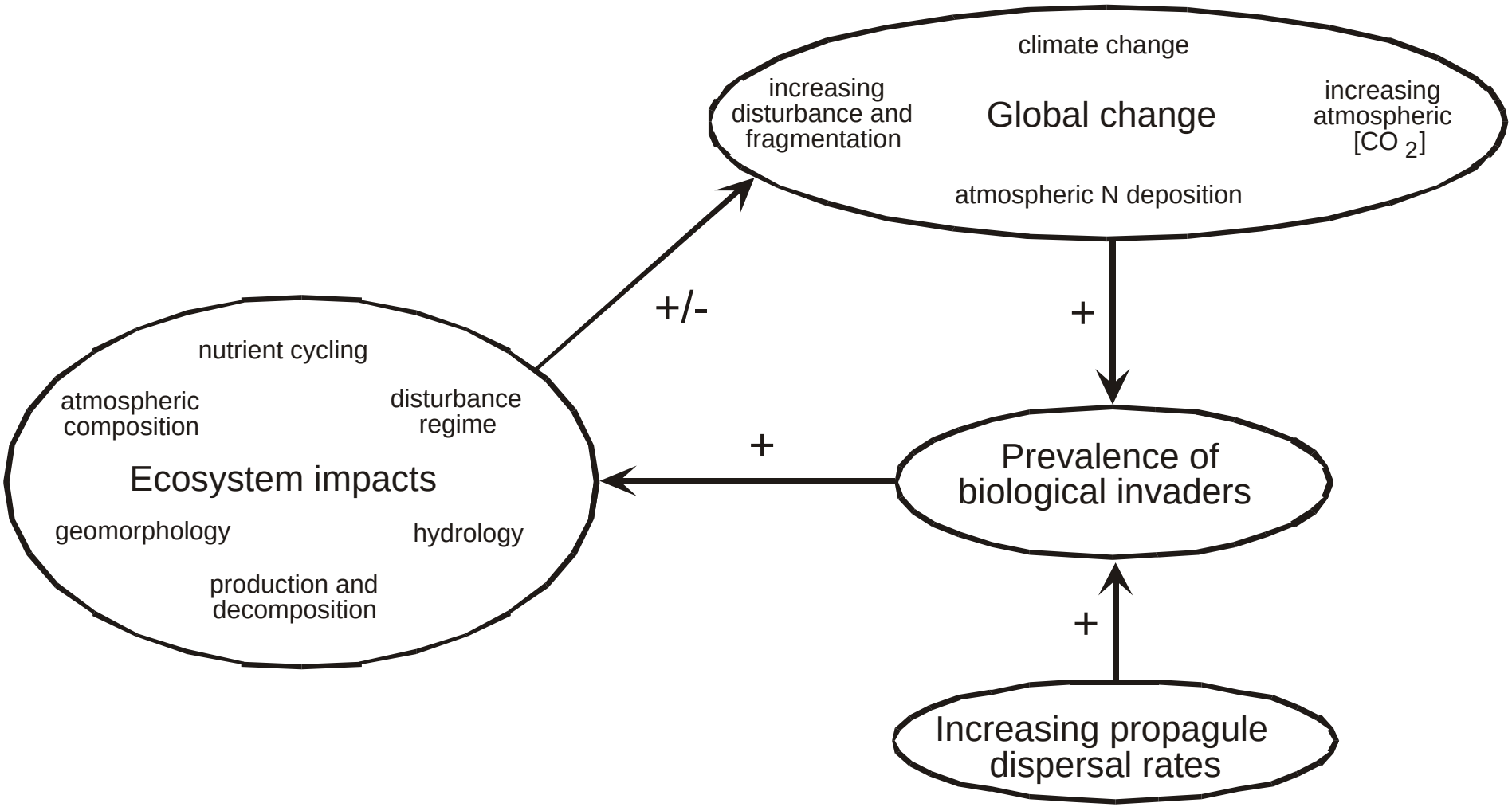
Warmer and weedier? Outlook for invasive plants in a changing world

