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Pollen movement and selection on phenological traits within time and space in self-incompatible annual, *Brassica rapa*

L. C. Leventhal, K.J. Bai, M. Peters, E. J. Austen, A. E. Weis, J.L. Ison

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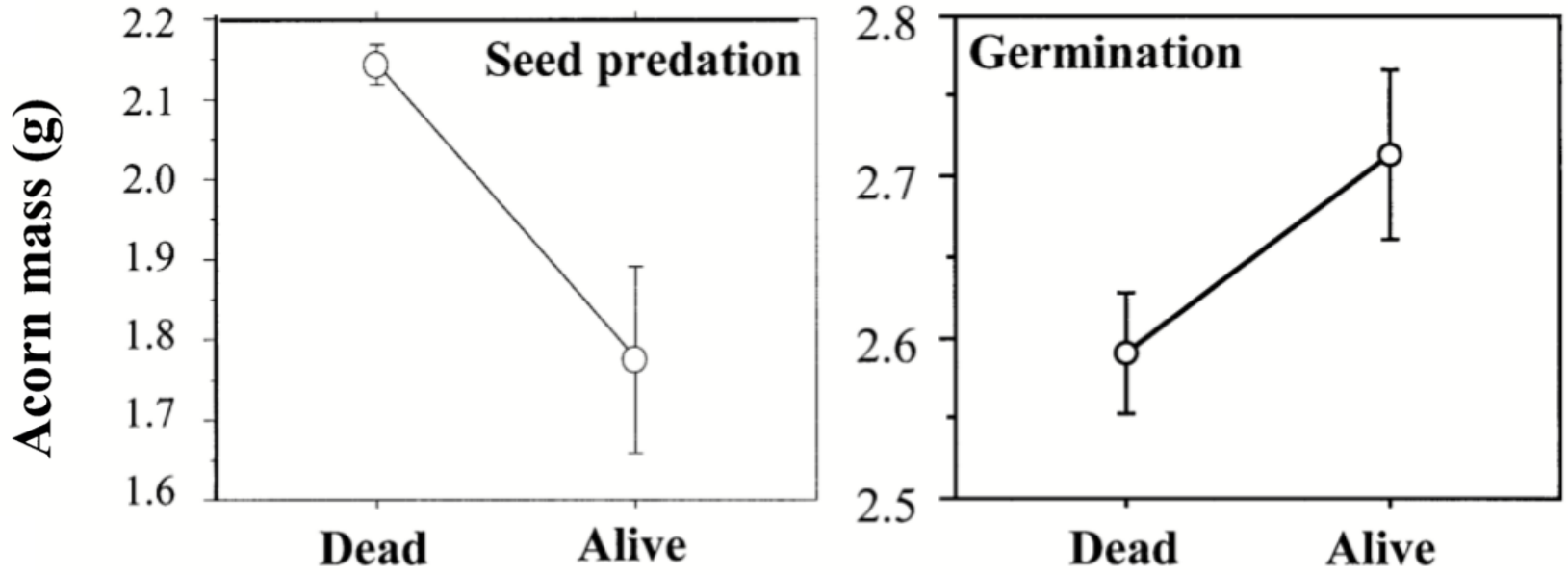
Selection is not stagnant and can change over time.



(Gomez 2004)

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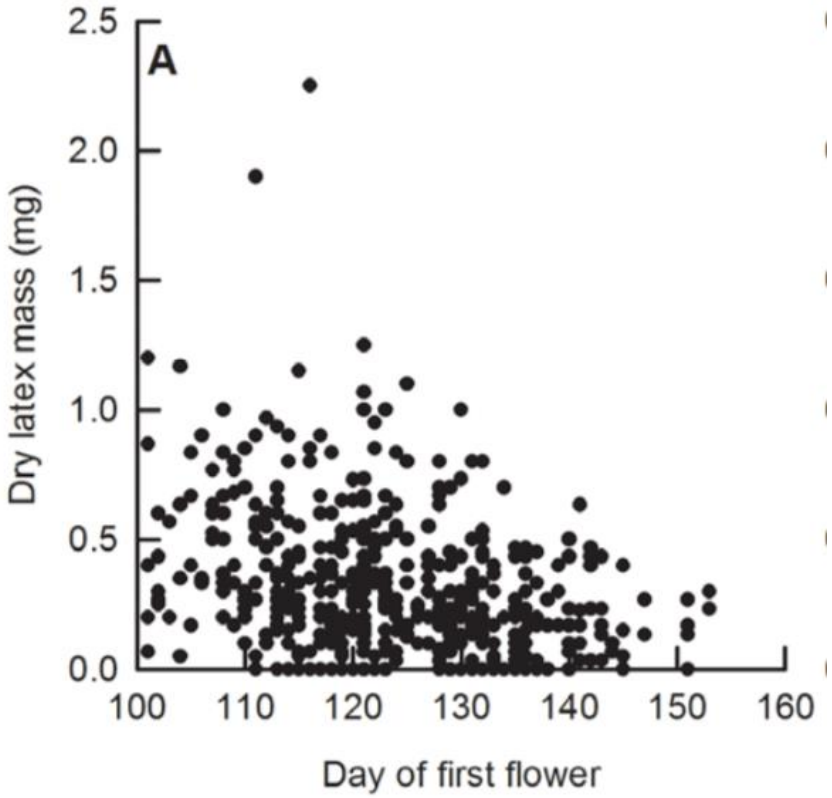
Selective pressures even change within a single reproductive season.



(Parachnowitsch et al. 2012)

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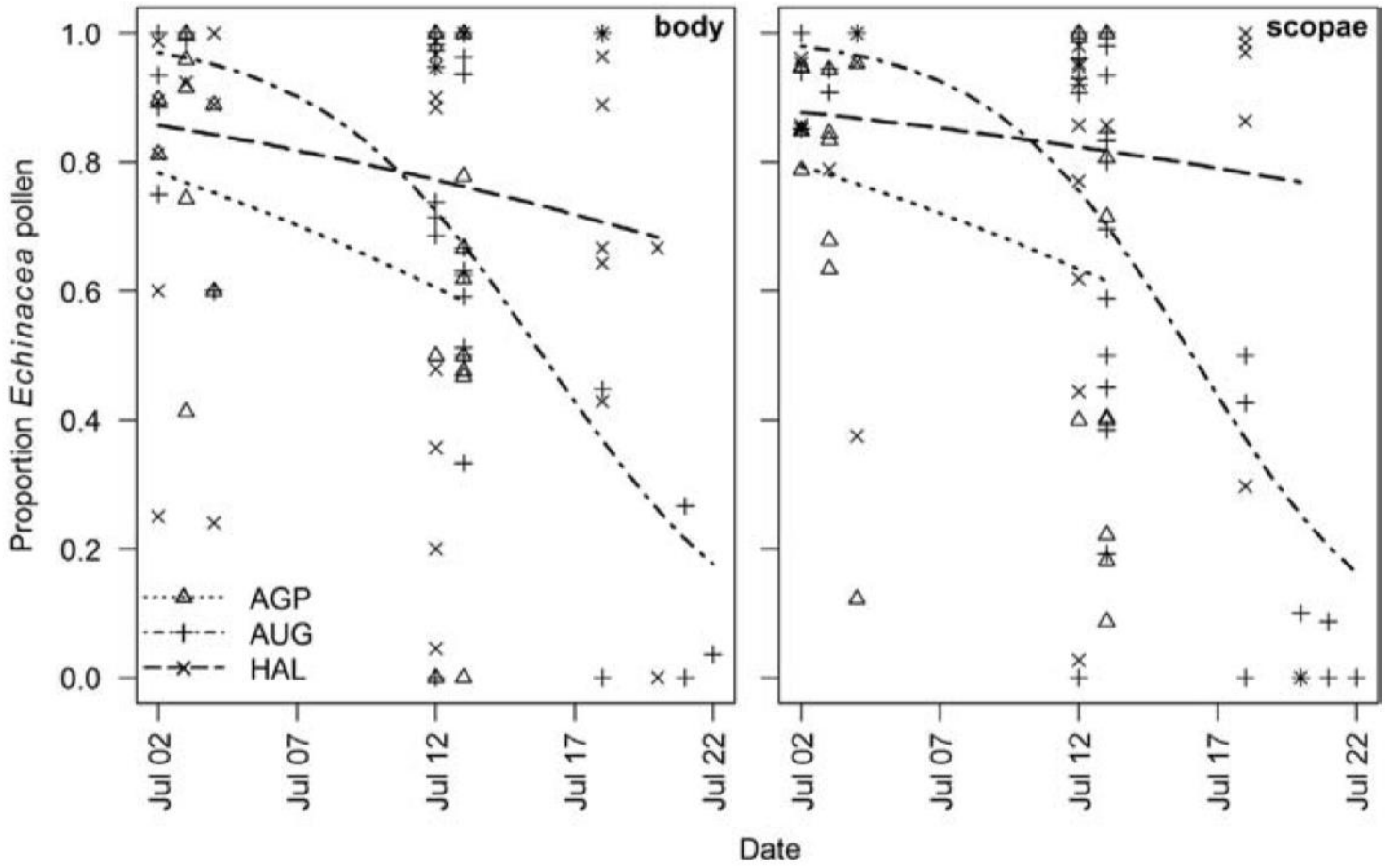
A selective pressure important for flowering plants is the pollinator community.



(Ison et. al, 2018)

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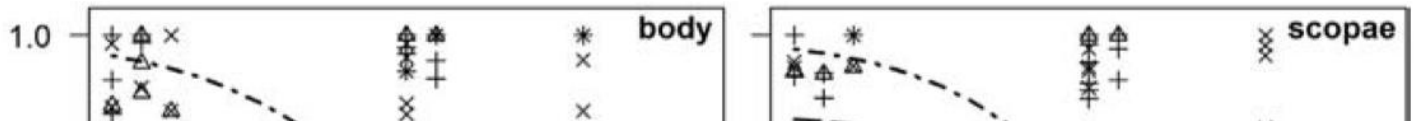
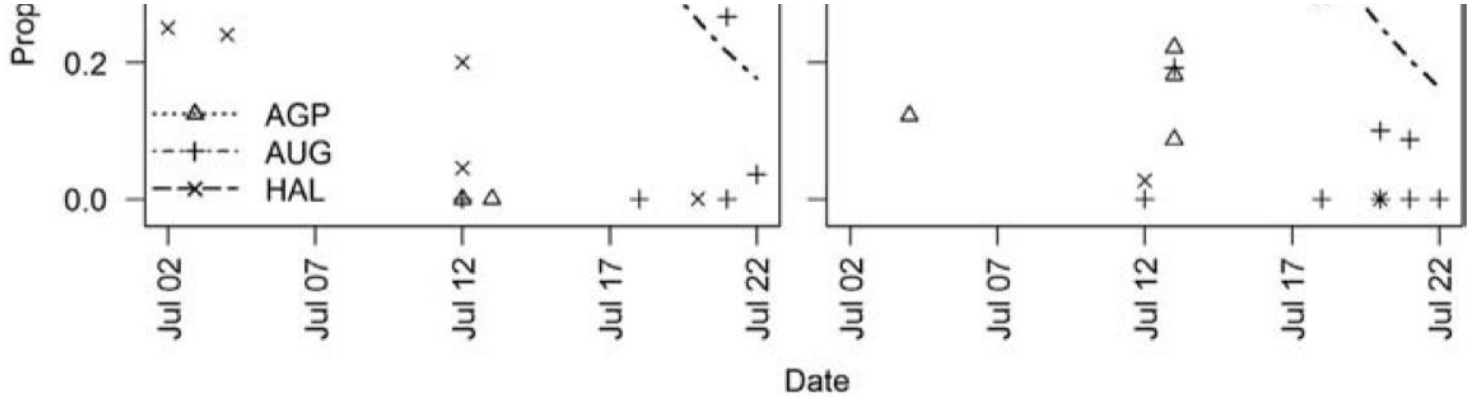
A selective pressure important for flowering plants is the pollinator community.



