Post-fire regeneration of pine: the role of animal dispersal

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Research questions and motivation

- How do pine forests regenerate after fire? – Prescribed vs. wild fire
- What role do small mammals play in this process? – Animal vs. wind dispersal
- How can forest managers/ecologists use this information?

‘Wind-dispersed’ pines

P. contorta

P. jeffreyi

S Vander Wall

‘Animal-dispersed’ pines

P. coulteri ?

P. monophylla

J. Hollander

Jeffrey pine: 2-phase dispersal

Animals cache (or consume) wind-dispersed seeds

Vander Wall 1992-2002

Caching by:

Ground Squirrel

- 14.9 seeds/cache
- 3 to 25 cm
--only 3/16 made >5 caches

Chipmunks

T. quadrimaculatus

- 6.7 seeds/cache
-1 to 4 cm

T. amoenus

- 3.9 seeds/cache
-1 to 3 cm

Deer mouse

-1.3 seeds/cache
- 0 to 1cm

40 animals combined:

prefer mineral soil under shrubs

Succession and Disturbance

H. Klieforth

- Development of plant communities after disturbance
- Facilitation by animals?
- Historic fire return interval JP/MC : 5-20 yr (*Skinner and Chang 1996*)

3 Experiments:

1) What are the fates of seeds dispersed before a fire?

2) Do animal communities change after fire?

3) What are the fates of seeds dispersed after a fire?

(Supplement- results of behavioral experiments)

