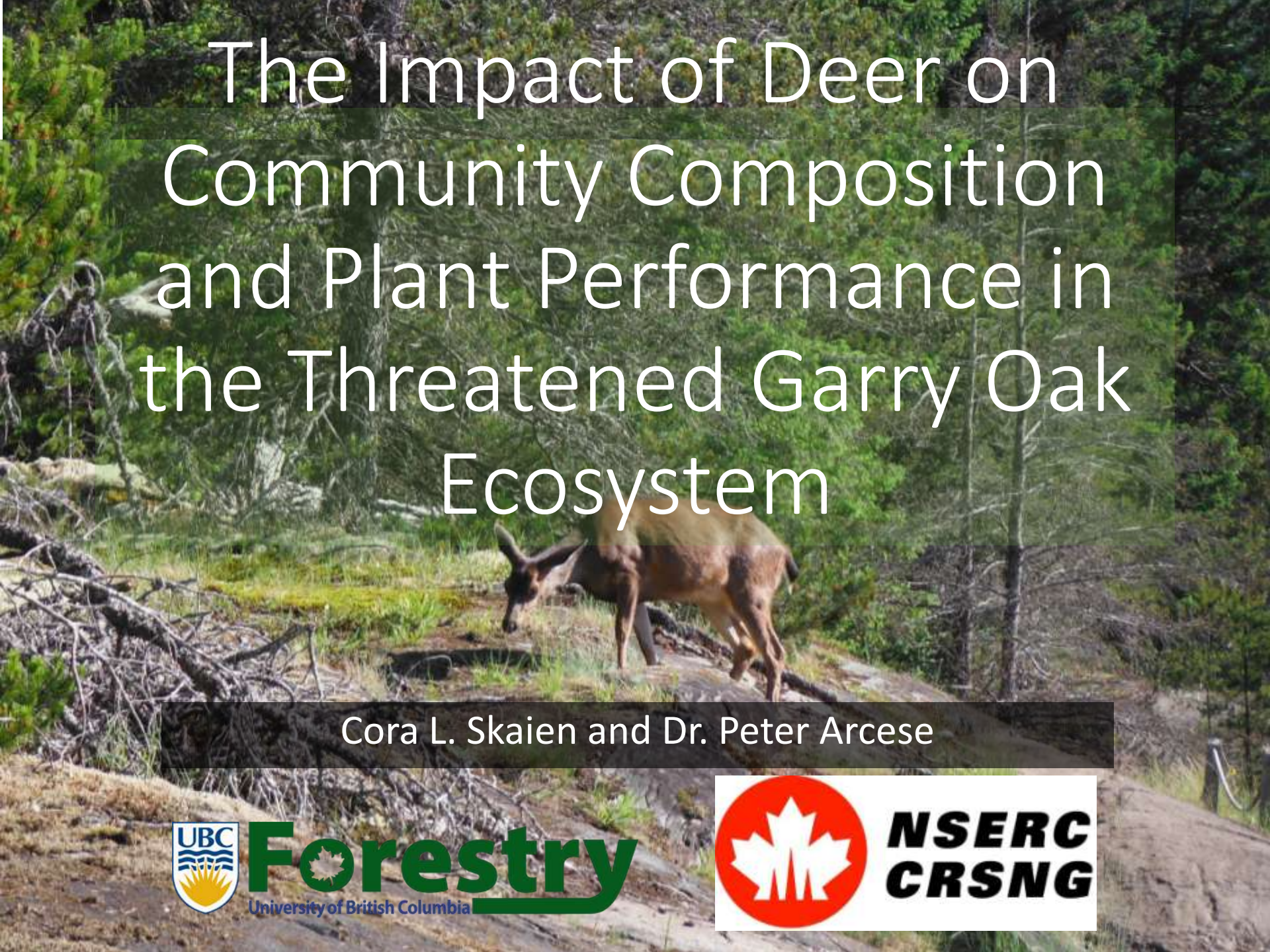
The Impact of Deer on Community Composition and Plant Performance in the Threatened Garry Oak Ecosystem



Cora L. Skaien and Dr. Peter Arcese

UBC Forestry
University of British Columbia

NSERC
CRSNG


http://www.deeranddeerhunting.com/articles/birds-birders-benefit-from-fewer-deer


Invertebrate and vertebrate herbivores consume ~15% of plant biomass annually (Cyr and Pace 1993).
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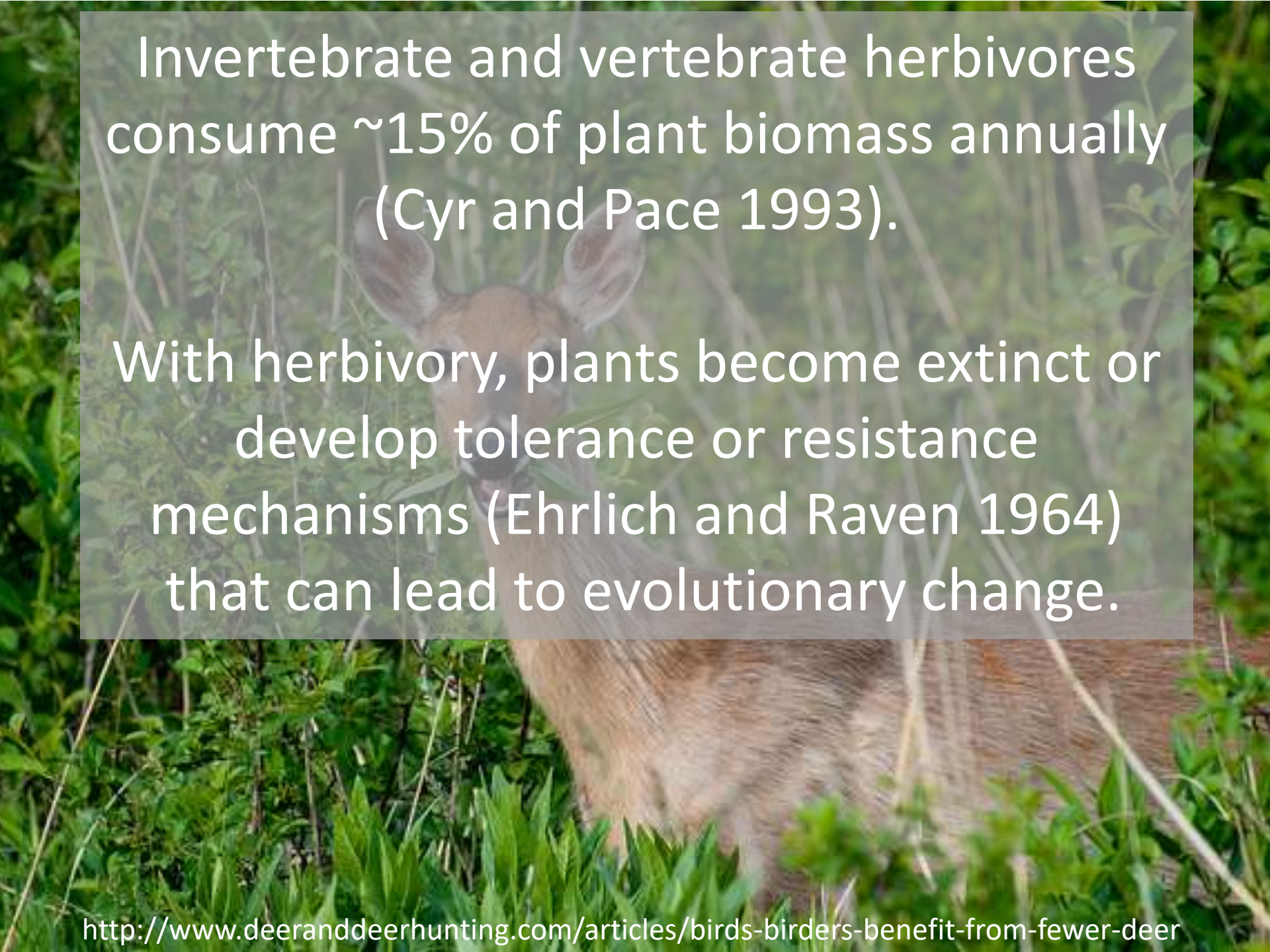

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With herbivory, plants become extinct or develop tolerance or resistance mechanisms (Ehrlich and Raven 1964) that can lead to evolutionary change.

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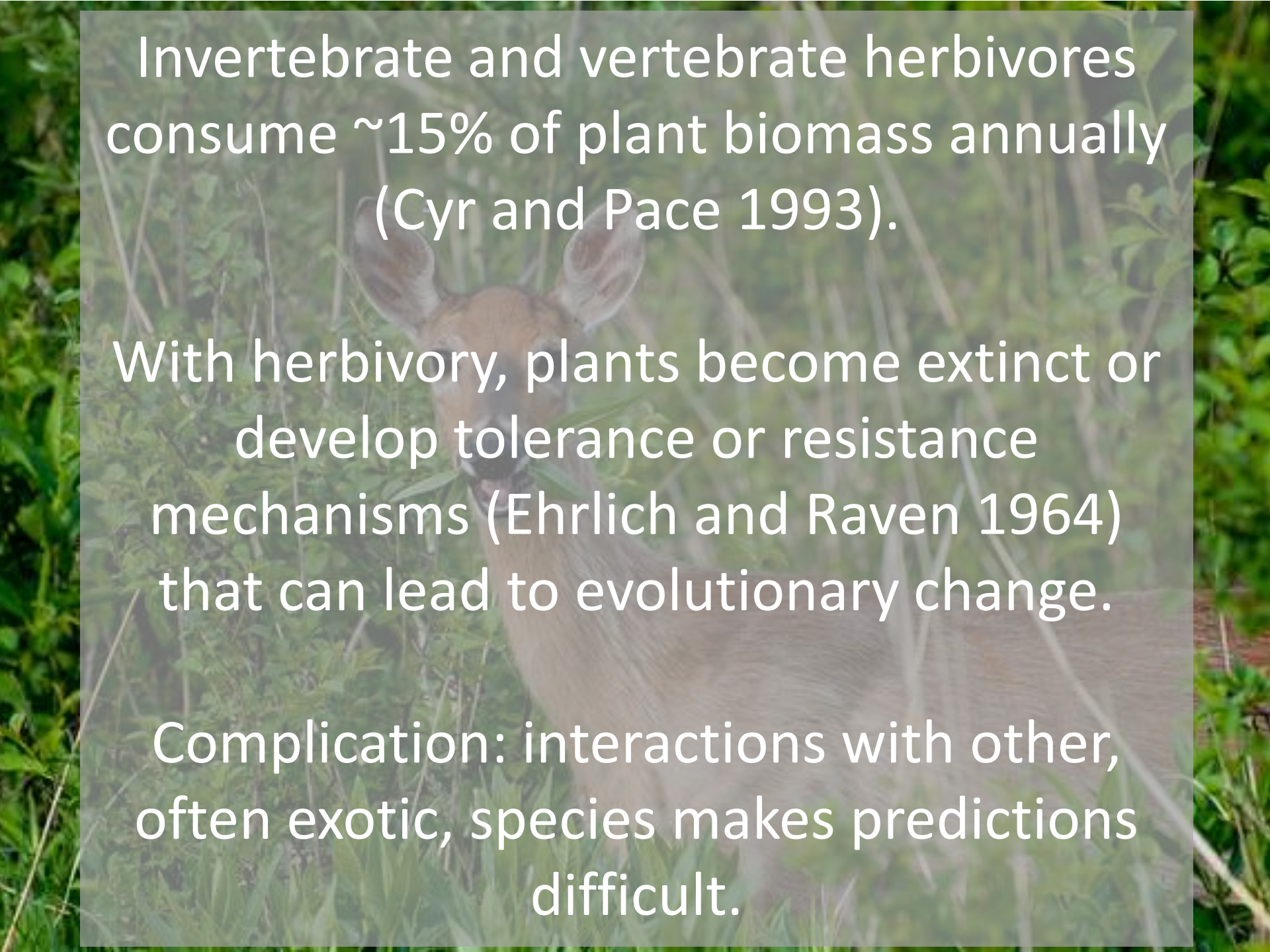

Invertebrate and vertebrate herbivores consume ~15% of plant biomass annually (Cyr and Pace 1993).

With herbivory, plants become extinct or develop tolerance or resistance mechanisms (Ehrlich and Raven 1964) that can lead to evolutionary change.

Complication: interactions with other, often exotic, species makes predictions difficult.

Herbivore Removal: Positive Influence on Species Abundance

Species in Habitat:

Native *Trillium erectum*[1]

Exotic *Alliaria petiolata*[2]

[1]http://www.fs.fed.us/wildflowers/plant-of-the-week/trillium_erectum.shtml
[2]http://www.naturespot.org.uk/species/garlic-mustard

Kalisz *et al.* 2014

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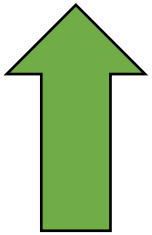

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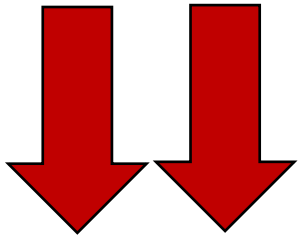

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Kalisz *et al.* 2014

Herbivore Removal: Positive Influence on Species Abundance

Native Sp. Benefits When Ungulate Herbivores Removed

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Exotic *Alliaria petiolata*[2]

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Kalisz *et al.* 2014

Species Response to Herbivore Removal: Negative Influence on Growth

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[2]http://pianteerbacee.wikispaces.com/Geranium+molle
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Waller and Maas 2013

Species Response to Herbivore Removal: Negative Influence on Growth

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Waller and Maas 2013

Species Response to Herbivore Removal: Negative Influence on Growth

Native Sp. Suffers When Ungulate Herbivores Removed

Native *Carex* spp.[1]

Native *Geranium* spp.[2]

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[3]http://www.naturespot.org.uk/species/garlic-mustard

Waller and Maas 2013

Species Response to Herbivore Removal: Evolutionary Change

Primula farinosa

Spatial variation in stipe length maintained by:

1. Presence of deer, herbivory selects for shorter plants.
2. Absence of deer, pollination selects for taller plants.

Agren *et al.* 2013

http://www.luontoportti.com/suomi/en/kukkakasvit/birdseye-primrose

Research Question

We know that natives respond differently to herbivore removal depending on community composition and interactions with other plant species.