We do not know how a changing pollinator community within a single season impacts gene flow and male fitness.



(Ison et. al, 2018)

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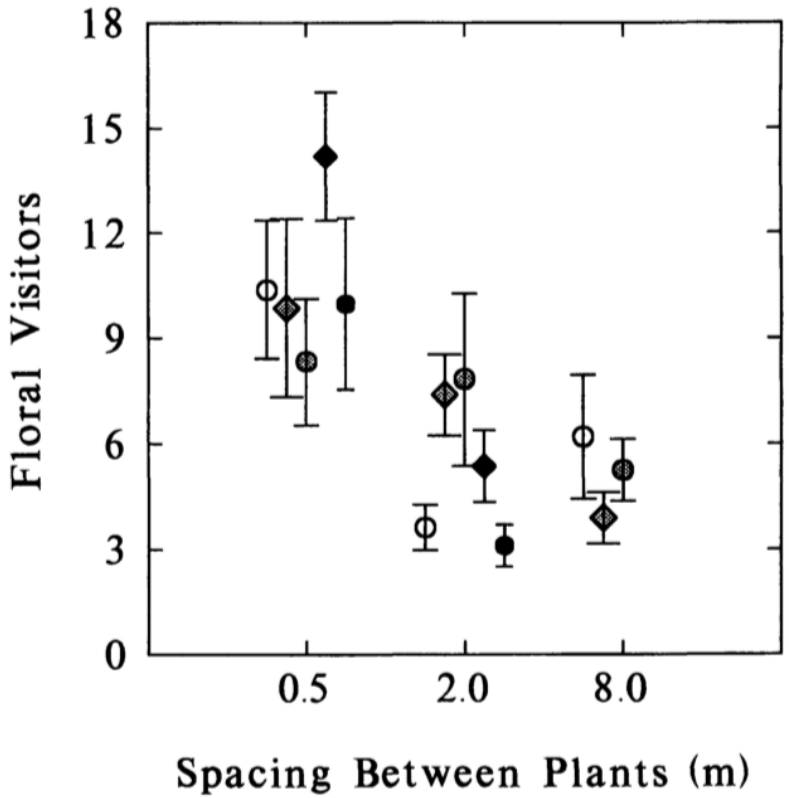
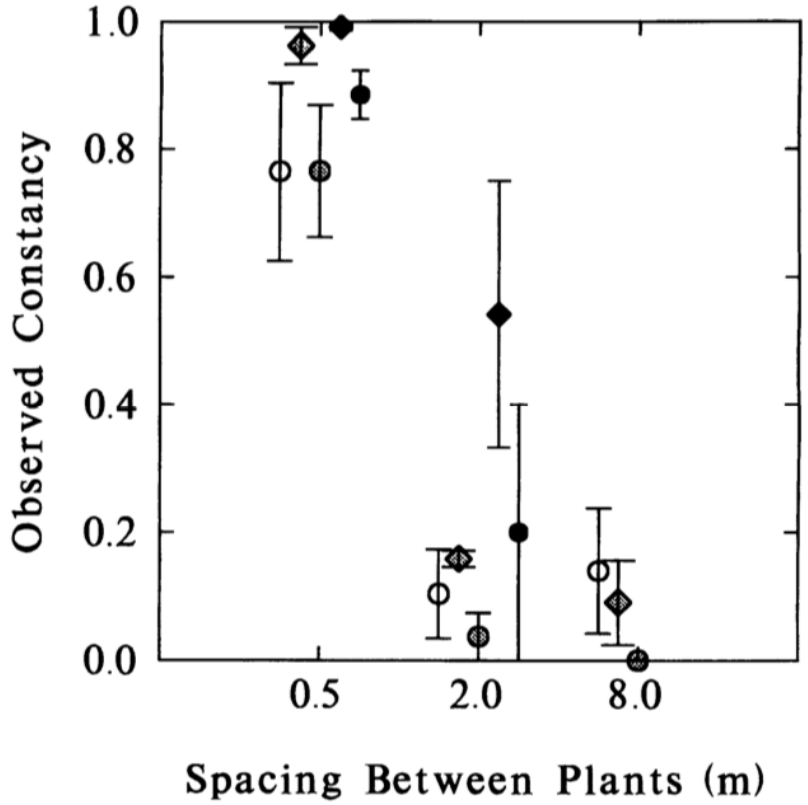
Pollinator behavior can also be influenced by the spatial density of plants.





(Kunin 1997)

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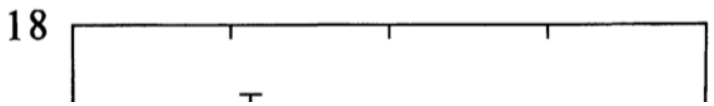
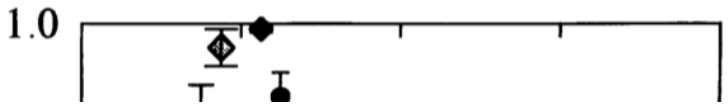
Pollinator behavior and gene flow can also be influenced by the spatial density of plants.





Together, we do not know how the spatial arrangement and the time within a single reproductive season **interact,** scale to gene flow, and affect male fitness for flowering plants.

Spacing Between Plants (m)

Spacing Between Plants (m)

(Kunin 1997)

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Brassica rapa

- Annual obligate out-crosser
- Hermaphroditic and self-incompatible
- Naturalized in North America
- Germinates in the spring
- Pollinated by bees in the Apidae and Halictiae family and flies in the Syrphidae family

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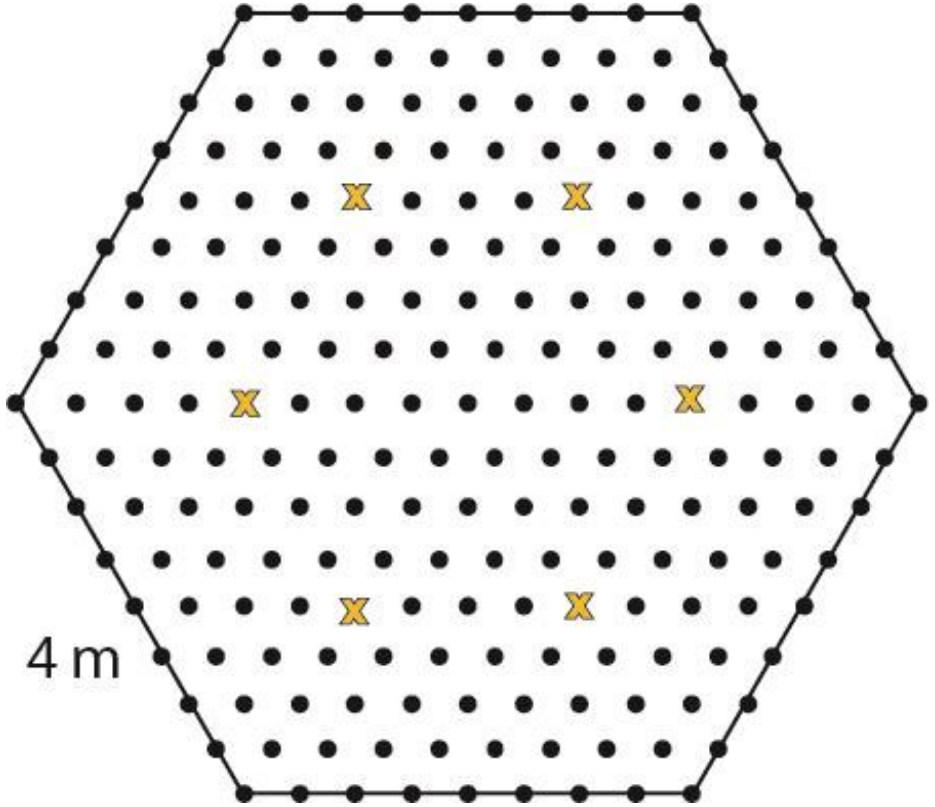
Field design: Space

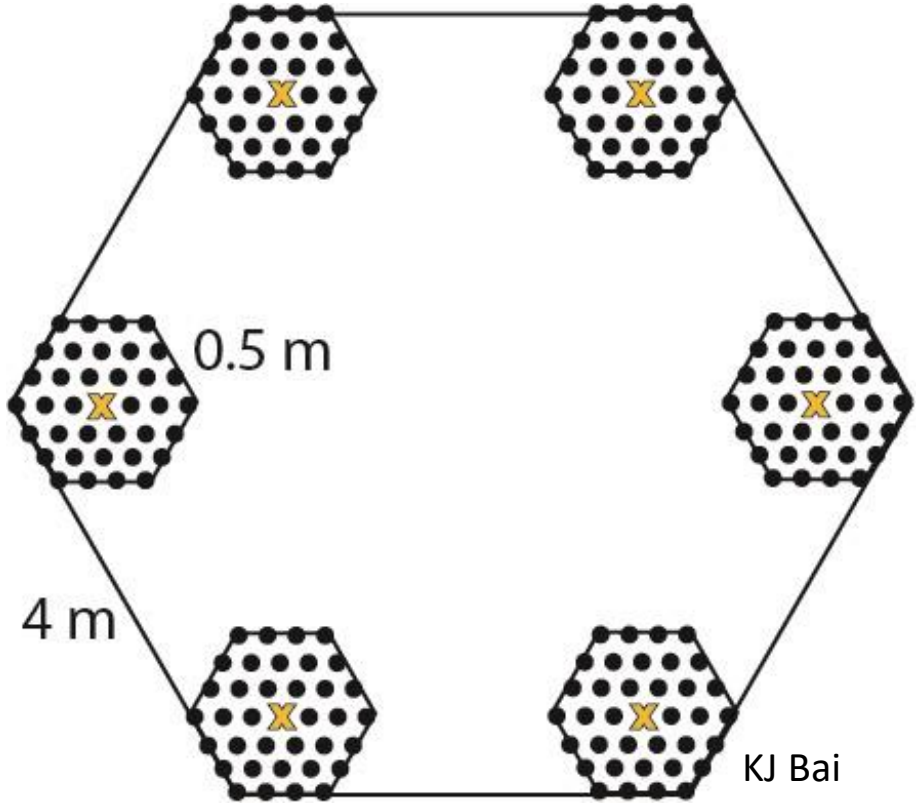
● Pollen donor
X Pollen receiver (genetrap)

