Seed bank density and viability in Santa Catalina chaparral shrub species

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“Team Seed”

Collaborative project between the labs of Dr. Anna L. Jacobsen & Dr. R. Brandon Pratt

CSU Bakersfield, Biology

Photo Credit: Dr. Anna Jacobsen

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Photo Credit: Dr. Anna Jacobsen

Photo Credit: Dr. Anna Jacobsen

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Photo Credit Top: Chevron Corporation

Photo Credit Bottom:https://en.wikipedia.org/wiki/United_States_Department_of_Education

Introduction

Southern California is 1 of 5 locations globally with a **chaparral shrubland biome**.

- mediterranean-type climate
- globally significant biodiversity
  - 16% of world plant species
  - 2.25% of world land area

Photo Credit: https://www.visitcatalinaisland.com/things-to-do/land-tours/discover-avalon/

Introduction

Catalina Island is located southeast of Los Angeles off the coast of southern California.

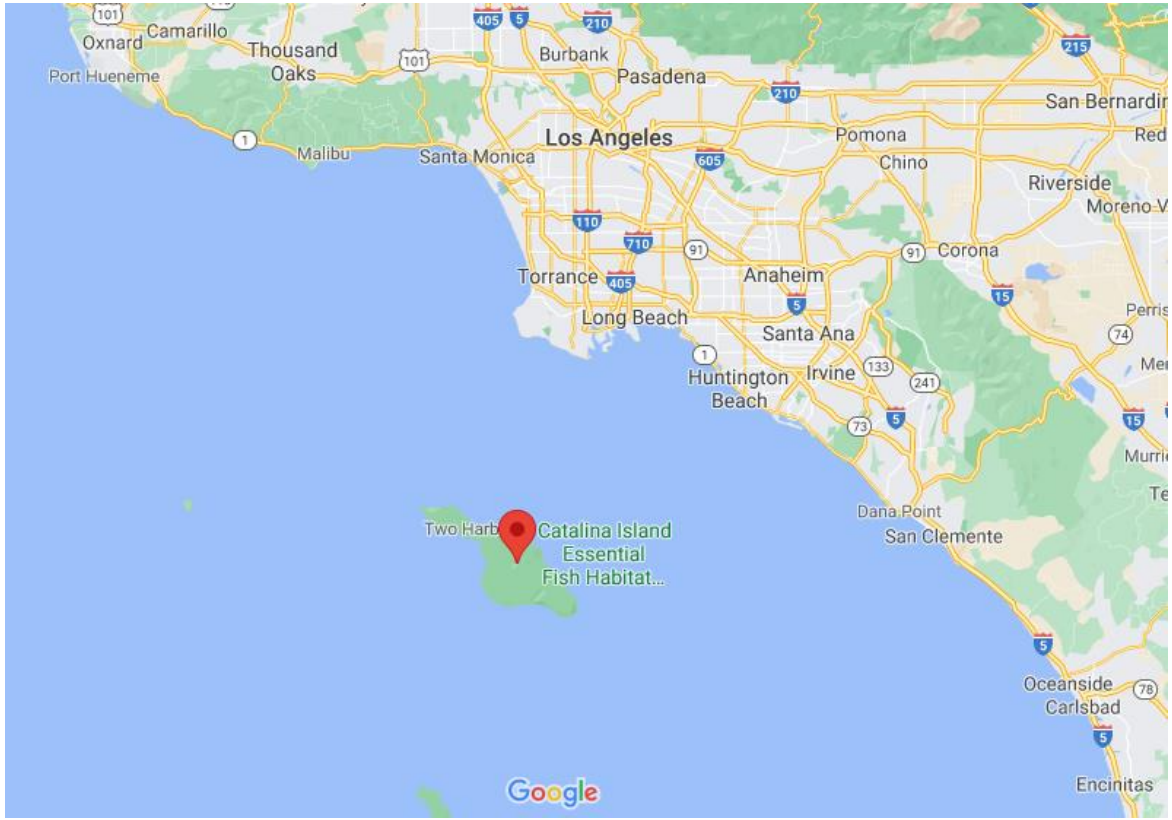


Photo Credit: https://www.google.com/maps/place/Santa+Catalina+Island/@33.7033005,-118.9089299,9z/data=!4m5!3m4!1s0x80dd6f237be18b25:0x3e59a3d5c5f50eab!8m2!3d33.3878856!4d-118.4163103