Exotics and Deer

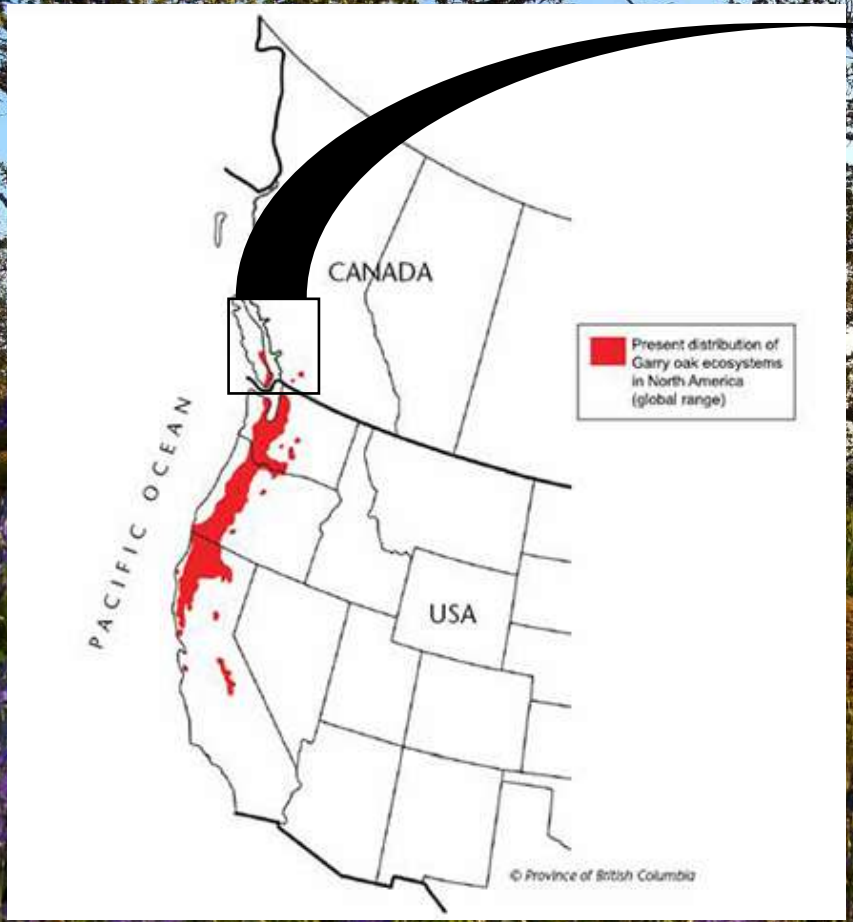
Natives

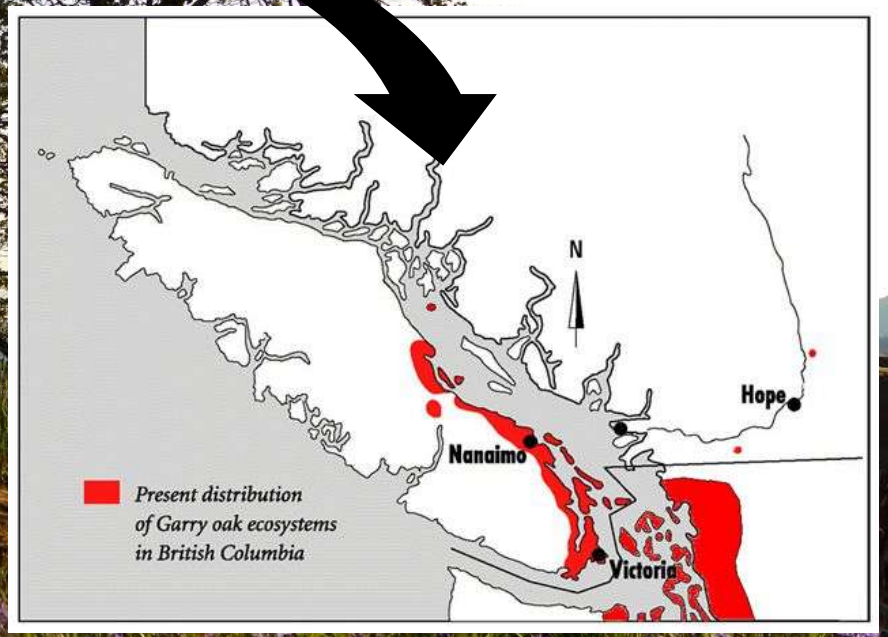
Research Question

We know that natives respond differently to herbivore removal depending on community composition and interactions with other plant species.

How does a degraded Garry Oak and Maritime Meadow Ecosystem respond to ungulate herbivore removal?

Garry Oak and Maritime Meadow Ecosystem





http://victoriadailyphoto.blogspot.ca/2012/05/garry-oak-ecosystem.html


Canada
USA
Thetis
to Vancouver
Galiano
Saltspring
Mayne
N. Pender
Saturna
S. Pender
Vancouver
Island
to Victoria
on Vancouver Island

N. Pender

Saturna

S. Pender

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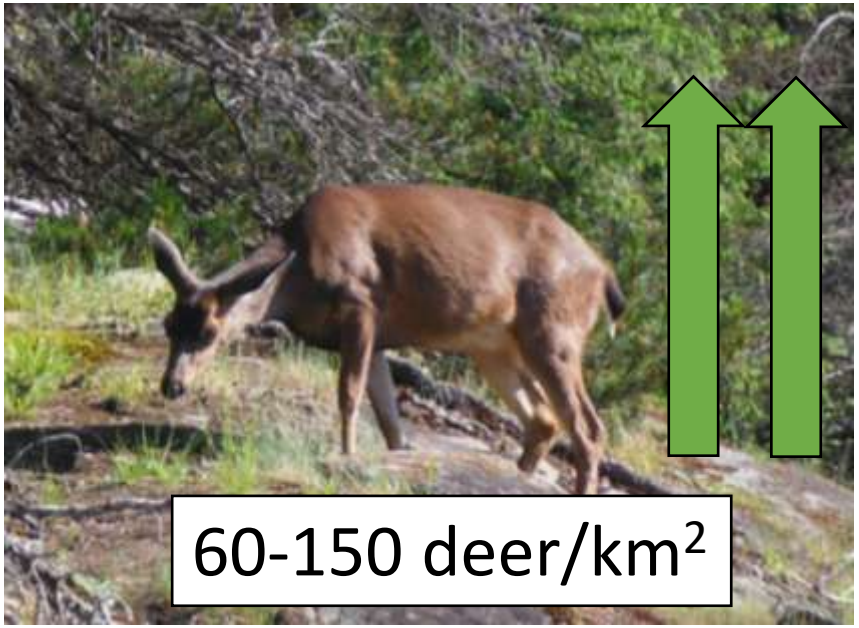
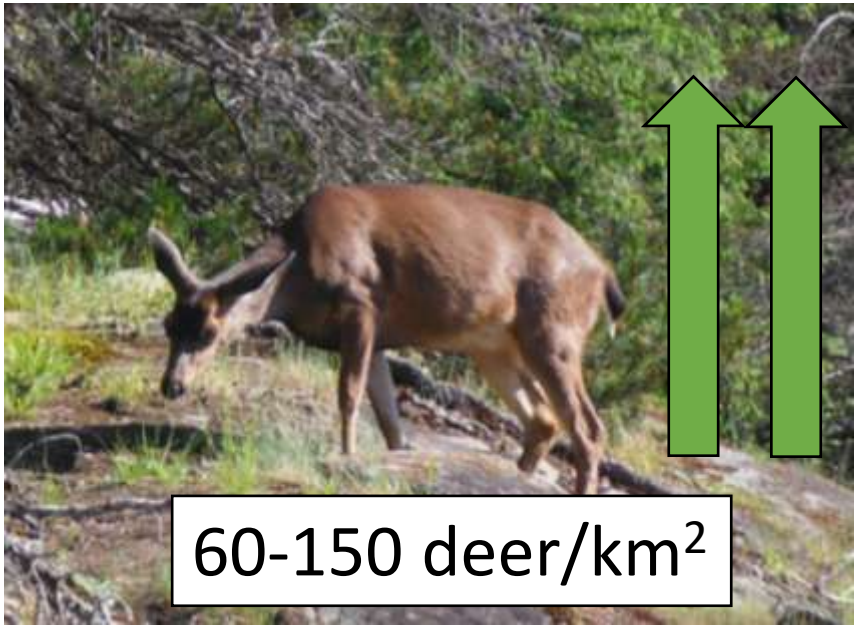
OR


OR


60-150 deer/km²



Martin, Arcese & Scheerder (2011)

Garry Oak and Maritime Meadow Ecosystem

1. **Reduced to 5% of its original extent**
2. **Highly invaded by exotic herbaceous and grass species**
3. **Habitats with spatial and temporal heterogeneity in deer densities: islands with over-grazed conditions or no deer**
4. **Some iconic natives include: *Plectritis congesta, Brodiaea spp.* and *Camas* spp.**

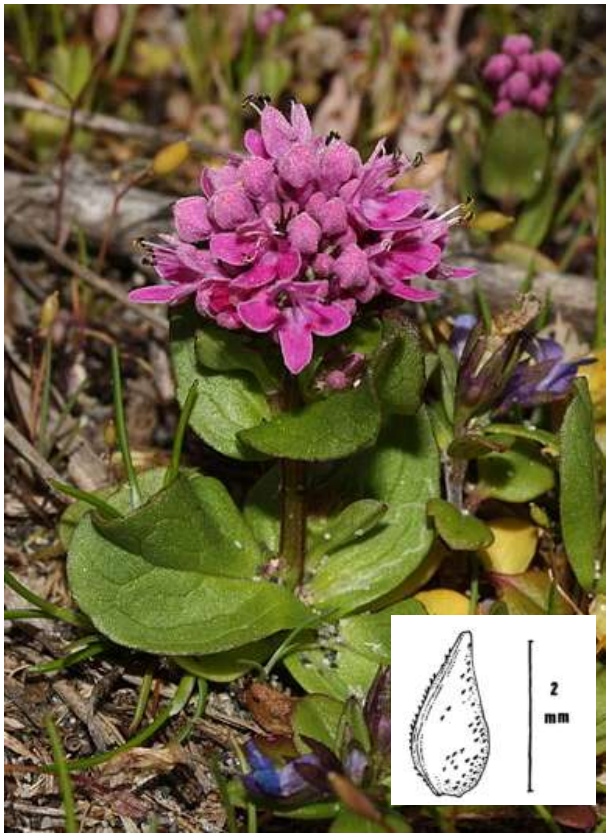
http://victoriadailyphoto.blogspot.ca/2012/05/garry-oak-ecosystem.html

Brodiaea Spp.

[1]http://www.heritageseedlings.com/page_747_53/triteleia-hyacinthine
[2]http://www.sevenoaksnativenursery.com/2013/04/05/brodiaea-coronaria-october-2012/
[3]http://arcadianabe.blogspot.ca/2014/06/harvest-brodiaea.html

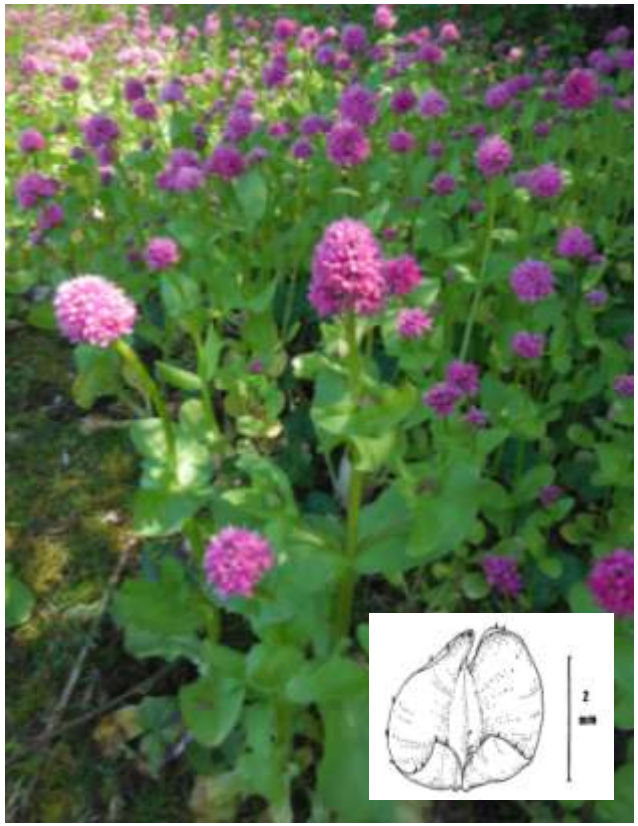
Plectritis congesta Morphology

With Deer:



10-20 cm

Without Deer:



50 - 110 cm

http://commons.wikimedia.org/wiki/File:Plectritis_congesta_5702.JPG

Skaien and Arcese, in review

Grazed vs Non-Grazed Locations

Garry Oak and Maritime Meadow Ecosystem

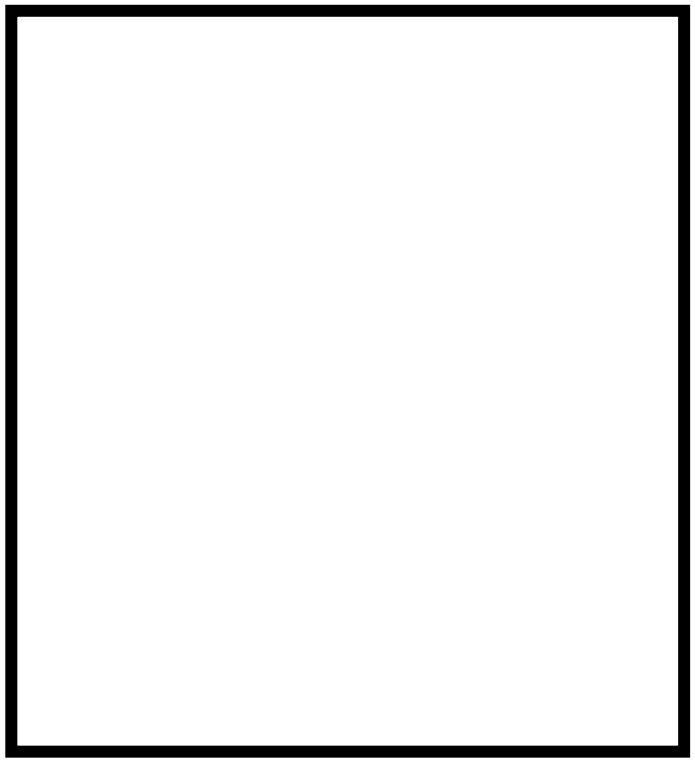
Research Questions

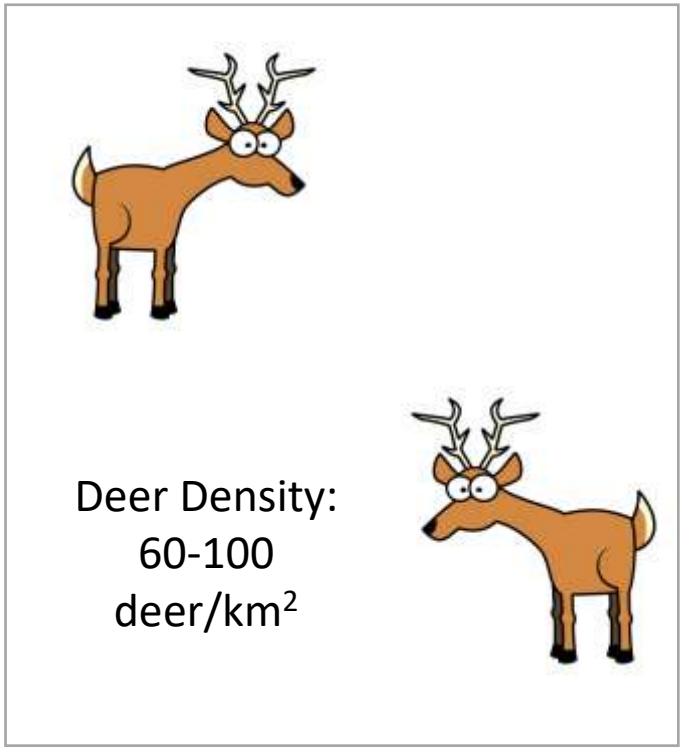
1. Does protection from deer influence native and exotic species cover in and out of exclosures?
2. Do exotic species impede or facilitate the recovery of natives when open to or protected from deer?
3. Do *Brodiaea* spp. increase in corm abundance and size after herbivore removal?
4. Do *Plectritis congesta* populations have a fitness advantage in presence of ungulate herbivores when originating from areas with deer?





Sidney Island Exclosures



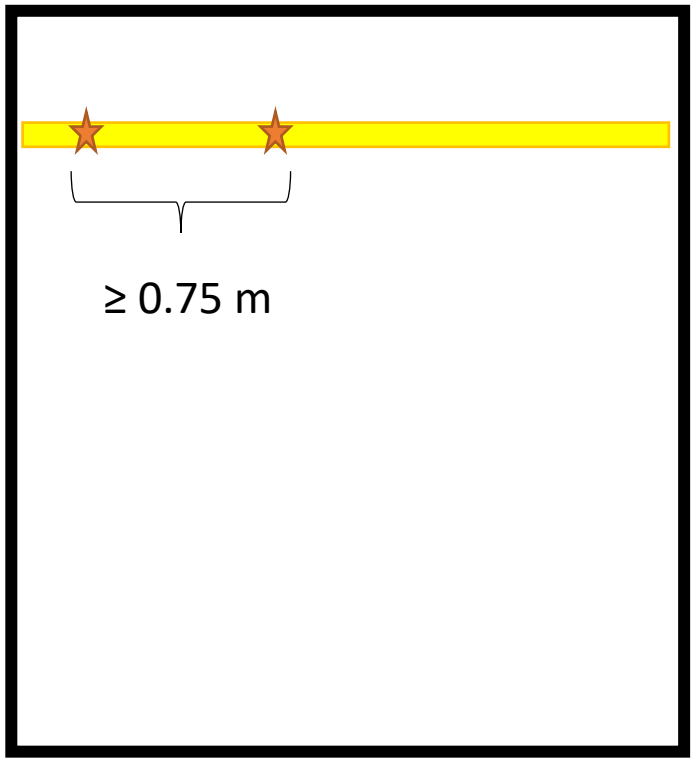


INSIDE EXCLOSURE (WEST)

OUTSIDE EXCLOSURE (EAST)

1. 4800 *P. congesta* seeds sown in 2013 (inside and out).
2. Native and exotic species cover, *Brodieae* spp. corm abundance and size, and fitness of *P. congesta* plants assessed in 2014 and 2016.

