

Temperate forest bees: Resource use and distribution based on functional traits



CIF STUDENT E-LECTURE SERIES
JULY 19, 2017
PRESENTATION BY SUSAN FRYE

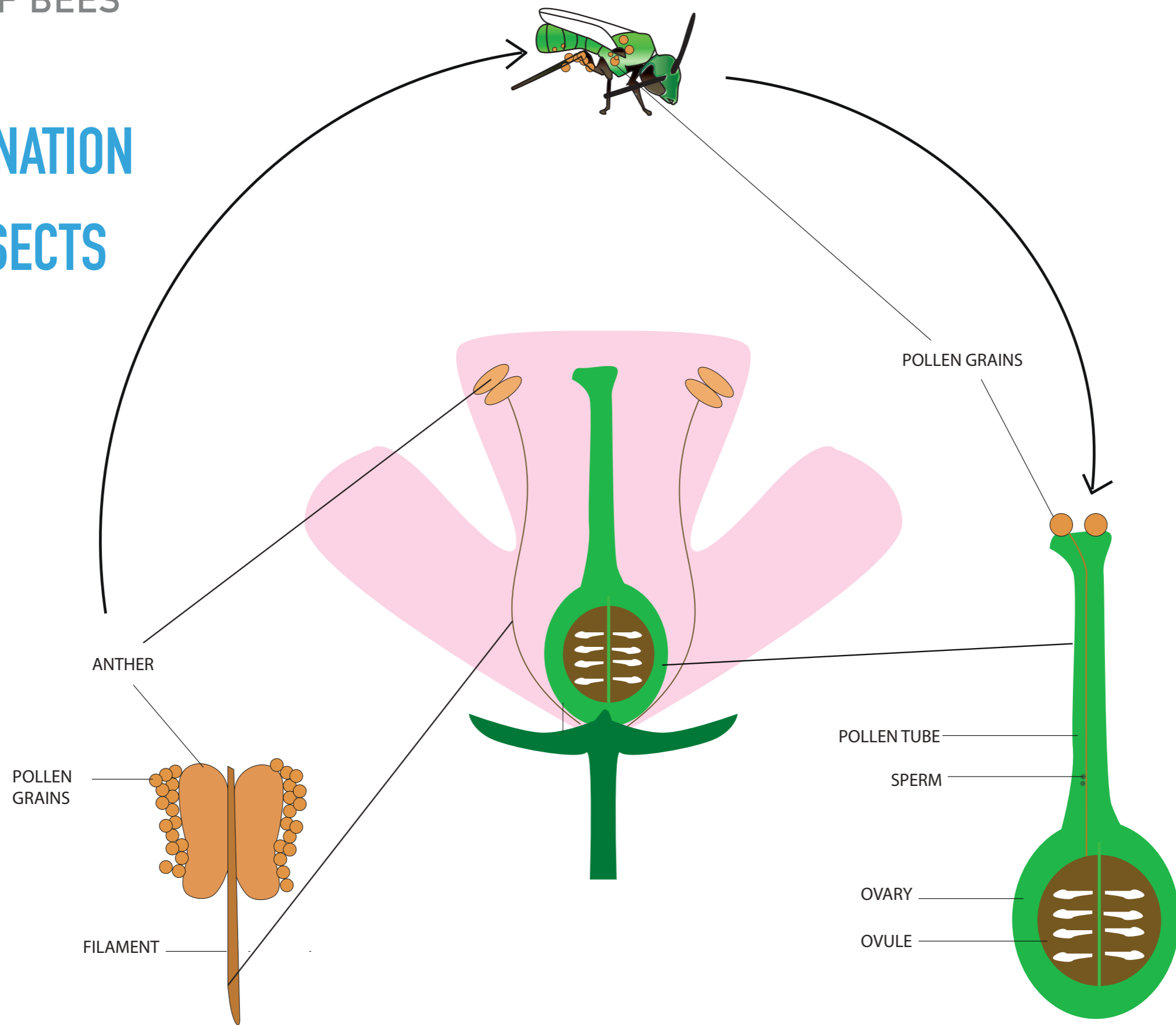
(Image by Susan Frye)



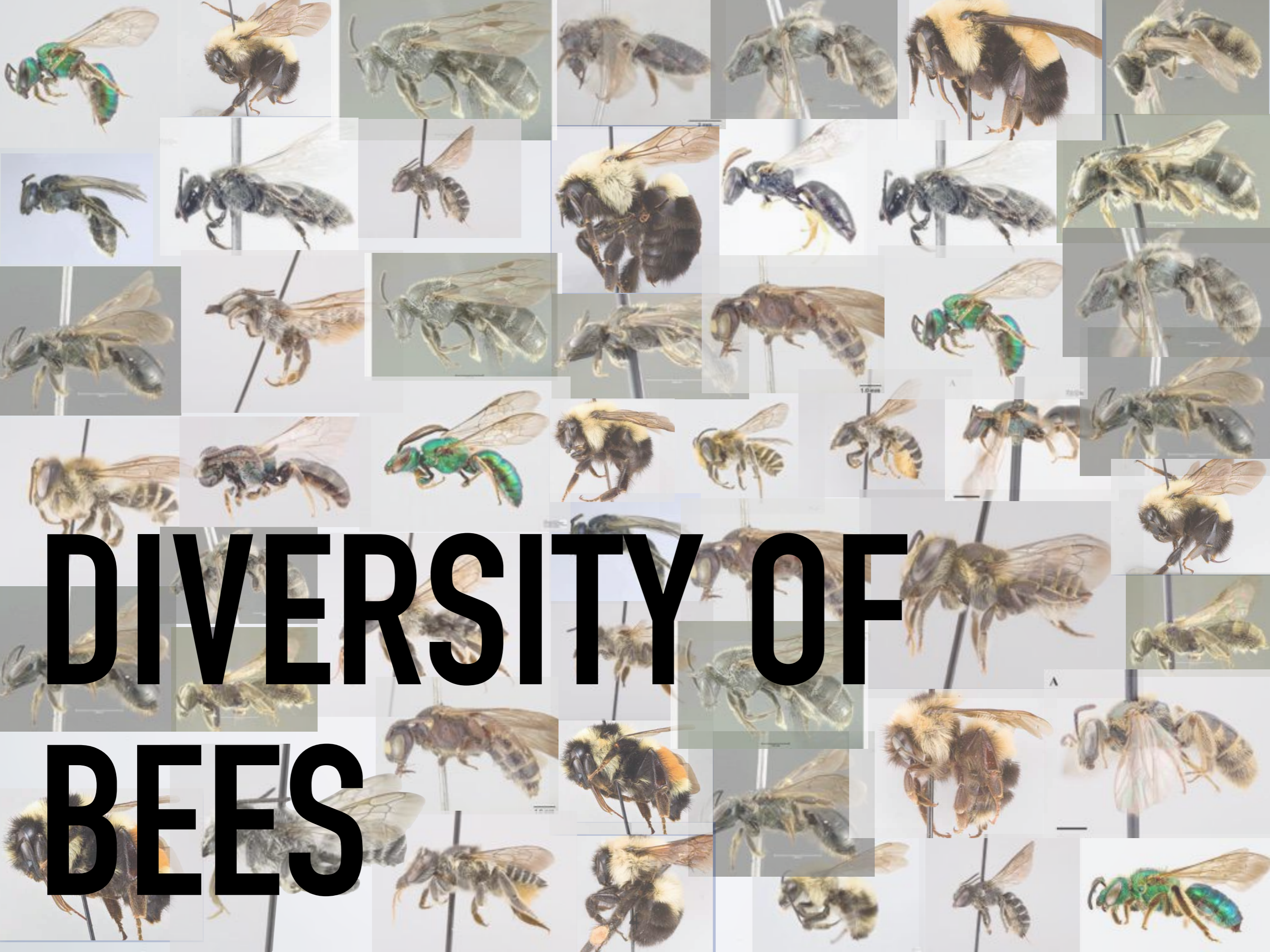
THE ROLE OF BEES

ROLE OF BEES

POLLINATION BY INSECTS



(modified from Willmer, 2011)



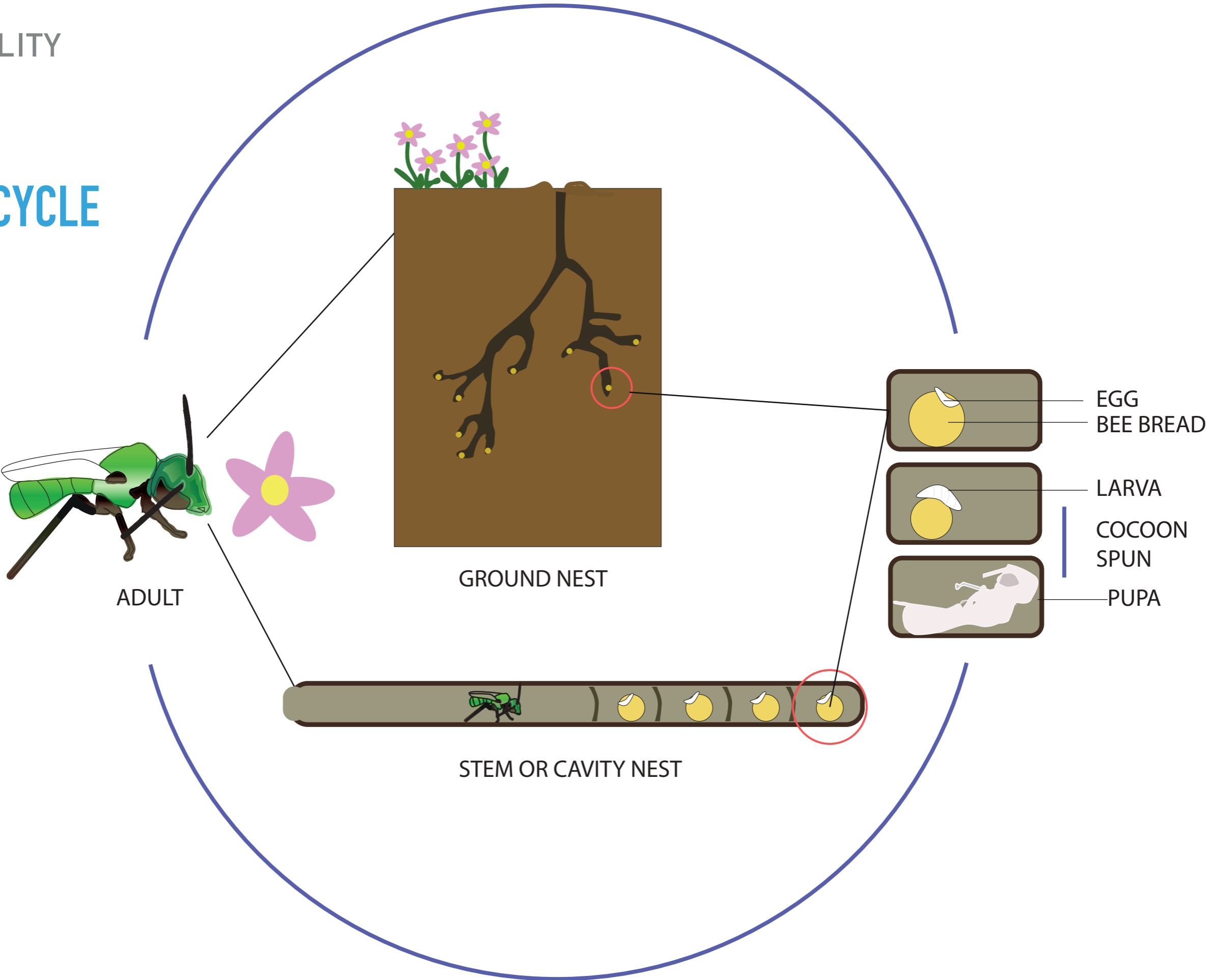
DIVERSITY OF

BEEES

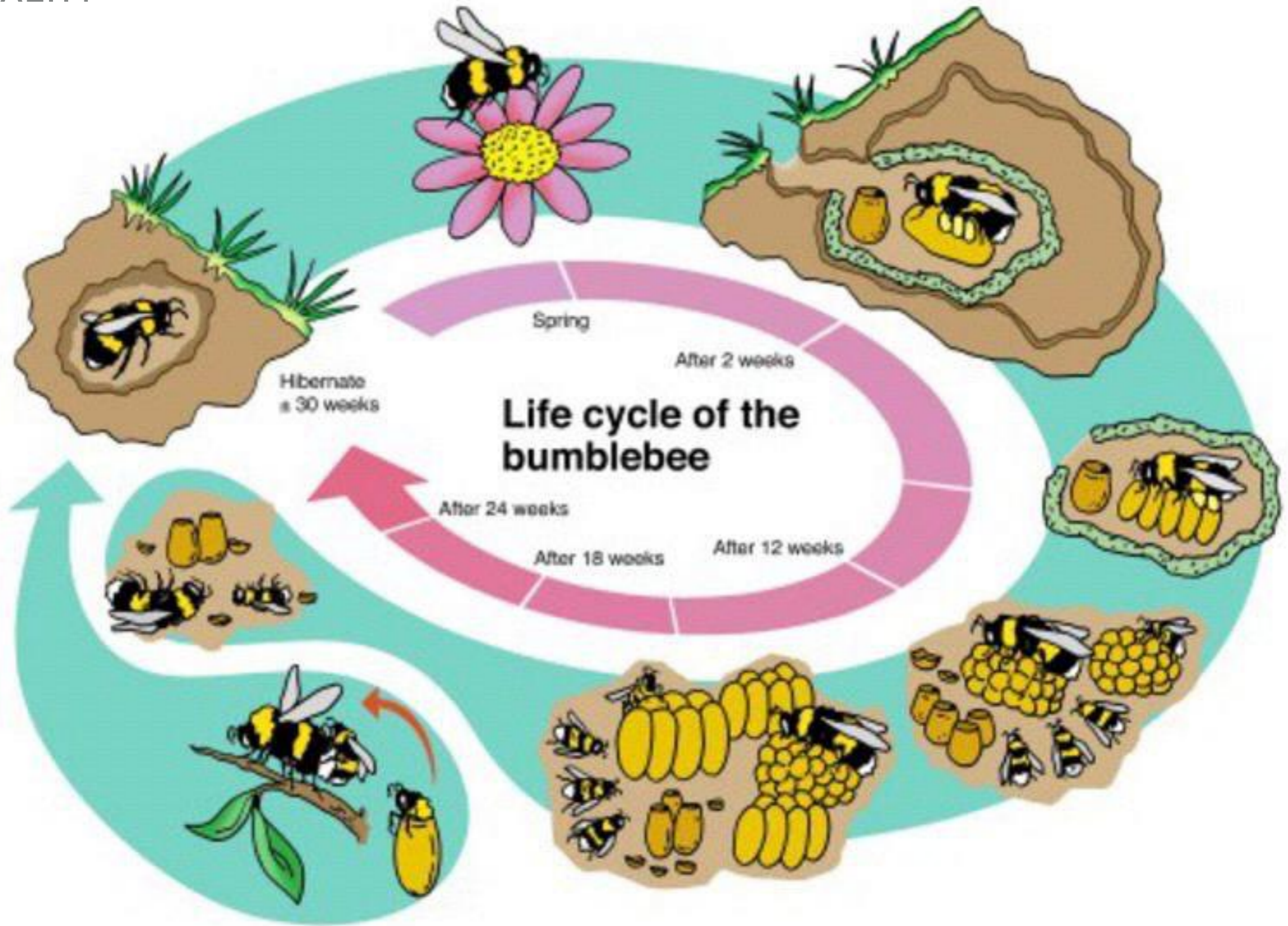
SOCIALITY

BEE

LIFE CYCLE



SOCIALITY





Peponapis



Bombus



Lasioglossum



Andrena



Melissodes



Colletes

NESTING



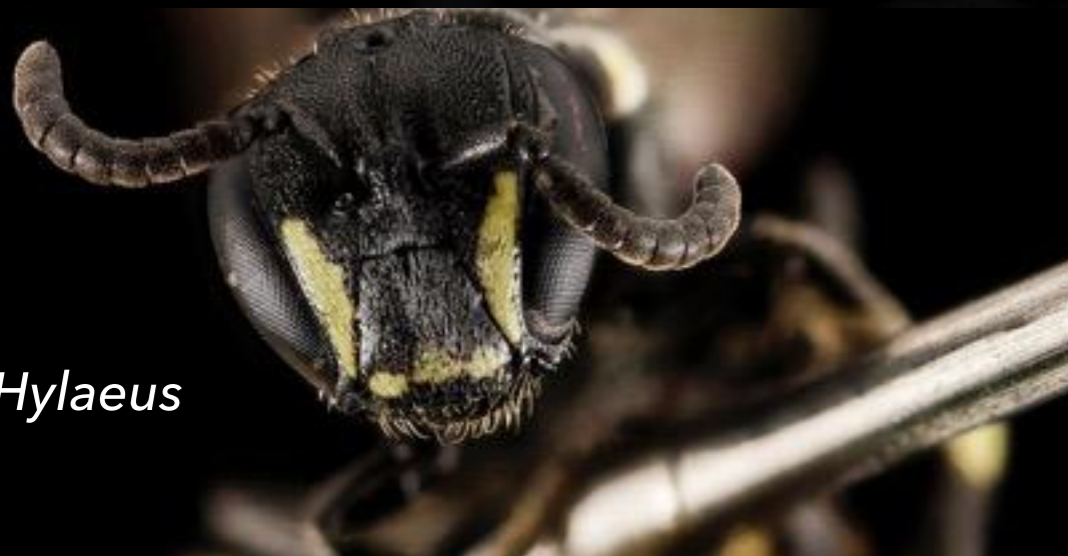
70%
GROUND
NEST



Megachile



Osmia



Hylaeus



Hoplitis



Anthidium



30% STEM NEST

DIET

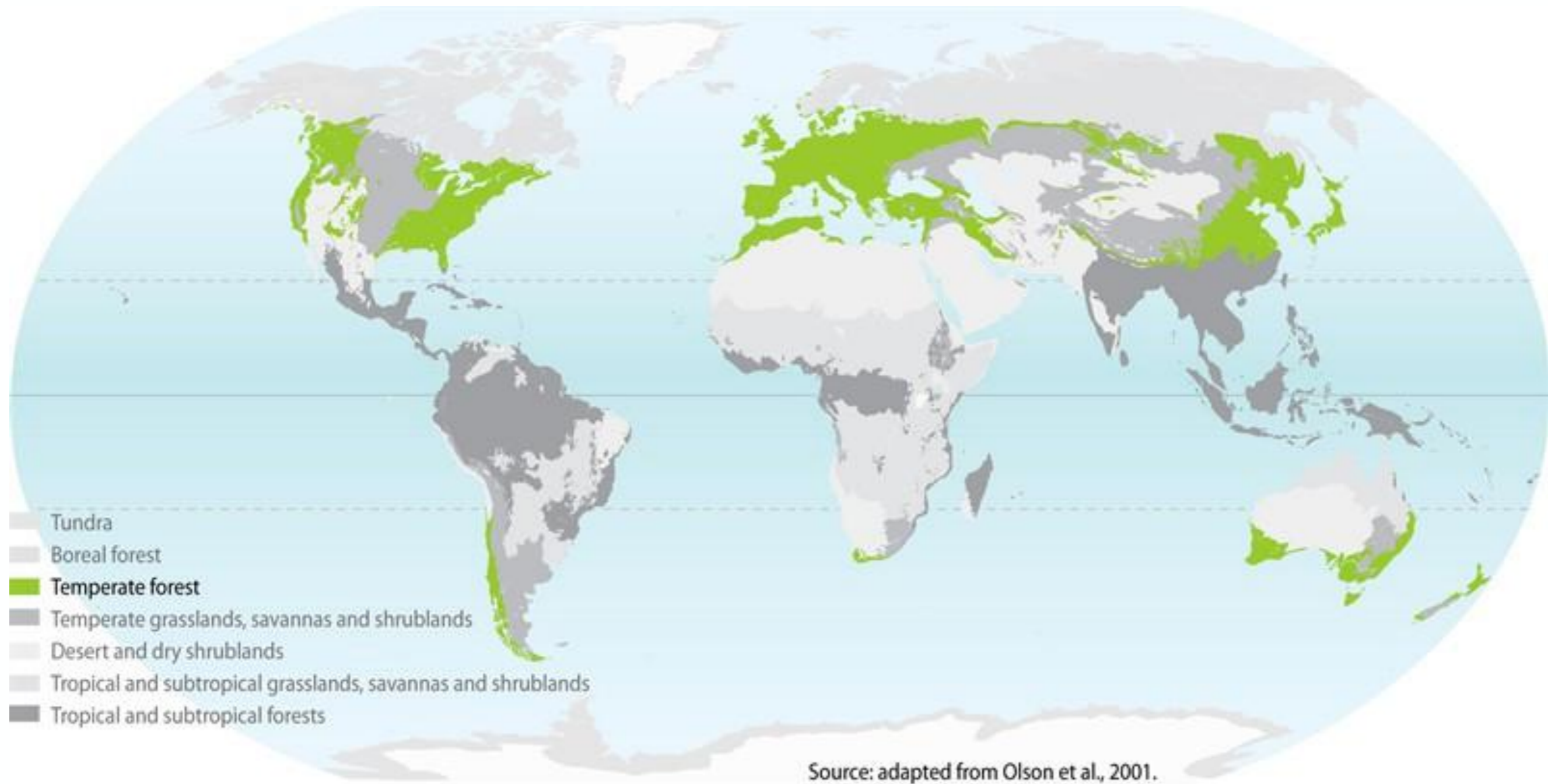
OLIGOLECTIC VS. POLYLECTIC

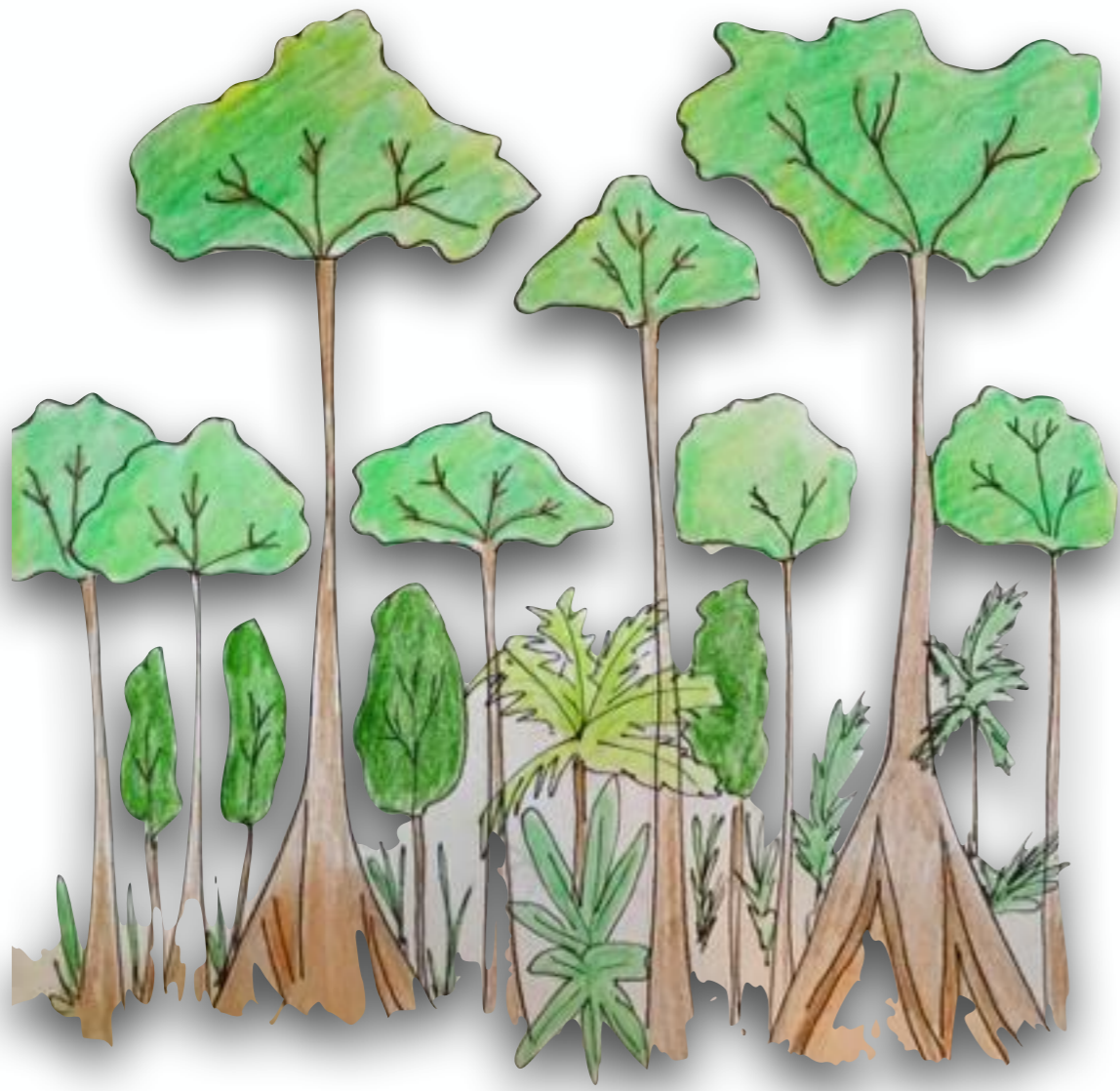




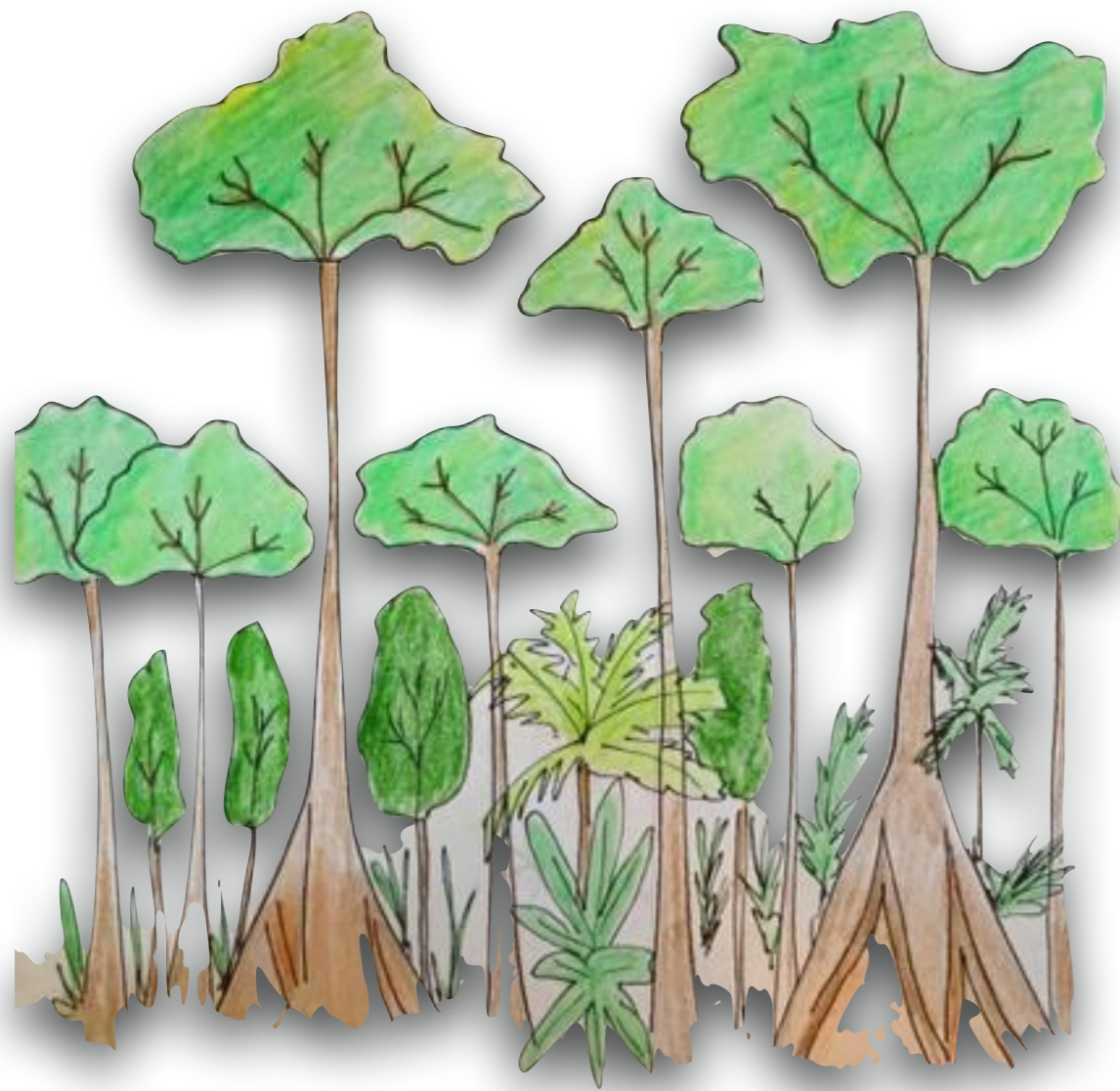
(Kremen 2005; Packer 2007)