Introduction

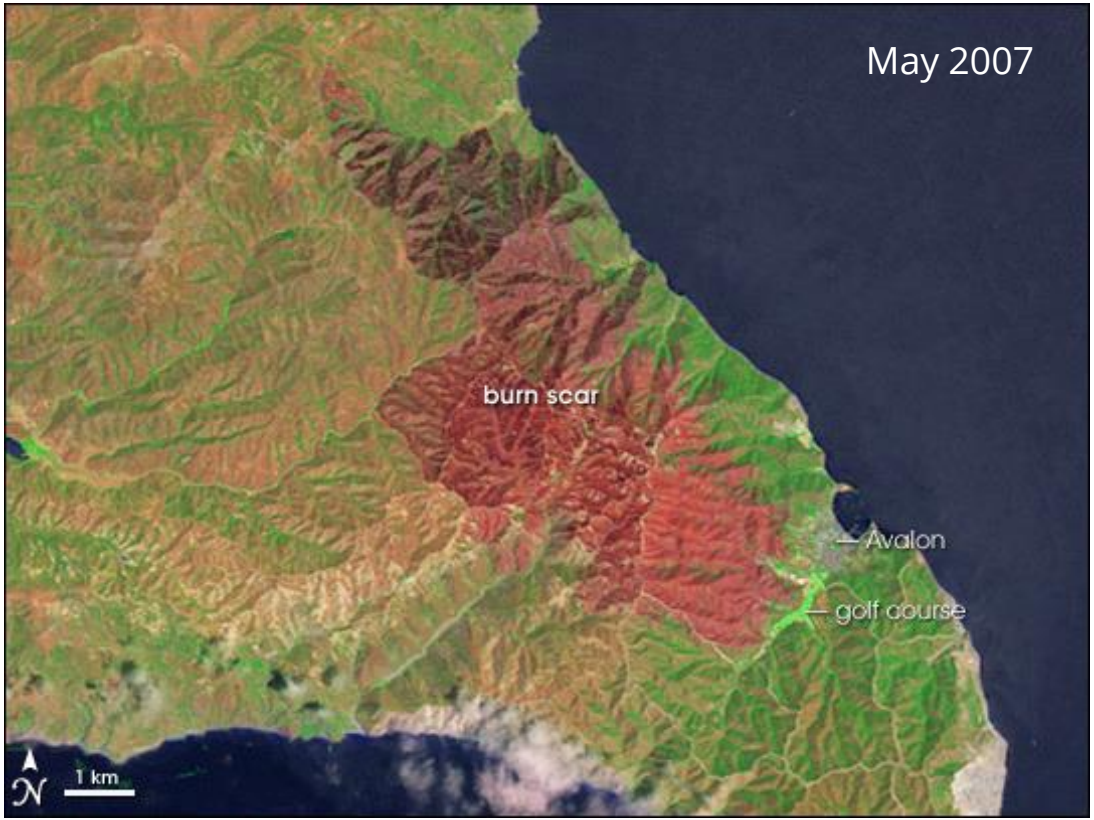


Photo Credit: https://earthobservatory.nasa.gov/images/8207/burn-scar-on-santa-catalina-island

- In recent years, fire events have become more common.
- Obligate seeders species
  - Adult plants burn and seeds germinate post-fire from a soil seed bank
  - Frequent fires threaten seed bank replenishment
  - Without a seed back, species will be extirpated by a fire

Introduction – our study sites

Introduction

- Mule Deer: Browsers, brought for game
- Bison: Grazers, herd managed

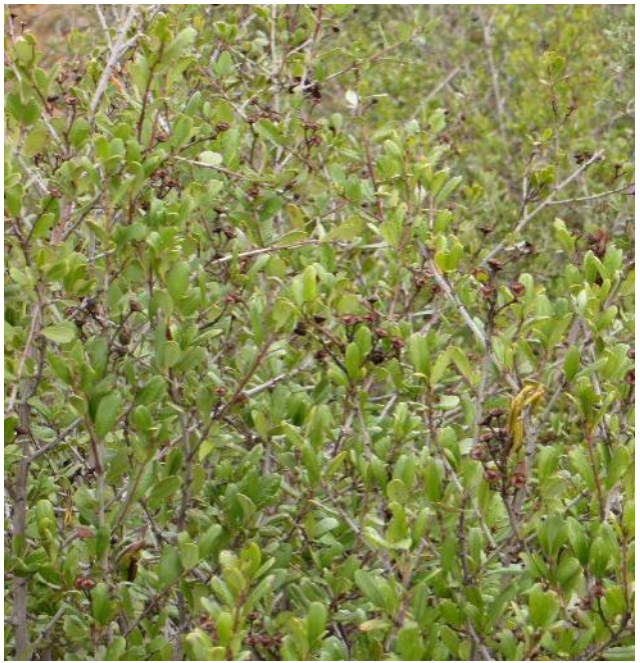
Photo Credit: Bob Chamberlin/Los Angeles Times
https://www.latimes.com/science/la-me-adv-catalina-deer-20140606-story.html

Photo Credit: Ferrebeekeeper. **https://ferrebeekeeper.wordpress.com/2019/08/19/the-buffalo-of-catalina-island/**

Introduction

Arctostaphylos catalinae

Ceanothus megacarpus



Ceanothus arboreus

Photo Credits: Dr. Anna Jacobsen

Introduction – each site has a fenced area (protected from browse) and a non-fenced area

C. arboreus at Summit site

Photo Credit: Dr. Anna Jacobsen

Question & Hypothesis: Natalie

Question: How does seed bank density differ between protected and unprotected sites?

Hypothesis: **Browsers influence seed bank density.**

Predictions: Natalie

- It was observed that deer favored the *C. arboreus* more than the other species (Jacobsen *et al.* 2018).

Soil seed bank abundance:

Fenced Status: **Protected > Unprotected**

Protected: ***C. arboreus* > *C. megacarpus* > *A. catalinae***

Unprotected: ***A. catalinae* > *C. megacarpus* > *C. arboreus***

Question & Hypothesis: Karely

Question: How does seed bank density differ between soil conditions in protected sites?

Hypothesis: **Soil moisture conditions influence seed bank density within protected sites.**

Predictions: Karely

- Hairpin has wet soil and Summit has dry soil (Jacobsen *et al.* 2018).

Prediction: *Ceanothus arboreus* seed bank density will be **greater** at **Hairpin** site than **Summit** site within protected areas.

Question & Hypothesis: Wyatt

Question: How does seed viability differ among protected and unprotected sites?

Hypothesis: **The presence of large invasive mammals (i.e. mule deer and bison) negatively affects seed viability.**

Predictions: Wyatt

- Fences were primarily [used] to limit deer access to shrubs, but also [limit] trampling by deer and bison (Jacobsen *et al.* 2018).

Seed Viability: **Protected > Unprotected**

Question & Hypothesis: Wyatt

Question: Can Catalina Island experience a vegetation-type conversion in post-fire regions?