Even



211 individuals

Clumped



216 individuals

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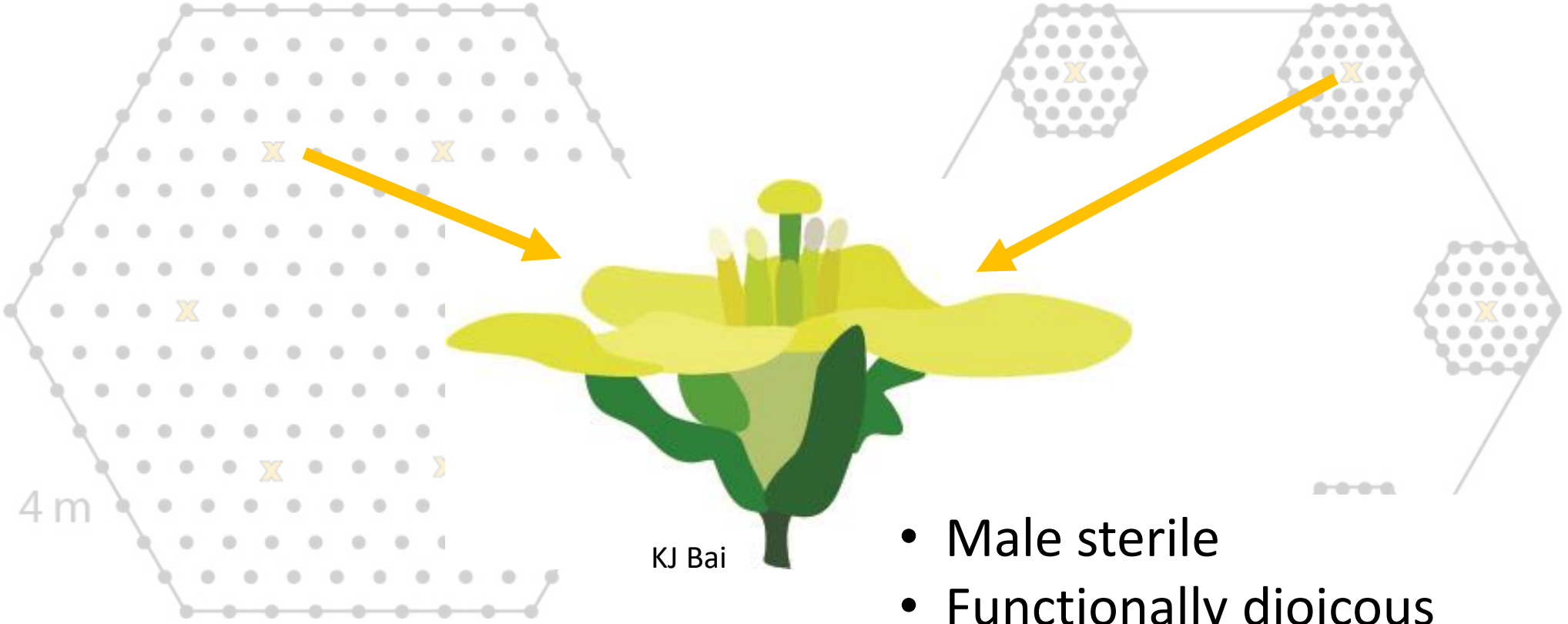
Field design: Time—“Genetraps”



- Male sterile
- Functionally dioicous
- Maternal “genetraps”

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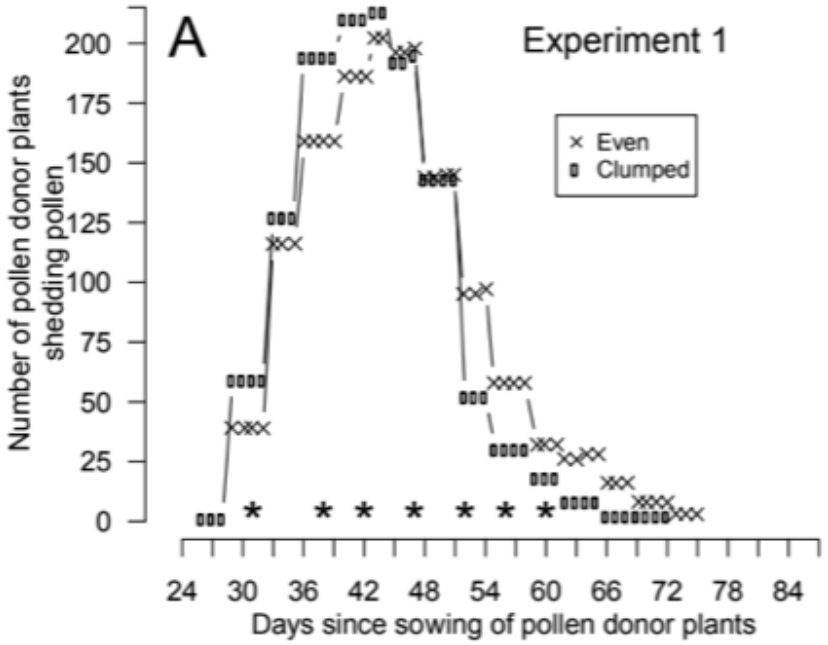
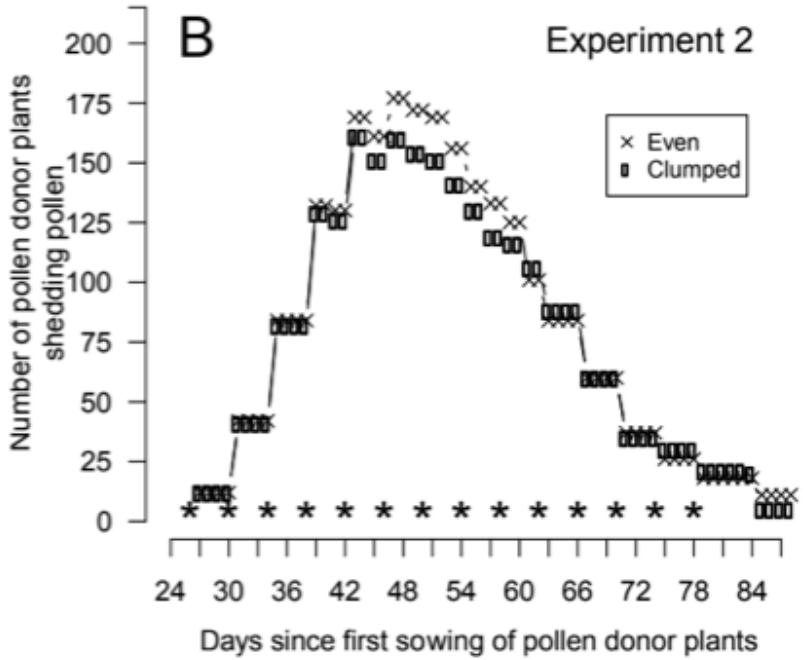
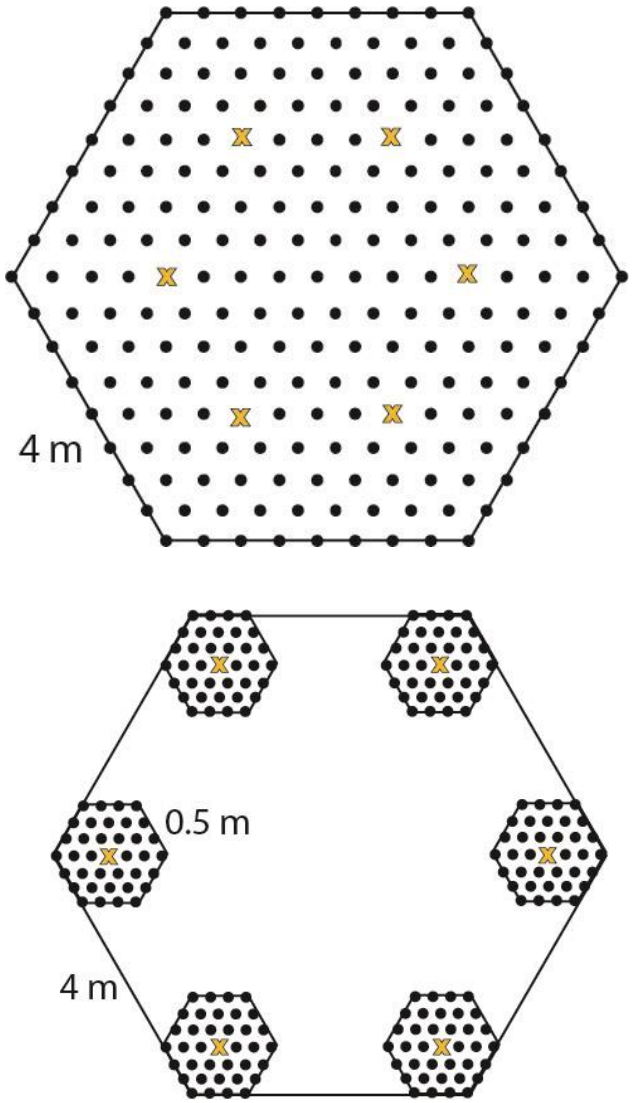
Field design: Time—"Genetraps"







(Ison and Weis, 2017)

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Parameters of interest:

- Start date of flowering
- Total number of flowers
- Duration of flowering

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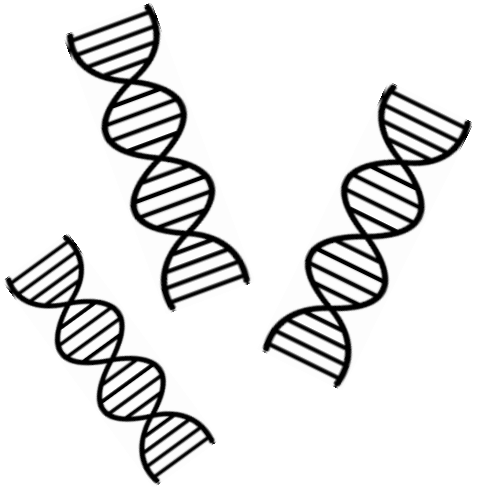
From Field to Lab to R

From the field:

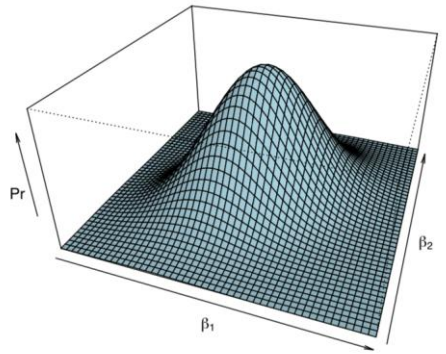
- 2064 offspring
- 287 “maternal-genetraps”
- 860 pollen donors

KJ Bai

Genotyped at 10 microsatellite loci—DNA fingerprinting



Using R-package, MasterBayes, reconstructed pedigrees and assigned proportional paternity



(Hadfield, 2012)

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Research questions

1) How does spatial aggregation impact pollen movement over the course of the flowering season?

