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The Role of Small Animals, Invasive Plants and Fire In Mojave Desert Seed Bank Dynamics and Vegetation Recovery

T.C. Esque[1,2], P.A. Medica[2], S.B. VanderWall[3],

R.H. Webb[4], D.F. Haines[1], L.A. DeFalco[1,2], and C. R. Tracy[2]

[1] US Geological Survey, Las Vegas, Nevada
[2] US Fish and Wildlife Service, Las Vegas, Nevada
[3] University of Nevada, Reno
[4] US Geological Survey, Tucson, Arizona

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Fire fighters on engines 147, 154, 163, 711 and 712
Student Conservation Association volunteers

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Objectives – Natural Restoration Processes

- How do ants, rodents, fire, microsite, and climate affect annual plant seed banks?
- What is the pattern of natural restoration for perennial vegetation?
  - Short-term (3-10y),
  - Long-term (a human generation)
- How are animals responding to large-scale habitat changes?
- What are some of the costs and benefits of small animals interacting with long-lived plants?

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Bromus madritensis ssp. *rubens*
Red Brome
Bromus tectorum
Cheatgrass
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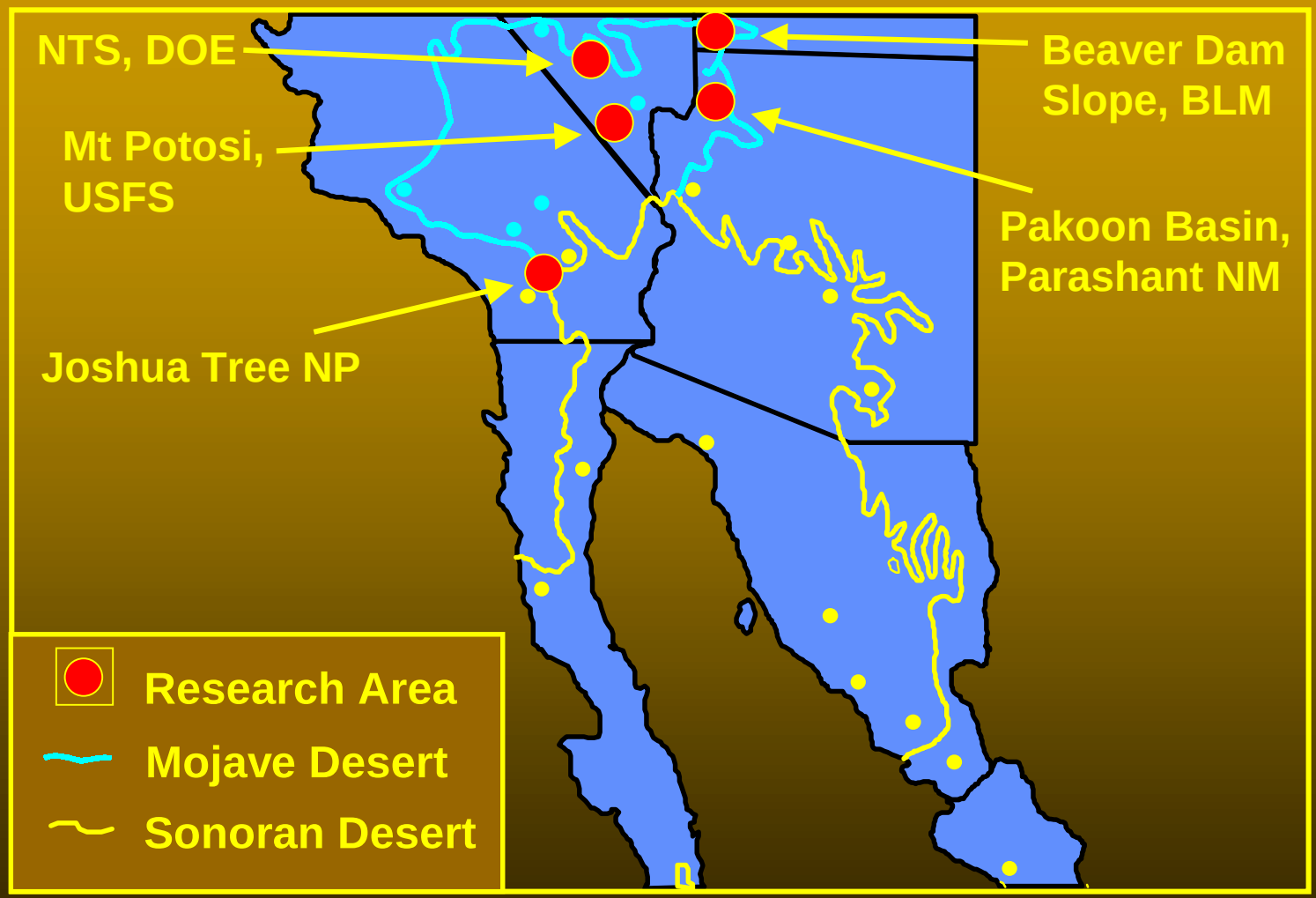
NTS, DOE
Mt Potosi, USFS
Joshua Tree NP
Beaver Dam Slope, BLM
Pakoon Basin, Parashant NM
Research Area
Mojave Desert
Sonoran Desert

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Active Restoration in Desert Sites

- Costly
- Labor intensive
- Risky in deserts
- Points or linear dimension of minimal size

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Wildlands – even bigger challenges

- Vast areas required
- Seed sometimes not available
- Limited return on investment
- Costly

Sources of Information

Searches of Archives

Janice C. Beatley legacy

- **retrieval of archived media**
- **retrieval of unpublished data**
- **re-establishment of well-designed, hypothesis-driven monitoring plots**

Department of Energy – Nevada Test Site legacy

B. Maza, et al. – *unpublished data*

Original Experimentation

- **government-supported science**
- **university-supported science**

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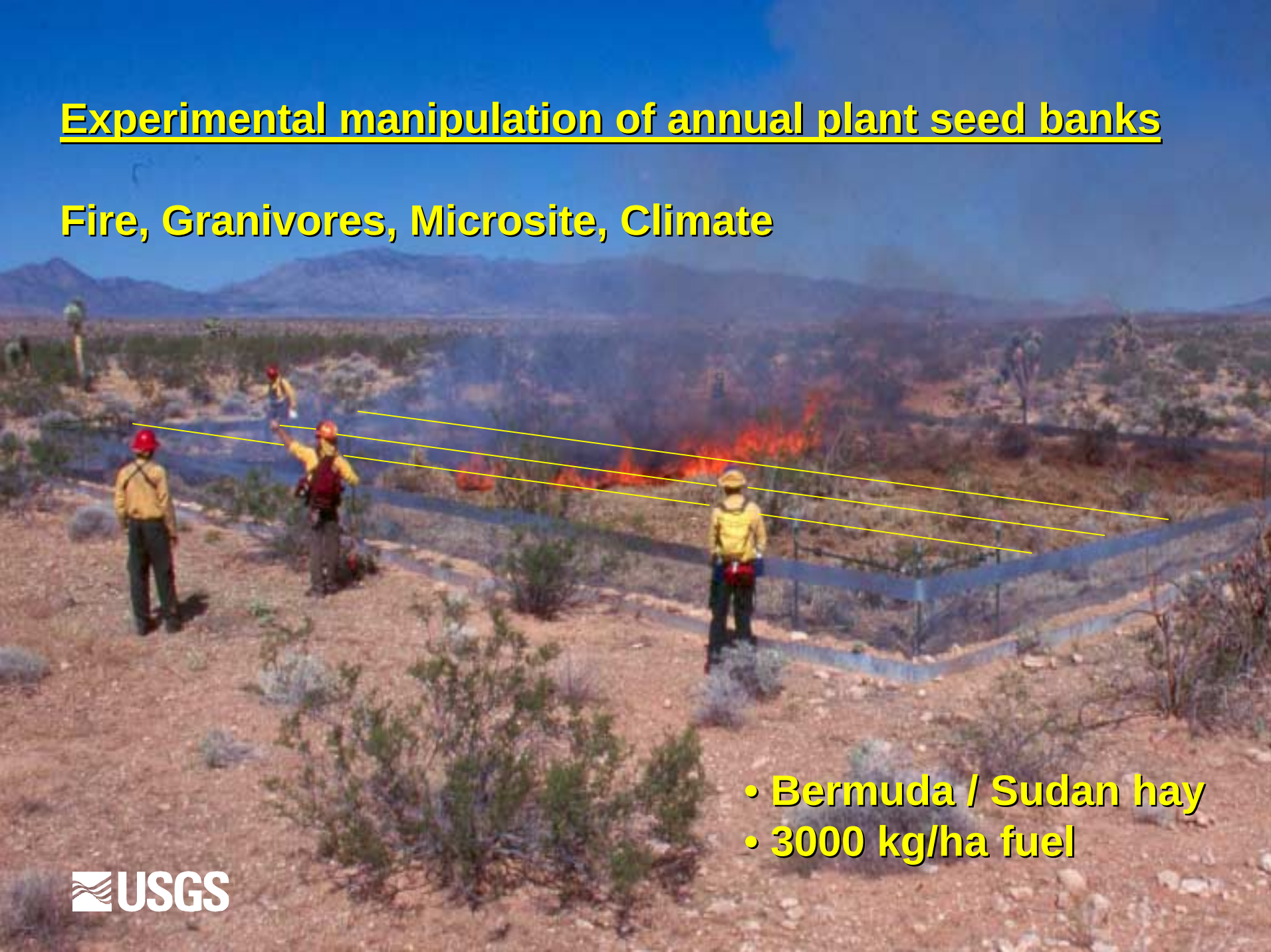
Experimental manipulation of annual plant seed banks
Fire, Granivores, Microsite, Climate
• Bermuda / Sudan hay
• 3000 kg/ha fuel
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1 Block of 6