Sidney Island Exclosures



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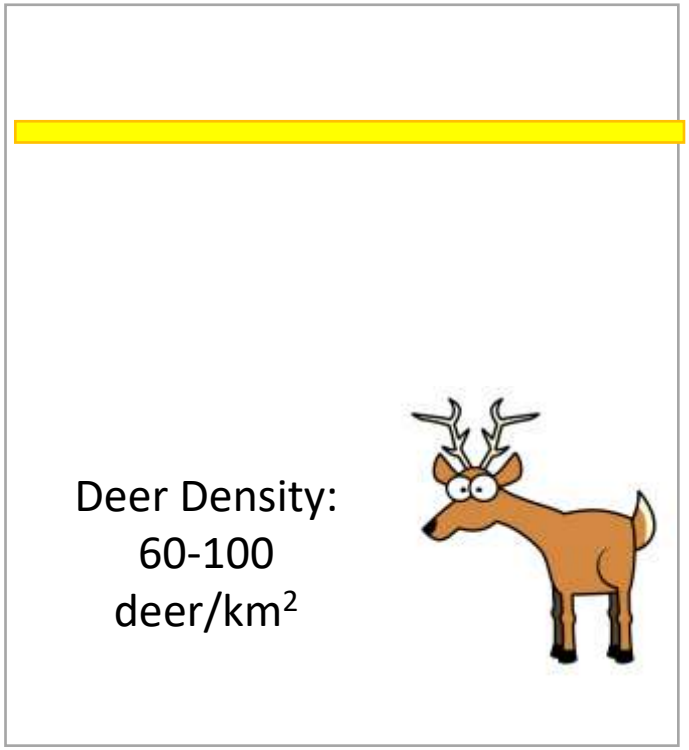


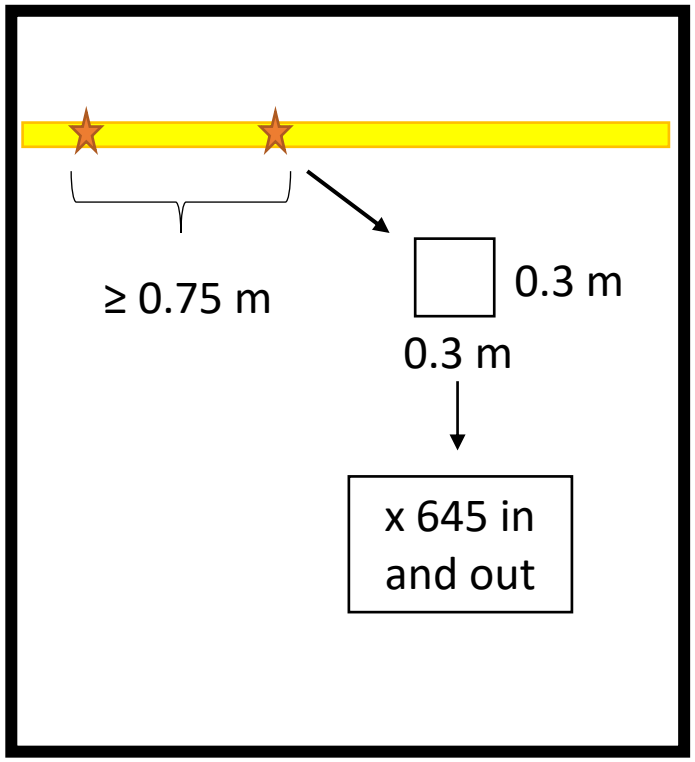
OUTSIDE EXCLOSURE (EAST)

x 2

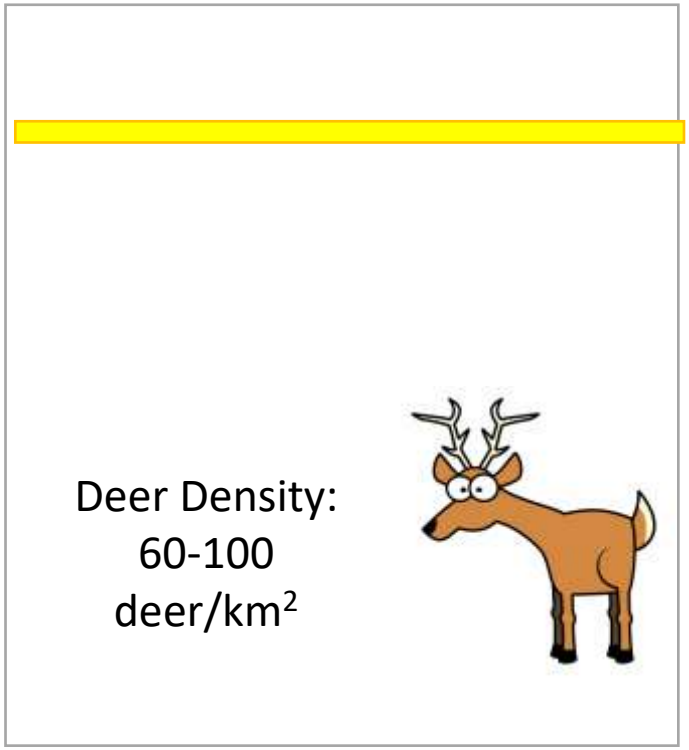
Established in May 2012

Planting locations of *P. congesta* and determination of exotic and native species cover

Sidney Island Exclosures



INSIDE EXCLOSURE (WEST)



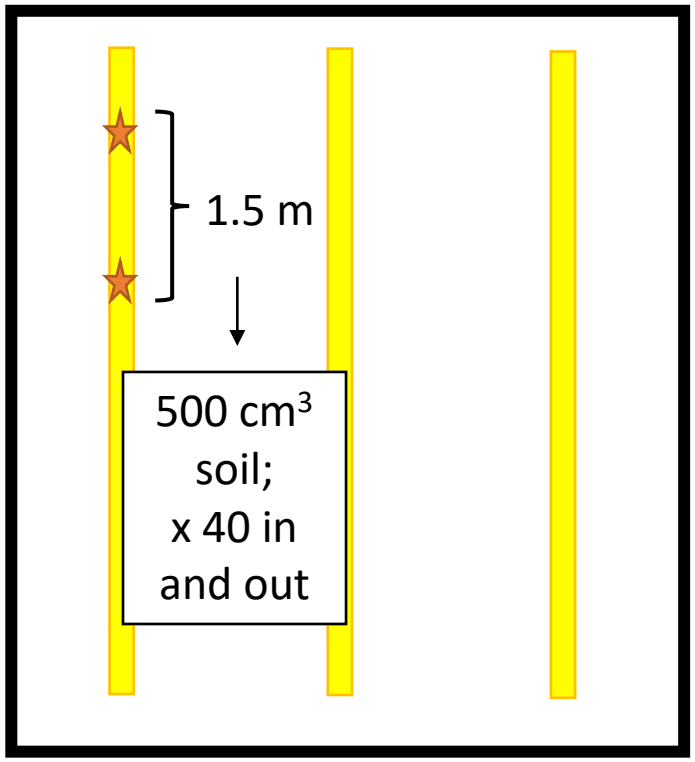
OUTSIDE EXCLOSURE (EAST)

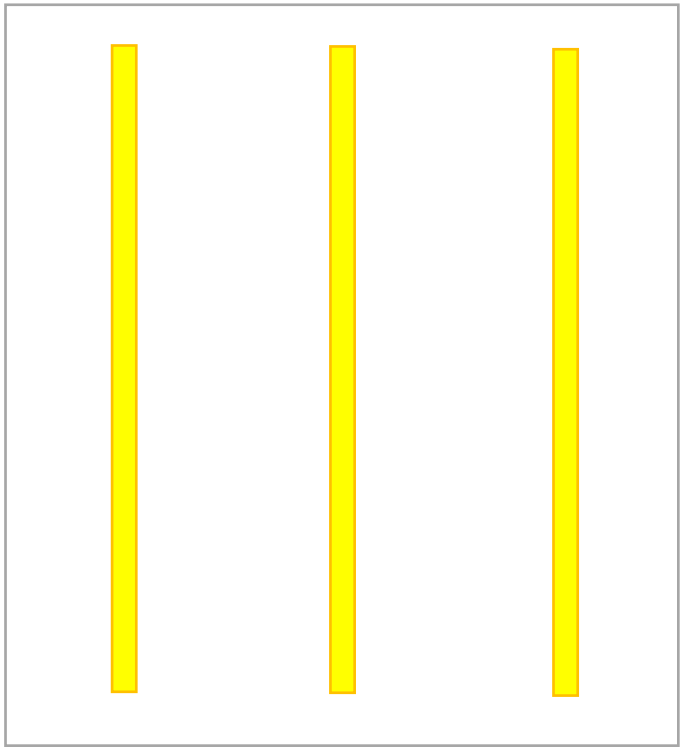
x 2

Established in May 2012

0.3 x 0.3 m quadrats to determine percent cover of all species present, native and exotic

Sidney Island Exclosures





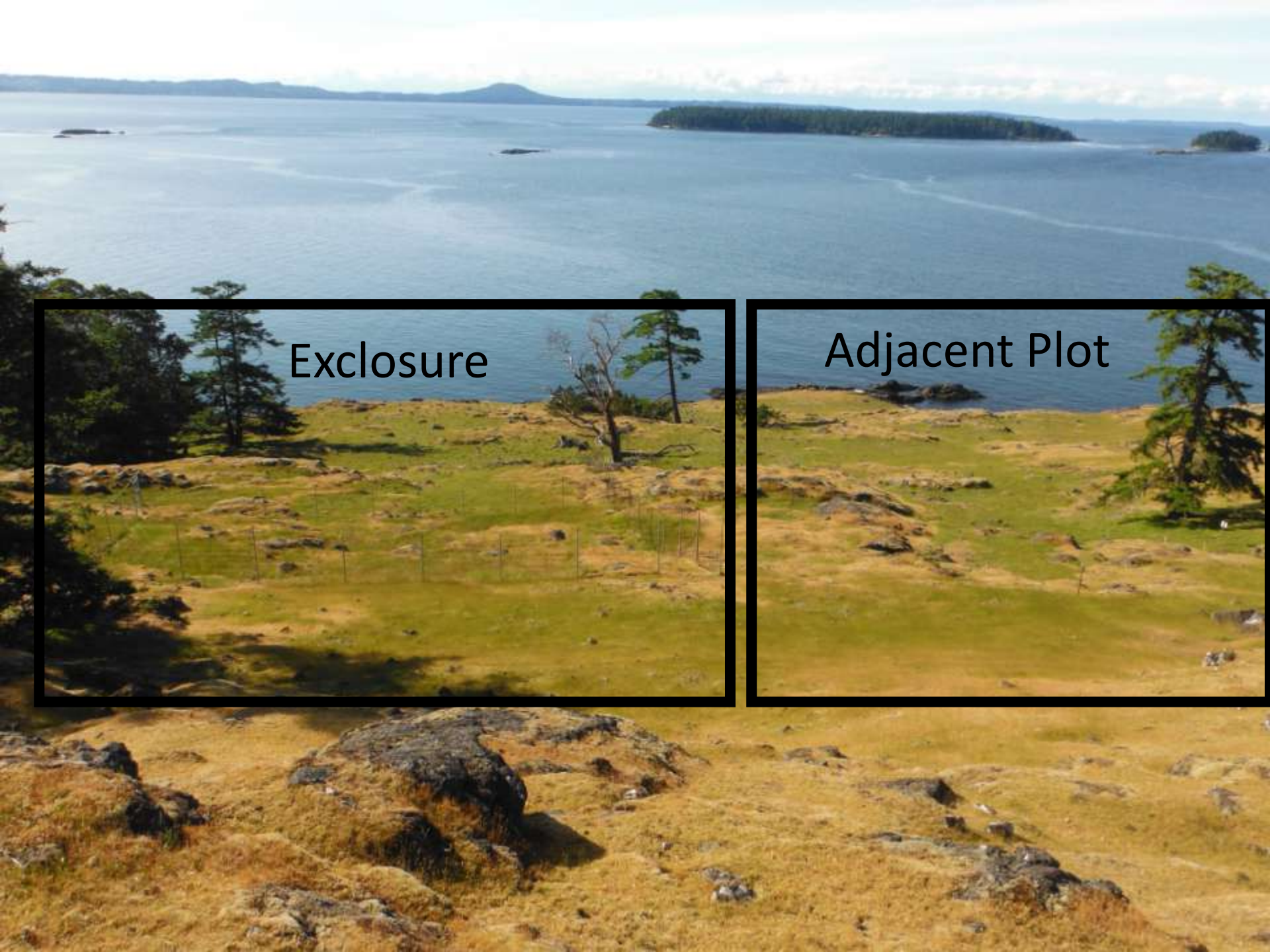
x 2

Established in May 2012

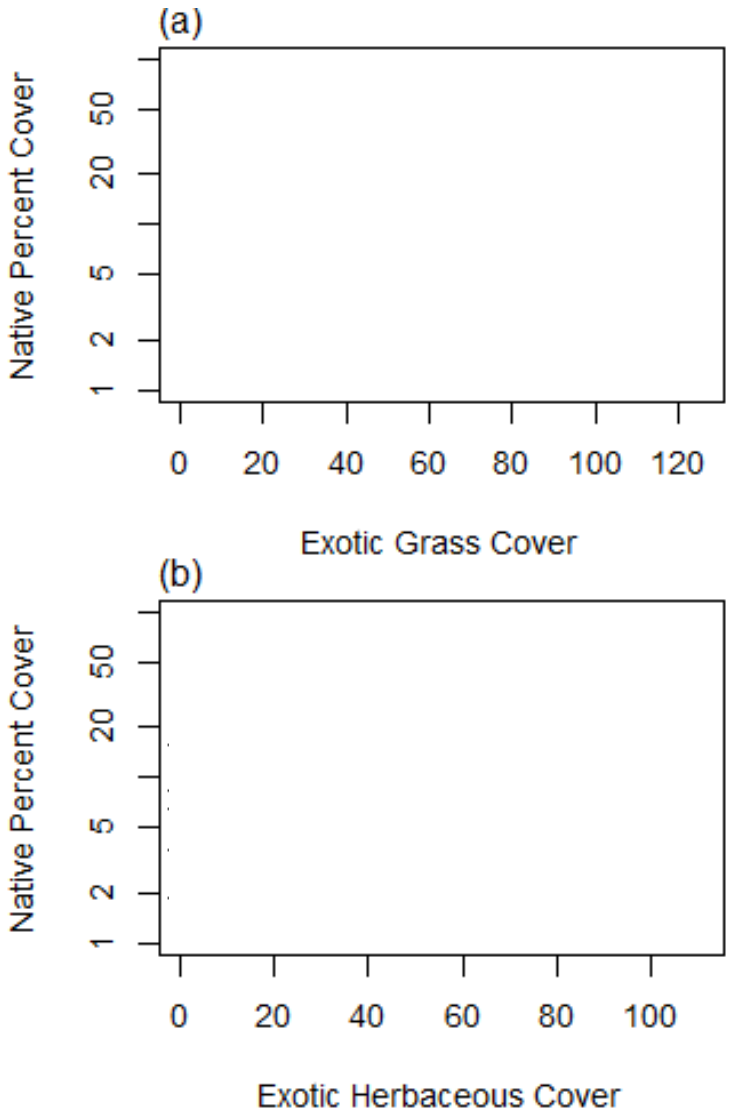
INSIDE EXCLOSURE (WEST)

