Linking pollinator behavior to gene flow to improve coexistence

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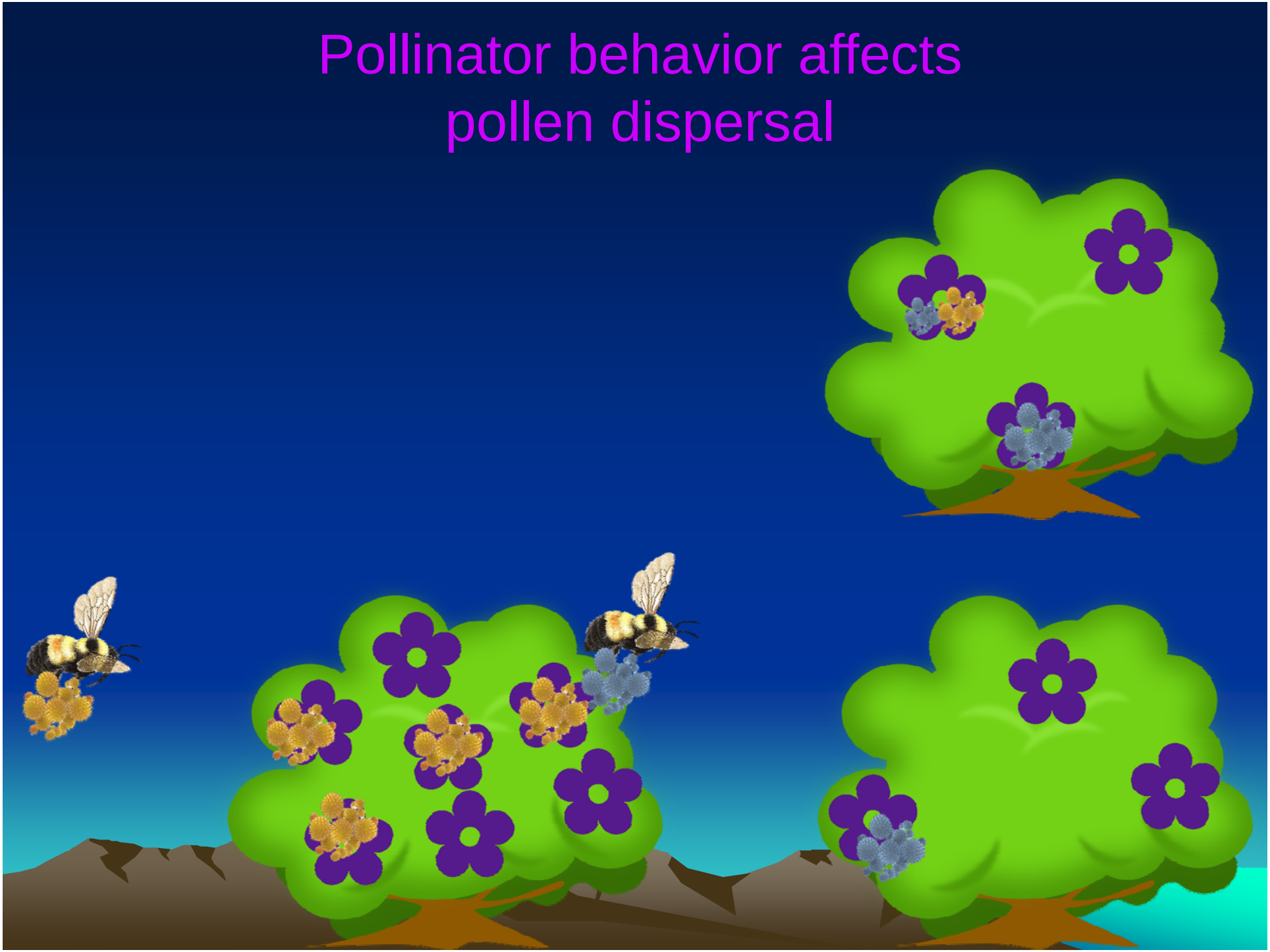
Outline

- Pollinator behavior and pollen movement
- Pollinator behavior to predict gene flow among bee species
- Agricultural landscape and pollinator behavior (residence)
- Knowledge of pollinator behavior and best management practices to reduce gene flow