Jeffrey S. Dukes

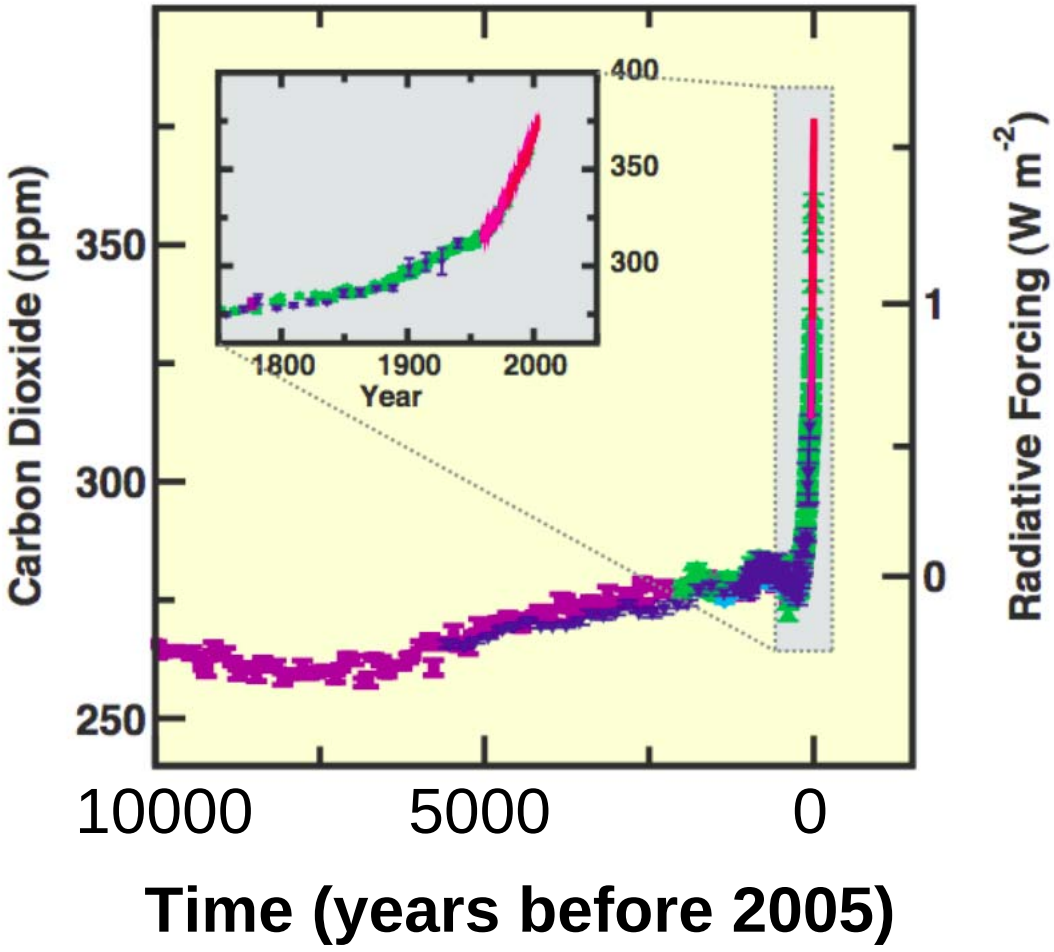
Purdue University

Climate change may increase success of invasive species



Dukes and Mooney 1999 *Trends in Ecol. Evol.*

Carbon dioxide in the atmosphere

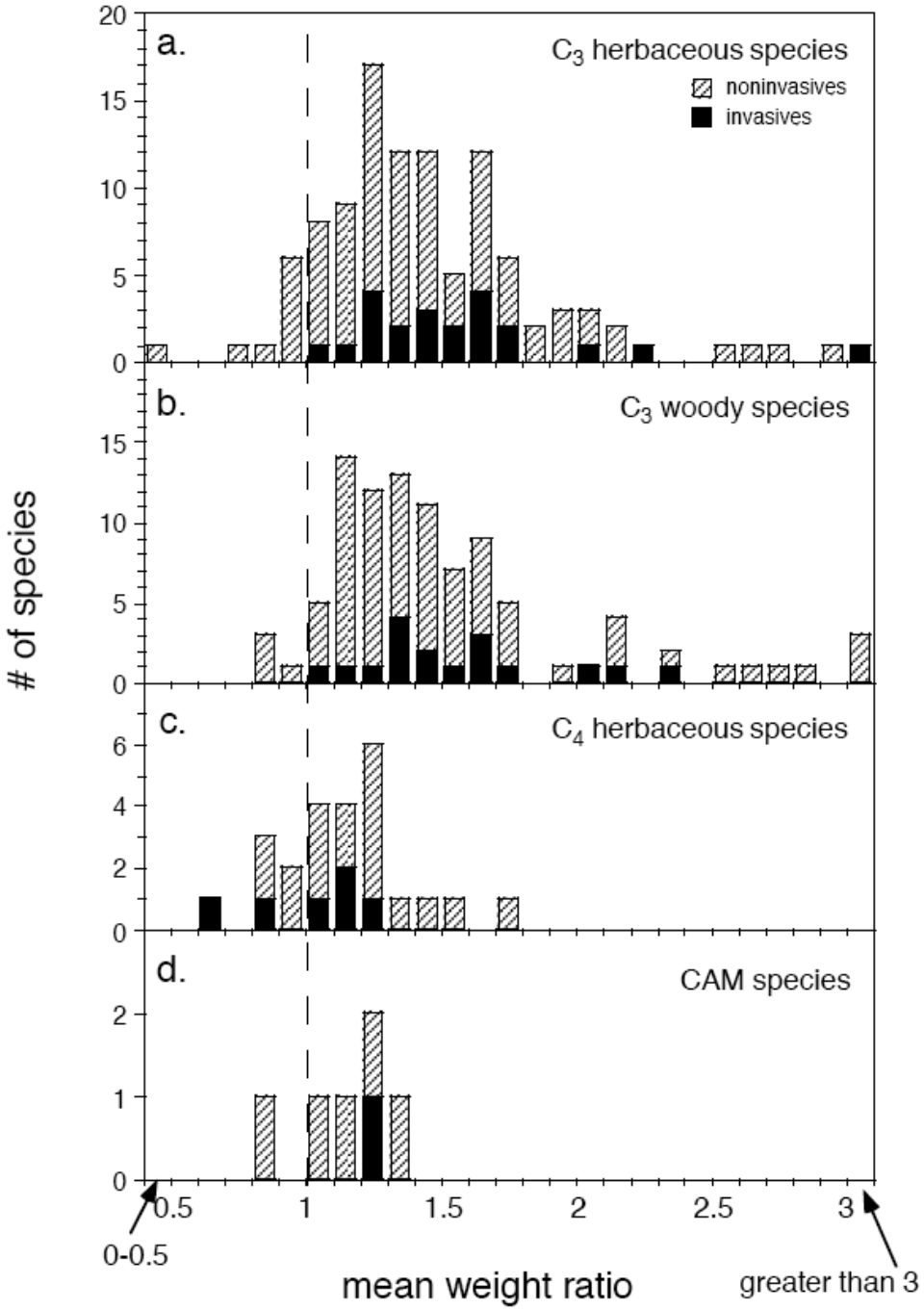


IPCC 2007

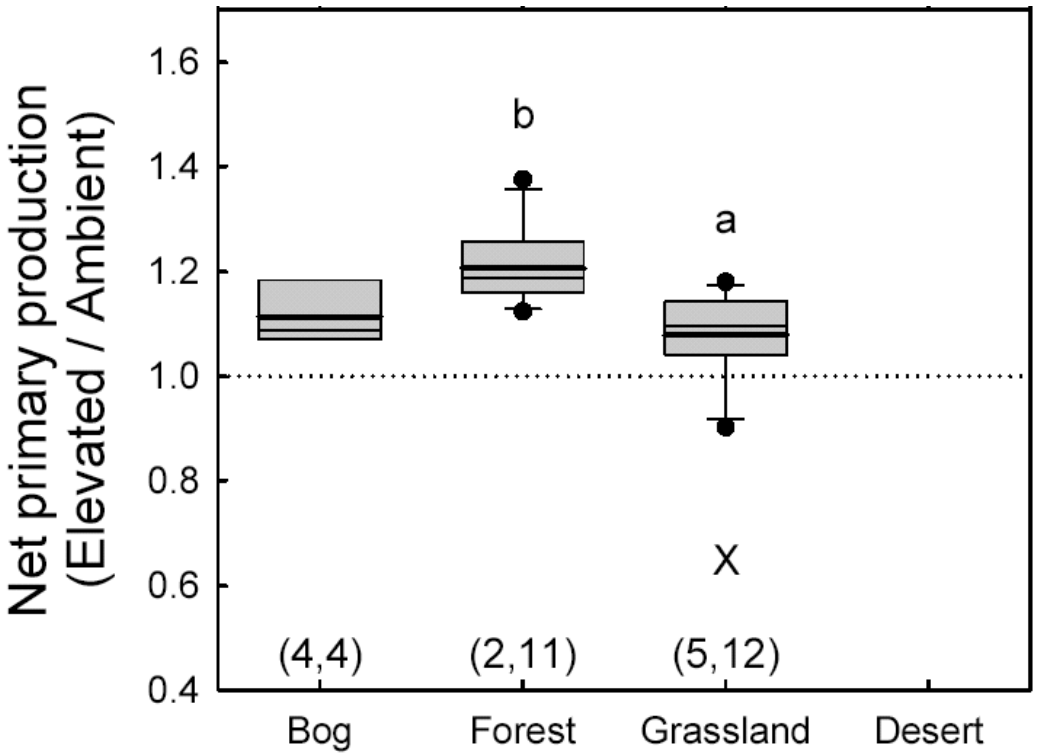
Elevated CO_2 stimulates growth of plants

