

# Chaparral Restoration Workshop

## *What are the issues? Biological Considerations*



Stephen Davis  
Pepperdine University, Malibu CA



**“Chaparral may be defined as a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen.”**

**W. S. Cooper 1922**



**“Chaparral may be defined as a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen.”**

**W. S. Cooper 1922**



**“Chaparral may be defined as a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen.”**

**W. S. Cooper 1922**





**“Chaparral may be defined as a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen.”**

**W. S. Cooper 1922**

# Restoration of Chaparral

~~“Many species .... of a single constant ecological type”?~~

# Restoration of Chaparral (biodiversity)

Niche diversity

Habitat diversity (microsite)

Diverse life history types

- seedling, resprout, adults
- post-fire sprouter vs. non-sprouter
- post-fire seeder vs. non-seeder

Diverse adaptations to survive:

- summer drought
- wildfire
- freezing



*Ceanothus  
megacarpus*

**Santa  
Monica  
Mountains**



**Santa  
Catalina  
Island**





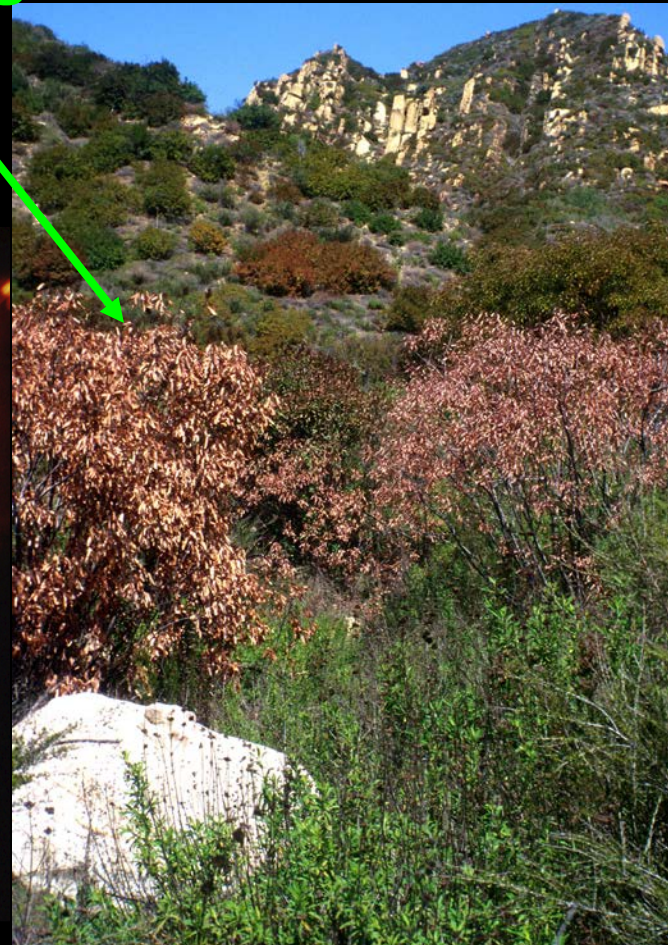
# Biological Considerations

- Why do chaparral species grow where they do?
- How are they adapted to environmental stress?

Drought

Freezing

Wildfire







# Interactions

**Drought -- Freezing -- Wildfire**

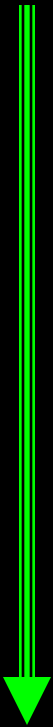
# **Drought Effects**

**How do you measure plant water status?**

Water Potential:

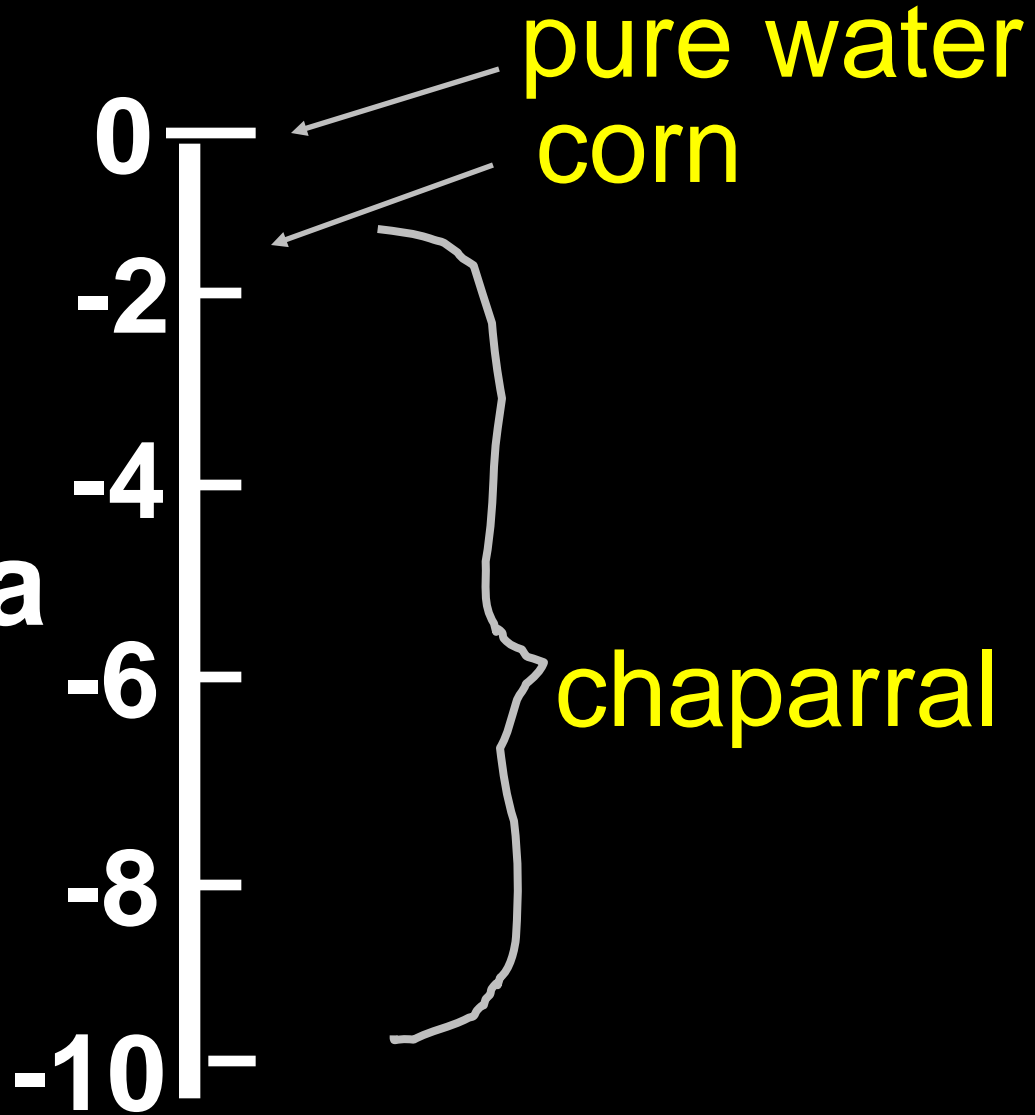
measure of tension on xylem water

wet



dry

MPa



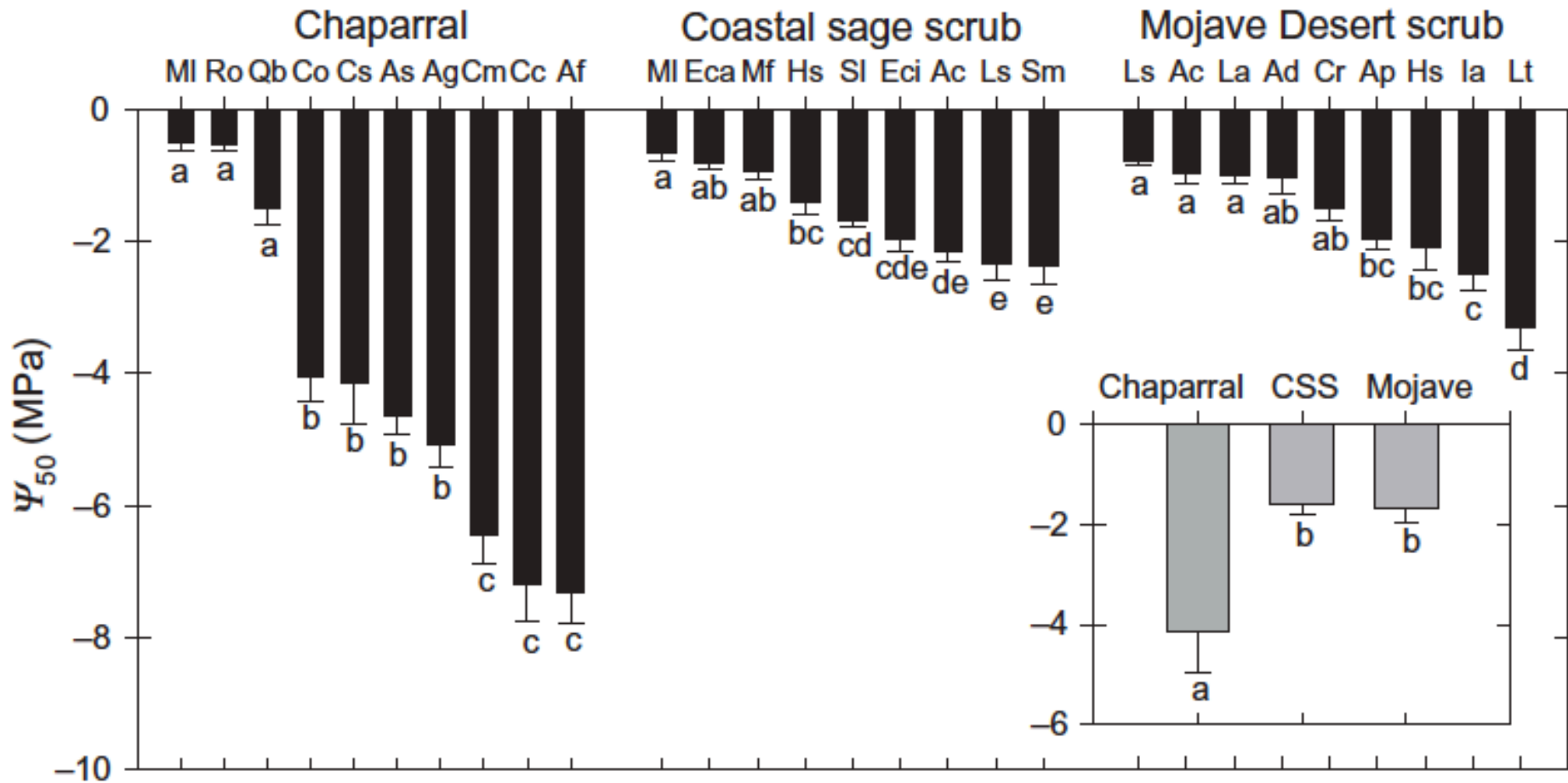


**How do chaparral  
shrubs compare to  
vegetation at drier sites?**

**How do chaparral  
shrubs compare to  
vegetation at drier sites?**

**Desert Scrub?**

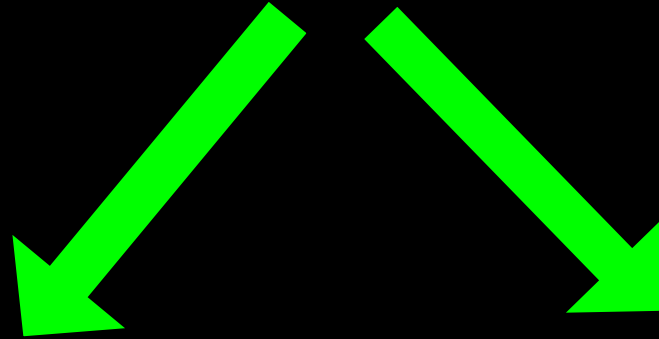
**Coastal Sage Scrub?**



$\Psi_{50}$  = Water Potential at 50% Hydraulic Failure

# Chaparral

---



**Non-sprouters**

*(Ceanothus megacarpus)*

**Sprouters**

*(Ceanothus spinosus)*

*(Malosma laurina)*





*Ceanothus megacarpus*

*Malosma laurina*

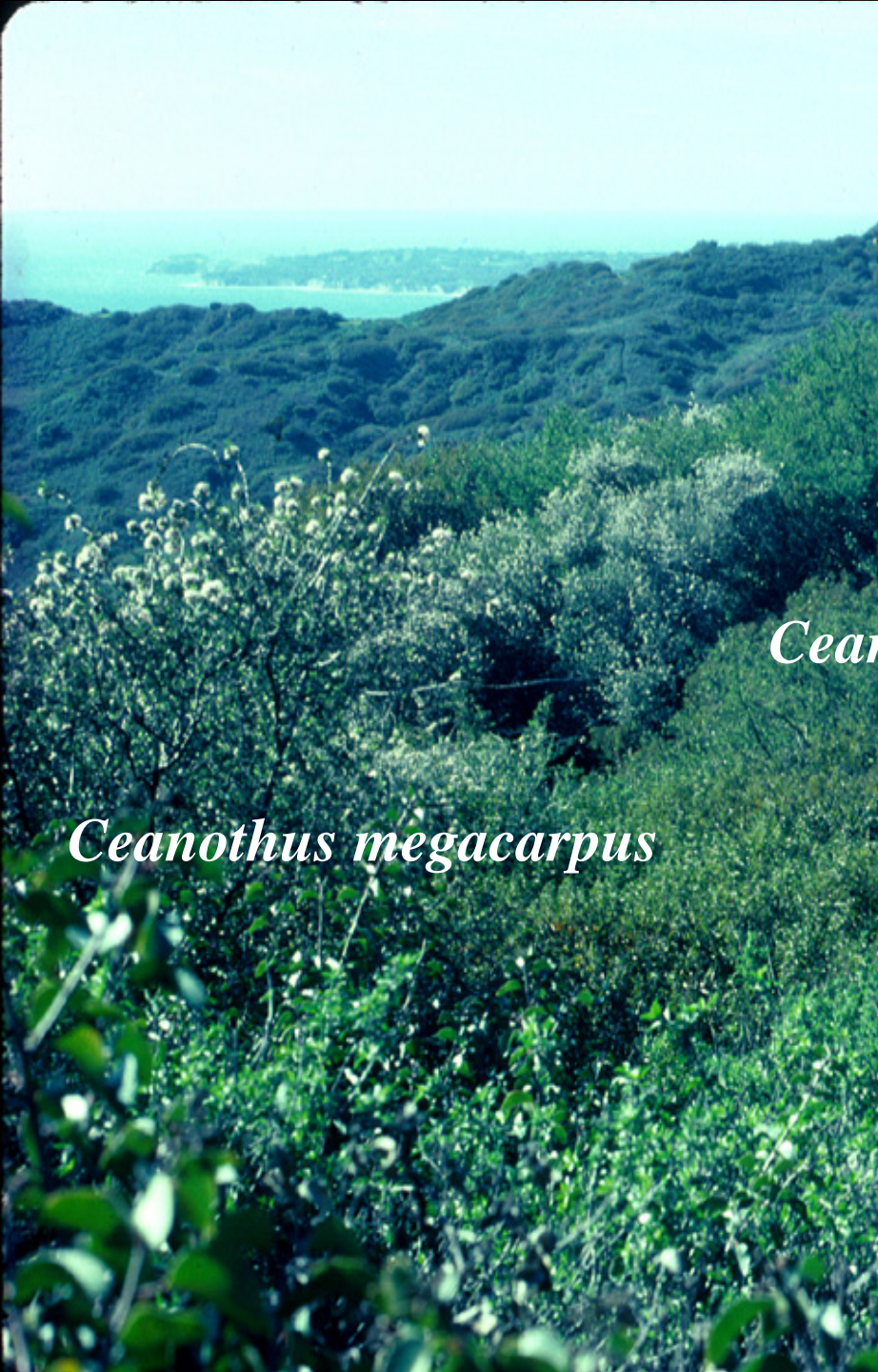












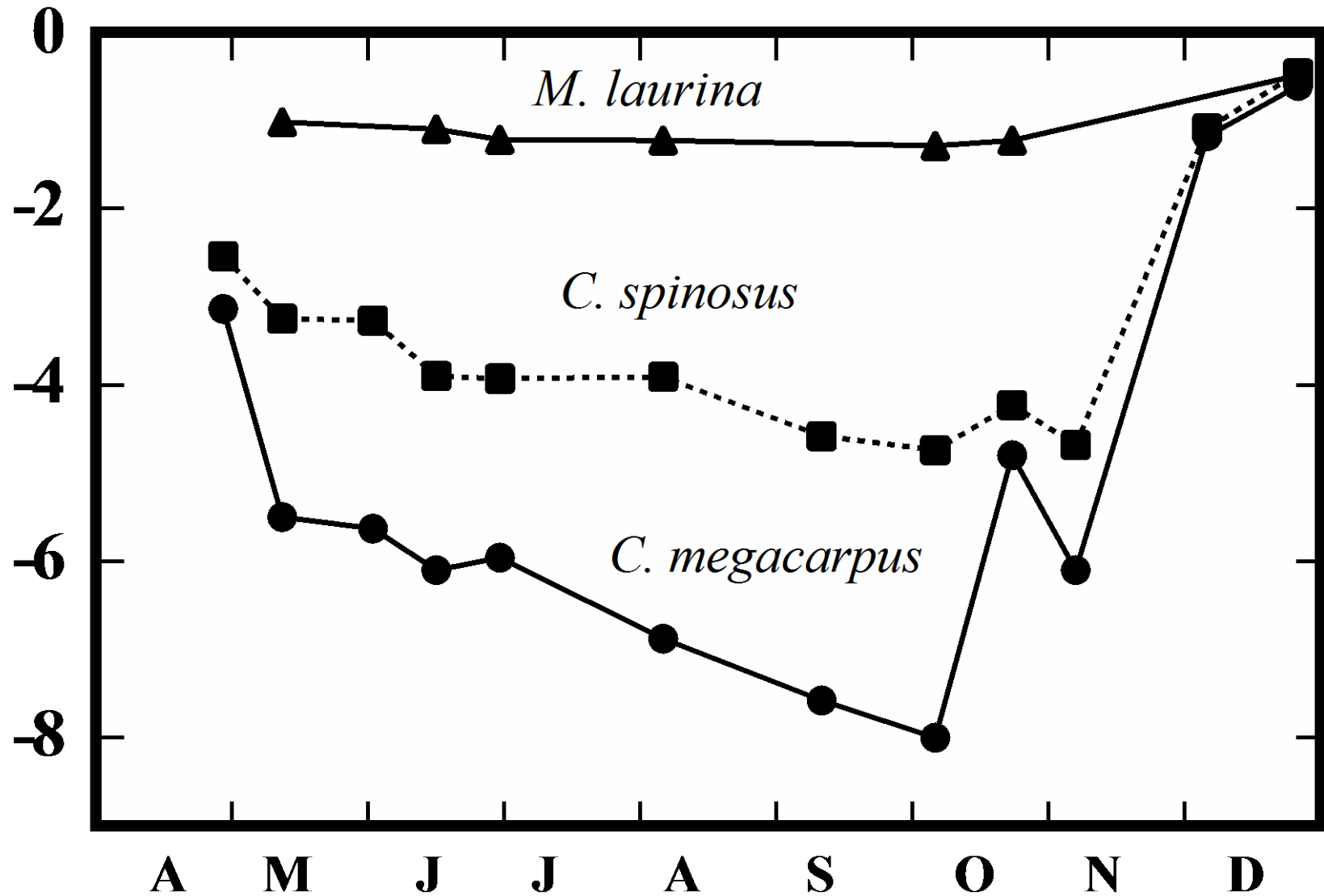
*Ceanothus megacarpus*

*Cean*





**Water Potential (MPa)**



**Month of Year**

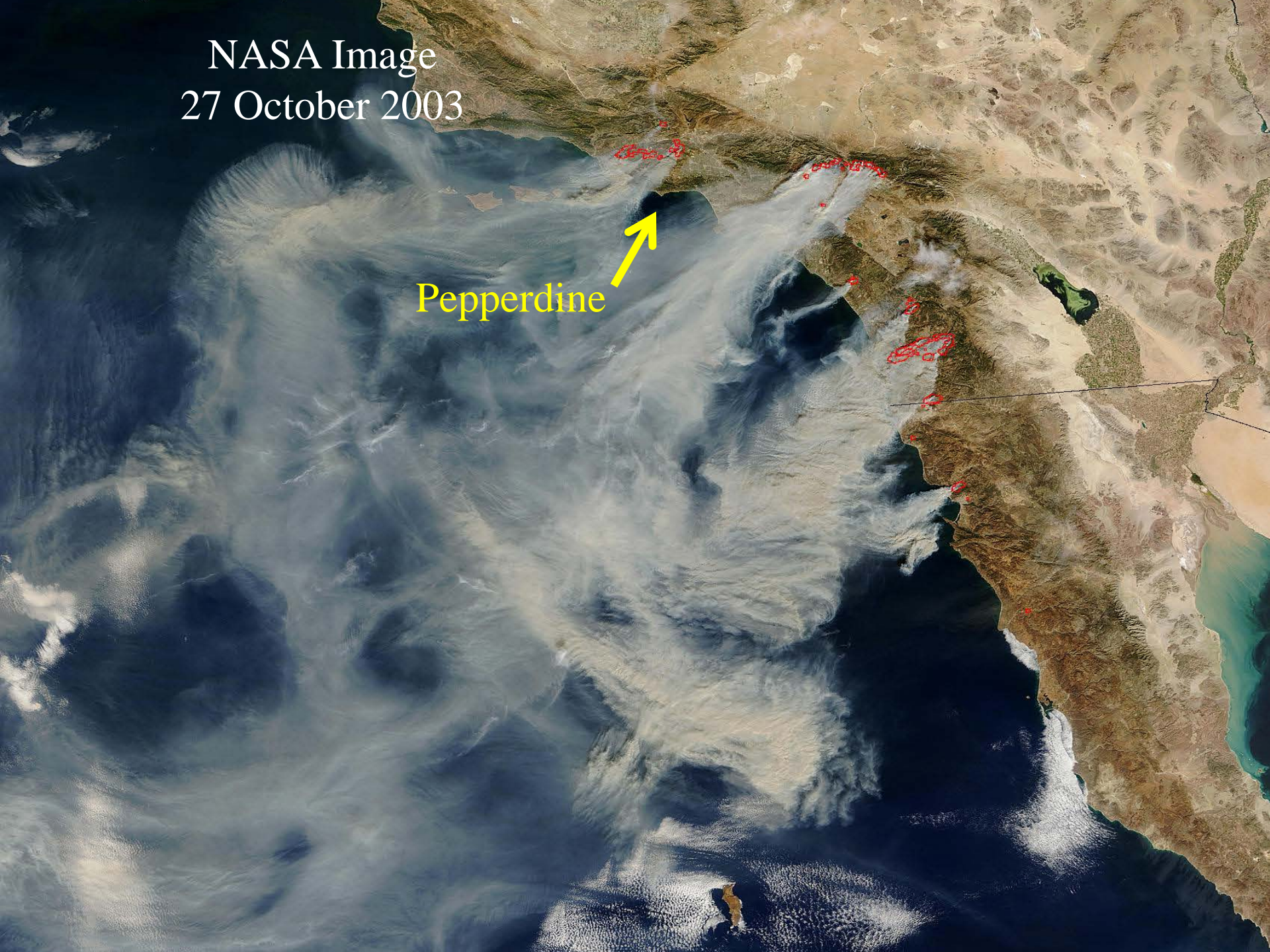






NASA Image  
27 October 2003

Pepperdine