Hypothesis: **Grass seed abundance in unprotected post-fire regions will be different than grass seed abundance in protected post-fire regions.**

Predictions: Wyatt

- A change in the fire regime that reduces the time interval between successive fires alter chaparral shrub community compositions or convert shrublands to alien grass-dominated savannahs or sage scrub communities (Jacobsen *et al.* 2018).

Grass Abundance: **Unprotected > Protected**

Soil Collection

- 4 sites: Hairpin, Summit, Hidden Pond, & Manzanitaville
- 24 soil samples collected per site
  - 12 protected, 12 unprotected
  - 97 samples total
    - 1 extra at Summit, Out

Photo Credits: Dr. Stephen Davis

Soil Sieves

Photo Credits: Dr. Anna Jacobsen

Shrub Seed Identification

- Seeds from 3 target chaparral shrub species:

Photo Credits: Dr. Anna Jacobsen

Grass Seed Identification

- 3 species of grass seed were commonly found in soil
- Categorized as “long”, “short”, and “fuzzy”
- Likely species are *Avena, Bromus madritensis*, and *Hordeum*

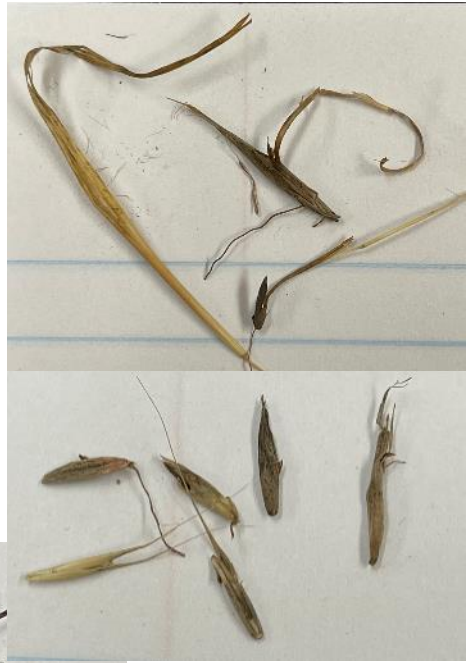


Photo Credits: Natalie Hernandez

Seed Collection and Visual Analysis

- Petri Dish Data: Site, collection year, plot number, fenced status, & total number of seeds
- Seeds separated by appearance of viability

Photo Credit: Dr. Anna Jacobsen

Viability of chaparral shrub seeds: Float Test

- Floaters = Non-viable seeds
- Sinkers = Viable seeds

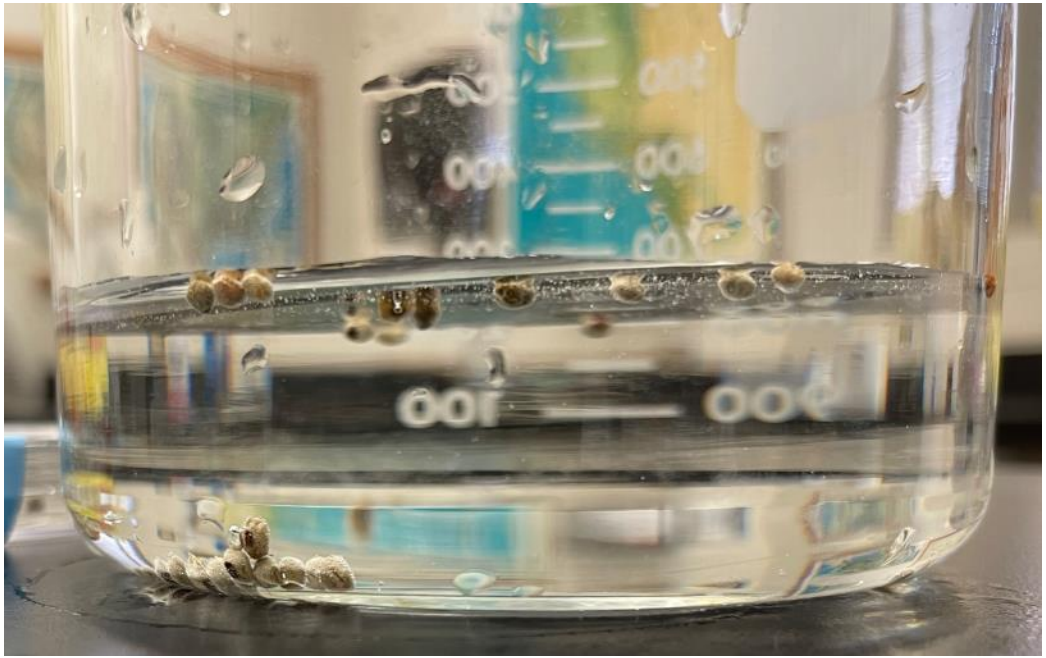


Photo Credit: Natalie Hernandez

Viability: Seed Micro-CT Scanning

- Vials separated seeds via float test results
  - Floaters (assumed to be non-viable) or sinkers (assumed to be viable)
- Measure of accuracy and results conformation from the float test