2) How does directional selection on phenological traits change over the flowering season?

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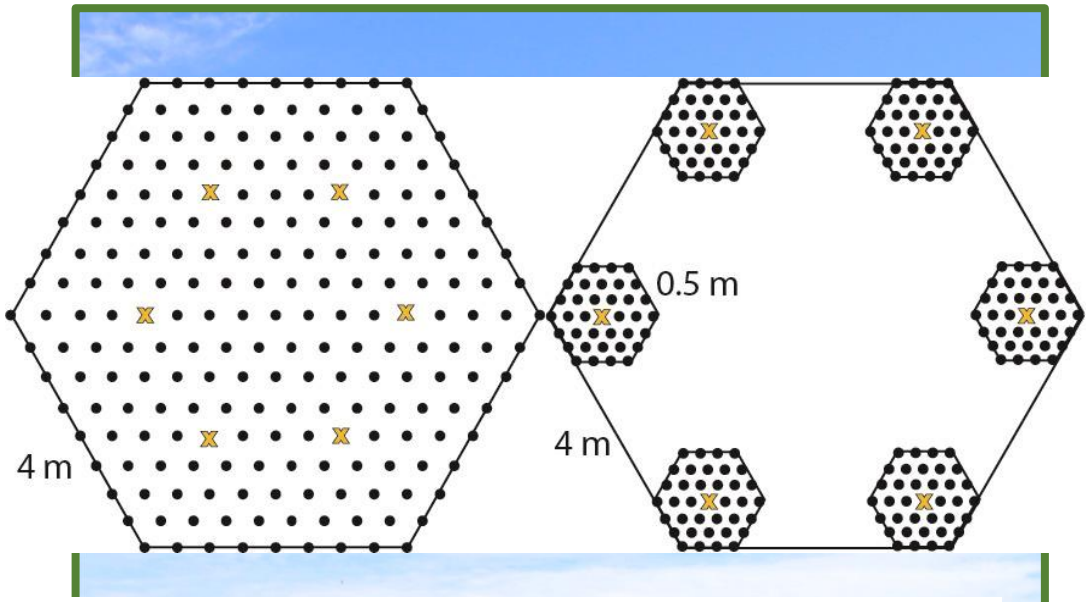
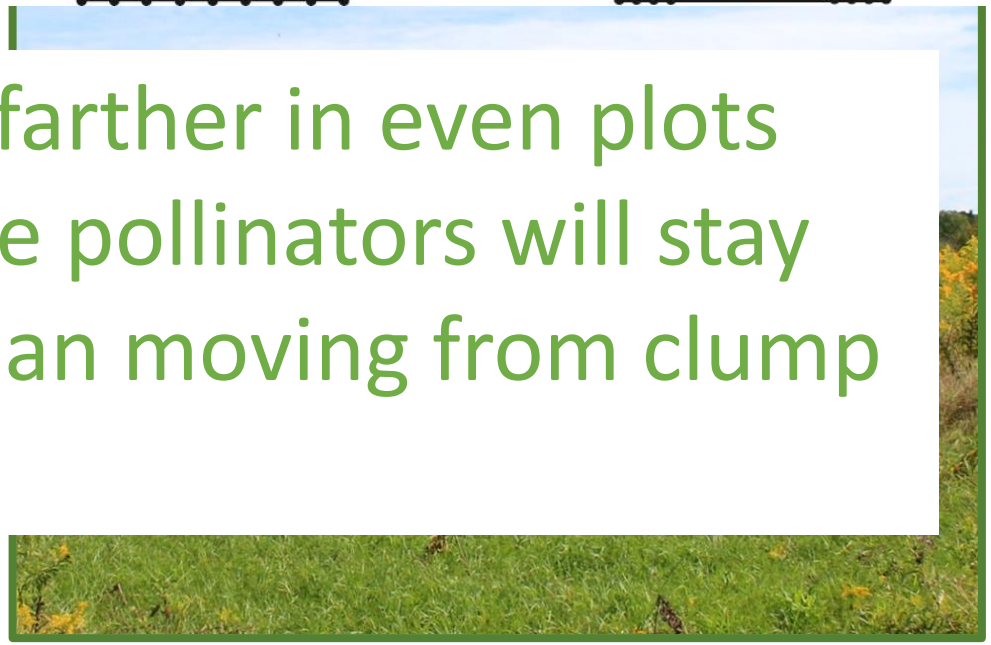


We predict that pollen will move farther in even plots than in clumped plots because the pollinators will stay within a clump of plants rather than moving from clump to clump.



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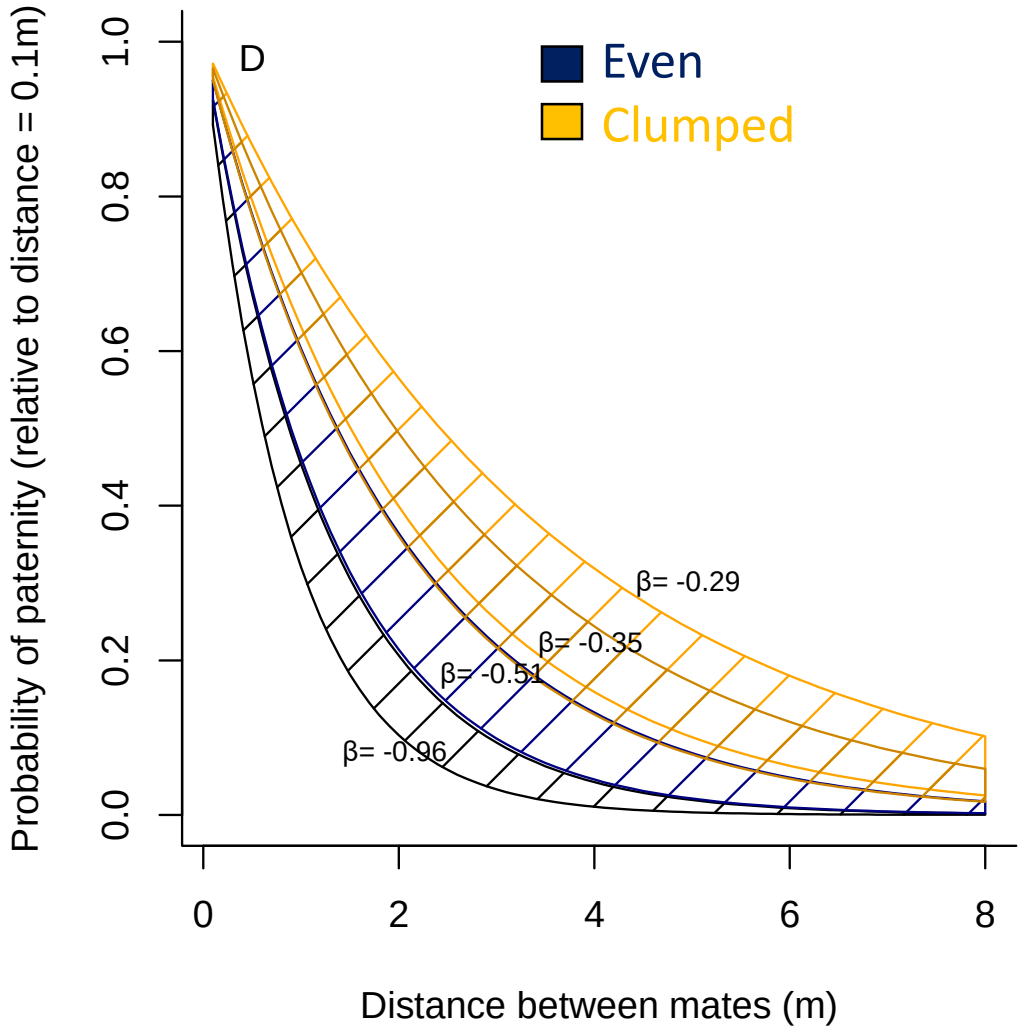
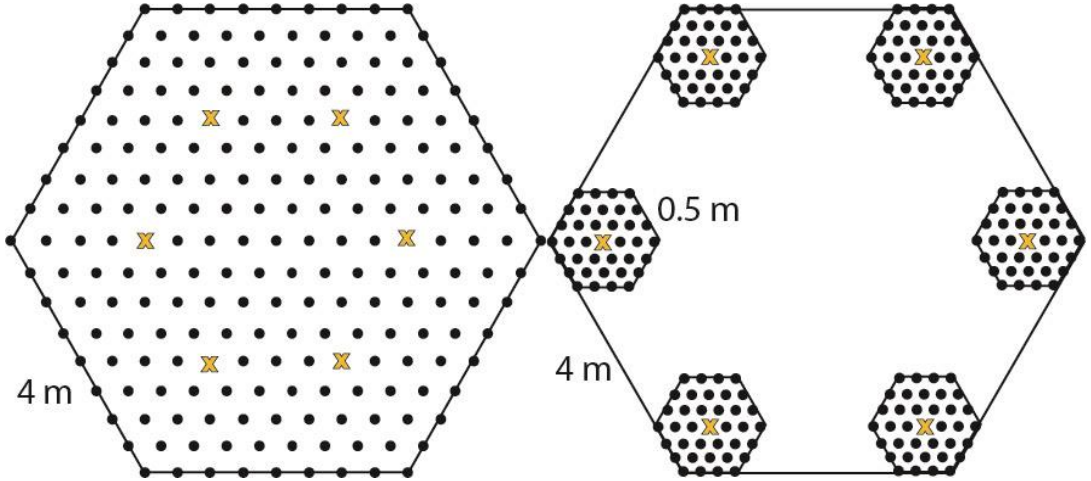
Pollen moves farther in clumped plots than in even plots