Pollinator behavior affects pollen dispersal

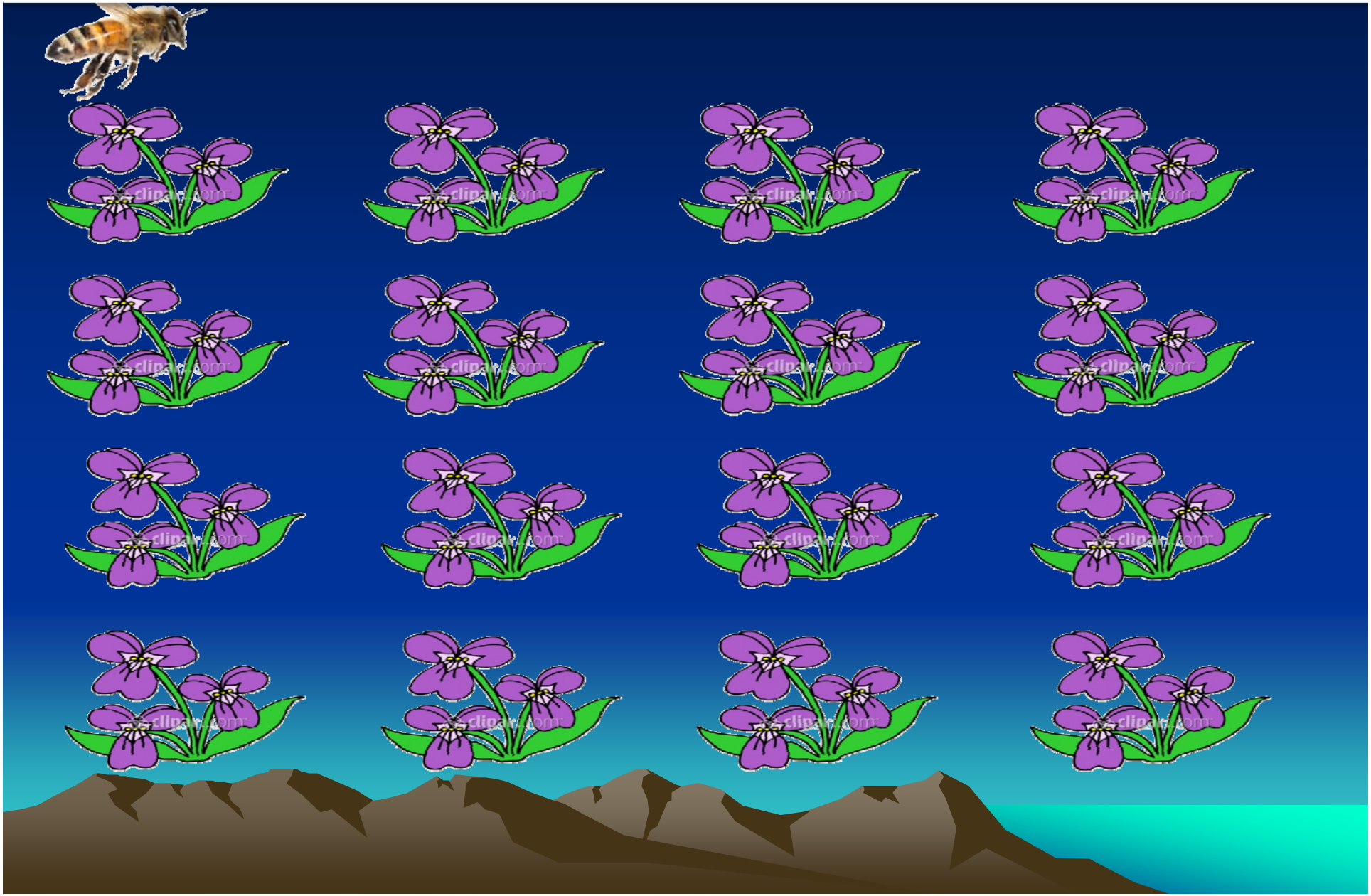


Pollinator foraging behavior

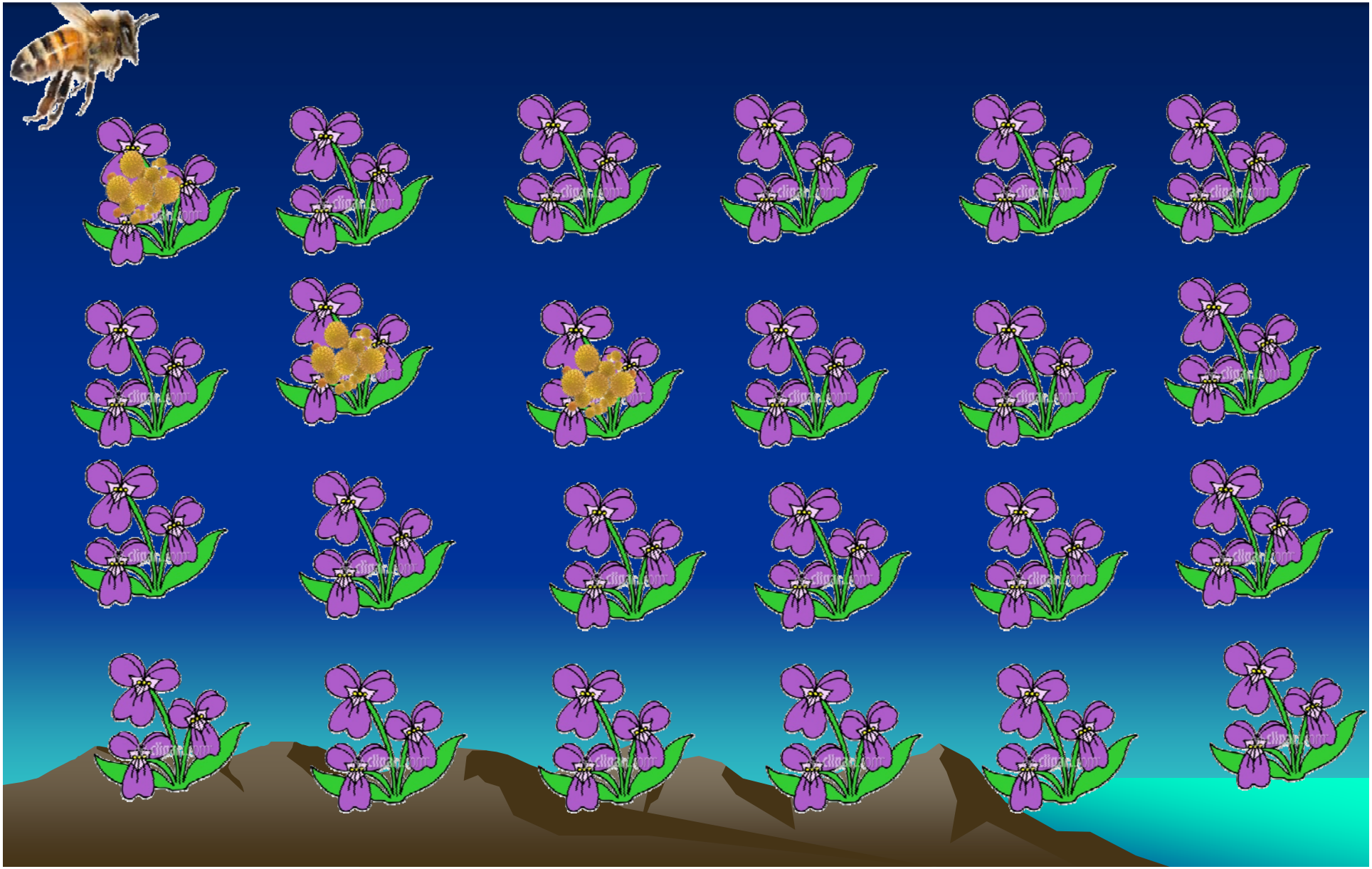
- The distance traveled between racemes
- Directionality in pollinator movement
- Net distances traveled
- Residence or number of flowers visited in a foraging bout
- Pollen deposition curve
- Tripping rate