OUTSIDE EXCLOSURE (EAST)

Determination of *Brodiaea* corm abundance and size

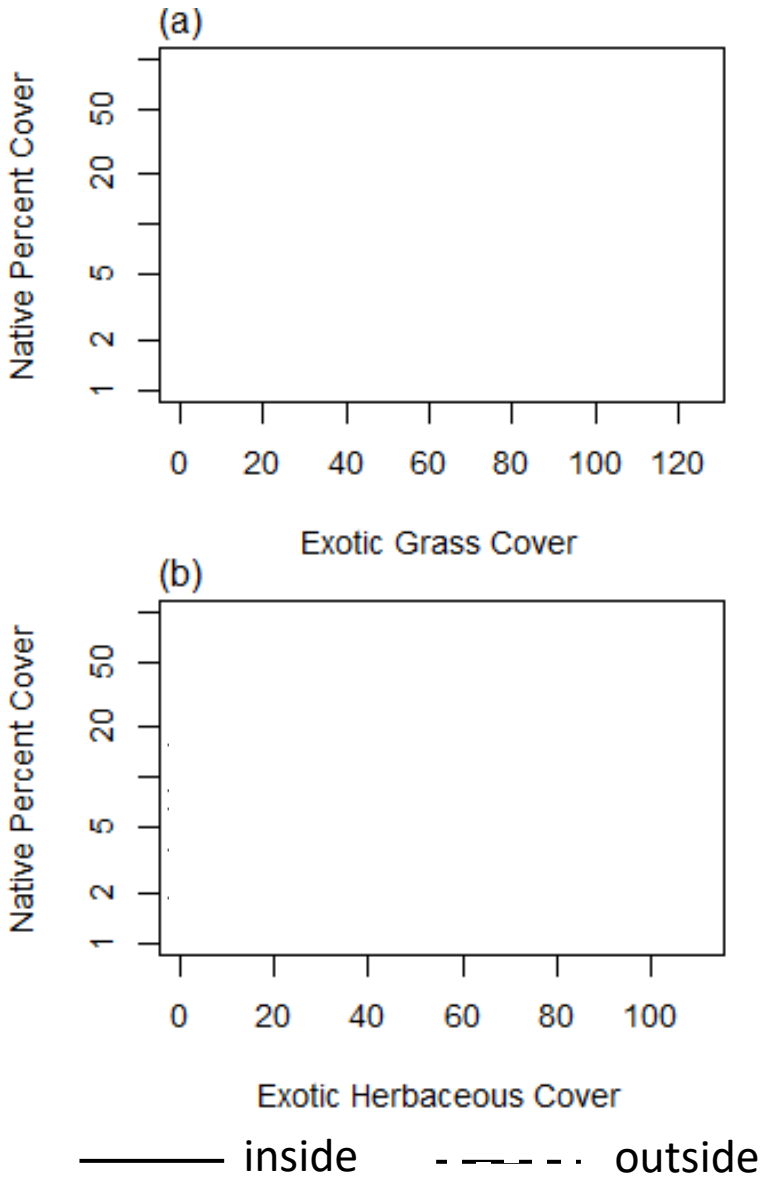

Exclosure
Adjacent Plot

Exotic and Native Species: 2014



Skaien and Arcese, submitted

Exotic and Native Species: 2014



1. Native species cover was 2x greater in exclosures; *Brodiaea* sp. 3.7x greater

2. Exotic species cover showed no differences in and out of exclosures

Skaien and Arcese, submitted

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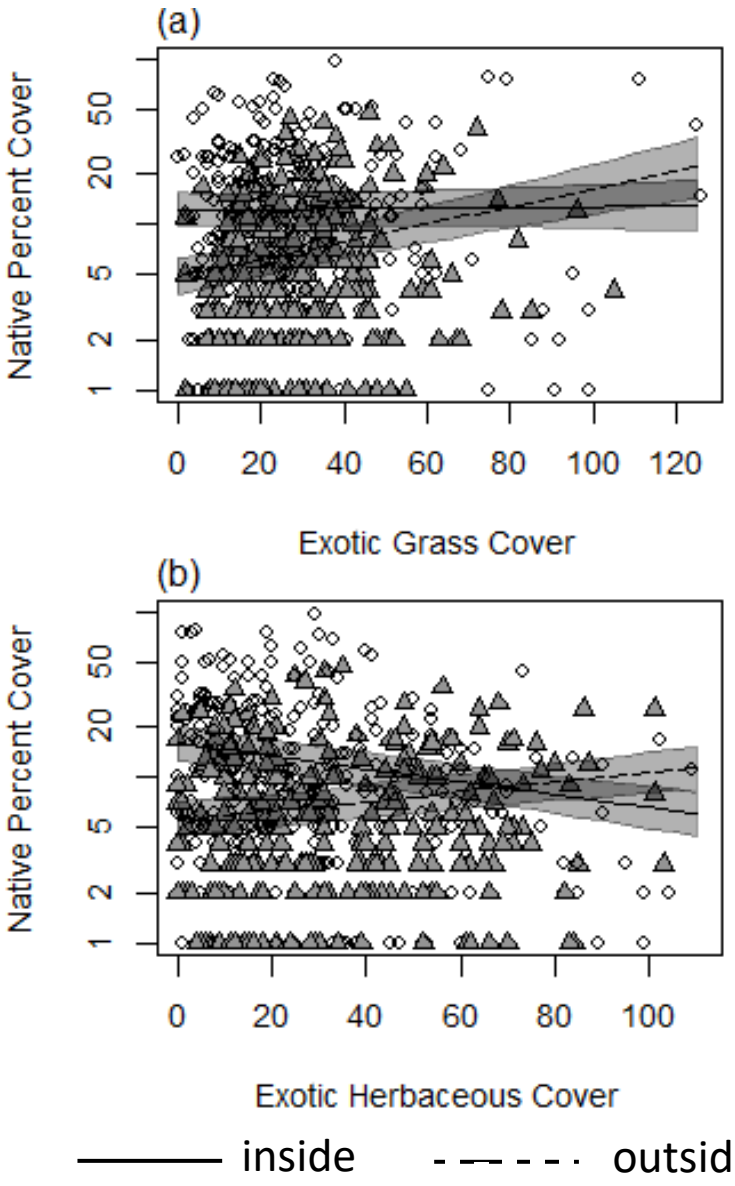

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Skaien and Arcese, submitted

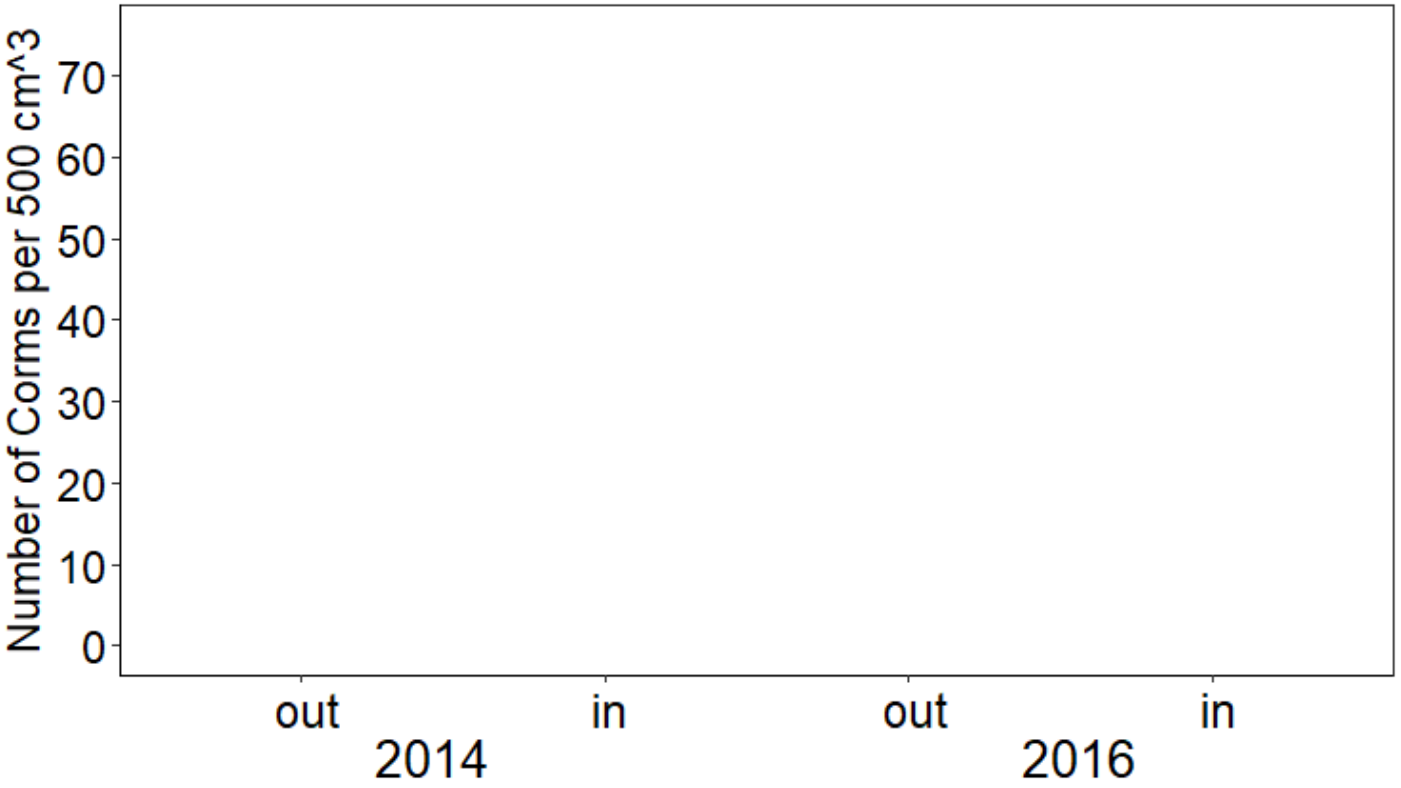
Exotic and Native Species: 2016

Table: The ratio of percent cover of above ground tissue inside exclosures relative to outside of exclosures. Values above 1 indicate higher percent cover inside exclosures.

	2014	2016
Native Species Cover	2.0 x	3.3 x
Brodiaea sp. Cover	3.7 x	7.4 x
Invasive Species Cover	=	=

Skaien and Arcese, submitted

Brodiaea Corm Abundance



Skaien and Arcese, submitted

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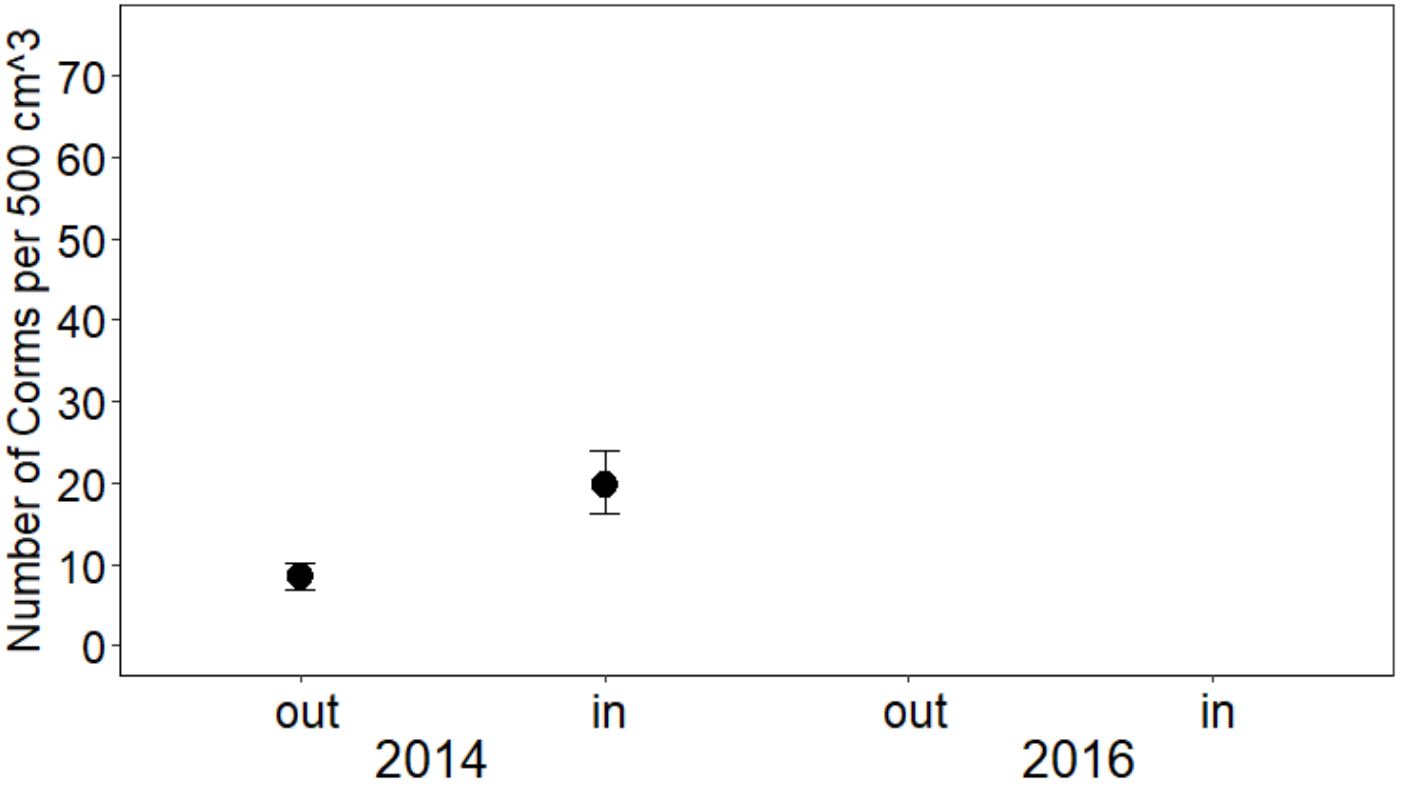
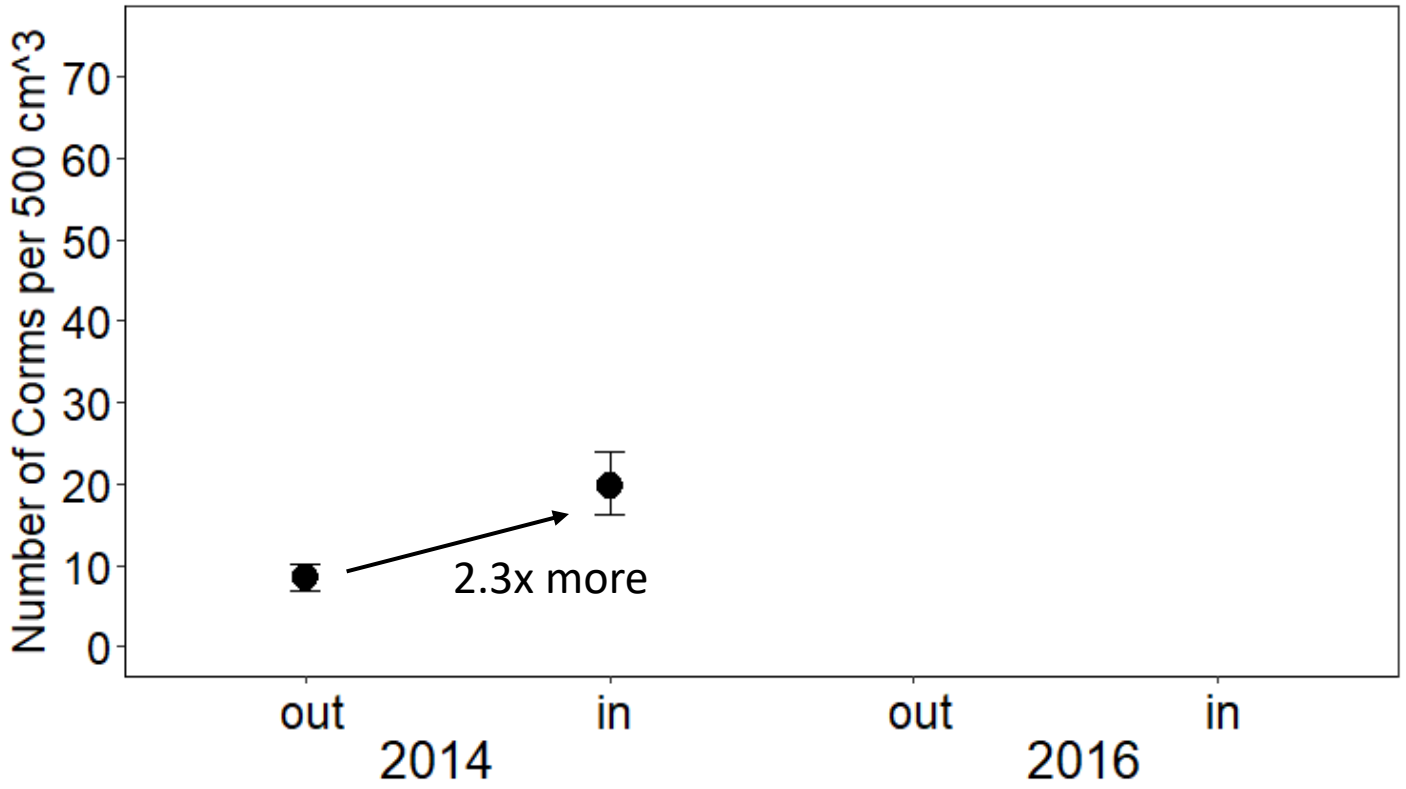