**NASA Image**  
**24 October 2007**







**Malibu Wildfire of January 5, 2007**



**Malibu Wildfire of October 21, 2007**



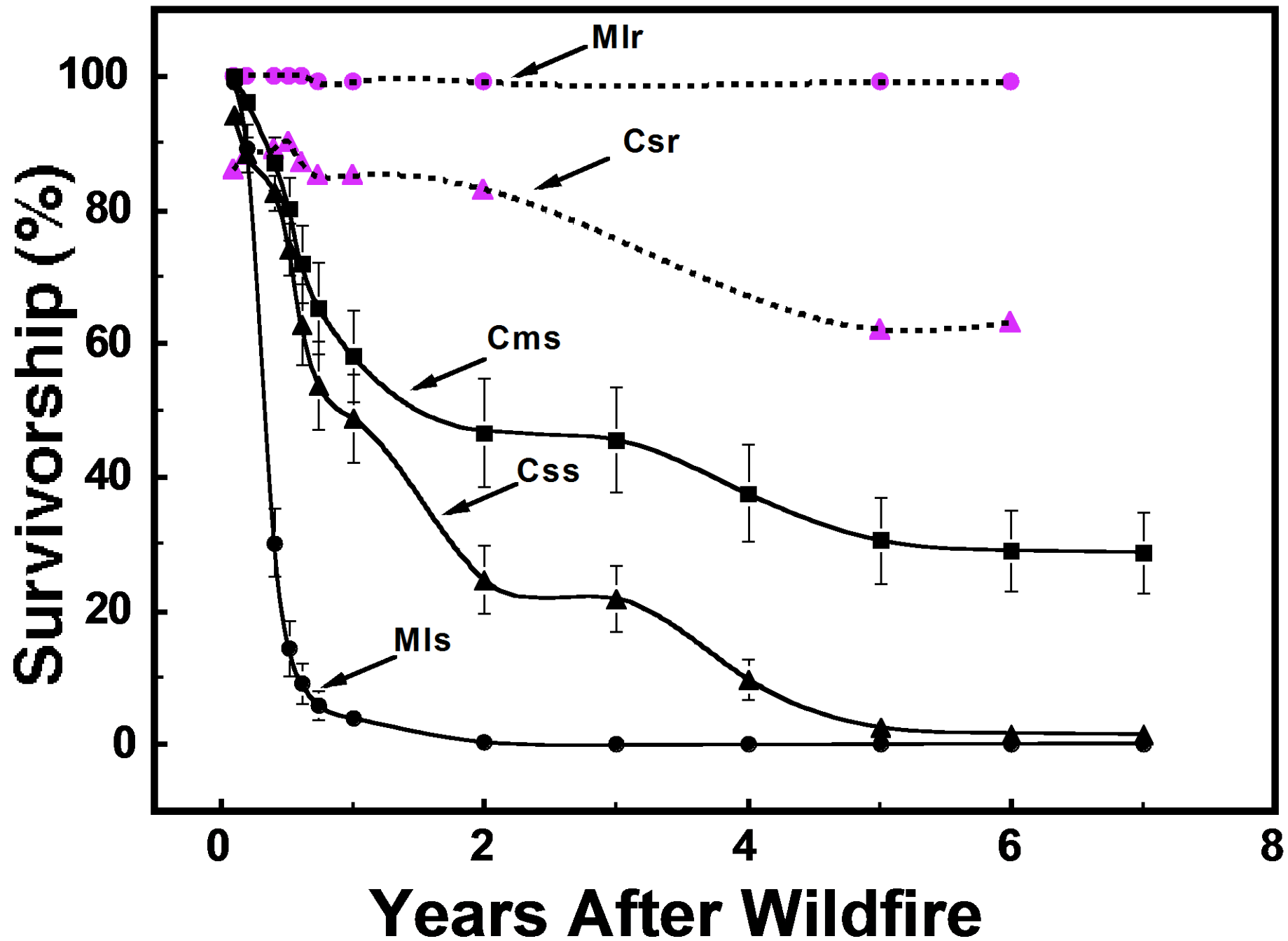


**Malibu Wildfire of November 24, 2007**









# Seedling Survivorship

63%

50%

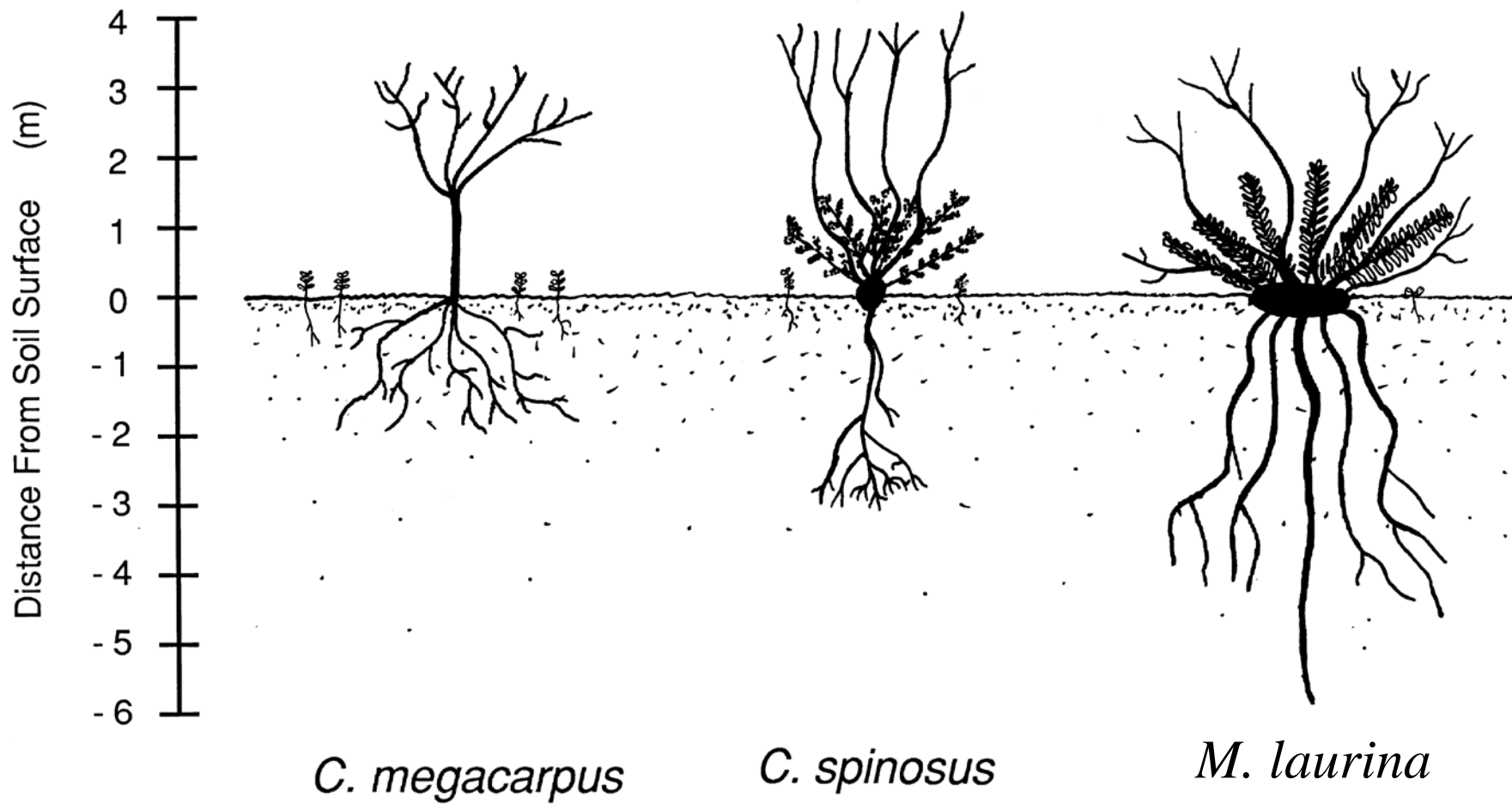
1%

# Sprouting Success

0%

86%

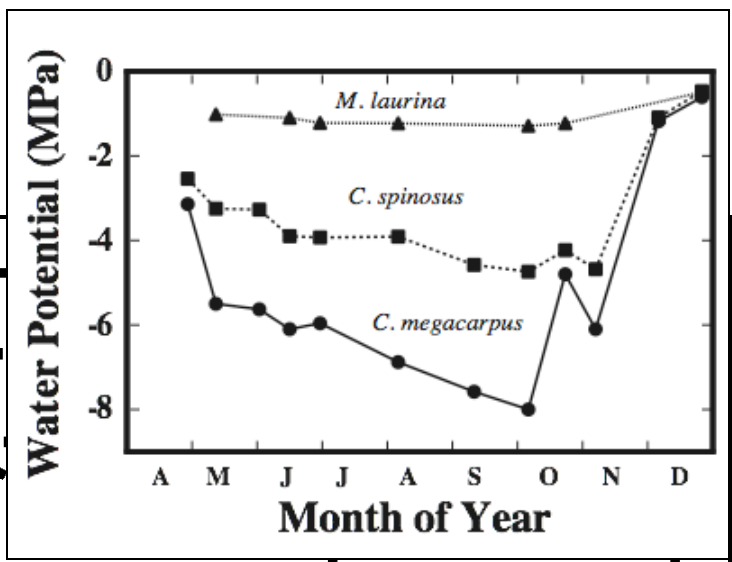
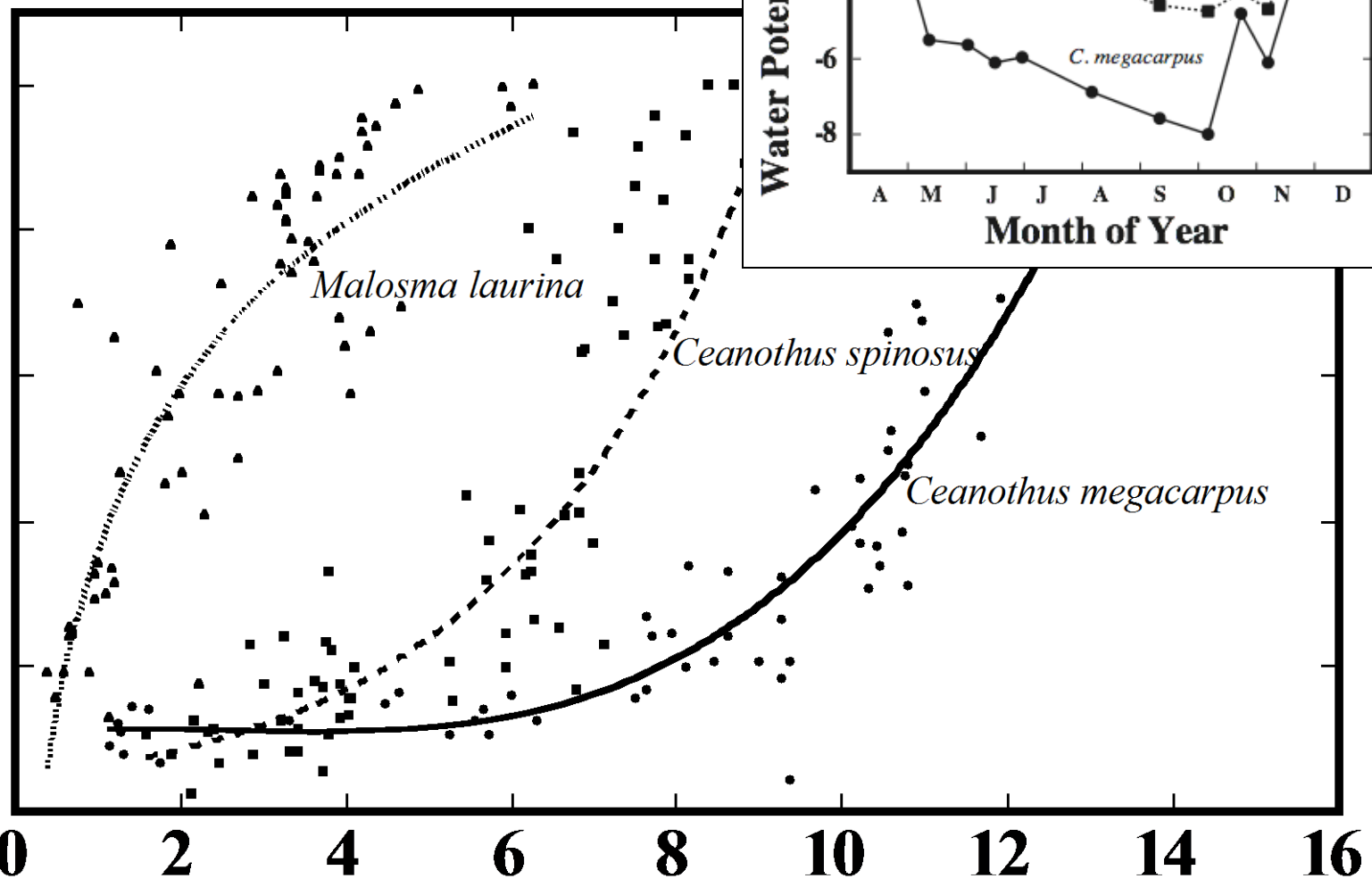
99%





**% Loss Conductivity**

100  
80  
60  
40  
20  
0



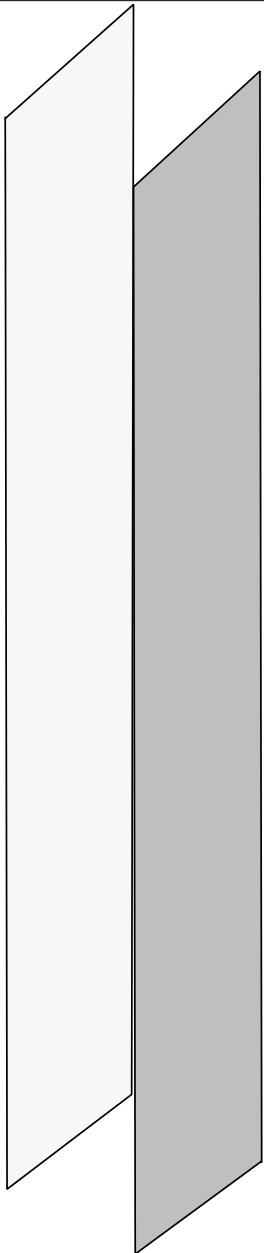


# What determines cavitation resistance?

---

Size of pores in cell walls

(air-seeding hypothesis)



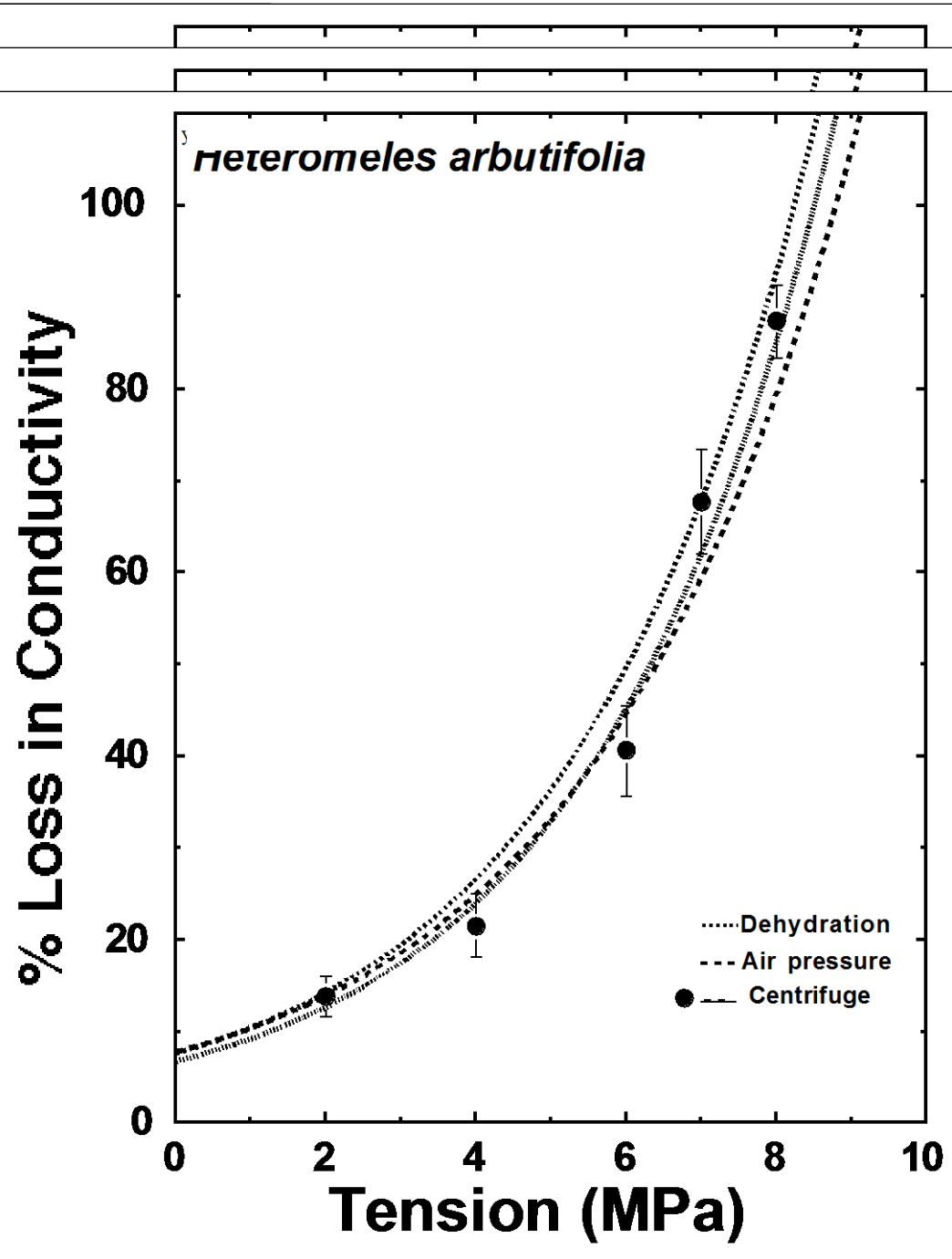
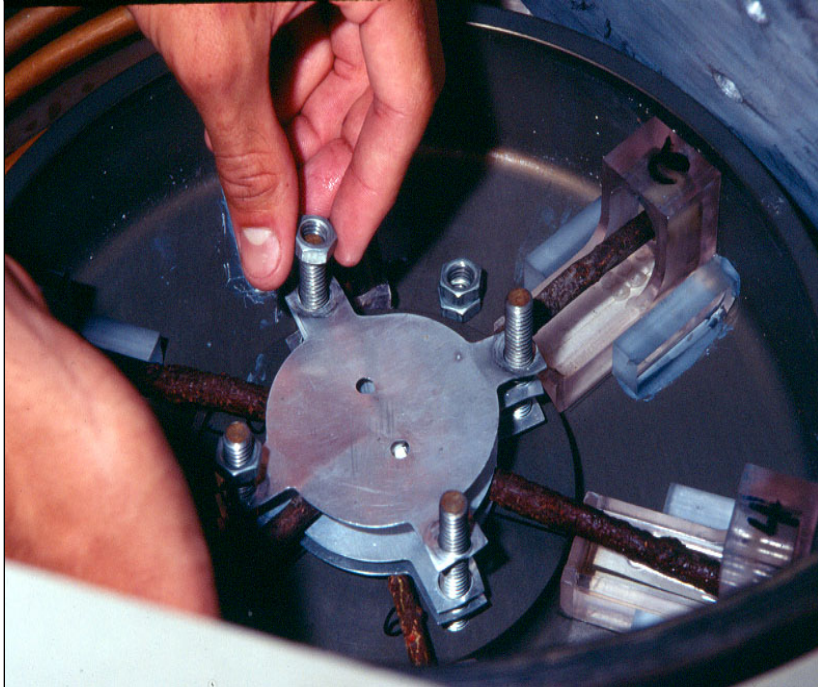
$P_{\text{water}} =$

$\Delta P_{\text{crit}} =$

### Air-Injection of Hydr

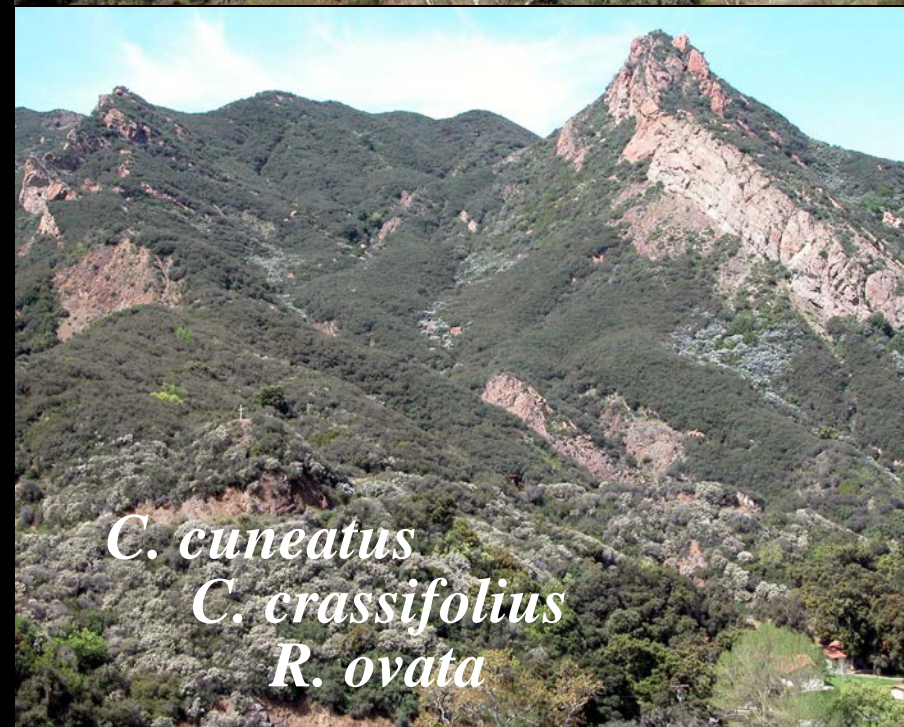
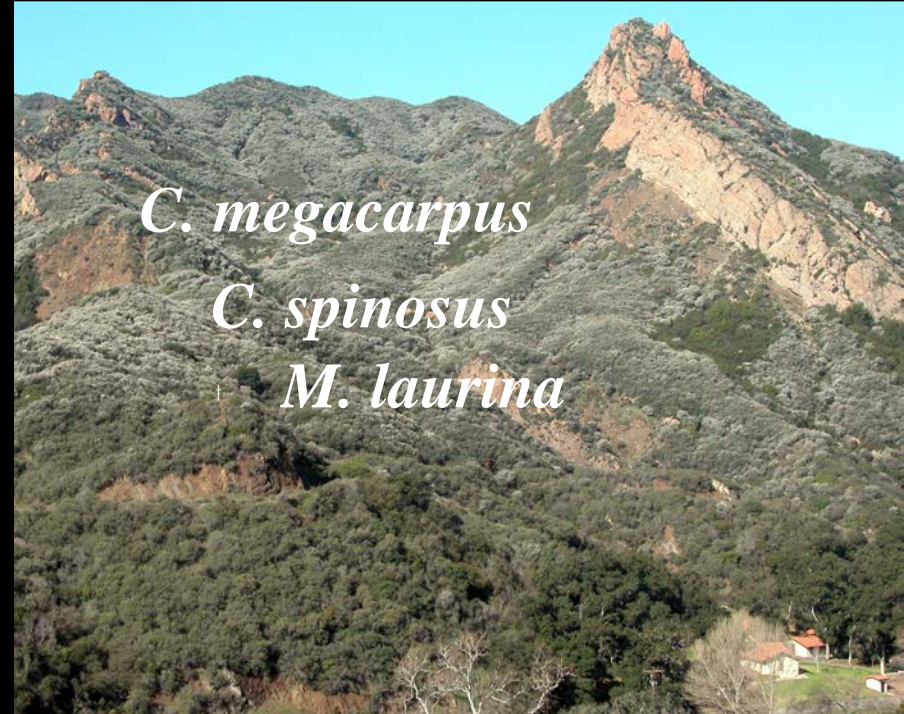






