

Community and Biodiversity Consequences of Drought

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Pinyon mortality

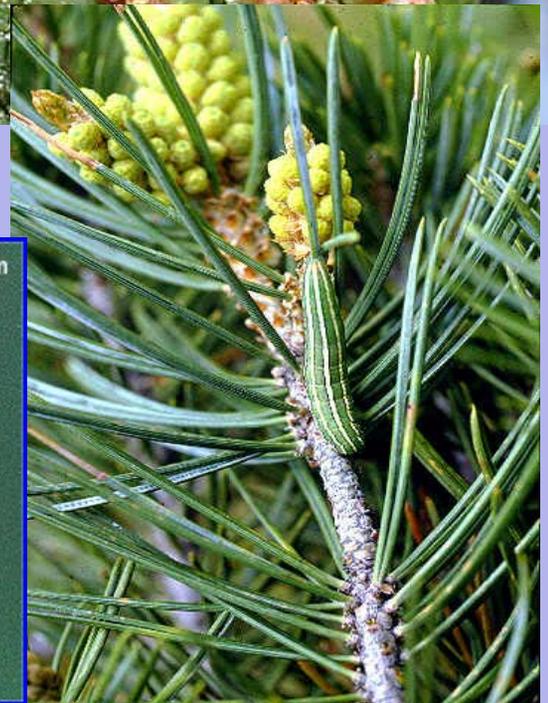
North side of the San Francisco Peaks, AZ

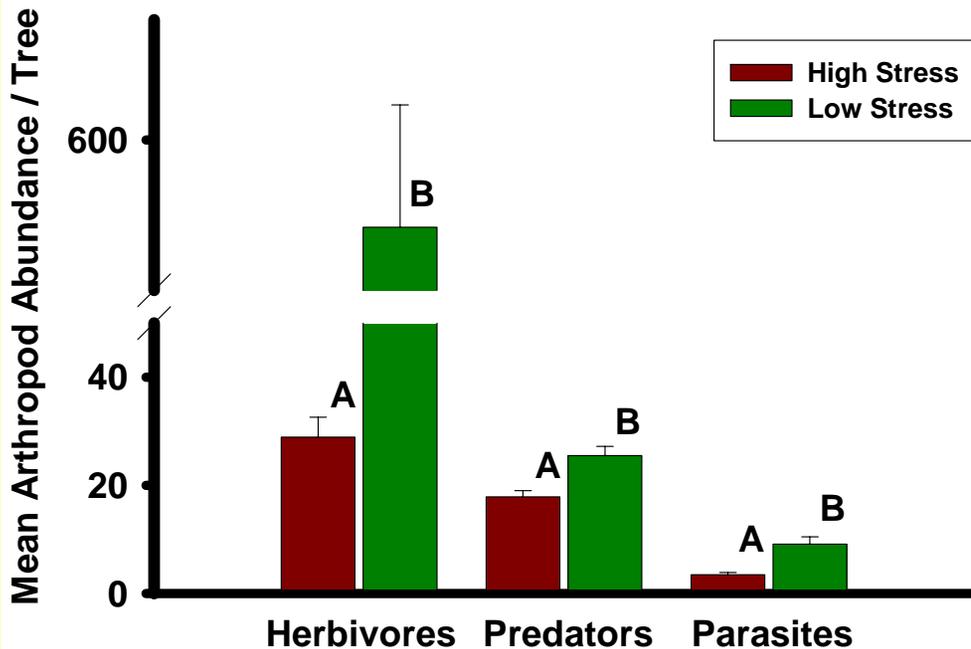
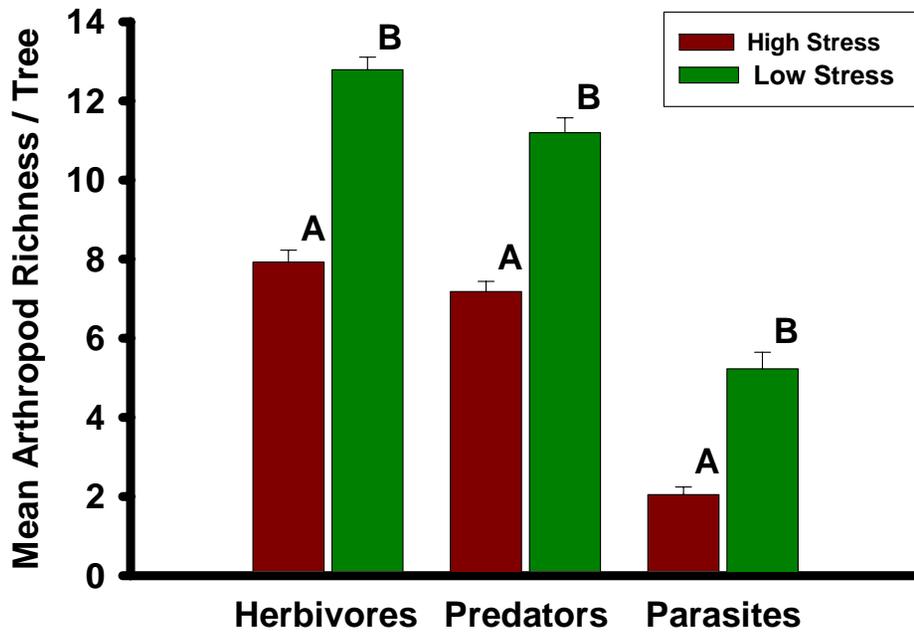


Photo mosaic by Paul Heinrich taken December 2003

Key Questions

- 1. As the dominant plant suffer water stress and die during a record drought, how will the rest of the dependent community be affected?**
- 2. Will all vegetation types be equally affected or is it just restricted to certain species like pinyon and ponderosa pine?**
- 3. What are the management implications for preserving biodiversity?**