PLOTS UNBURNED

ANTS INCLUDED RODENTS EXCLUDED

ANTS EXCLUDED RODENTS EXCLUDED

ANTS INCLUDED RODENTS INCLUDED

ANTS EXCLUDED RODENTS INCLUDED

NO FENCE

PLOTS BURNED

ANTS INCLUDED RODENTS EXCLUDED

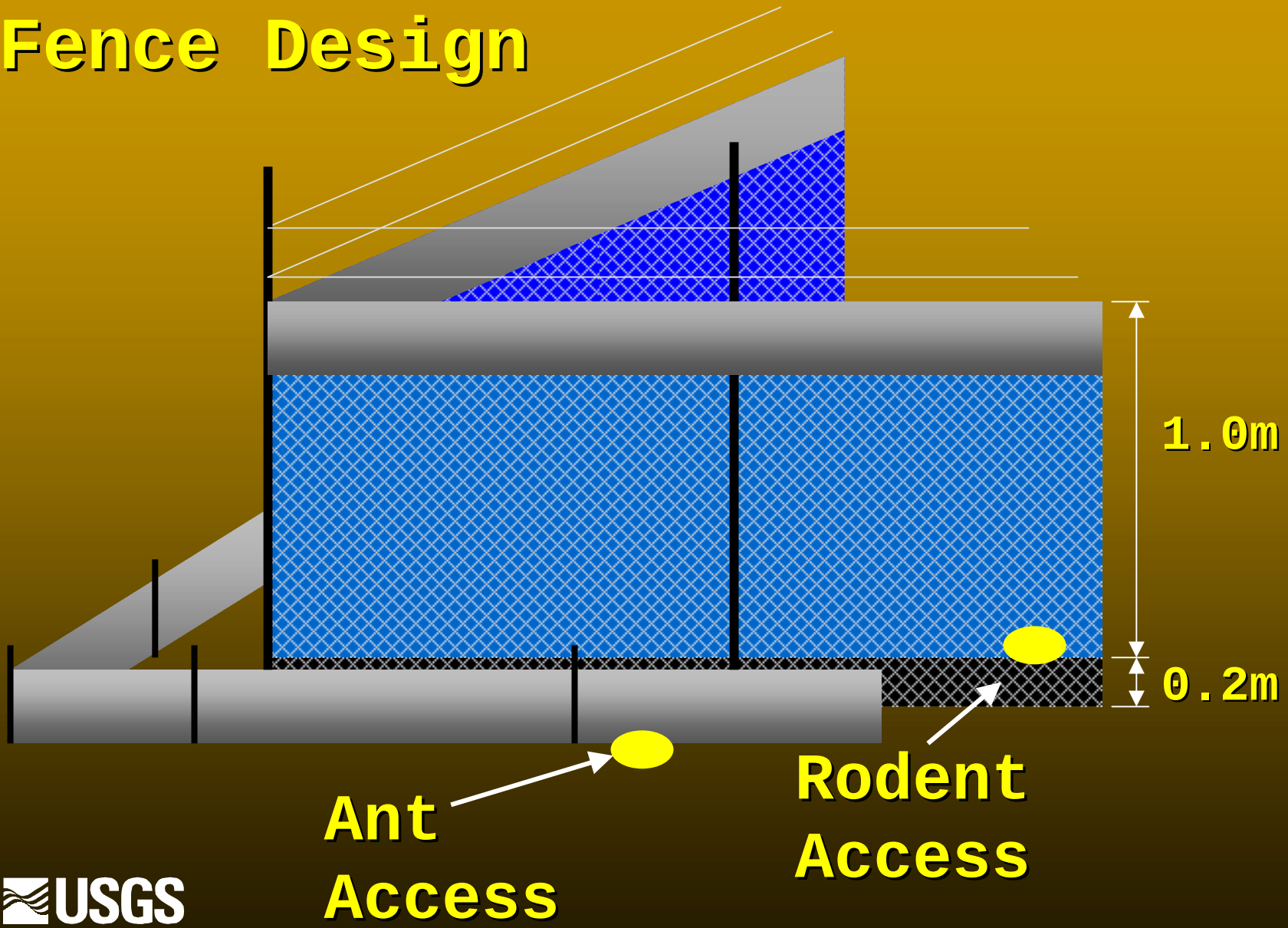
ANTS EXCLUDED RODENTS EXCLUDED

ANTS INCLUDED RODENTS INCLUDED

ANTS EXCLUDED RODENTS INCLUDED

NO FENCE

Fence Design



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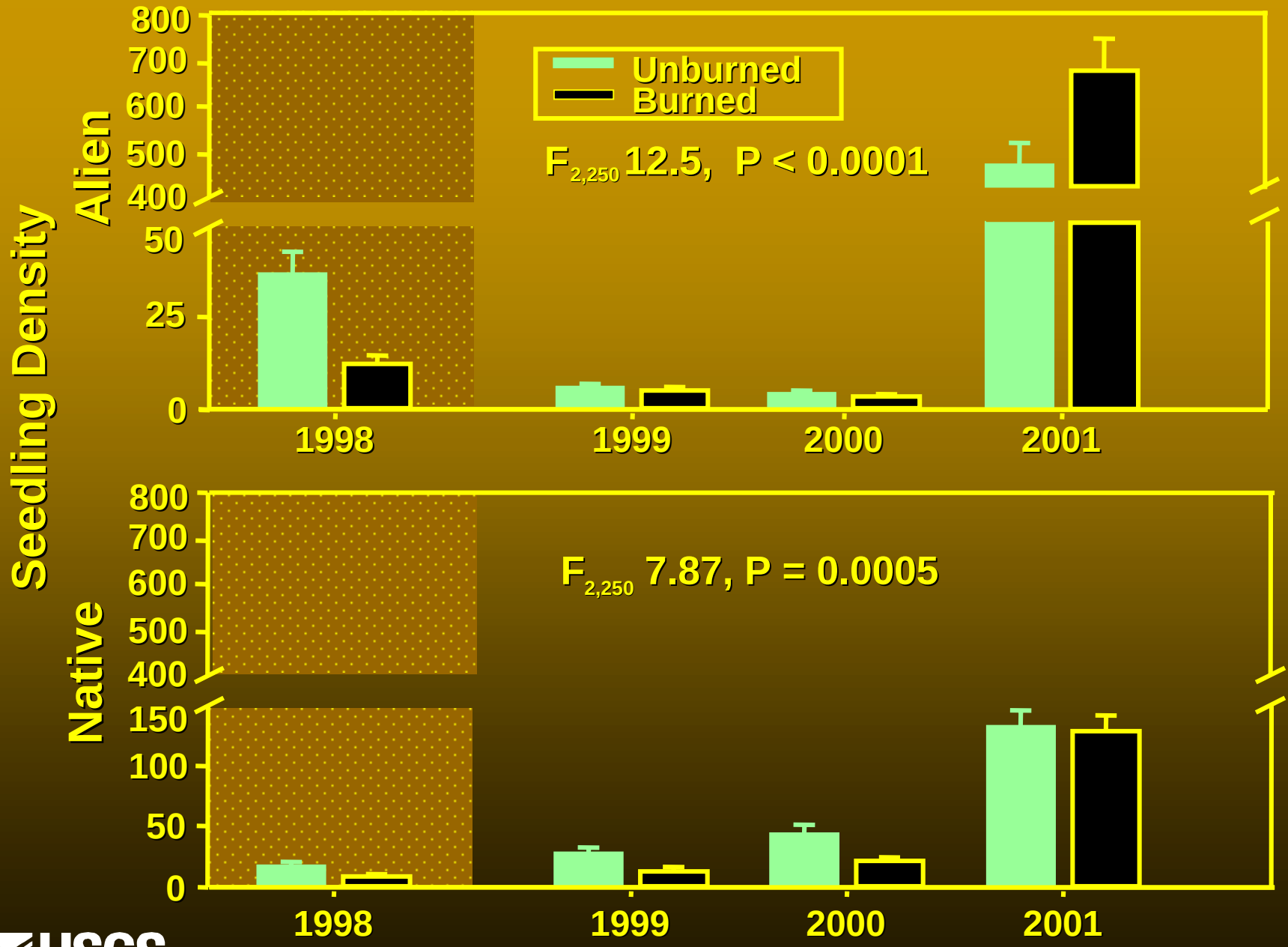
Seed bank assay in the greenhouse

Burn x Year Treatment Interactions



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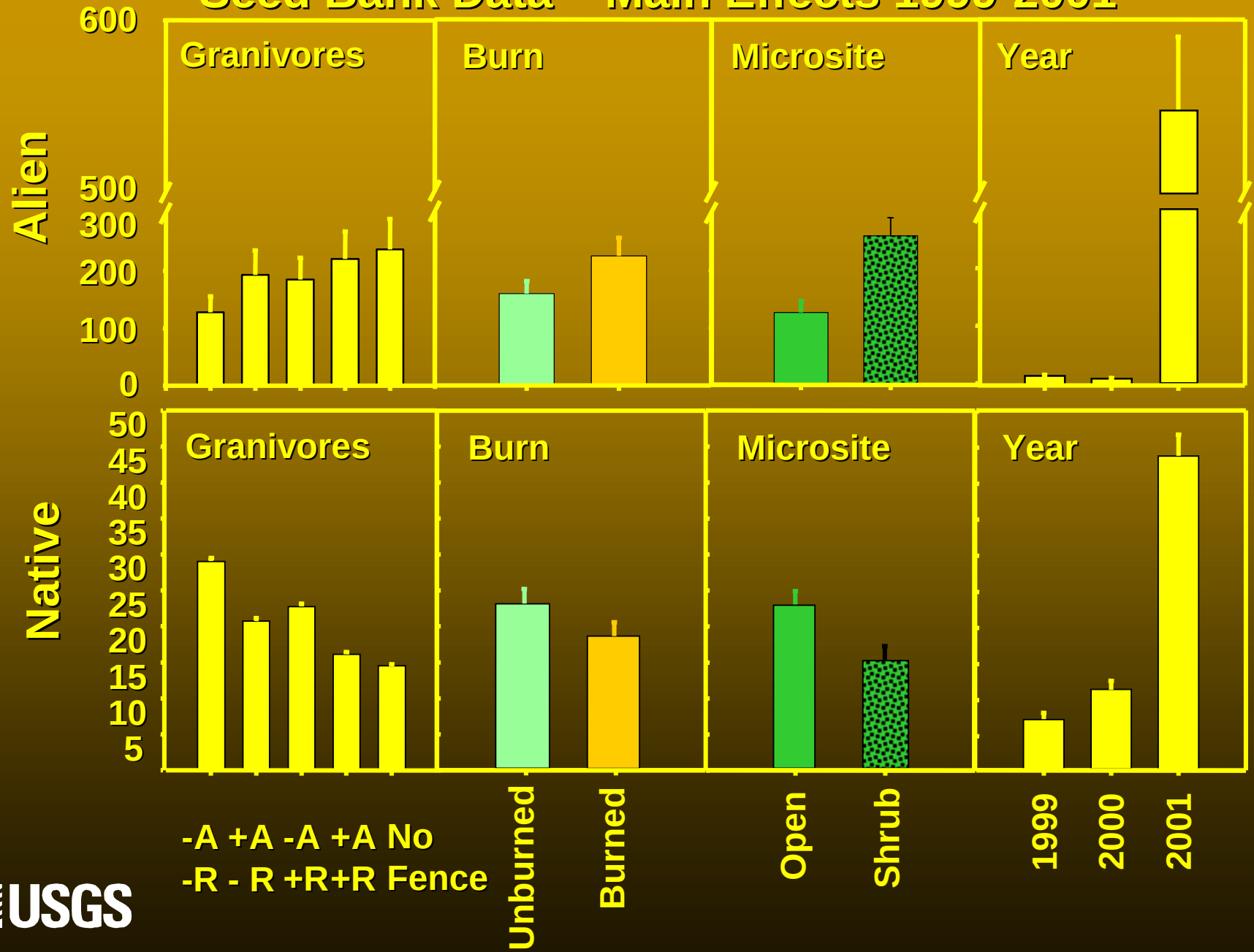
Seed Bank Data – Main Effects 1999-2001



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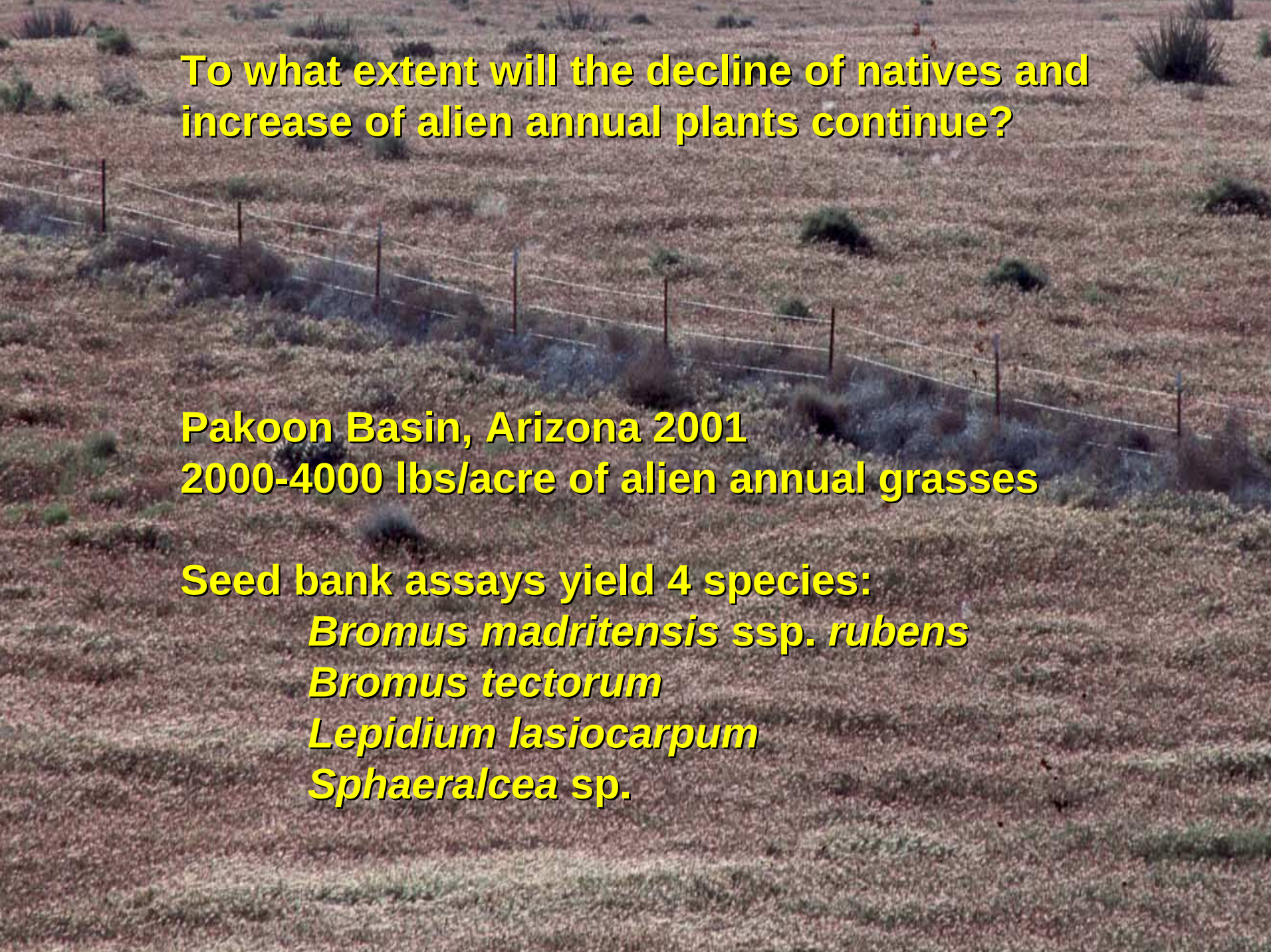