Skaien and Arcese, submitted

Brodiaea Corm Abundance



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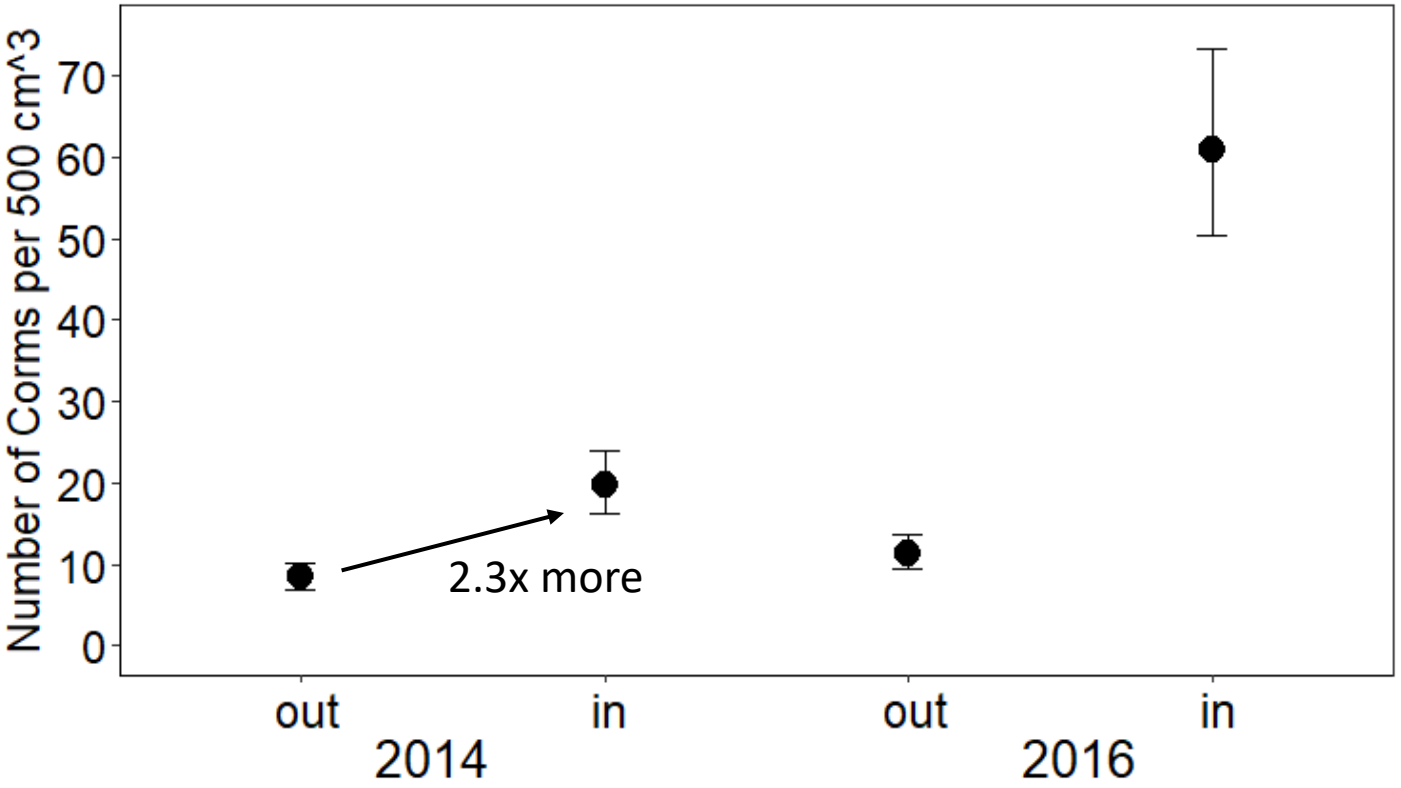
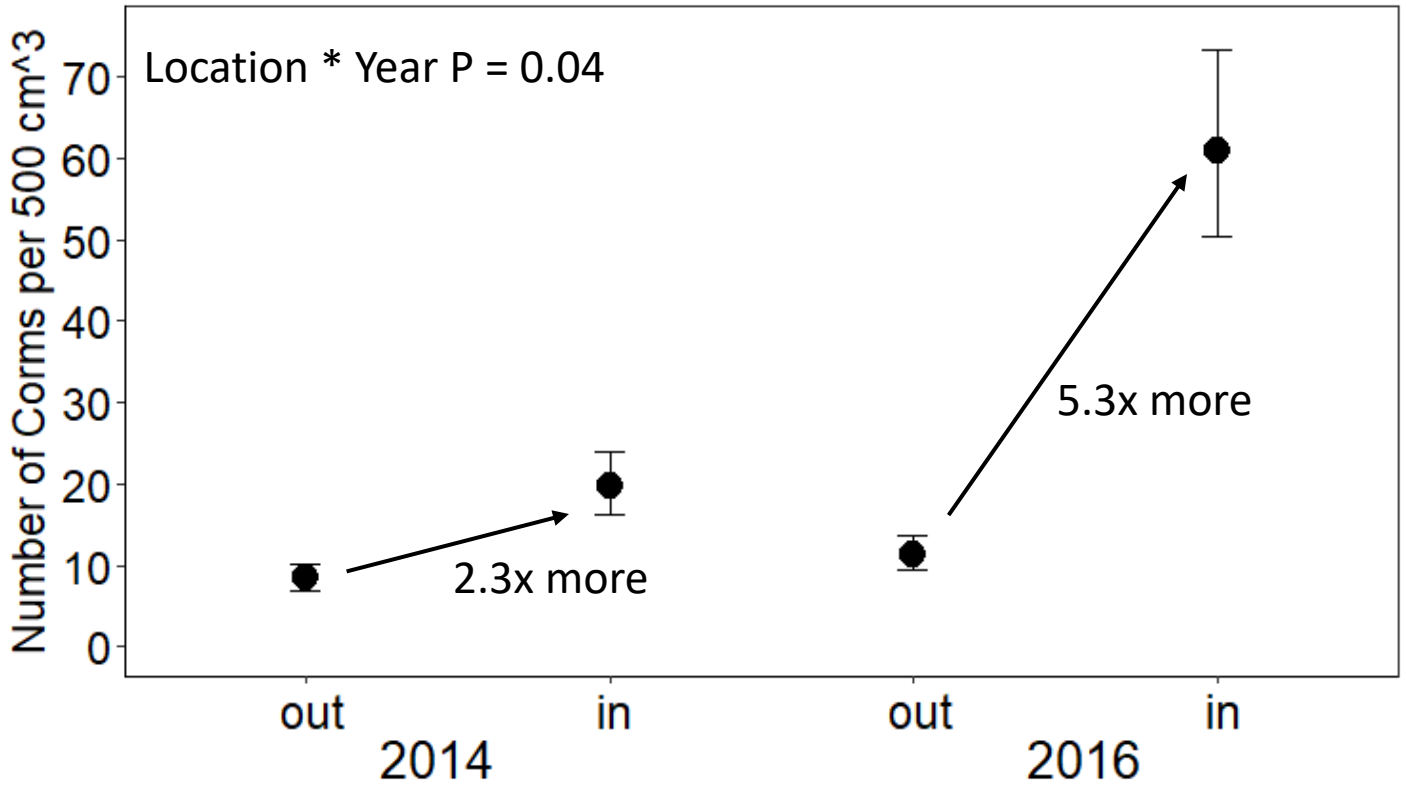