…both invasive and non-invasive

Dukes 2000



Supplemental CO_2 increases plant growth in most ecosystems



Nowak et al. 2004

- Increases smaller than in pot-grown plants

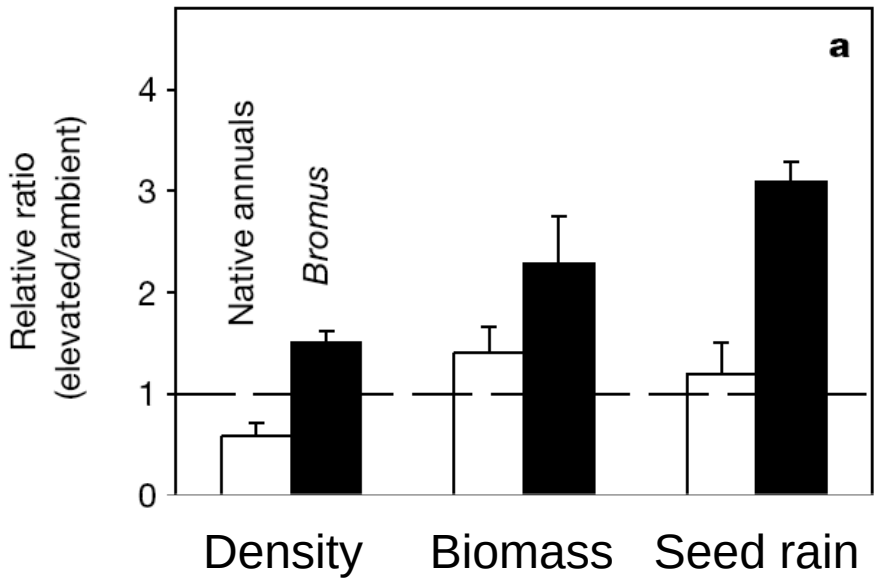
Mojave desert: red brome responded strongly in wet year

- Population then declined, response was less pronounced

Smith et al. 2000 *Nature*

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Bromus madritensis ssp. *rubens*



Other experiments have mixed results

- In Tasmania, CO_2 did not affect population growth rates of two invasive rangeland plants

Williams et al. 2007 *New Phytologist*

Will CO_2 alter herbicide effectiveness?

- Glyphosate effectiveness decreased under elevated CO_2

Ziska & Goins 2006 *Crop Science*

So, what about climate?

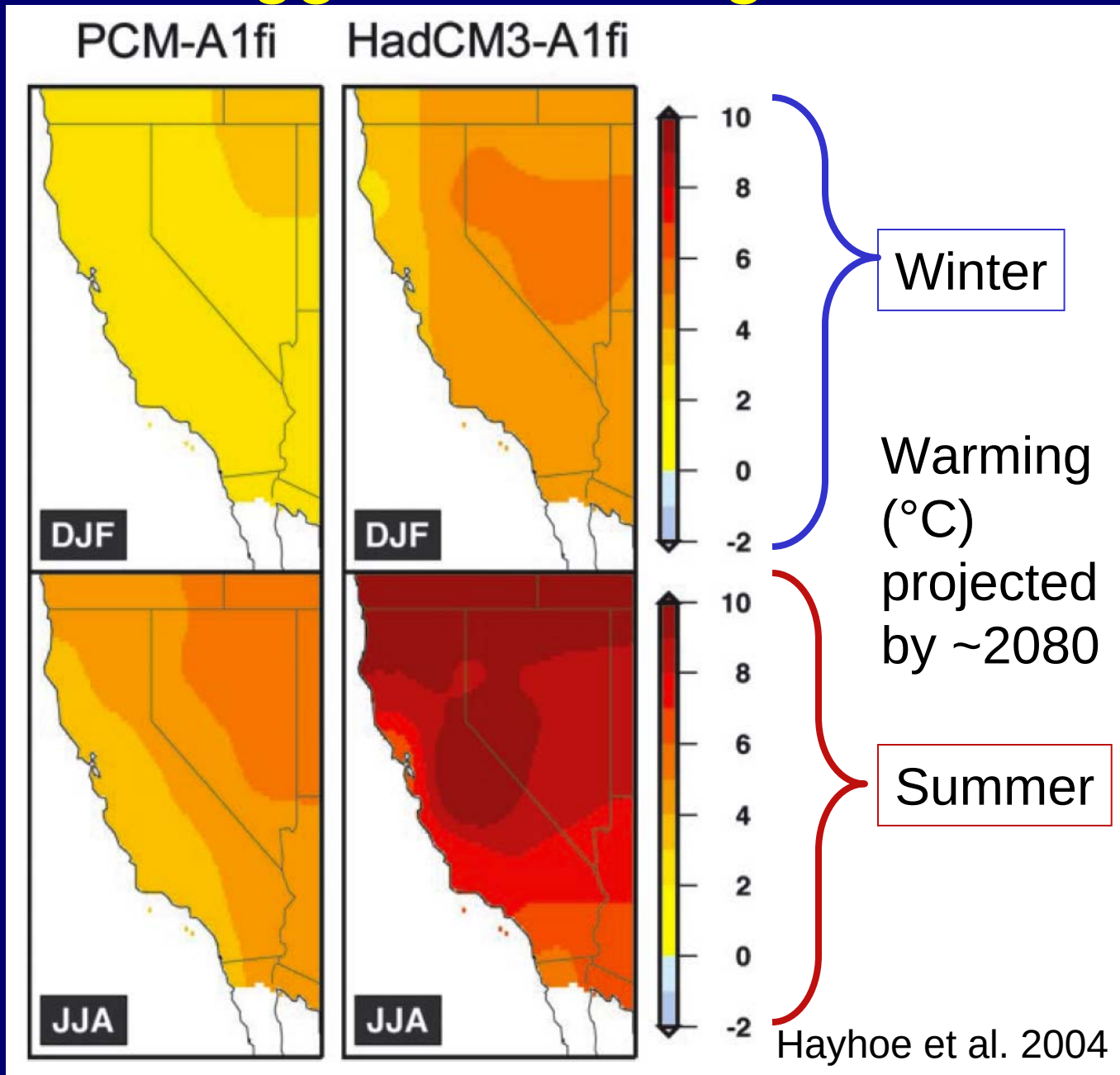
Climate models suggest warming

Warmer!