To what extent will the decline of natives and increase of alien annual plants continue?

Pakoon Basin, Arizona 2001
2000-4000 lbs/acre of alien annual grasses

Seed bank assays yield 4 species:

Bromus madritensis* ssp. *rubens
Bromus tectorum
Lepidium lasiocarpum
***Sphaeralcea* sp.**

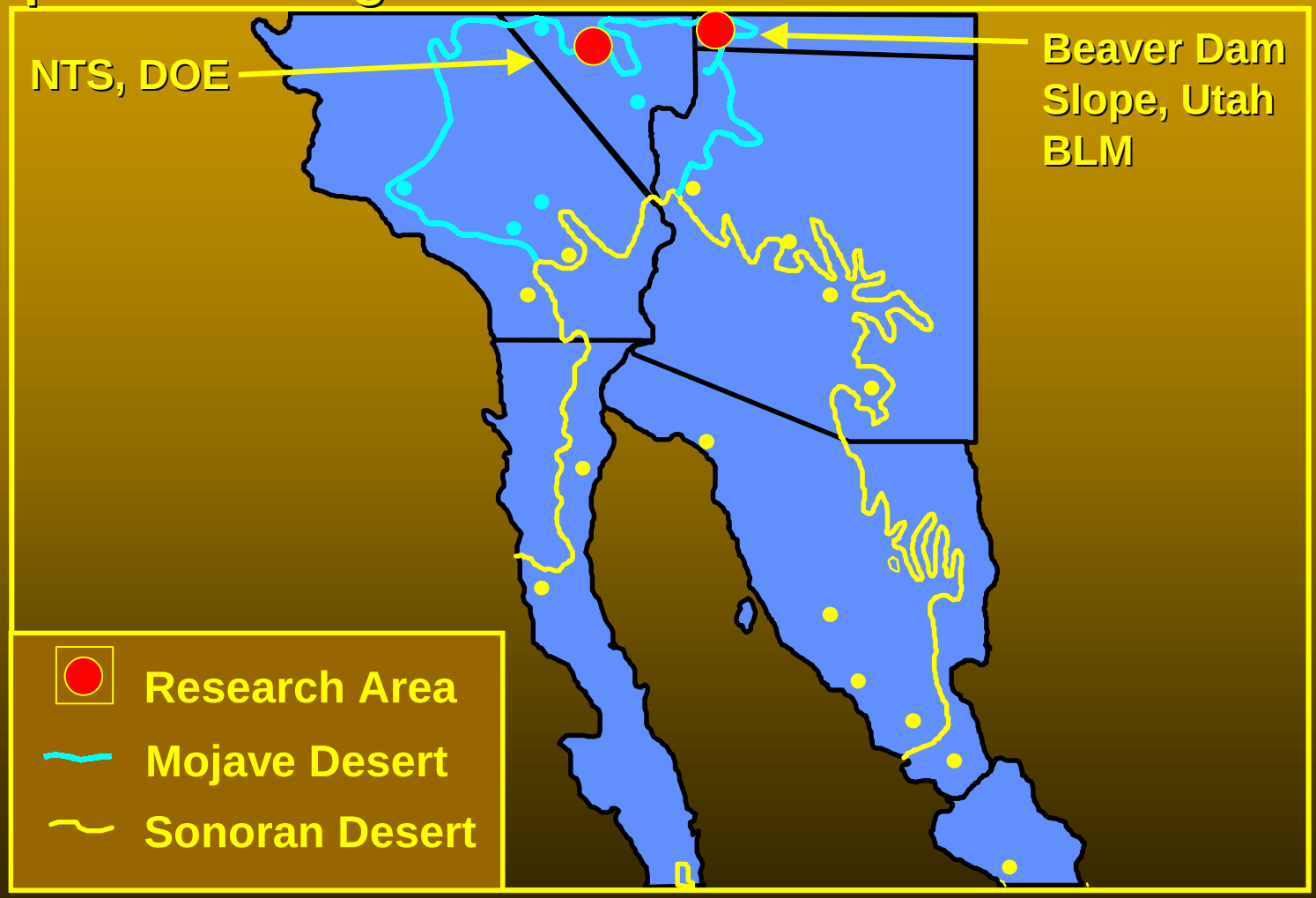
Archived data can aid and guide current research

Nevada Test Site 1962

Rodent cheek pouches *contain* *Bromus rubens* seed

B. Maza – *Unpublished data*

What is the pattern of natural restoration for perennial vegetation?



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Perennial Plant Re-growth
Bulldog Fire, Utah - 1993
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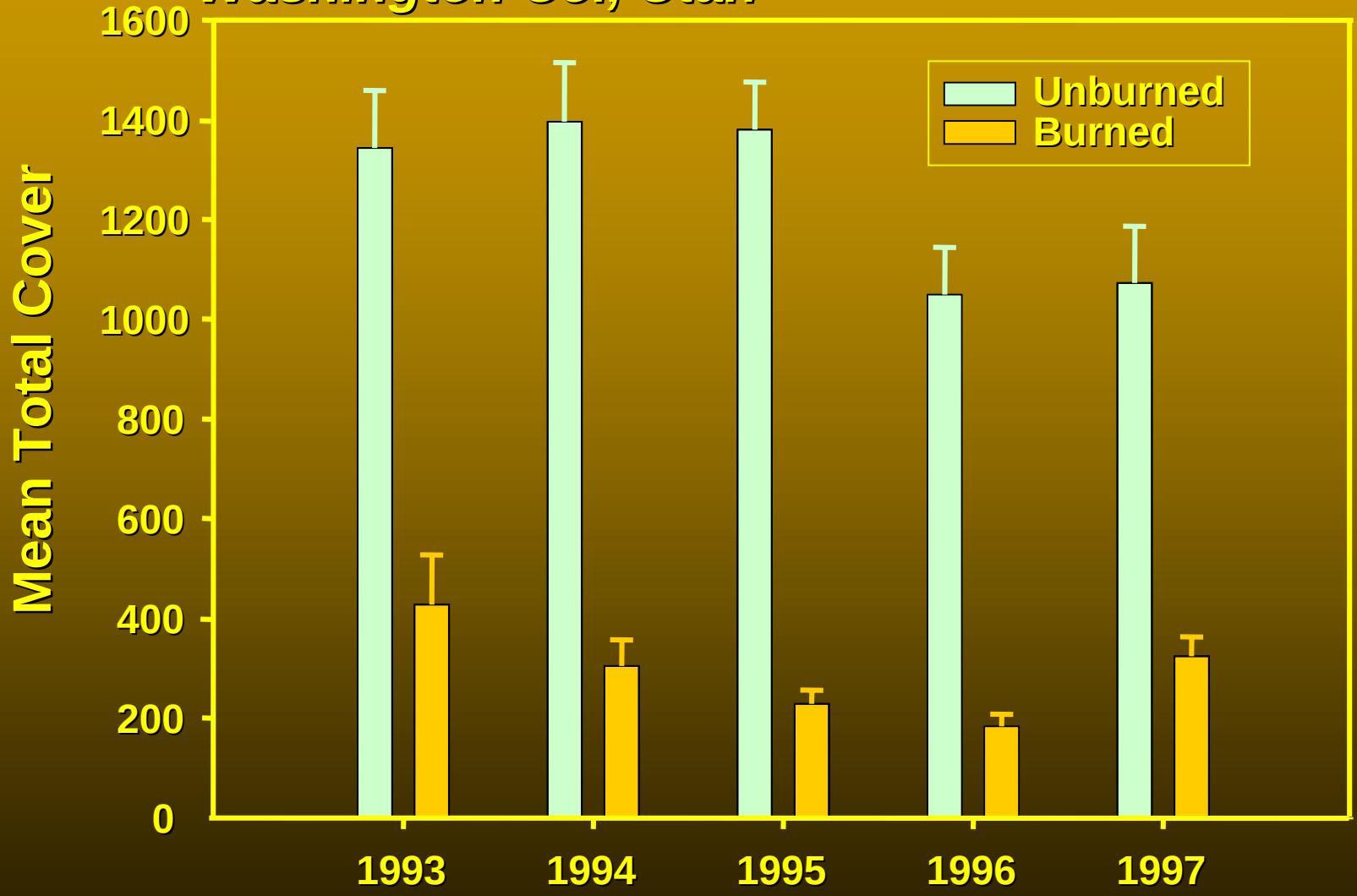
Total Cover at Bulldog Canyon, Washington Co., Utah