Directionality of movement

Residence



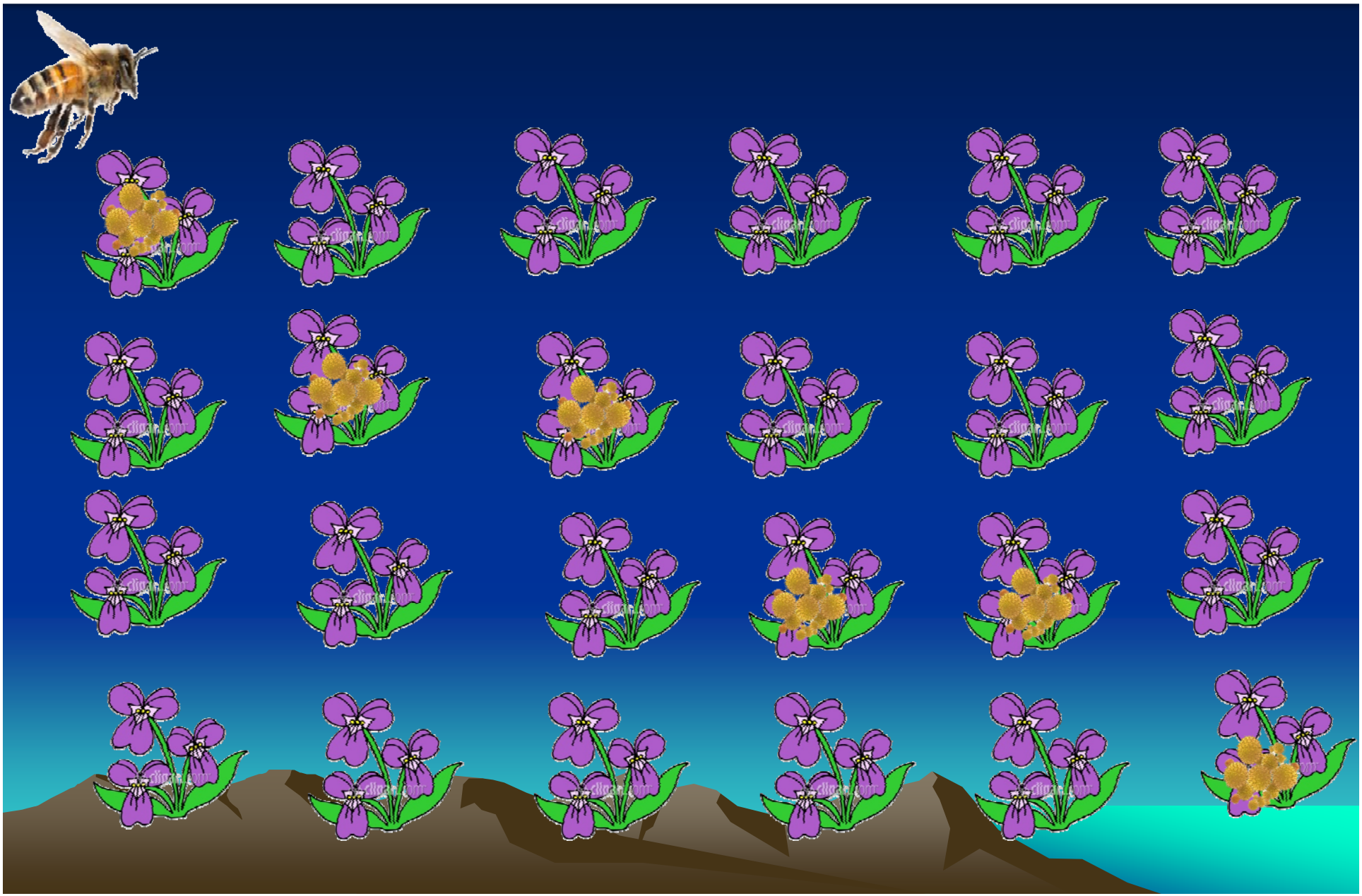
Pollen deposition and pollinator movement



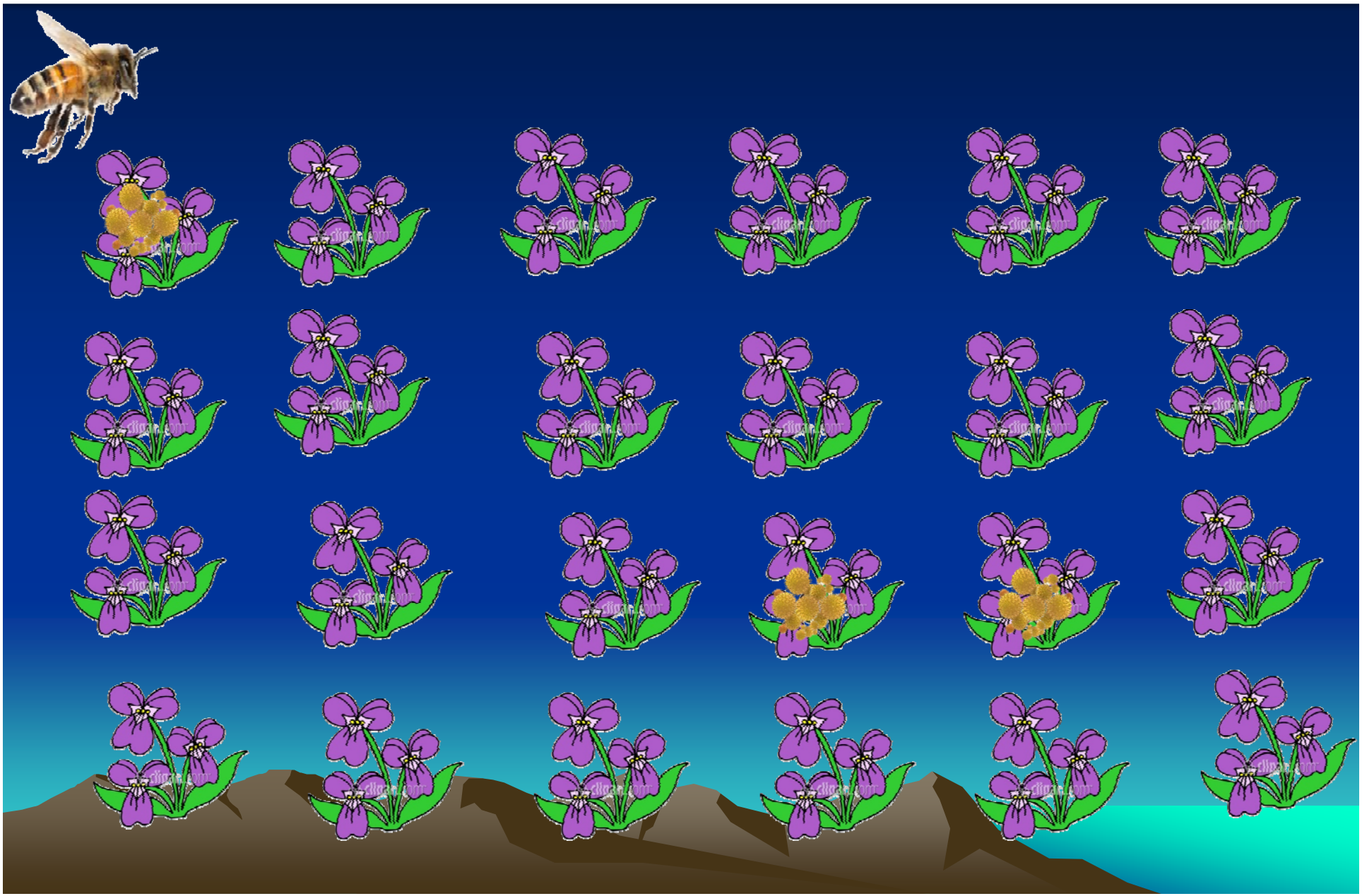
Pollen deposition curve

Fig. 4 Example of pollen carryover curves resulting in shorter (solid line) and longer (dashed line) pollen dispersal