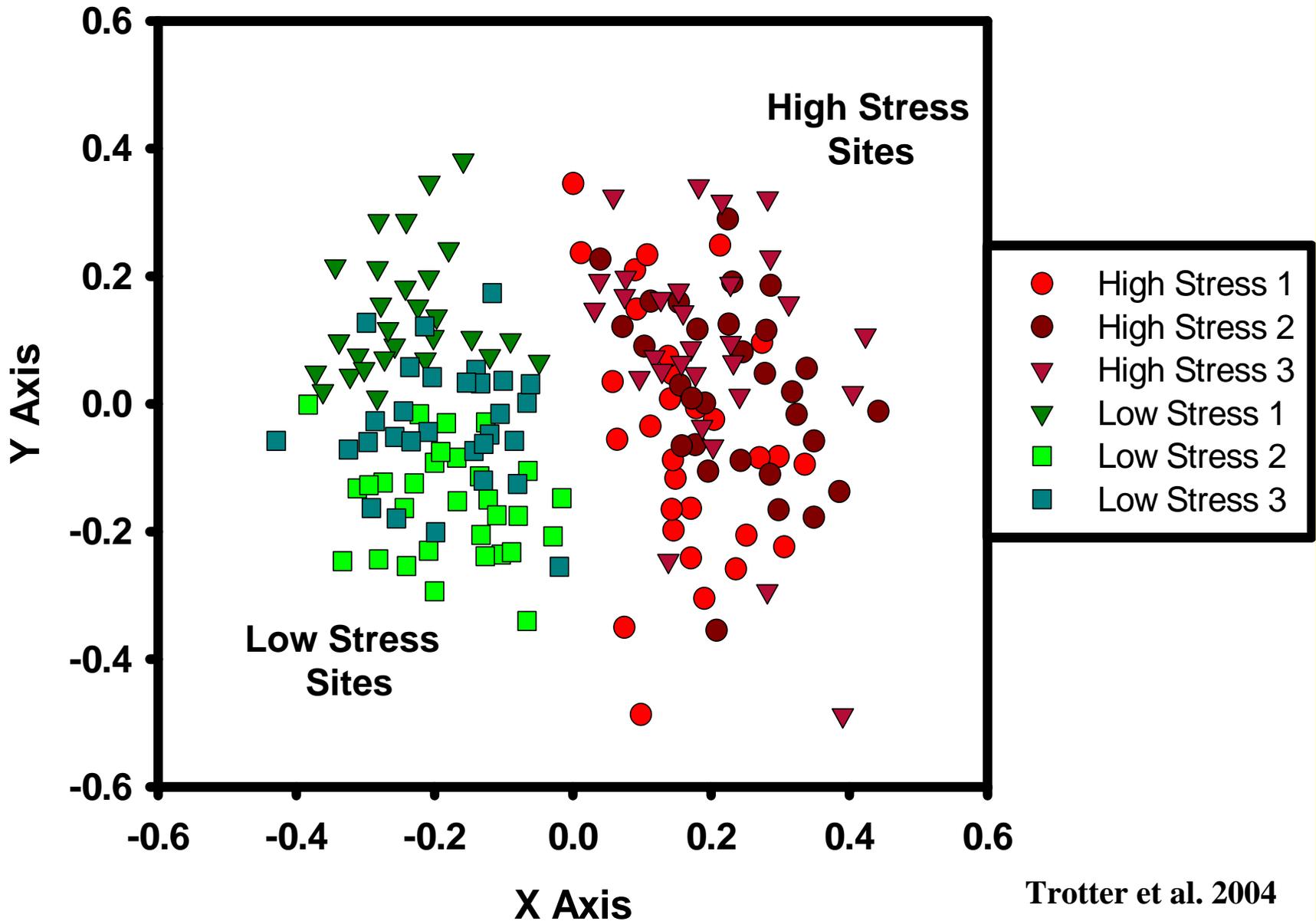




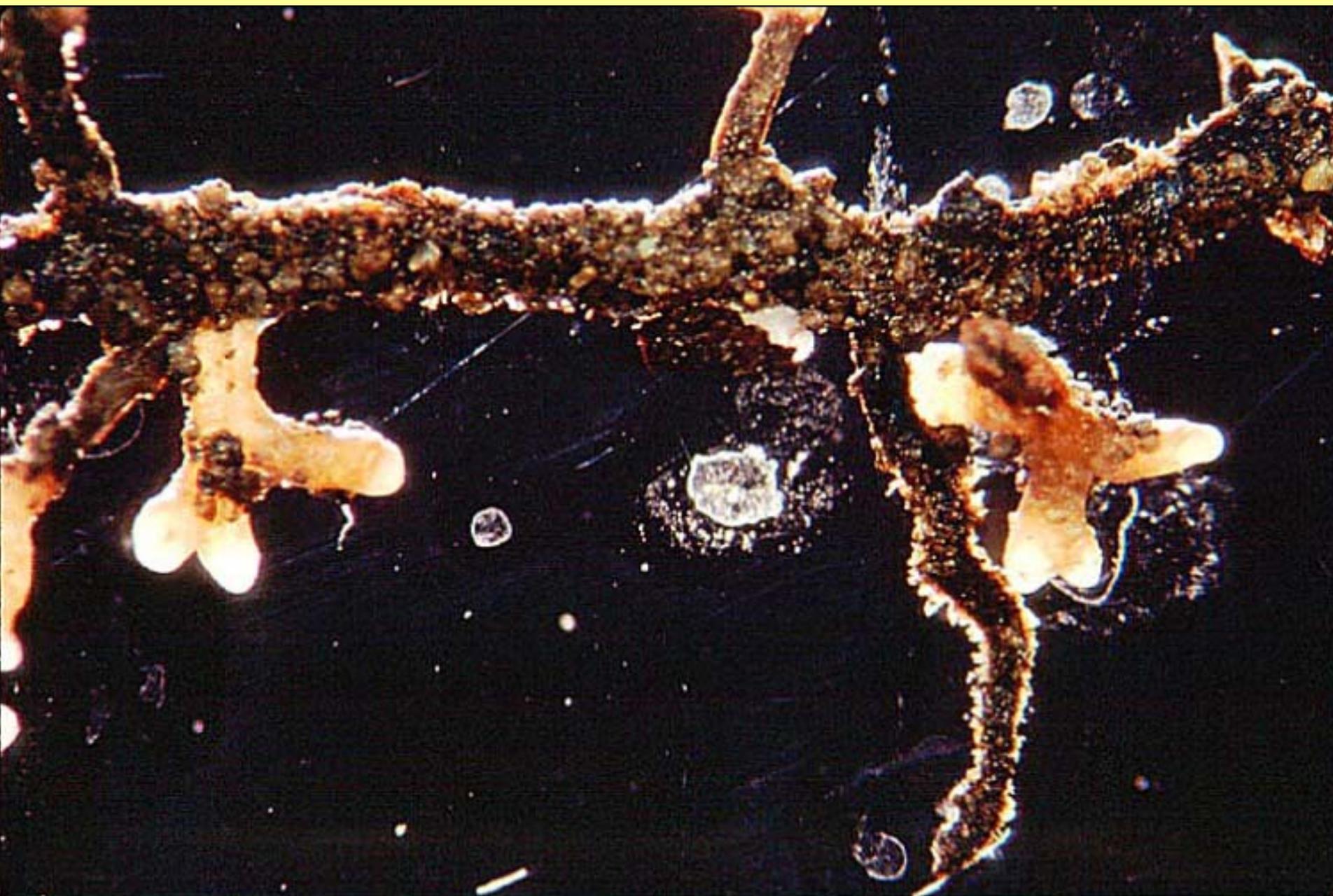
In an arthropod community of 266 species, species richness is 2 X higher and abundance is 12 X higher in low stress sites than high stress sites.