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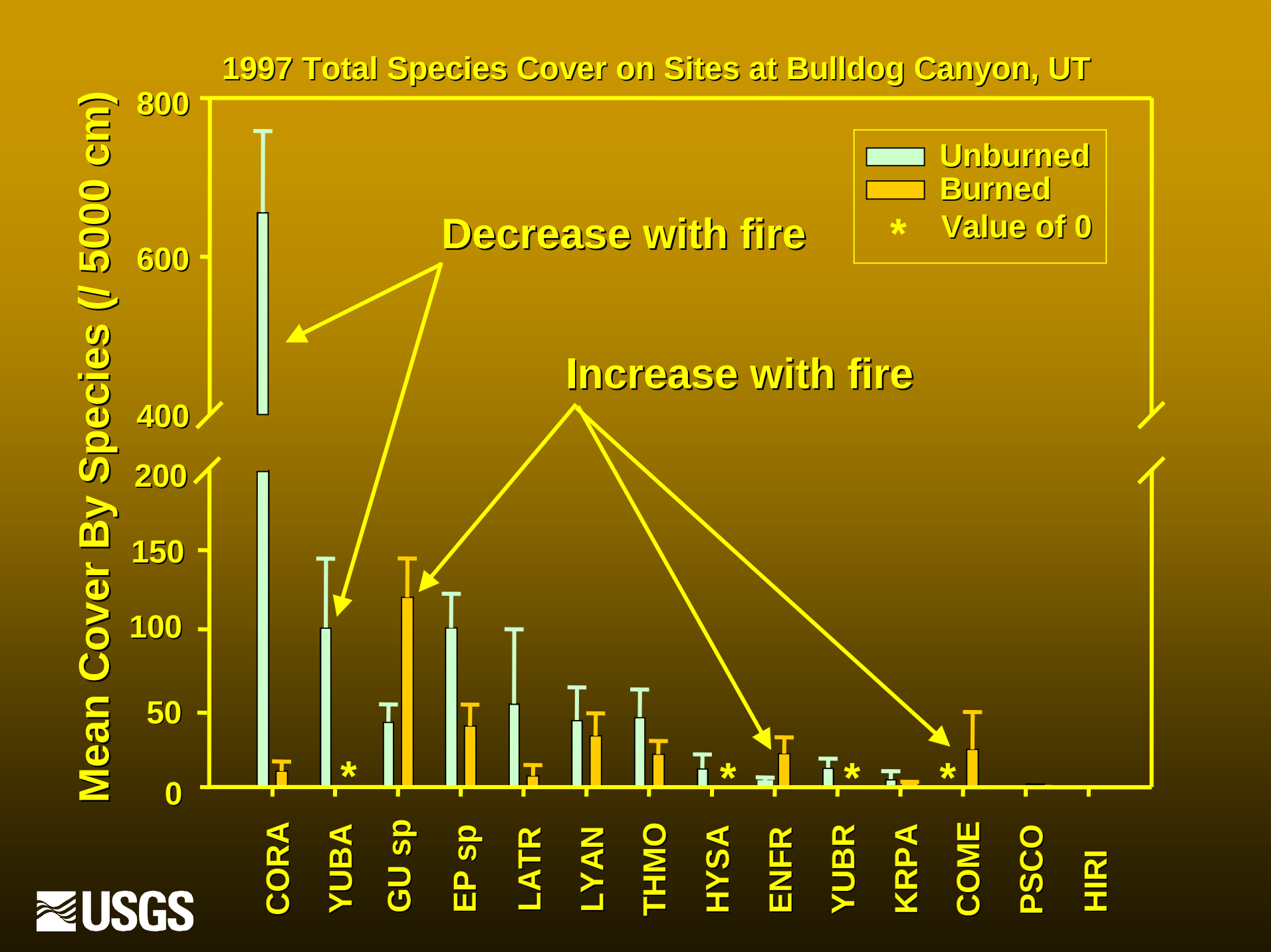
1997 Total Species Cover on Sites at Bulldog Canyon, UT
Mean Cover By Species (/ 5000 cm)
800
600
400
200
150
100
50
0
Unburned
Burned
* Value of 0
Decrease with fire
Increase with fire
CORA
YUBA
GU sp
EP sp
LATR
LYAN
THMO
HYSA
ENFR
YUBR
KRPA
COME
PSCO
HIRI
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40 Years of Recovery
The Janice C. Beatley Long-term Monitoring Plots

Full range of climatic variation

No livestock or other Anthropogenic disturbance

Close to pre-disturbance cover values

Community composition still not the same as pre-disturbance

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Plot 40 (1963) burned 1959

Plot 40 (2000) 41 years of recovery

How are small animals responding to large-scale habitat changes?

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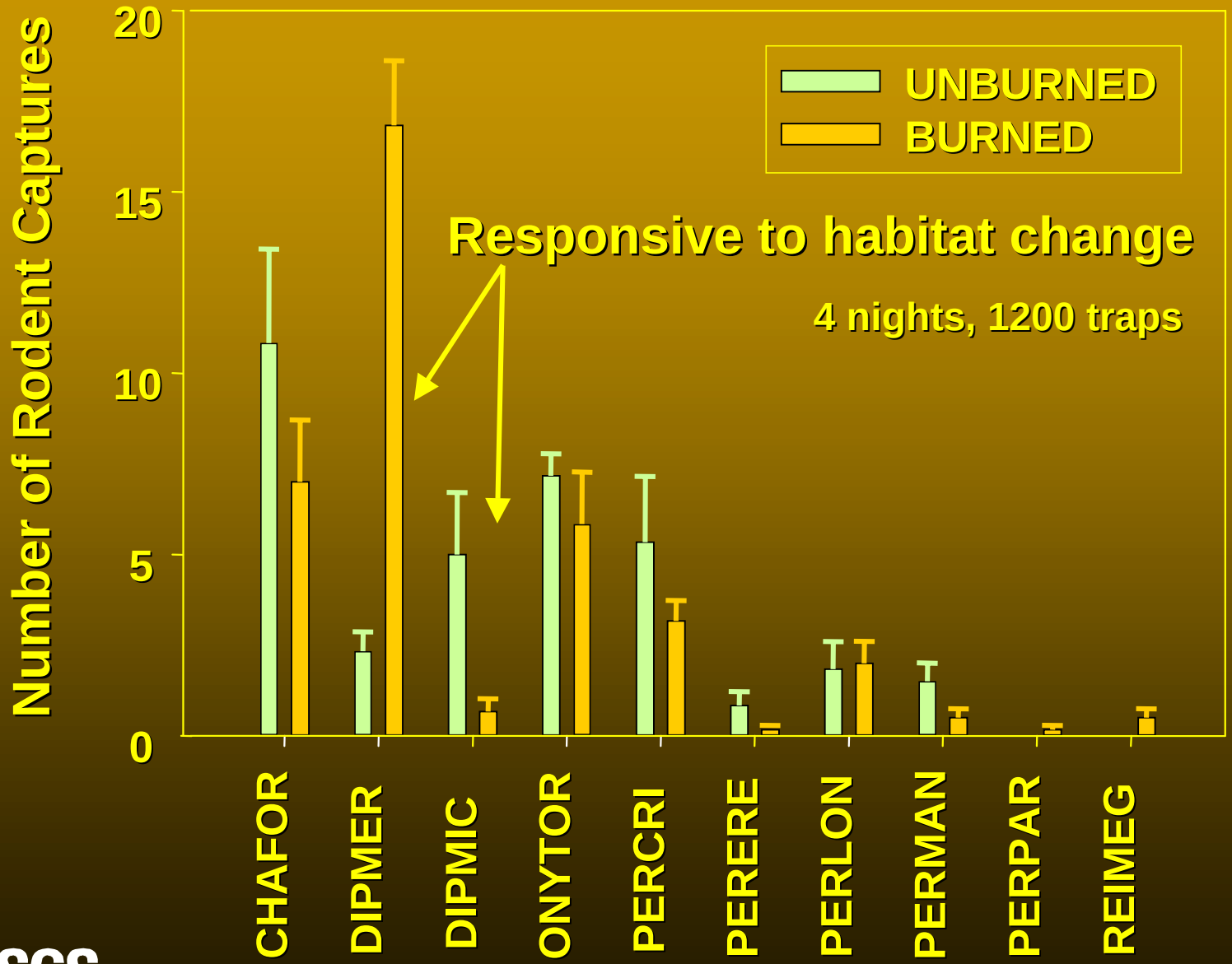
We hypothesized that rodent communities would respond to disturbance with lower abundance and diversity

Rodent Community Recovery – 40 years



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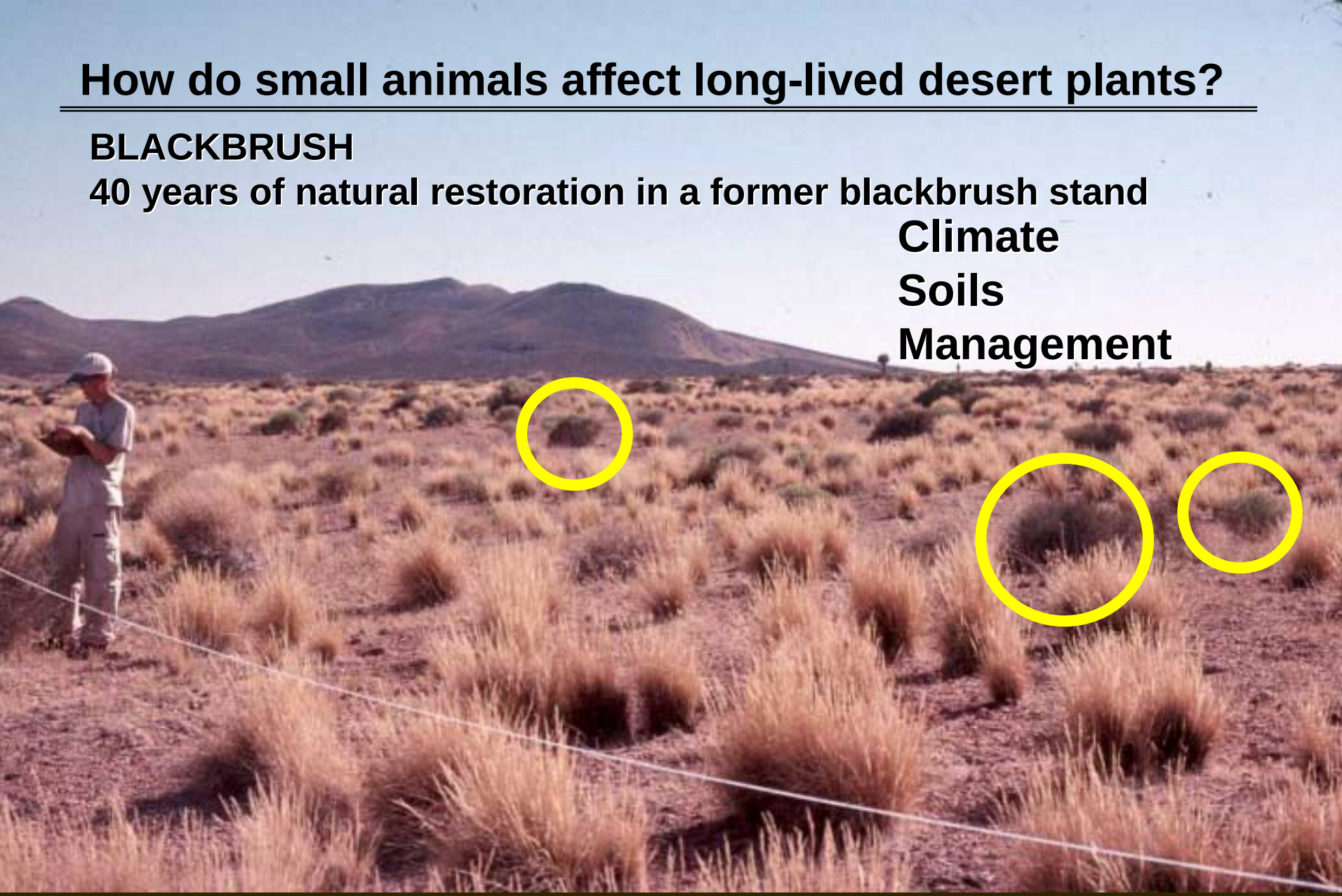
How do small animals affect long-lived desert plants?