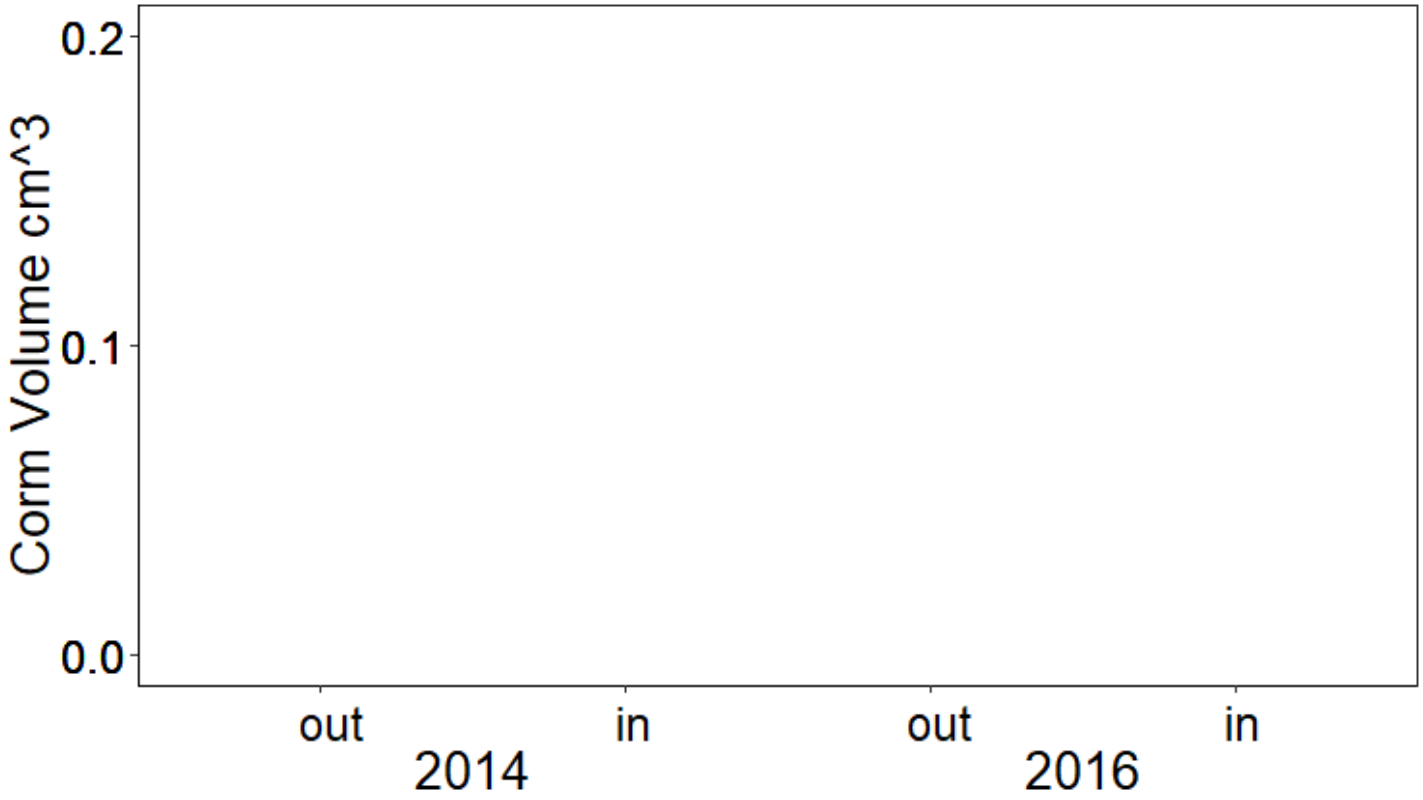
Skaien and Arcese, submitted

Brodiaea Corm Abundance



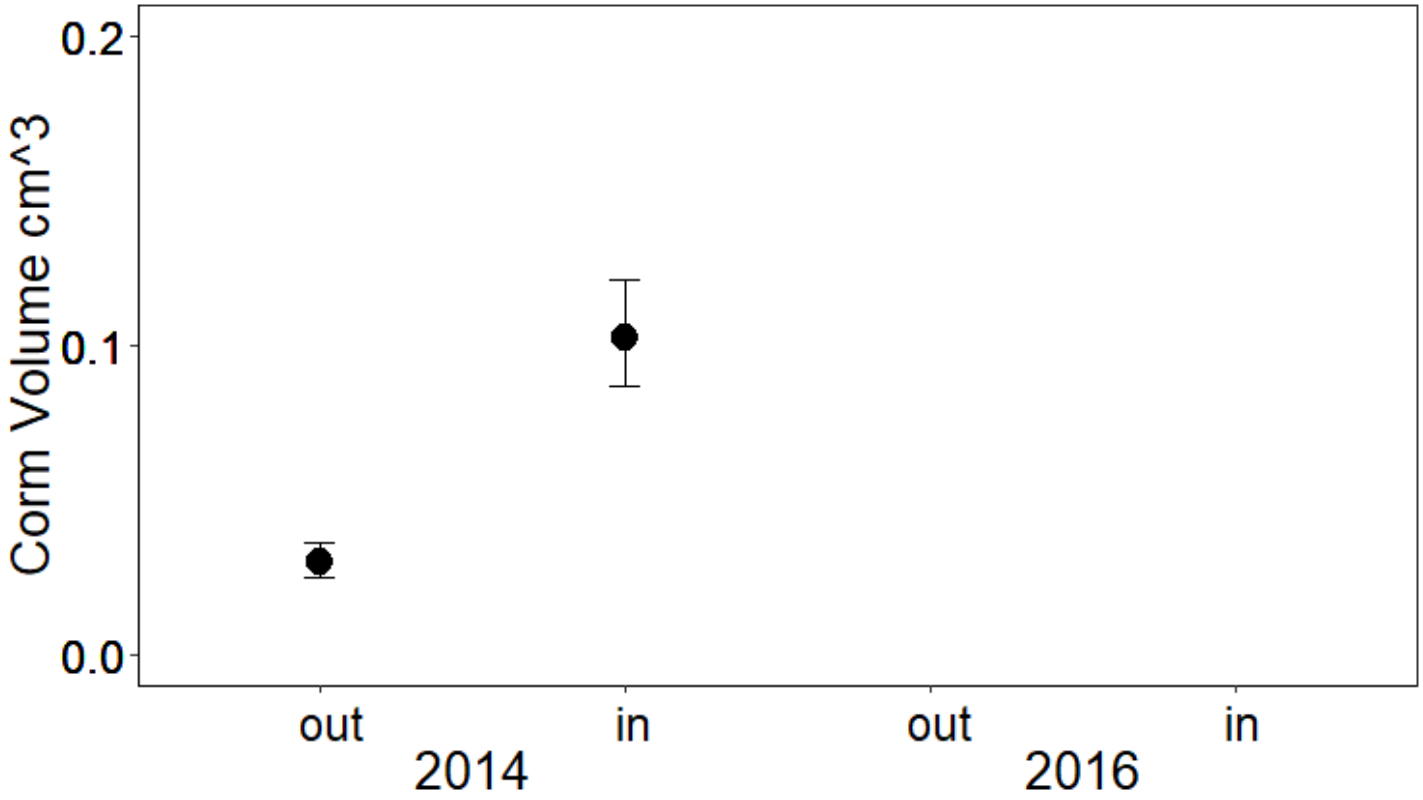
Skaien and Arcese, submitted

Brodiaea Corm Size



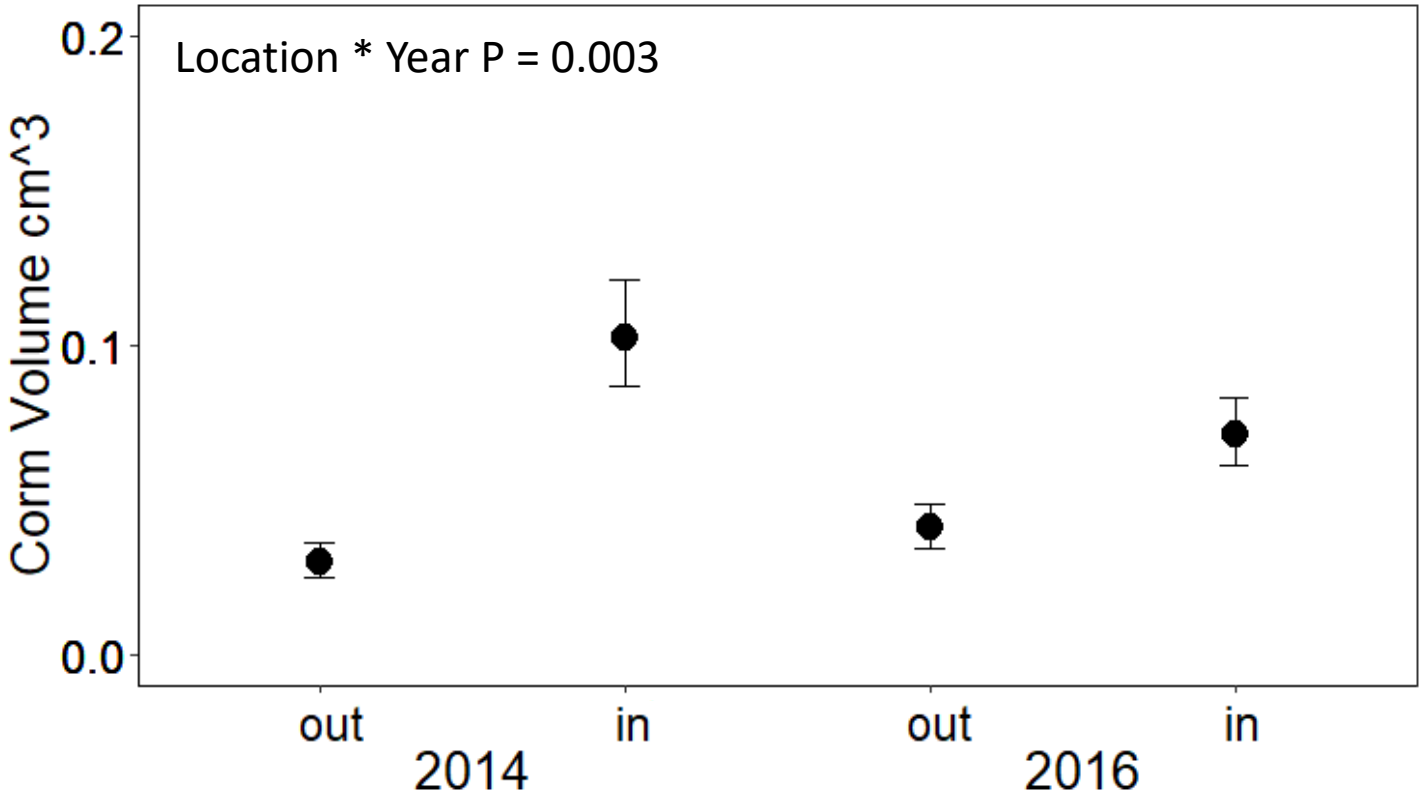
Skaien and Arcese, submitted

Brodiaea Corm Size



Skaien and Arcese, submitted

Brodiaea Corm Size



Skaien and Arcese, submitted

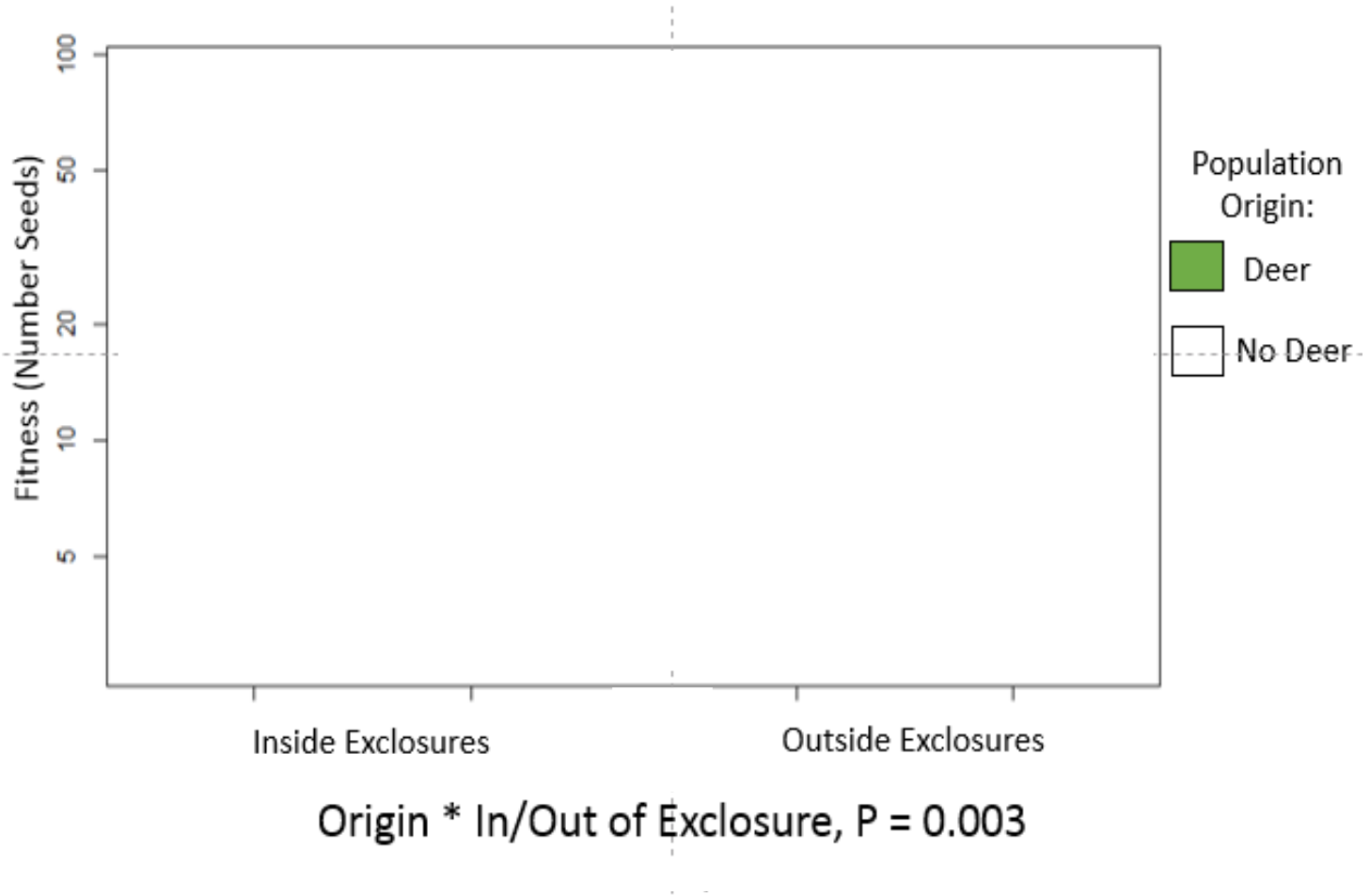
Brodiaea Sp.

- Number of corms increasing over time with deer removal compared to locations with deer

- Average size of corms larger where deer are absent in both years, but decreased from 2014 to 2016: suggestive of asexual budding causing a larger number of smaller bulbs being present

Fitness Differences in *P. congesta*

P. congesta inside exclosures in May



Skaien and Arcese, submitted

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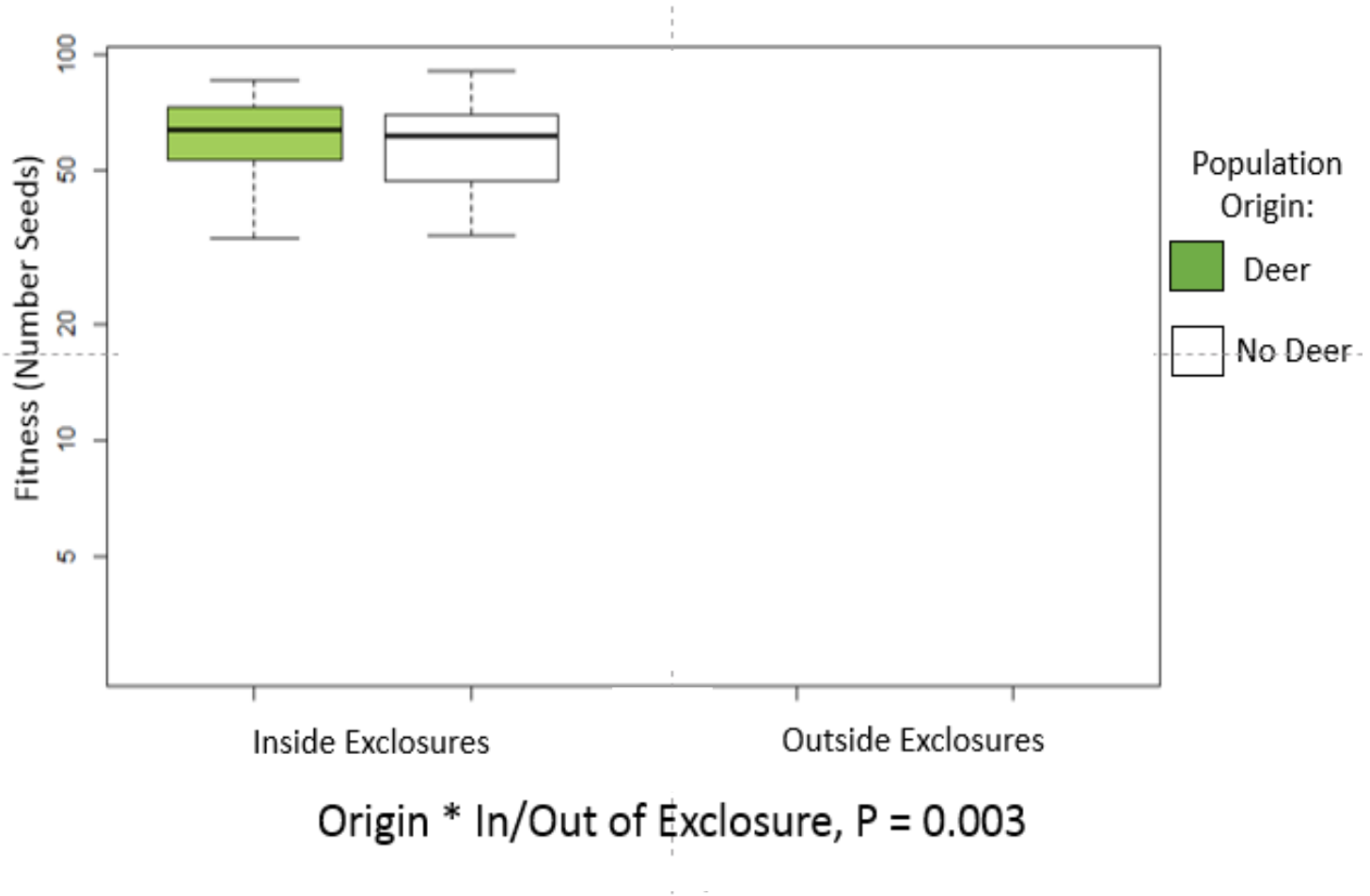
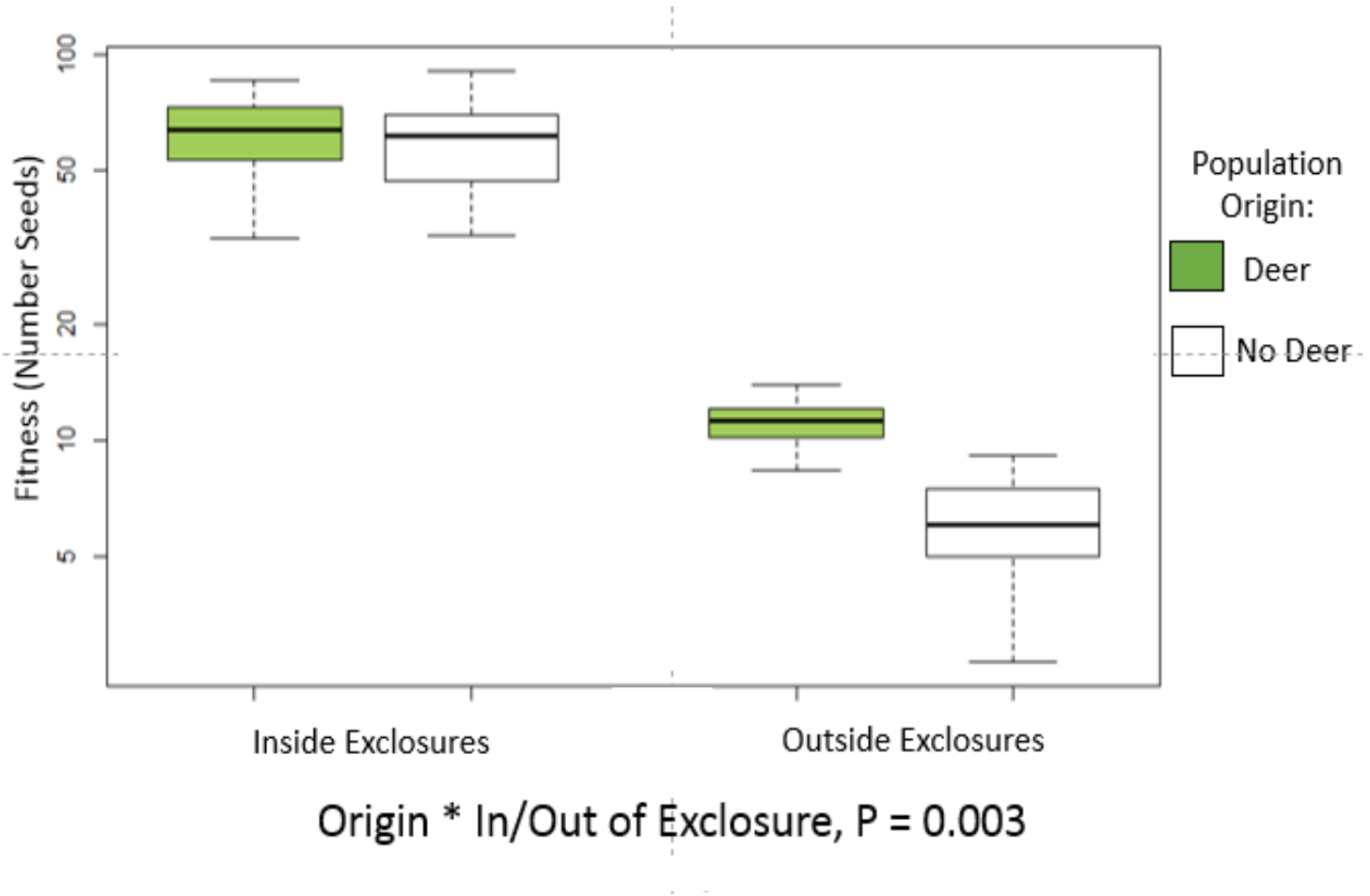