Recent Wildfires

Gondola Fire

July 2002

Martis Fire

July 2001

Martis wildfire after 5 months

Floriston wildfire after 2 yrs

Prescribed burns at Incline Village, Nevada

IVGID and Norb Sczurek,

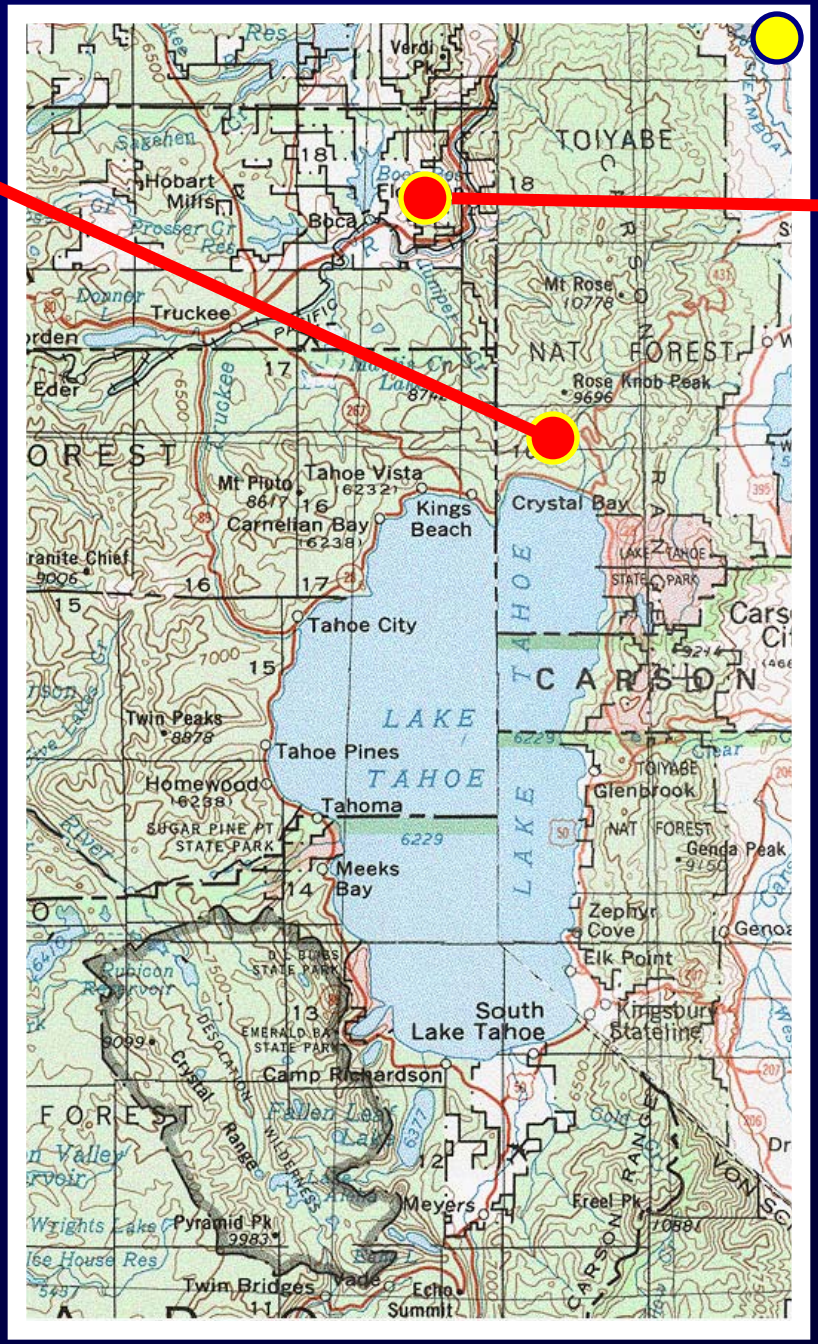
Mitch Geissinger, NLTFPD

Incline Village prescribed burns

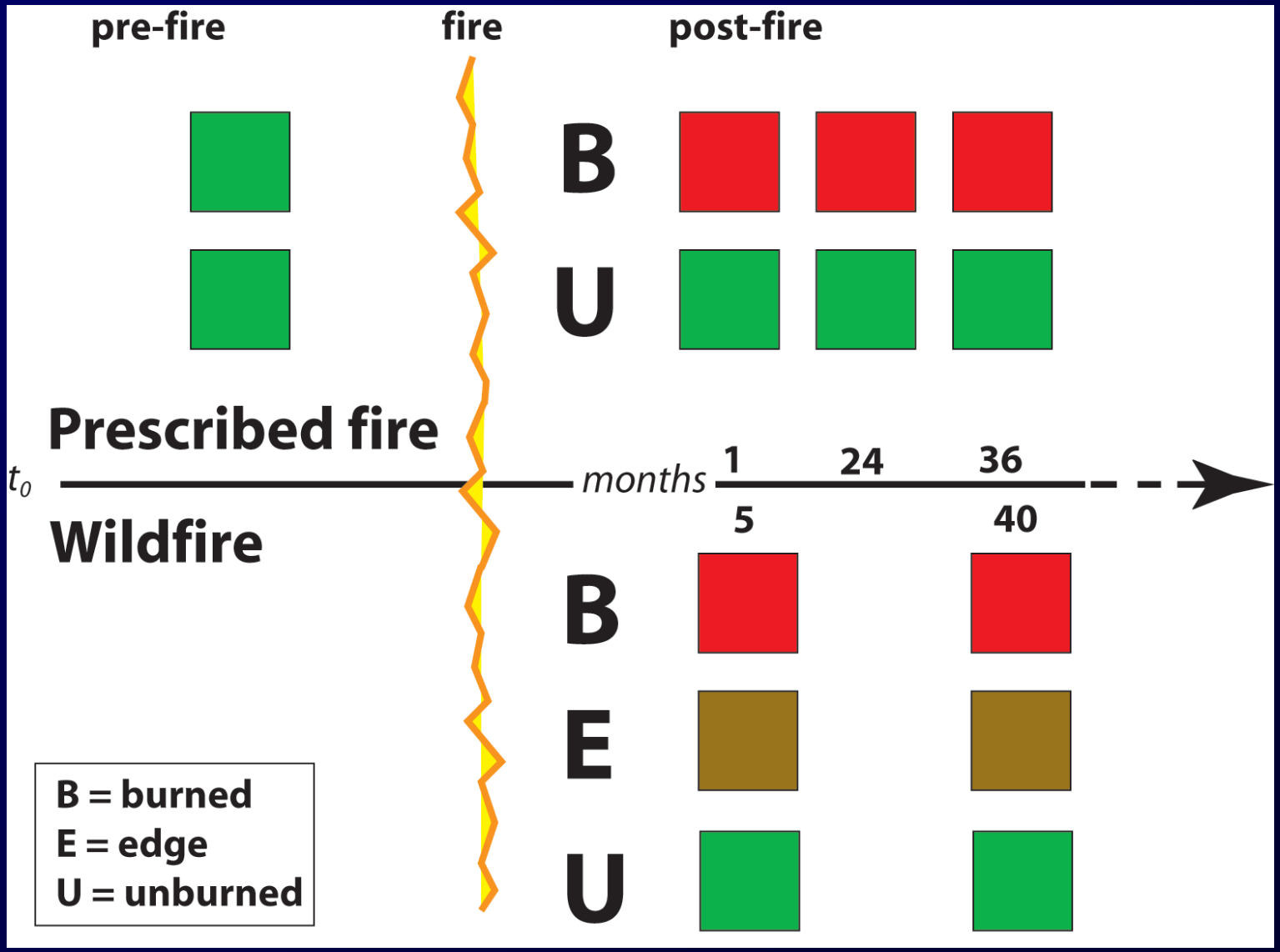
1999-2001

(Incline Village Gen. Improvement Dist.; N. Lake Tahoe Fire Dept.)

plot size: 7-37 ha.