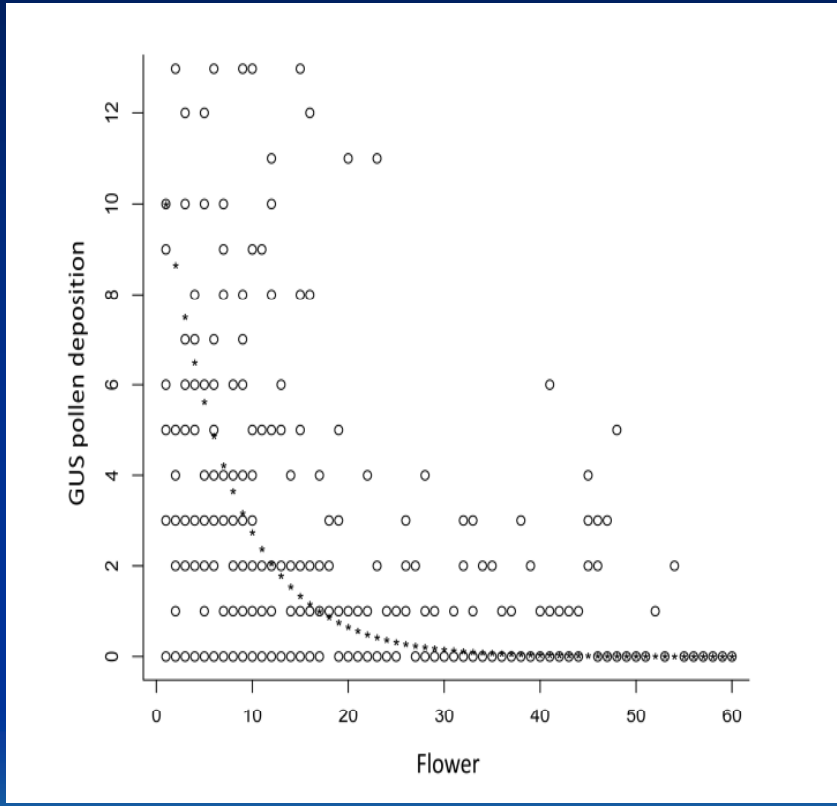
Tripping rate



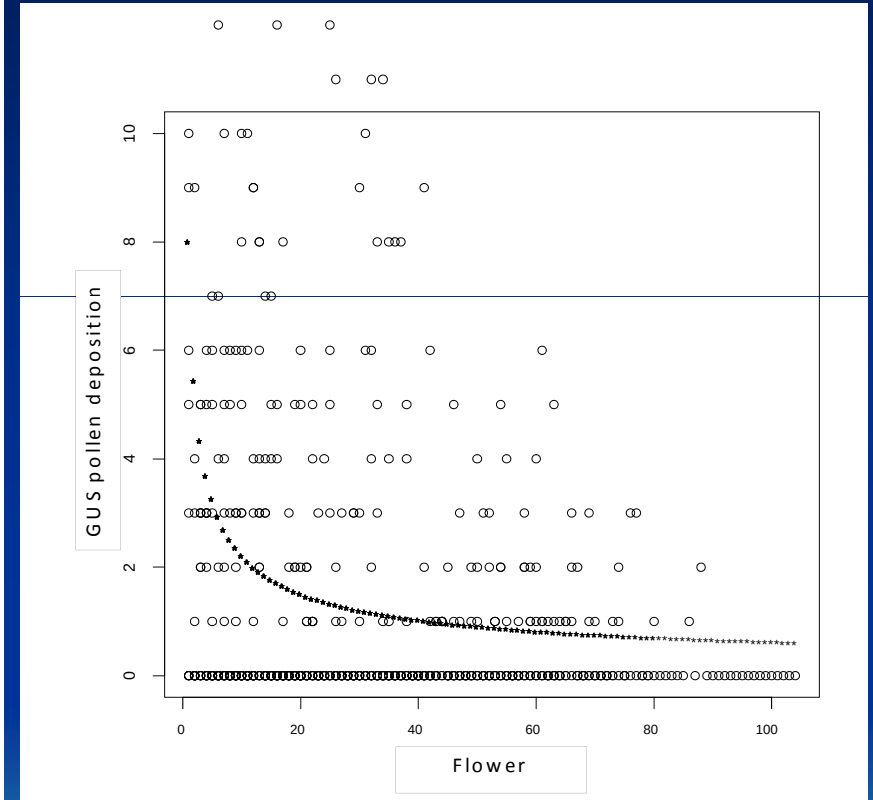
Tripping rate



Tripping rate and gene flow



Tripped flowers only



Untripped flowers included

Bee species

- Compare foraging behaviors among three bee species
- Can we use these behaviors to predict gene flow among bee species?