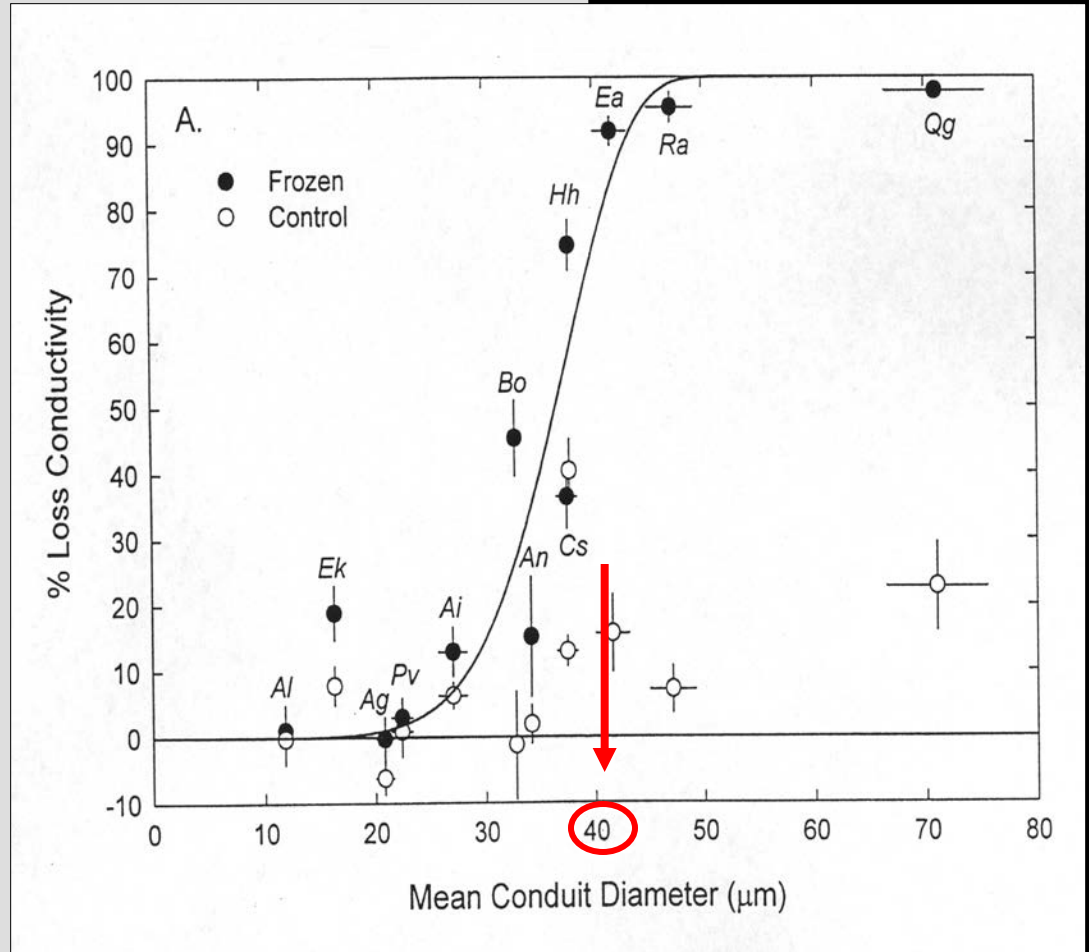
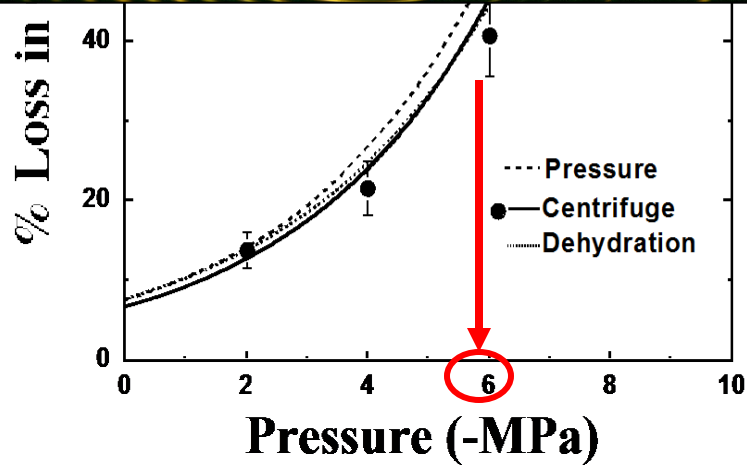
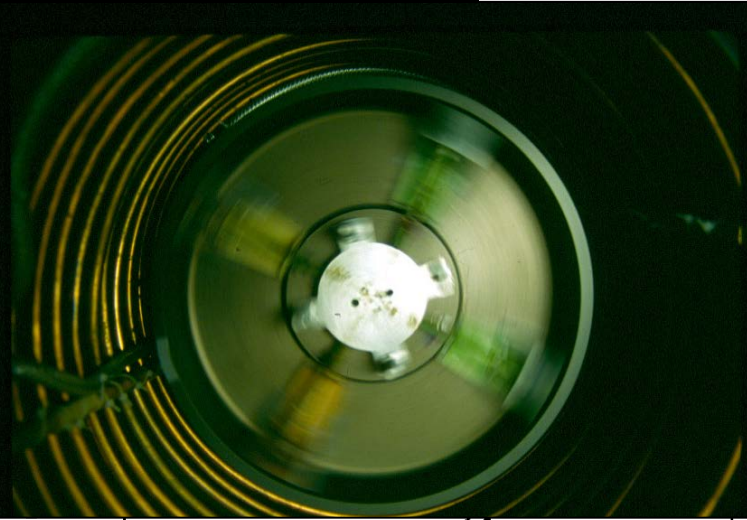


# Chaparral Distribution and Freezing





# Xylem Safety from Embolism



**Pore Size  
Conduit Wall**



# Chaparral

-11 MPa

- 18 C

roots < 2 m

non-sprouter

xylem safe

-water stress  
-freezing

# Extremes

-3 MPa

- 6 C

roots > 10 m

vigorous sprouter

xylem efficient

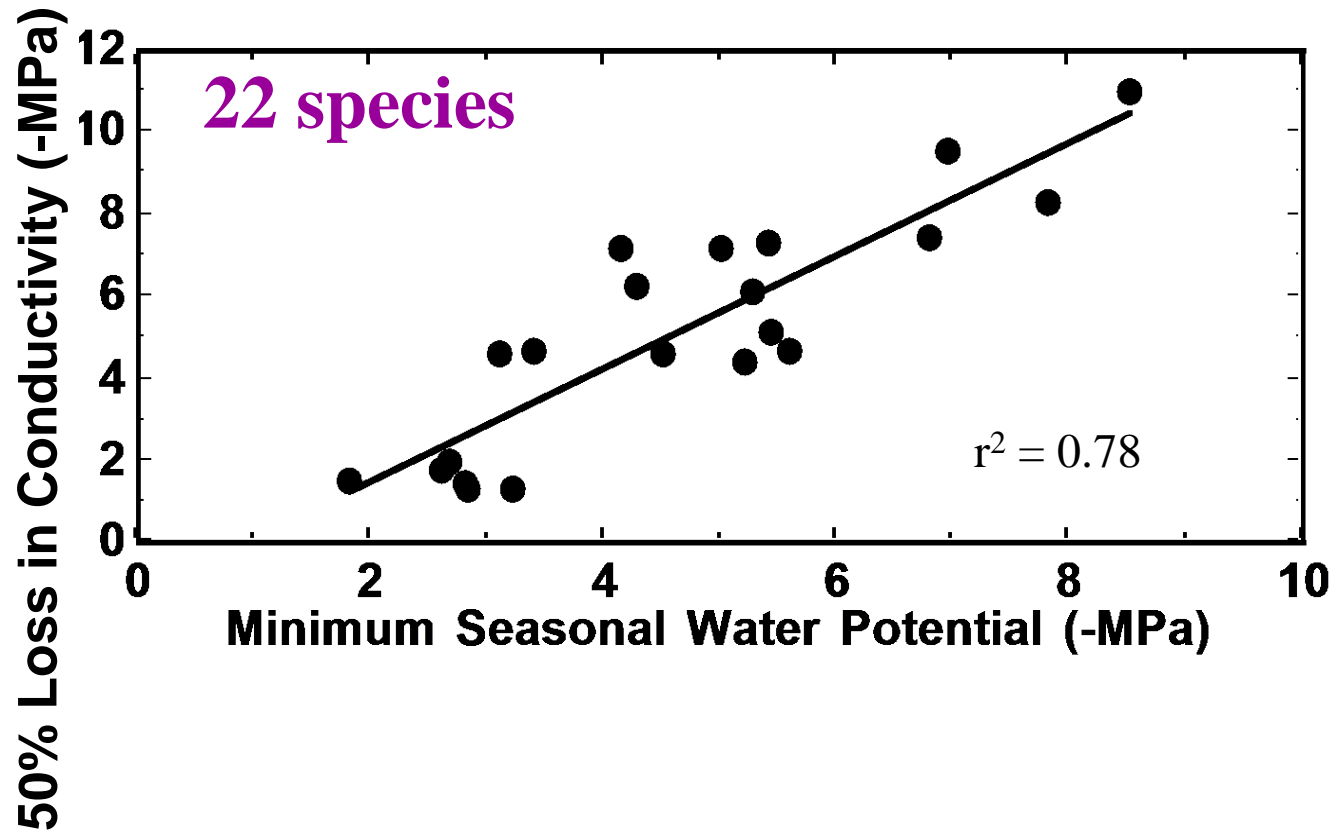
-water transport



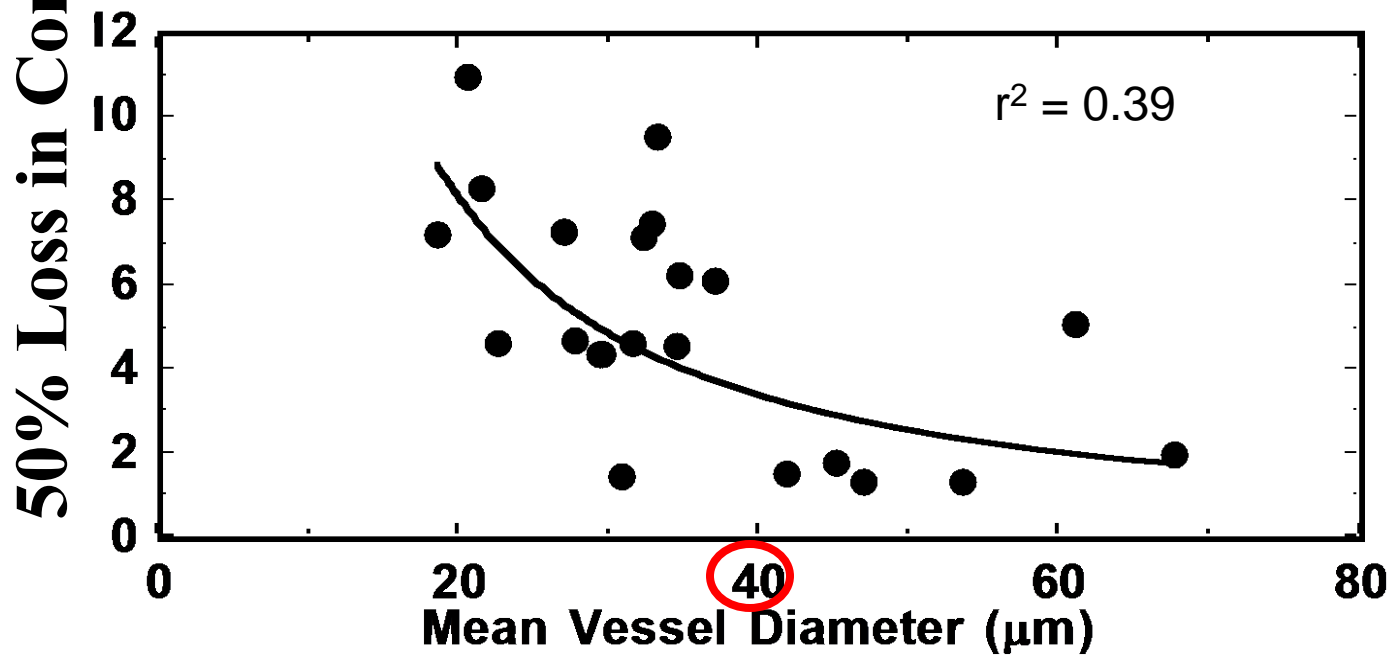
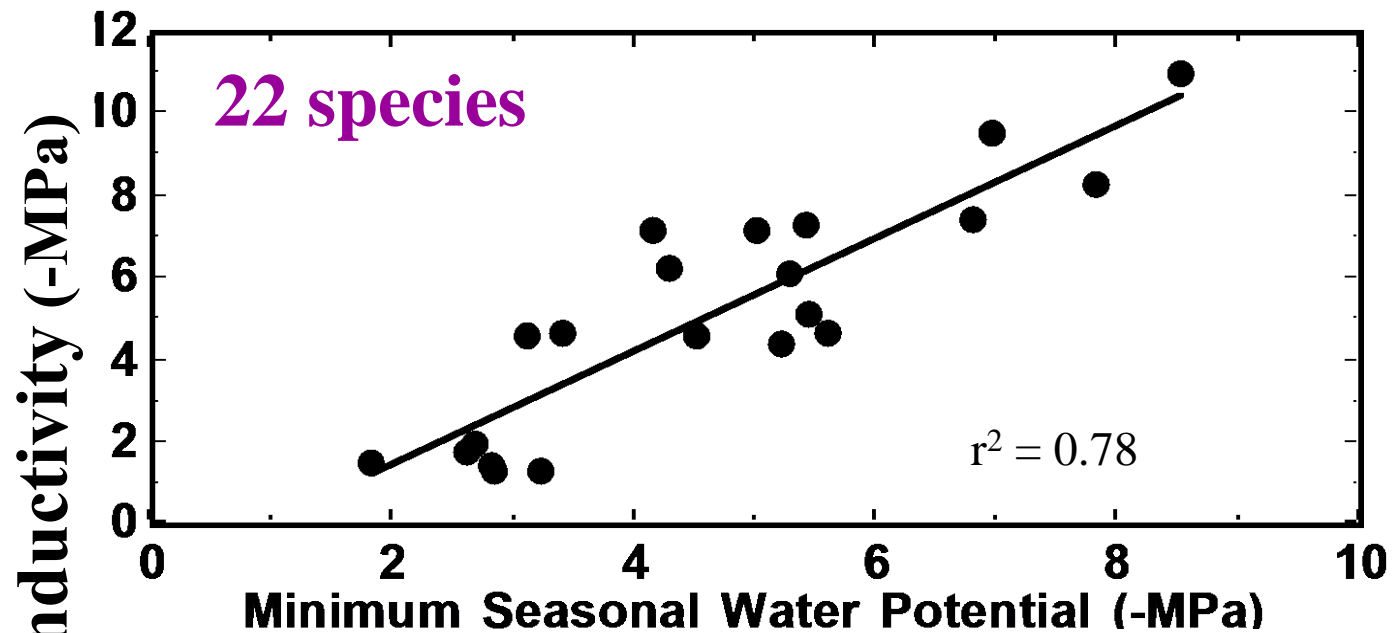
**Theory of xylem safety appears to  
work for chaparral extremes --  
*C. megacarpus* & *M. laurina*.**