BLACKBRUSH

40 years of natural restoration in a former blackbrush stand



Blackbrush

Multiple transects at burn edge

Test the hypothesis that initial establishment was limited to the burn edge

A provocative pattern emerges

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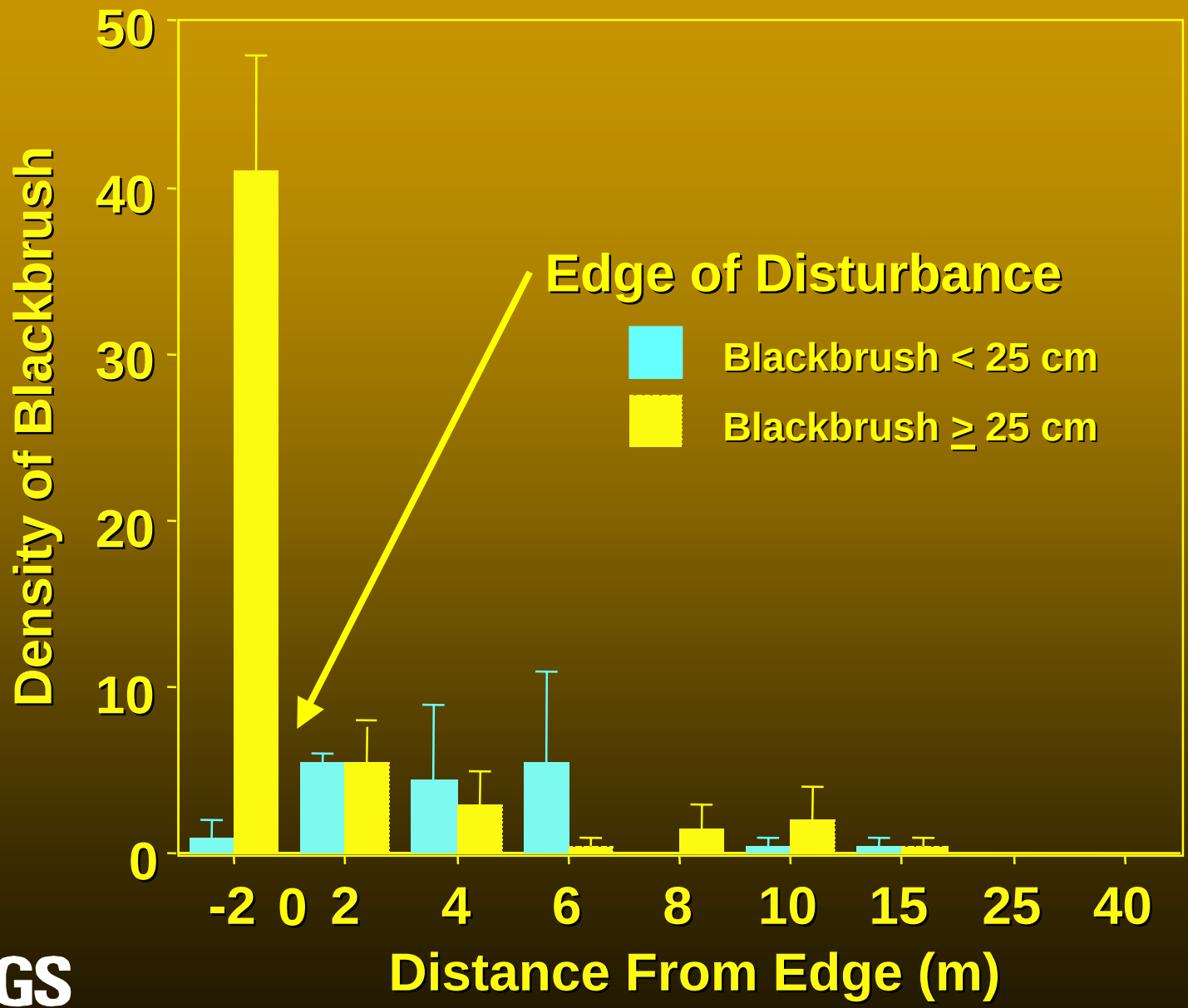
Blackbrush Recovery - Mojave Desert



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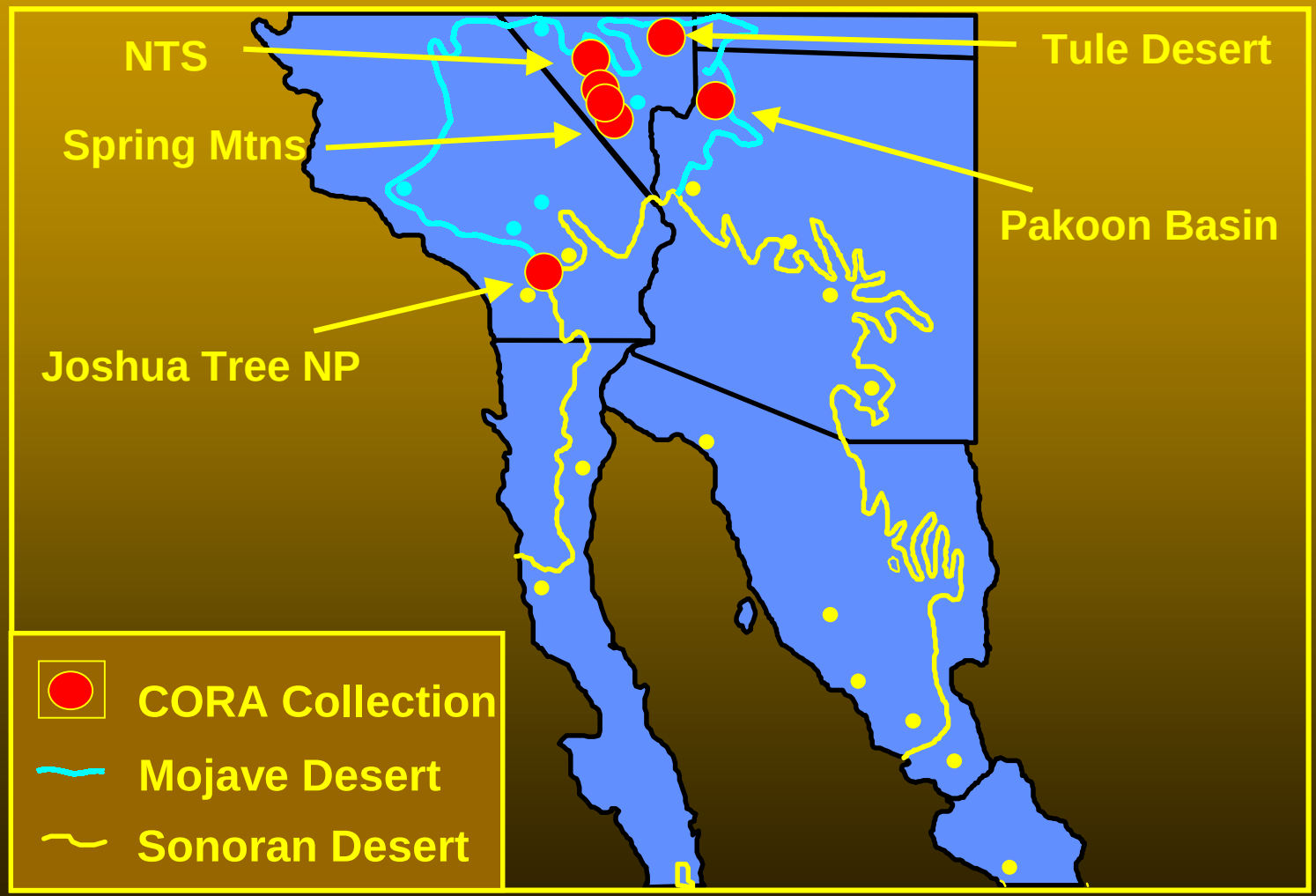
USGS A rodent cache germinating 2 blackbrush seedlings

A Pulse Event?

Is blackbrush establishment the result of a climatic event that affected the entire Mojave Desert in 1993?



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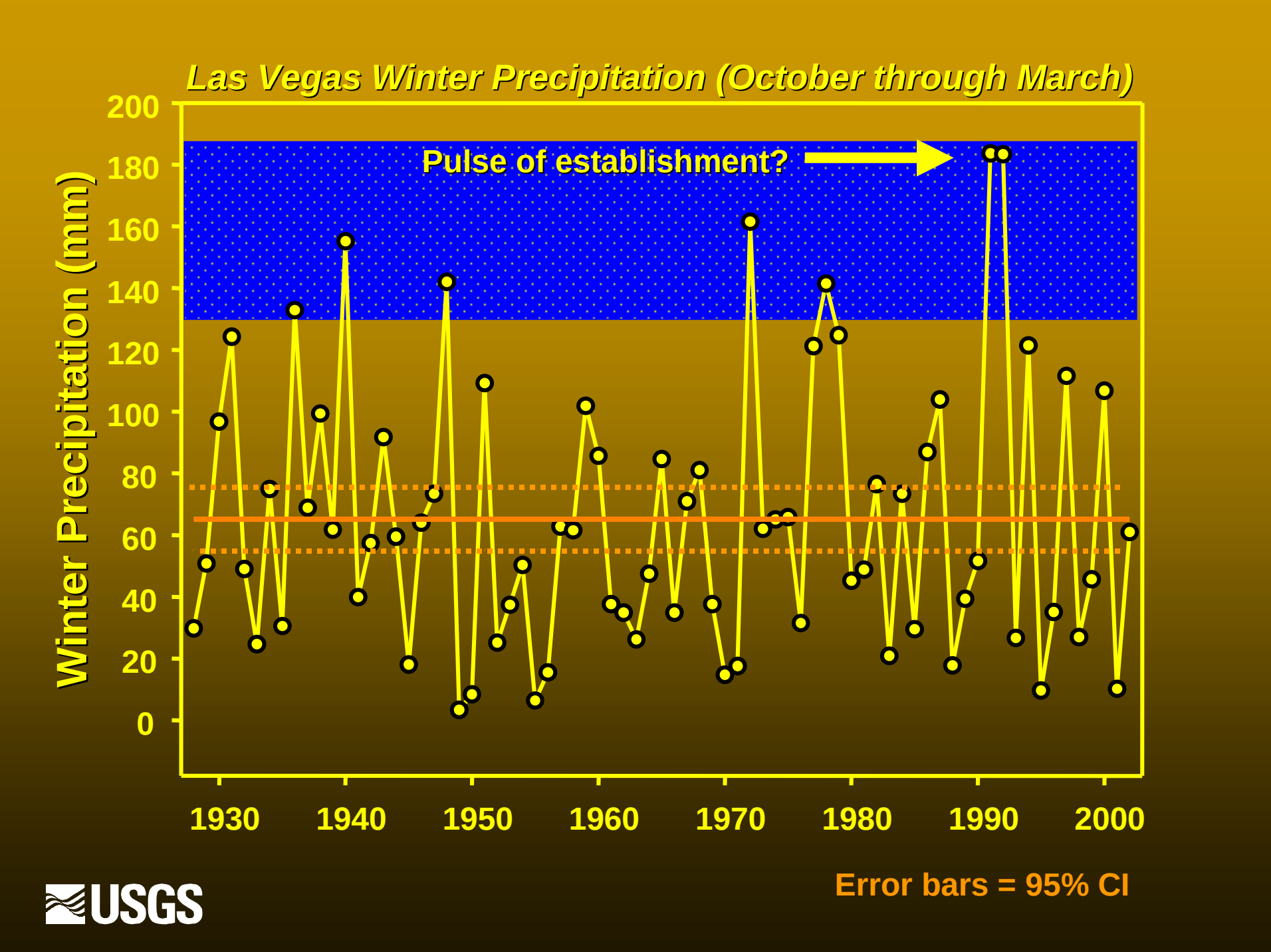
Las Vegas Winter Precipitation (October through March)
Winter Precipitation (mm)
200
180
160
140
120
100
80
60
40
20
0
Pulse of establishment?
1930
1940
1950
1960
1970
1980
1990
2000
Error bars = 95% CI
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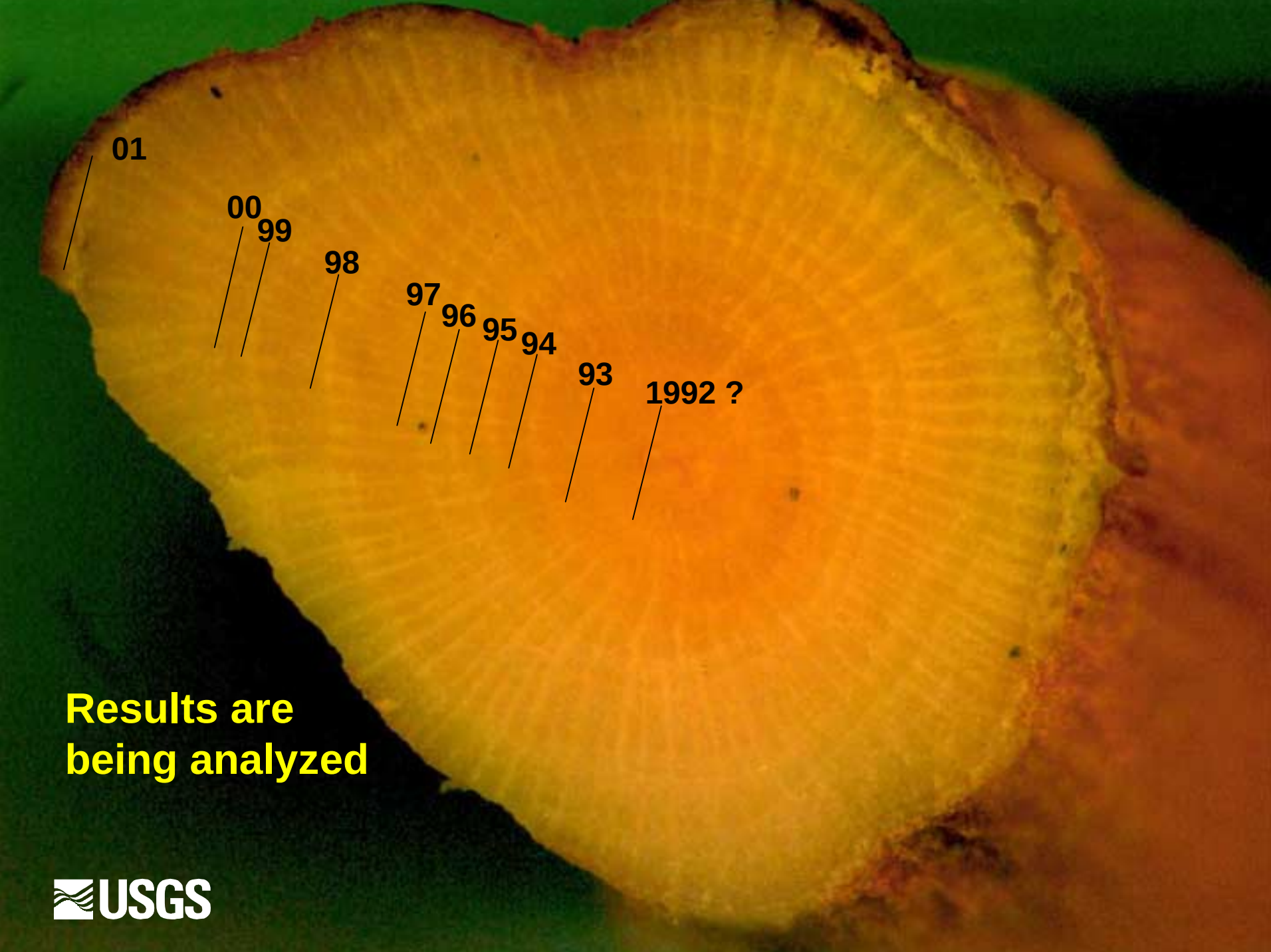
01
00
99
98
97
96
95
94
93
1992 ?
Results are being analyzed
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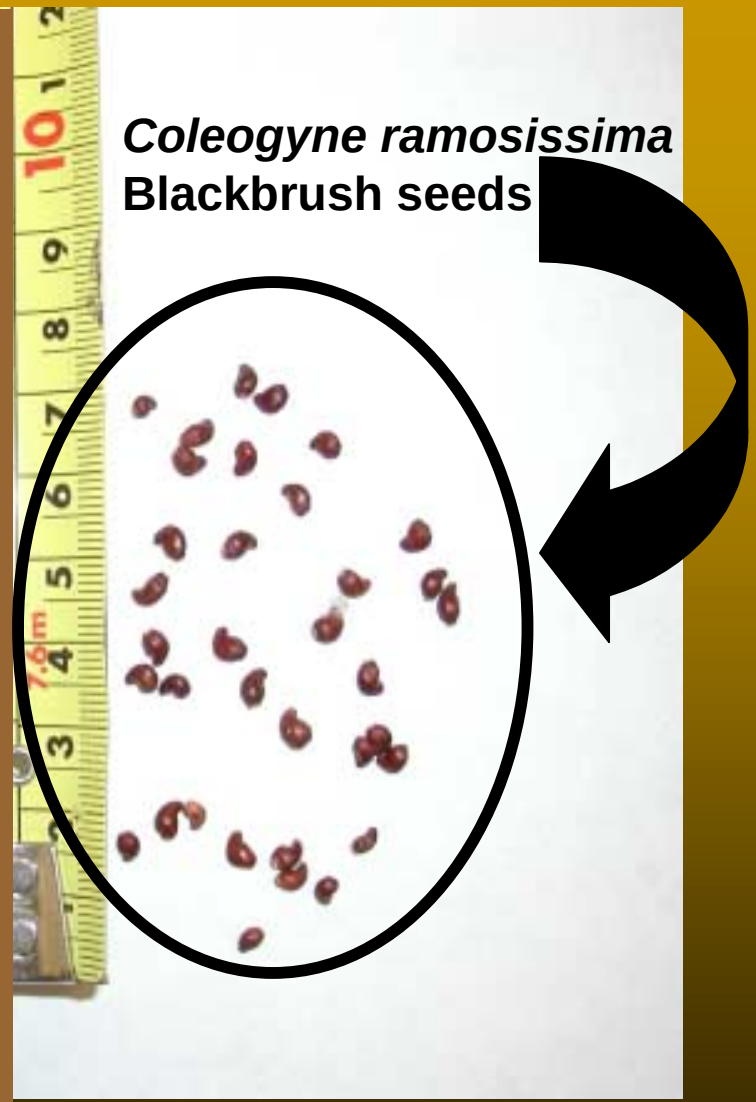
How can we determine the costs and benefits of rodent : plant interactions?