Bees on alfalfa

Leaf cutting bee

Honey bee

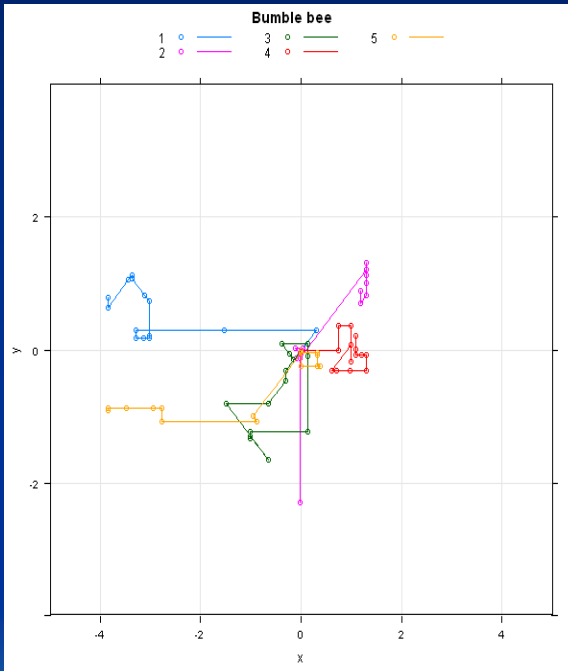
Bumble bee

Gene flow in alfalfa seed production fields

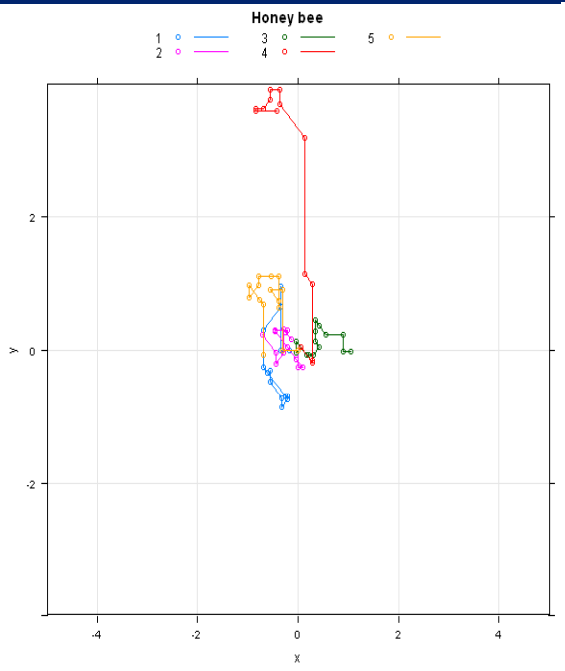
- Distances traveled by RR pollen, i.e. detection of Roundup Ready (RR) seeds are greater when pollen is carried by honeybees relative to leafcutting bees.
- Quick decline in the probability of finding any RR genes after 1,000 feet for leafcutting bees and closer to 3,000 feet for honey bees.
- Bumble bees are not used in alfalfa seed-production and there currently exists no gene flow data on this bee species foraging on alfalfa flowers.