Temperate Forests of the World

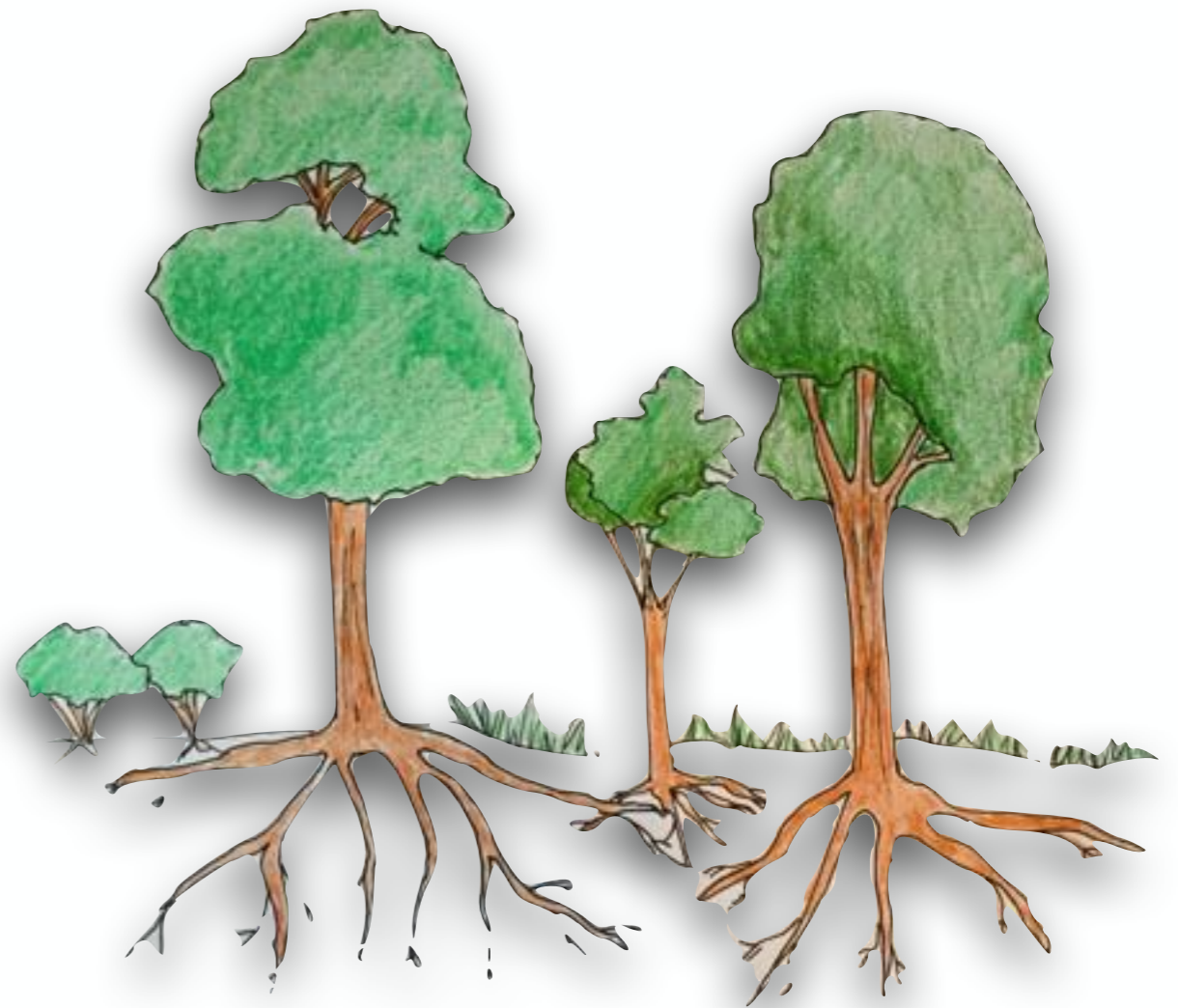




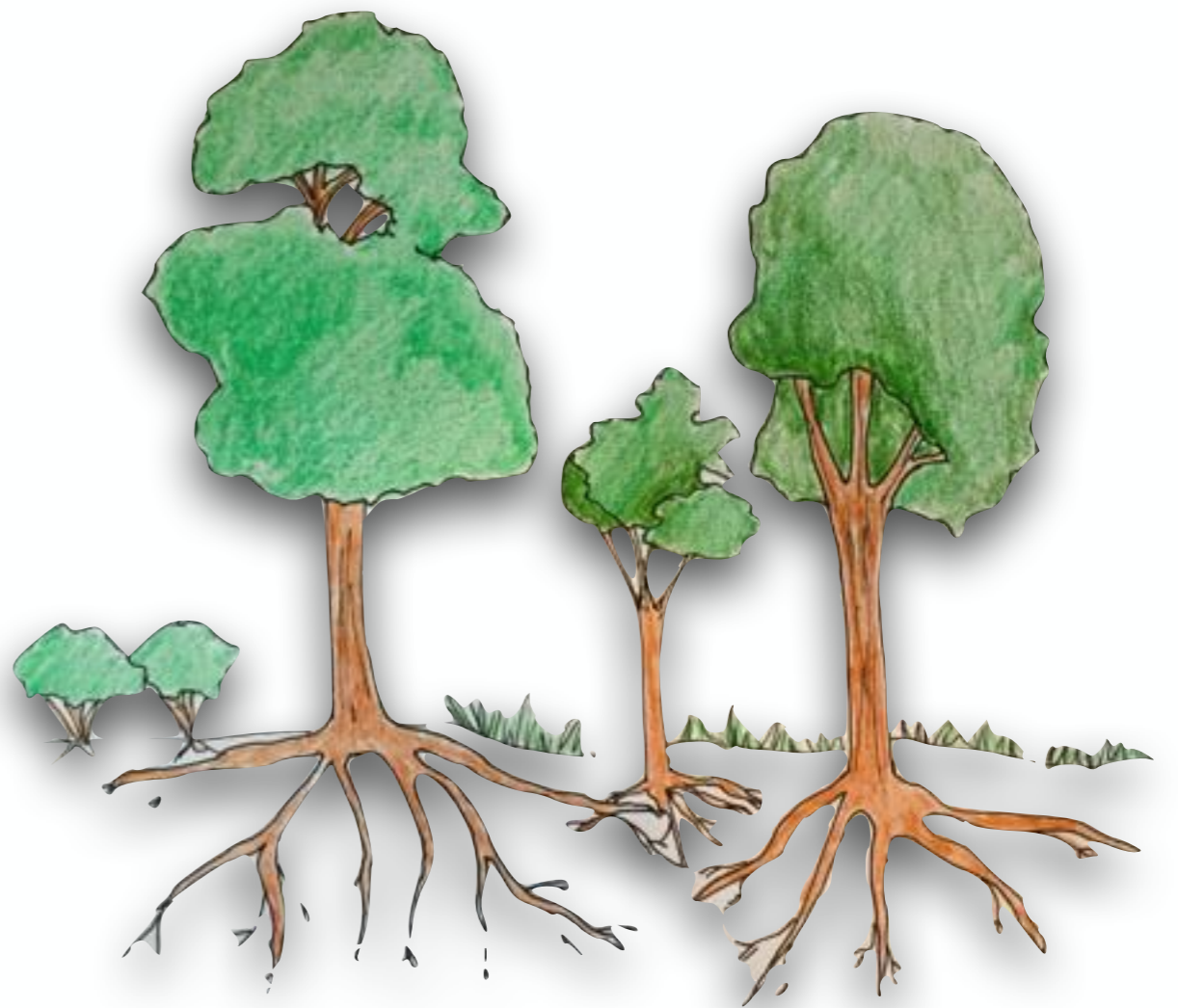
Tropical Forests



Tropical Forests



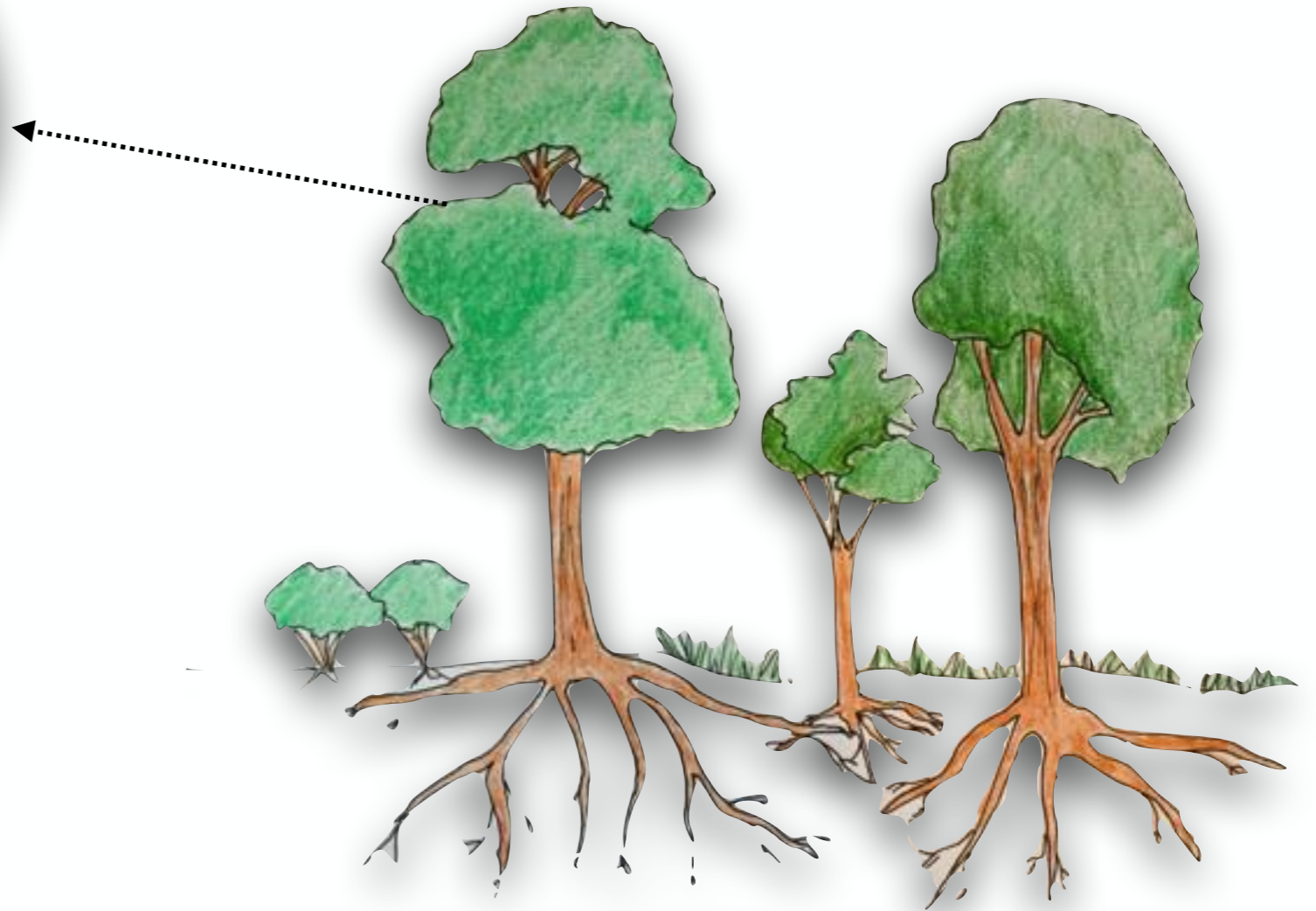
Temperate Forests



Temperate Forests



Thiele, 2005



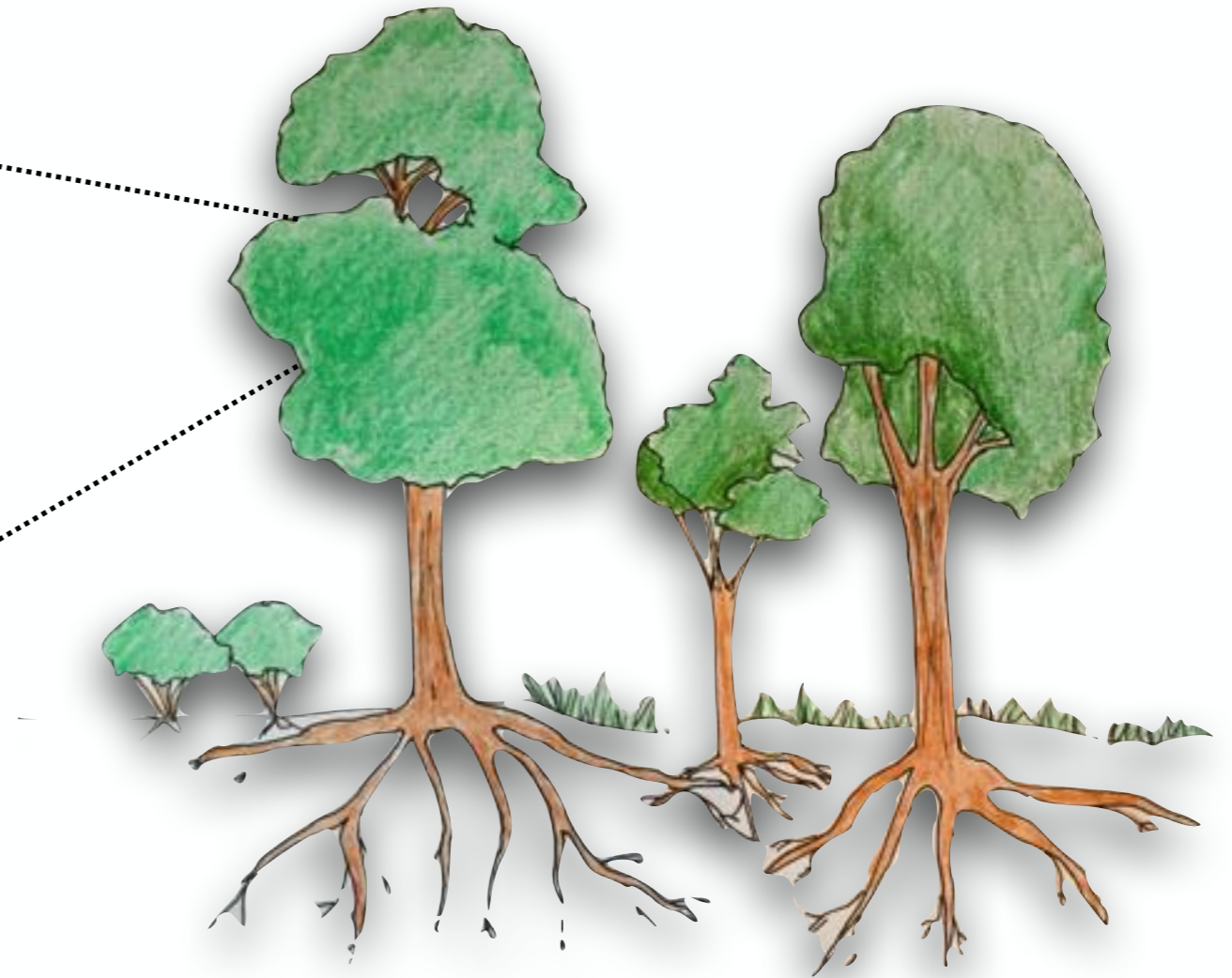
Temperate Forests



Thiele, 2005



Ewers 2003,
Ulyshen et al. 2010,
Wäckers 2008



Temperate Forests

Native bee fauna



Native bee fauna



Vulnerable

Native bee fauna



food and nesting sites are being eliminated

Native bee fauna



highly sensitive to insecticides

Native bee fauna



don't reproduce in large numbers

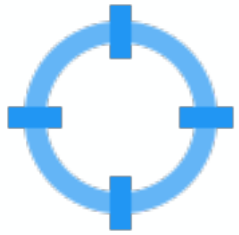
Native bee fauna



genetic diversity is reduced

Native bee fauna





Broad objective: To examine temperate forest bees in relation to habitat use, resources, and their responses to introduced European honeybees.



Problem: Forest bees in the northern hemisphere are still widely unexplored, and in order to inform conservation initiatives, we need a greater understanding of the driving mechanisms for their distribution.

Project 1: Differential use of tree canopies by bees in a mixed woods forest

Project 2: Lecanium scale and maple mealybug distribution within a temperate forest canopy

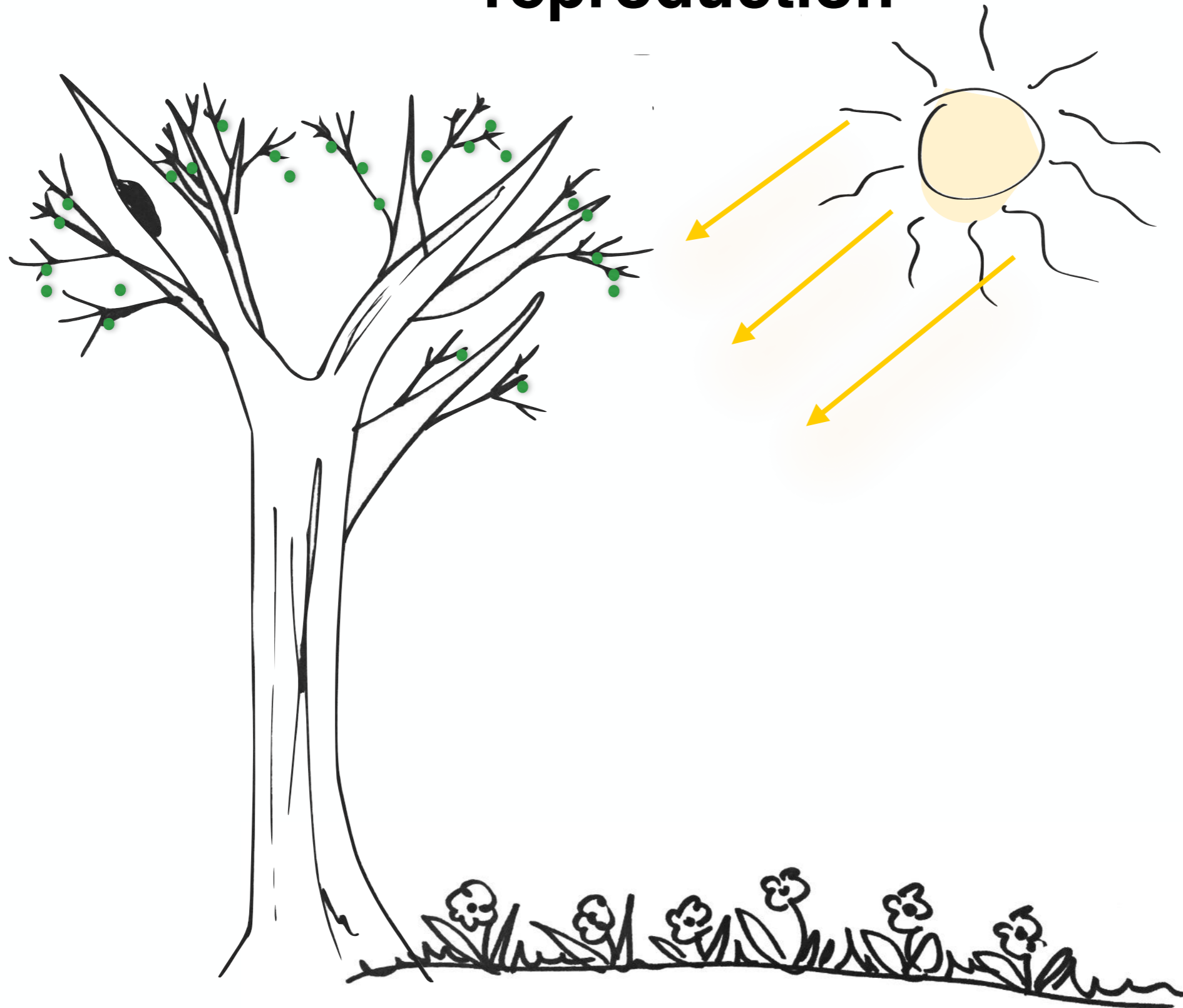
Project 3: Effects of introduced honeybees on native stem nesting bees in a temperate mixed-wood forest

A photograph of a person walking away on a dirt path through a dense hardwood forest. The trees are tall and thin, with a thick canopy of green leaves. Sunlight filters through the trees, creating dappled light on the path and the surrounding vegetation. The person is wearing a light-colored jacket and dark pants, and is carrying a bag. The overall scene is a lush, green woodland.

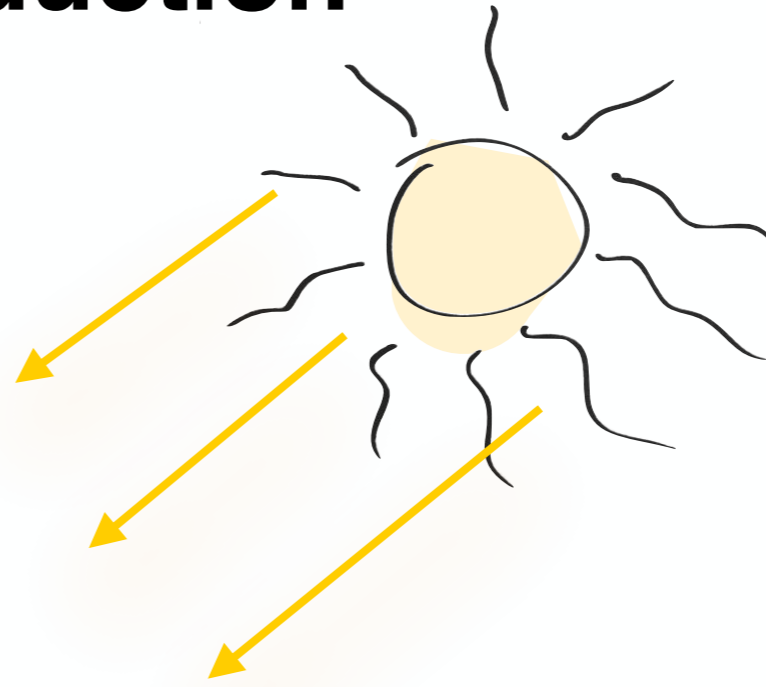
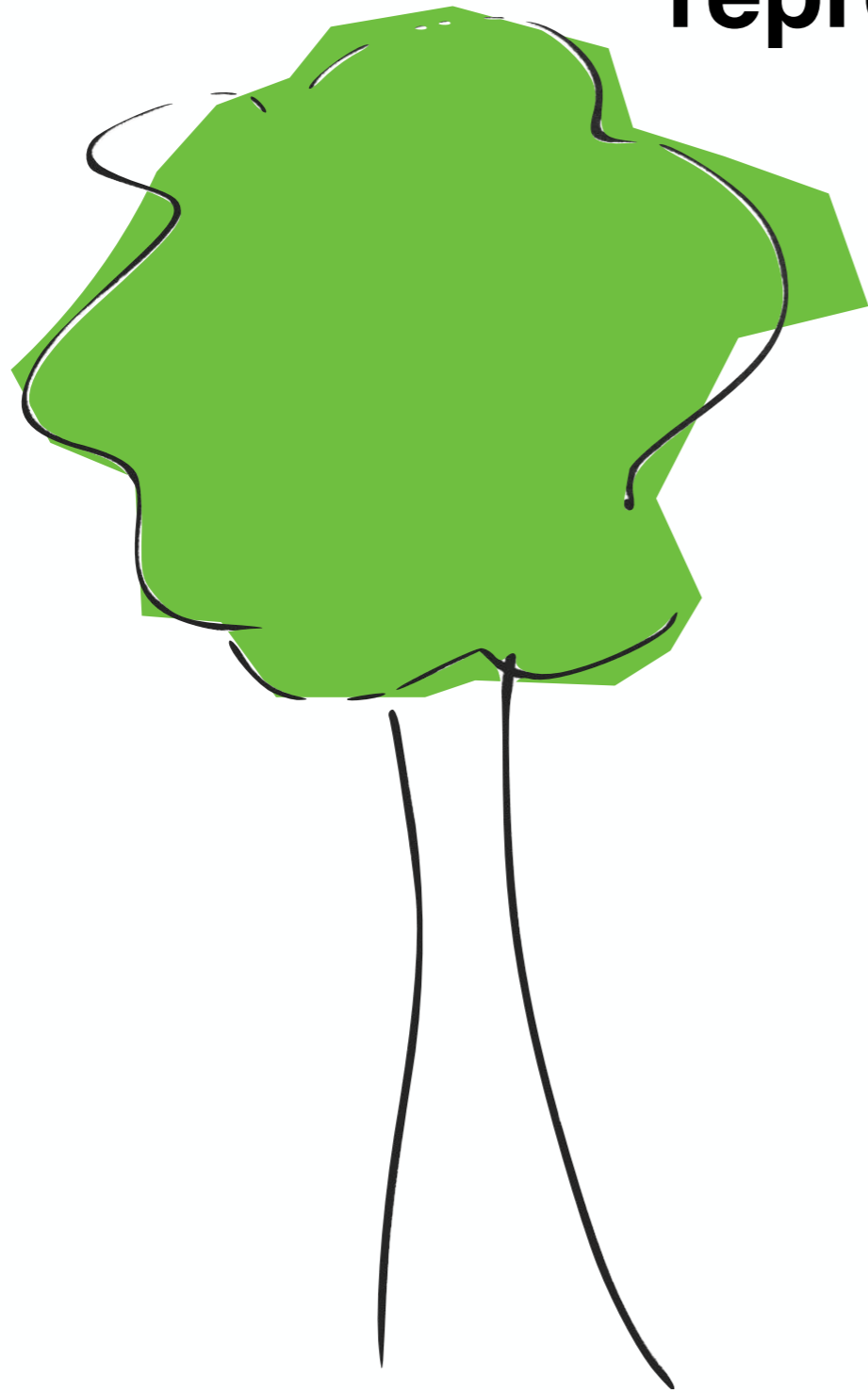
Project 1