---

**But what about the entire  
chaparral community?**









# Chaparral

-11 MPa

- 18 C

roots < 2 m

non-sprouter

xylem safe

-water stress

-freezing

**costly construction**

# Extremes

-3 MPa

- 6 C

roots > 10 m

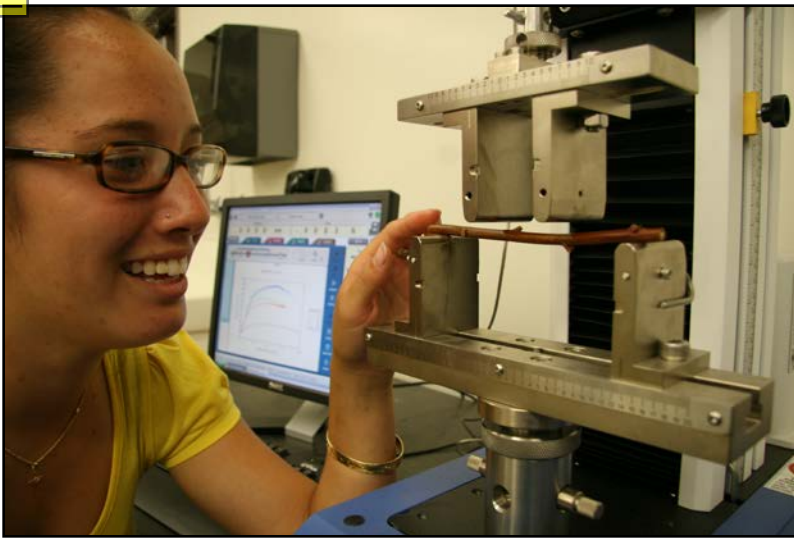
vigorous sprouter

xylem efficient

-water transport

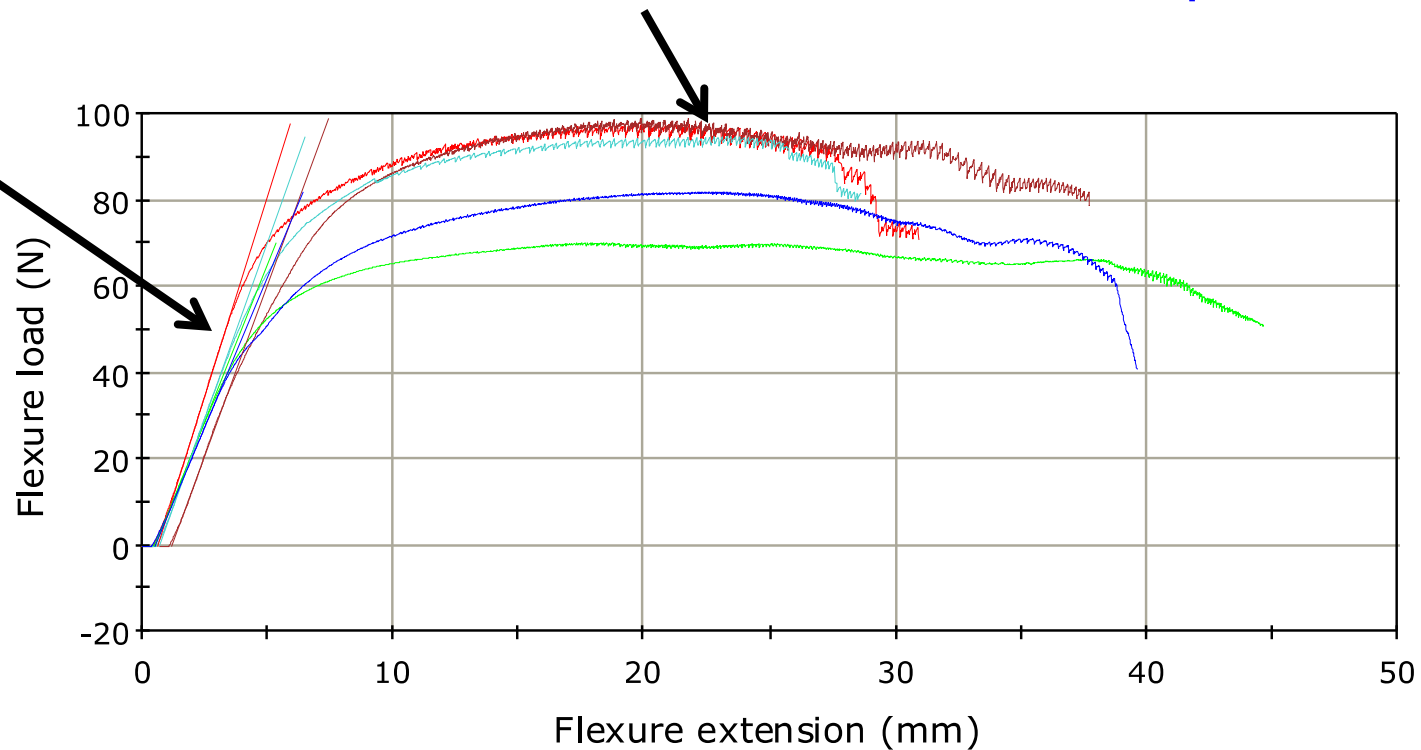
**cheap construction**

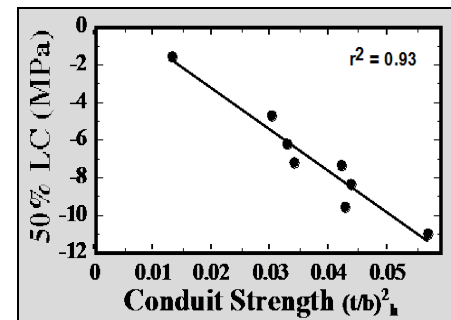
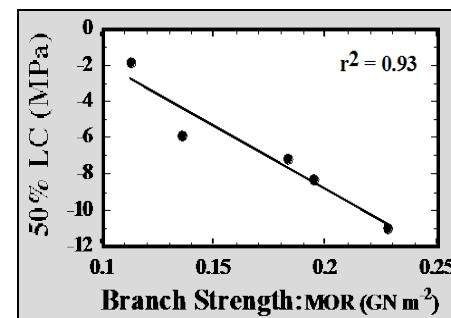
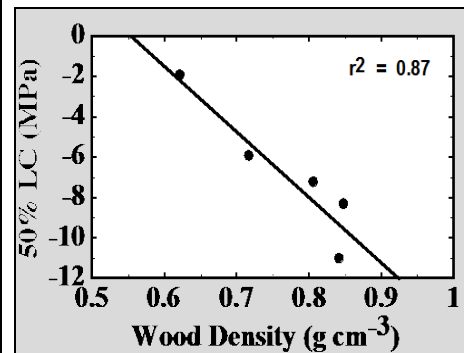
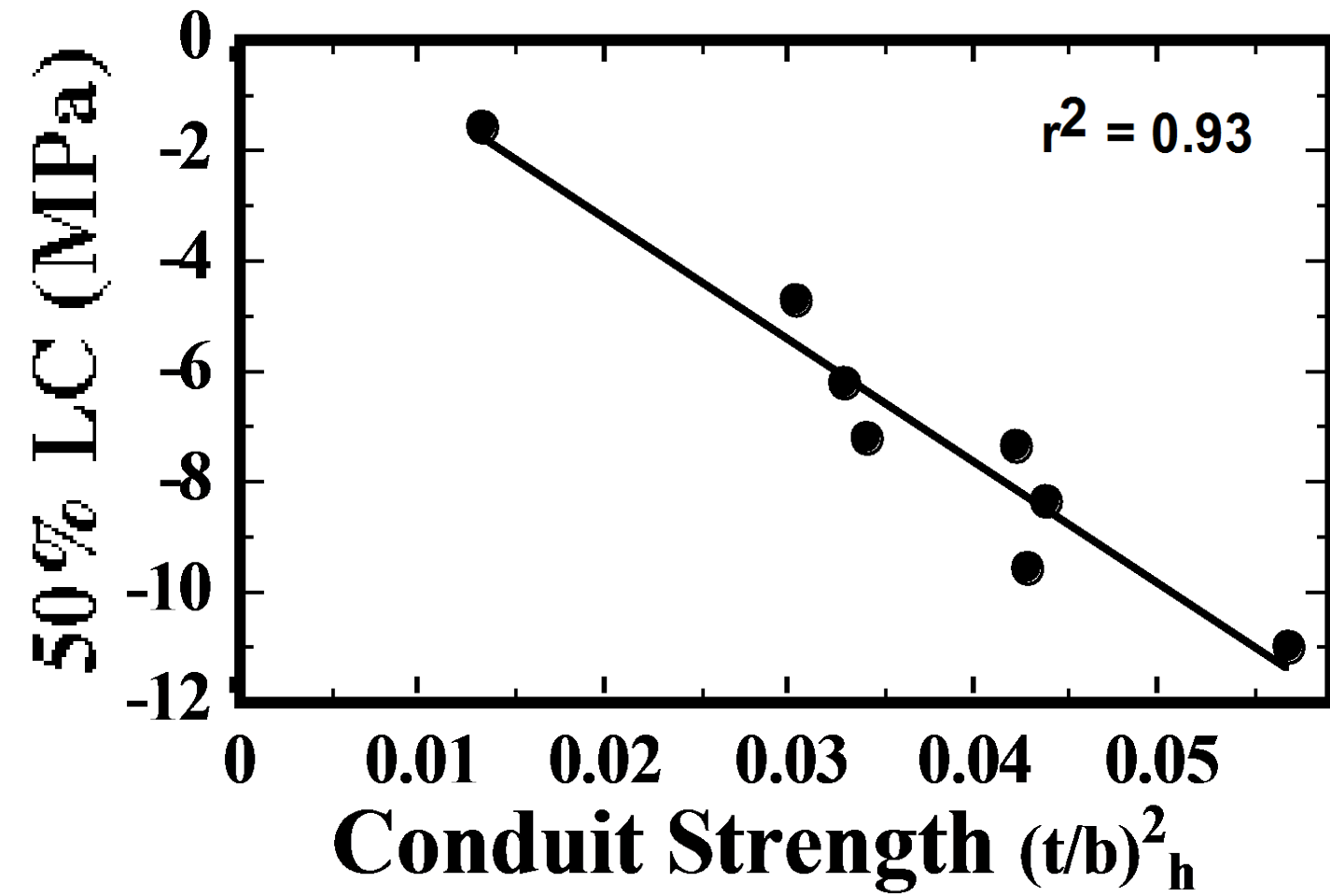




# Stem Mechanical Strength

MOE = Modulus of Elasticity    MOR = Modulus of Rupture



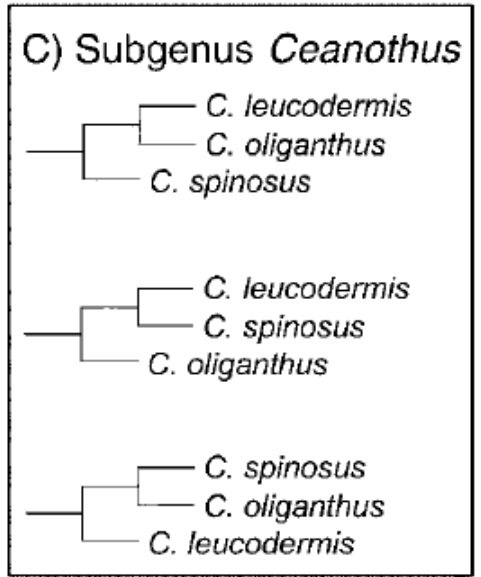
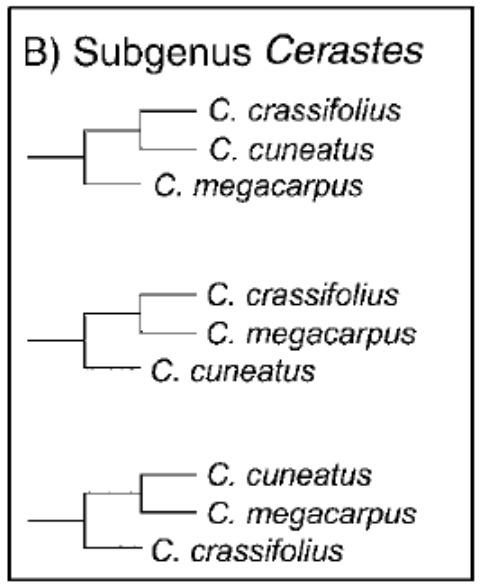
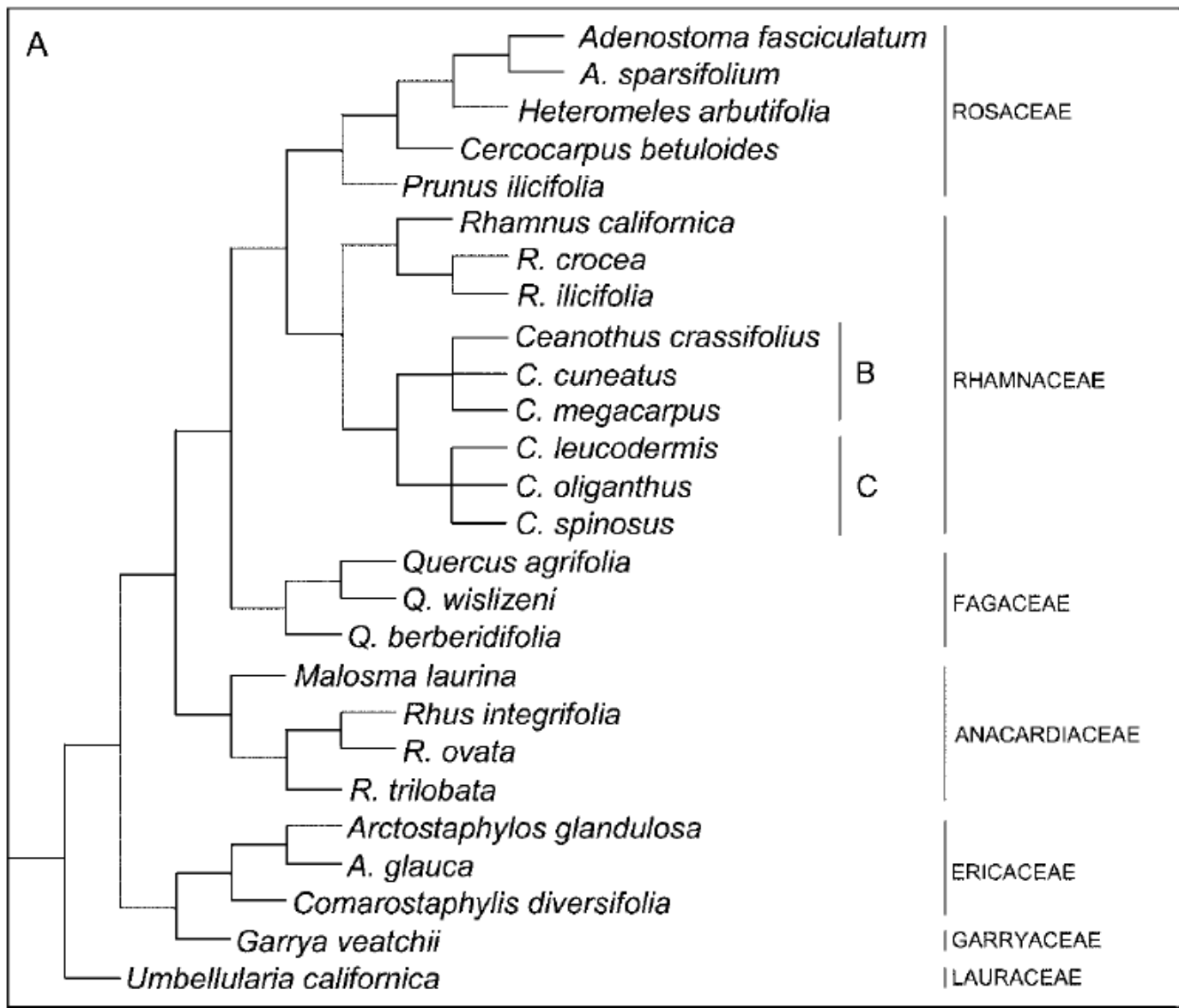