Photo Credit: Natalie Hernandez

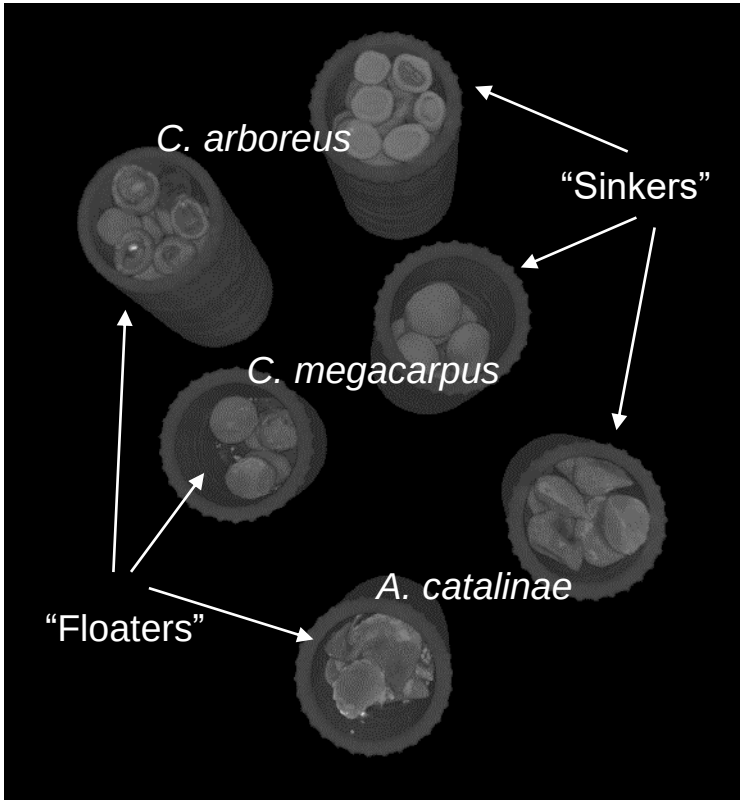


Photo Credits: Dr. Brandon Pratt

Grass Weighing

- Grass seeds were counted and weighed

Photo Credit: Natalie Hernandez

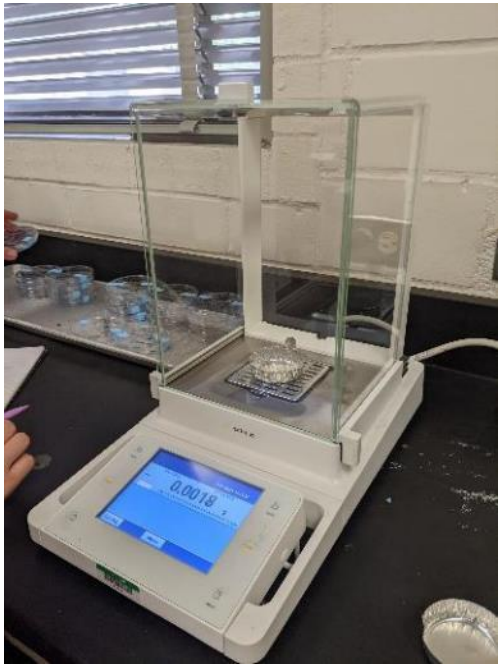


Photo Credit: Wyatt Beller

Total Seeds

Summit Site, *C. arboreus*

Hairpin Site; *C. arboreus*

Photo Credits: Dr. Anna Jacobsen

Total Seeds

Manzanitaville Site; *A. catalinae*

Hidden Pond Site; *C. megacarpus*

Photo Credit: Dr. Anna Jacobsen

Results: Natalie

Protected > Unprotected

Pattern most prevalent in *C. arboreus*

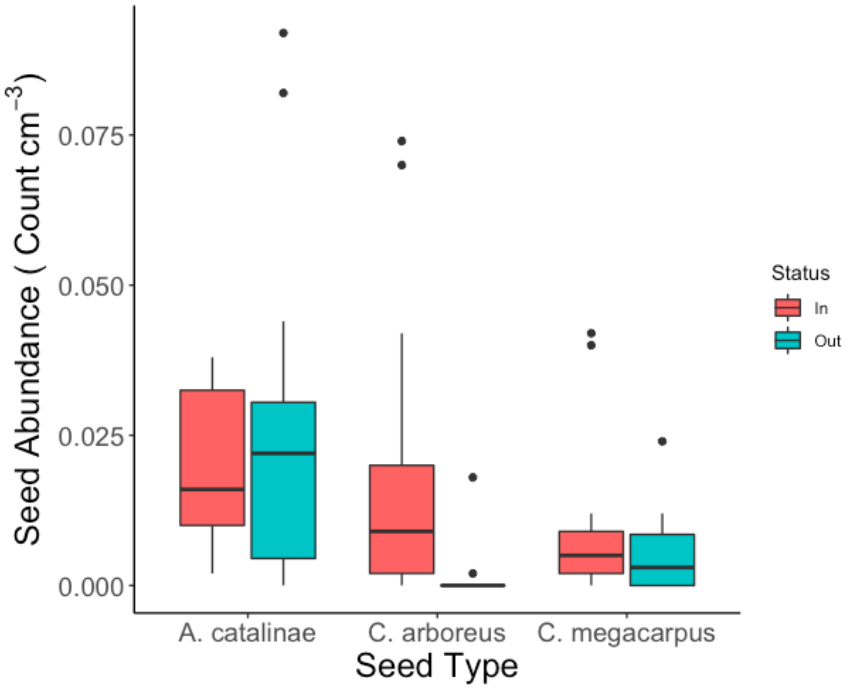
Protected

A. catalinae* > *C. arboreus* > *C. megacarpus

Unprotected

A. catalinae* > *C. megacarpus* > *C. arboreus

*These abundance values include all seeds from the soil regardless of their viability (see later data for viability information)