Differential use of tree canopies by bees in a northern hardwood forest

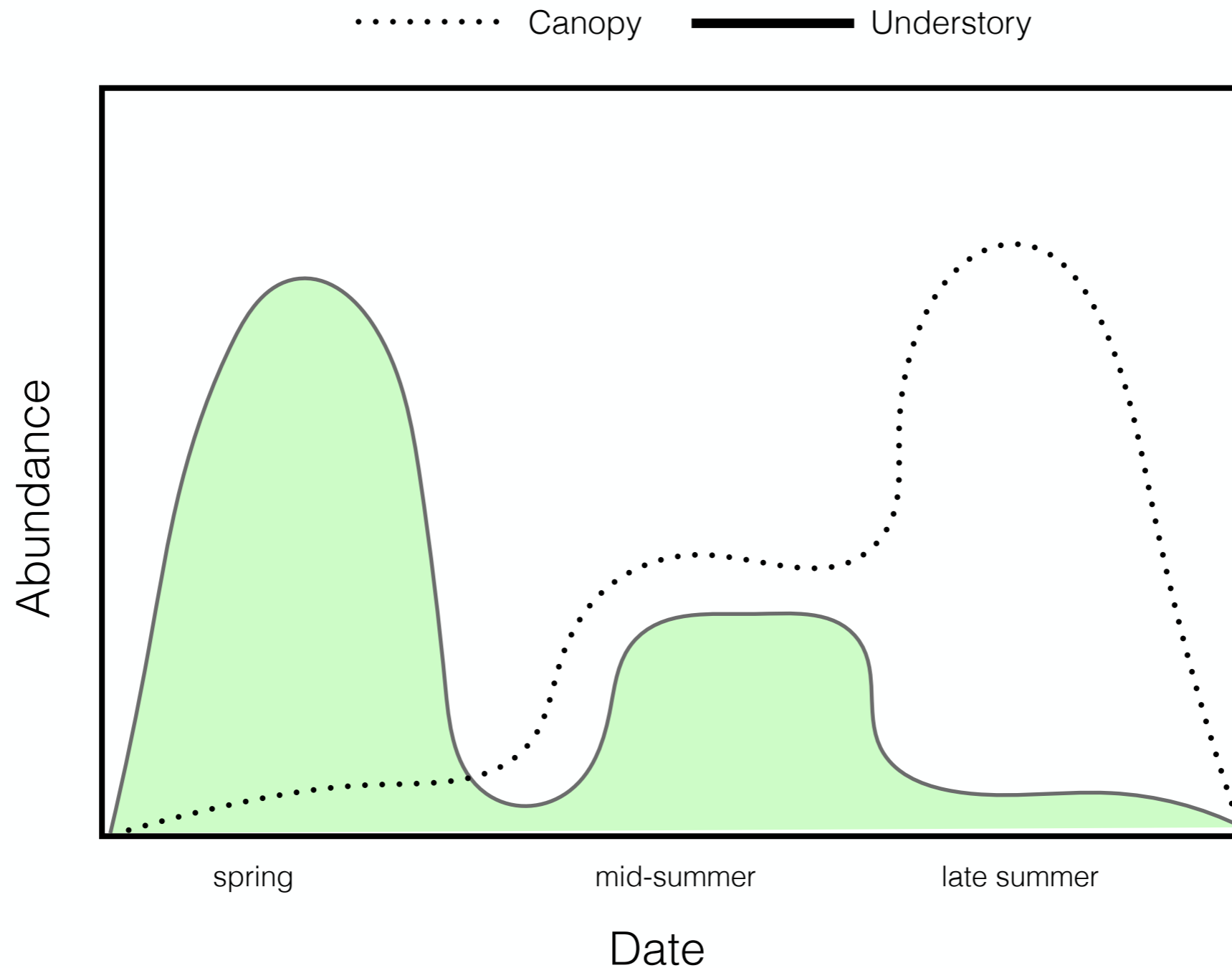
Requirements for bee functioning and reproduction



Requirements for bee functioning and reproduction

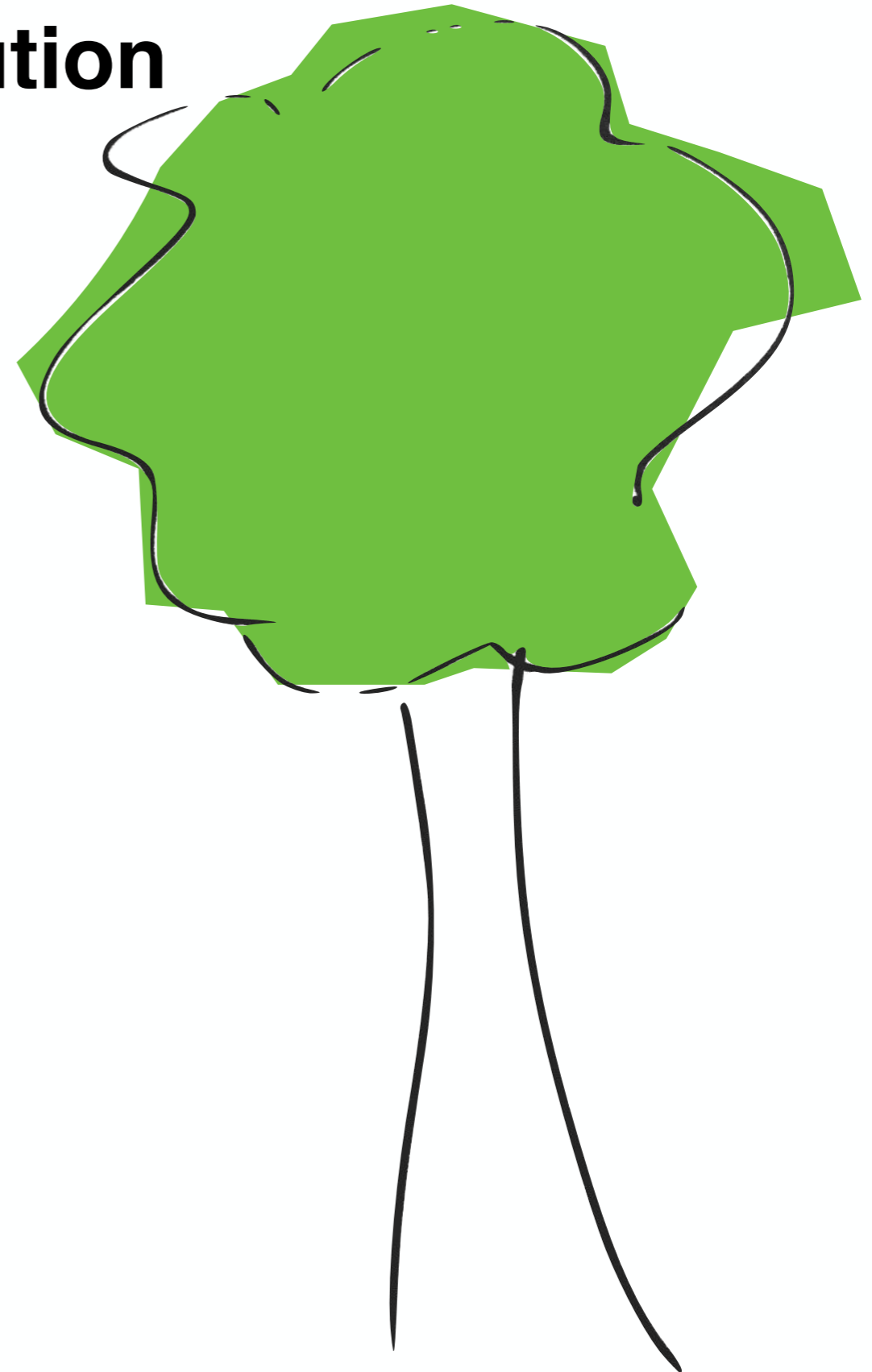


Abundance of canopy bees will be dependent on available resources in the understory and niche partitioning

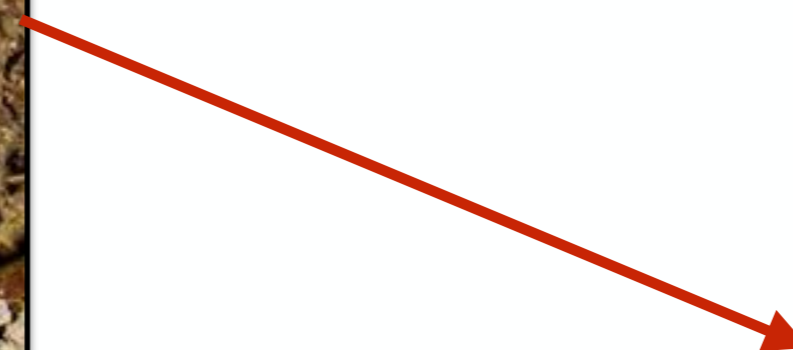
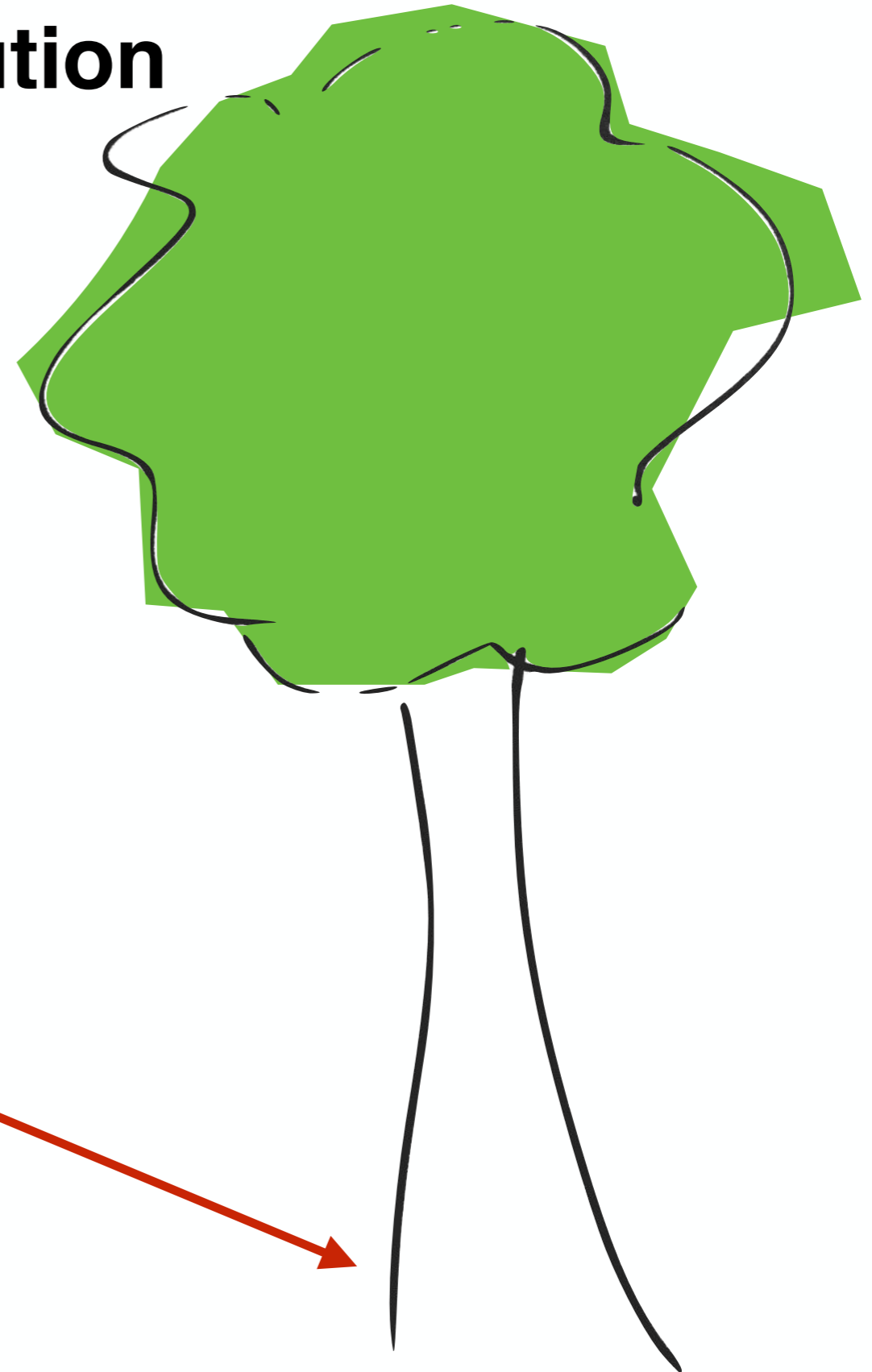


Adapted from Ulyshen *et al.* 2010

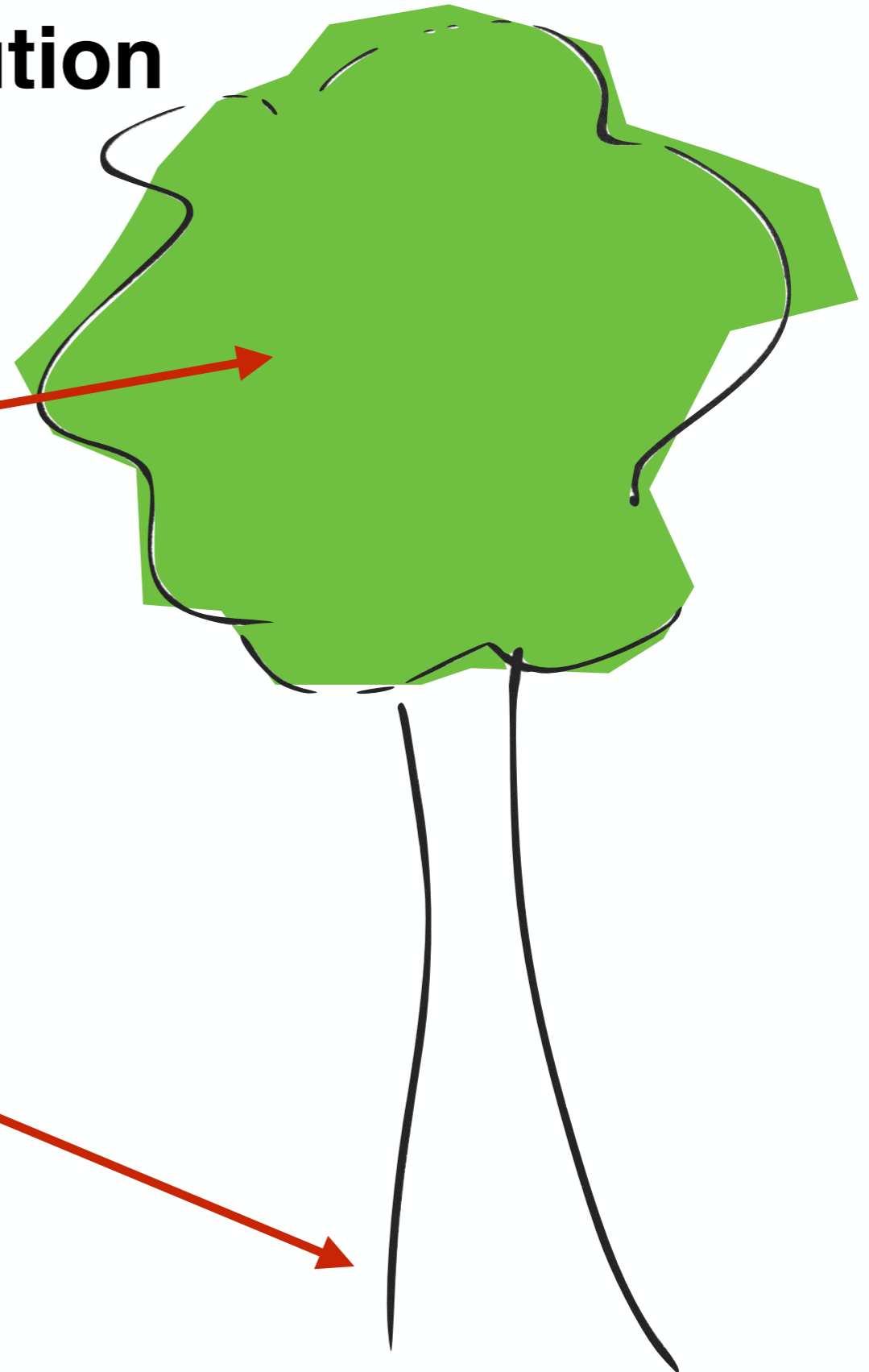
Functional Traits Could Predict Bee Distribution



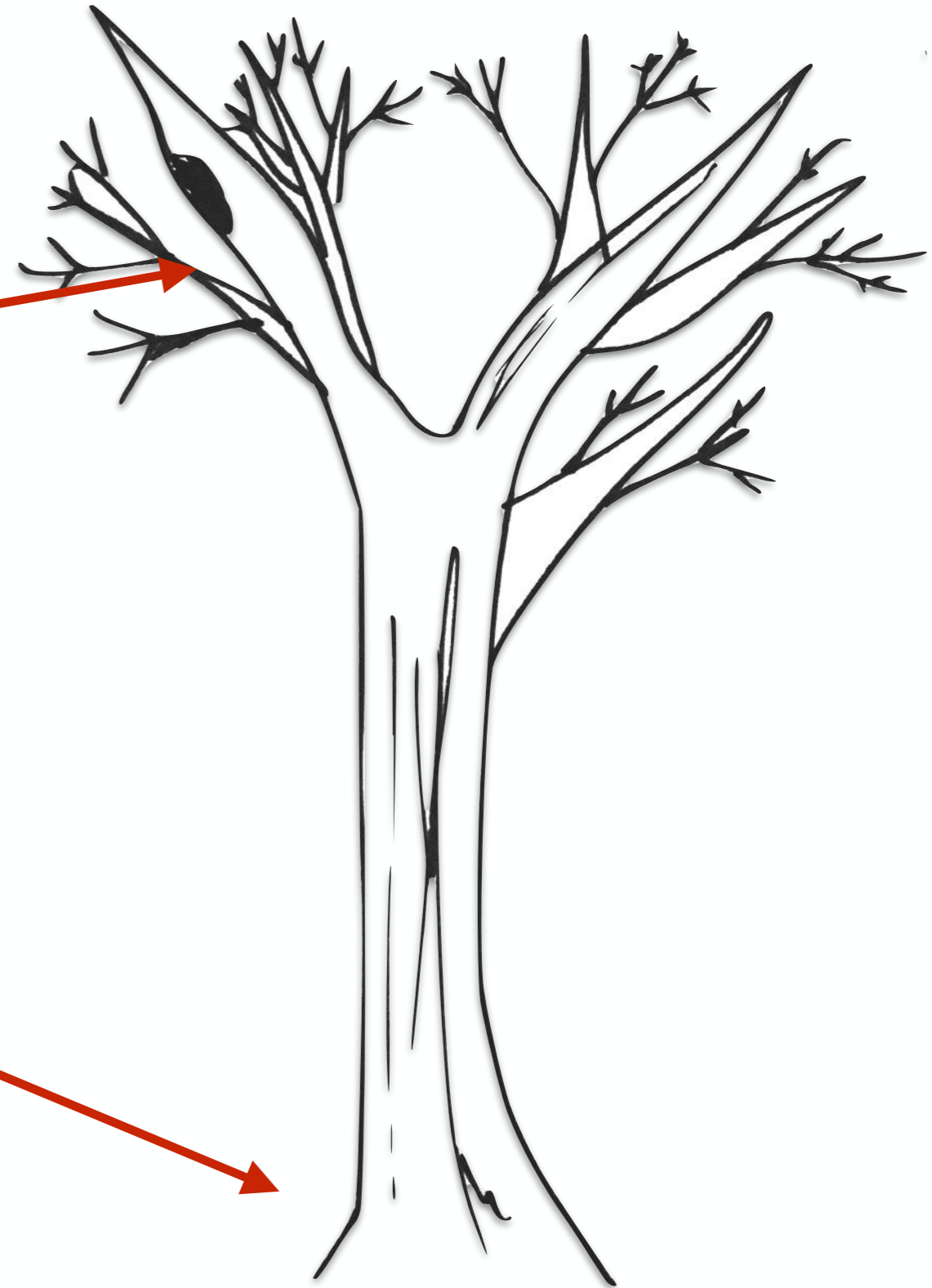
Functional Traits Could Predict Bee Distribution



Functional Traits Could Predict Bee Distribution



Functional Traits Could Predict Bee Distribution



All existing studies have:



1. Examined bee diversity in canopies of tropical forests (e.g. Thiel 2005).



2. Few other study in temperate forests. (Sobek *et al.*, 2009; Ulyshen *et al.* 2010; Ewers *et al.*, 2013)



Problem: It is not known how bees in other temperate forests use vertical space, or the driving factors for their distribution.

Research Questions:

1. Is there differential use of vertical space by bees in temperate deciduous forests?



2. Do functional traits predict vertical distribution of bees?



3. Does tree size influence bee community composition?

Study system: Great Lakes St. Lawrence

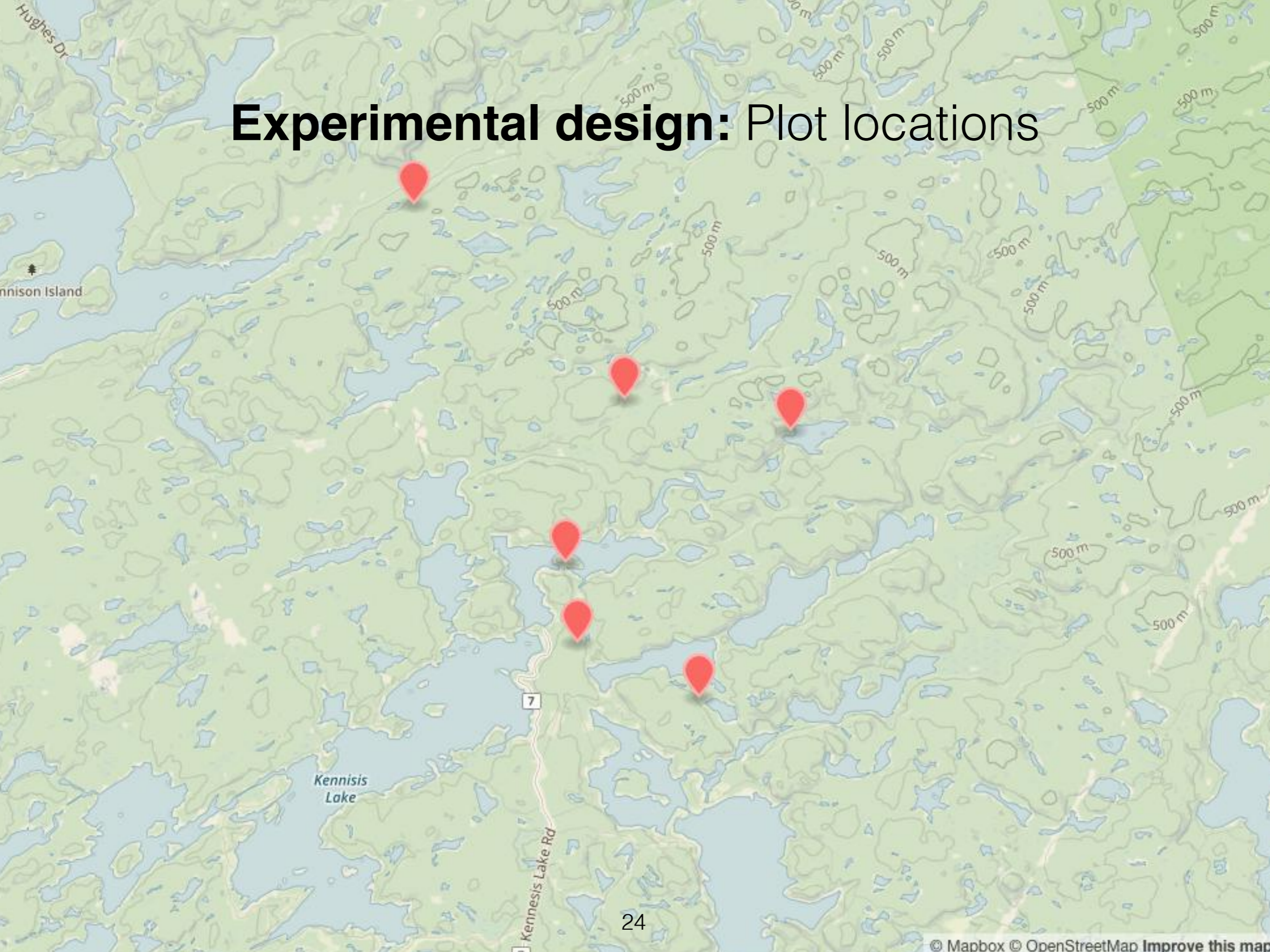


Haliburton Forest
& WILD LIFE RESERVE LTD

Uneven aged
Mixed-woods
vulnerable habitat



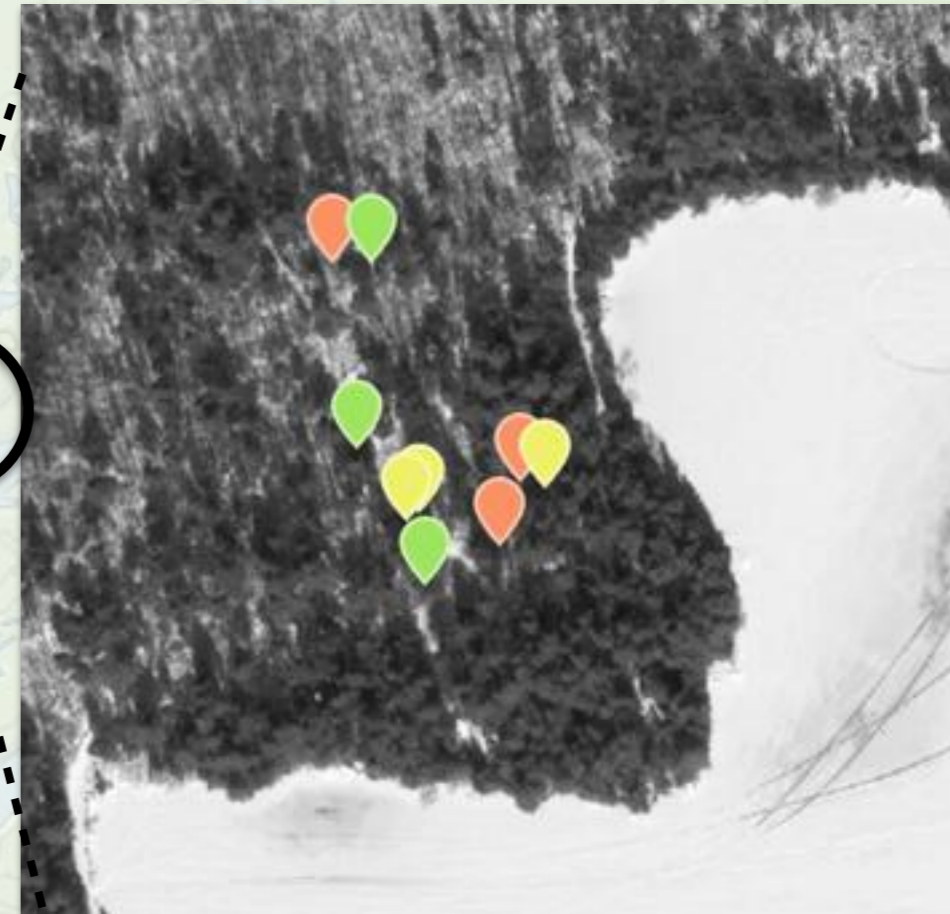
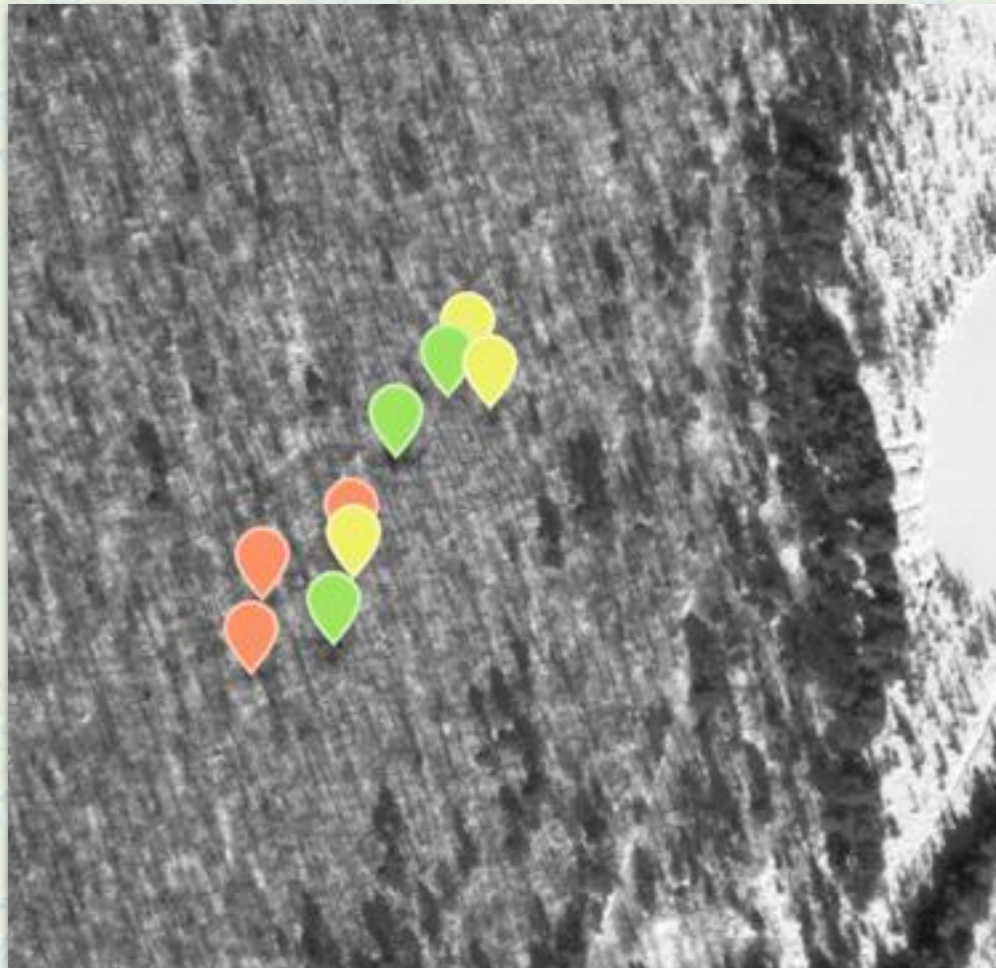
Experimental design: Plot locations