Study Design



1) What happens to seeds dispersed before a burn?

Hypothesis: Animal-dispersed seeds survive and grow better than wind dispersed seeds

Methods

3 pairs treatment/control plots

n= 378 caches, 2000
n= 540 caches, 2001

Substrate—soil, litter

Cover– open, under shrub

Depth– surface, 5 mm, 25 mm

Regression/Survival analysis

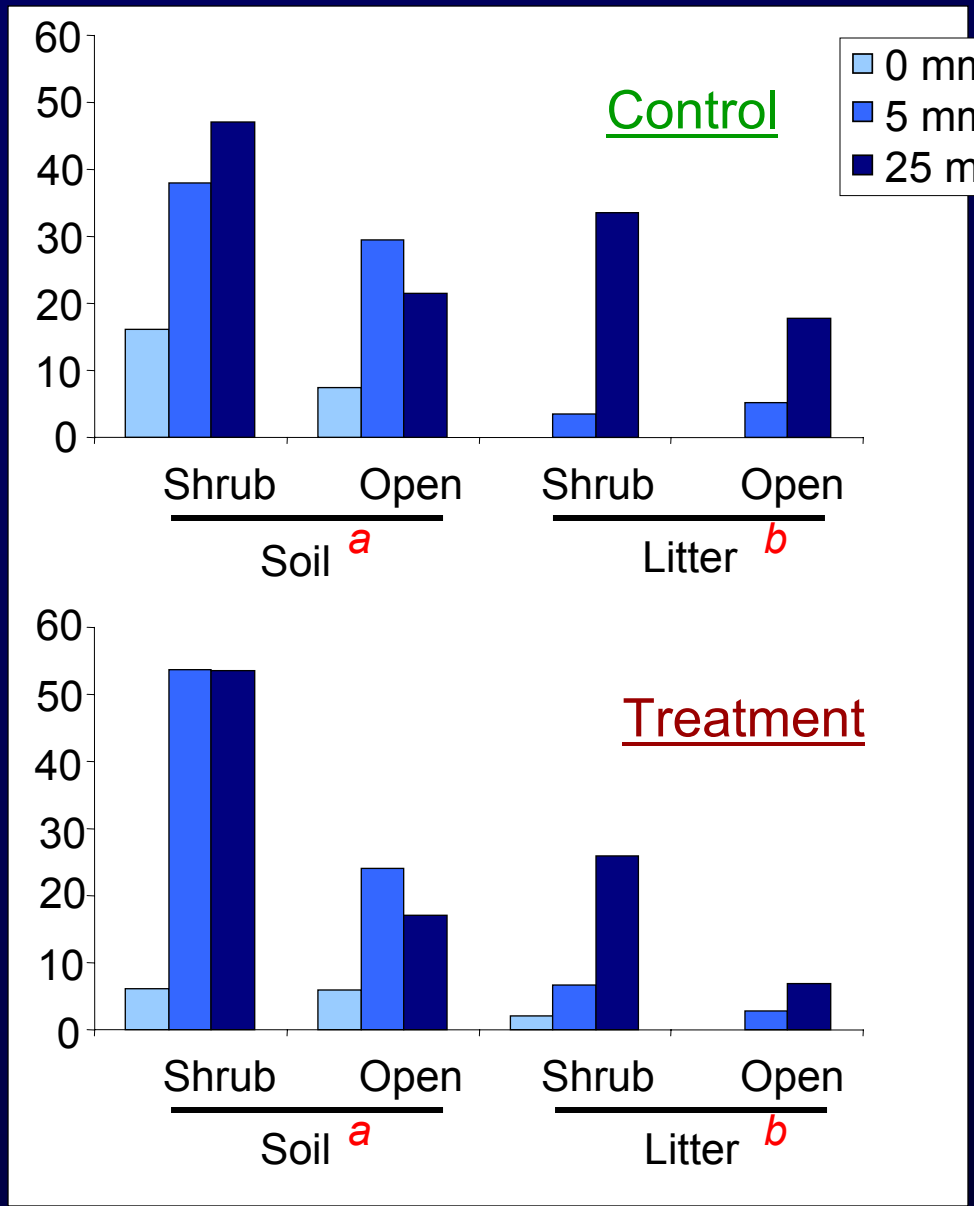
Results

Surface seeds die!