Directionality in movement

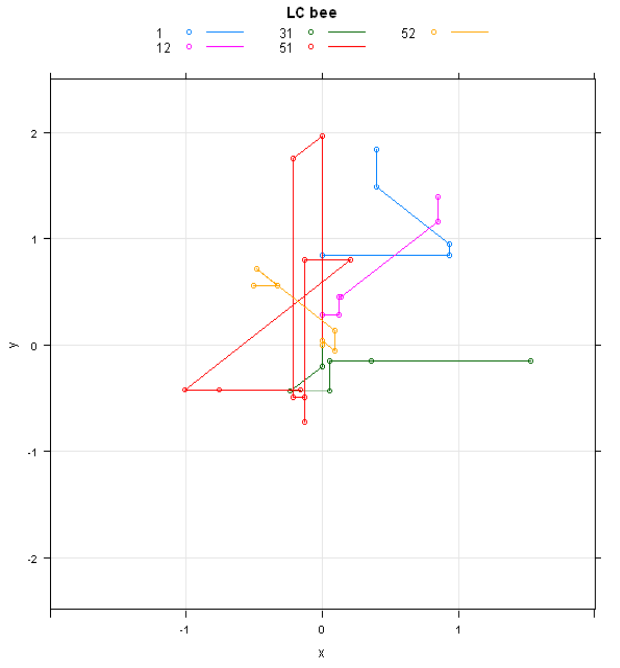
Bumble bee



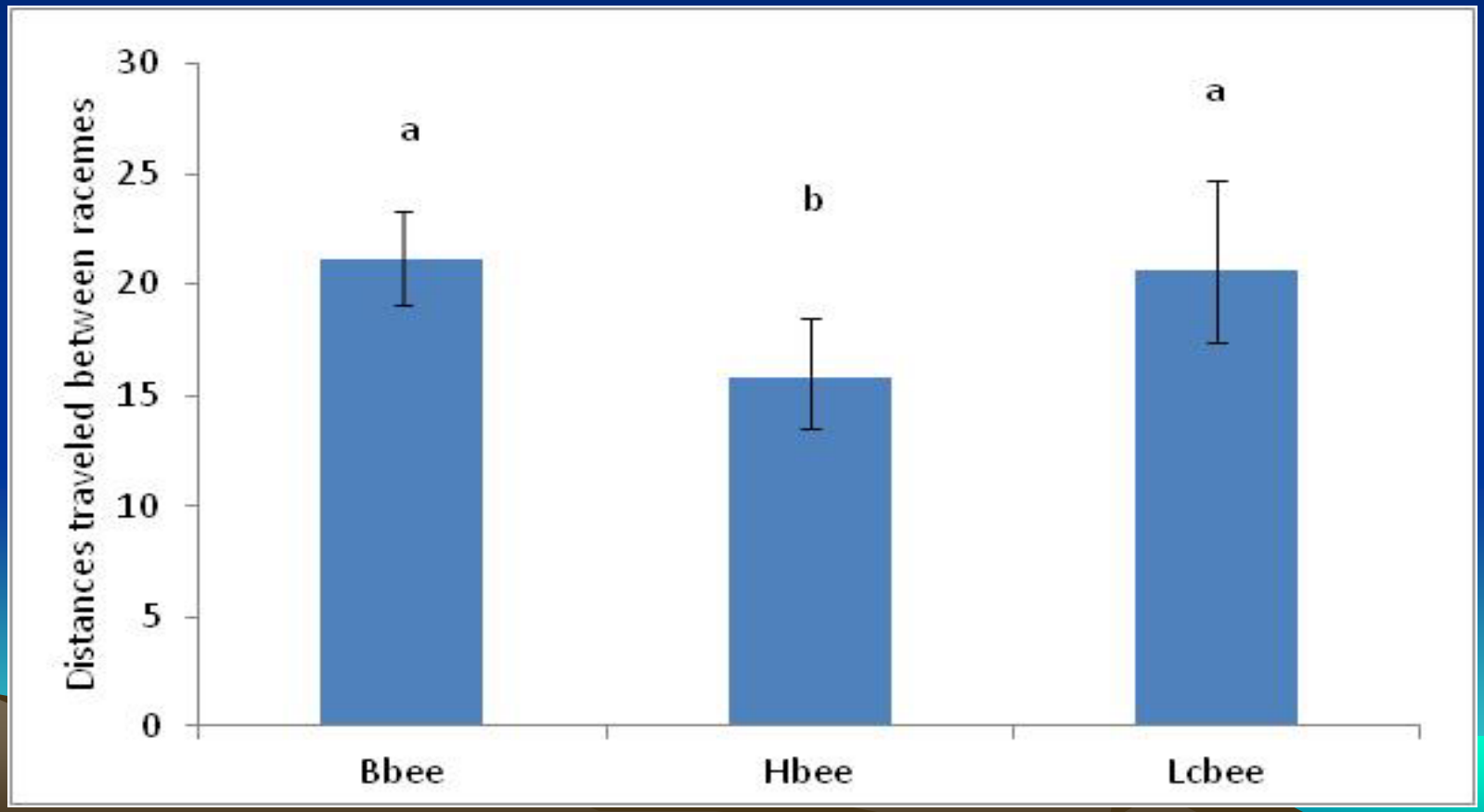
Honey bee



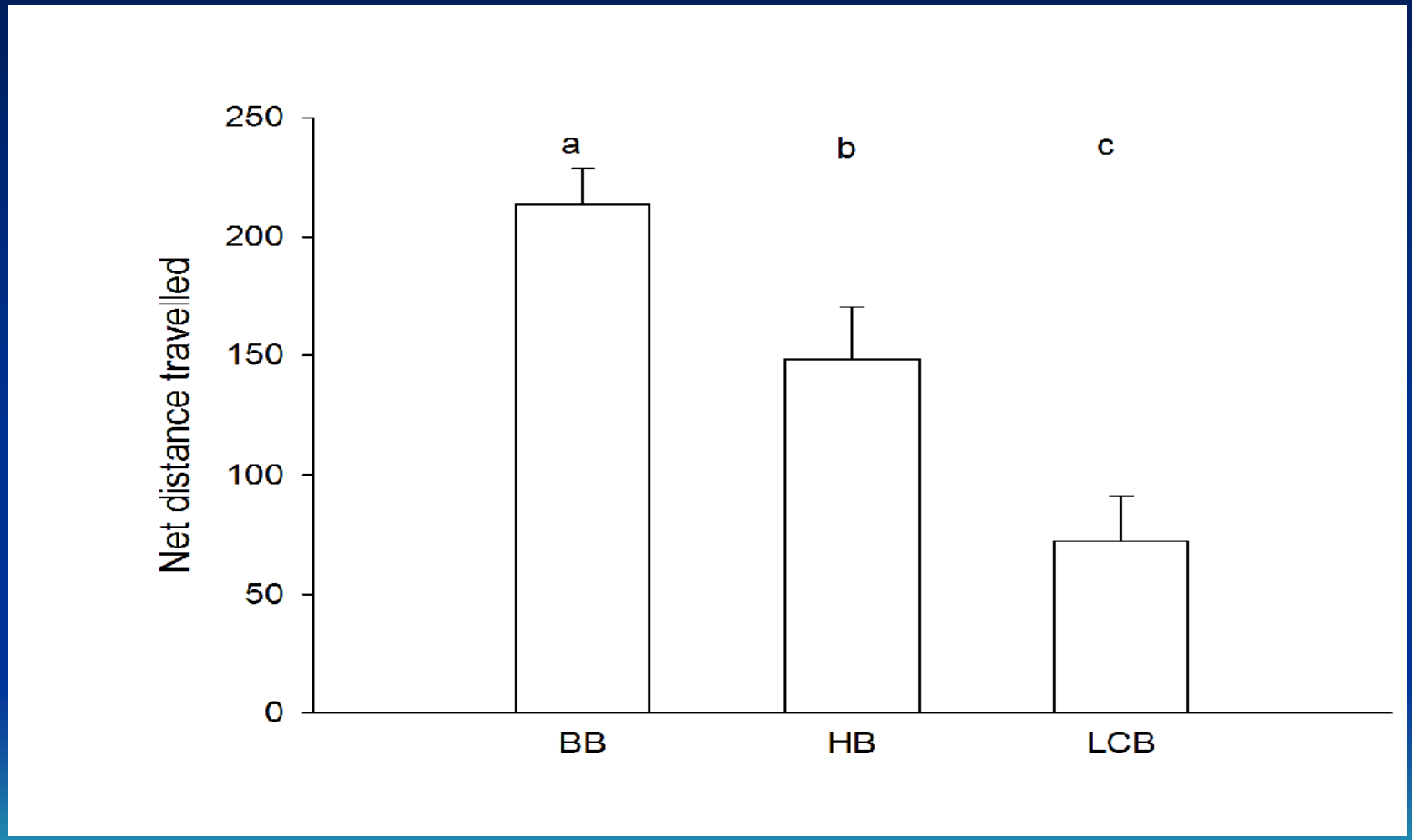
Leaf cutting bee



Distance traveled between racemes



Net Distances Traveled (cm)