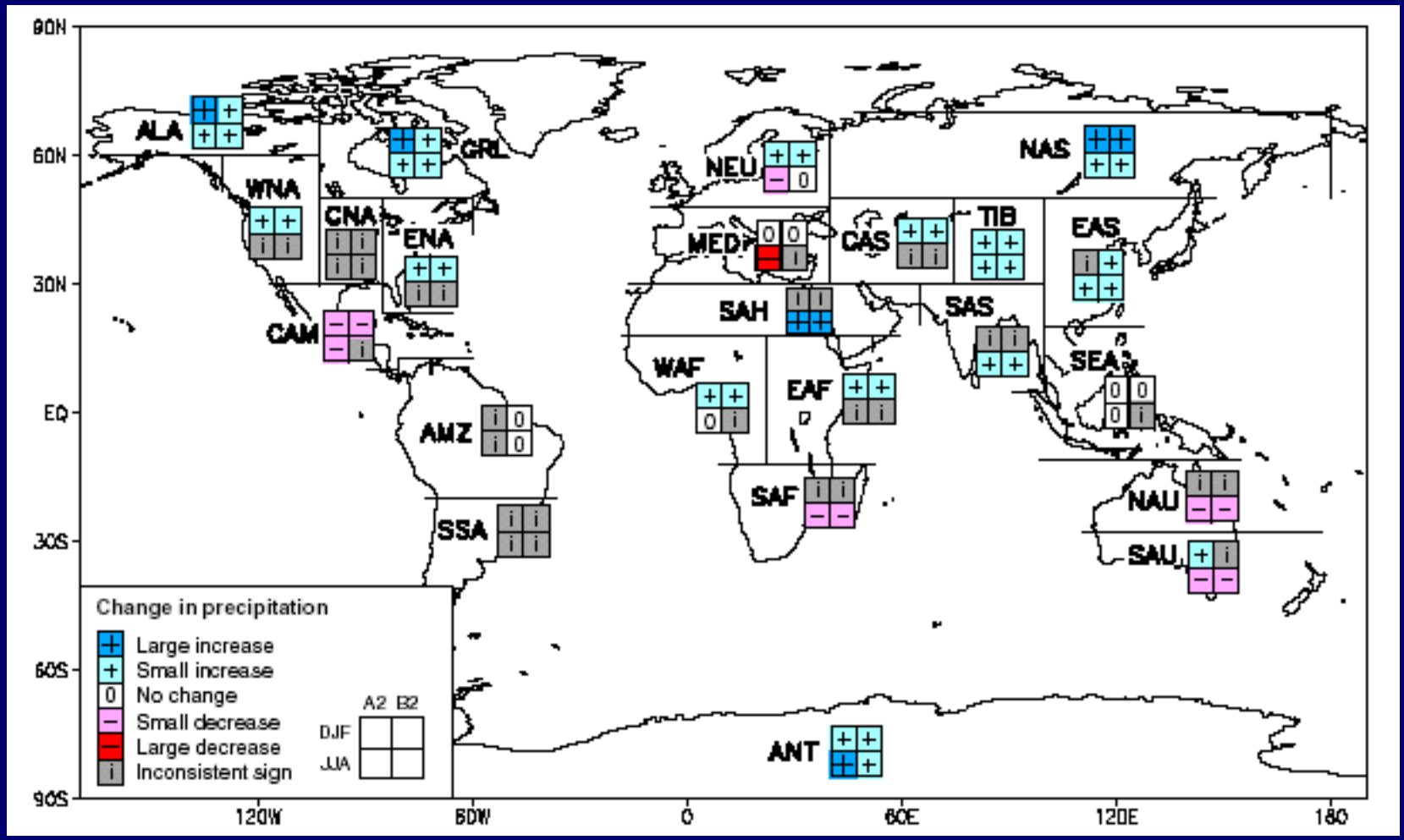
Warming greatest at poles

Degree depends on scenario, year

Warming in CA greatest in summer



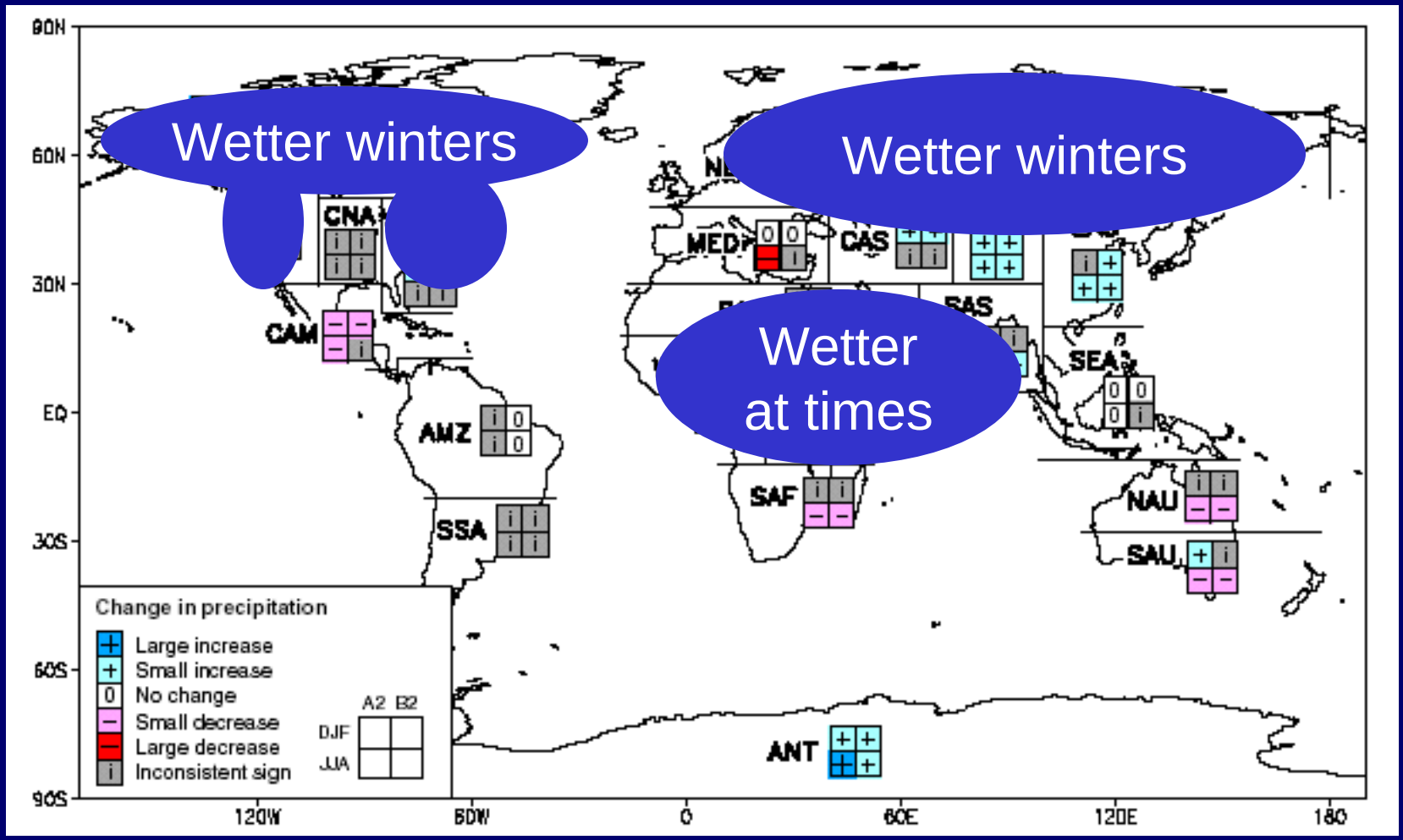
Predicted changes - precipitation



- Changes less certain

IPCC 2001

Predicted changes - precipitation



- Wetter winters in Northern Hemisphere

Five potential consequences of climate change

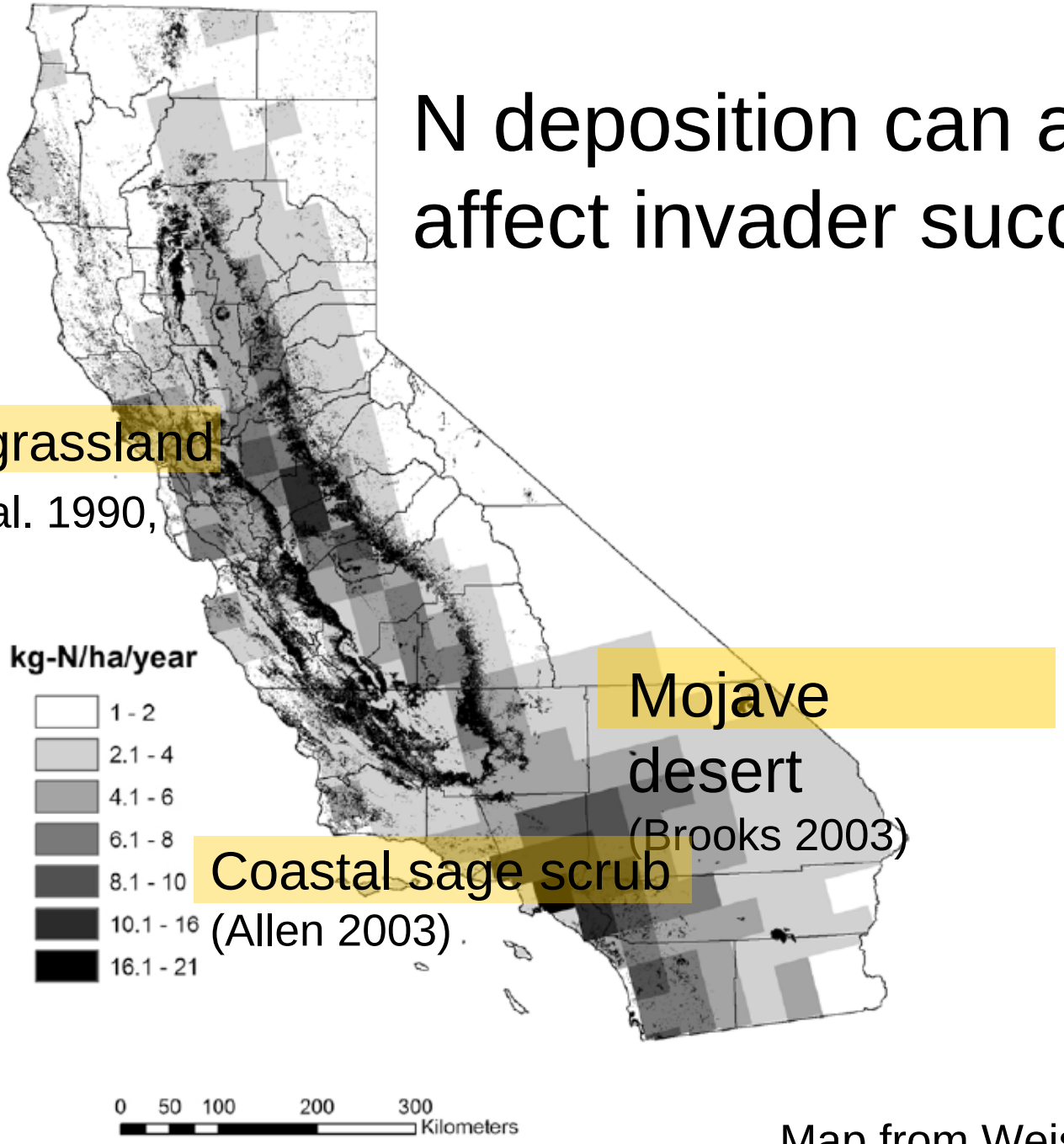
1. Altered transport (e.g., *Arundo*?)
2. Altered climatic constraints
3. Altered distributions
4. Altered impacts (*Tamarix* more costly?)
5. Altered effectiveness of management strategies (salt cedar leaf beetle?)

Hellmann et al. 2008 *Conservation Biology*

Why might climate change favor invasives?

- Few research projects have addressed this question
- Several reasons to think it will…
  - Natives being displaced from own climatic niche
  - Native plants may depend more on specialists
  - Invasive plants tend to have broader climatic tolerances

N deposition can also affect invader success



Serpentine grassland

(Huenneke et al. 1990, Weiss 1999)

Mojave desert

(Brooks 2003)