Experimental design: Plot locations

A. saccharum

- 15-30cm
- 30-55cm
- >55cm



Experimental design: data collection



Trap building and set up



Canopy trap set up



Bi-weekly collection

Experimental design: data collection

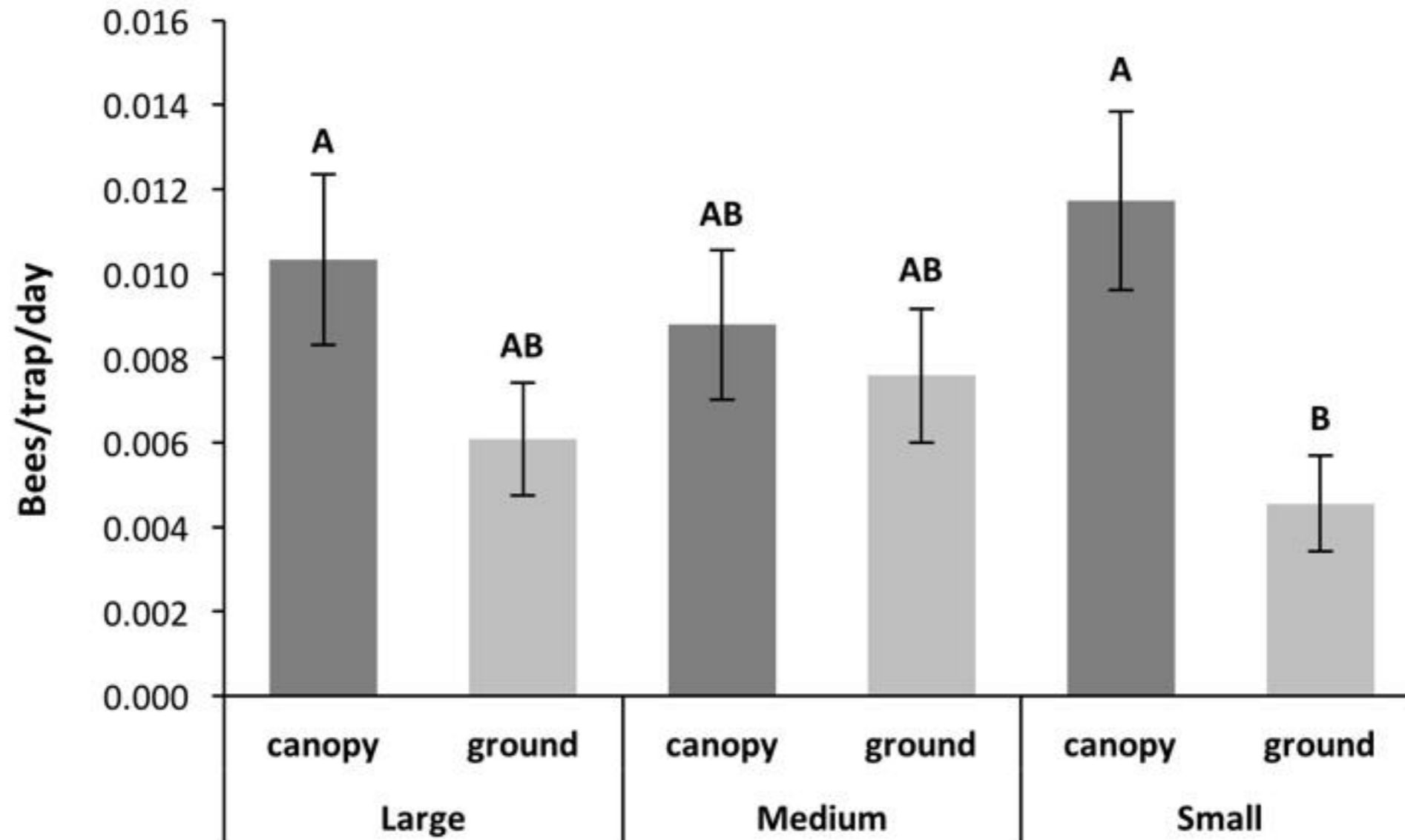


Trap building and set up

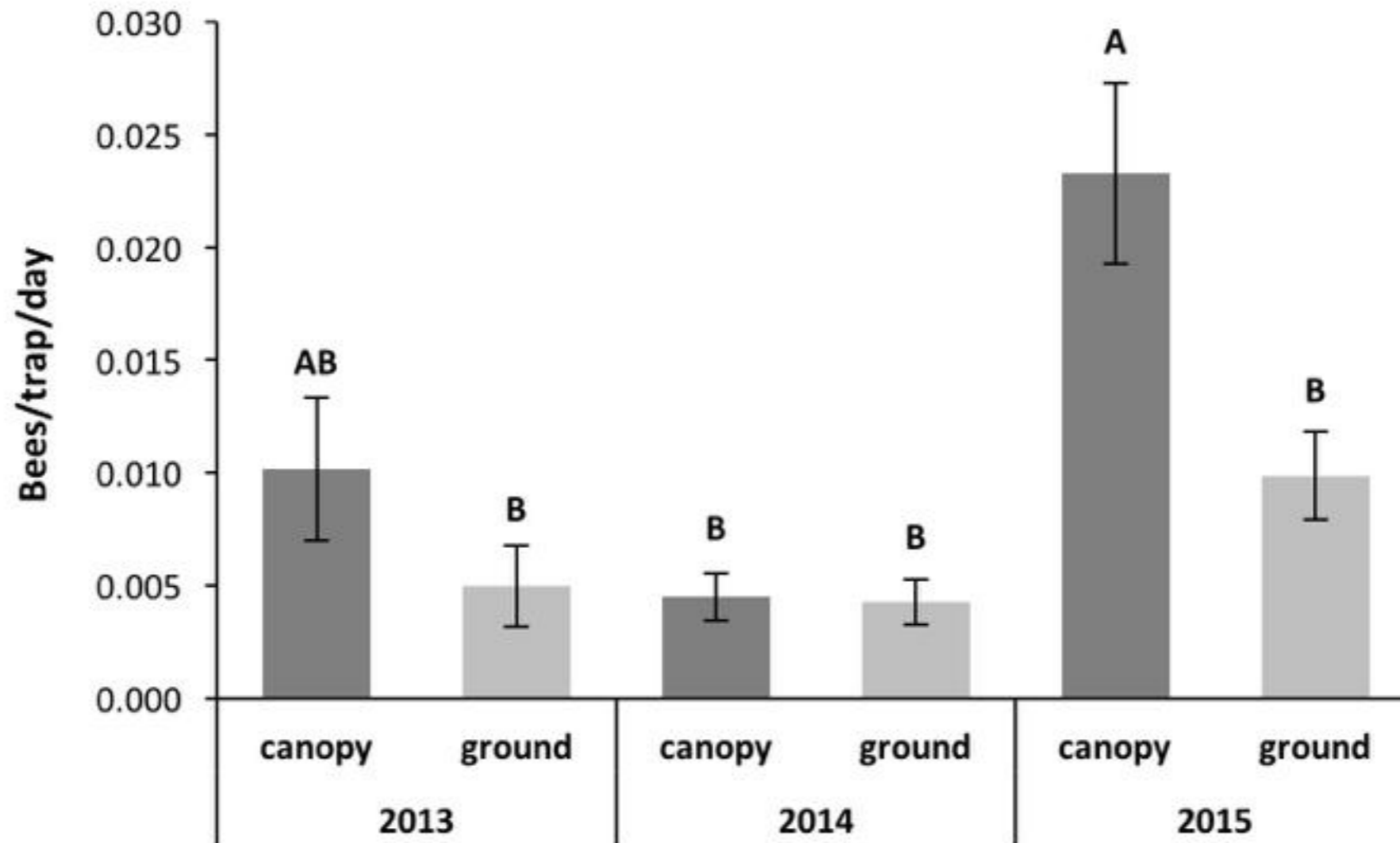
Canopy trap set up

Bi-weekly collection

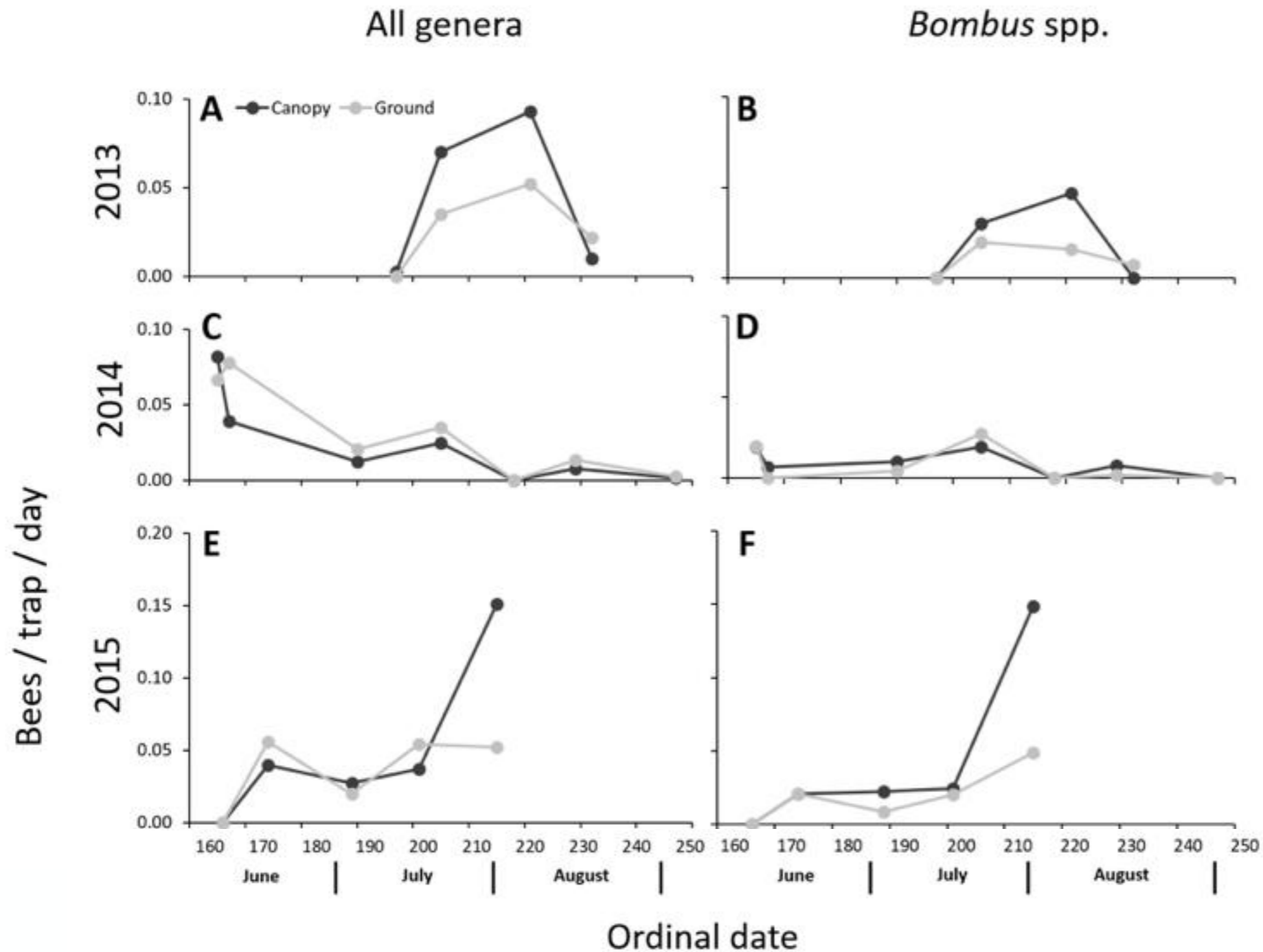
Results: No preferential distribution between tree sizes



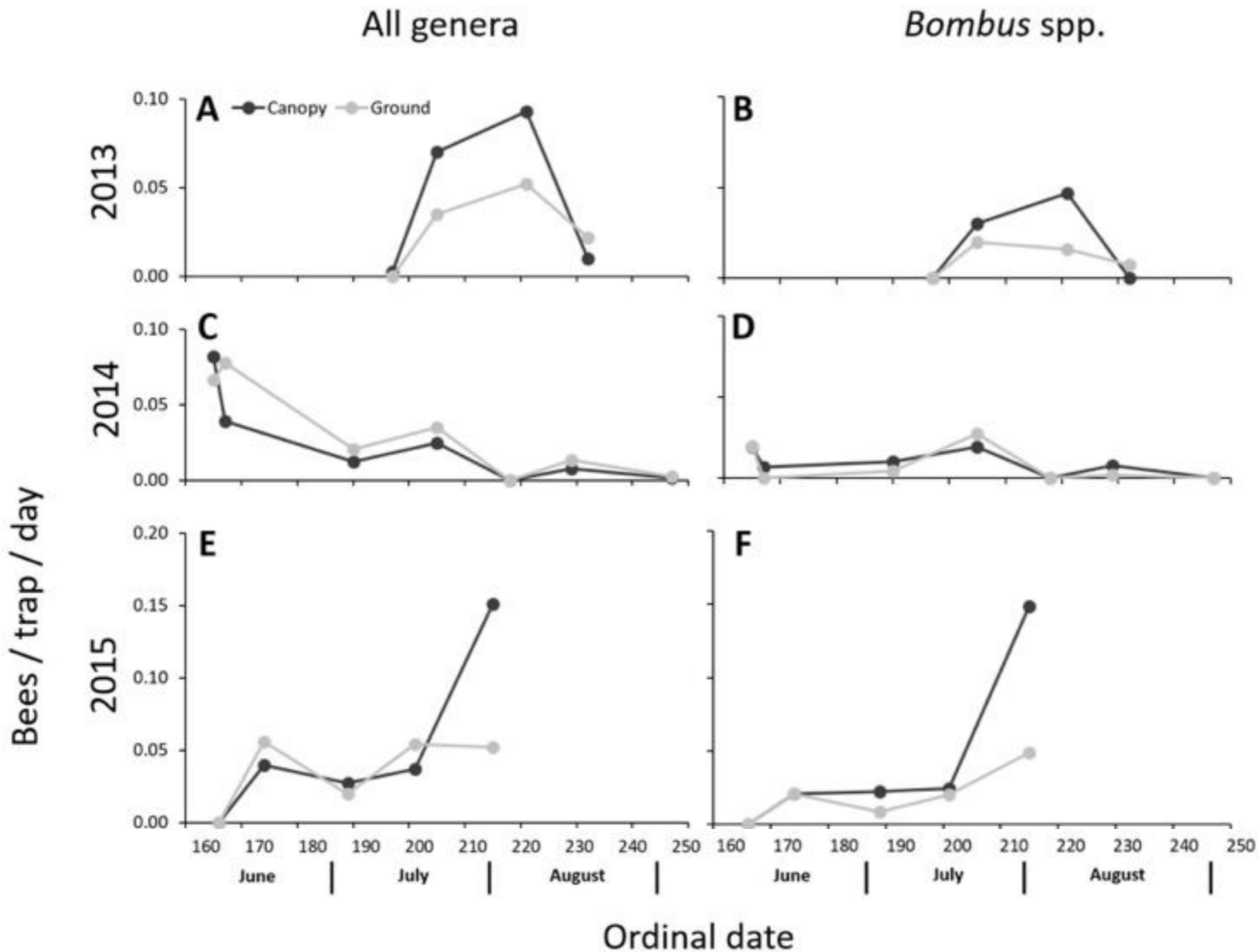
Results: More bees in canopy in 2015



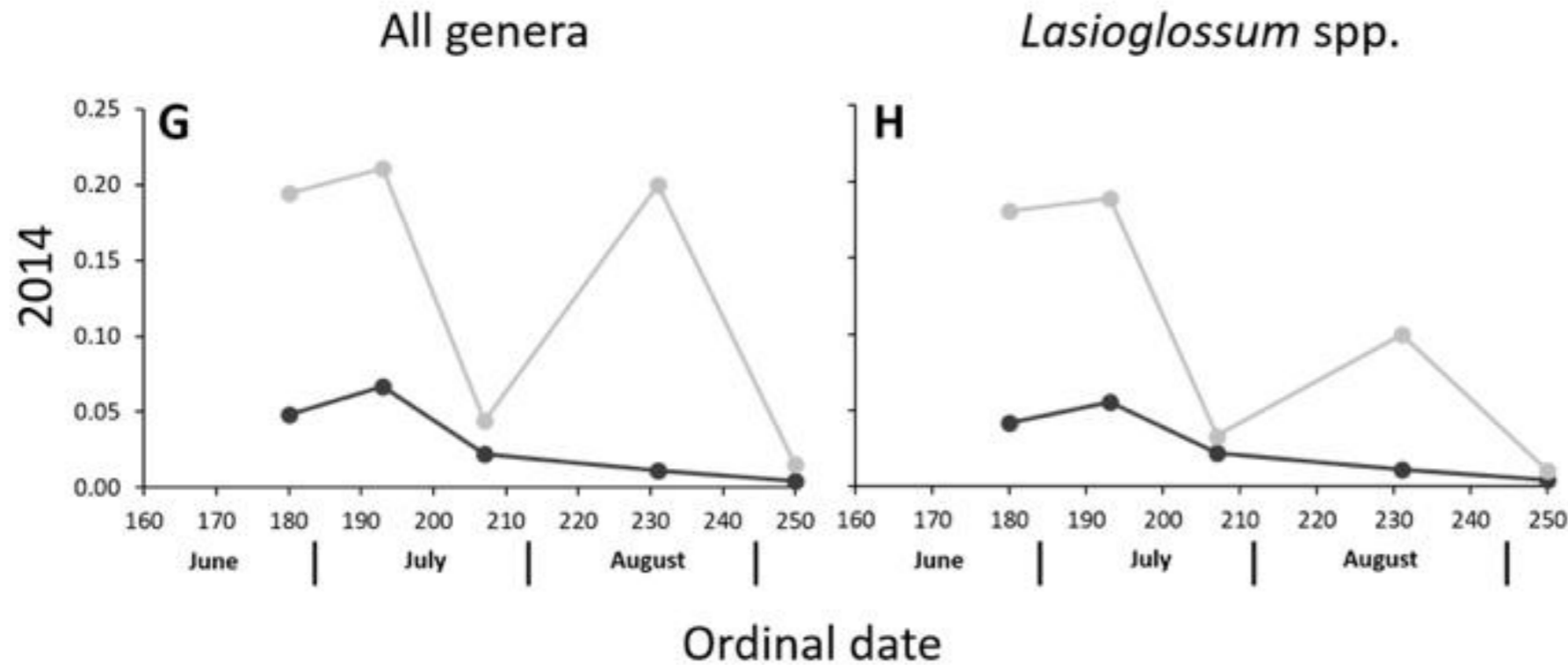
Results: Two most abundant bee groups have an association with either understory or canopy



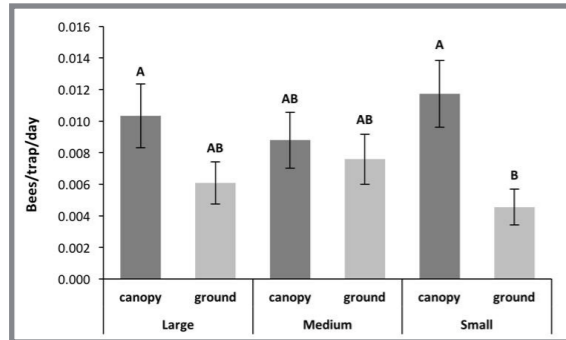
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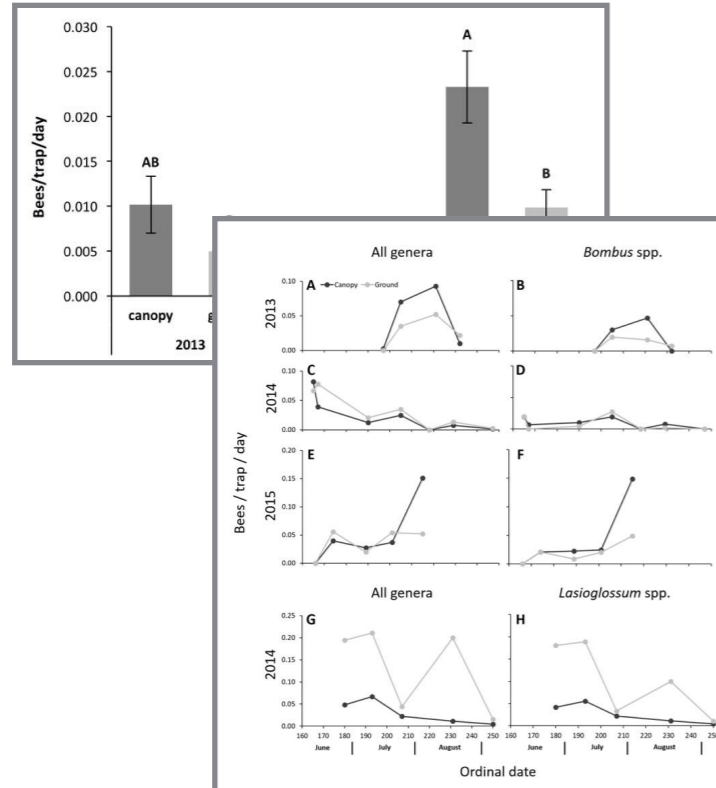
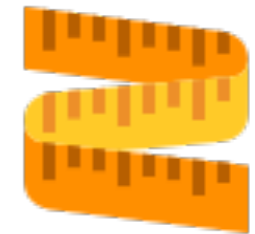
Results: Two most abundant bee groups have an association with either understory or canopy



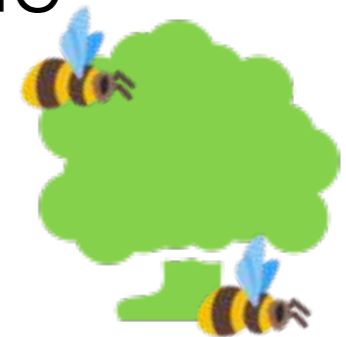
Summary



No apparent preference for variable tree size by bees



Bee community in the canopy was distinct from that found in the understory



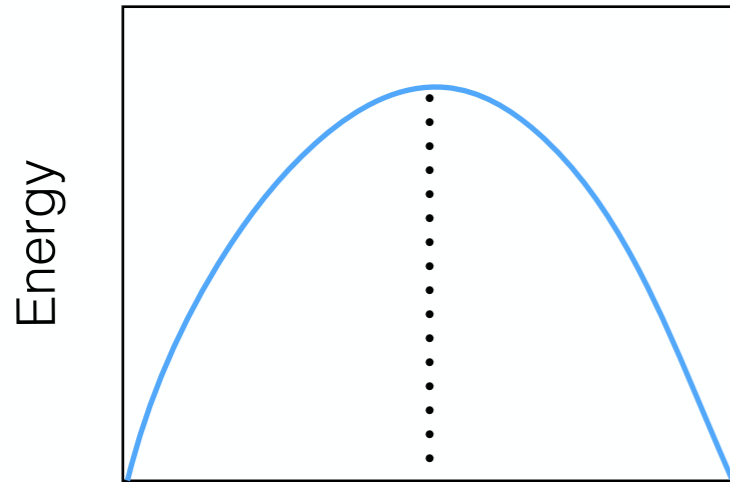
Functional traits

Table 1. Traits used in analysis

Traits	Trait type	Categories	Notes
Intertegular distance (mm)	Continuous	NA	Measurement for body size and wing muscle capacity Cane (1987)
Wing length (mm)	Continuous	NA	Measured from tegula to farthest point from body
Hind tibia (mm)	Continuous	NA	
Flight season	Continuous	NA	
Sex	Categorical	Female or Male	
Body hair	Categorical	Short hair, long hair, sparse hairs	
Lefcty (dietary specialization)	Categorical	Polylectic (pollen generalist) Oligolectic (pollen specialist)	Krombein et al. (1967)
Nesting location	Categorical	Above-ground, Below-ground, or Mixed	Krombein (1967); Michener (2000); Cane, Griswold & Packer (2007); Sheffield et al. (2011)
Nest construction	Categorical	Excavate, Rent, Cleptoparasitic	Michener (2000)
Sociality	Categorical	Social (including all forms of sociality) Solitary Cleptoparasitic	Michener (2000)

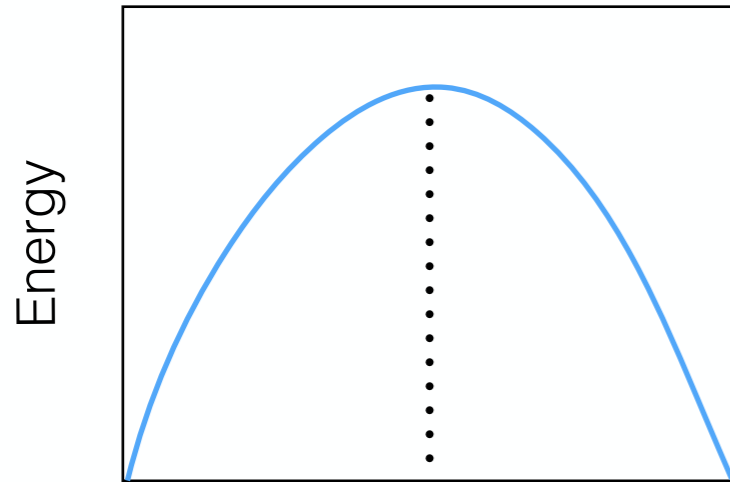
Significance

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Bombus are large bodied bees, social, and need resources throughout the summer, therefore might forage opportunistically in temperate canopies.