Burial in soil seems crucial

Results: Emergence

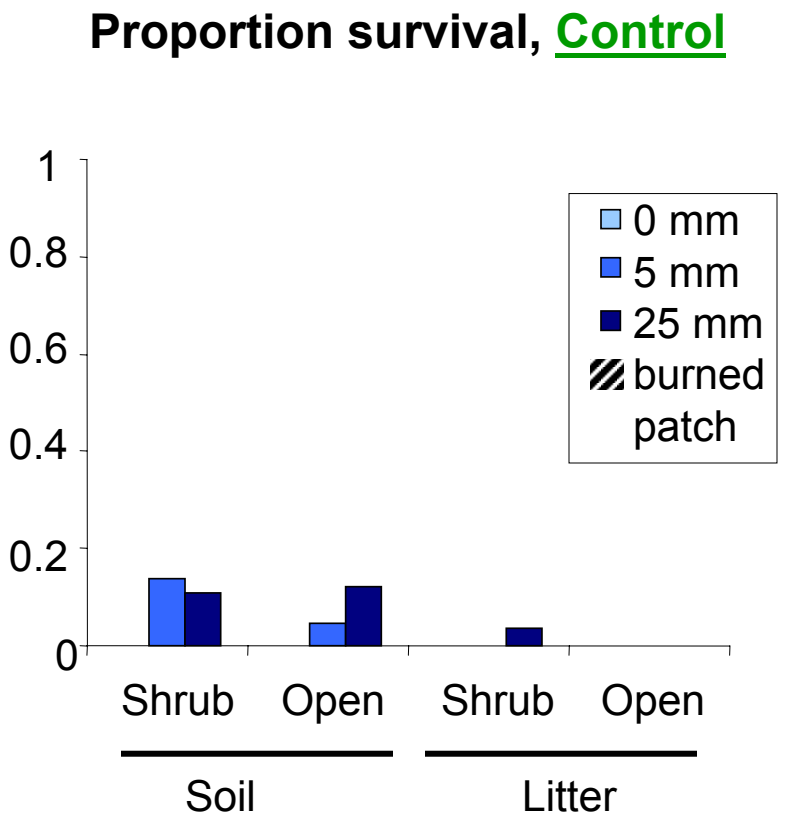
percent emerging per category

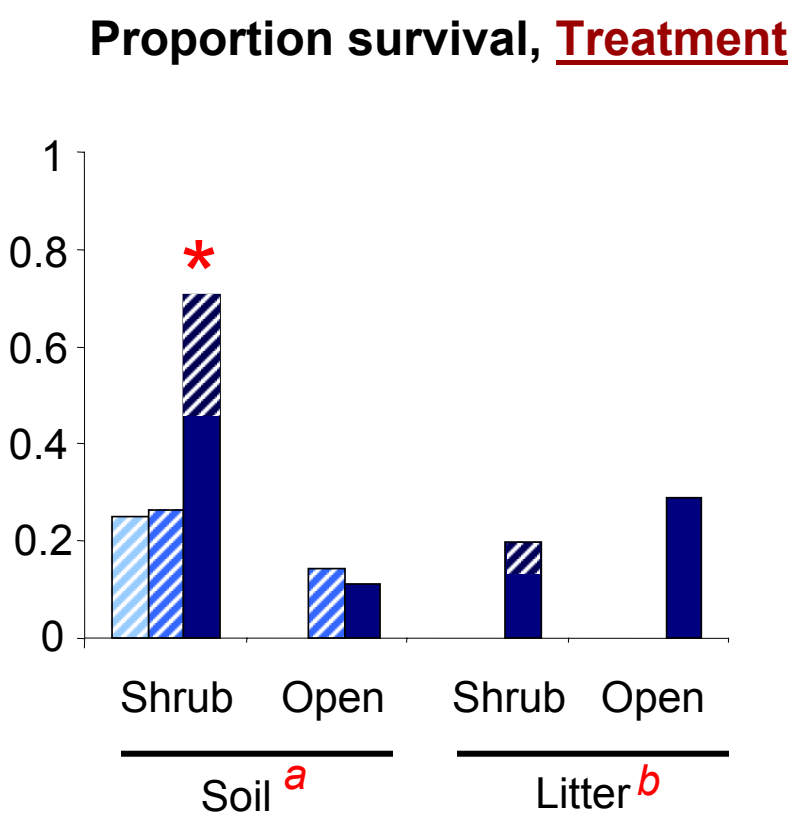


percent emerging per category

unlike letters = $p<0.05$, odds ratios for logistic regression

Results: Survival (1 yr)