↓

Seed Fate Experiments

- **Collect Seed**
- **Radio-label seeds**
- **Place in the environment**
- **Follow them through the seasons**



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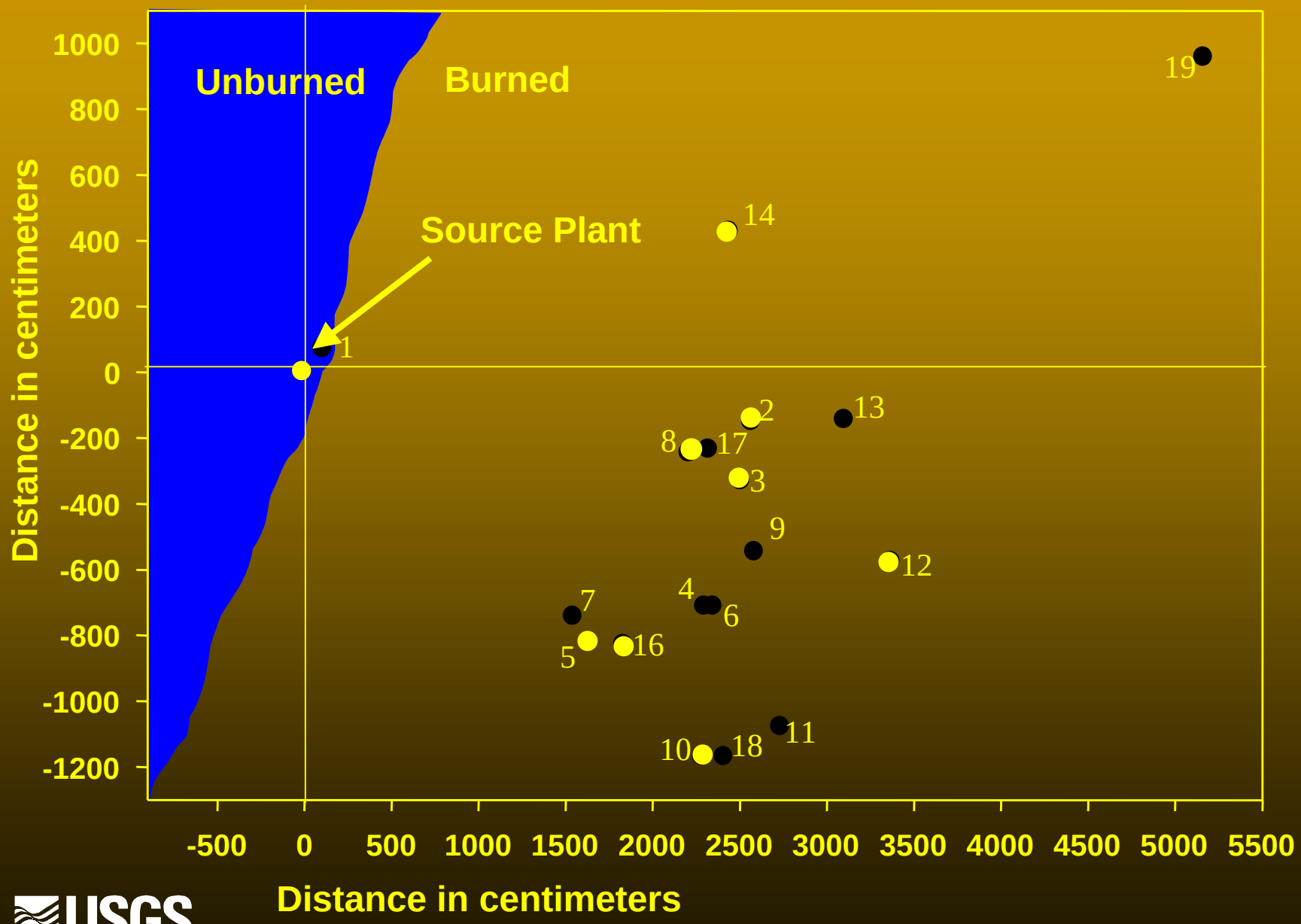

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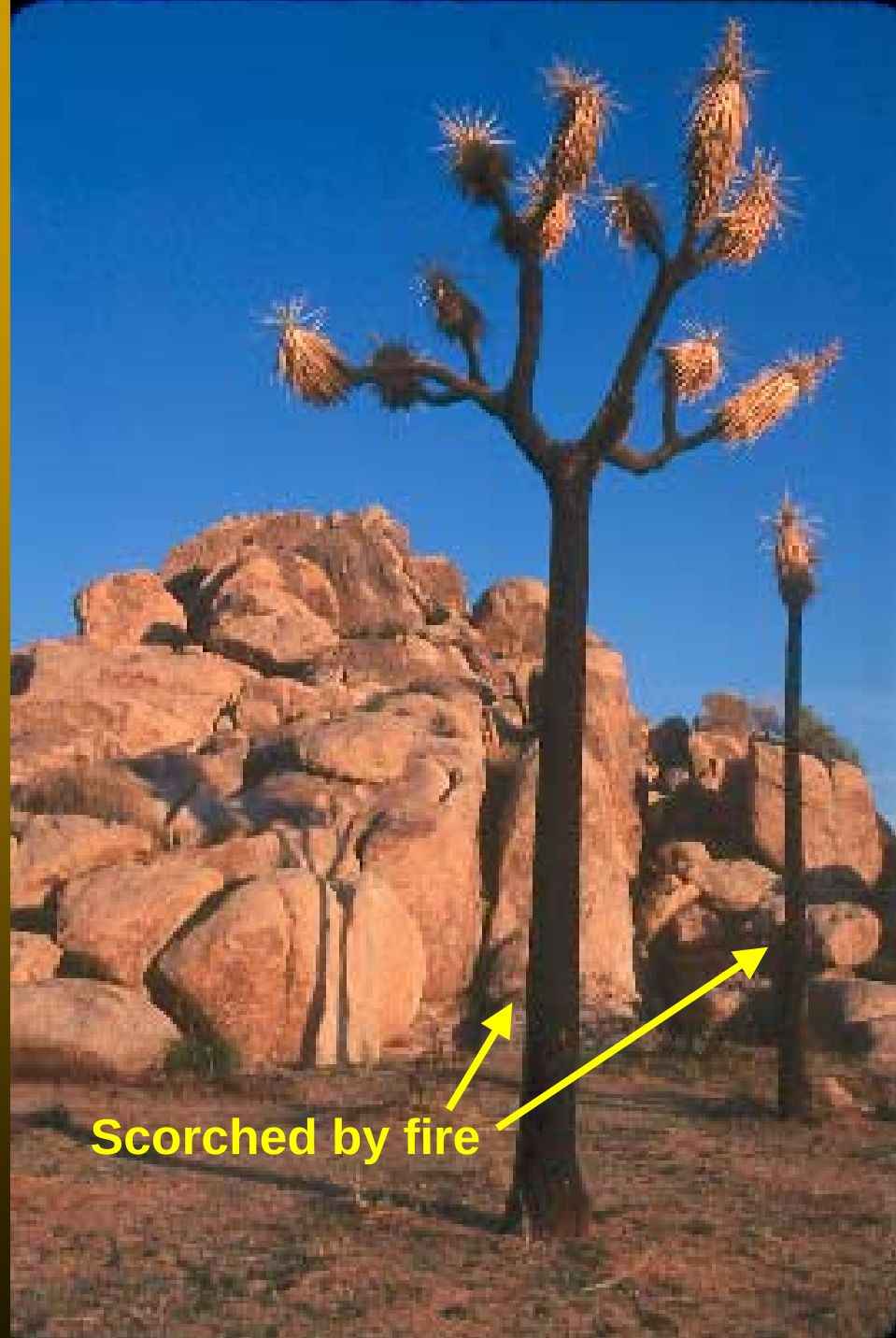
VanderWall, et al. – *Unpublished Data*

How do fire and small animals affect long-lived desert plants?