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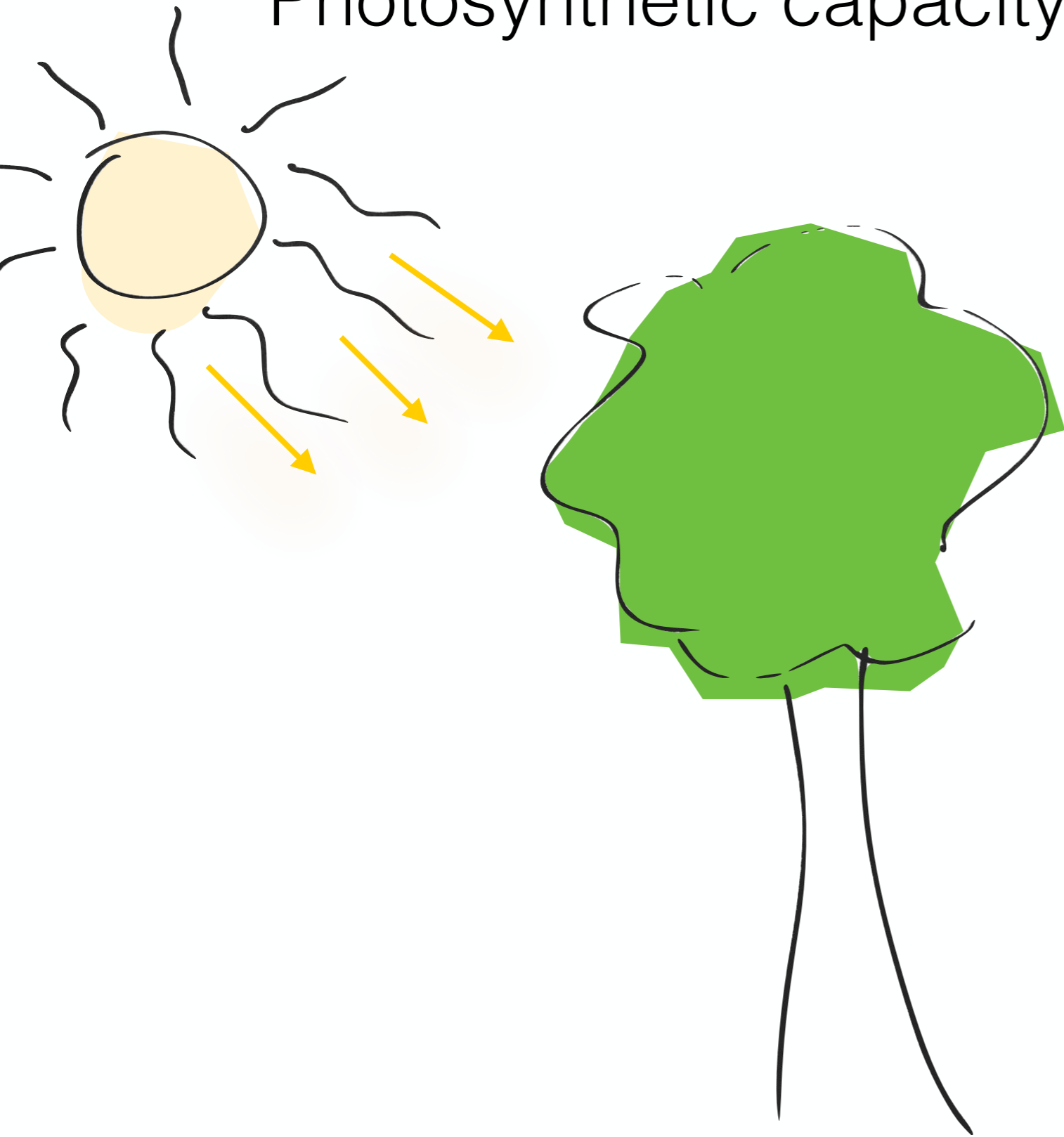
Management implications for pollinator conservation.

Project 2

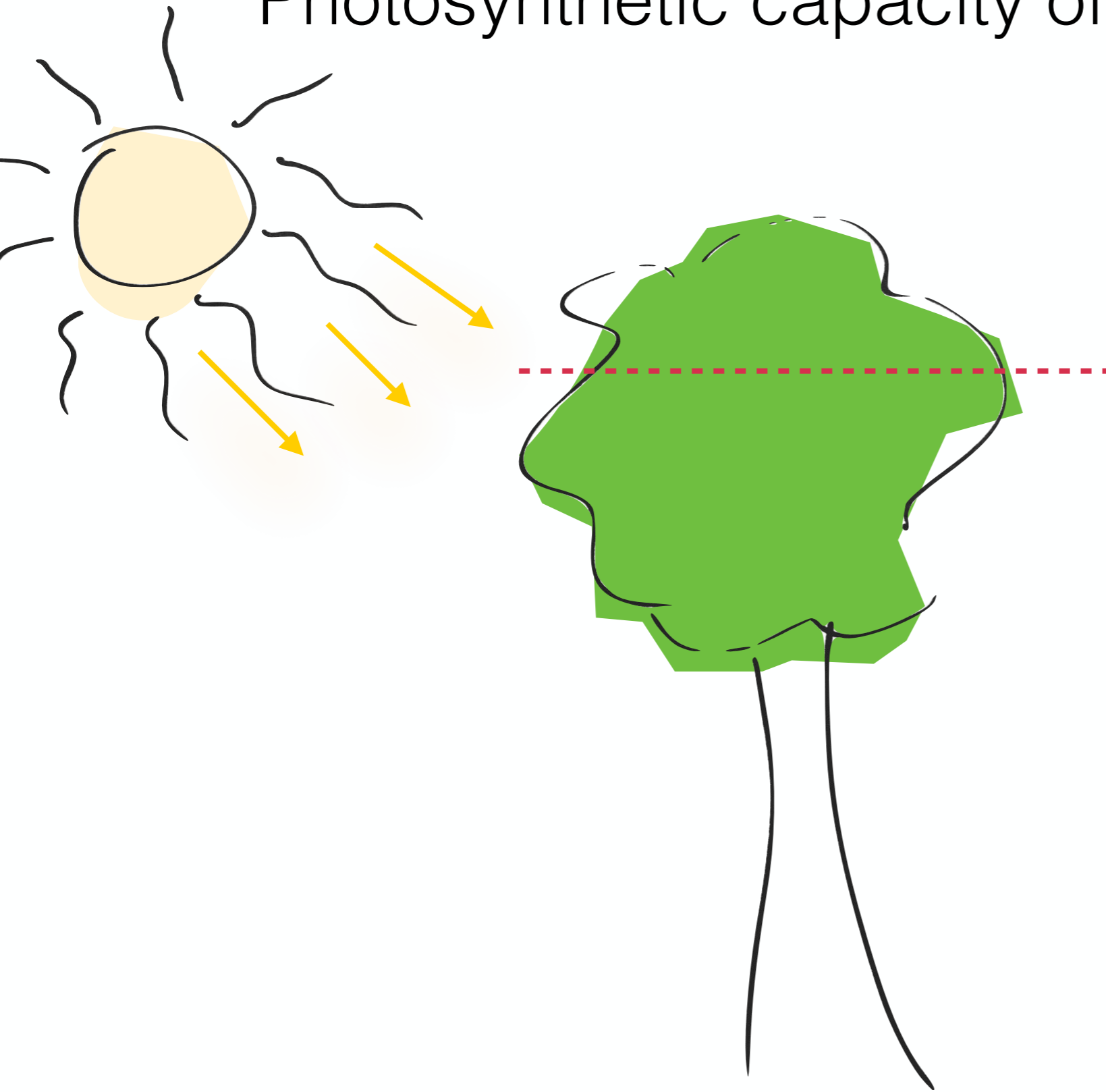
Honeydew as a food resource for native bees:
scale and maple mealybug distribution within *Acer*
saccharum canopies



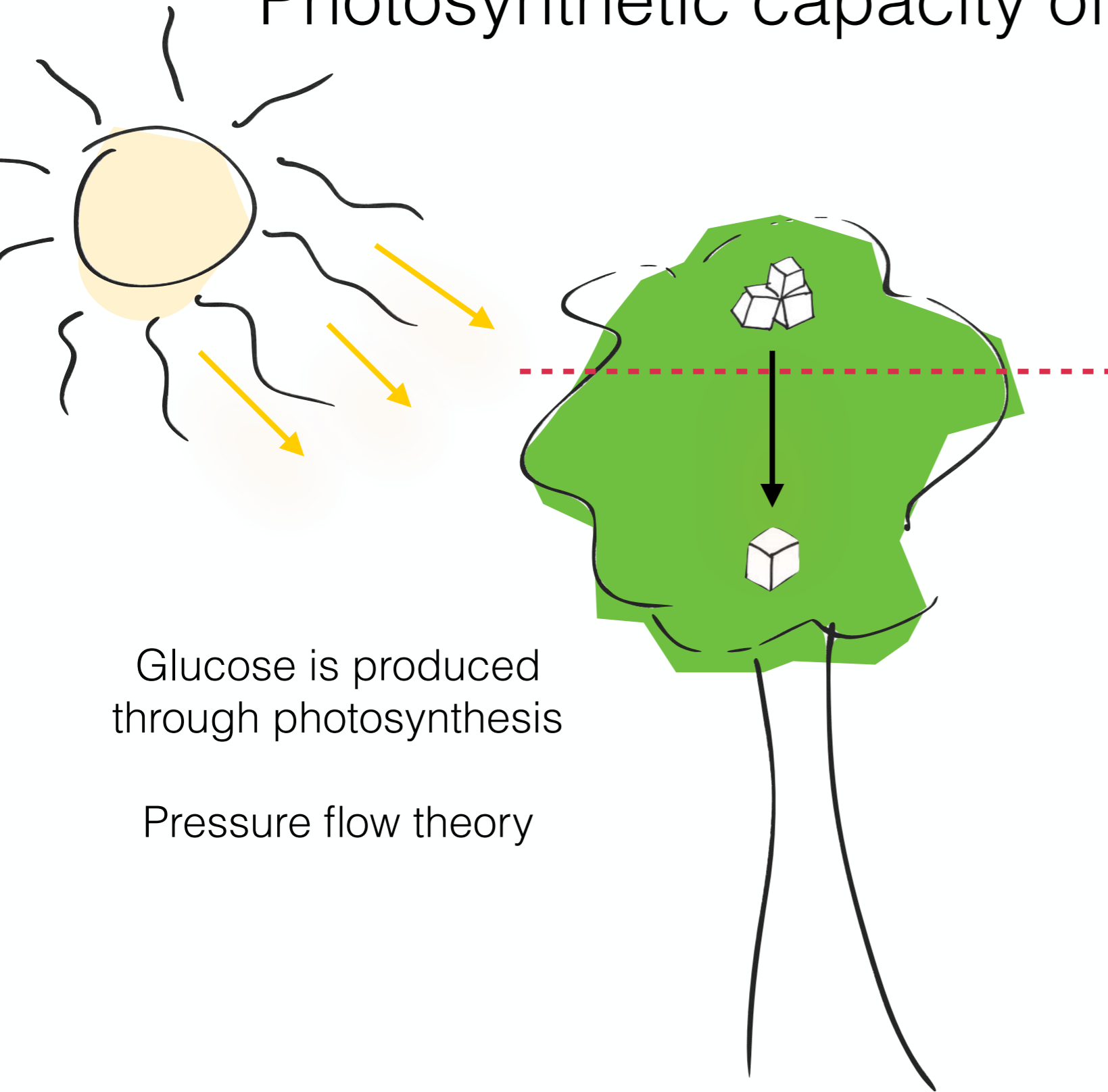
Photosynthetic capacity of *Acer saccharum*



Photosynthetic capacity of *Acer saccharum*



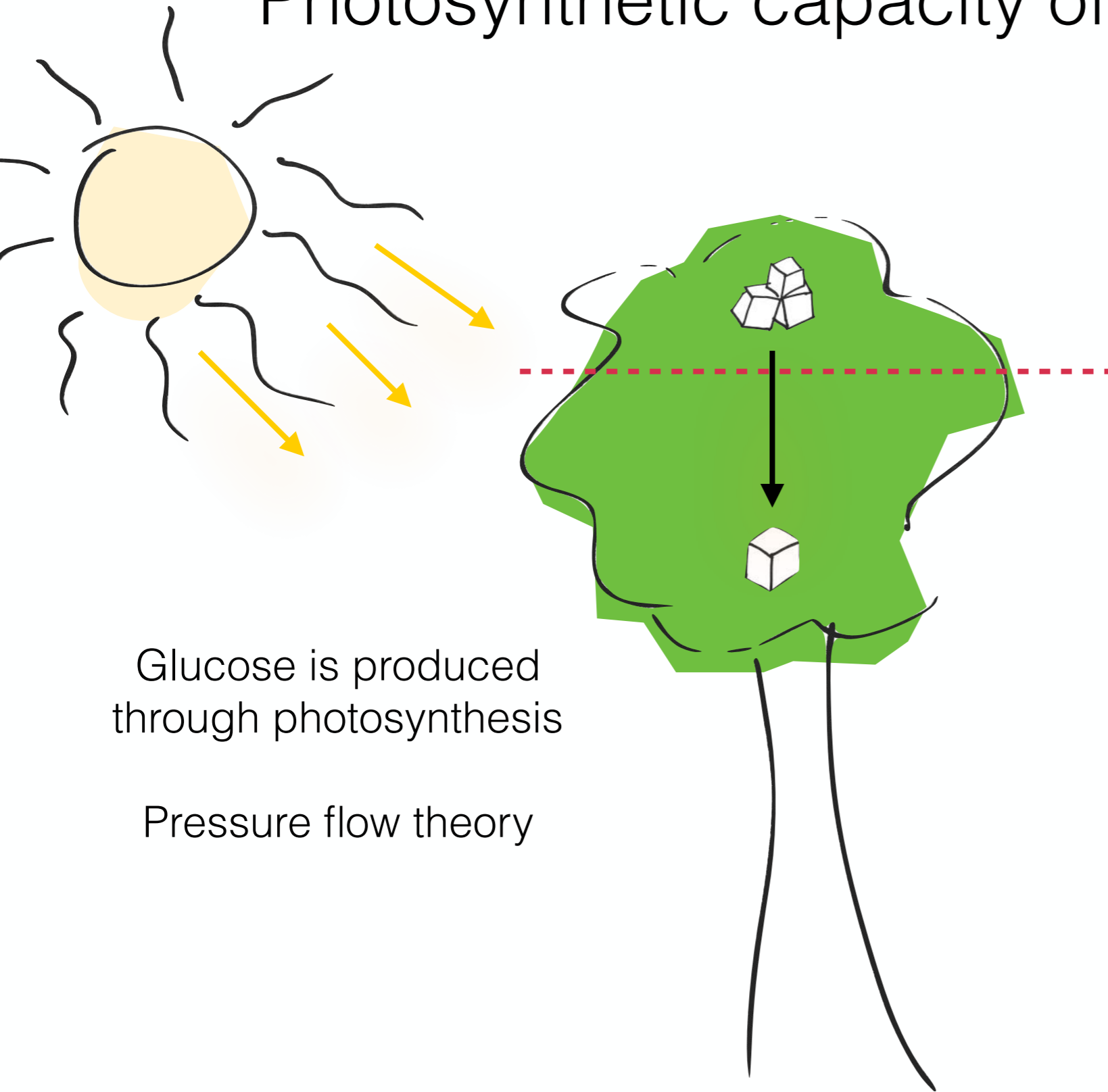
Photosynthetic capacity of *Acer saccharum*



Glucose is produced through photosynthesis

Pressure flow theory

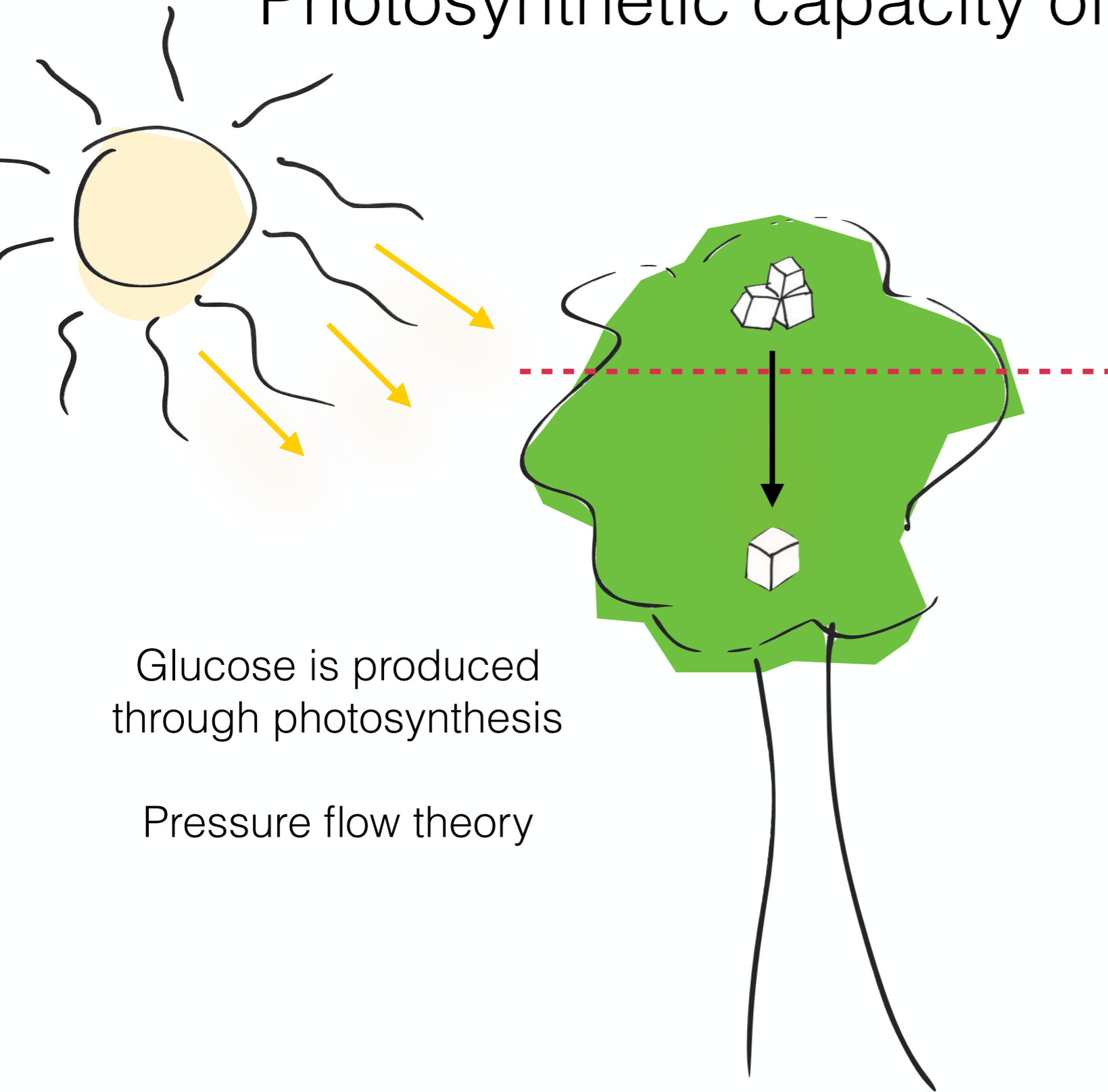
Photosynthetic capacity of *Acer saccharum*



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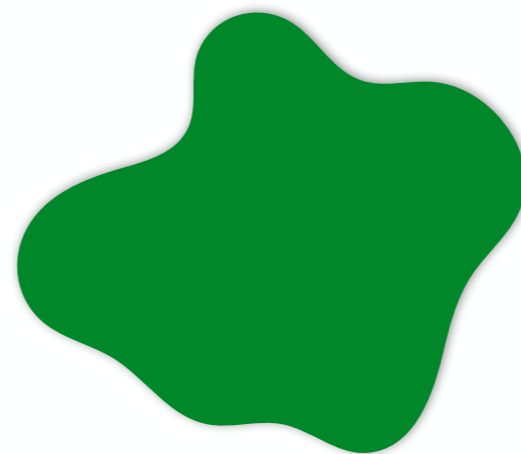
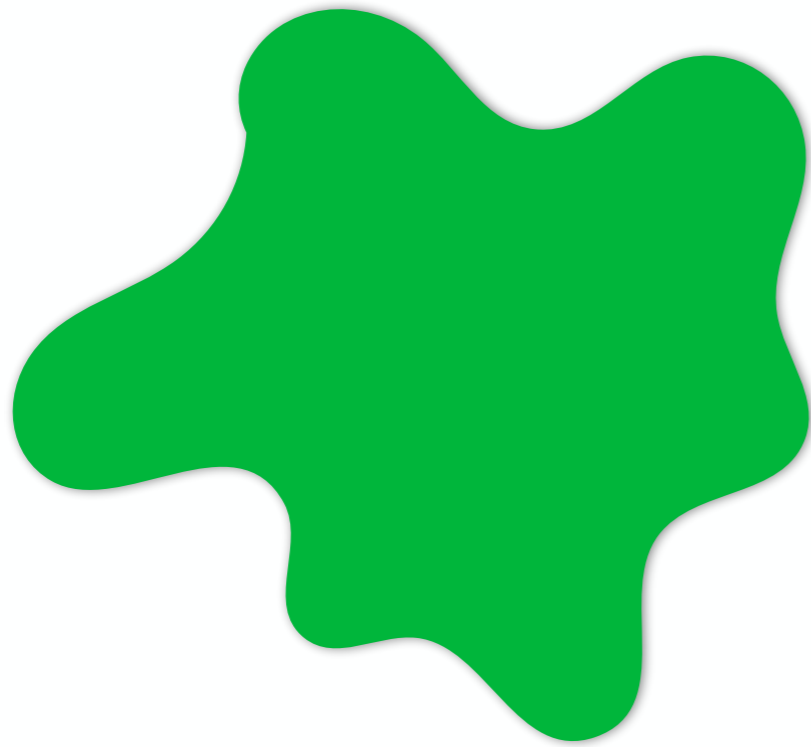
Photosynthetic capacity of *Acer saccharum*

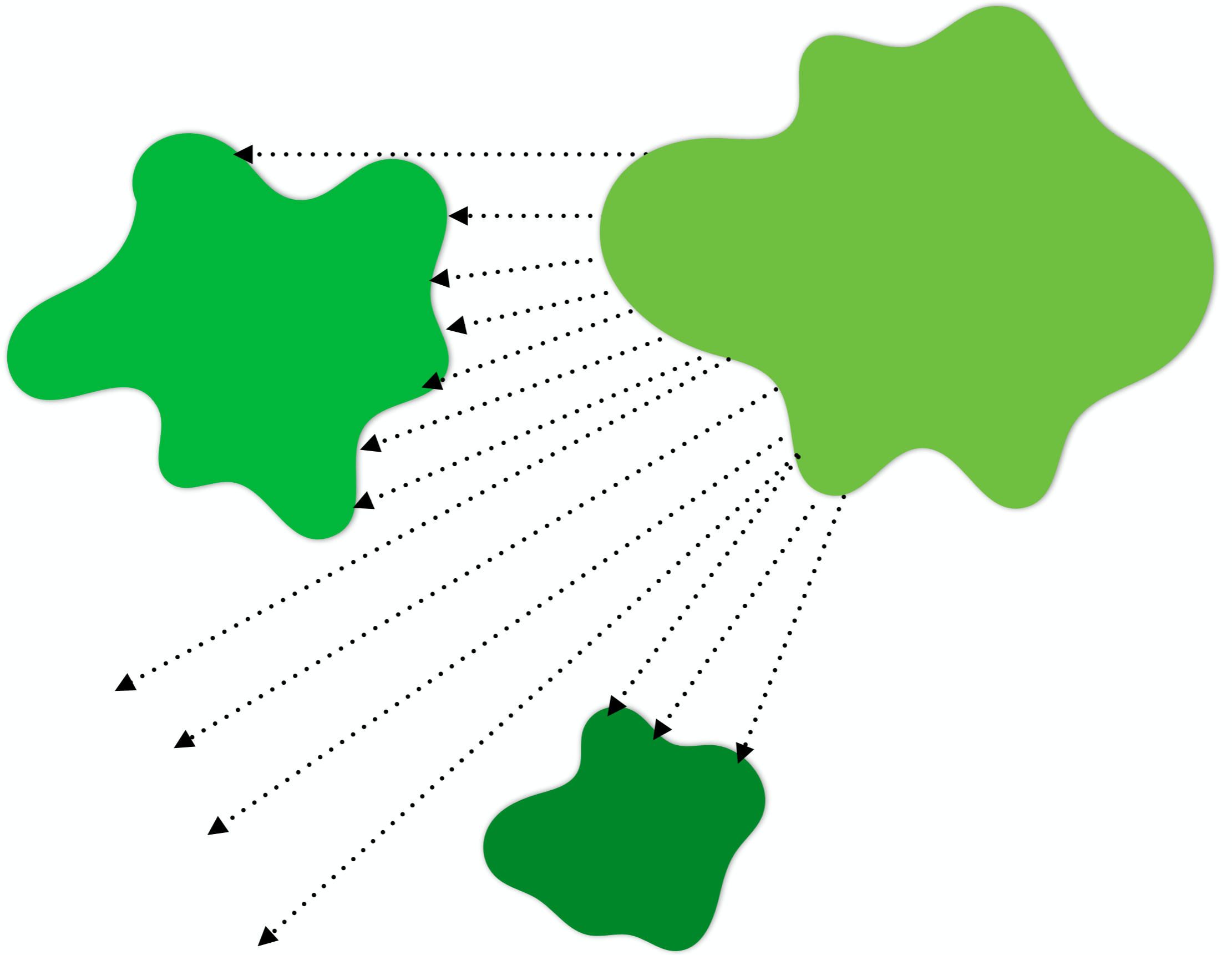


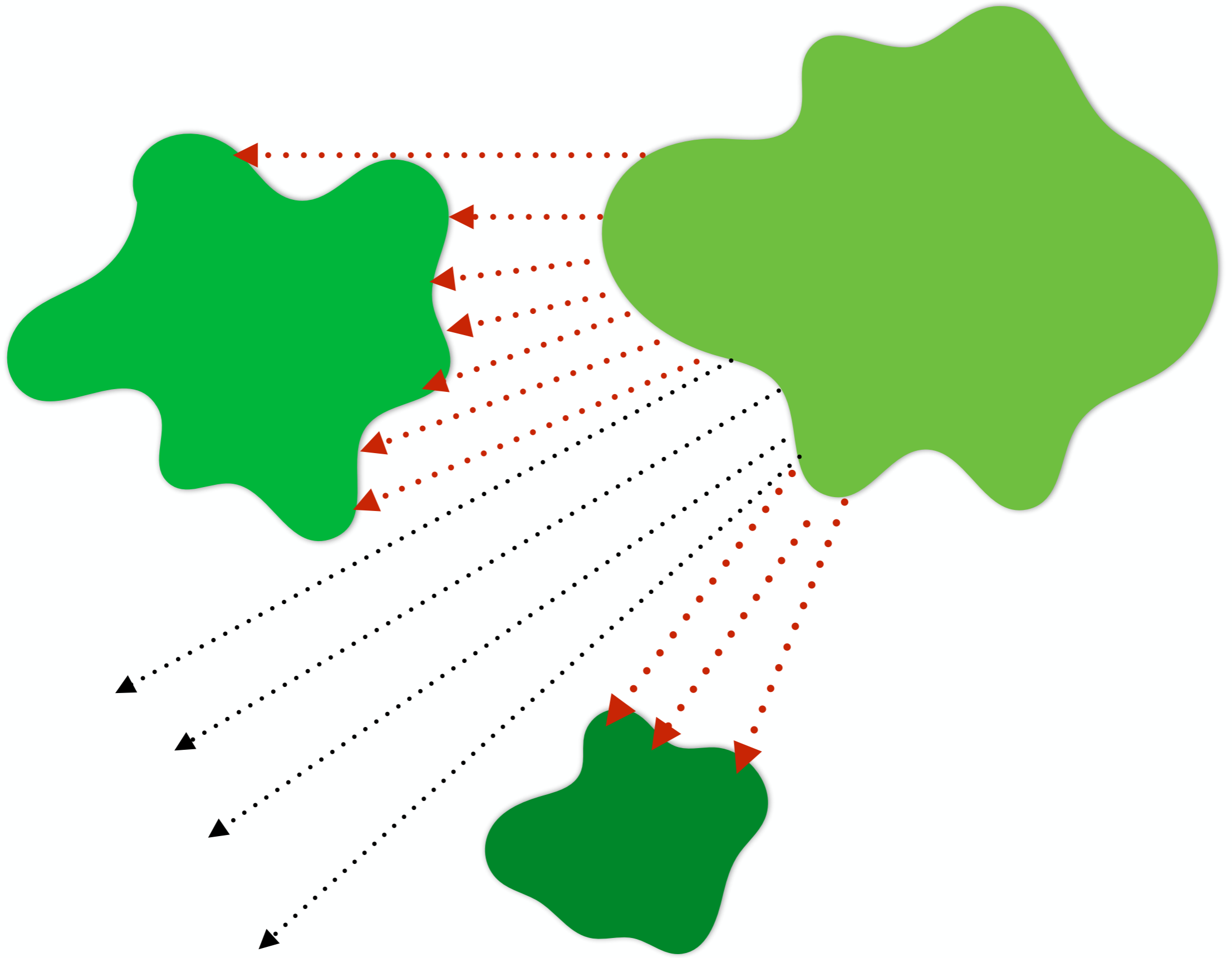
Glucose is produced through photosynthesis