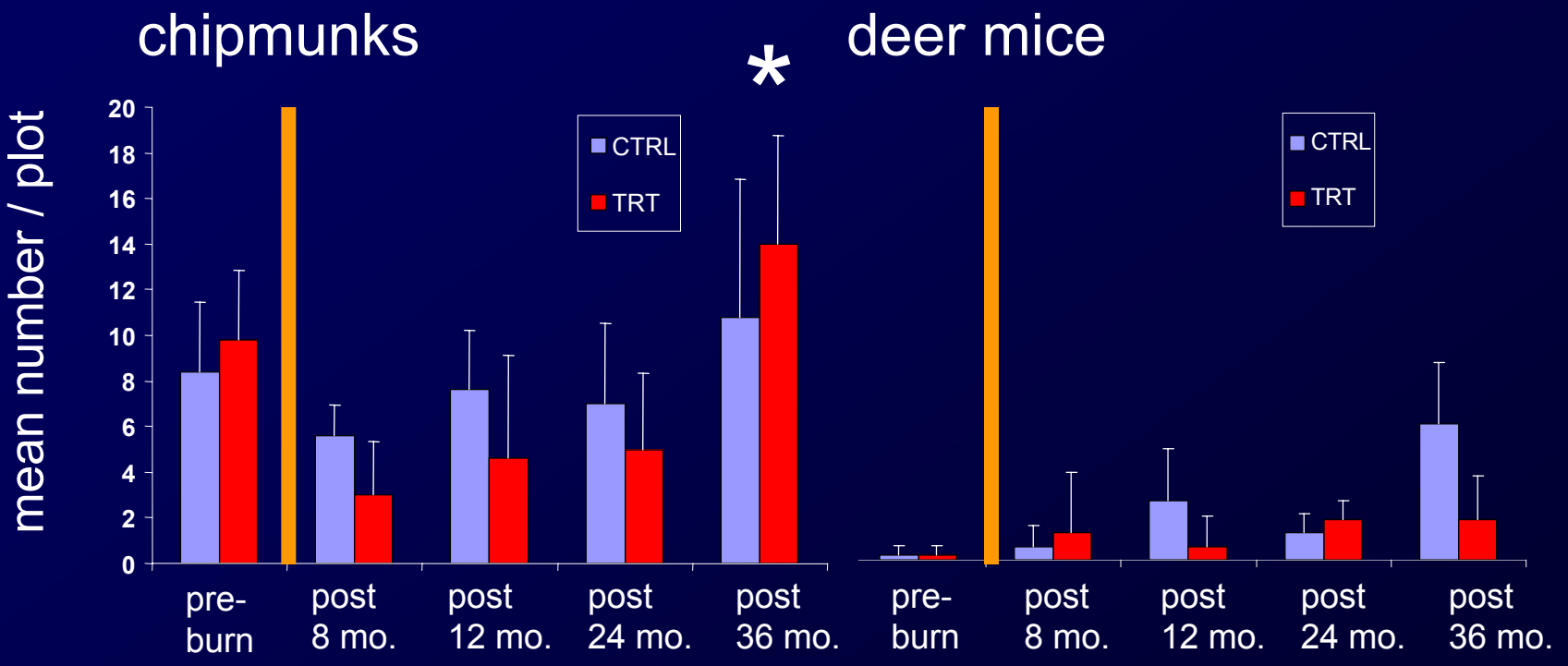


2) Do animal communites change after a fire?