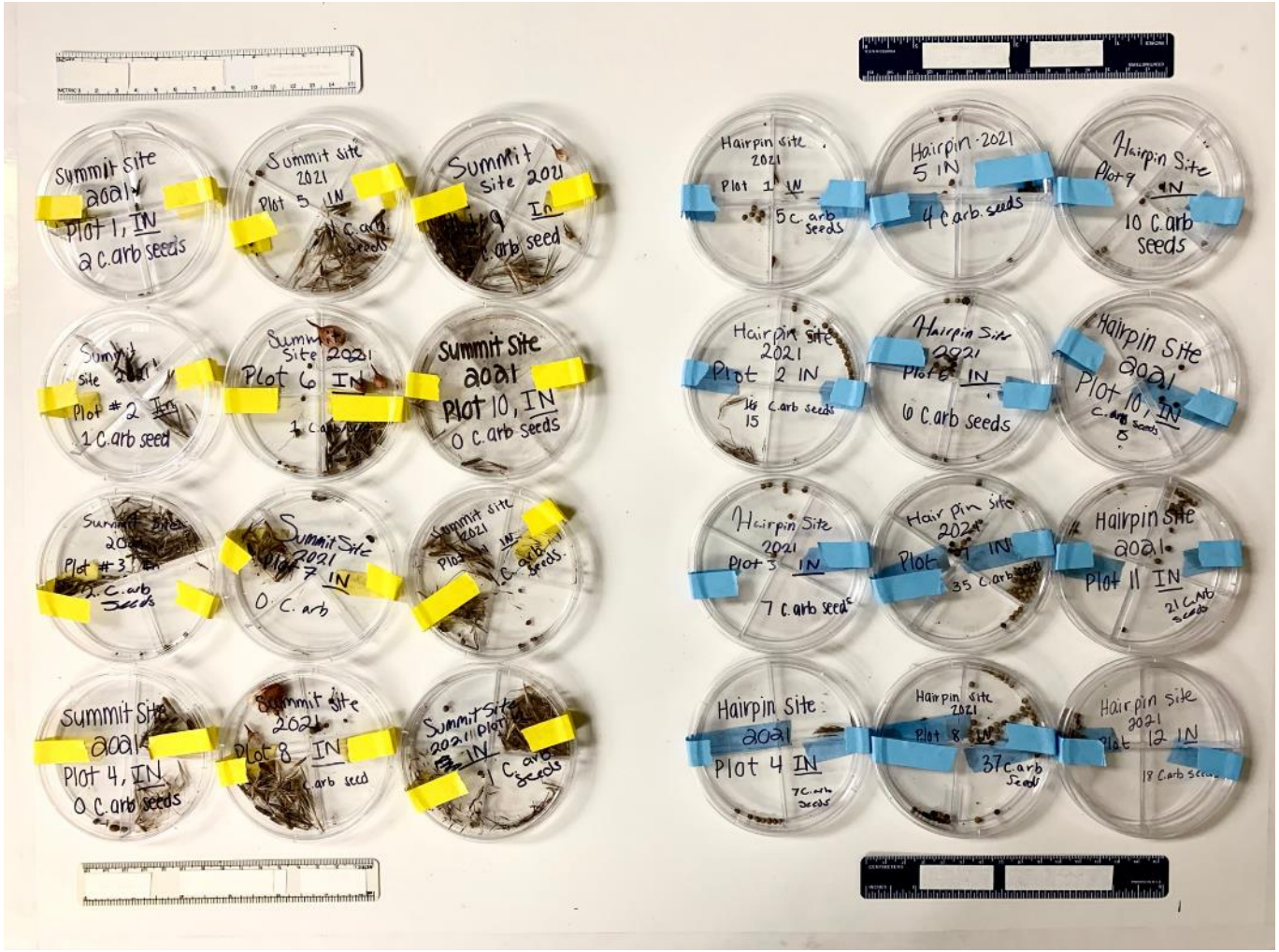
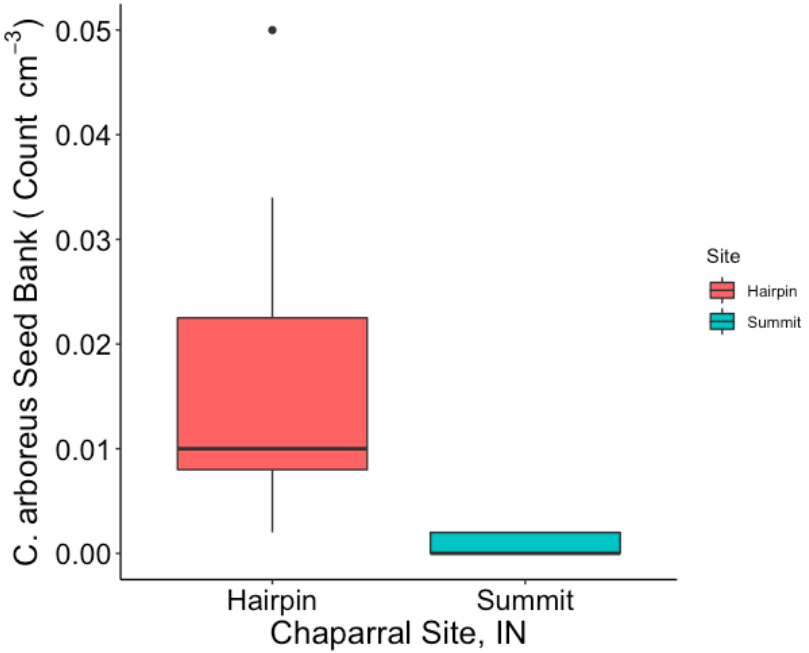


Photo Credit: Dr. Anna Jacobsen

Results: Karely

Source	LR Chisq	Df	Pr(>Chisq)
Site	12.674	1	< 0.001
Status	41.534	1	< 0.001
Site:Status	0.000	1	1.000

For *C. arboreus*:
More seeds at the wet site compared to the drier site.