Trotter et al. 2004

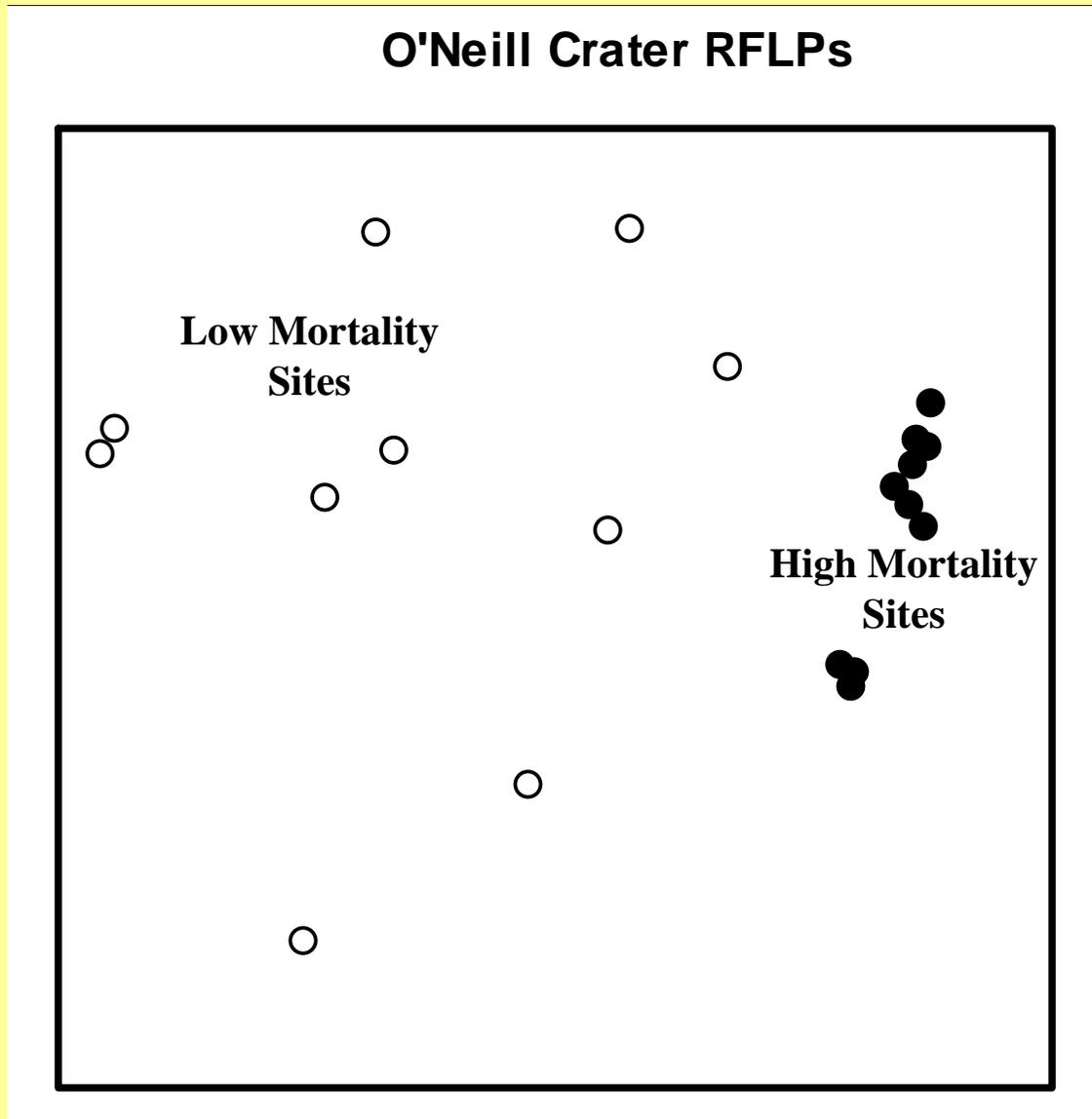
Stress Changes Arthropod Communities



Ectomycorrhizae on fine root of pinyon pine



Environmental Stress Shifts Ectomycorrhizal Community



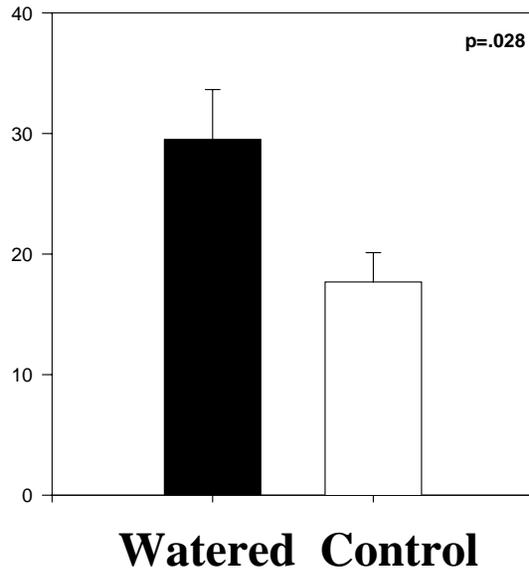
Swaty et al. 2004 Ecology



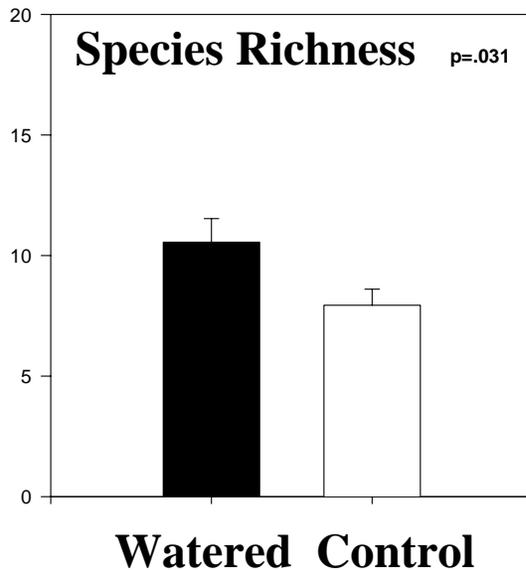