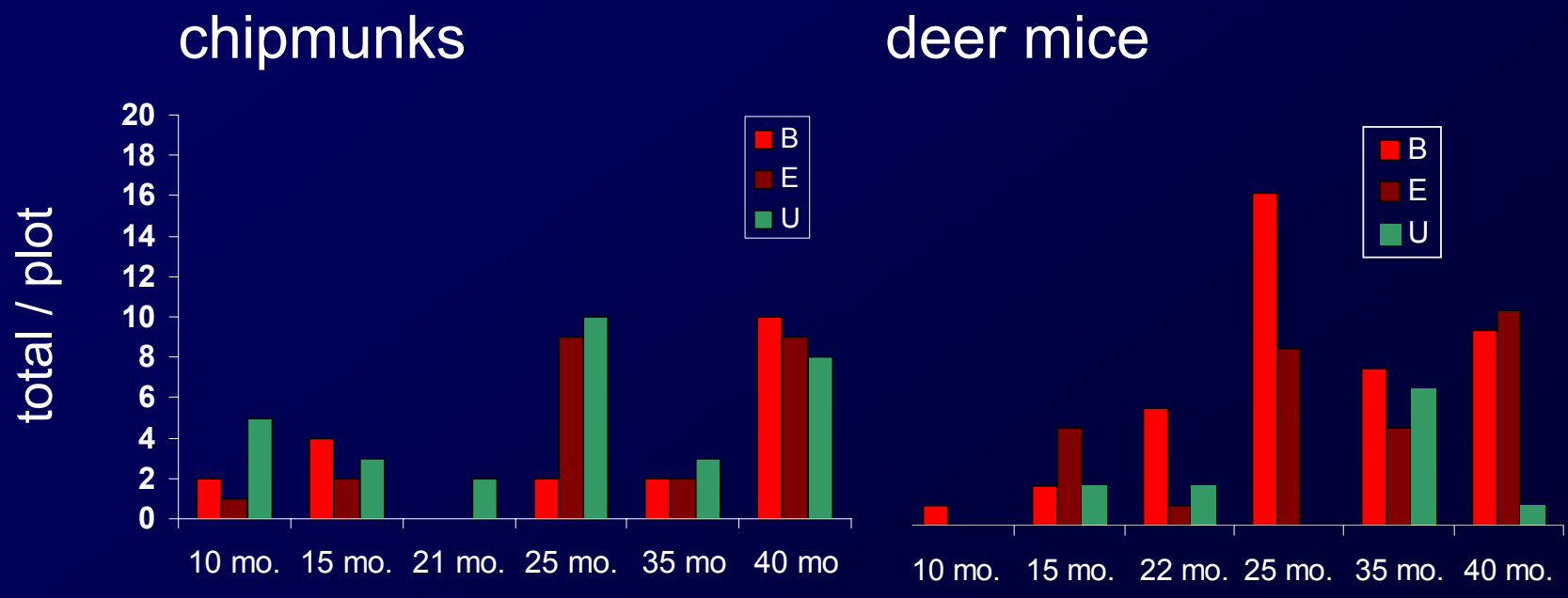
Hypotheses: Chipmunks leave the area for several years
Deer mice recolonize rapidly

Results: Incline prescribed burns

(n= 5, 1999)



Results: Floriston wildfire



2 b) Does animal behavior change after fire?

-Seed removal rates (= foraging) tracked pop. size

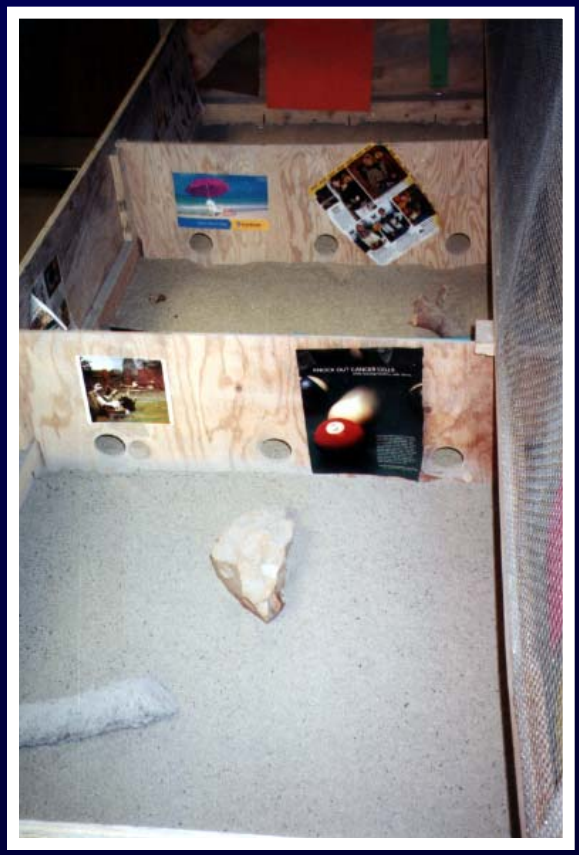
-Few clumps of seedlings (= caching) in field

...but drought

→ Lab study with 12 captive chipmunks

Arena: 6 compartments (3 ash, 3 sand)