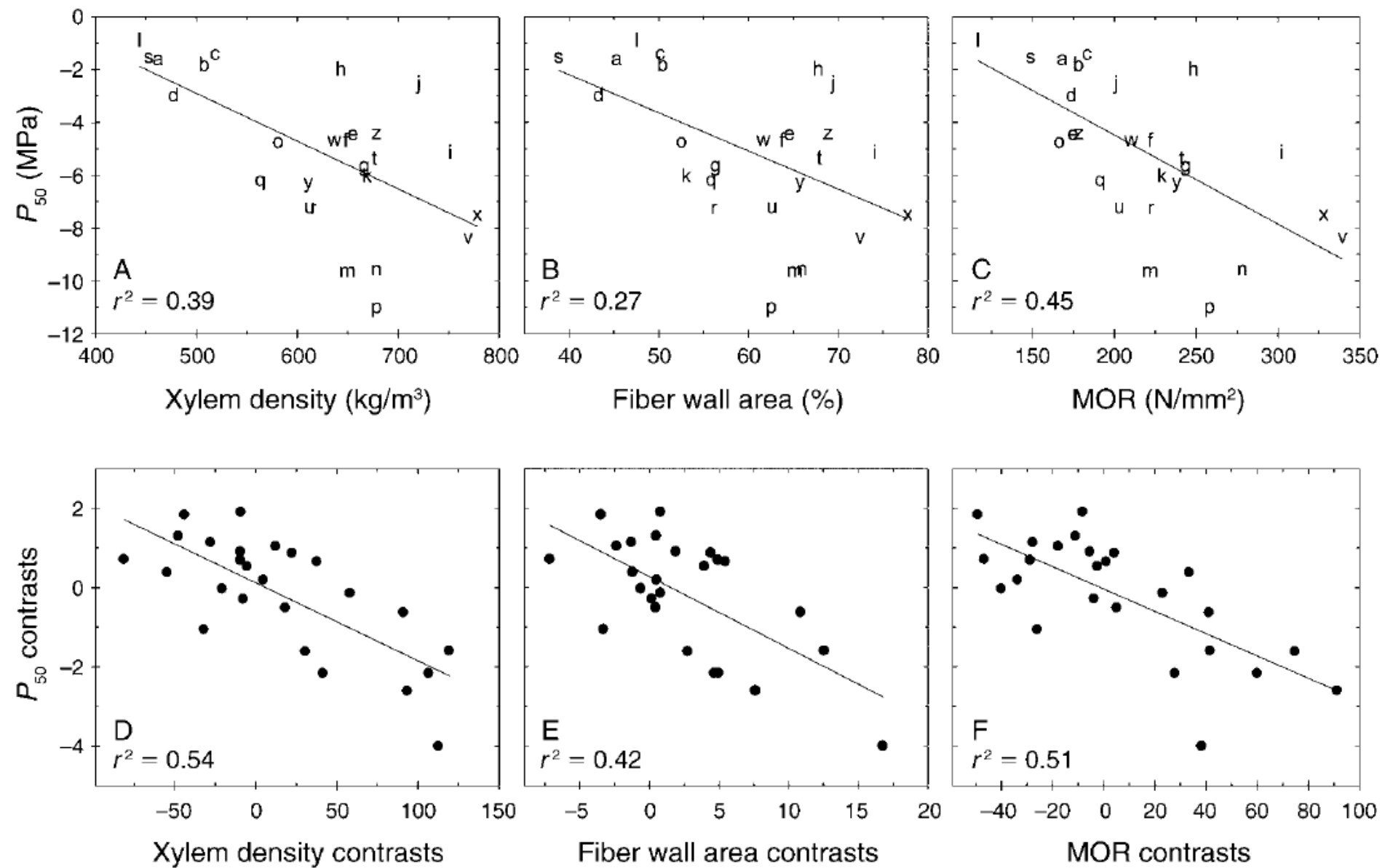
# **Does the Pattern Hold**

---

**For all chaparral species in the  
Santa Monica Mountains?**







# Does the Pattern Hold

---

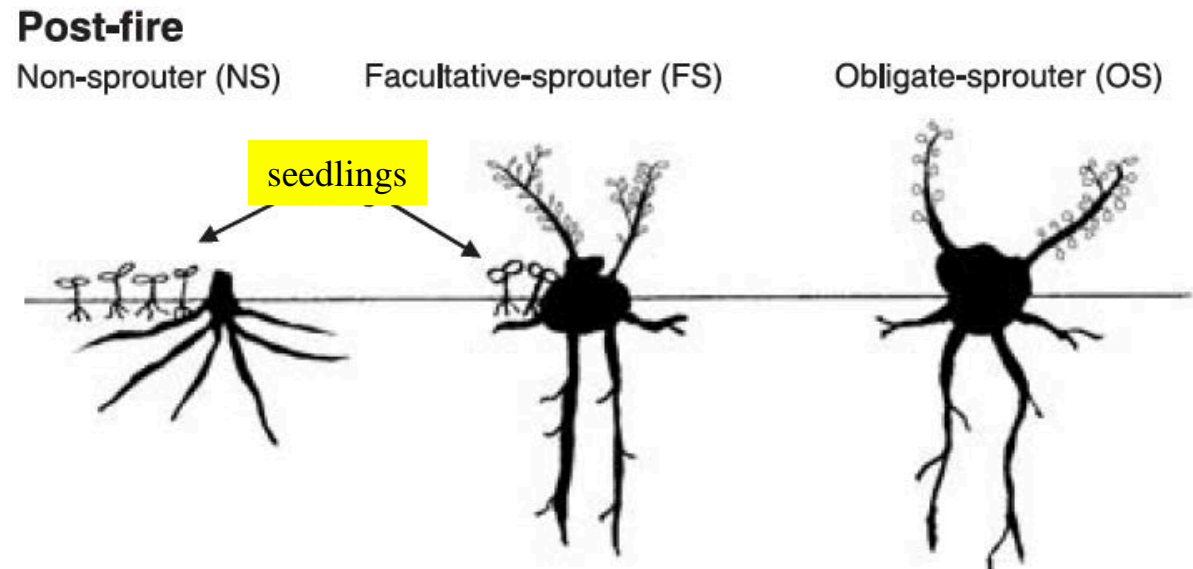
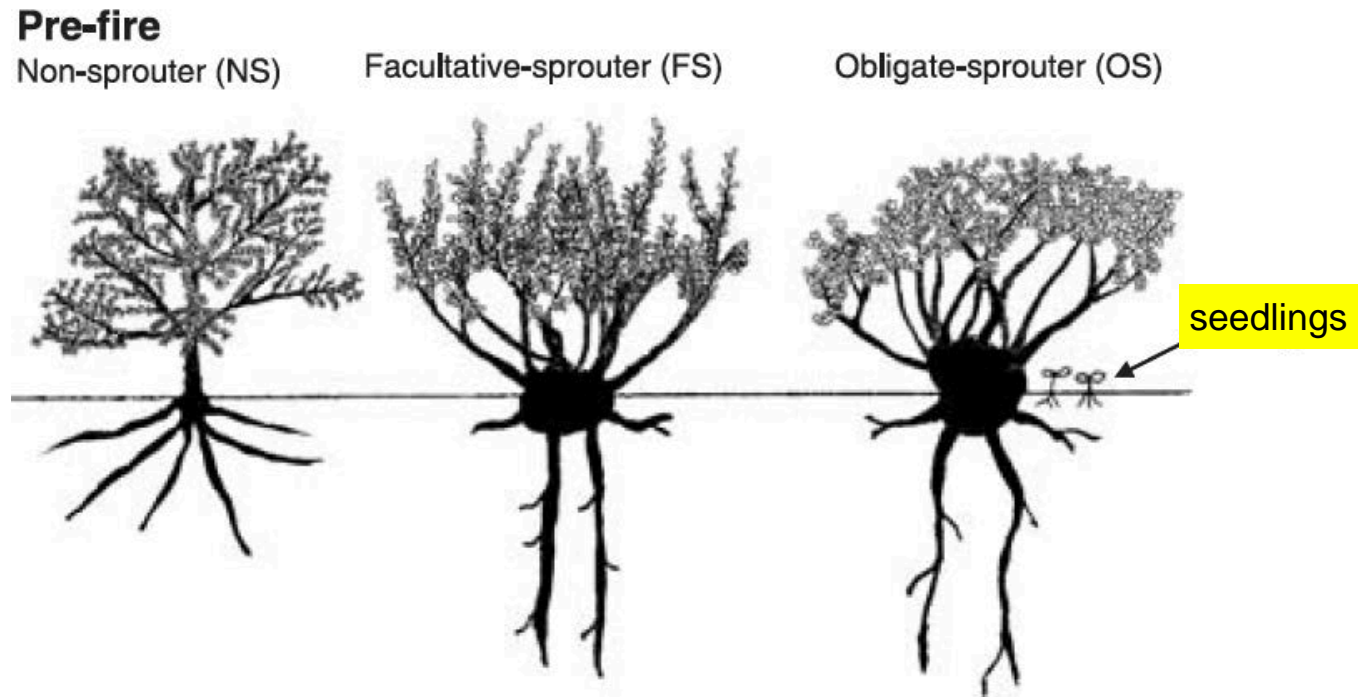
For seedlings as well as adults?



# Hypotheses

Shade Tolerant  
OS > FS > NS

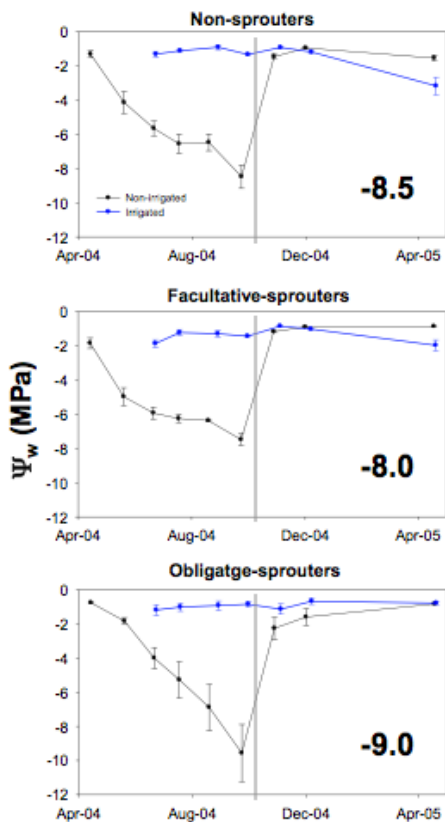
Drought Tolerant  
NS > FS > OS



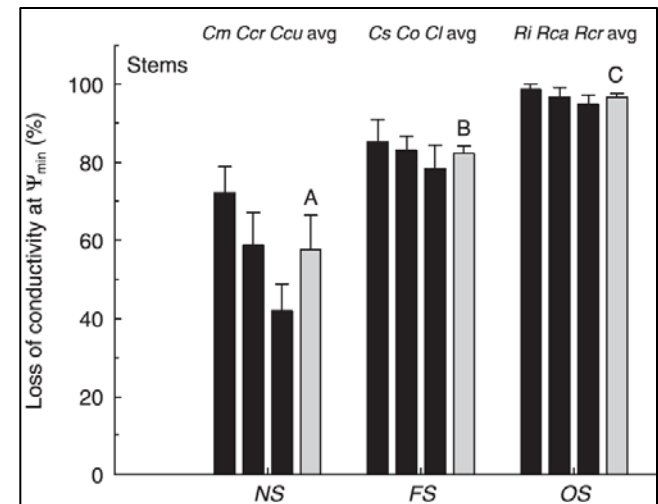
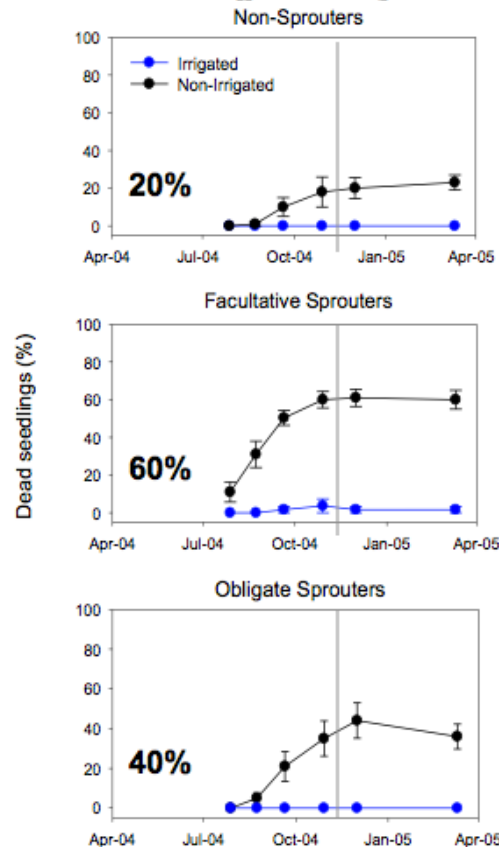
# Differential Mortality in Seedlings and Susceptibility to Xylem Embolism



## Predawn Water Potential



## Seedling Mortality





# Does the Pattern Hold

---

For resprouts as well as adults?