**Watering
experiment
conducted by
Crescent Scudder
to test for
community
release.**

May 23, 2003

Arthropod Abundance



Supplemental watering increases arthropod abundance and species richness.



Scudder unpub. data

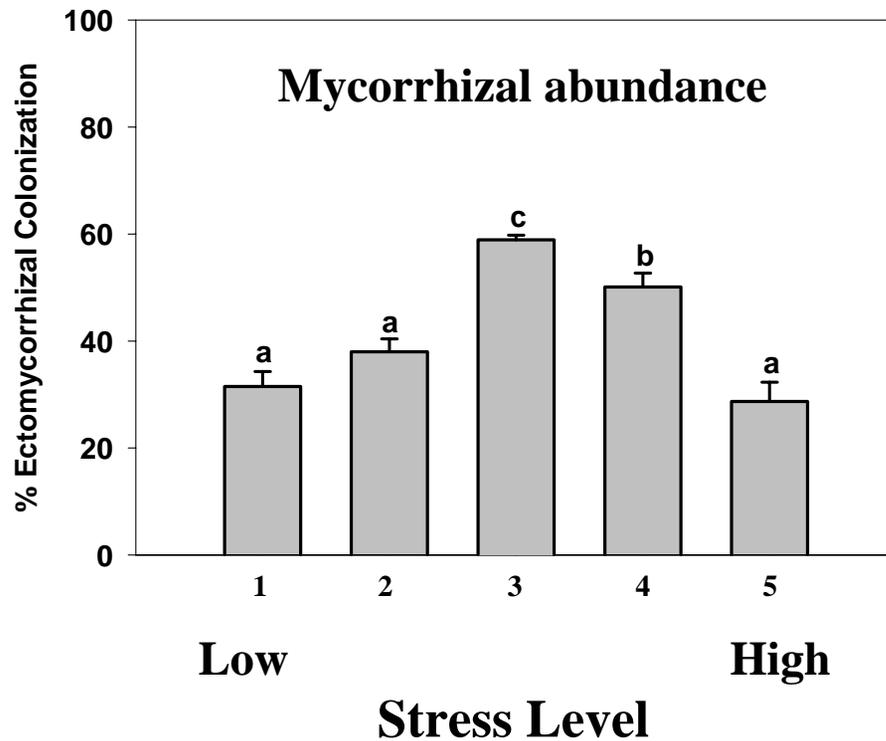
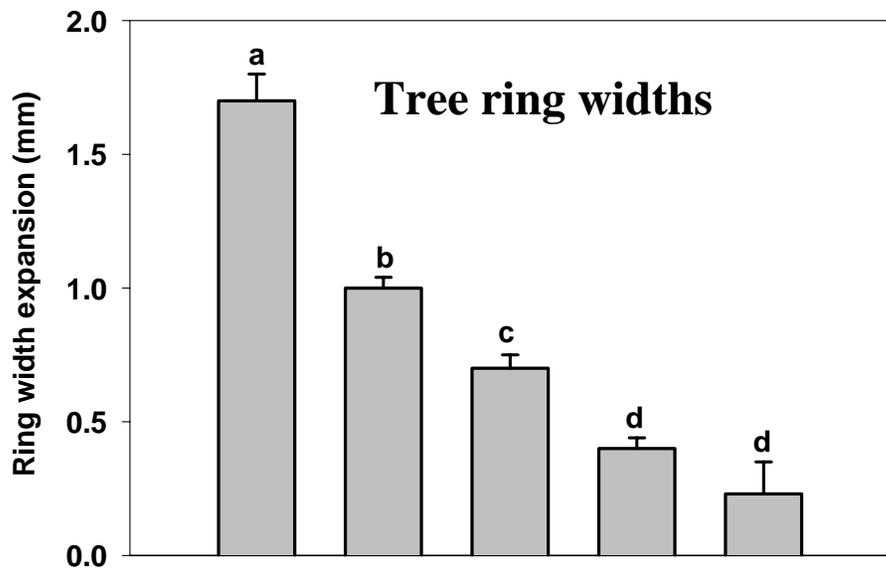