Pressure flow theory

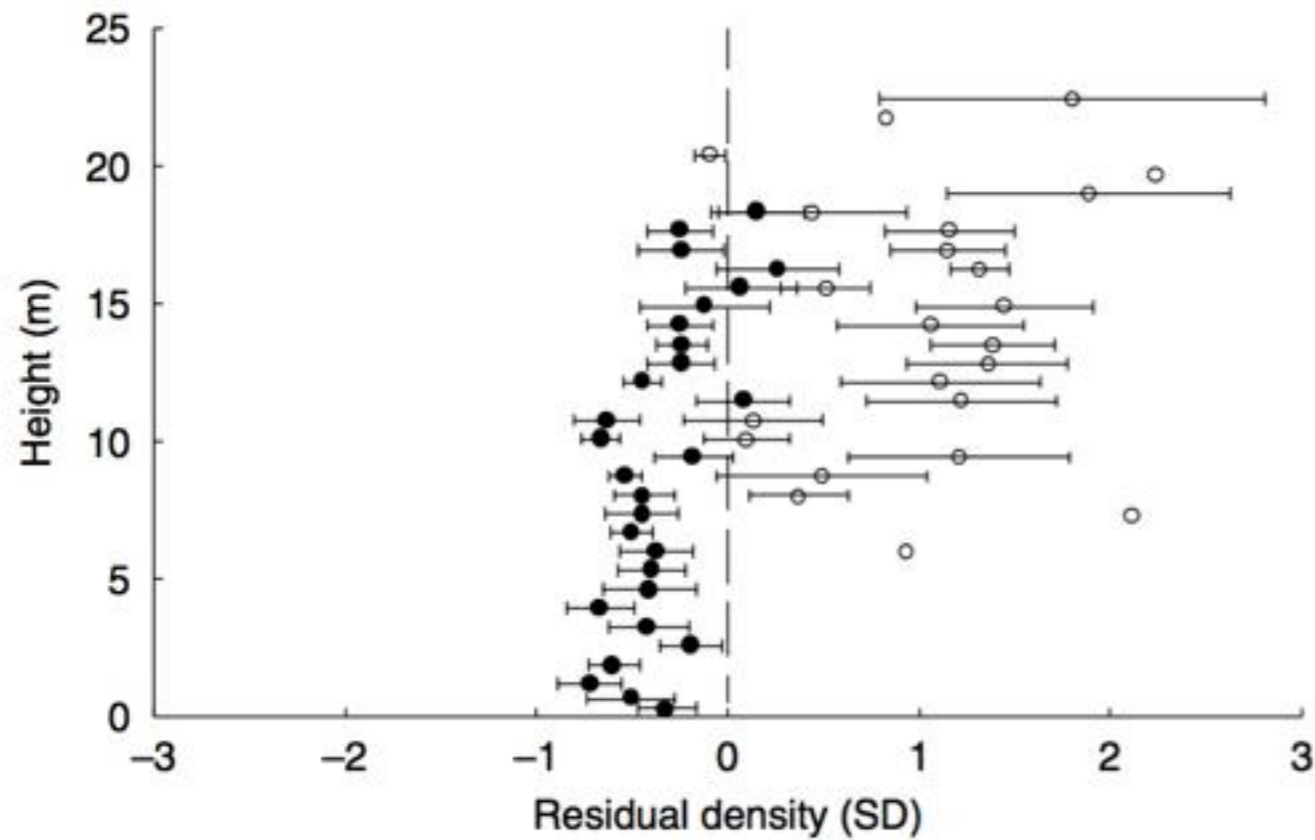






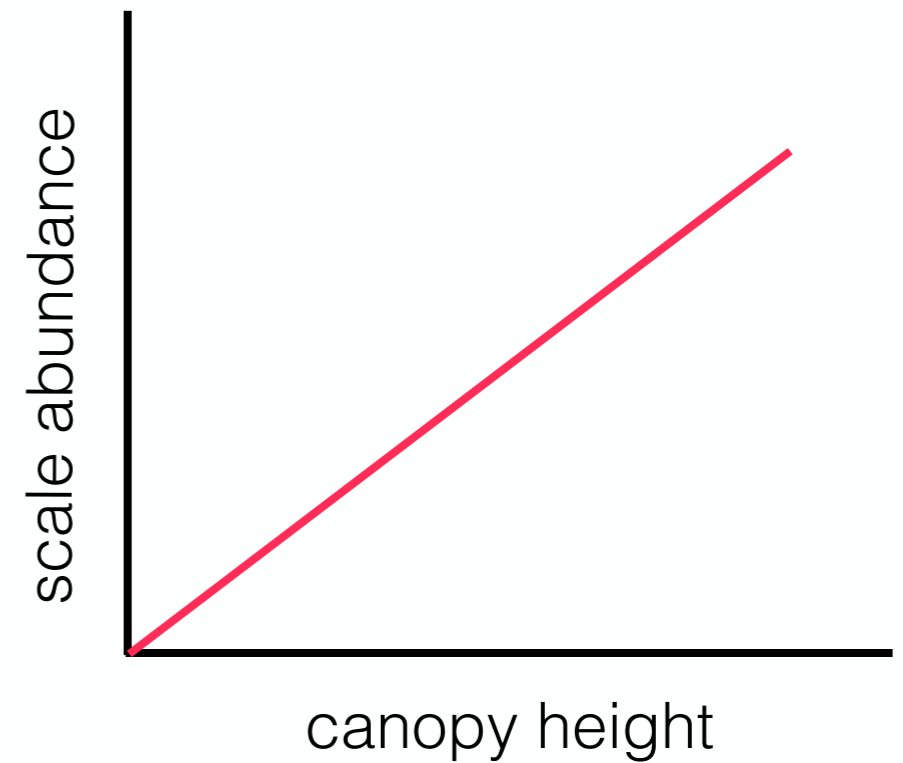
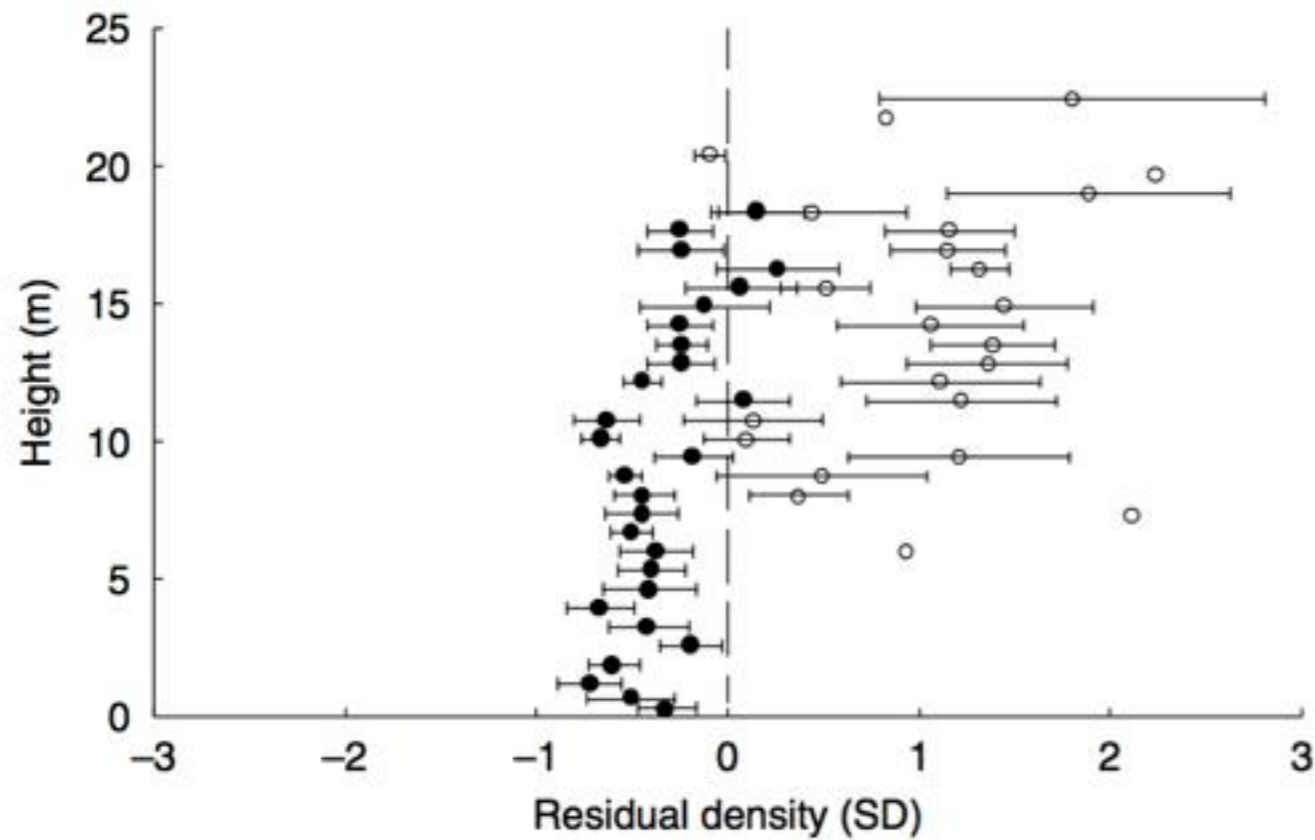


Scale density is higher as height increases off the ground



Wardhaugh *et al.*, 2006

Scale density is higher as height increases off the ground



Wardhaugh *et al.*, 2006

All existing studies have:



1. looked at scale density between trunk and branches (e.g. Wardhaugh et al., 2006)



2. examined arthropod communities on trees with and without honeydew (e.g. Ewers 2002)

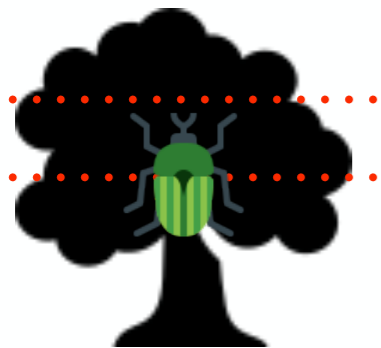


Problem: It is not known how sap-sucking insects are distributed on *Acer saccharum* in temperate forest within the canopy

Research Questions:

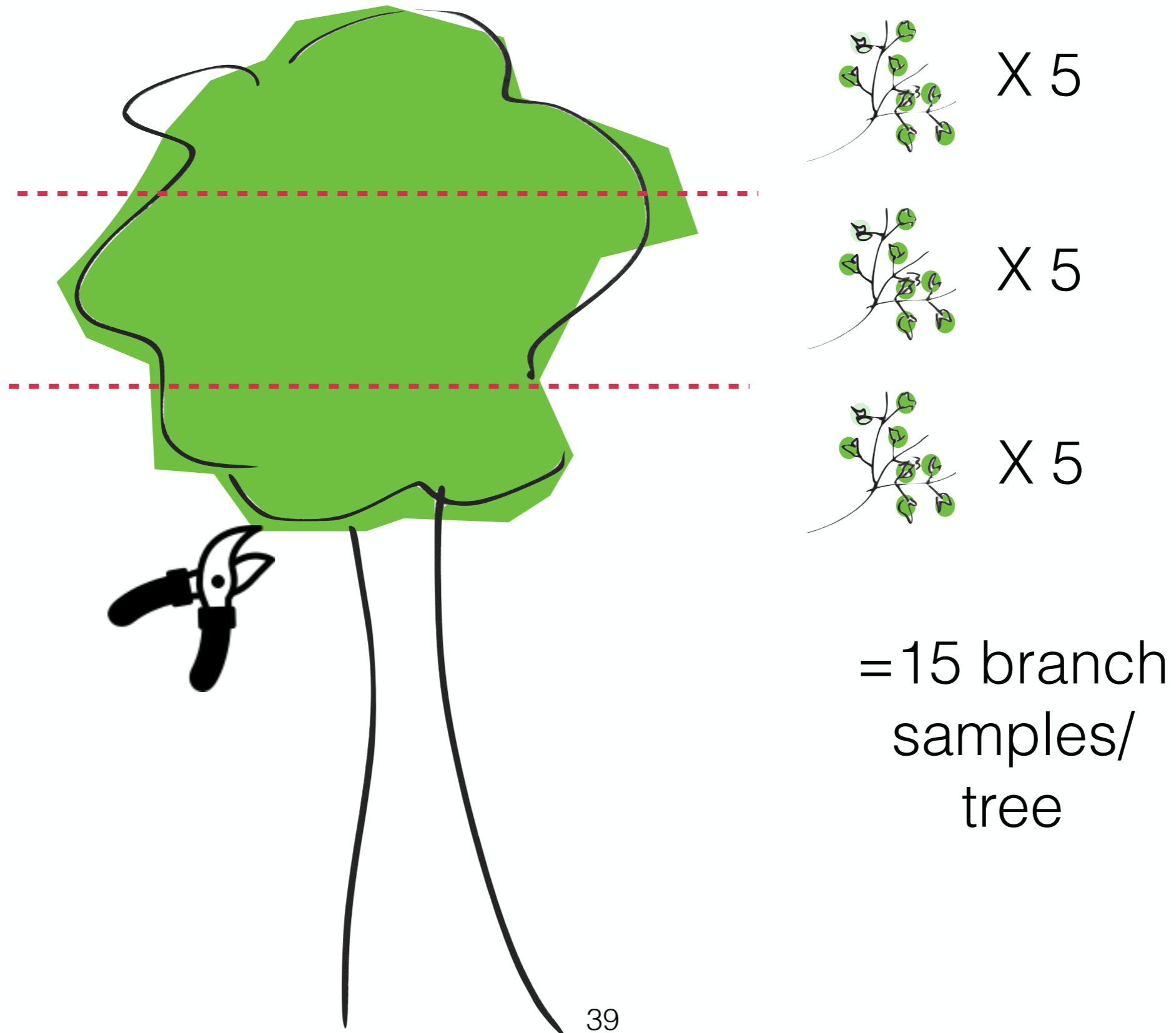


1. What is the vertical distribution of sap-sucking scale insects within sugar maple in a northern hardwood forest?



2. Does scale density differ between canopy strata or tree size within sugar maple canopies?

Experimental design: data collection



Experimental design: data collection

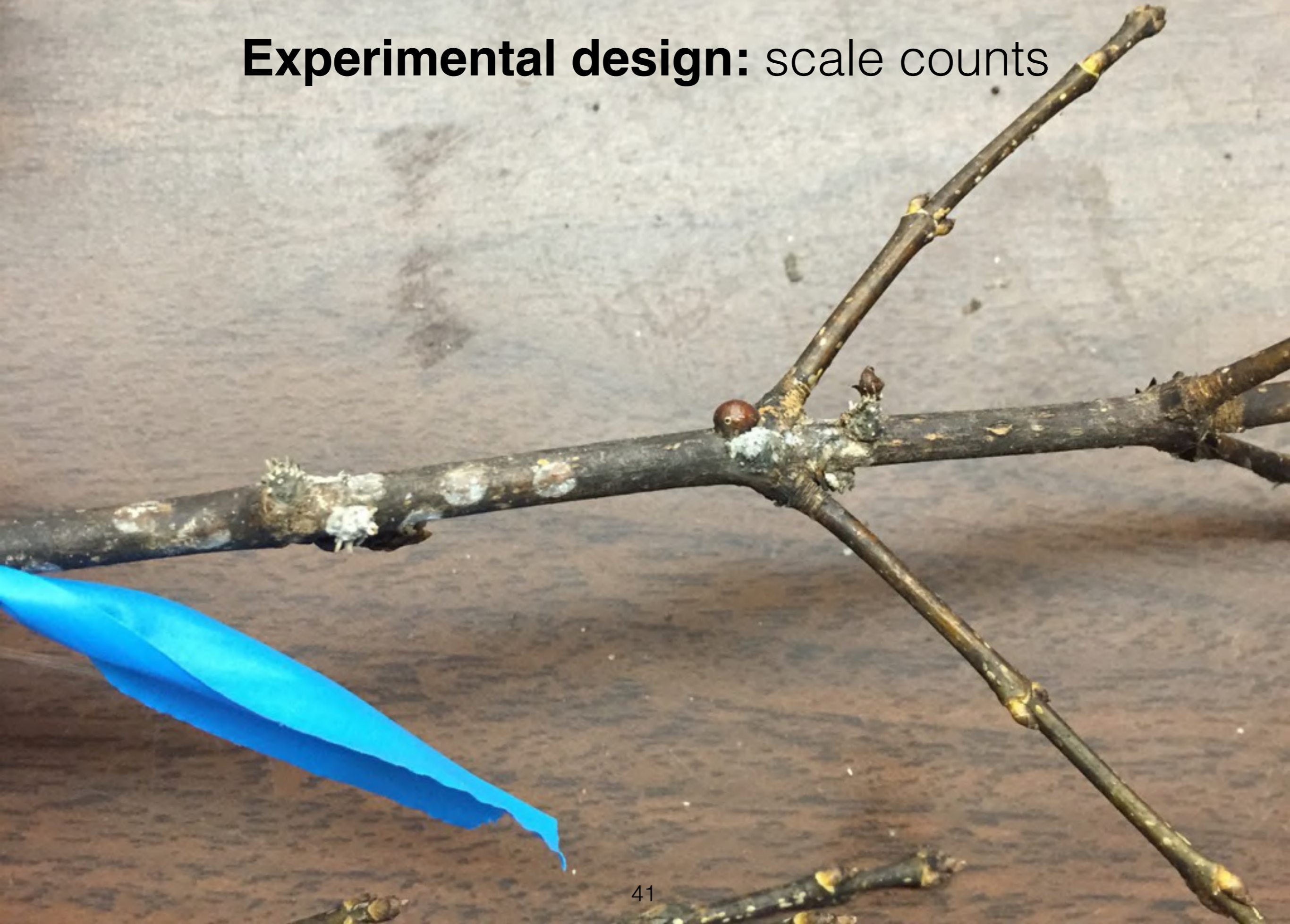


measure leader
length

measure width

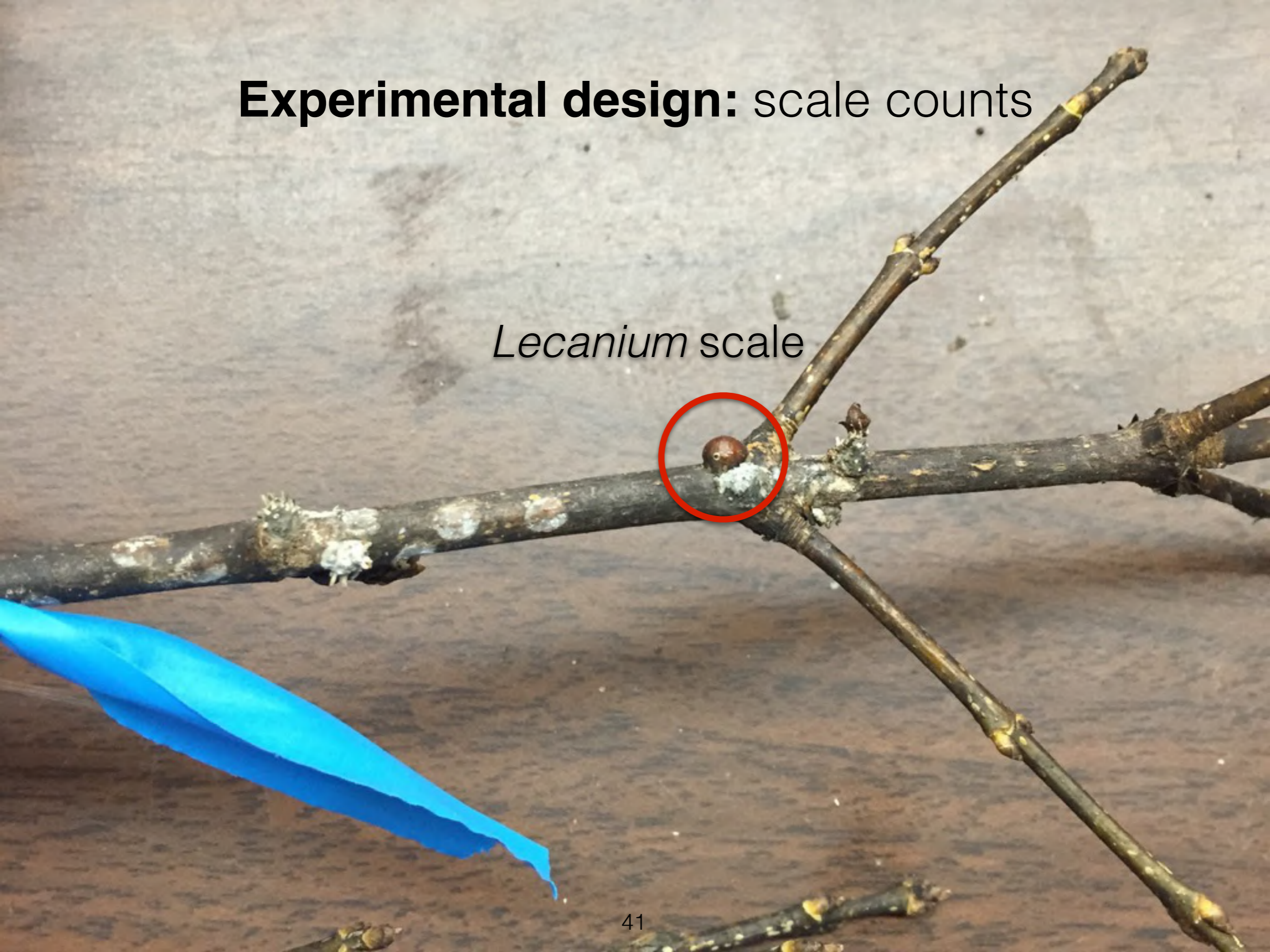
count scale

Experimental design: scale counts



Experimental design: scale counts

Lecanium scale

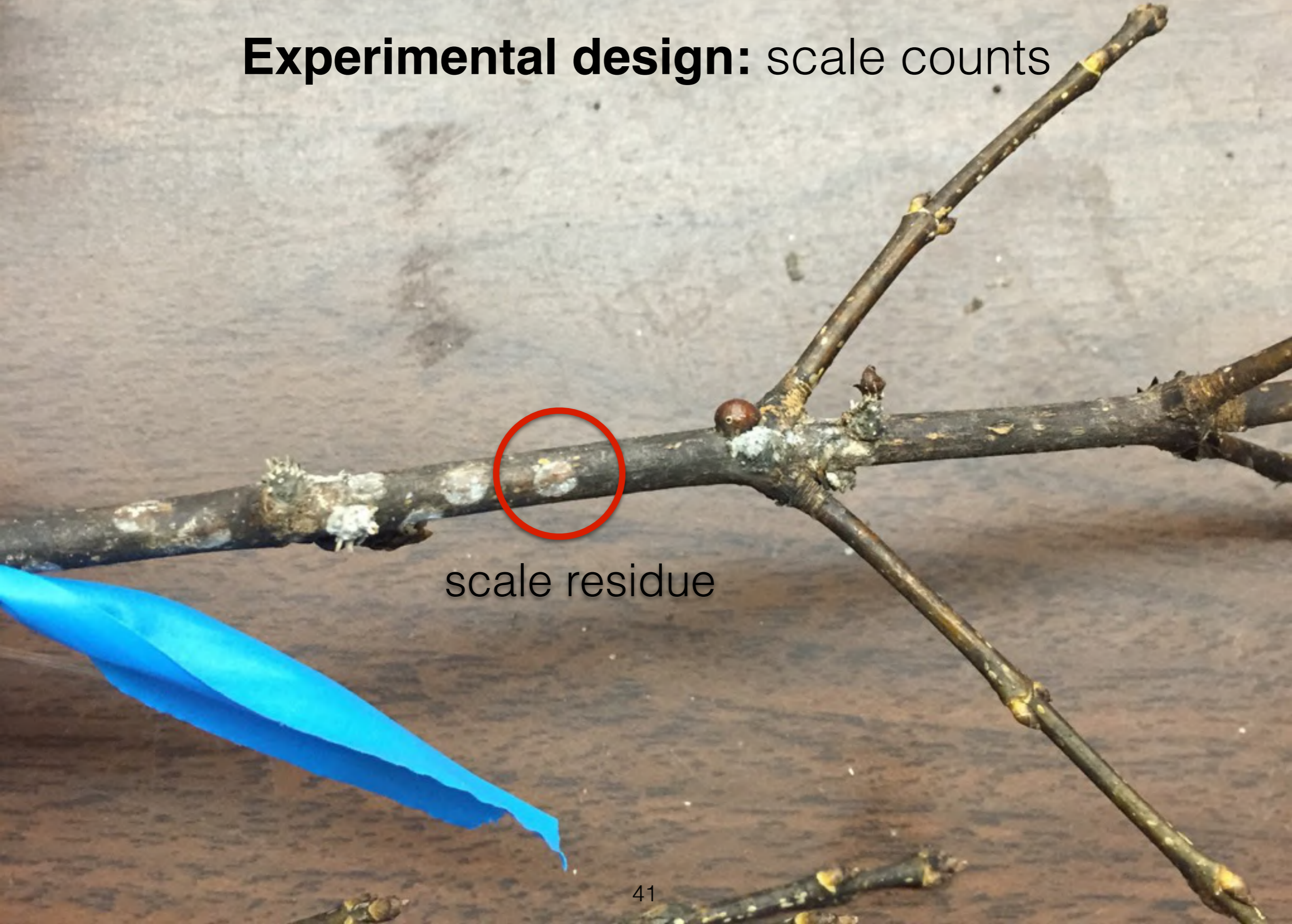


Experimental design: scale counts

Phenacoccus
(maple mealybug)