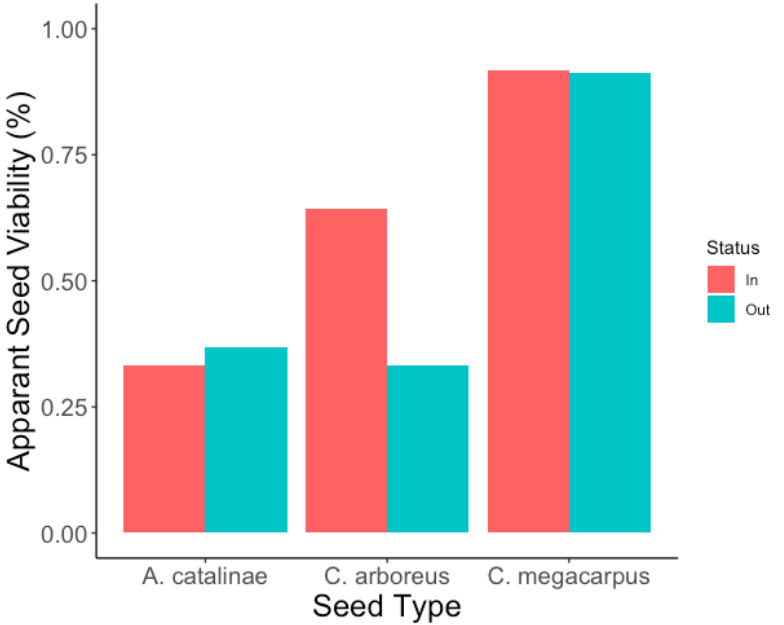


Results: Wyatt

Seed Viability (**Float test**) =
“sinking” seeds / total # of seeds

Comparing fenced (in) and non-fenced (out) plots:

- ***A. catalinae***: No apparent difference in seed viability
- ***C. arboreus***: Strong difference in viability between fenced status
- ***C. megacarpus***: No apparent difference in seed viability



Viability: Micro-CT Scanning vs. Float Test

- ***A. catalinae***: Micro-CT results correspond to Float Test results for “floaters” but NOT “sinkers.” Float test is over-estimating the percentage of viable seeds for this species
- ***C. arboreus***: Micro-CT results correspond to Float Test results
- ***C. megacarpus***: Micro-CT results correspond to Float Test results

	A. catalinae	*C. arboreus*	*C. megacarpus*
% "Sink" seeds that were micro-CT "Full"	41.18%	86.96%	92.31%
% "Float" seeds that were micro-CT "Empty"	83.87%	100.00%	80.00%

Micro-CT Scans:
Arctostaphylos catalinae

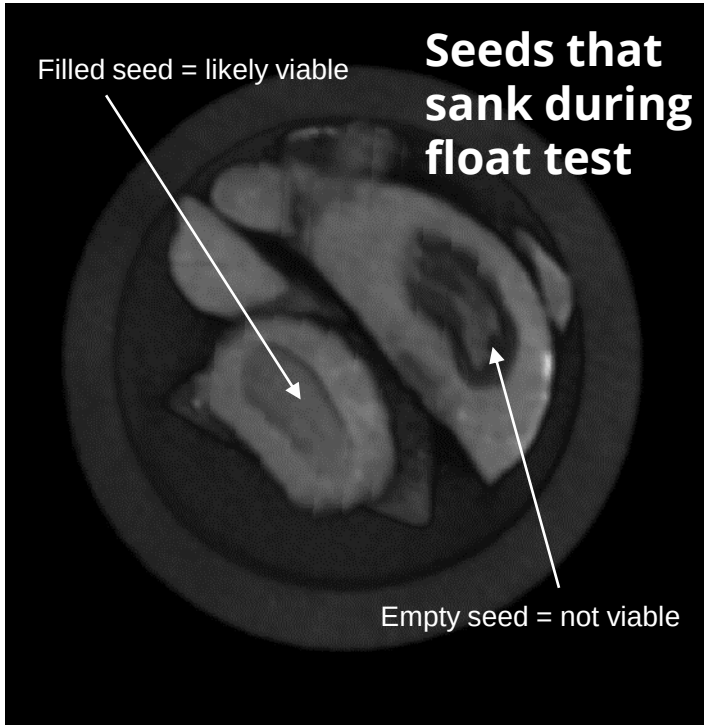
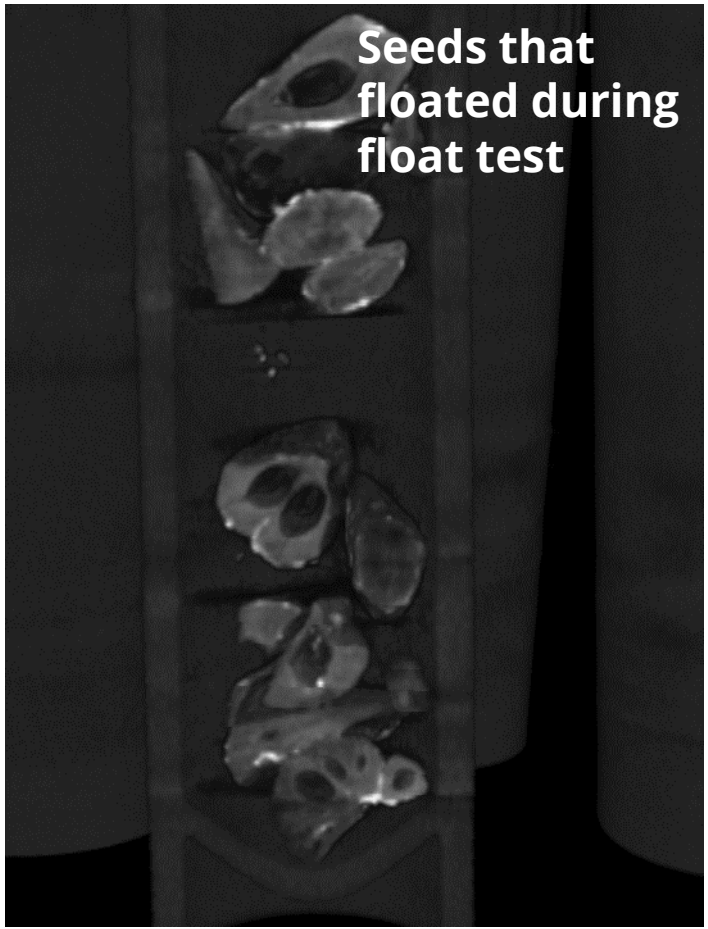