Low Stress



High Stress

**Plant stress affects arthropod
and microbial communities differently.**

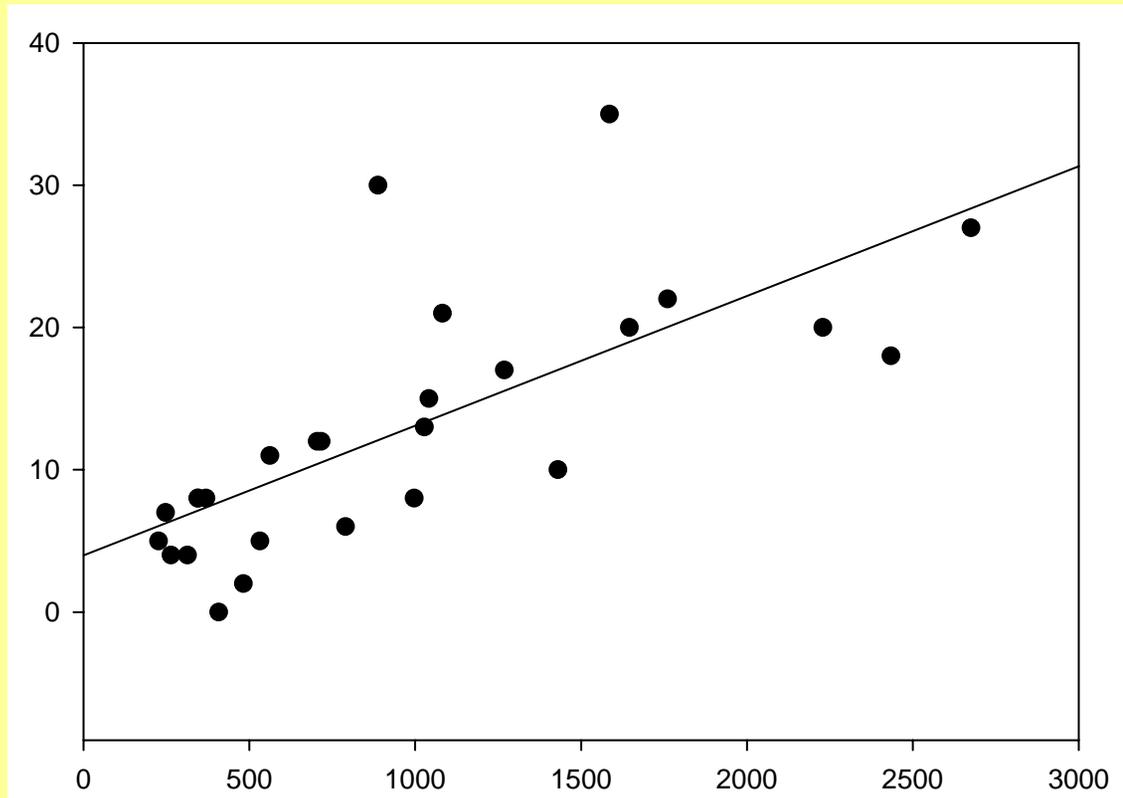


Climatic stress negatively affects pinyon growth.

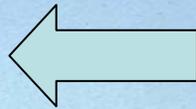
Mycorrhizal mutualists increase with intermediate stress, but decline at high stress levels.

Tree Rings Predict Arthropod Species Richness

Species
Richness
per Tree

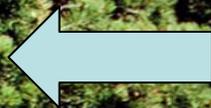


Average Tree Ring Width 1997-2001



Moth Resistant Pinyon

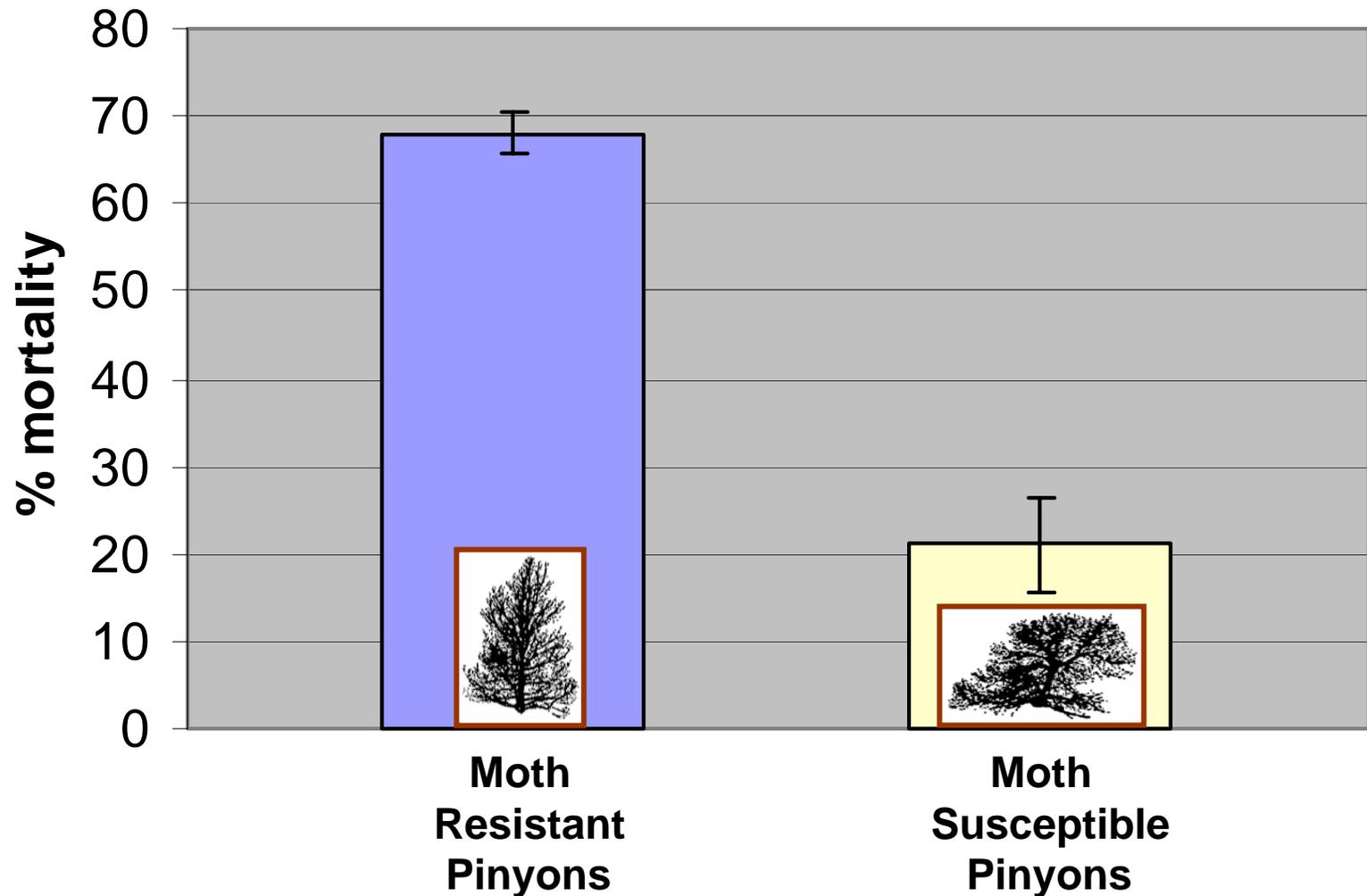
These phenotypes are genetically based and have extended phenotypes that have community consequences.