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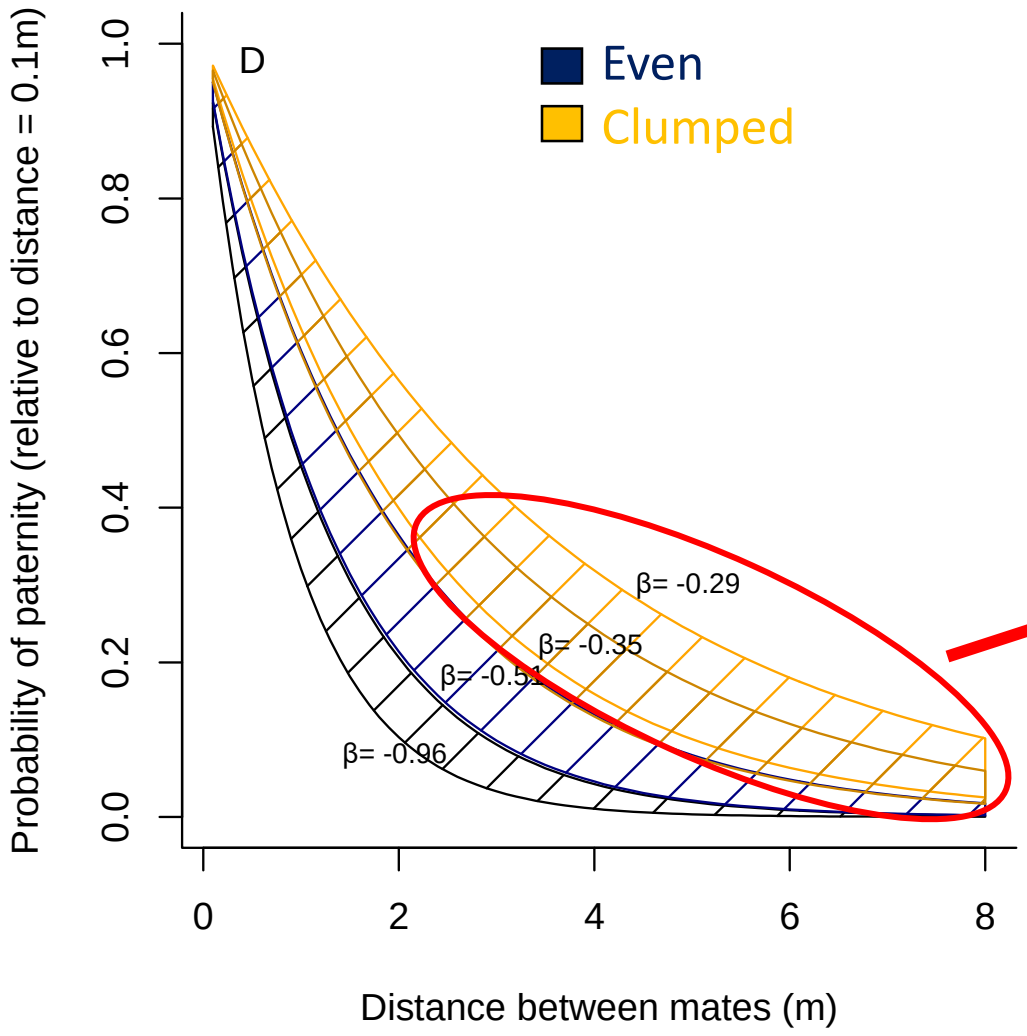
Pollen moves farther in clumped plots than in even plots



Higher probability of being the pollen donor at a greater distance

Pollen is moving

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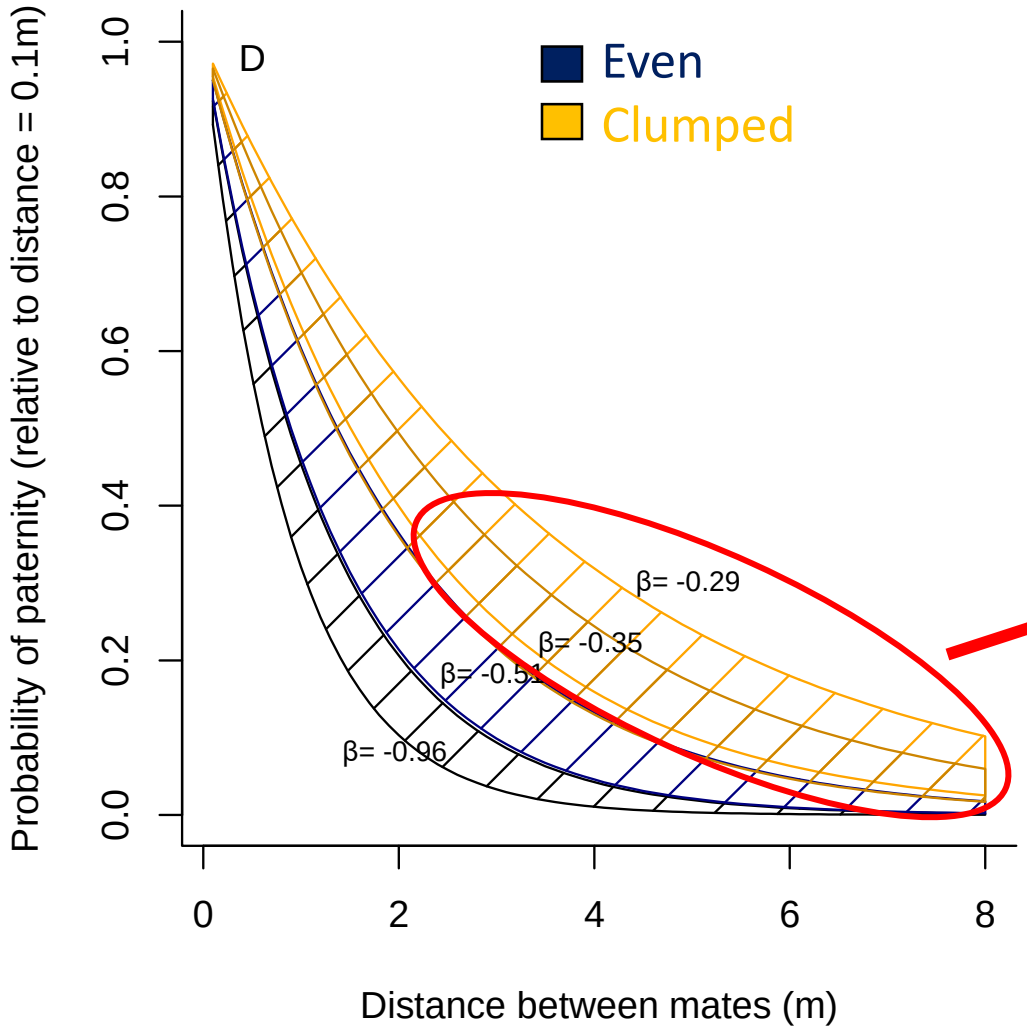
Pollen moves farther in clumped plots than in even plots



Higher probability of being the pollen donor at a greater distance

Pollen is moving **farther** in clumped plots

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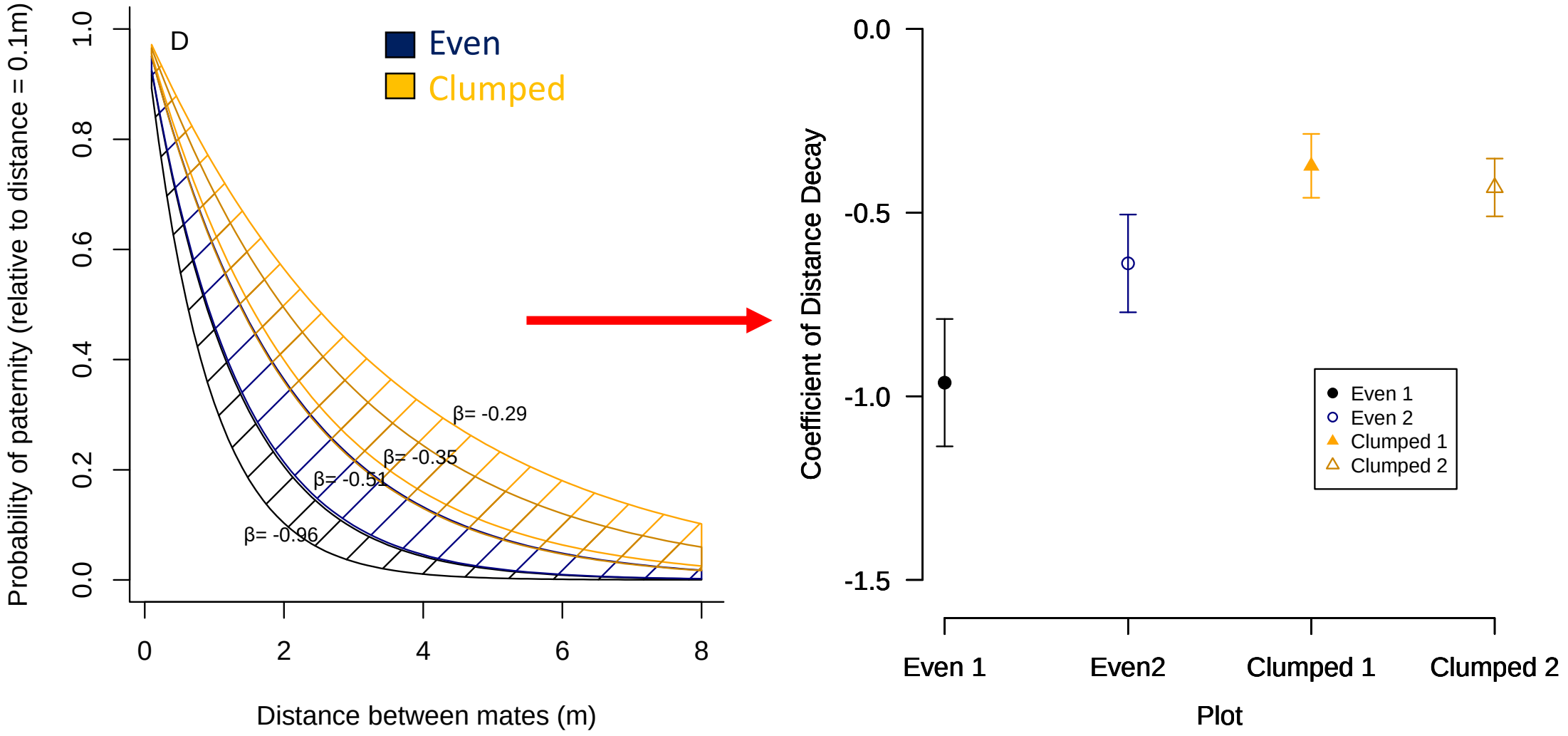
Pollen moves farther in clumped plots than in even plots



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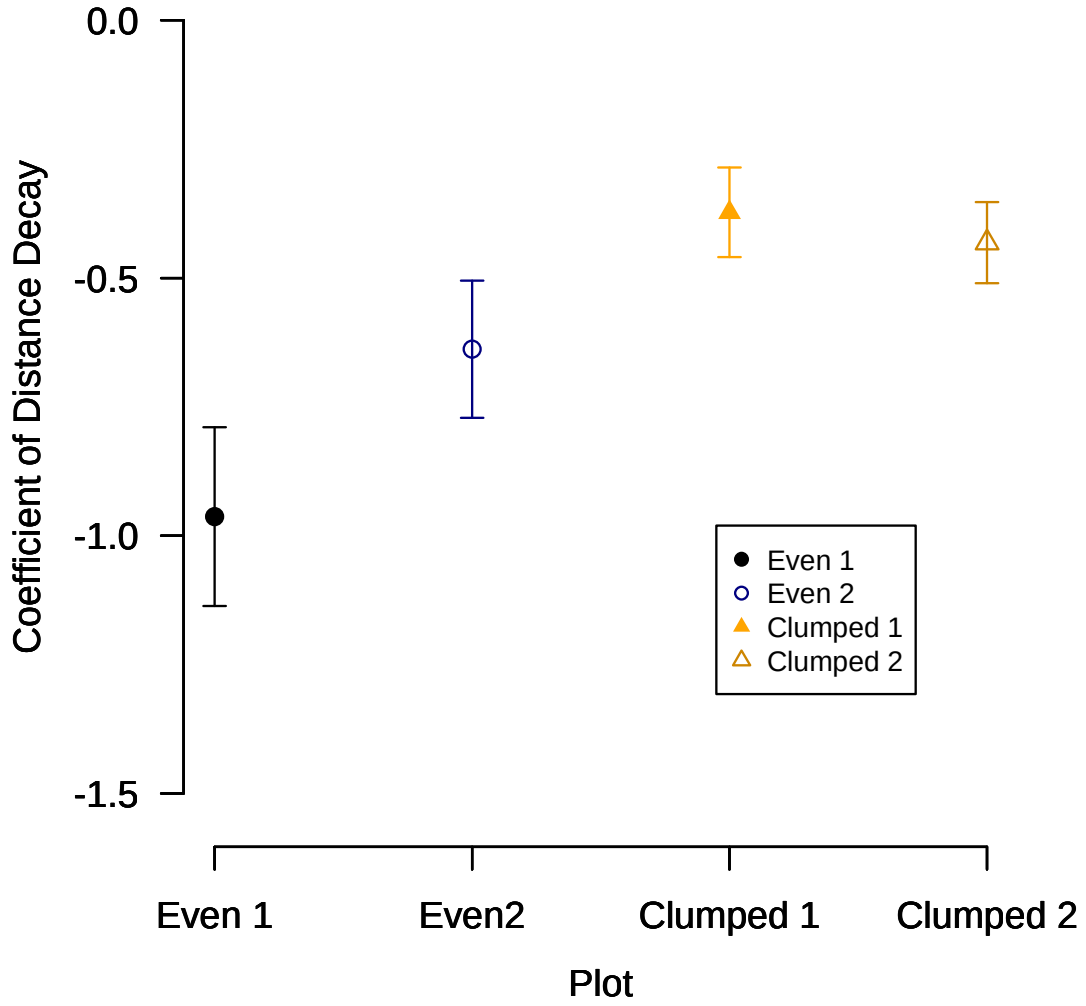
Pollen moves farther in clumped plots than in even plots