Tunnel, nest box, removable floors, wall art



→ Caching in ash occurred sig. more often

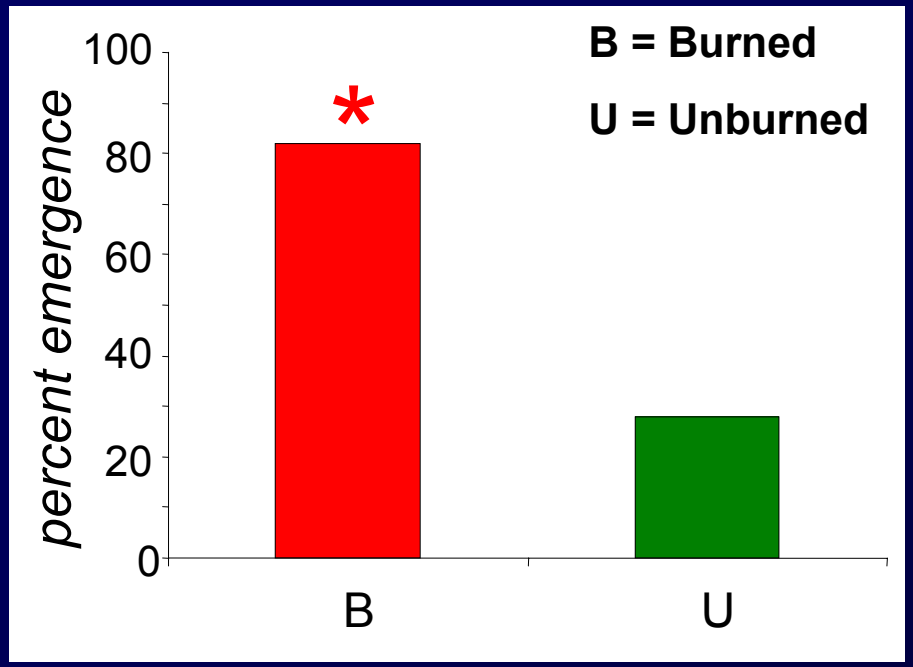
→ Pilfering in ash occurred sig. less

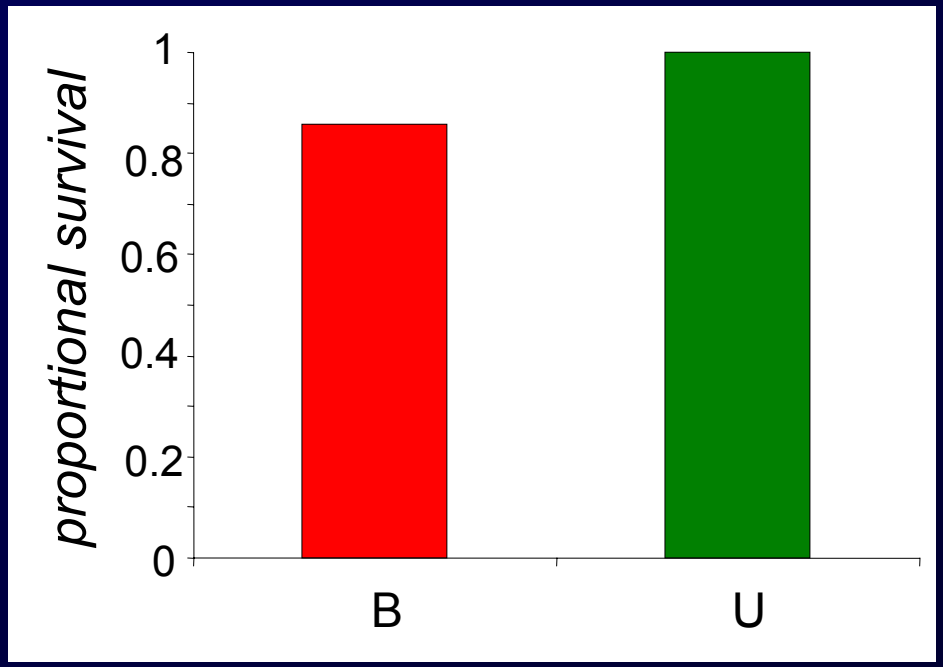
3) What are fates of seeds dispersed after fire?

Hypothesis: Buried seeds fare better than surface seeds

Results: emergence and survival

Prescribed burns (1 mo)