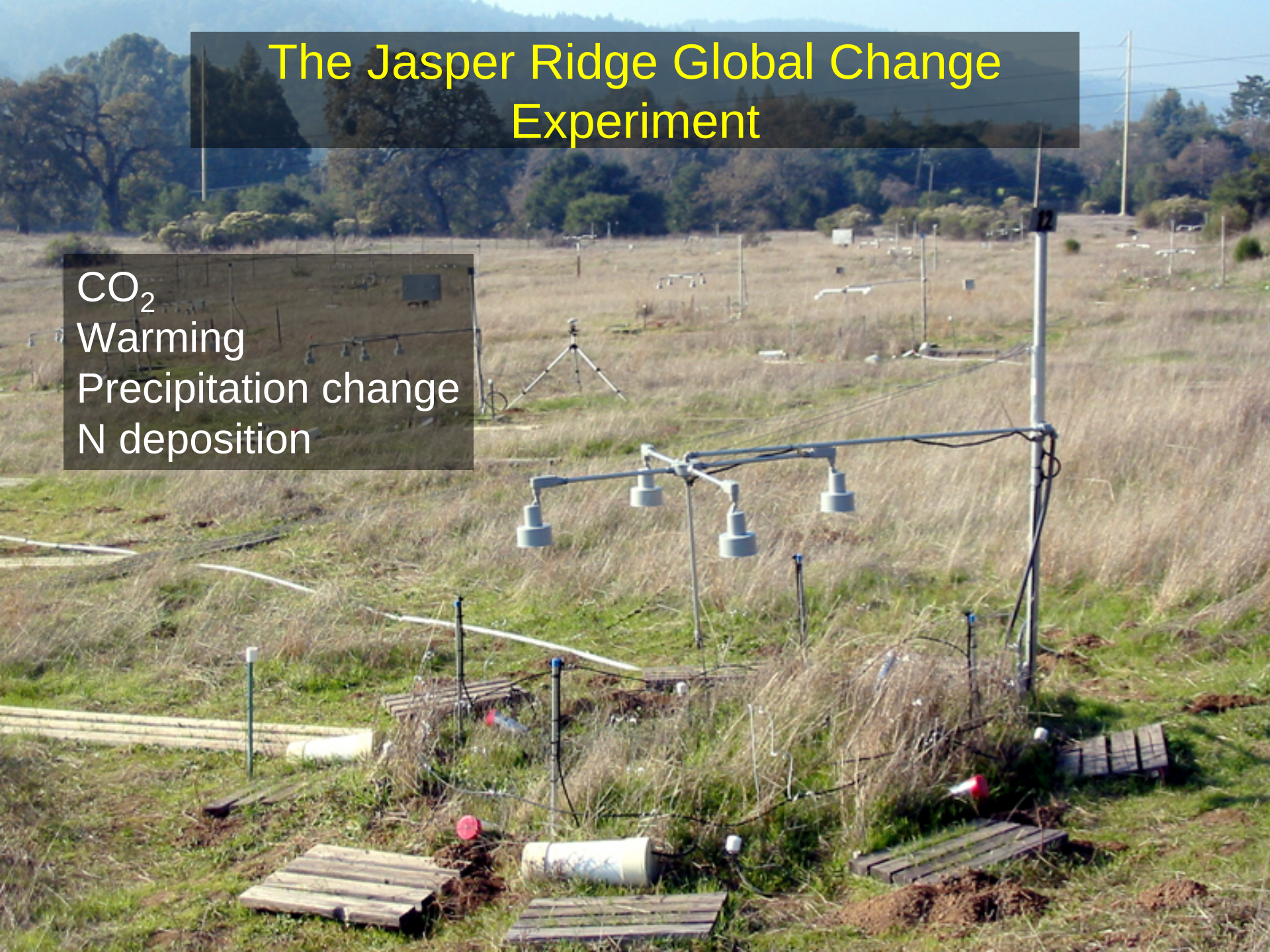
Coastal sage scrub

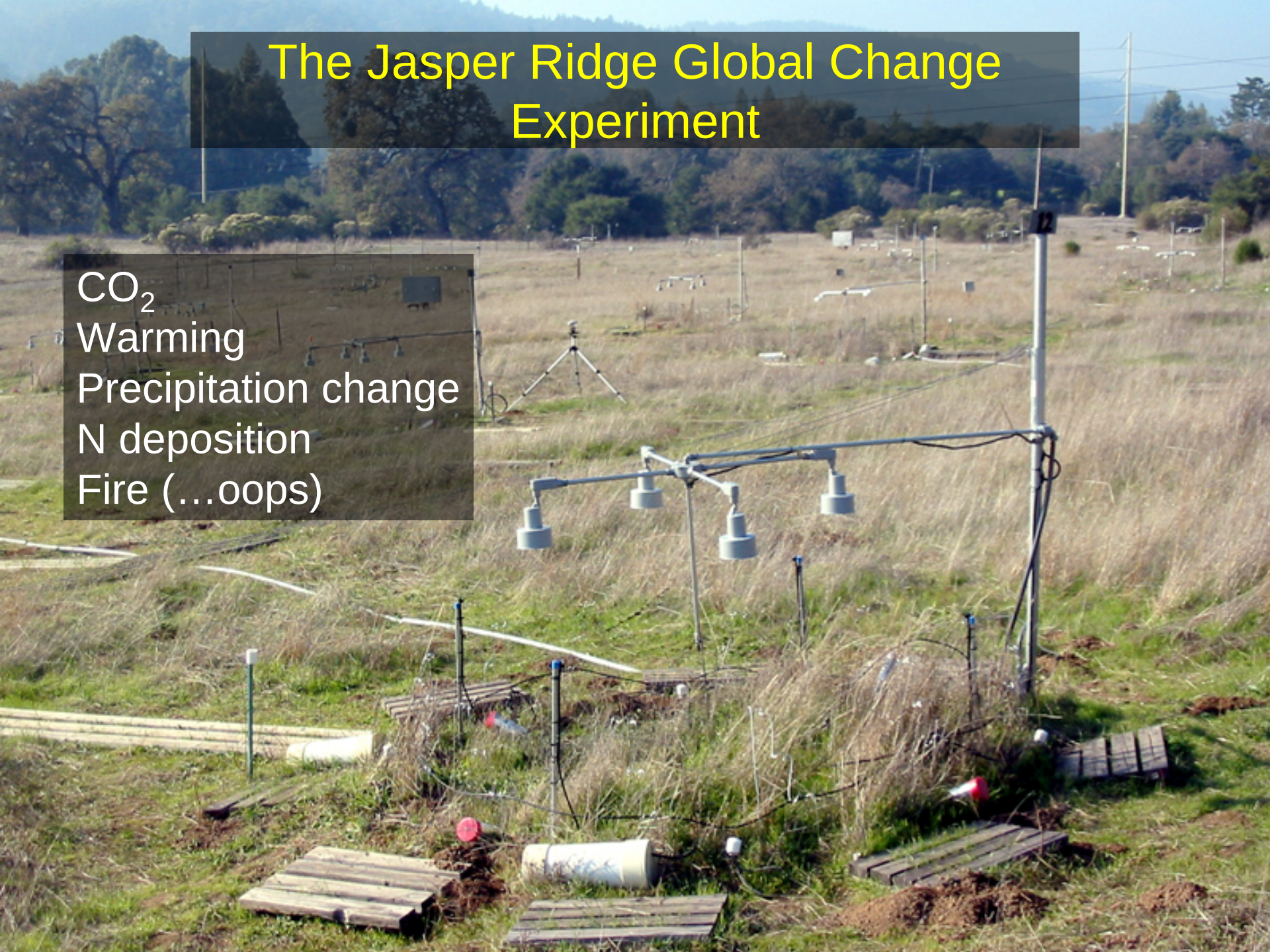
(Allen 2003)

Map from Weiss 2006

What about interactions?