Pollen is moving longer distances

Pollen is moving shorter distances



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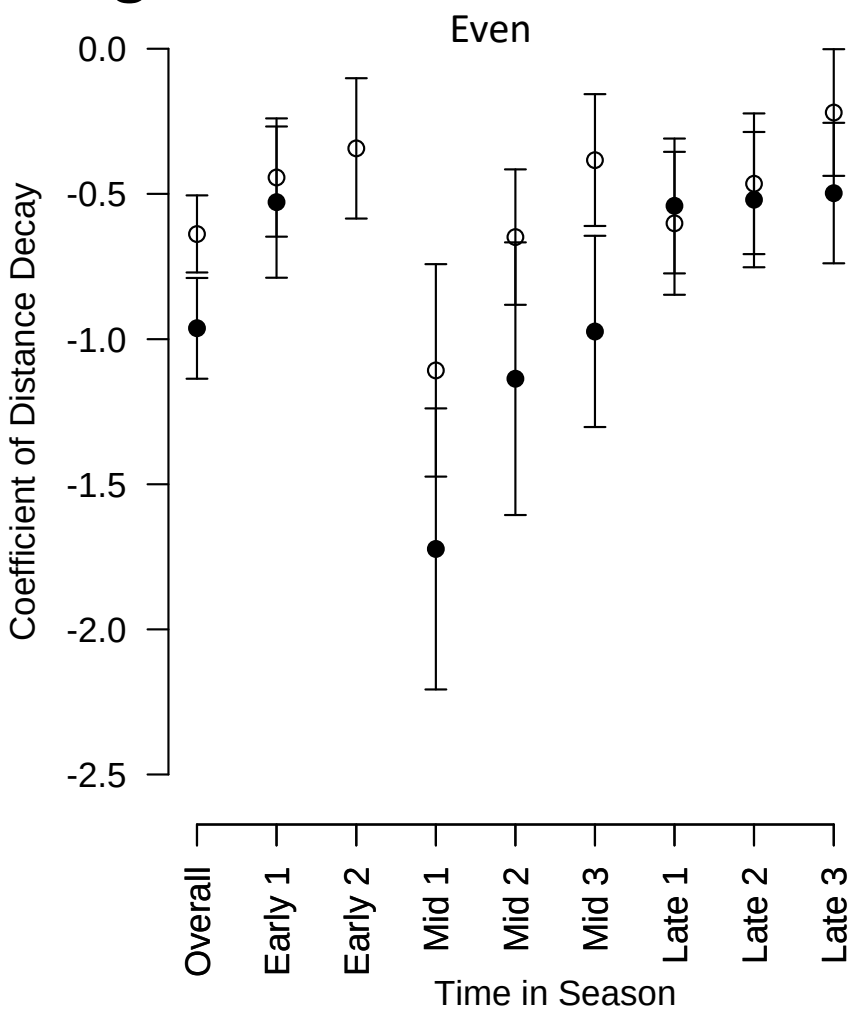
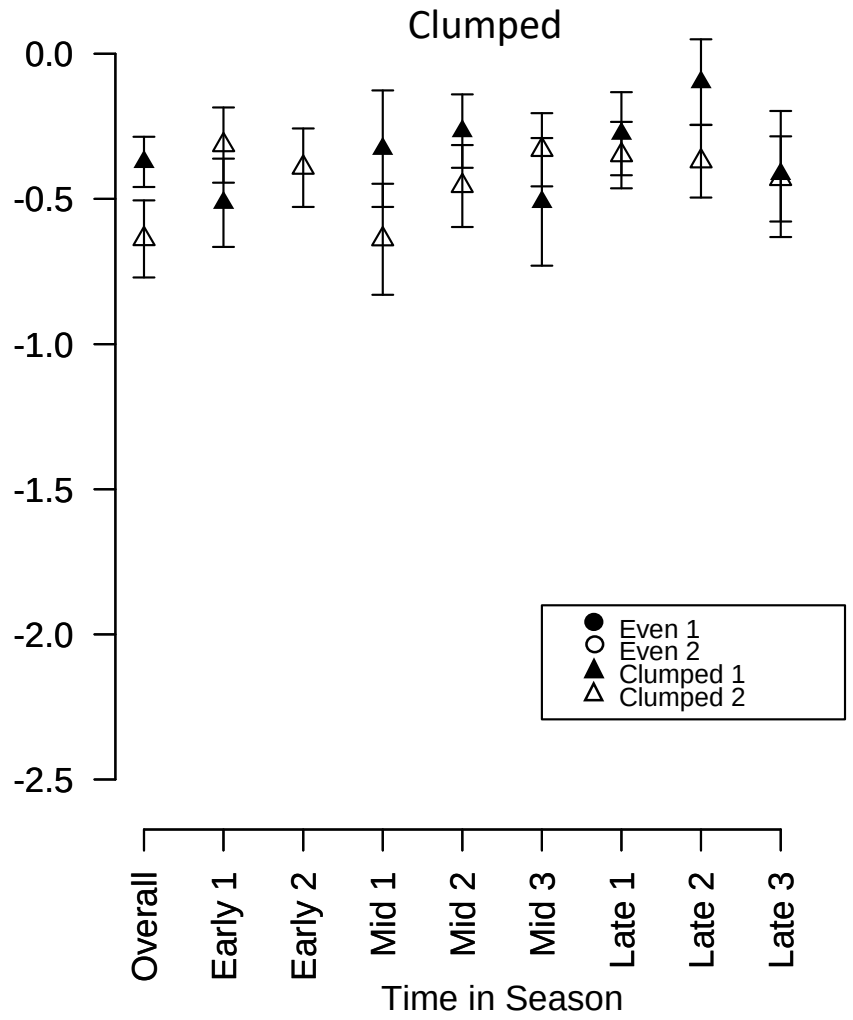
Pollen moves farther distances in clumped plots at most time intervals within a single season

Pollen is moving longer distances

Pollen is moving shorter distances





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Pollen moves farther distances in clumped plots at most time intervals within a single season

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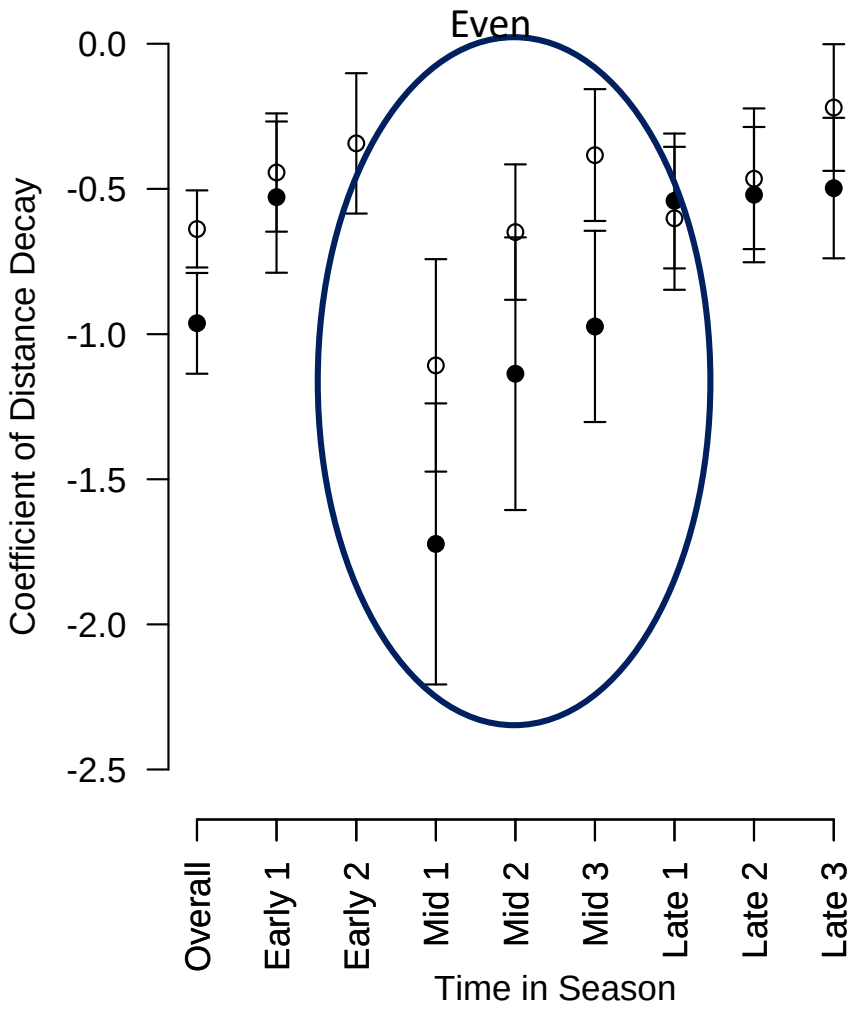