**Image courtesy of NASA Johnson Space Center**

Earth Sciences and Image Analysis Laboratory, Astronaut Photo ISS018E005053

Sherwood Lake Fire (6 July 2006)



Island Fire (16 July 2006)



**Santa Monica Mountains**

**Santa Catalina Island**



# Exotic deer diminish post-fire resilience of native shrub communities on Santa Catalina Island, southern California

A. R. Ramirez · R. B. Pratt · A. L. Jacobsen ·  
S. D. Davis

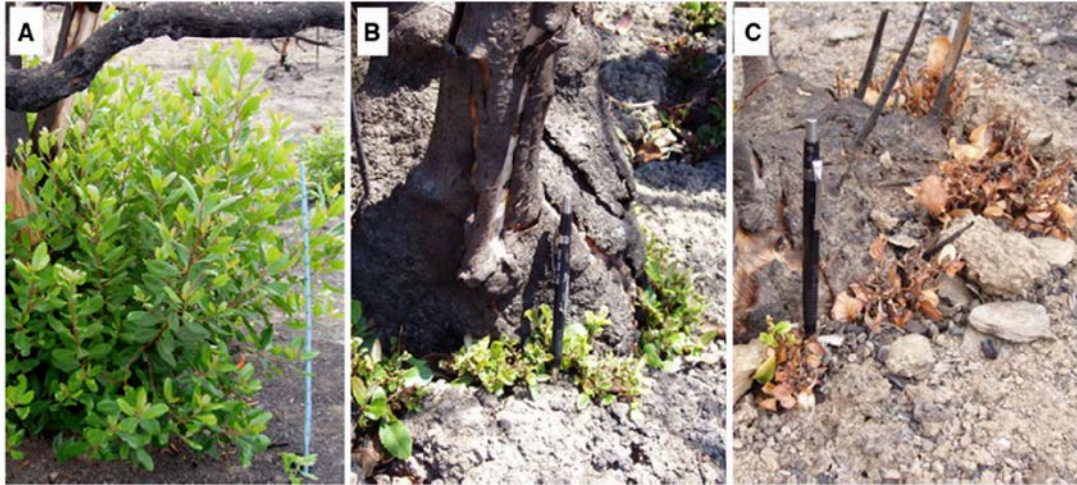
[Plant Ecology, 2012, 213:1037-1047](#)

**Santa  
Catalina  
Island**



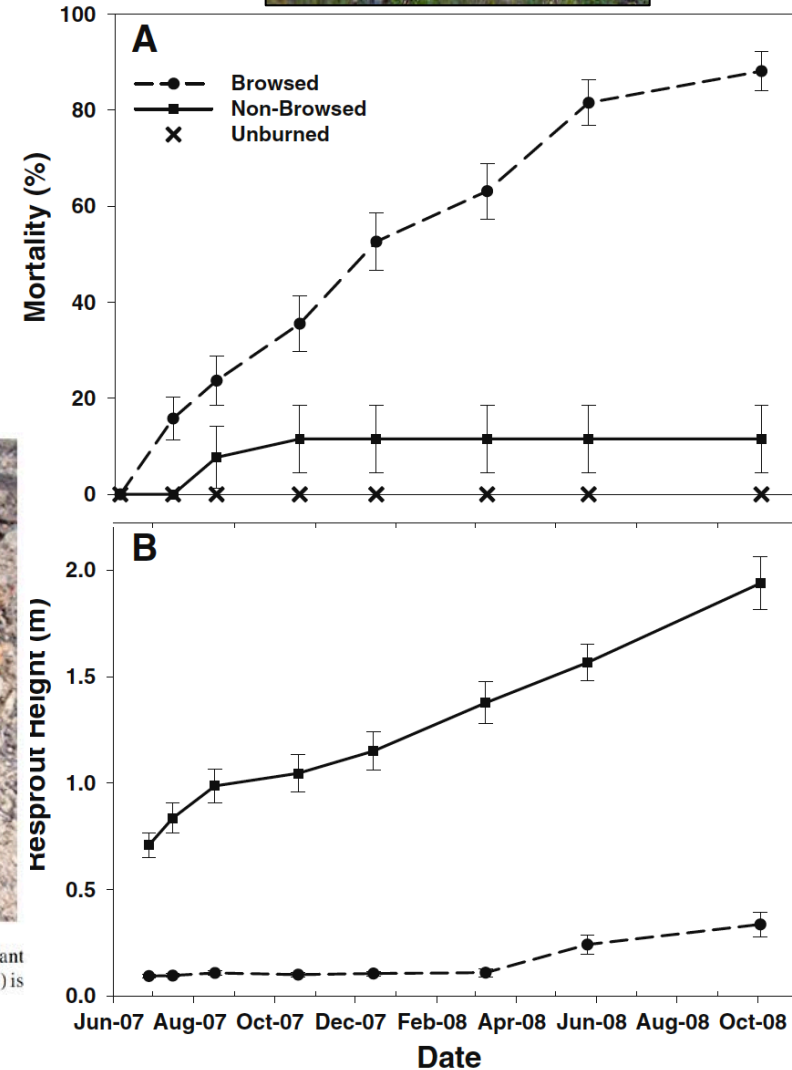


# Santa Catalina Island Fire 16 July 2006



**Fig. 1** Photos of resprouting *H. arbutifolia* taken 1 year after fire, showing a non-browsed resprout inside a deer enclosure (A), a browsed resprout outside enclosures (B), and a browsed

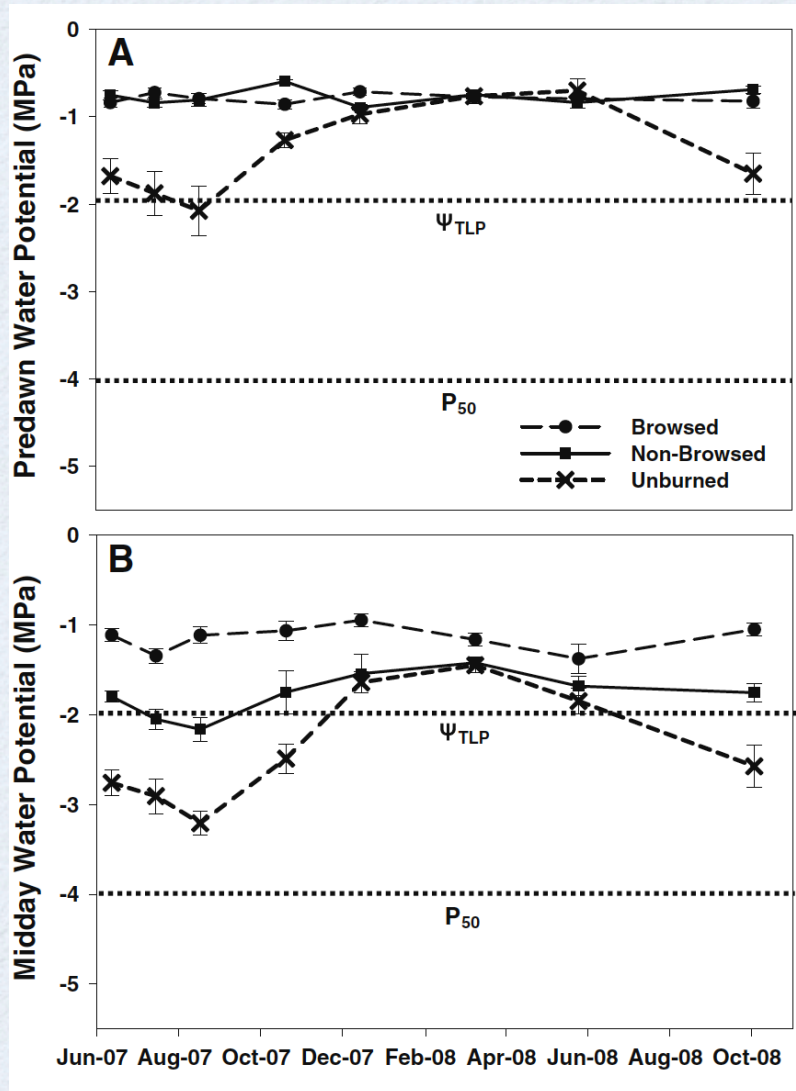
resprout with dieback outside enclosures (C). To reference plant size a 1 m stick (blue; A) or a 0.14 m mechanical pencil (B, C) is shown in each panel. Photos by Stephen D. Davis



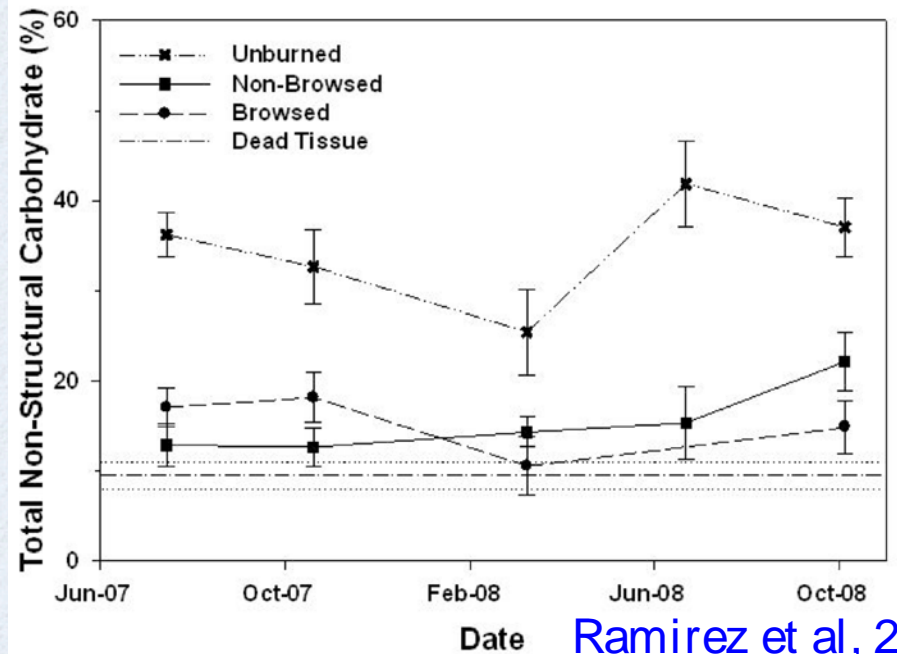


# Primary Cause of Resprout Mortality?

## Xylem Embolism?



## Carbon Starvation?



**Image courtesy of NASA Johnson Space Center**

Earth Sciences and Image Analysis Laboratory, Astronaut Photo ISS018E005053

Sherwood Lake Fire (6 July 2006)



Island Fire (16 July 2006)



**Santa Monica Mountains**

**Santa Catalina Island**



# Sherwood Lake Fire (6 July 2006)



*M. laurina*

*A. fasciculatum*

*C. spinosus*








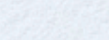
*H. arbutifolia*

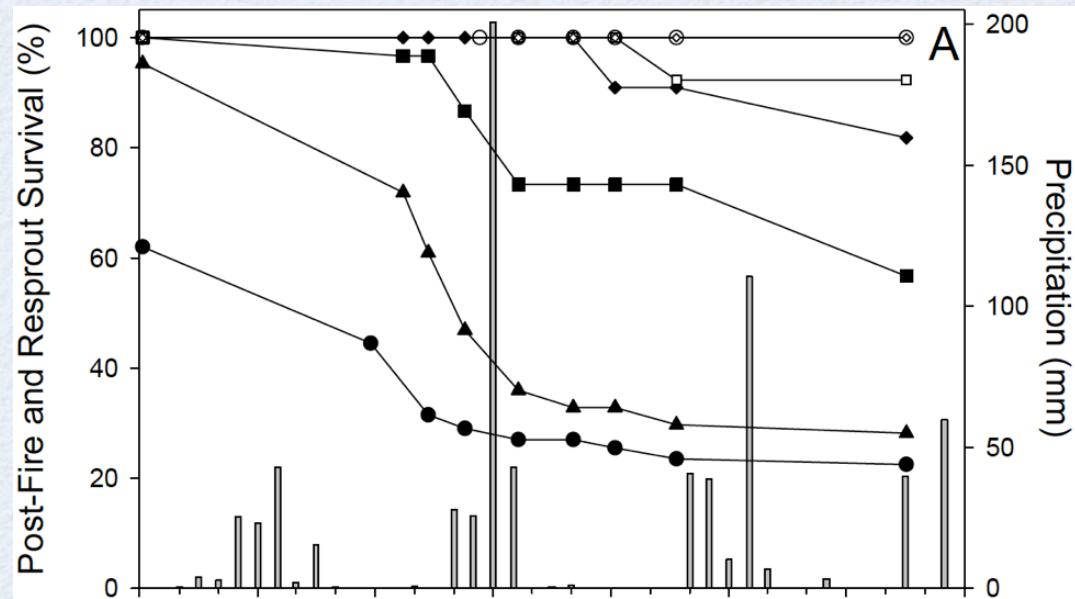
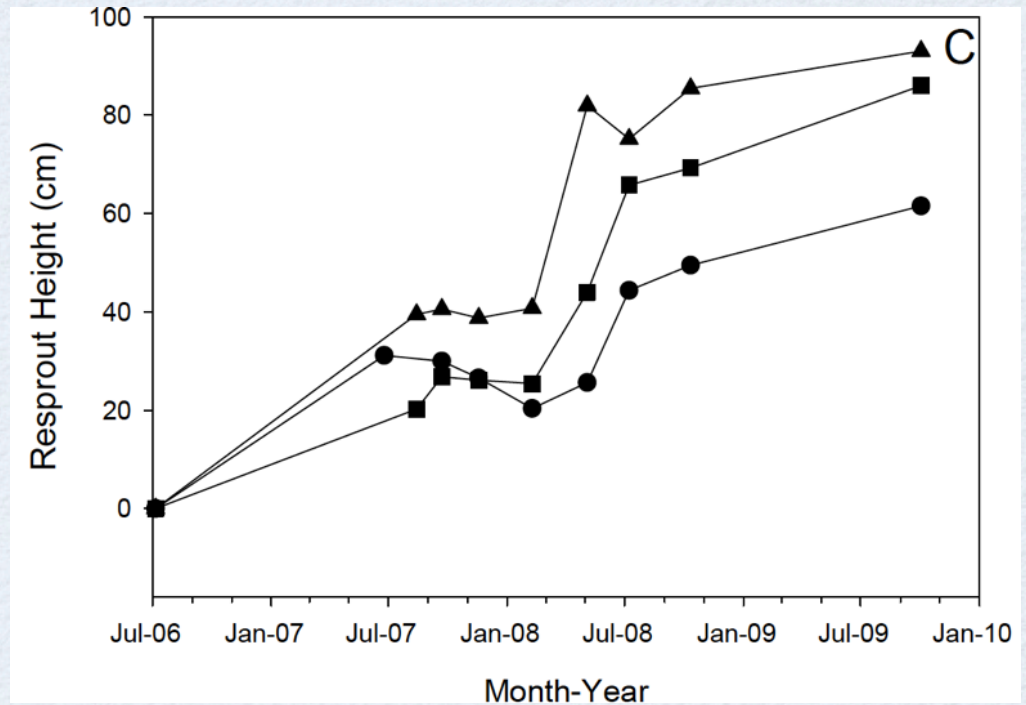