Photo Credit: Dr. Brandon Pratt



Micro-CT Scans: *Ceanothus arboreus*

Sinkers (In)

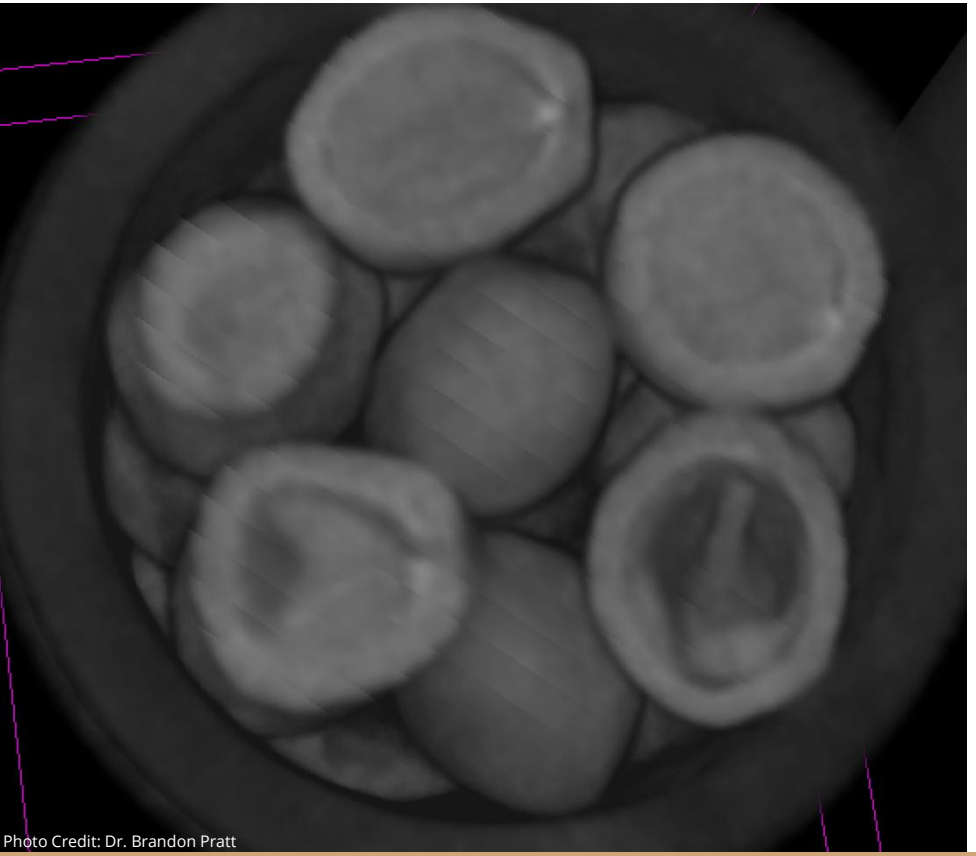
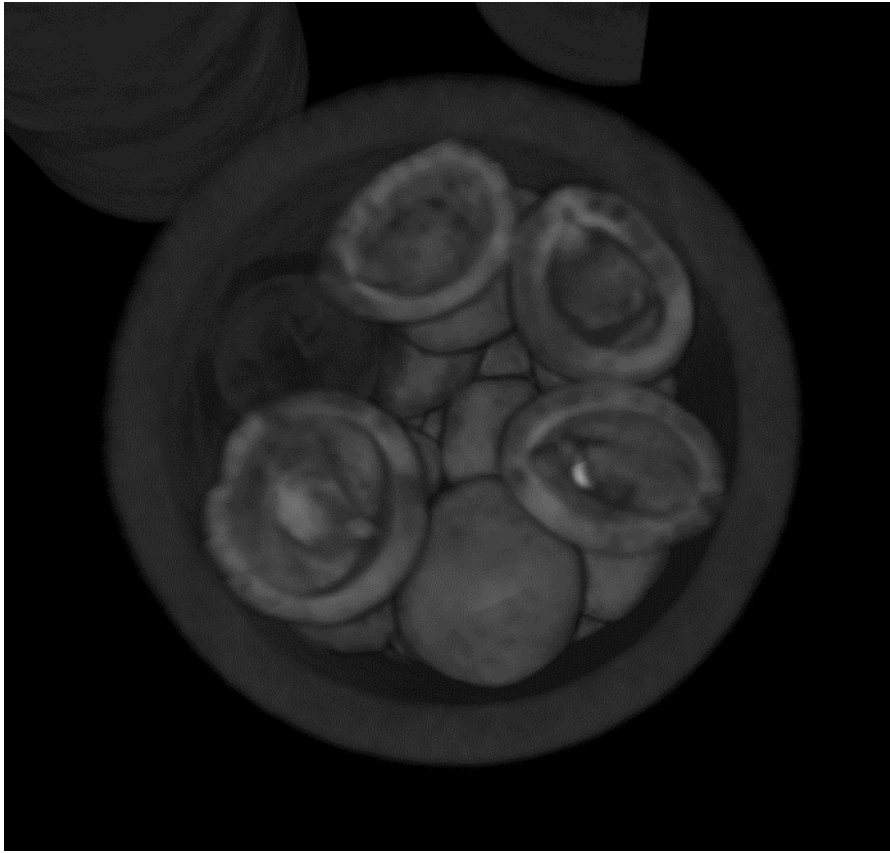