Susceptible Pinyon

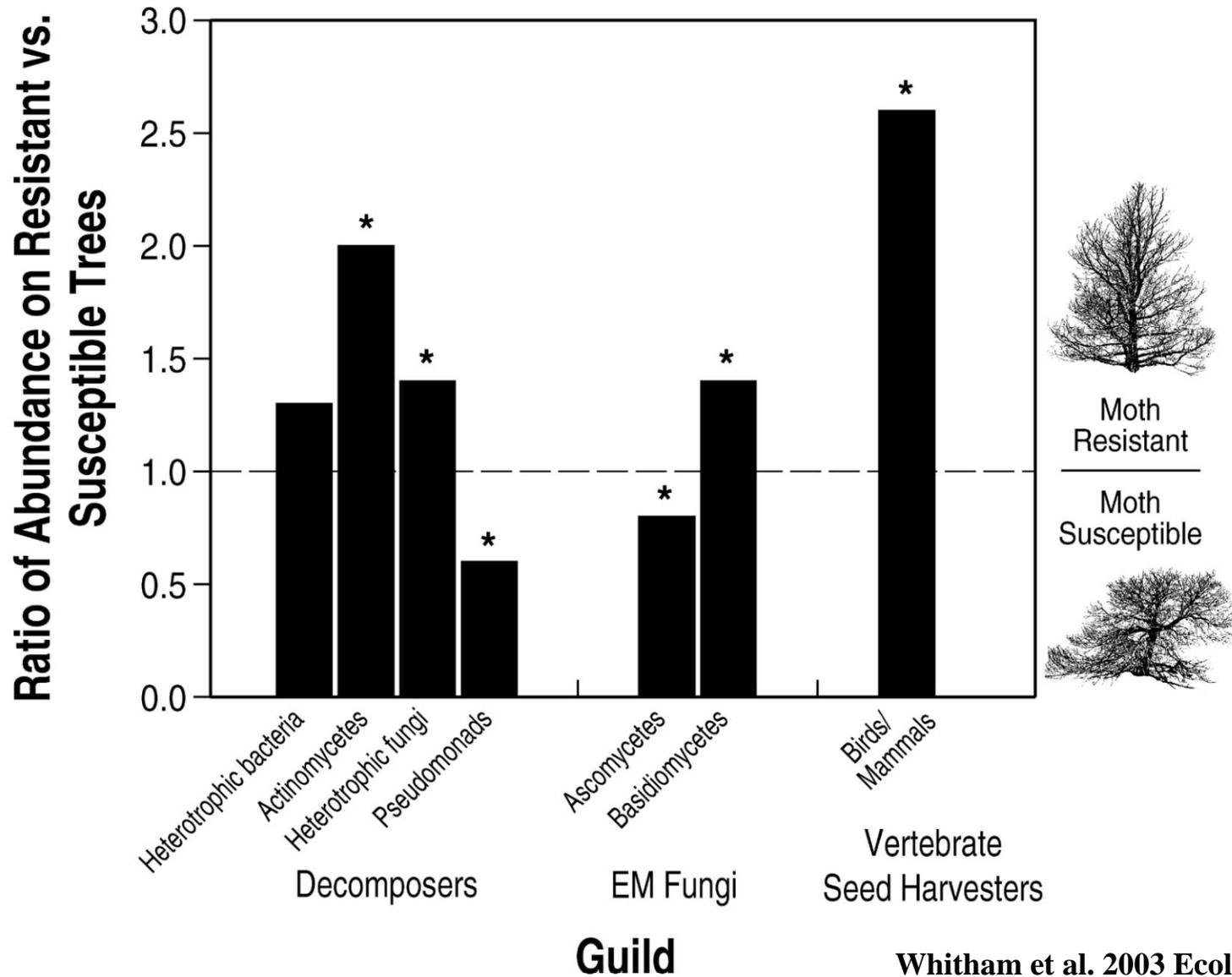
Photo by Tom Whitham

Moth Resistant Tree 3X More Likely to Die During 2002 Drought Than Moth Susceptible Trees

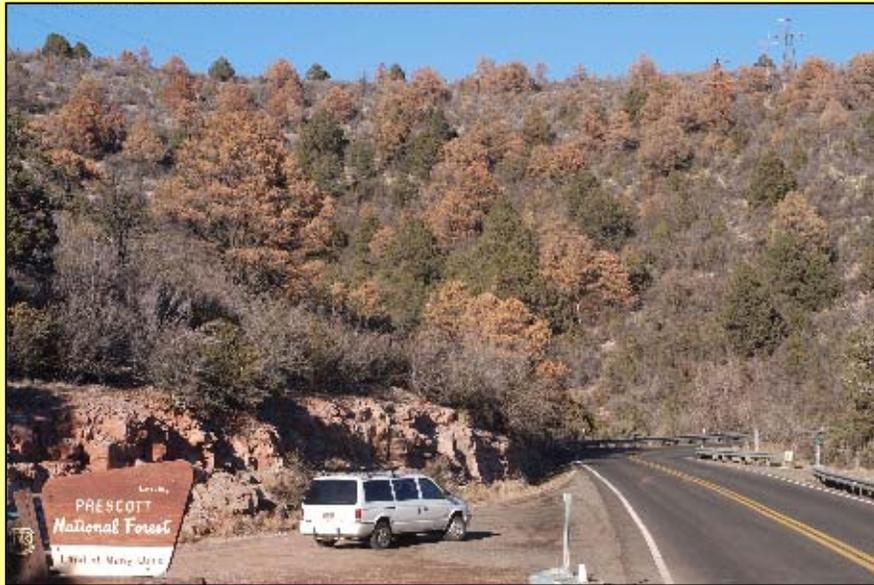


Stulz et al. unpub. data

The extended phenotypes of moth resistant and susceptible trees affect a diverse community of about 1000 species.