# Sherwood Lake Fire (6 July 2006)

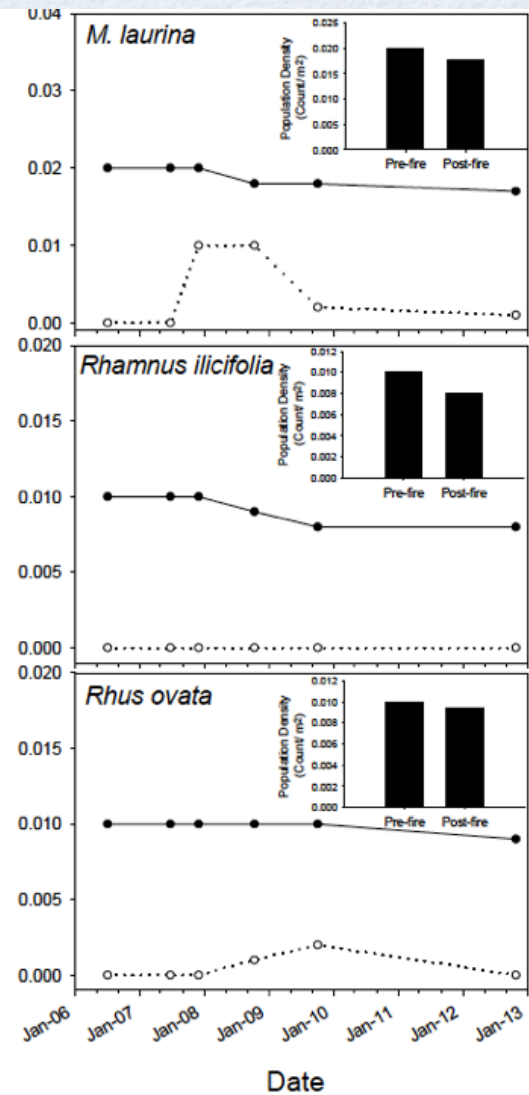
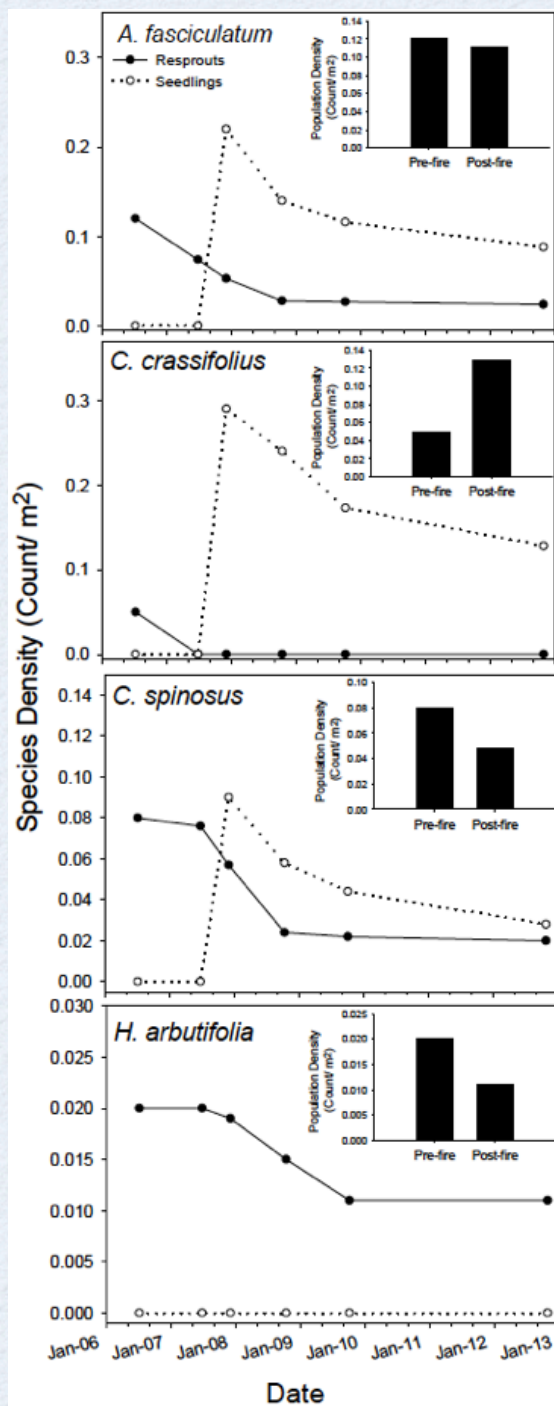


-  Precipitation
-  *A. fasciculatum*
-  *A. sparsifilium*
-  *C. spinosus*
-  *H. arbutifolia*
-  *R. ilicifolia*
-  *M. laurina*
-  *R. ovata*





# Sherwood Lake Fire (6 July 2006)



# With Climate Change

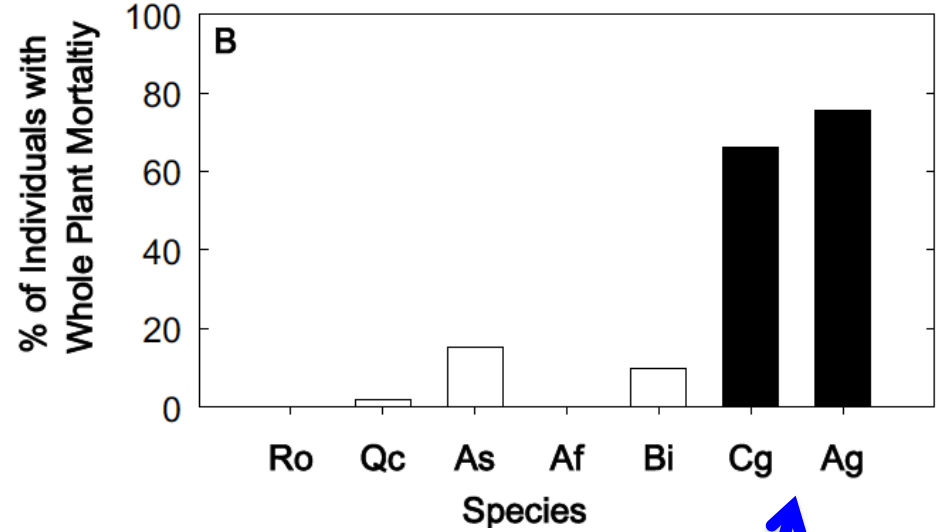
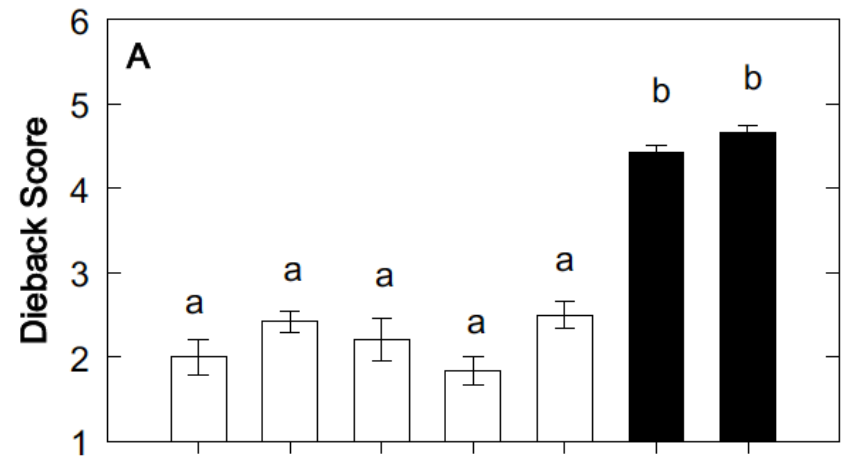
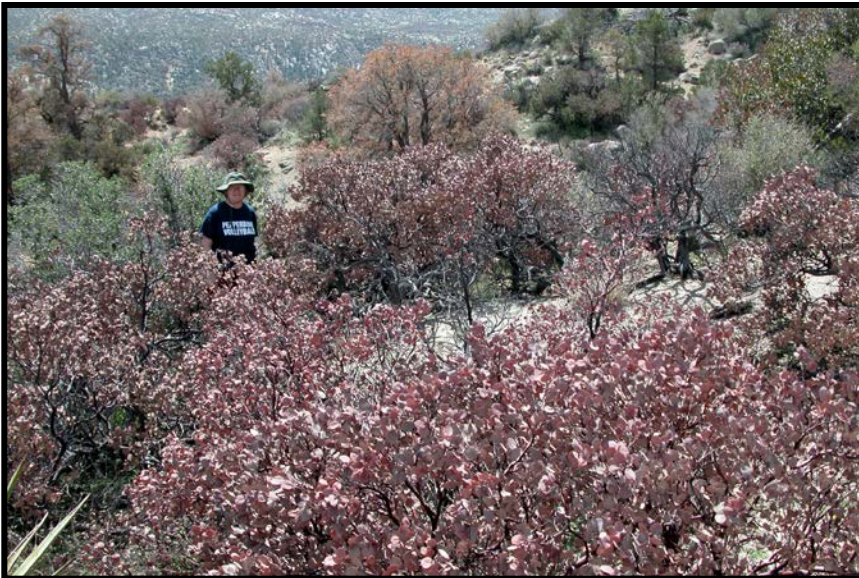



**Will non-sprouters expand?**

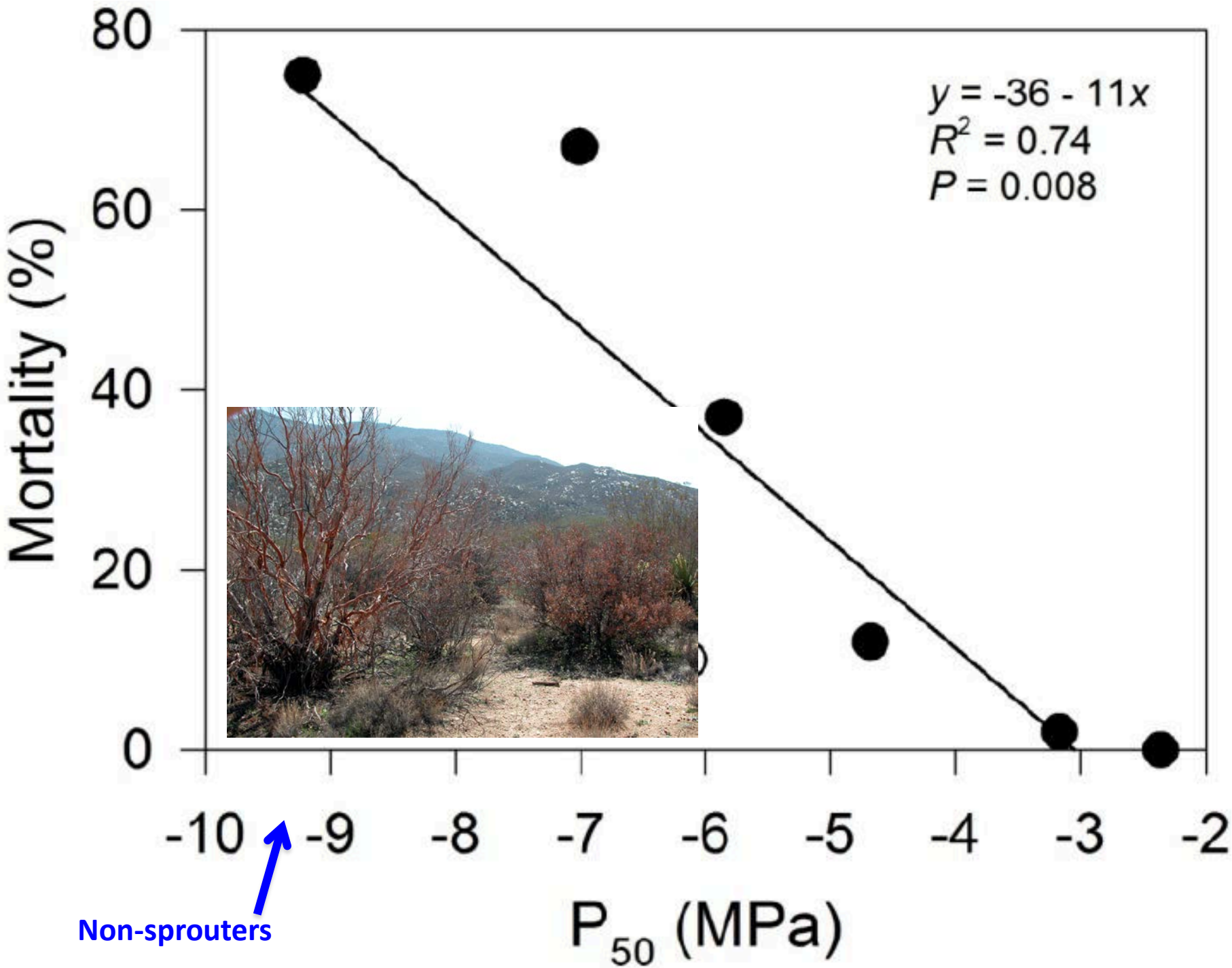


# Differential Mortality in Adults

Palms to Pines Highway (Hwy 74)



  
**Non-sprouters**







**Non-sprouters challenged  
by short fire-return-intervals**





Fire '85 '93 '96

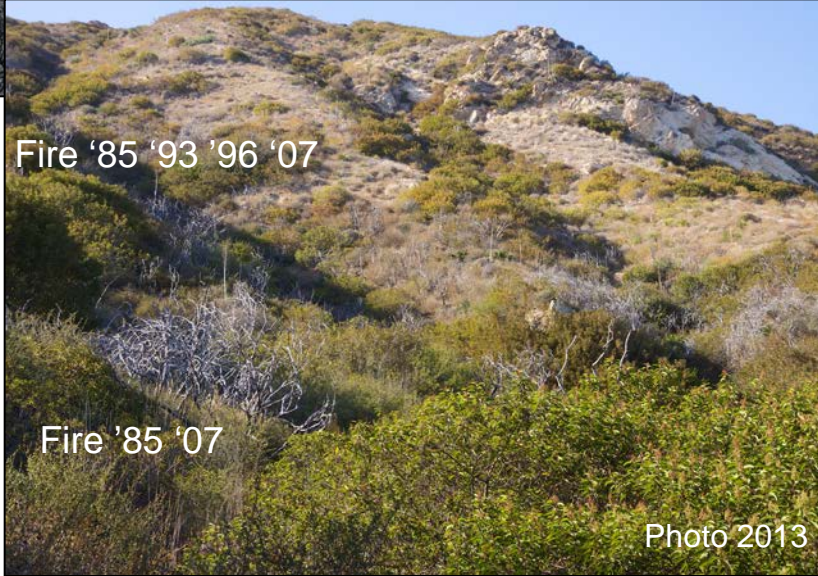
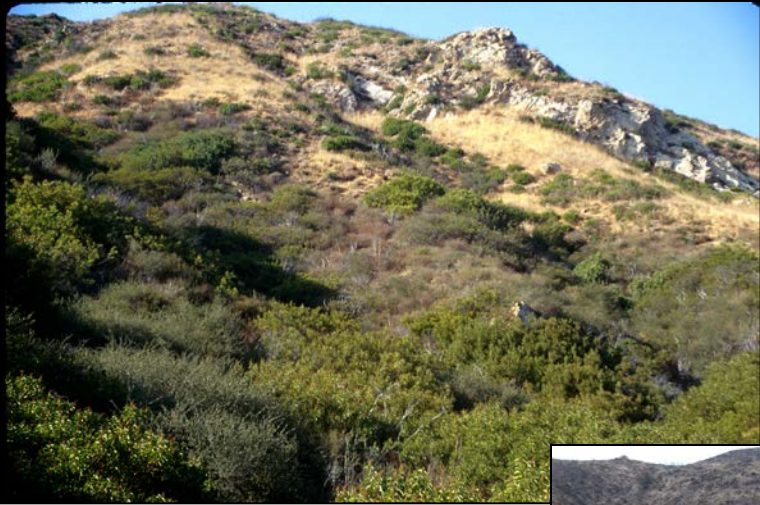
Fire '85



Fire '85 '93 '96 '07

Fire '85 '07







# Restoration of Chaparral Biological Considerations

**Drought**

**Wildfire**

**Freezing**