- Will effects of warming and CO_2 (for instance):
  - Cancel?
  - Amplify?
  - Be additive?


The Jasper Ridge Global Change Experiment
CO_2
Warming
Precipitation change
N deposition


The Jasper Ridge Global Change Experiment
CO_2
Warming
Precipitation change
N deposition
Fire (…oops)

Experimental design

Circular plots, 2m in diameter

Experimental design

Circular plots, 2m in diameter

Plots receive infrared radiation from ceramic heaters

Experimental design

Circular plots, 2m in diameter

Plots receive infrared radiation from ceramic heaters

Atmospheric CO2 enhanced by FACE technique

Experimental design

Circular plots, 2m in diameter

Plots receive infrared radiation from ceramic heaters

Atmospheric CO2 enhanced by FACE technique

Plots divided into quadrants

Experimental design

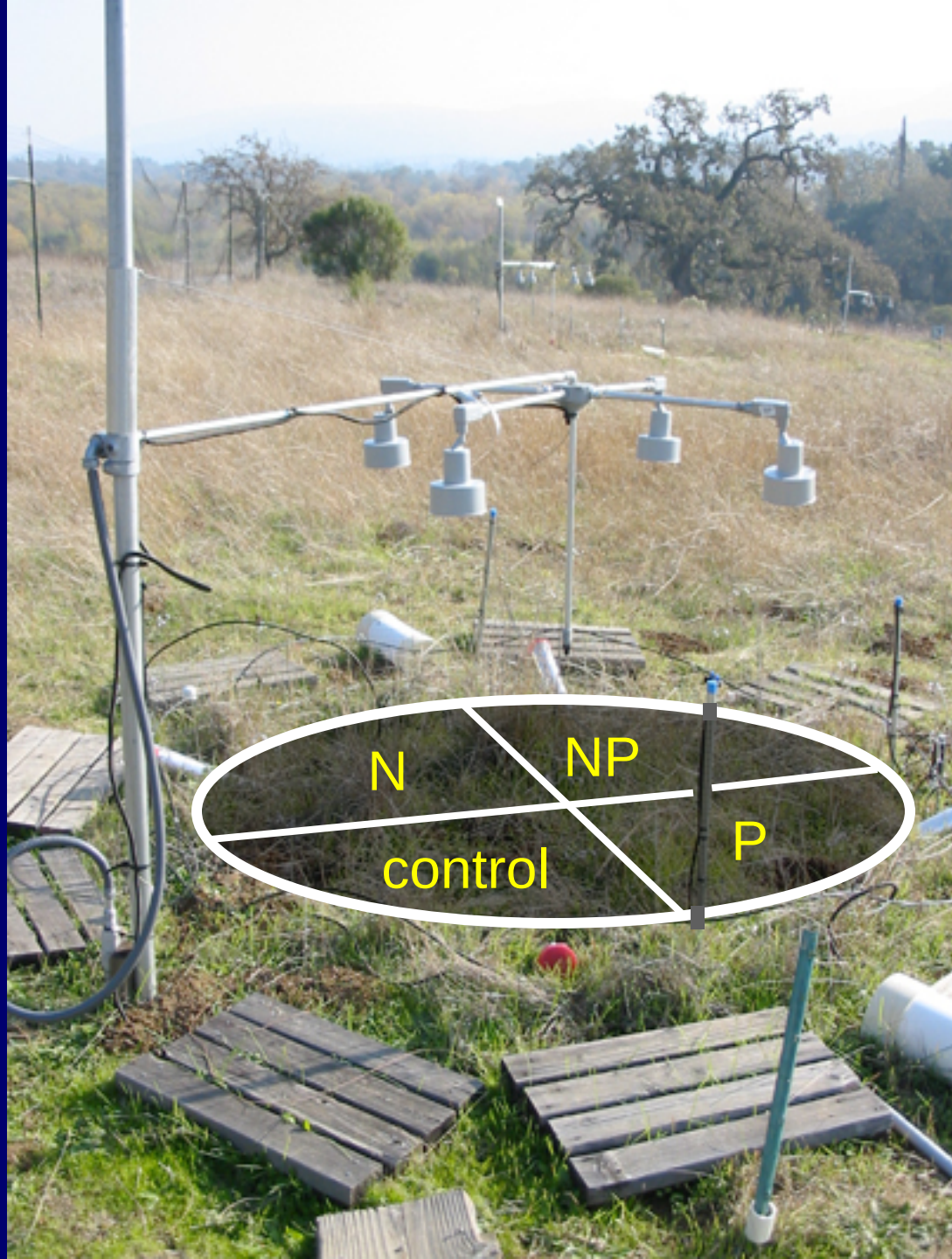
Circular plots, 2m in diameter

Plots receive infrared radiation from ceramic heaters

Atmospheric CO2 enhanced by FACE technique

Plots divided into quadrants

Nitrate and precipitation increased by quadrant



Will environmental changes favor yellow starthistle?