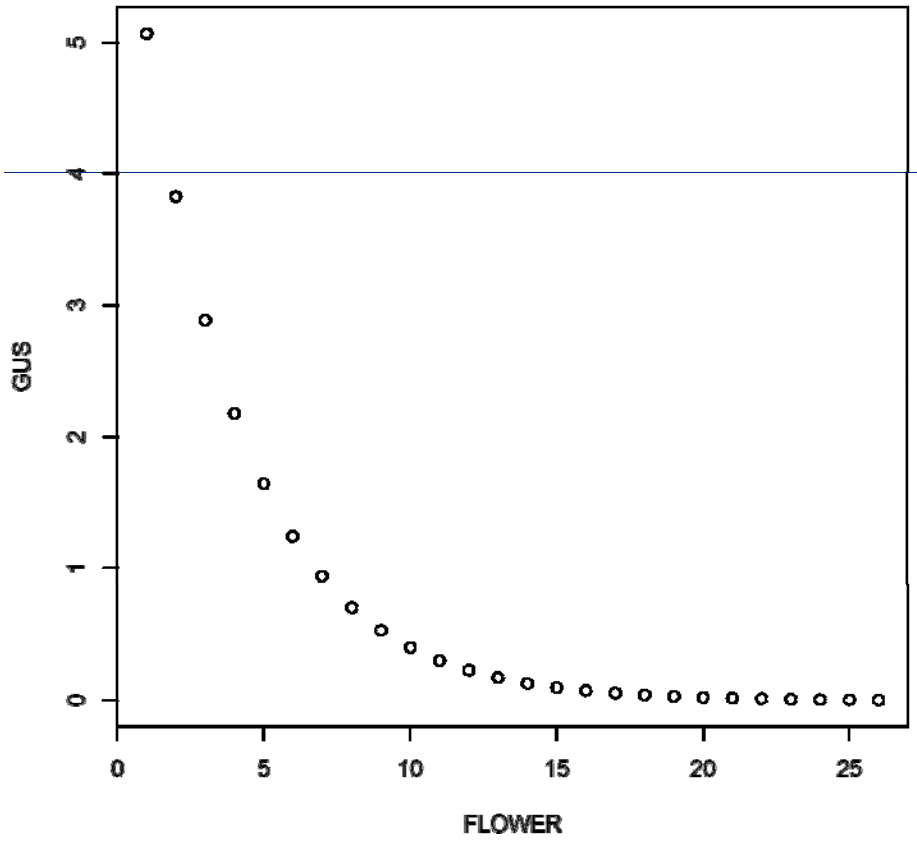
Residence

Location	Bbee	Hbee	Lcbee
Field	53.9	48.2	
Greenhouse	45		12

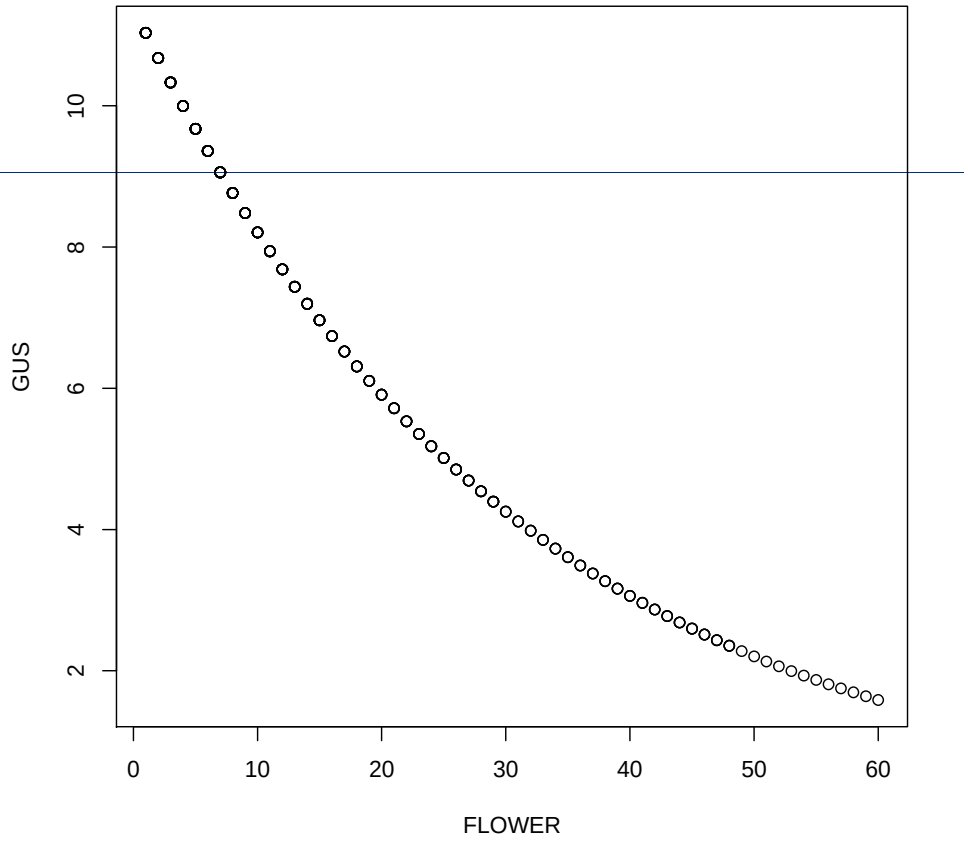
Greenhouse experiment: Leafcutting bees: 11.8 Bumble bees : 44.7 flowers per foraging bout (df= 1,29 F= 31.54, P < 0.0001)