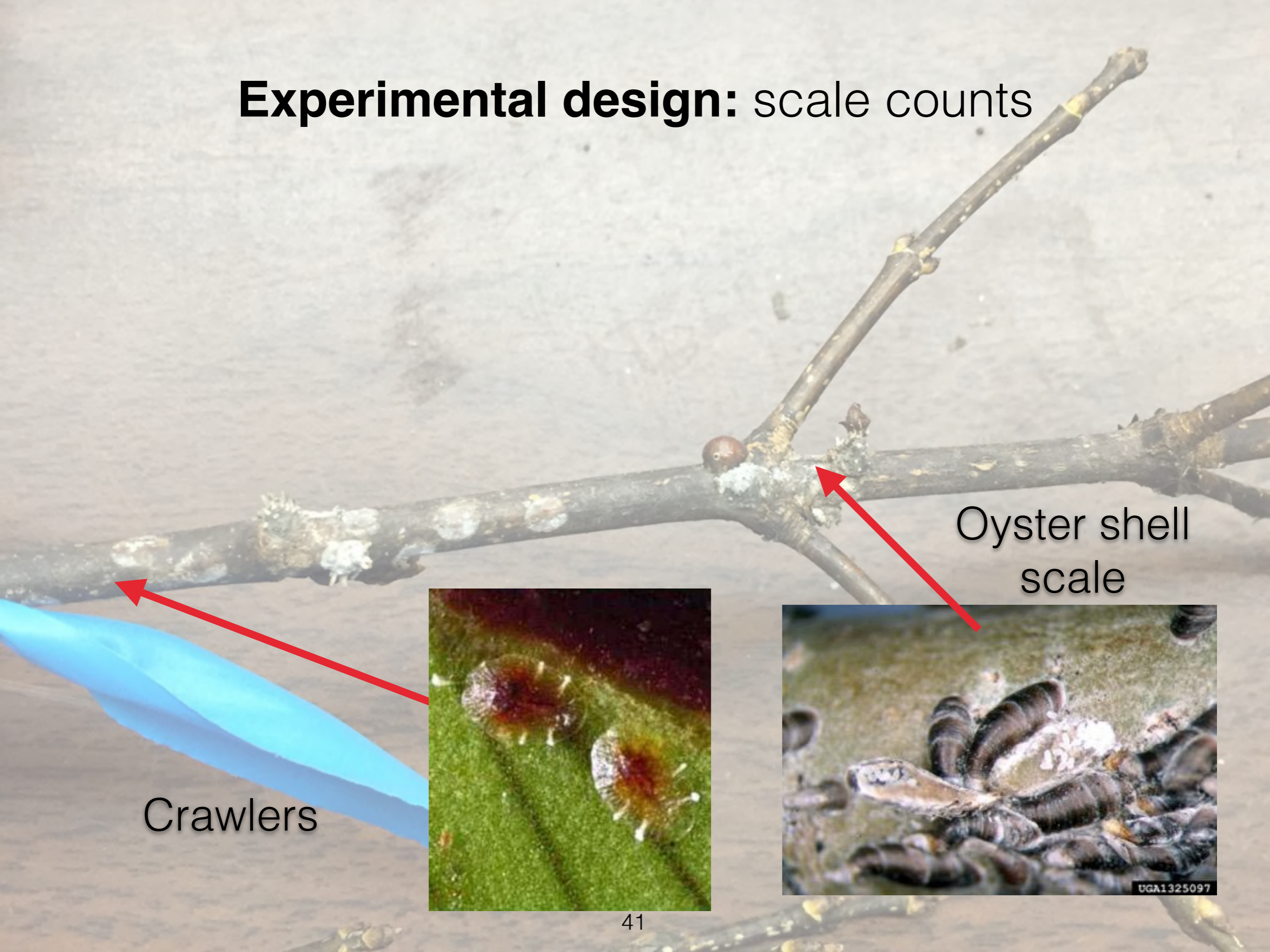


Experimental design: scale counts



scale residue

Experimental design: scale counts



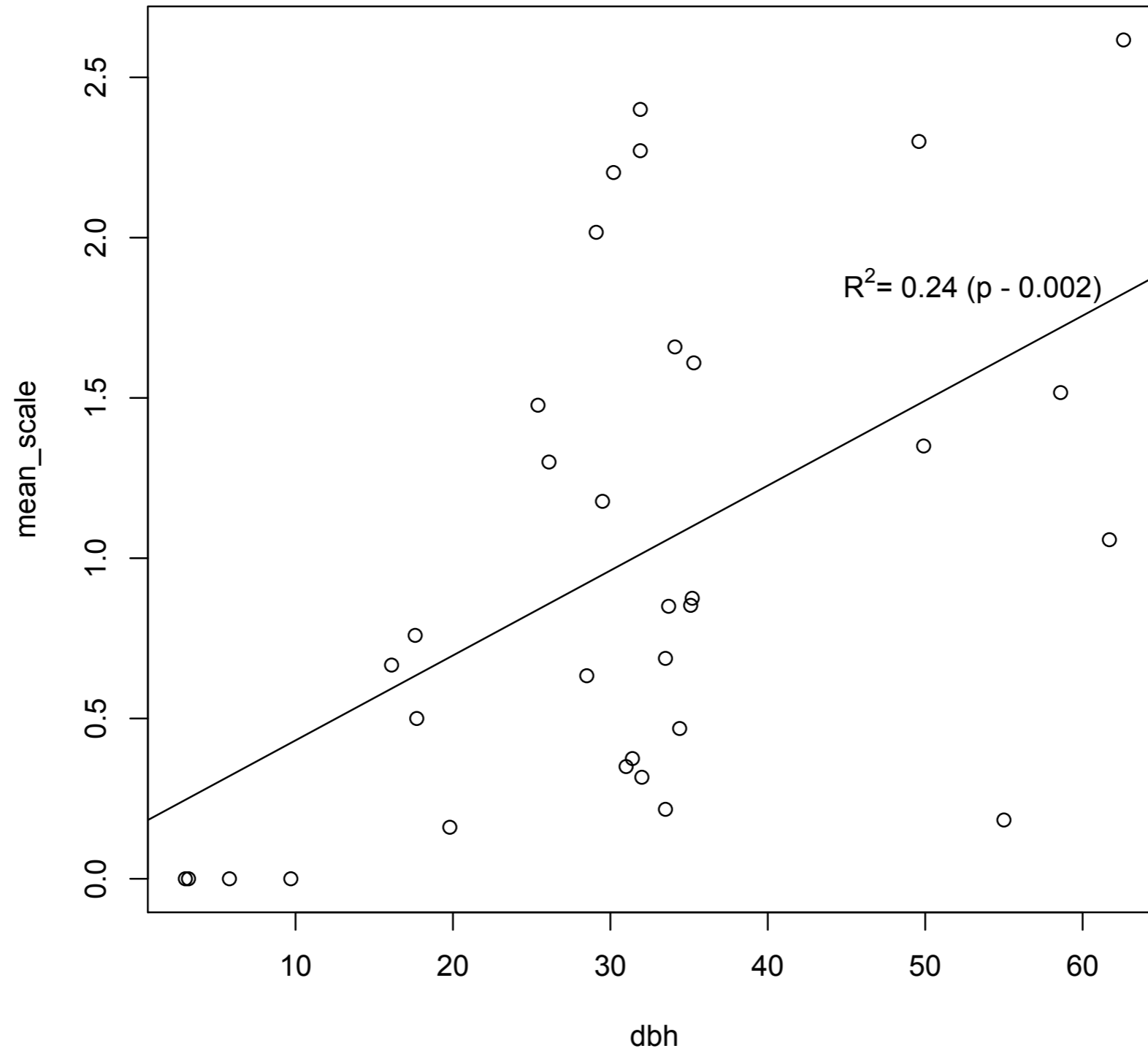
Oyster shell scale

Crawlers

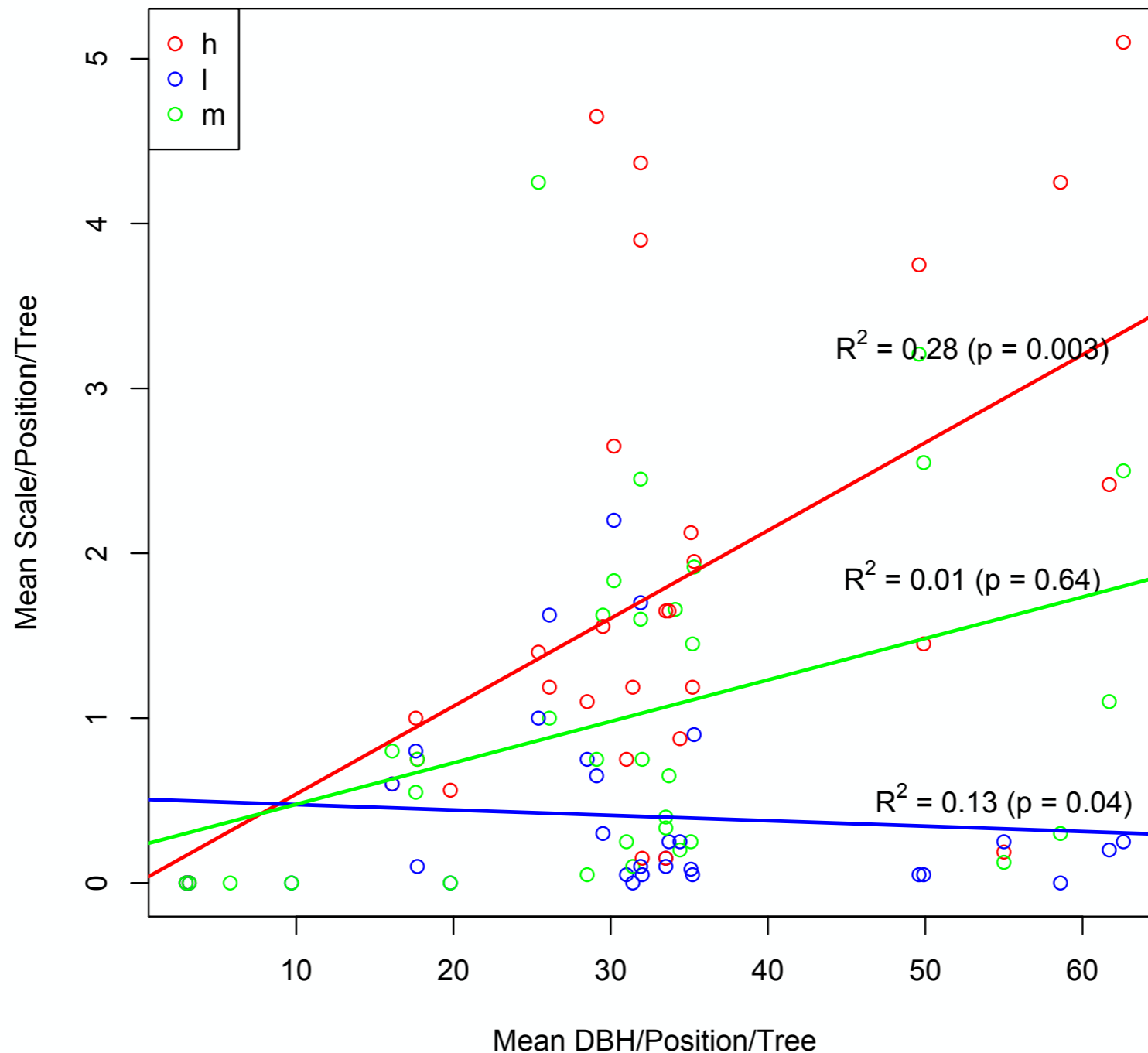


UGA1325097

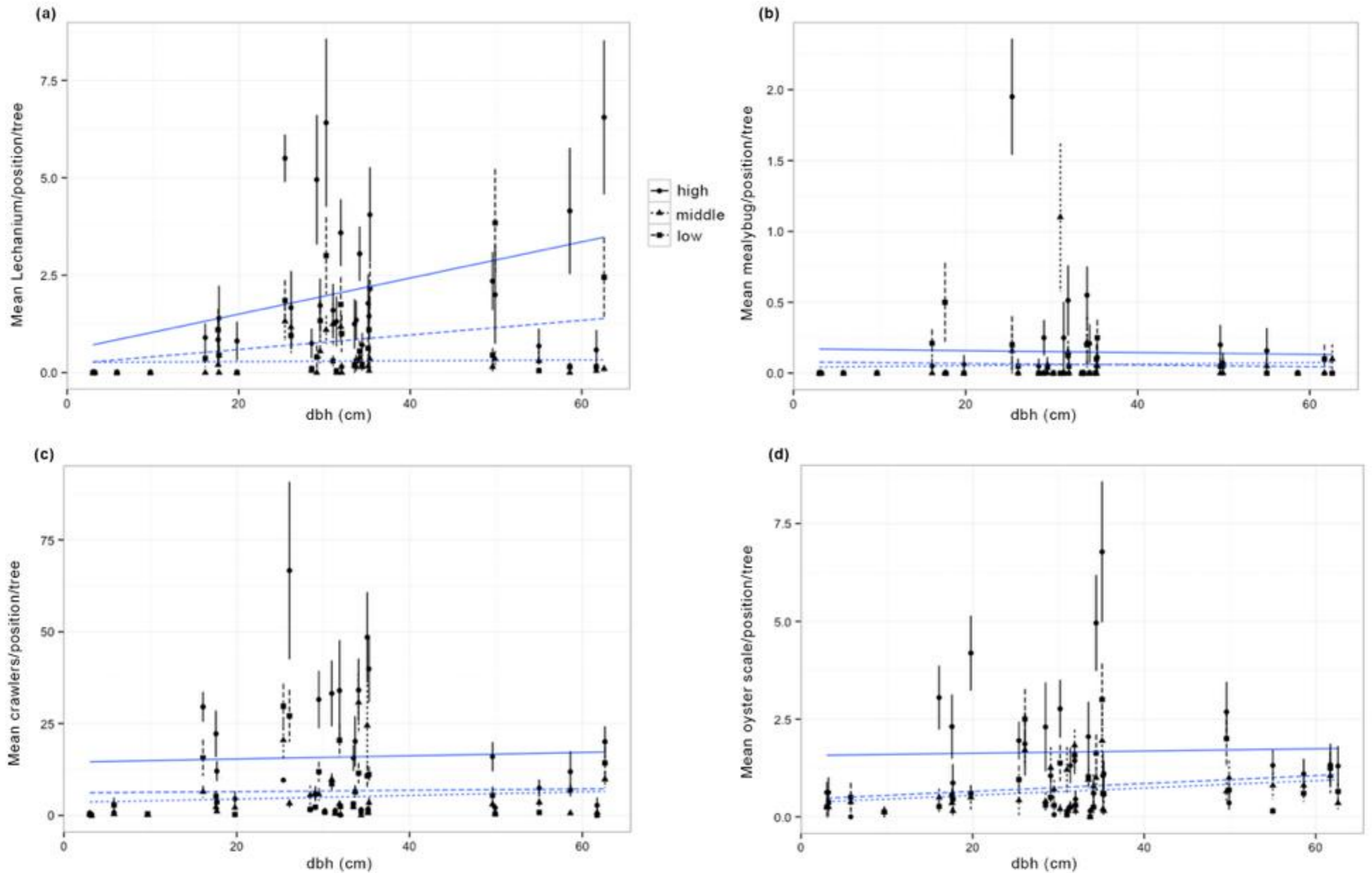
Preliminary results: higher scale/mealybug density on larger trees



Preliminary results: linear relationship between scale/mealybug density and canopy height

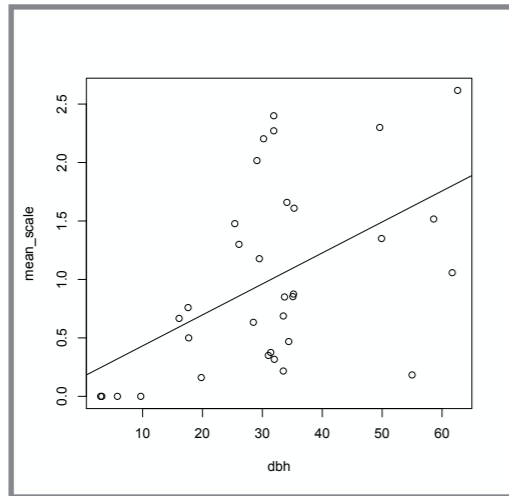


Preliminary results: high canopy supports higher abundance of scale



Summary

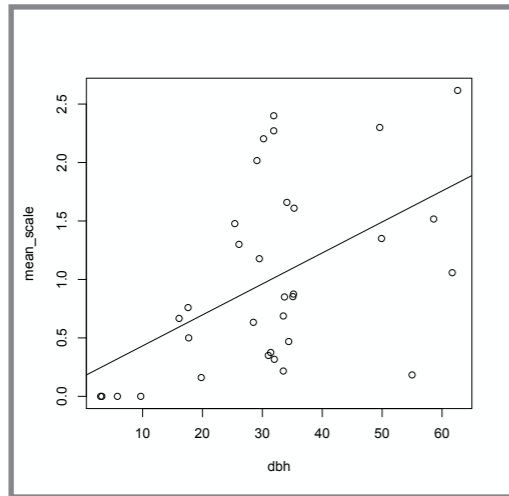
Summary



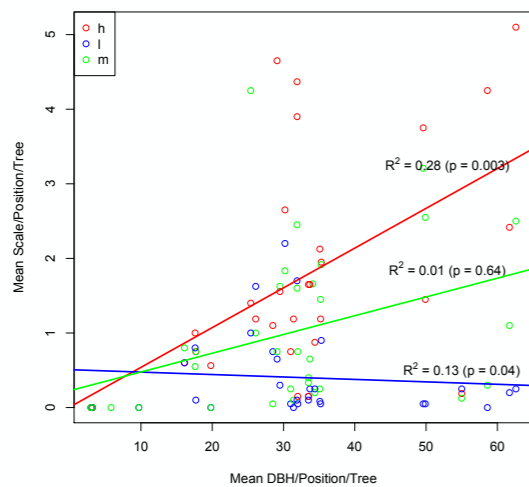
There's a linear relationship between tree size and scale density



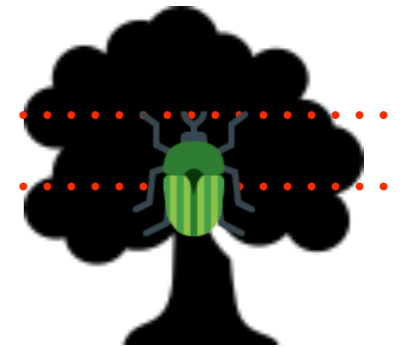
Summary



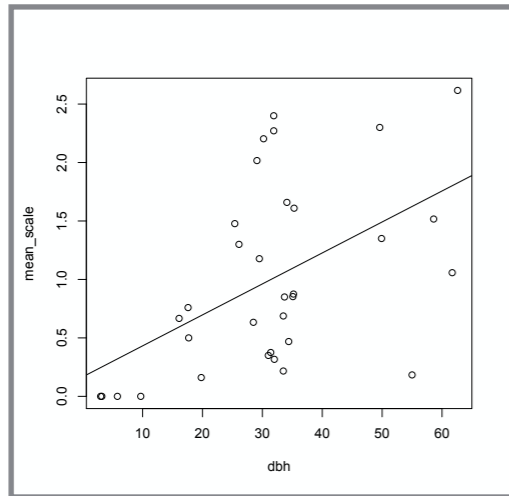
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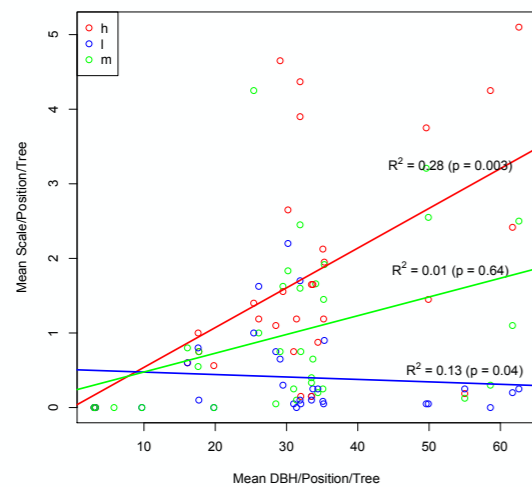
Linear relationships between canopy height and density of scale



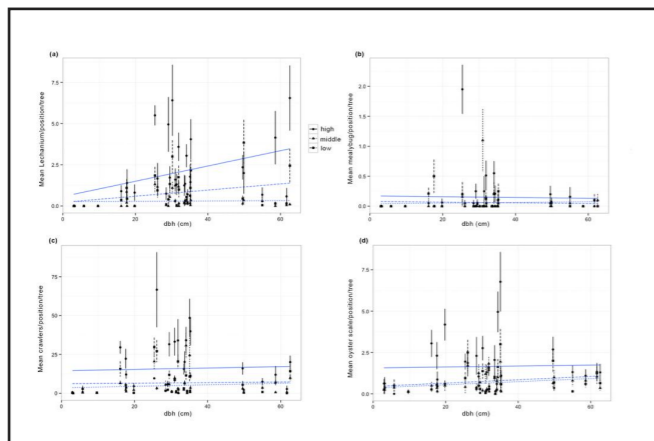
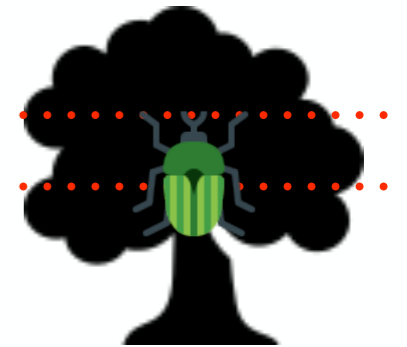
Summary



There's a linear relationship between tree size and scale density



Linear relationships between canopy height and density of scale



High canopy supports higher abundance

Significance



Non-floral carbohydrate resources have received little attention. *Bombus* had association with canopies (Project1)



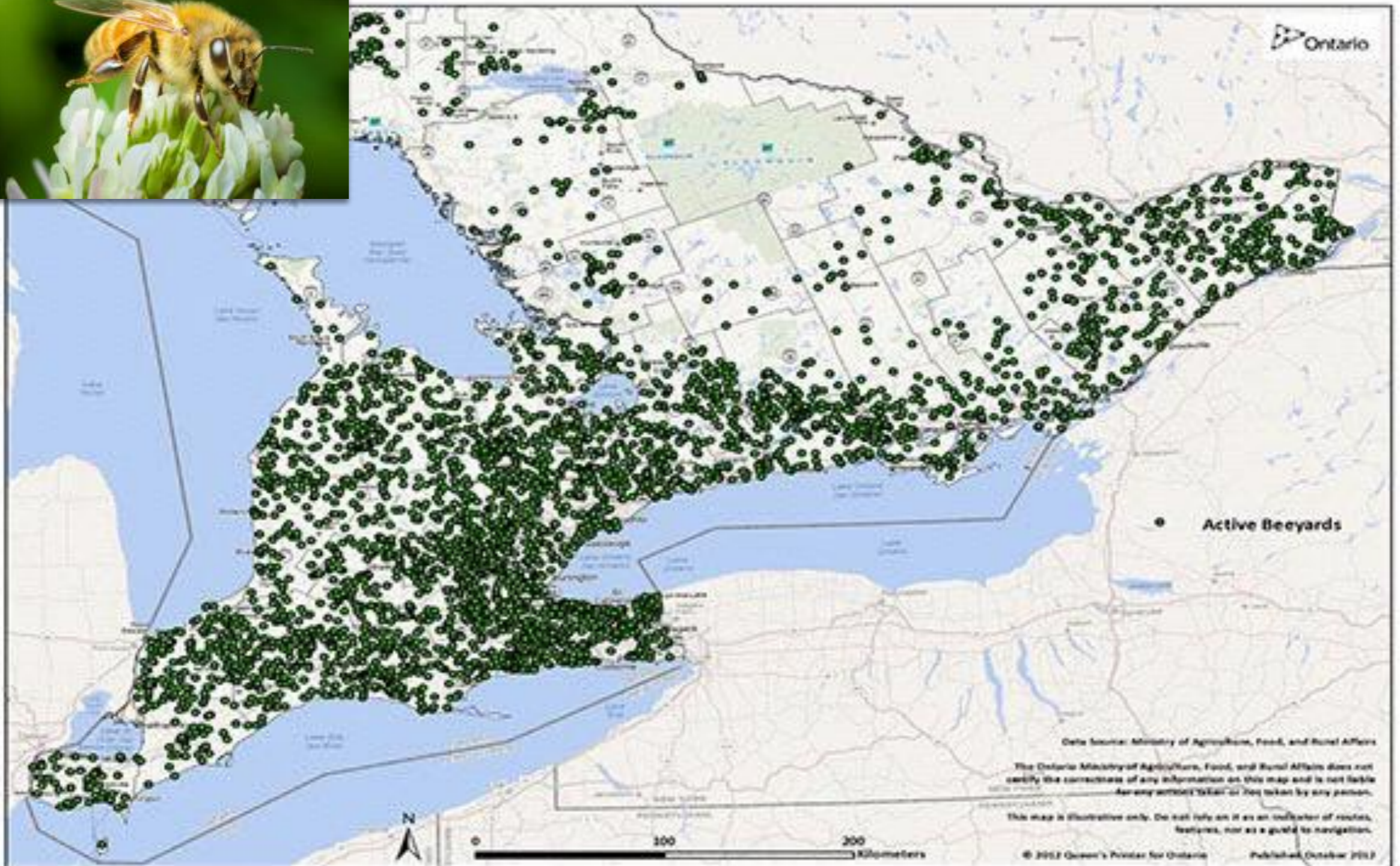
Climate change is shifting bee foraging ranges, but could be having impacts on scale abundance as well.

A piece of light brown cardboard is attached to a tree trunk with a black strap. The cardboard has several circular holes drilled into it, and small white plastic tubes are inserted into these holes. The background is a dense forest with green foliage.