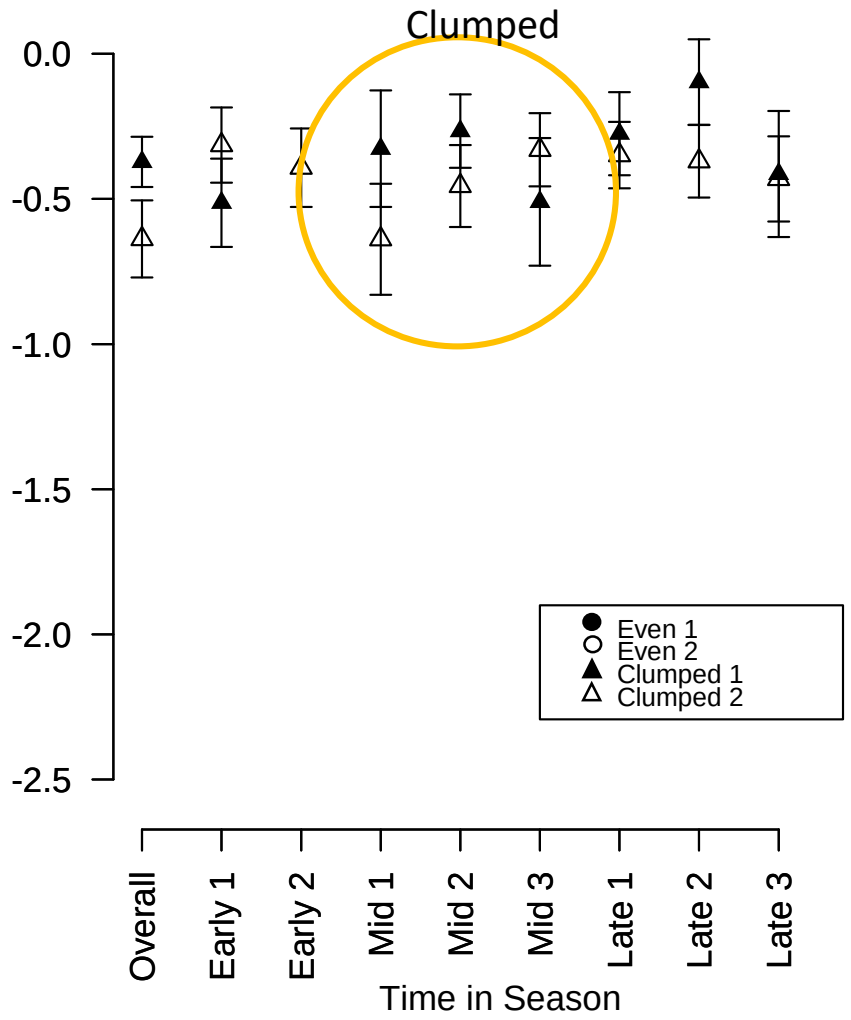

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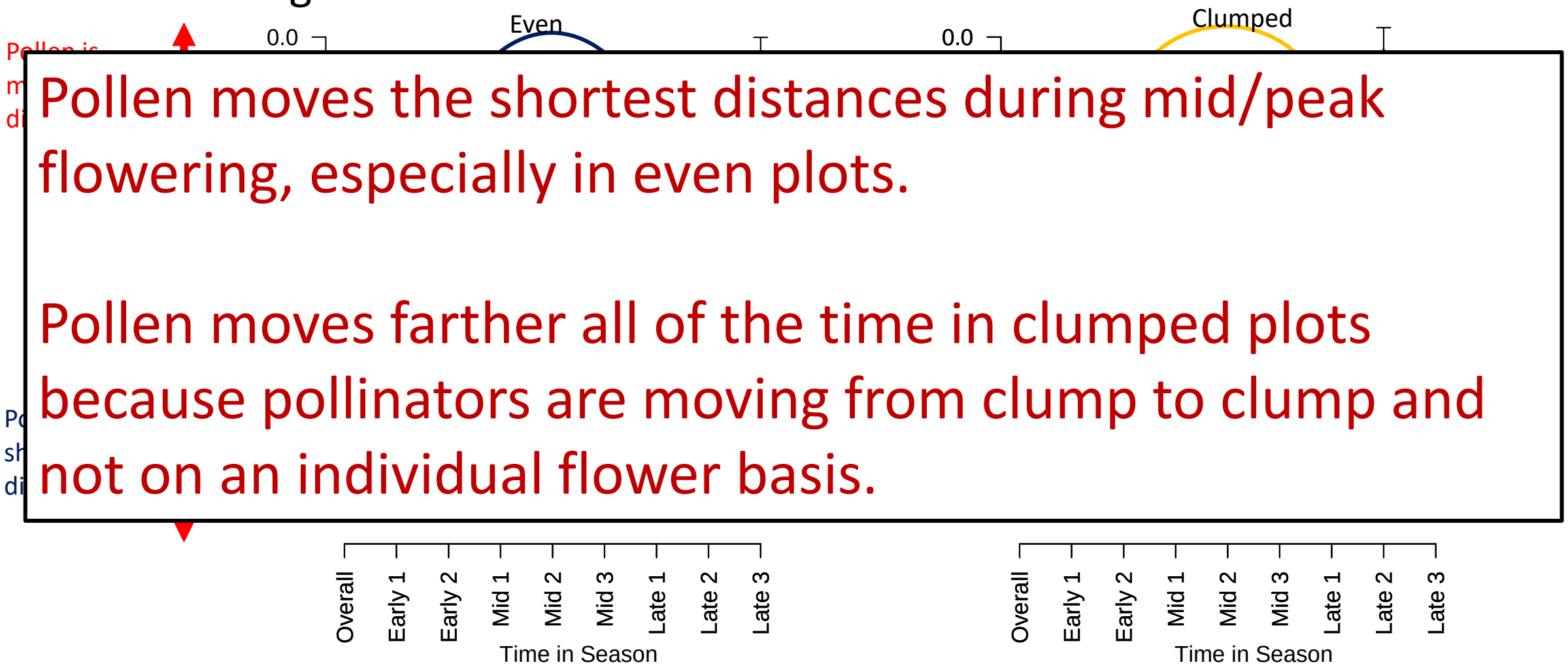
Pollen moves farther distances in clumped plots at most time intervals within a single season



Pollen moves the shortest distances during mid/peak flowering, especially in even plots.

Pollen moves farther all of the time in clumped plots because pollinators are moving from clump to clump and not on an individual flower basis.

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Research questions

1) How does spatial aggregation impact pollen movement over the course of the flowering season?

2) How does directional selection on phenological traits change over the flowering season?

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Research questions

We predict that directional selection **will change** depending on the time within the flowering season. Specifically how will it change… not sure.

2) How does directional selection on phenological traits change over the flowering season?

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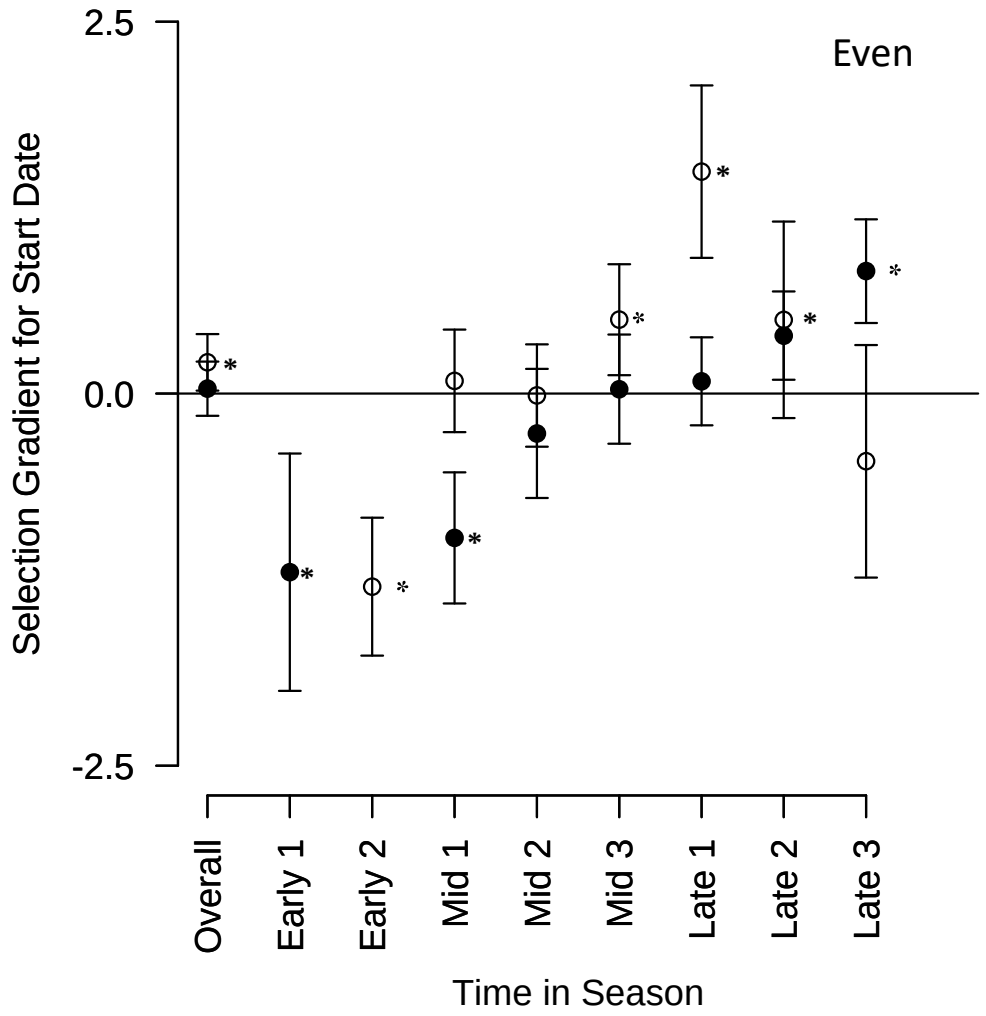
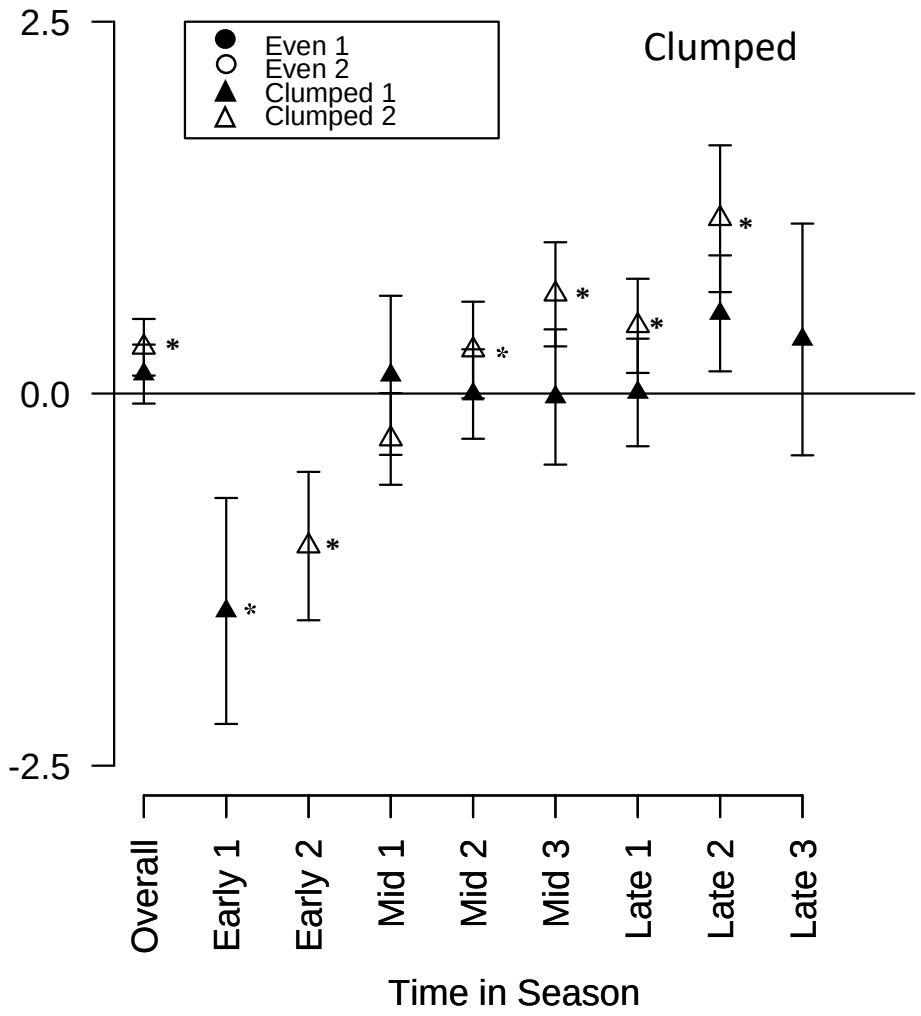
Proof of concept: directional selection for start date corresponds with time in season