Pollen deposition curves- Flower

Leafcutting bee



Bumble bee



Tripping rate

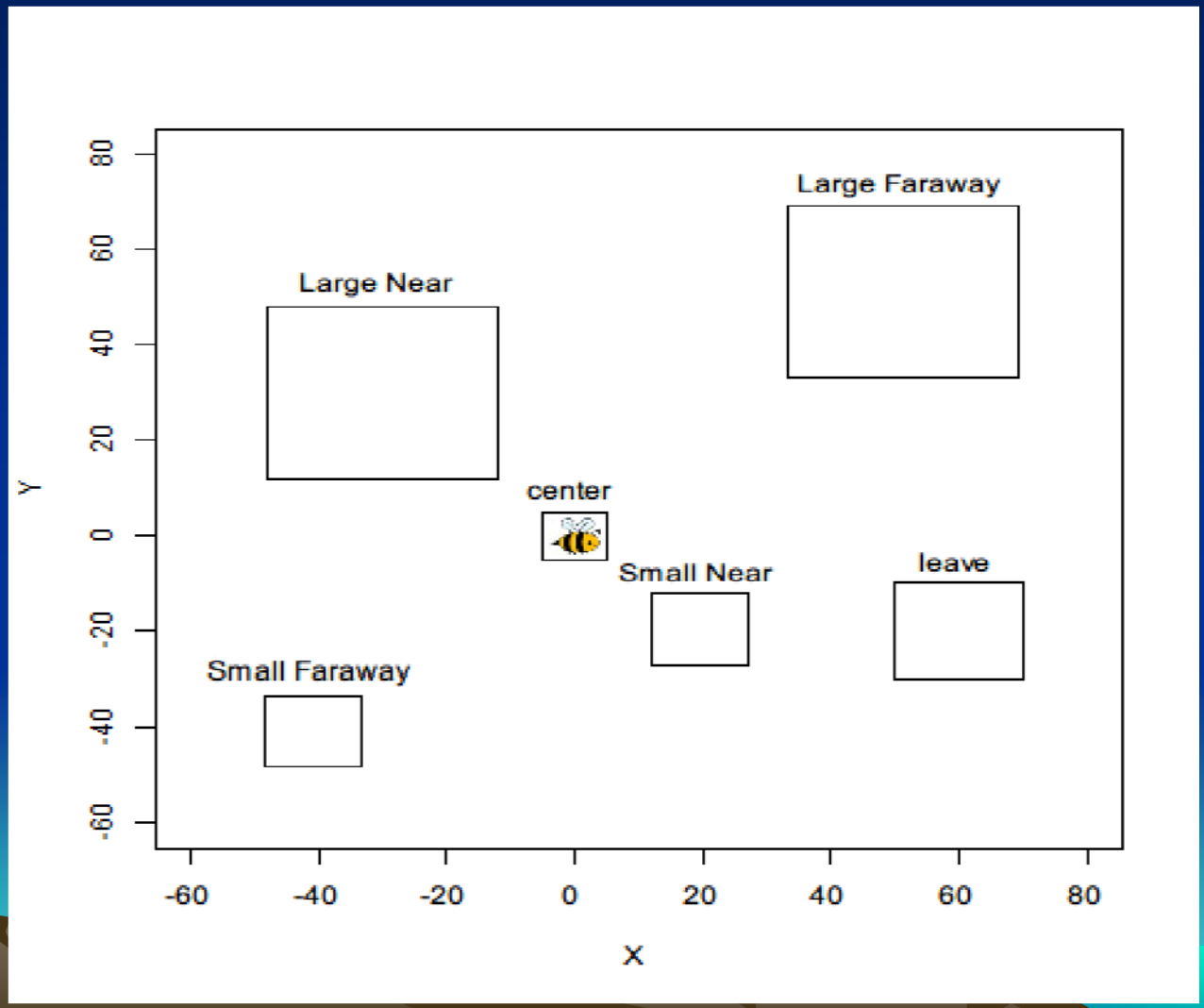
Bbee	Hbee	Lcbee
45	35	80
b	b	a

Percentage of visited flowers that were tripped

Gene flow predictions- Bee species

- Greater net distances: Yes
- Directionality of movement : Yes
- Residence: No
- Pollen depositio curve: Yes
- Tripping rate: Yes

Bee movement in a discontinuous landscape



Patch size and Residence

Effect	Numdf	Dendf	Fvalue	Pr>F
Patch size	1	353	5.13	0.02
Bee type	1	353	0.11	0.74
Patch size * Bee type	1	353	1.16	0.28

Large 50.9 +/- 6.9 (SE)

Small 36.4 +/- 8.9 (SE)

Isolation Distance and Residence

Effect	Num df	Den df	F value	Pr > F
Isolation	1	252	12.43	0.0005
Bee type	1	252	0.63	0.43
Isolation* Bee type	1	252	12.58	0.18

Far 51.8 +/- 6.5 (SE) **Near** 33.8 +/- 4.2 (SE)

Conclusions

- Agricultural landscape can affect bee behavior
- Pollinator behavior affects gene flow
- Differences in behavior among bee species can help predict differences in gene flow

Management Practices and gene flow

- Higher tripping lowers gene flow
- Tripping rate varies among bee species
- Leafcutting bees high tripping rate
- Honey bees low tripping rate
- Selection for higher tripping rates in alfalfa

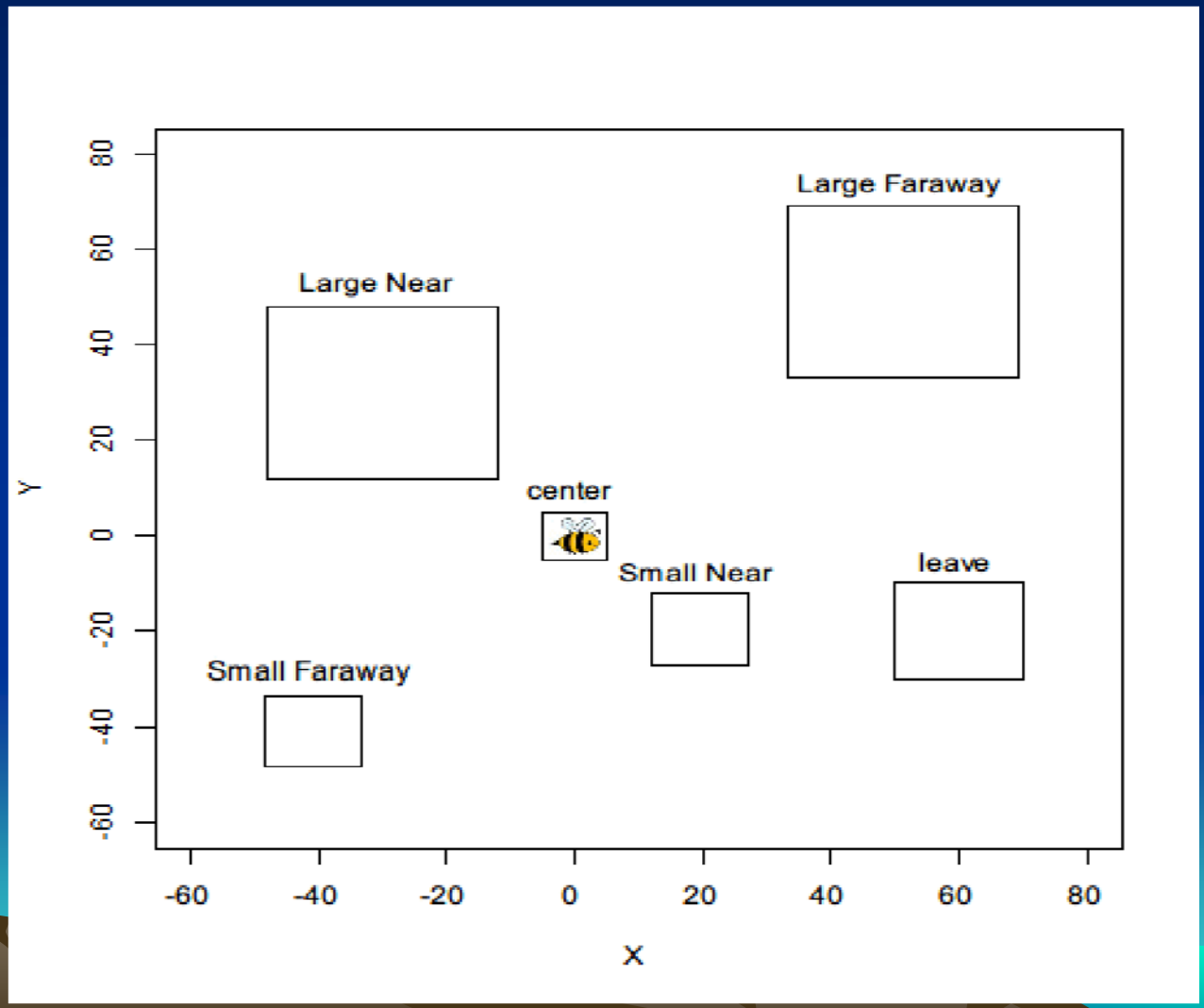
Management Practices and gene flow

- Tripping rate is influenced by environmental factors
- Leafcutting bees high tripping unless temperatures are cool
- Prediction: Cold temperatures increase gene flow by leafcutting bees
- Honey bees higher tripping rates with higher temperatures
- Prediction: Higher gene flow by honey bees in PNW relative to CA?

Management practices and gene flow / coexistence

- High residence lowers gene flow
- Agricultural landscape impacts residence
- Large patches higher residence
- Far away patches higher residence
- Relative patch sizes of conventional and RR alfalfa when grown in proximity

Bee movement in a discontinuous landscape



QUESTIONS?