Joshua Trees
(*Yucca brevifolia*)



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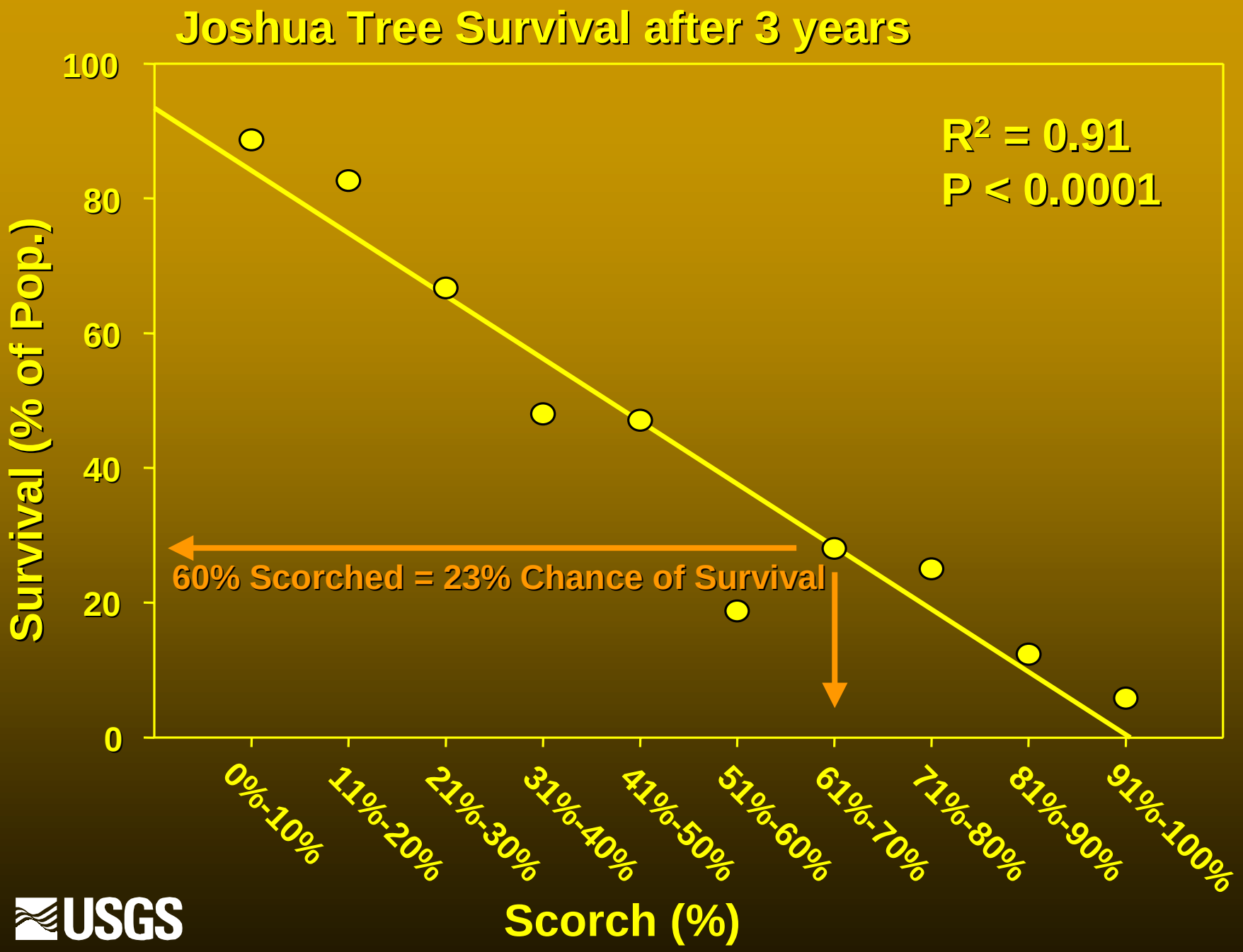
Joshua Tree Survival after 3 years
100
80
60
40
20
0
Survival (% of Pop.)
$R^2 = 0.91$
$P < 0.0001$
60% Scorched = 23% Chance of Survival
0%-10%
11%-20%
21%-30%
31%-40%
41%-50%
51%-60%
61%-70%
71%-80%
81%-90%
91%-100%
Scorch (%)
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Adding insult to injury…..

In fall of 2001 joshua trees At JTNP started looking like this

It was so obvious that the local newspaper did an article on it

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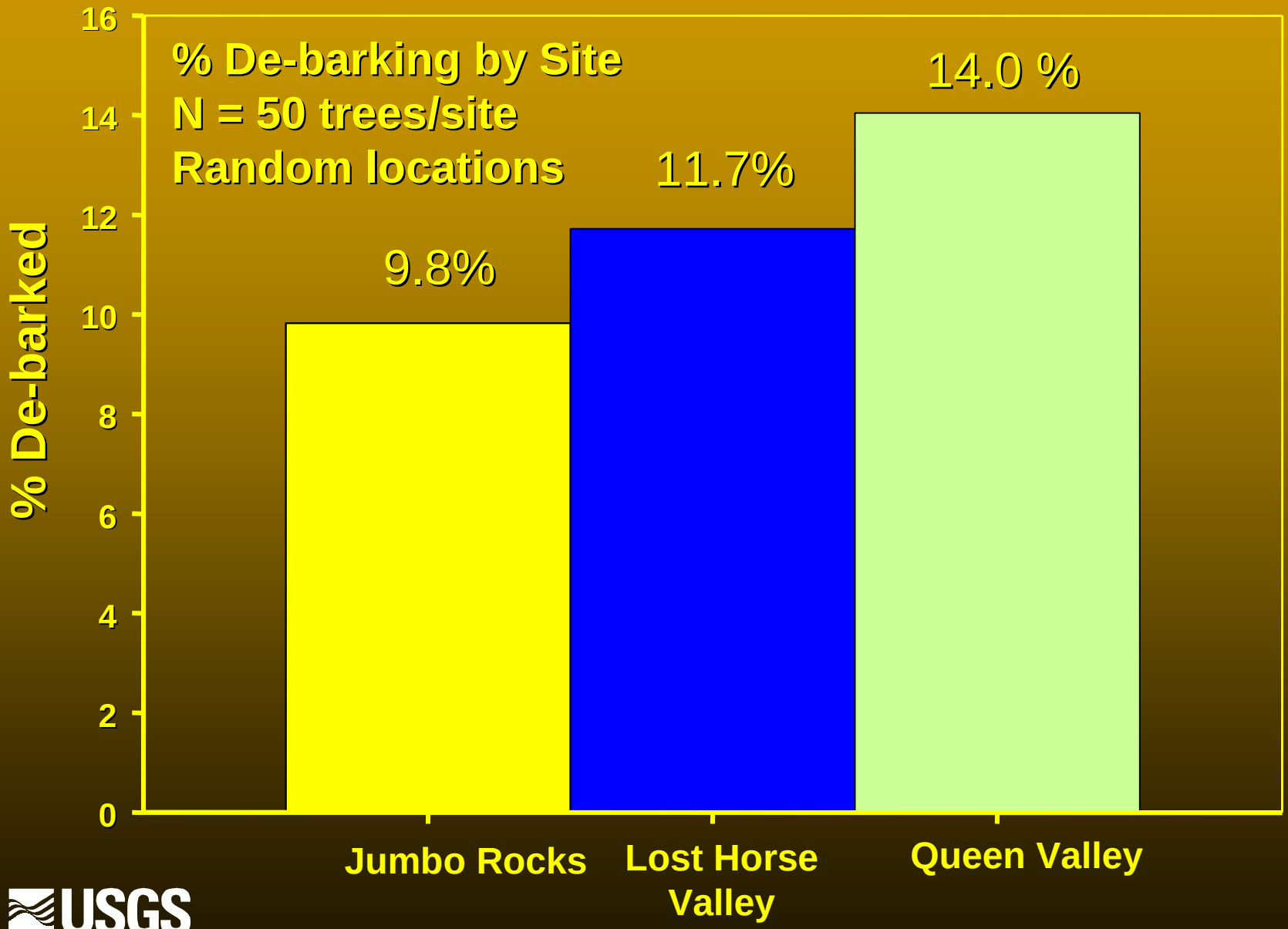
A view of rodent damage
under the microscope
1 mm

Joshua Tree National Park 2001 & 2002



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New
Scars
Old Rodent
Scars
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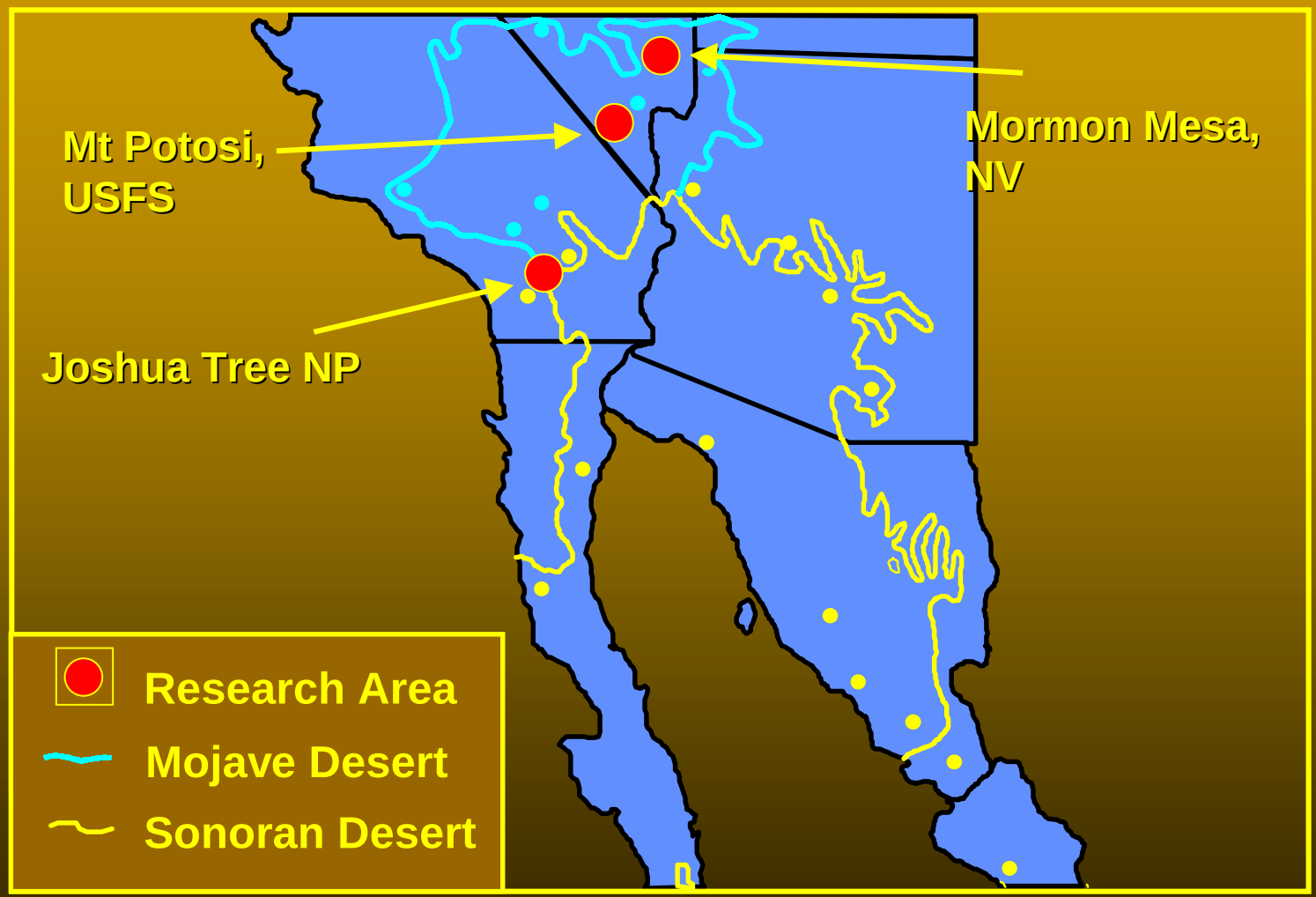
How widespread is the de-barking phenomenon?