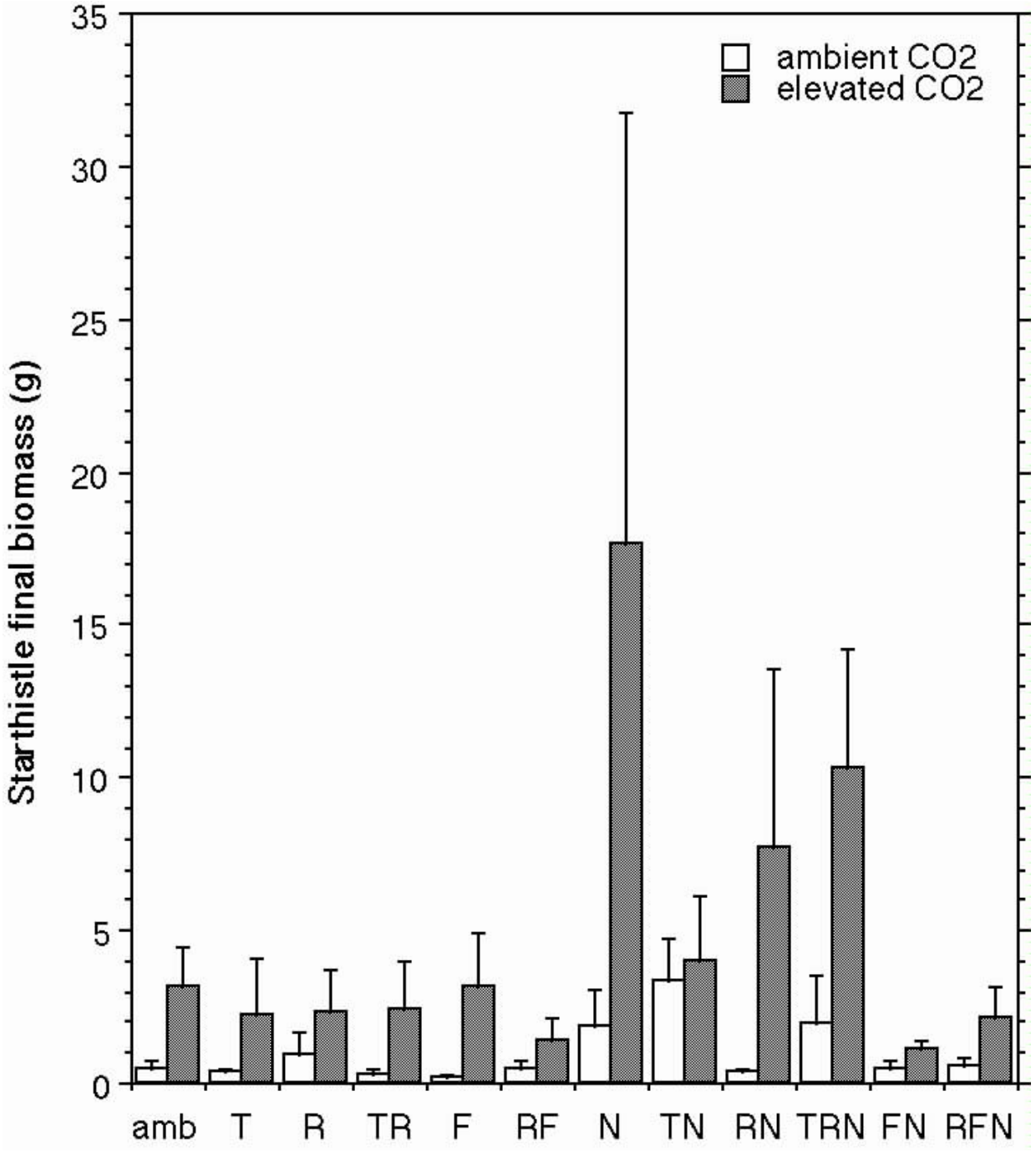
- Added *Centaurea* to JRGCE plots
- Observed responses to global changes

Methods

- Fall: added 10 seeds to 2 circular areas in each quadrant

Shoot biomass responses

- CO_2*
- N**
- N x F x T?

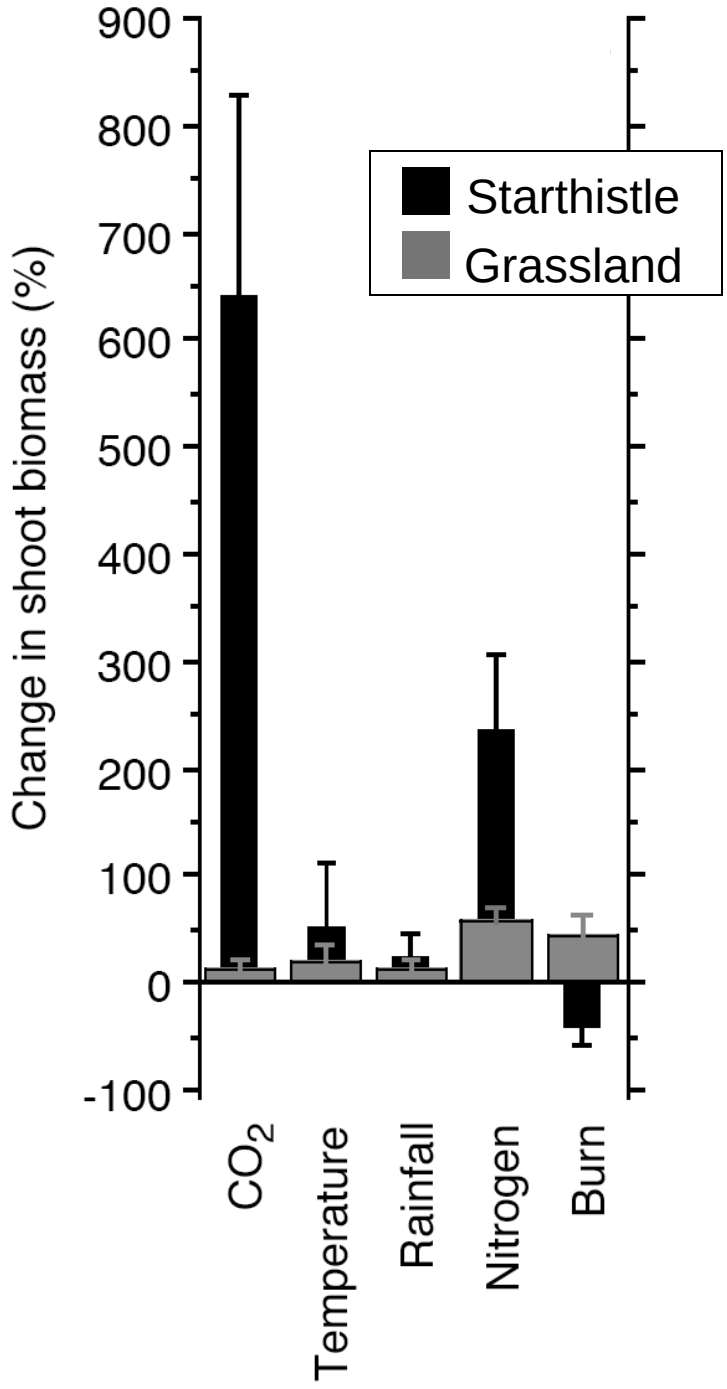


Dukes et al. unpublished

Average shoot growth responses

- Extremely strong CO_2 response
- Strong N response
- Responses of starthistle much stronger than those of grassland

Dukes et al. unpublished



How to prepare?

- The same, but more!
- Integrated monitoring and assessment systems
  - Increased cooperation
  - Lee et al. 2008 *Conservation Biology*
- Focus on neighboring areas

Thank you!

Cheryl McCormick
& Cal-IPC Organizers

JRGCE work: Scott Loarie, Nona Chiariello, Chris Field, many helpers

Many coauthors