Skaien and Arcese, submitted

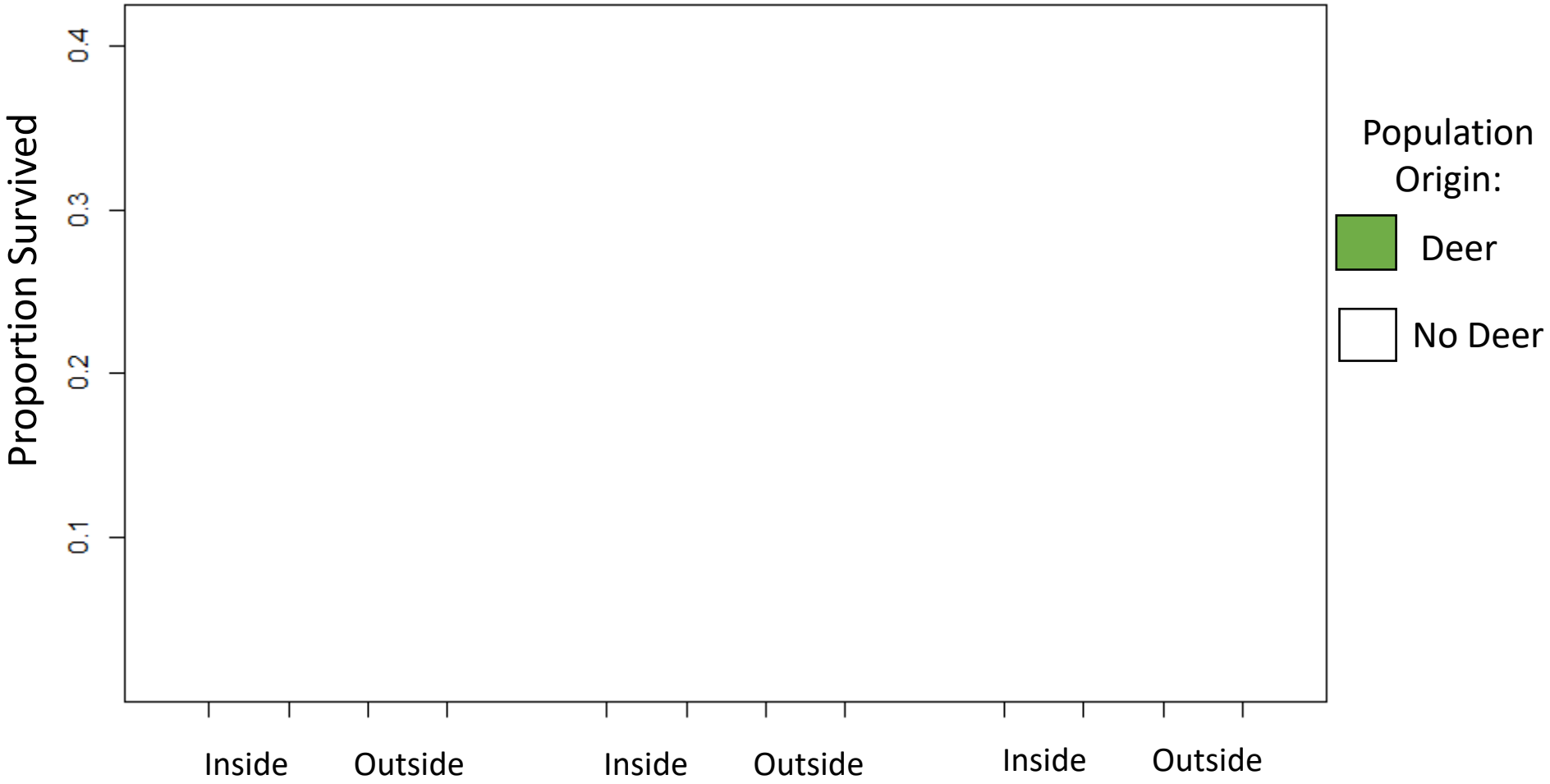
Fitness Differences in *P. congesta*

P. congesta inside exclosures in May



Skaien and Arcese, submitted

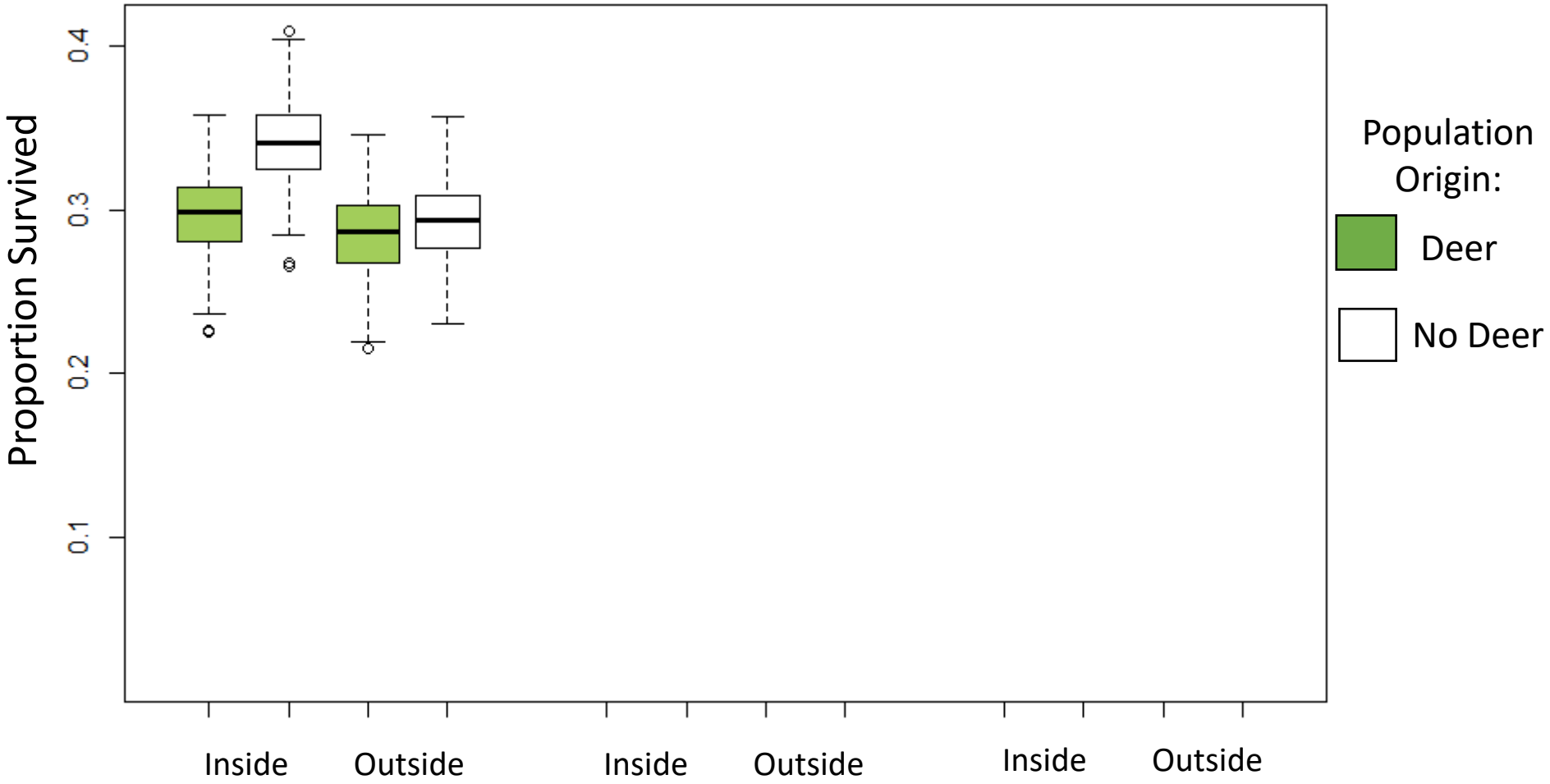
Survival Differences?



3-way interaction P < 0.001

Skaien *et al.* unpublished

Survival Differences?



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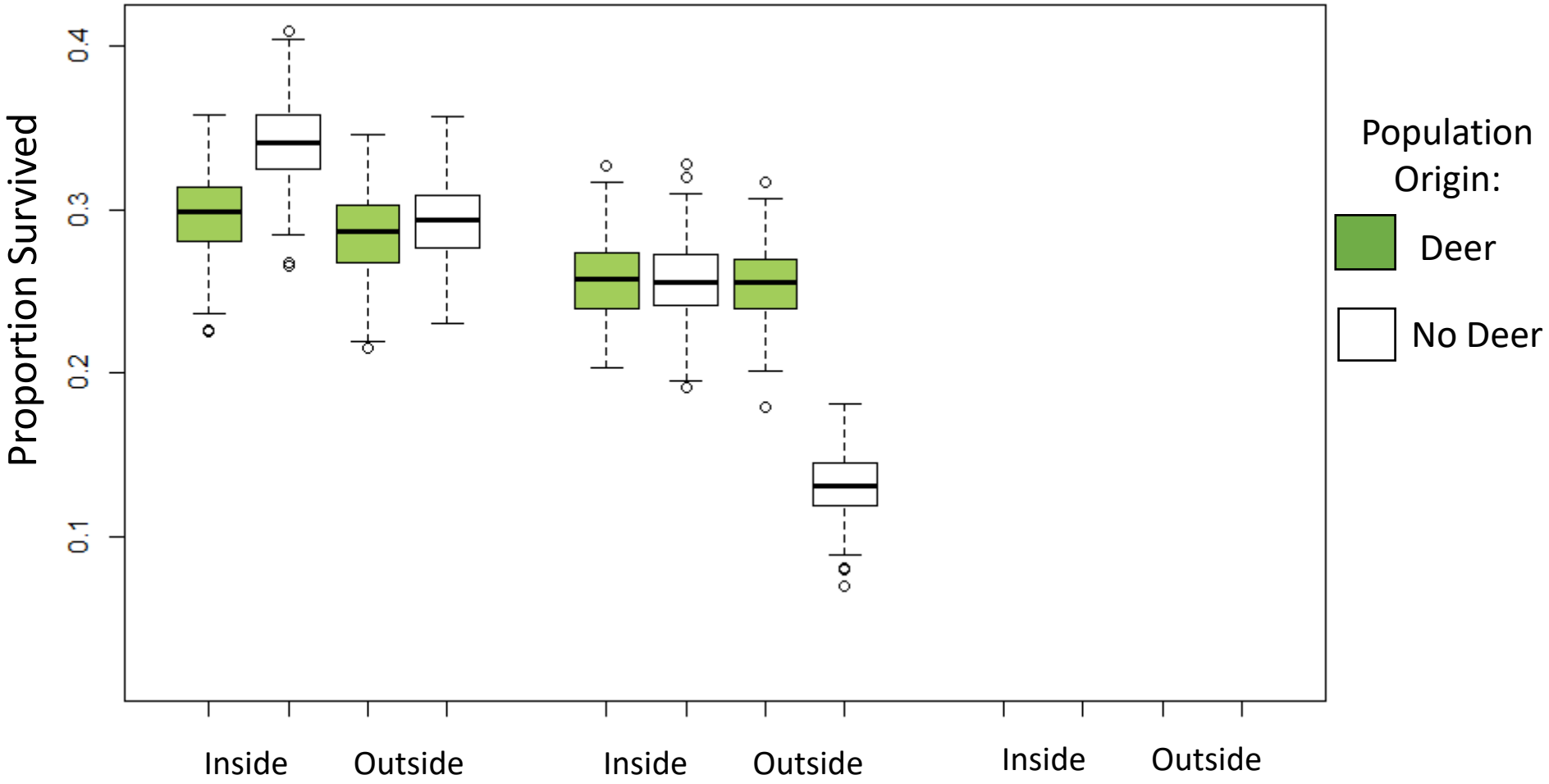

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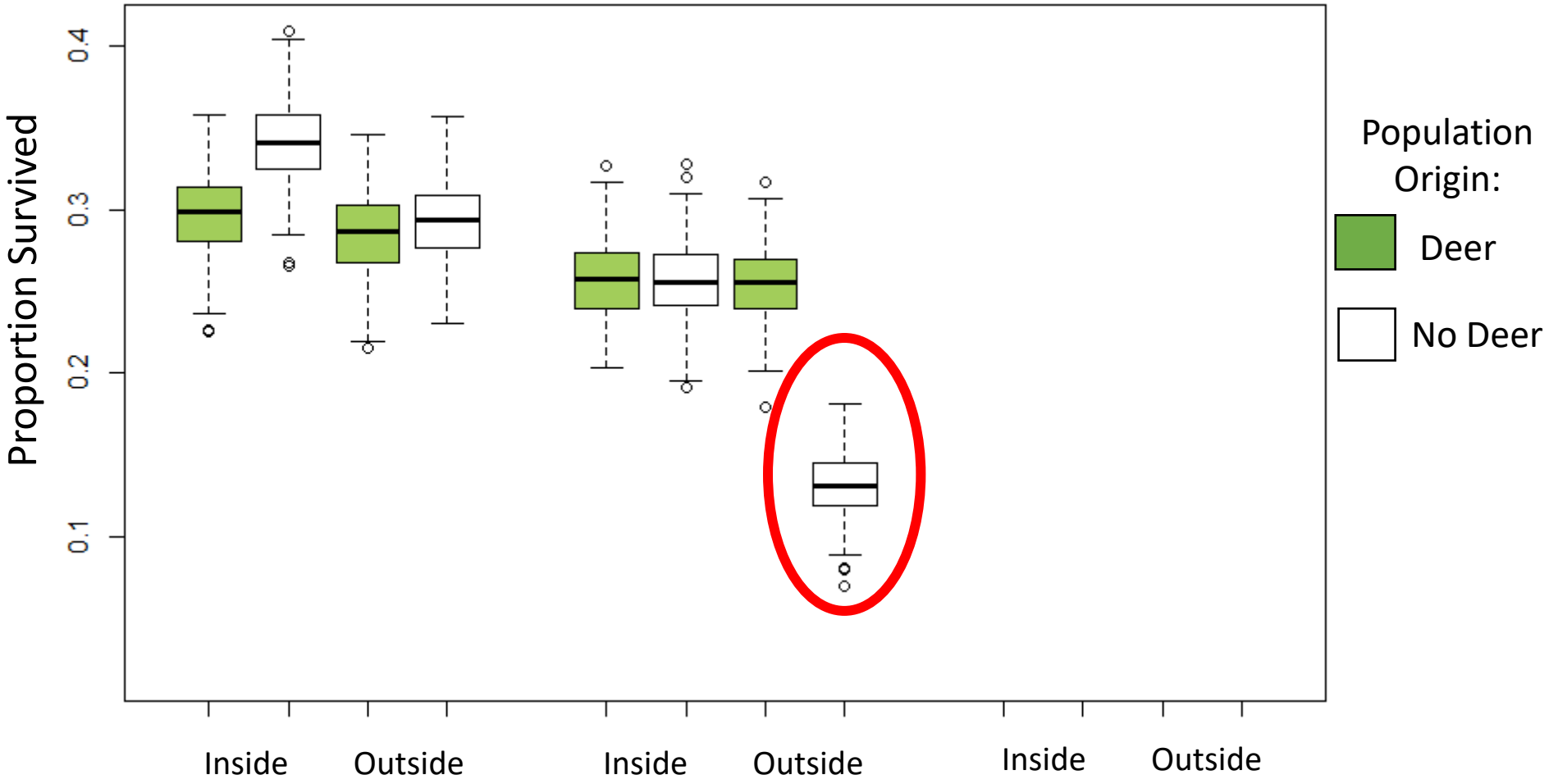
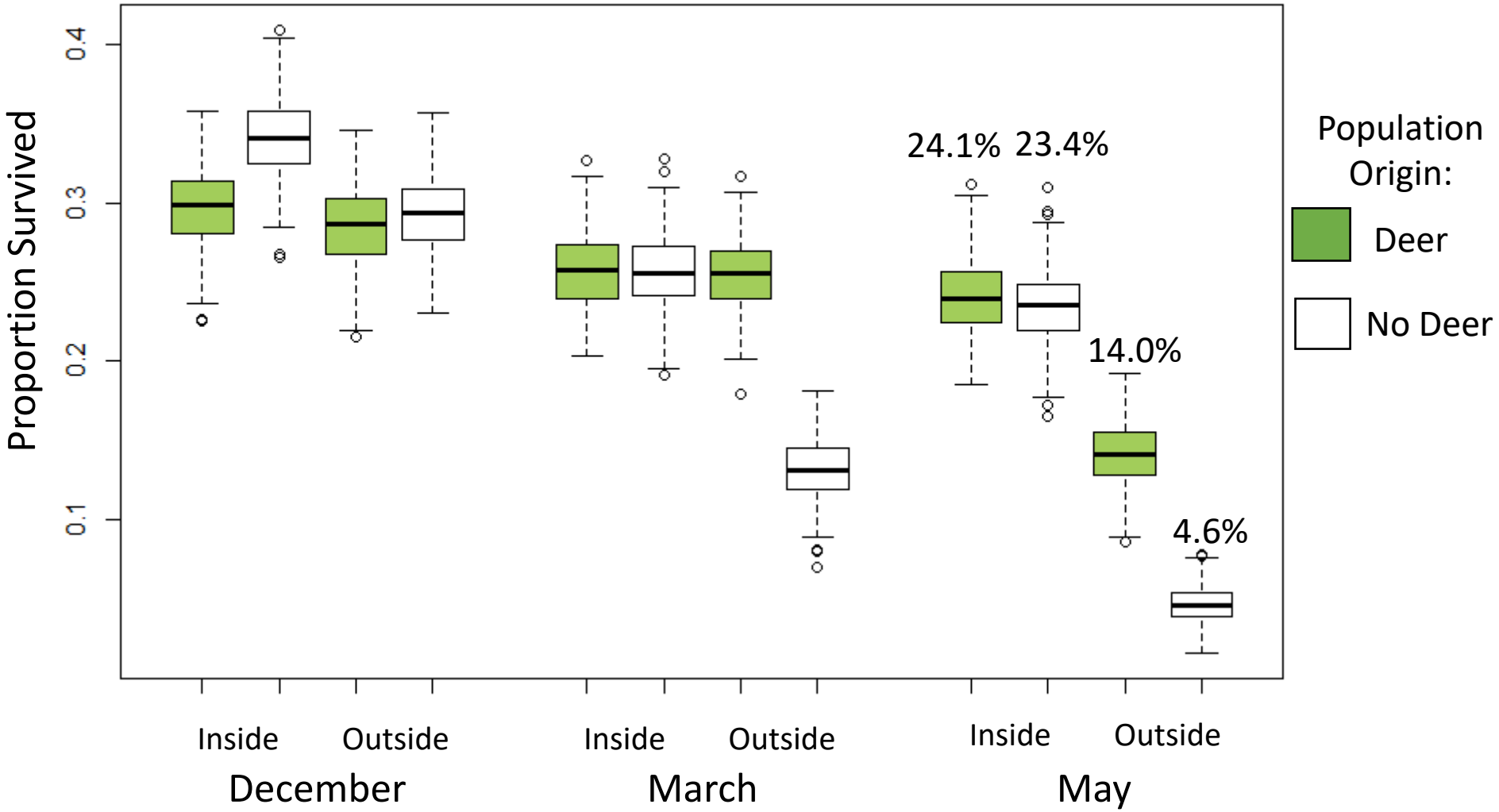
Survival Differences?