Photo Credit: Dr. Brandon Pratt

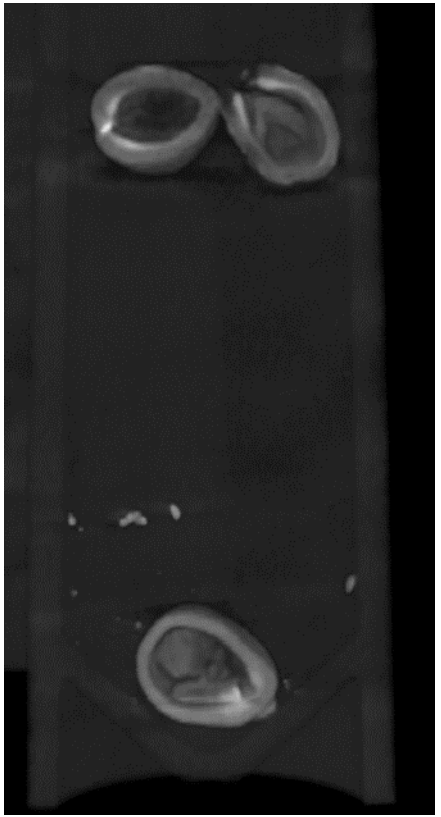
Floaters (In)



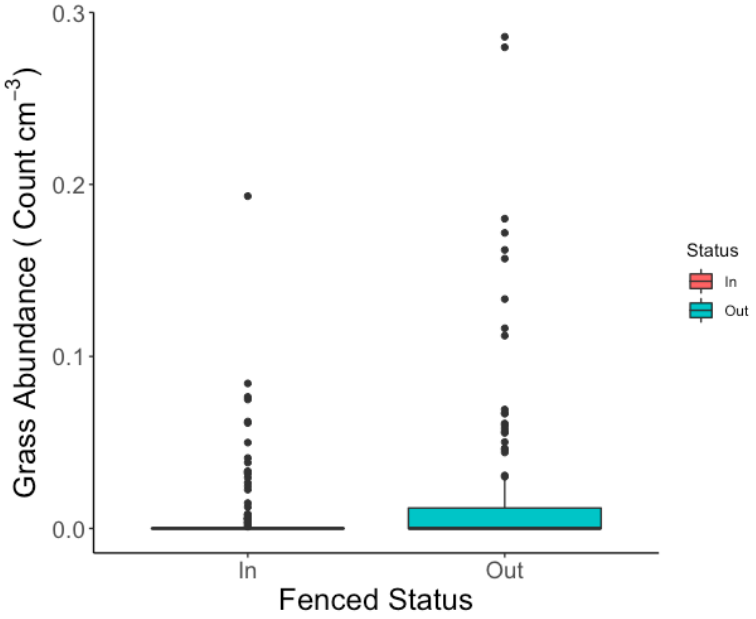
Micro-CT Scans: *Ceanothus megacarpus*

Sinkers (In)

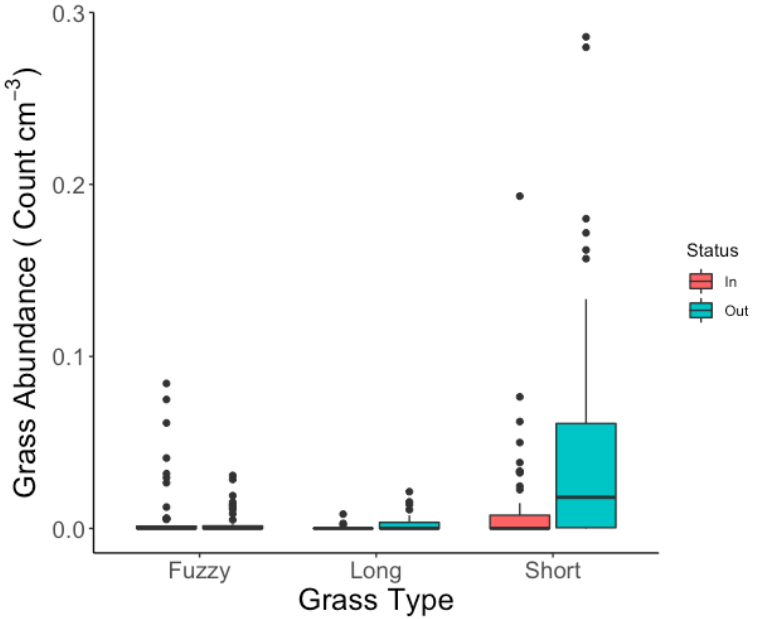
Floaters (In)



Results - Wyatt



OUT plots have greater grass abundance.



"Short" type grass was the most abundant.

Conclusions & Summary

Natalie: Results **support** the hypothesis that large mammals influence seed bank density.

There may be a continued decrease in seed bank density if large mammal populations increase or additional browsing animals were introduced to the island.

Karely: Results **support** the hypothesis that soil moisture conditions influence seed bank density in protected sites.

Increased or prolonged drought stress may negatively affect *C. arboreus* seed bank density.

Photos Credit: Dr. Anna Jacobsen

Conclusions & Summary

Wyatt: Results for *Ceanothus arboreus* **support** the hypothesis that large mammals affect seed viability. Further analysis is required to verify this for *Arctostaphylos catalinae* and *Ceanothus megacarpus.*

Even if they produce seeds, *Ceanothus arboreus* may not be able to form a viable seed back in unprotected sites.

Grass results **support** the hypothesis that grass seed abundance differs between unprotected and protected post-fire regions. Unprotected plots had a greater presence of grass than protected plots.

Catalina Island may be experiencing a vegetation-type conversion from mediterranean shrubland to grass-dominated savannah.