Drought impacts on dominant plants will negatively affect their dependent communities.

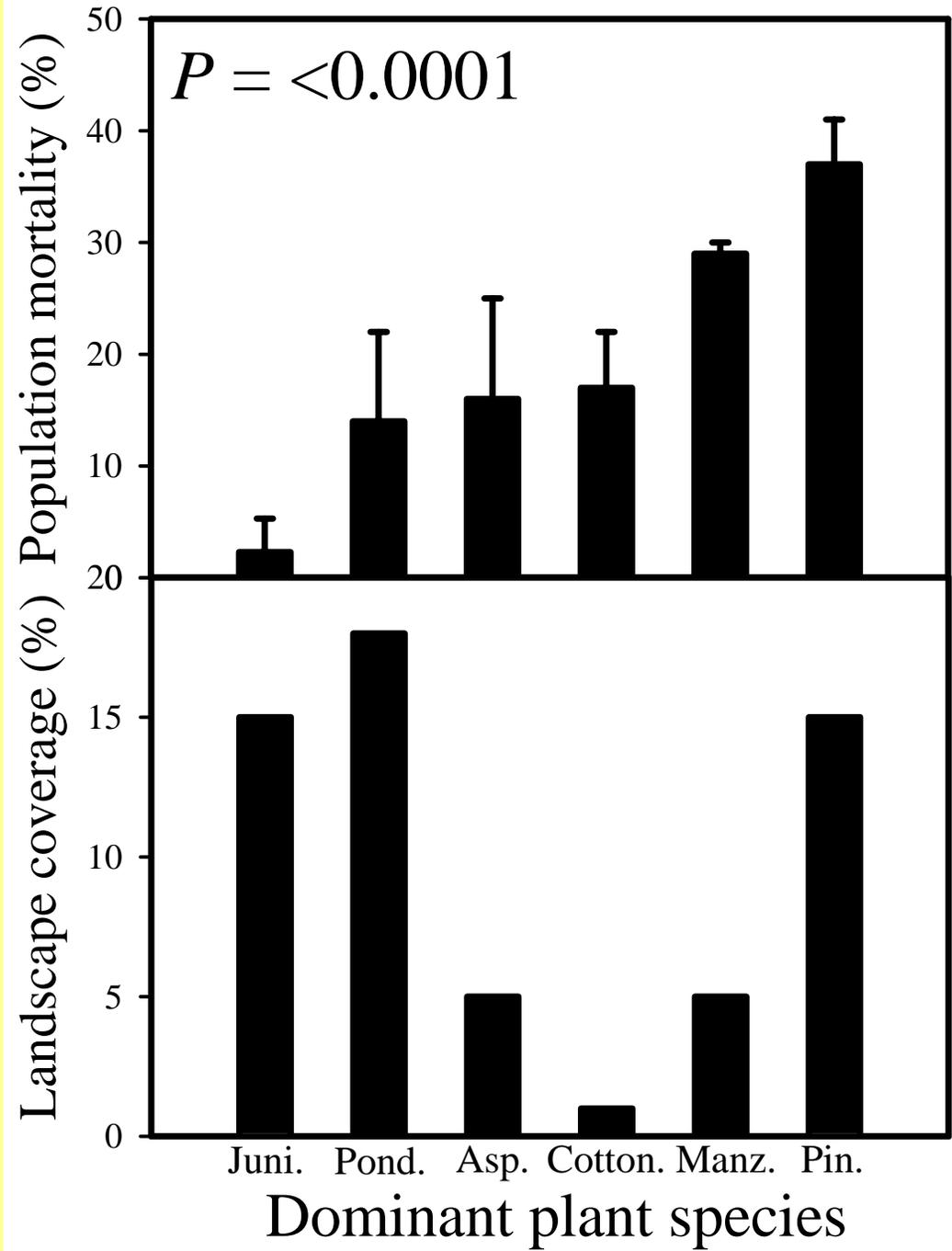


Photos by Tom Whitham & Alicyn Gitlin

Mortality of dominant plants at 20 randomly selected sites for each species within a 80km radius of Flagstaff.

Trees like cottonwoods should be of special concern due to low coverage.

Gitlin et al. unpub. data



Summary

- 1. Through its effects on community drivers (i.e., dominant and keystone species), drought negatively affects biodiversity.**
- 2. Arthropod and mycorrhizal mutualist communities are negatively affected by extreme drought, but differ in their community responses at low stress levels.**
- 3. Unexpected outcomes are likely (e.g., insect resistant trees are more likely to die).**
- 4. Extreme drought is a bottleneck event that is also an evolutionary event.**

Mistletoe (*Phoradendron juniperinum*) on One-Seed Juniper

(*Juniperus monosperma*)