3-way interaction P < 0.001

Skaien *et al.* unpublished

Survival Differences?



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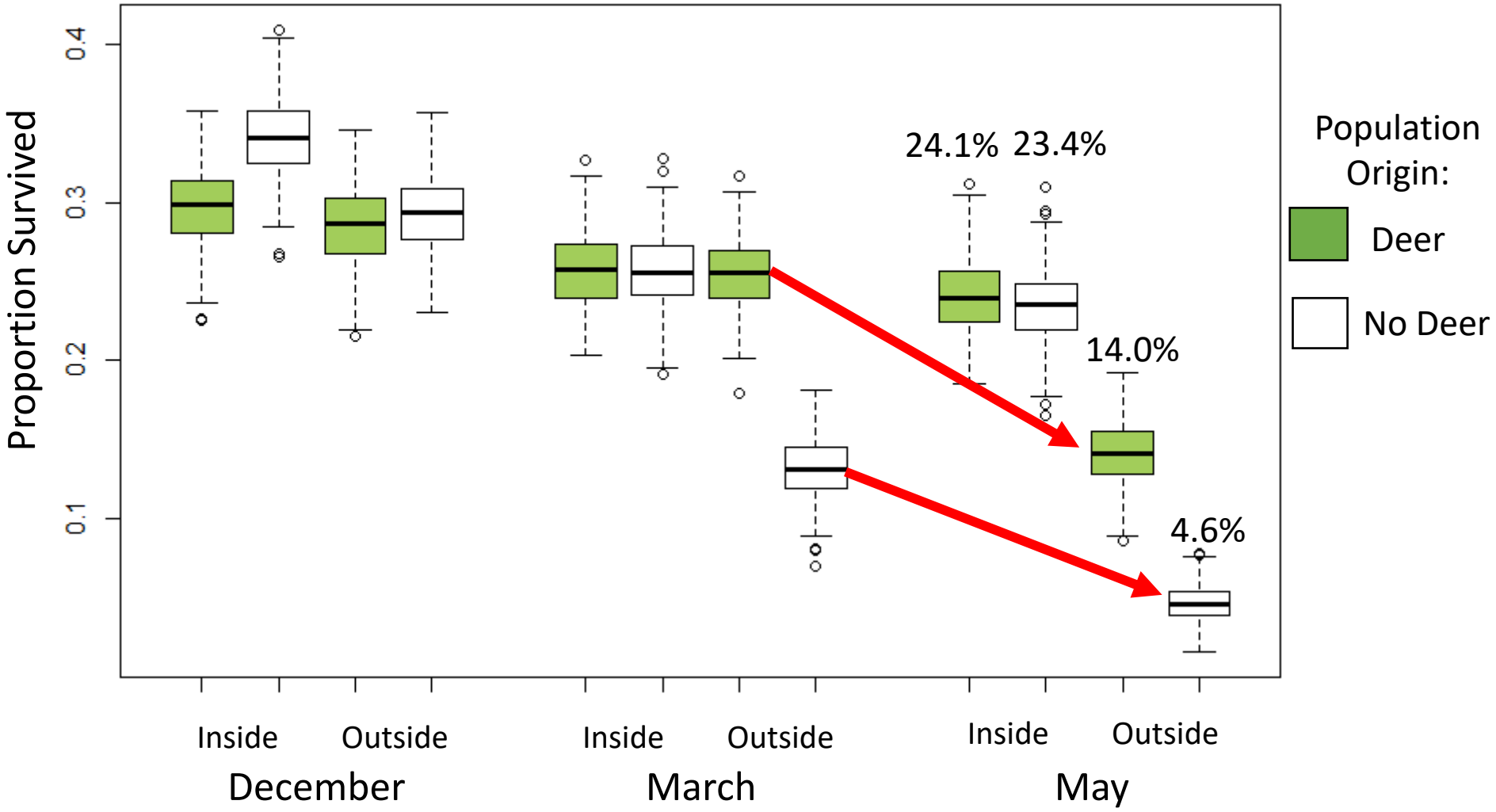
Survival Differences?



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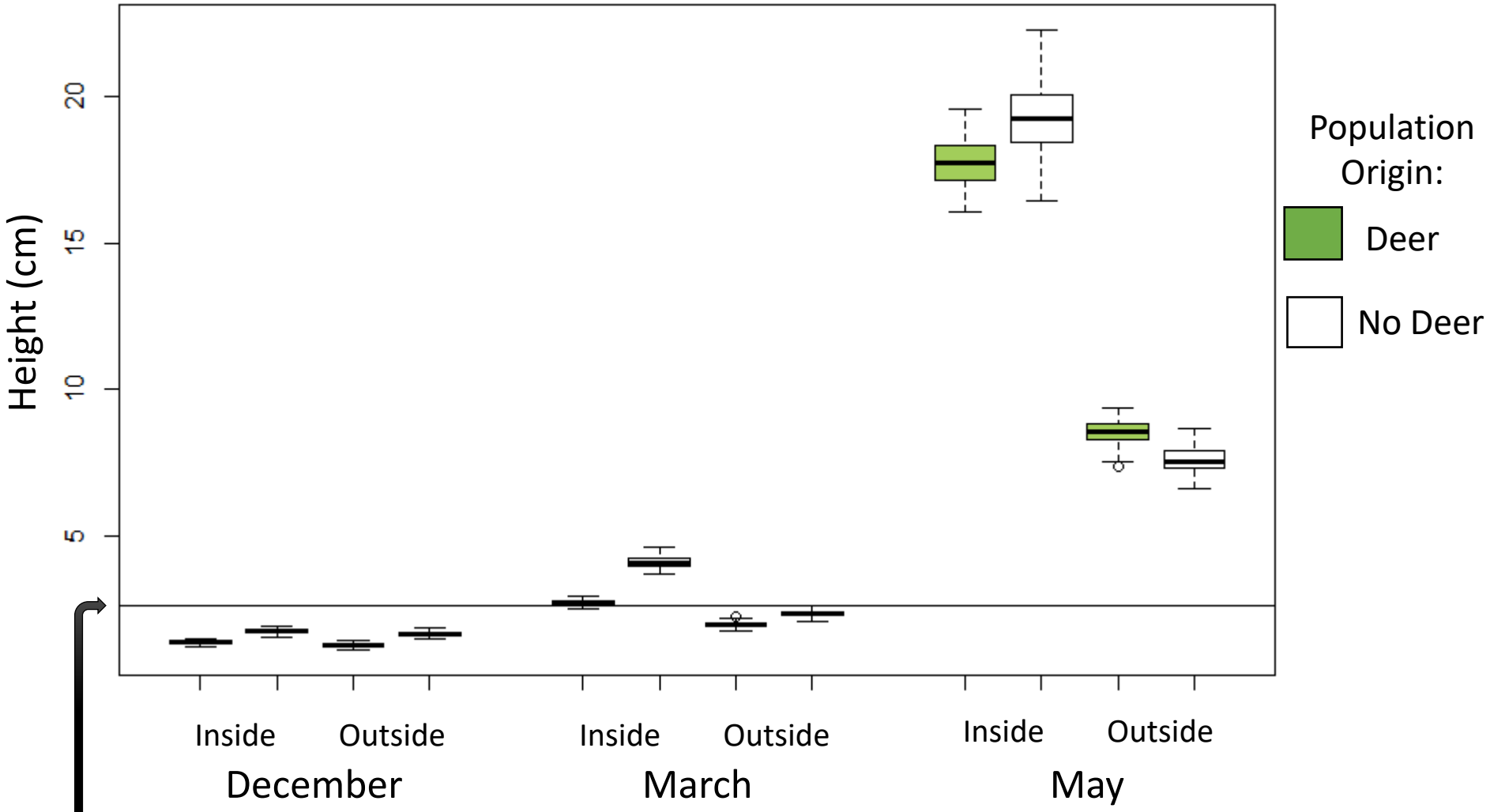
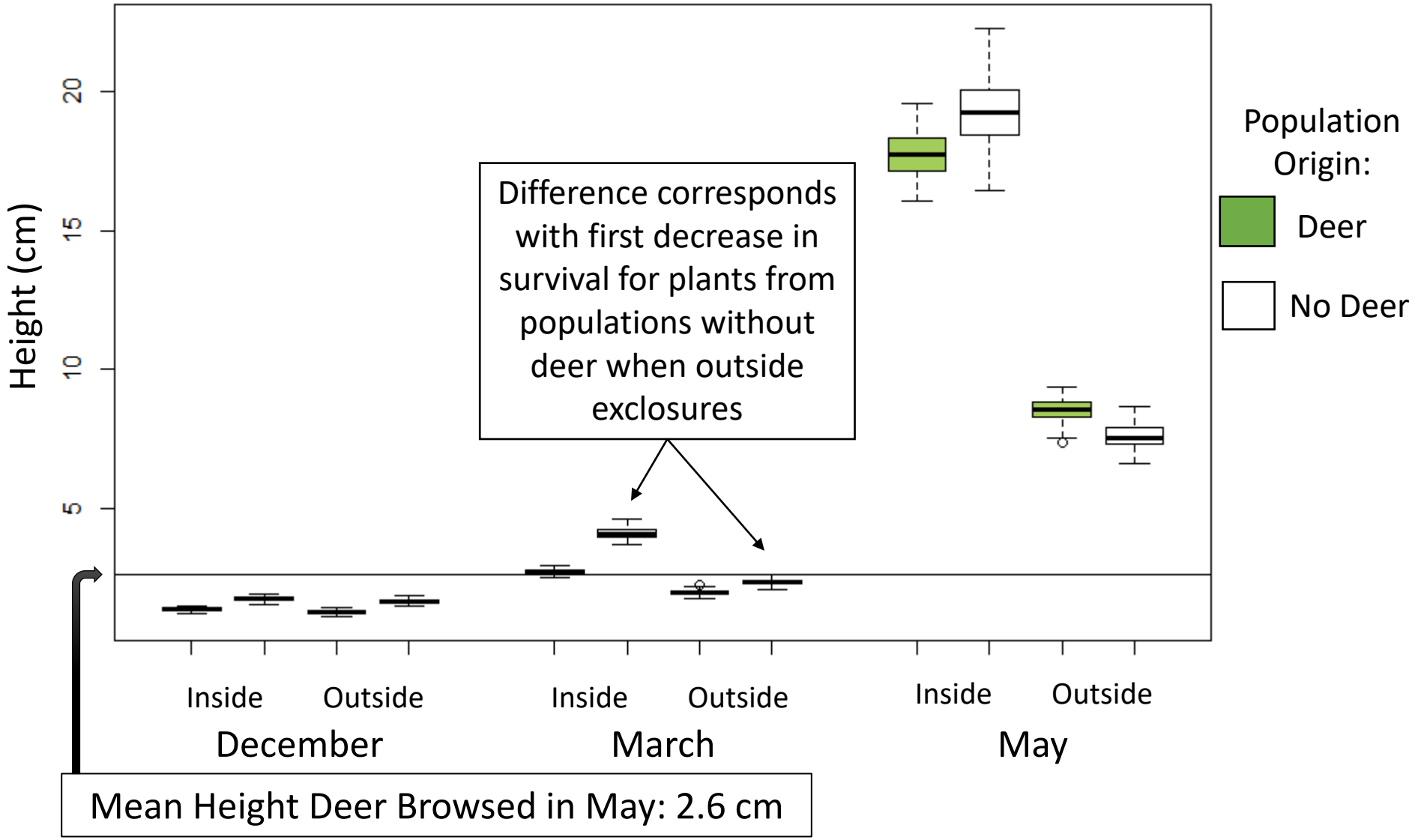
How Does Mean Height Affect Survival?



Mean Height Deer Browsed in May: 2.6 cm

How Does Mean Height Affect Survival?



Conclusions

Natives

Exotics

Conclusions

Natives

Exotics

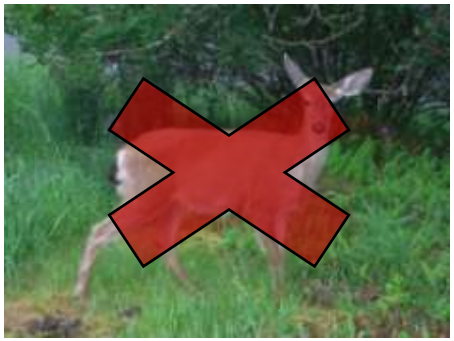
Conclusions

Natives

Exotics

Potential
Facilitation

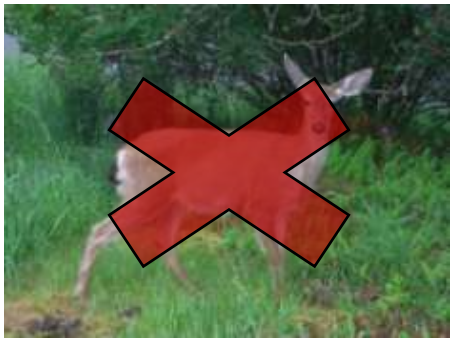
Conclusions



Natives

Exotics

Conclusions



Natives

Fitness, Survival

Cover, Corm Abundance and Size

Exotics

Implications

These results suggest:

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These results suggest:

1. Removal of deer is sufficient to instigate restoration of degraded Garry Oak and Maritime Meadow Ecosystems.
2. Locally adapted *P. congesta* populations should be used as a source of seed for restoration of these ecosystems.

- Caution: exotics likely to influence natives negatively on longer time scale

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Questions?