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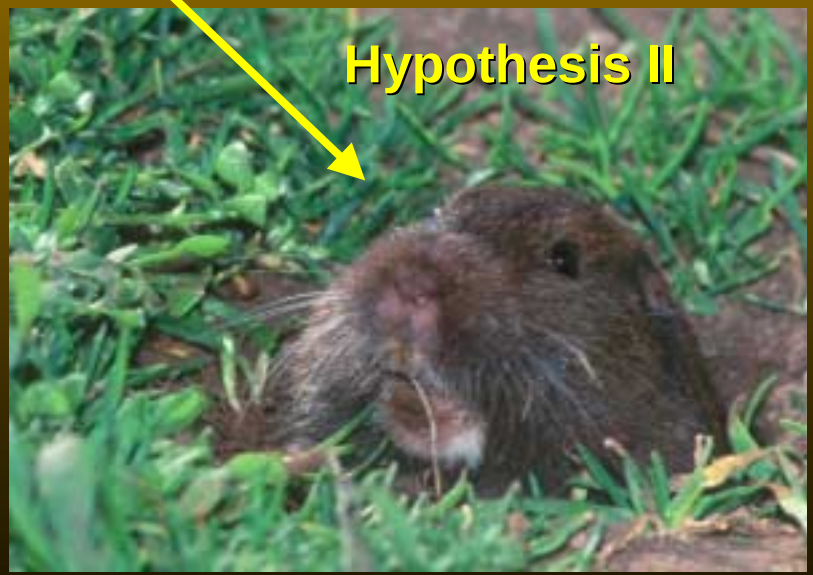
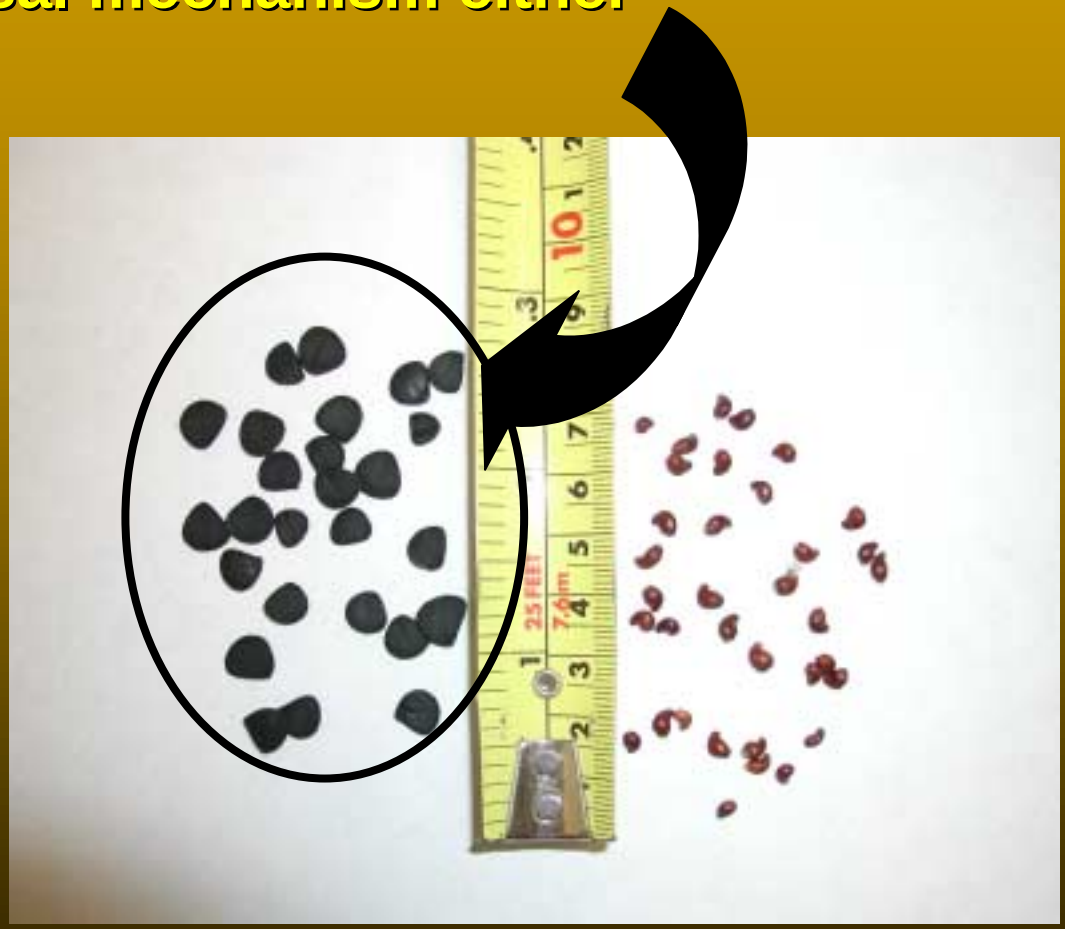
Small mammal damage was greater on recently burned sites than on unburned sites

***Pocket gopher Thomomys* sp.**



Joshua Tree seeds have no apparent dispersal mechanism either



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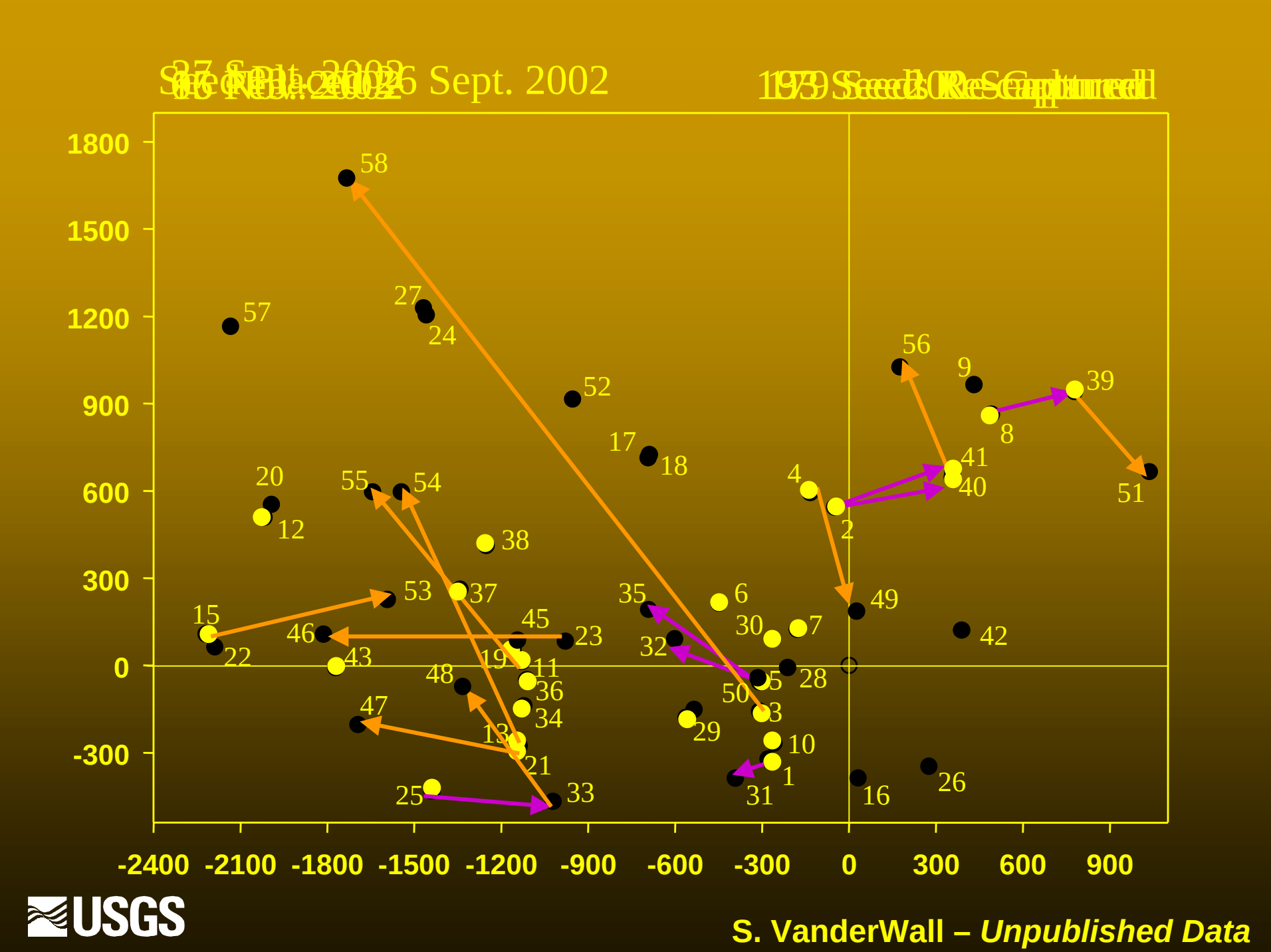
USGS Source Plant - 200 individually numbered seeds


26 Sept. 2002
1800
1500
1200
900
600
300
0
-300
-2400
-2100
-1800
-1500
-1200
-900
-600
-300
0
300
600
900
58
57
27
24
52
17
18
56
9
39
8
41
40
51
4
2
20
12
55
54
38
53
37
35
6
49
15
22
46
43
45
23
30
7
42
32
19
11
48
36
28
5
50
47
34
3
29
13
10
21
1
25
33
31
16
26
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S. VanderWall – *Unpublished Data*

Summary 1 – Natural Restoration Processes

How do ants, rodents, fire, microsite, and climate affect annual plant seed banks?

Rodents and ants increase aliens while decreasing native seed bank density.

Fire increases aliens while decreasing natives

Native seeds more abundant in open, while alien seeds more abundant in shrubs

Climate affects aliens and natives similarly, but there was a 10-fold increase in aliens over natives in a good year.

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Summary 2 – Natural Restoration Processes

What is the pattern of natural restoration for perennial vegetation?

Short-term (3-10y)

Short-lived herbaceous and woody plants with

Definite increasers and decreasers

Long-term

After 50 years, similar cover, but skewed composition

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Summary 3 – Natural Restoration Processes

How do rodents respond to large-scale Disturbance like desert wildfires?

Predict short-term response to severe disturbance to be lower diversity and abundance

Long-term responses depend on the trajectory of the vegetation, but diversity and abundance can increase

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Summary 4 –Natural Restoration Processes

Costs and benefits of fire and small animals interacting with long-lived plants?

The amount of scorch damage is related to fire intensity and there is a linear relationship between the amount of scorched surface and mortality

Costs of small mammals interactions can be great, but normally within the range of disturbance sustained by *populations*

We hypothesize that rodents are essential to the dispersal of seed for blackbrush and joshua trees

Preliminary data are promising

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Species Richness and Abundance

biomass, density, phenology

Ecosystem Function

nutrient cycling, hydrology, erosion, disturbance

Species Richness and Abundance

biomass, density, phenology