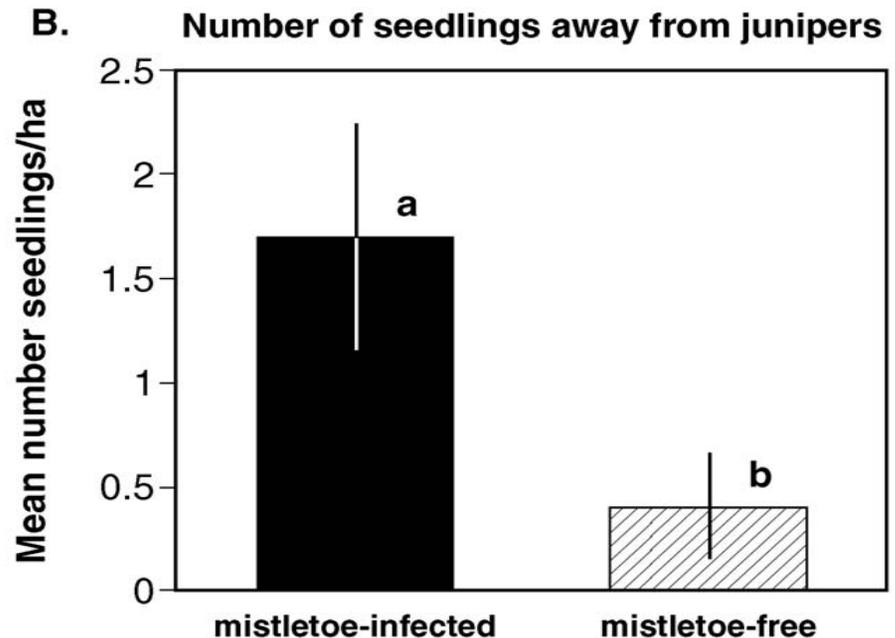
**As a two-way
interaction,
a classic example
of a parasite-host
interaction**

Juniper and Mistletoe Share a Common Avian Seed Dispersal Agent



Stands with mistletoe support 2x more seed dispersing birds

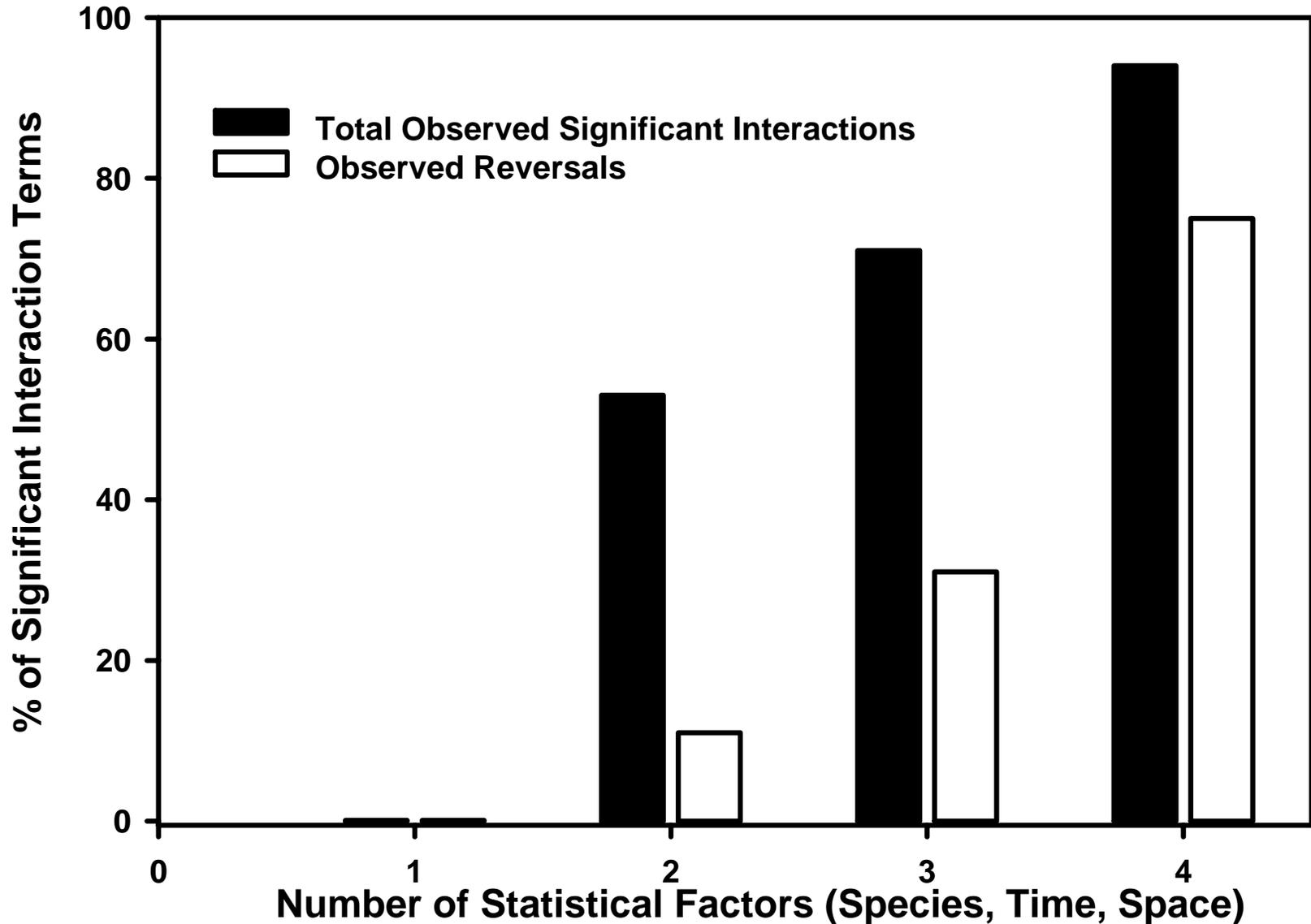
Stands with mistletoe have 4x more juniper seedlings



Scales associated with reversals

- **Number of species**
- **Time**
- **Spatial scales**
- **Any mix of above**

Interactions Increase With the Addition of Factors



Management & Research Issues

- 1. In the absence of long-term community-level studies, fundamental errors in interpretation are likely due to the high probability of reversals. Need to support such studies to minimize these errors.**
- 2. Need to minimize human impacts that exacerbate the effects of drought.**
- 3. Need special emphasis on rare habitat types that are especially sensitive to drought (e.g., riparian habitat and springs).**
- 4. Marginal or edge habitats that suffer chronic stress can be barometers of change and may be crucial to preserve as sources of extreme genotypes that may be best adapted to changing environments.**