Project 3

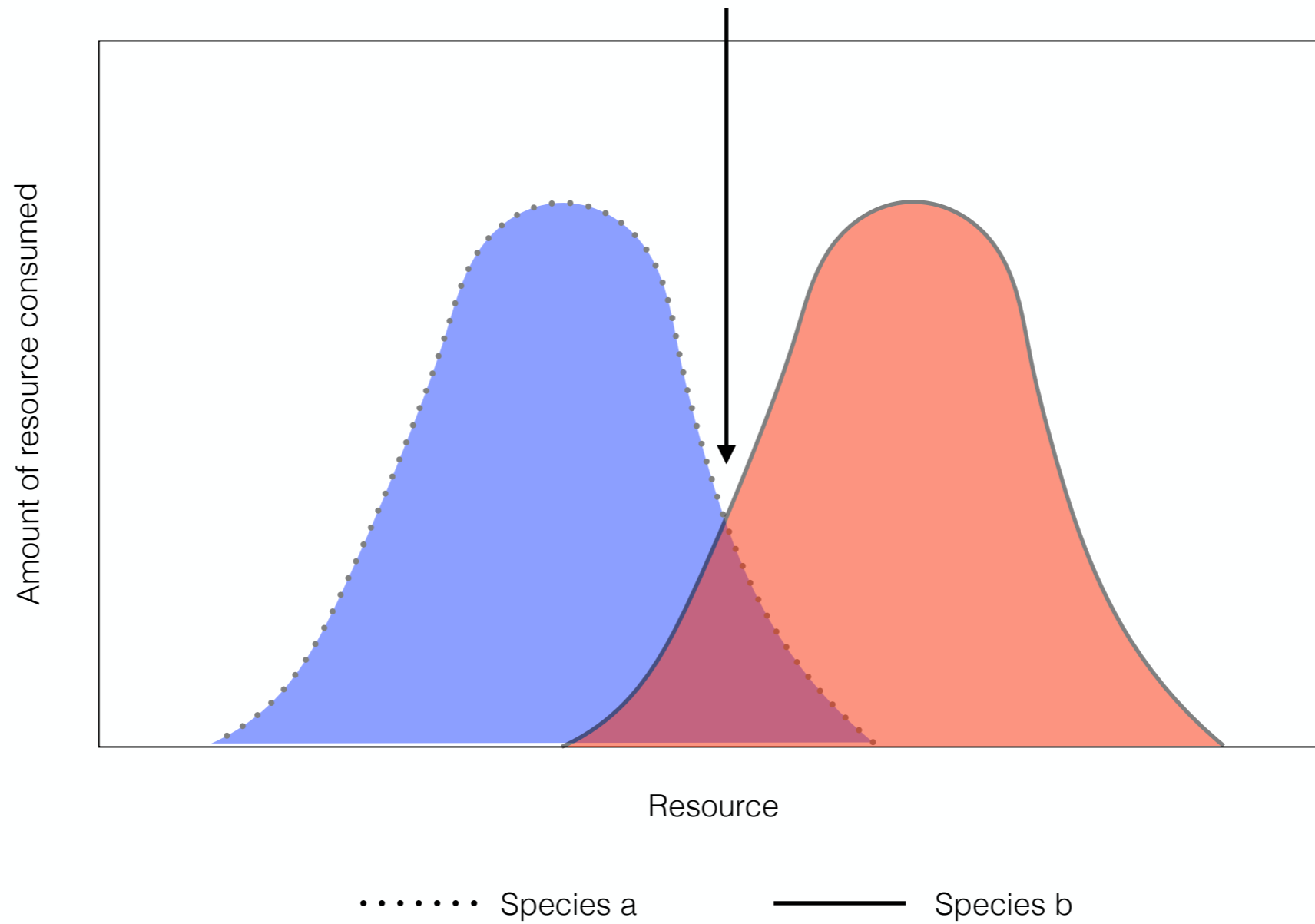
The short term effects of introduced honey bees on native bees (Hymenoptera: Apidae) in a mixed-woods, deciduous forest

Honeybee distribution in Ontario



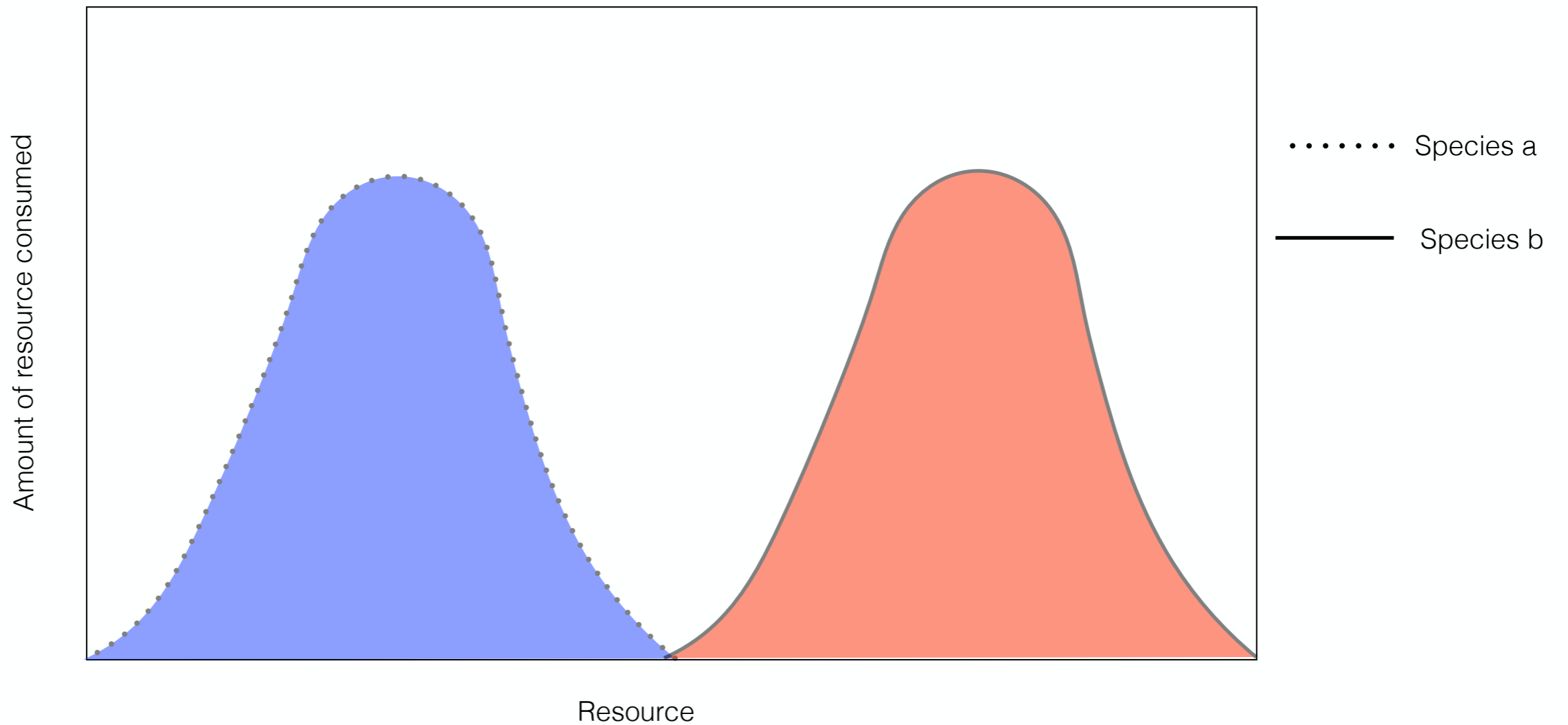
Resources: Competitive exclusion theory

zone overlap



Resources: Competitive exclusion theory

resource partitioning



All existing studies have:



1. honeybee/wild bee interactions on flowers
(e.g. Wratt, 1968; Pyke & Balzer, 1985; Kato *et al.*, 1999)



2. fecundity of wild bees native to Europe
(Evertz 1995; Pechhacker & Zeillinger 1994; Steffan-Dewenter & Tscharntke, 2000; Hudewenz & Klein, 2015)

3. “introduced” feral colonies in (Paini *et al.* 2005)



Problem: It is not known how the introduction of honeybees into North American temperate forests will impact the reproductive viability of native bee species.

Research Questions:



1. Does the presence of European honeybees impact the reproductive success of native bees?



2. Does honeybee abundance influence diversity and abundance of native bees in temperate forest systems?

Experimental design: Plot locations

Legend

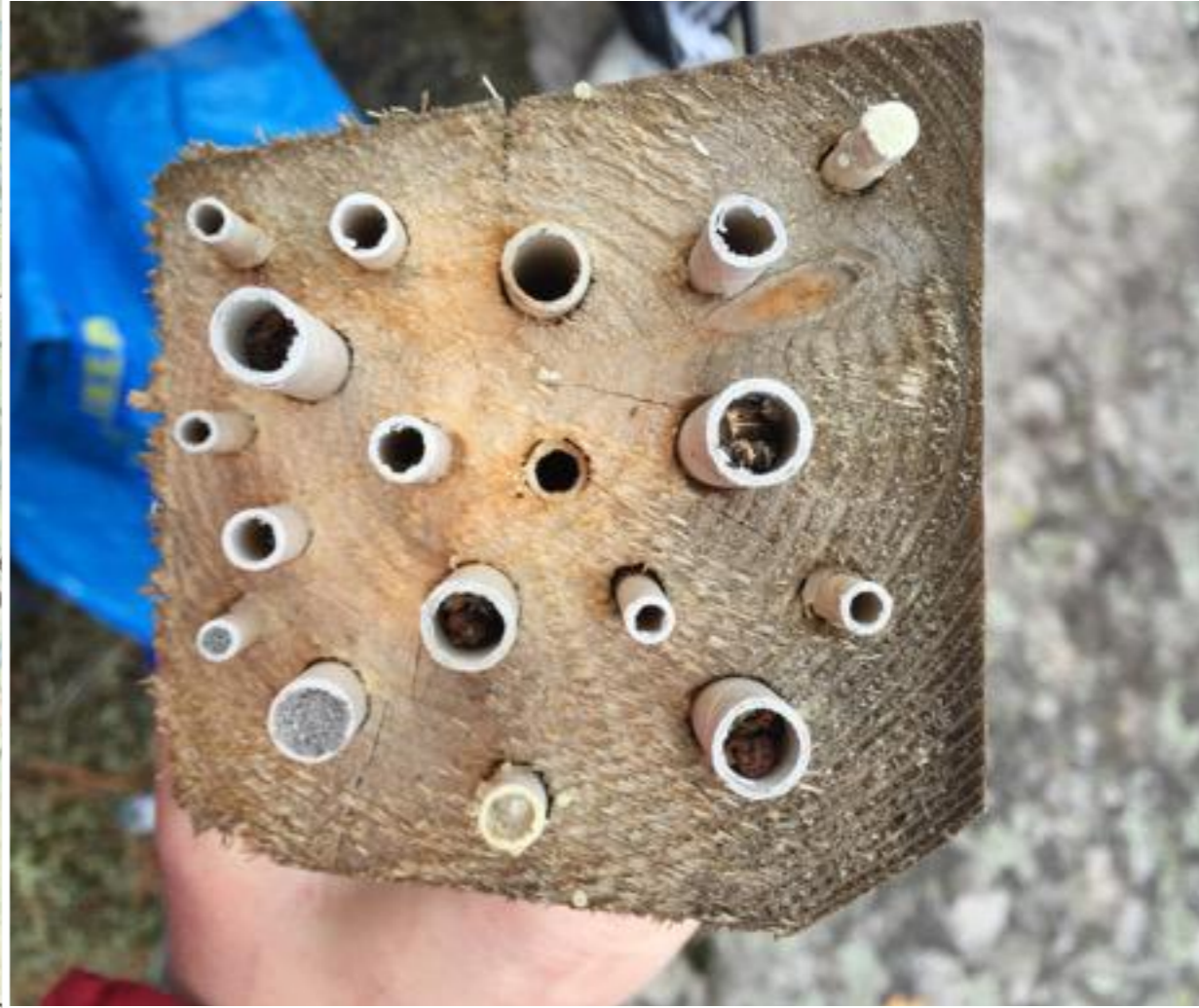
- With Honeybees
- Without Honeybees



Experimental design: Plot locations

Legend

- With Honeybees
- Without Honeybees



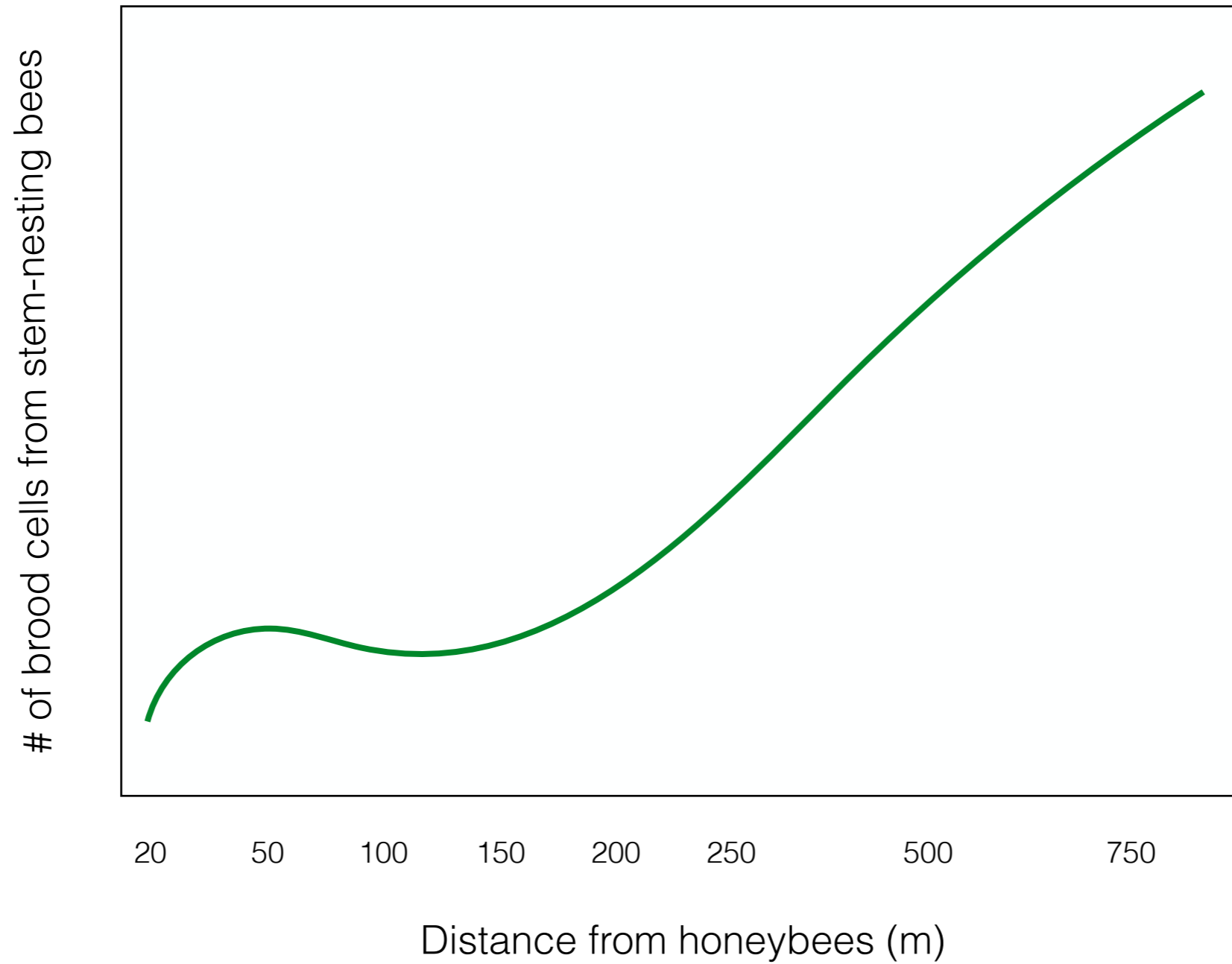
Experimental design: hand collection and bee bowls

Legend

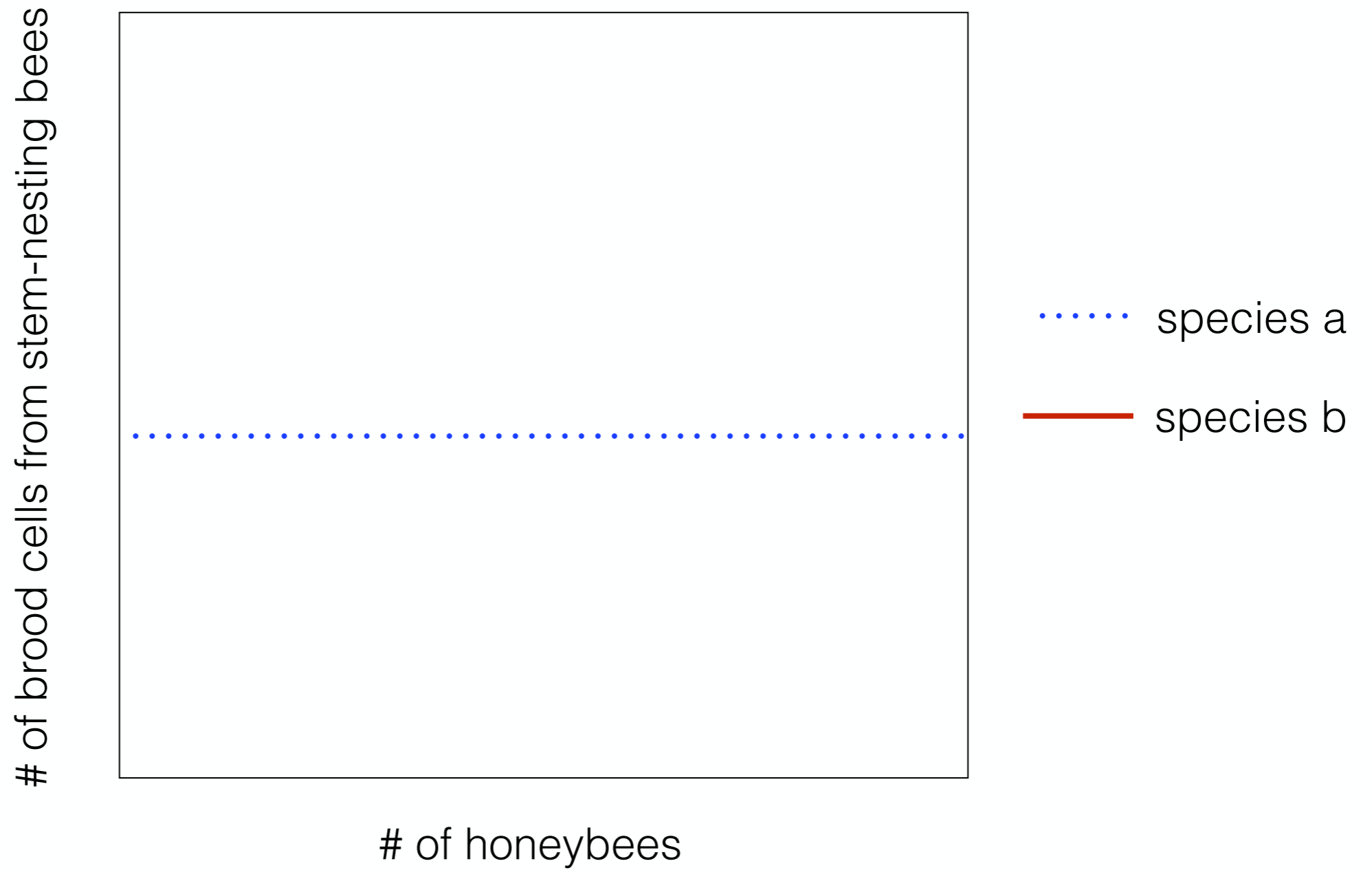
- With Honeybees
- Without Honeybees



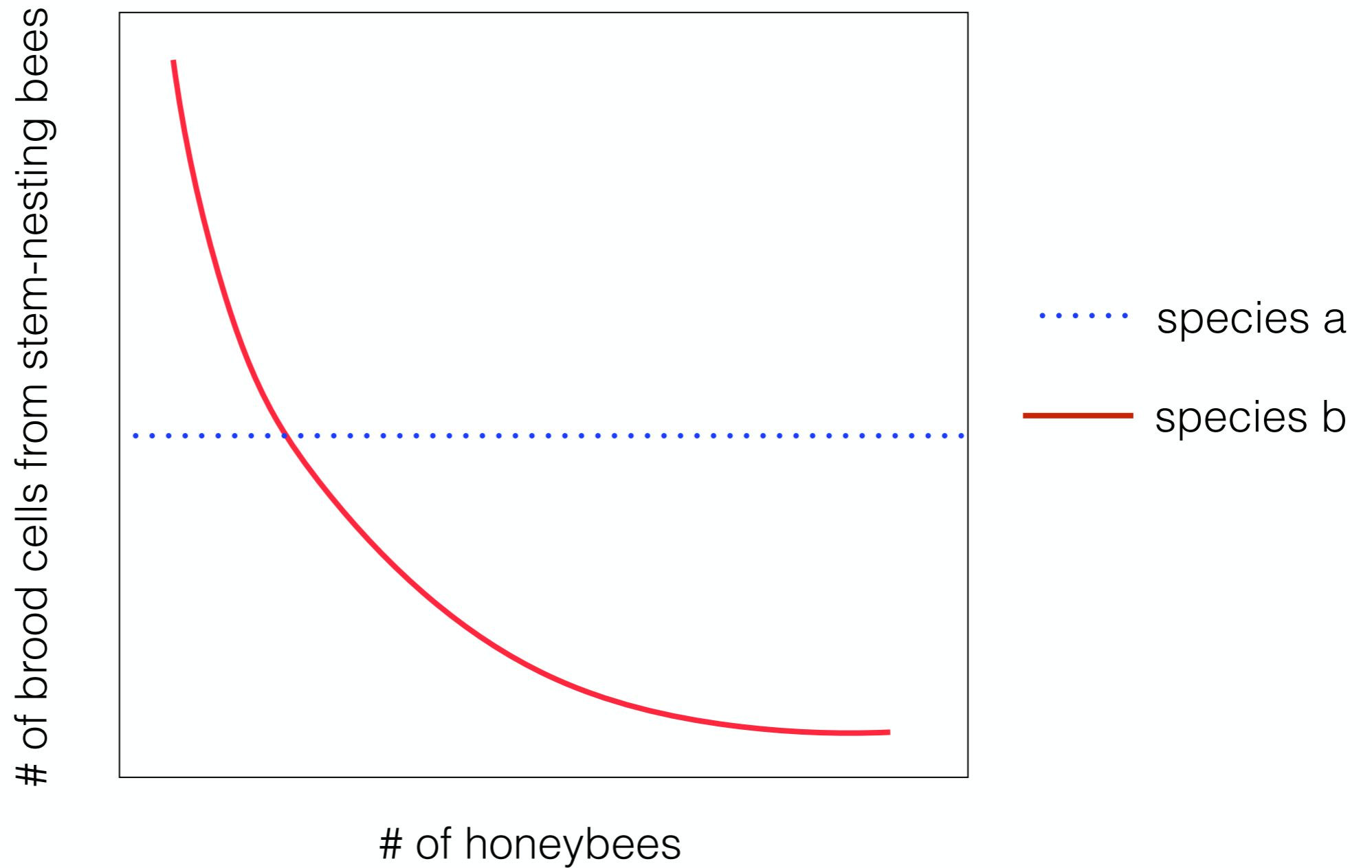
Expected Results



Expected Results



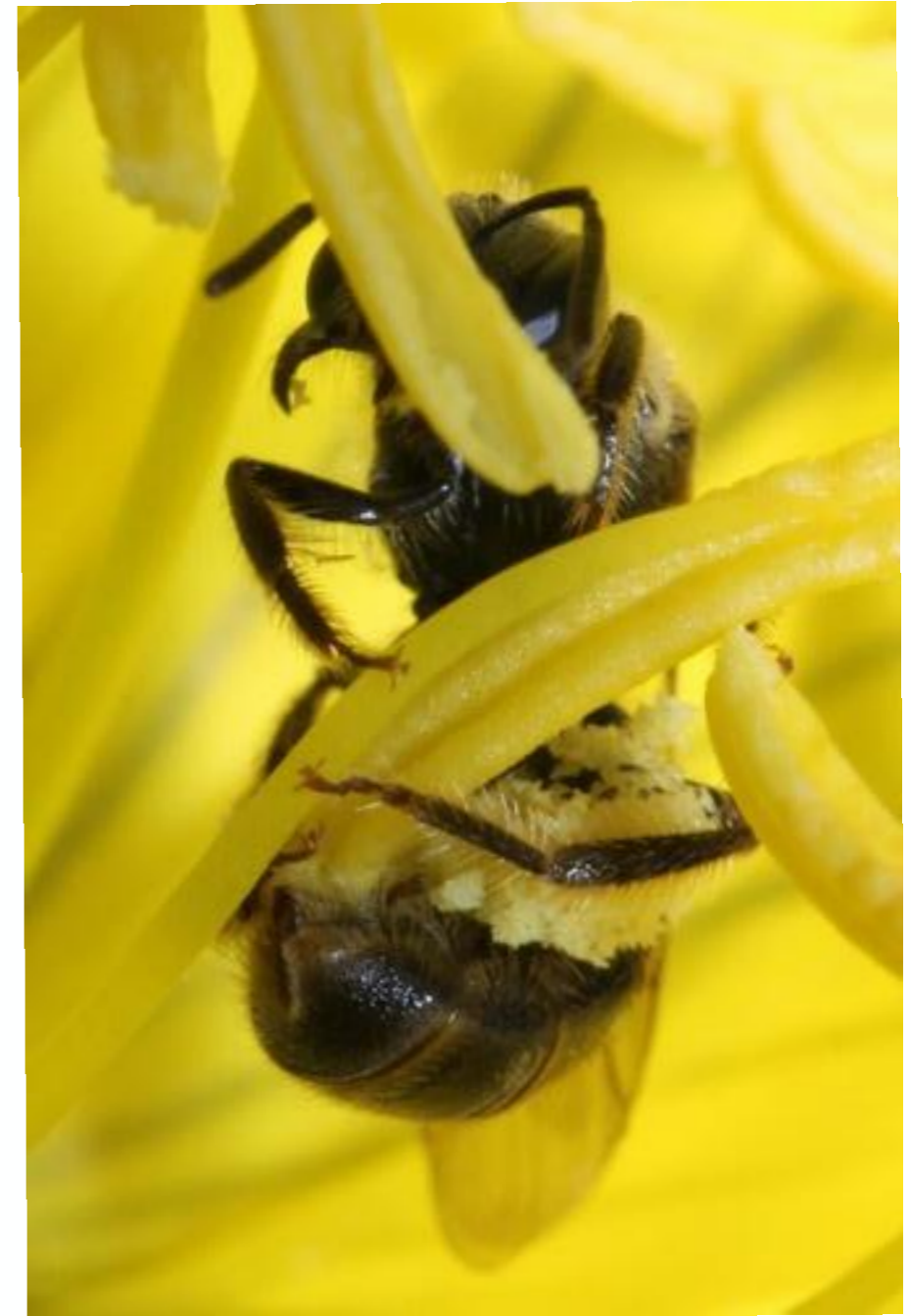
Expected Results



Oligolectic species



Melissodes desponsa



Lasioglossum oenotherae

(Packer et al., 2005; Zayed et al., 2005)

Significance

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No studies from North America have looked at native bee fecundity where honeybees are present.

Significance



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Data such as these can help us understand potential impacts of honeybee expansion moving northward

Overall summary

Bee declines have resulted in northward expansion of domestic honeybees into forested areas

Most studies have examined native bees in agriculture and prairie systems, but forest systems are largely unexplored

Non-floral nectar resources are potentially important for honeybees and native bees (specifically *Bombus*), but has received little attention.

Acknowledgments

Forest Entomology Laboratory (Dr. Sandy Smith)
Forest Silvicultural Laboratory (Dr. Sean Thomas)
Peter Schleifeinbaum
Lukas Seehausen
Md. Halim Abdul
Ian Kennedy
Tony Ung



School of
Graduate Studies

Remi Mauxion



Gabriel Vansteenbergh



Kathleen Manson



Caroline Cornu



Ellis Chang



Alexis Neiryck



Hortense Vallée



Marbia Biff Cera



s.frye@mail.utoronto.ca

www.wildbees.ca



[susanmafrye](https://twitter.com/susanmafrye)



[wildbeesontario](https://www.instagram.com/wildbeesontario)