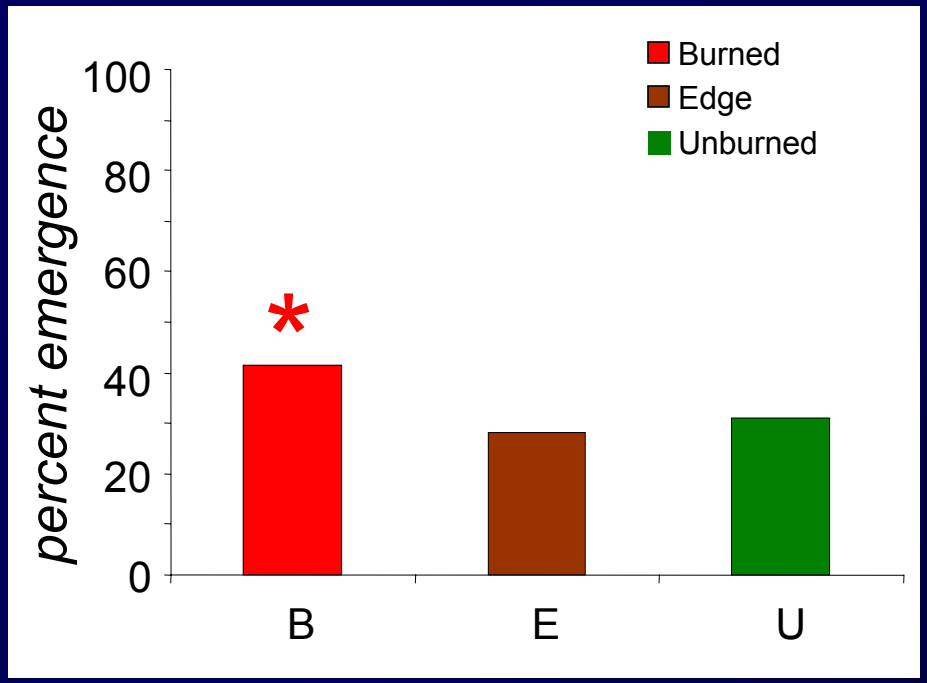


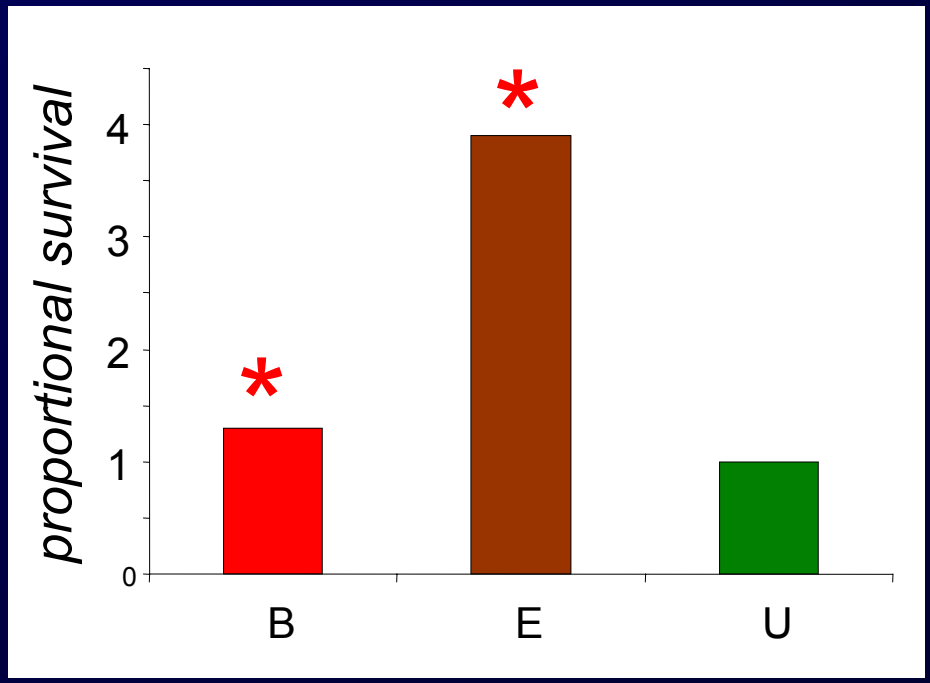
* odds ratio = 14.8, p=0.002

survival ratio = 0.89, p>0.05

Results: emergence and survival

Wildfire (3 yr)





* odds ratio = 6.1, p=0.0005

survival ratios = 1.3 (B), 3.9 (E), p<0.0001

Summary: Q1

a) “Wind-dispersed” seeds fared badly on burns + ctrls

b) Emergence of “animal-dispersed” seeds was similar on burns + ctrls

c) Survival of seedlings was longer on burns

d) Burial in soil and under shrubs enhanced all emergence and survival

Summary: Questions 2-3

2) Rodent pop. declines were brief in both studies

Caching occurred in ash

3) Seedling emergence was greater and survival was similar (or greater) in ash vs. soil

Conclusions

- Prescribed burns maintain and enhance seed dispersal by animals
- Late fall, patchy, small burns favorable
- Process more episodic after severe wildfires?

Implications for restoration

Best to burn after seed fall and caching occurs

Post-fire environment favors seedlings– more resources?

Seed-broadcasting post-fire may succeed:

-Ash substrate enhances “burial” of fallen seeds

-Ash impairs retrieval (olfaction) by rodents

→Seeds remain undetected and protected longer

Where/when to distribute seed? Target and/or decoy?

Wind dispersal may be prolific at times . . .

. . .but for mild burns in late fall, animals are effective, inexpensive reseeding agents.

Acknowledgments

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