Directional selection for a later start date

No directional selection

Directional selection for an earlier start date





* Indicates that the line does not cross zero

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Proof of concept: directional selection for start date corresponds with time in the season

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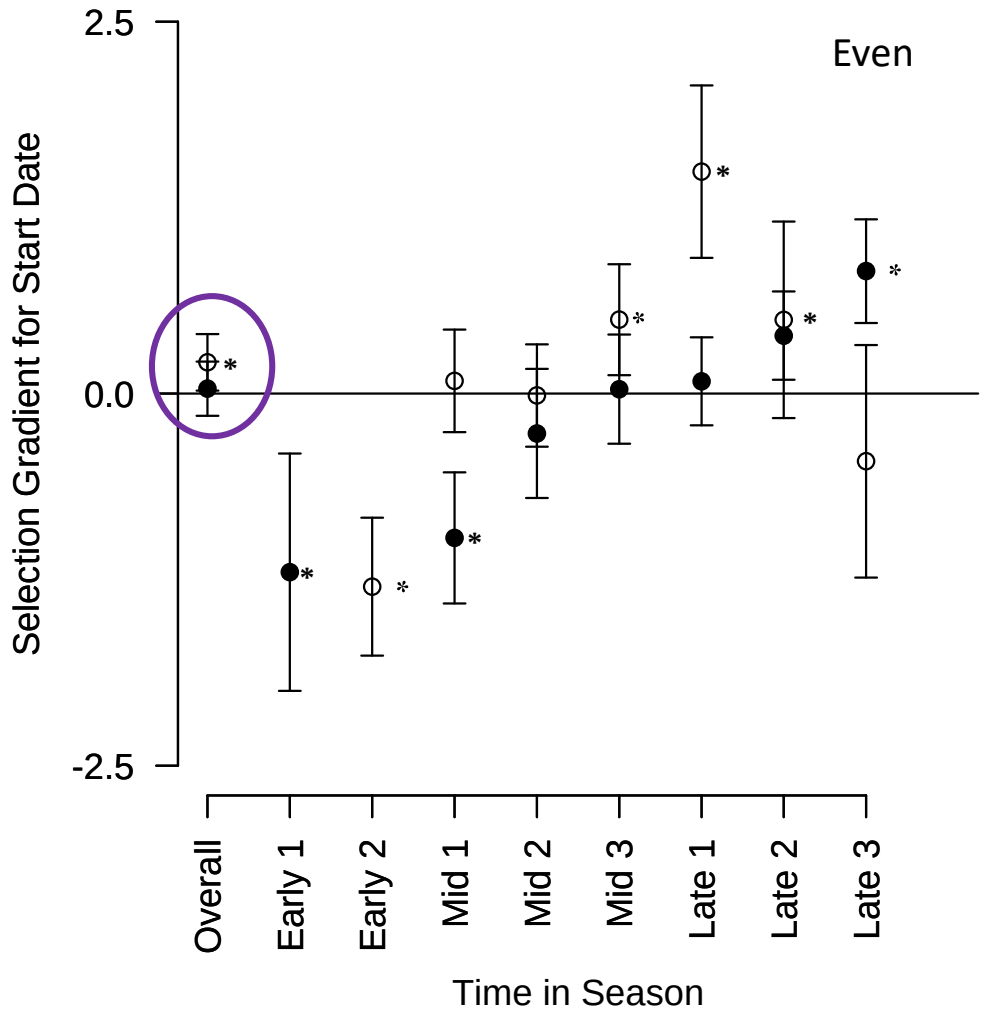

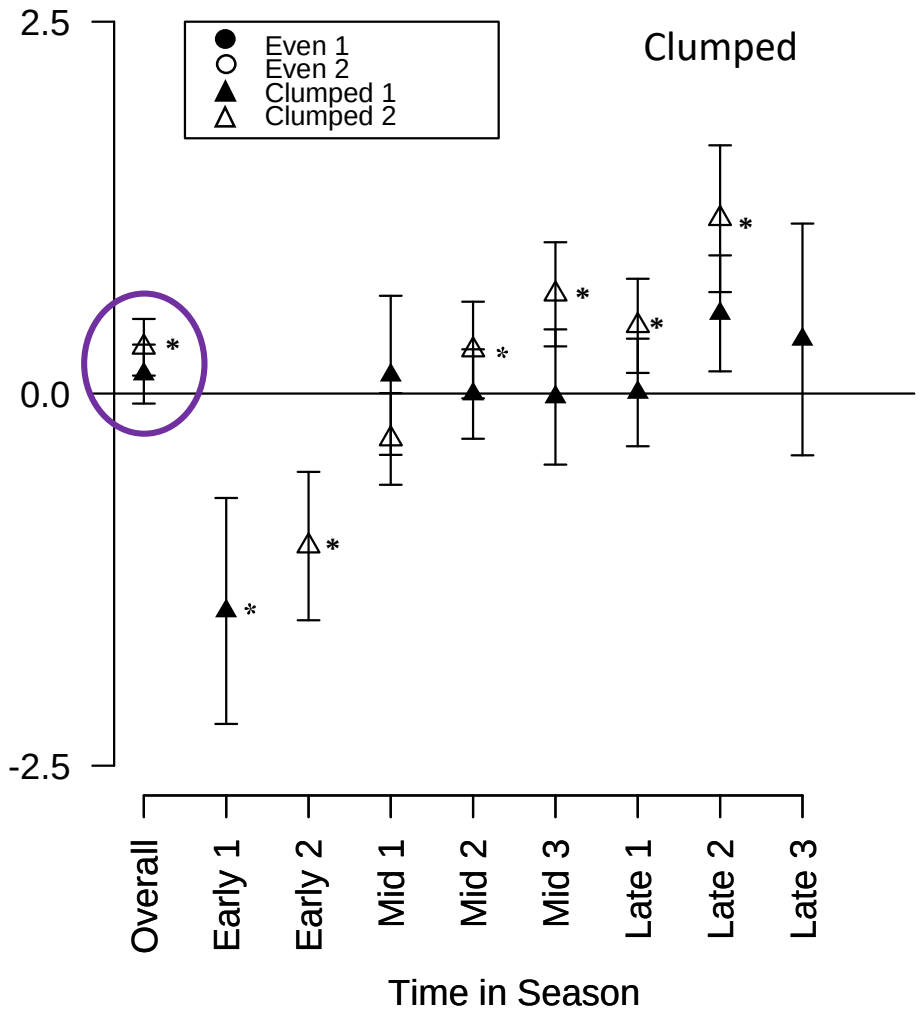

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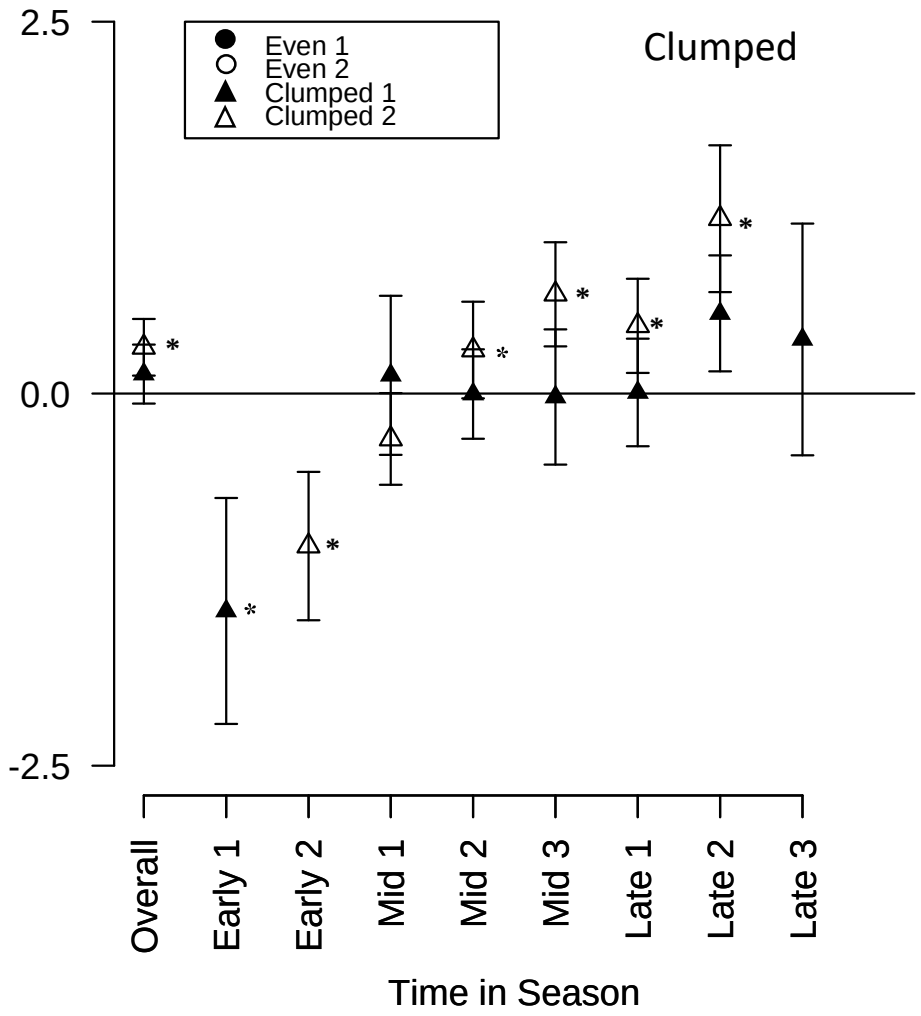
Proof of concept: directional selection for start date corresponds with time in the season

Take aways: Our interpretation of selection gradients work!

Observing directional selection (via male fitness) for a late start date in two out of four plots could suggest a potential mechanism for maintenance of flowering time variation.



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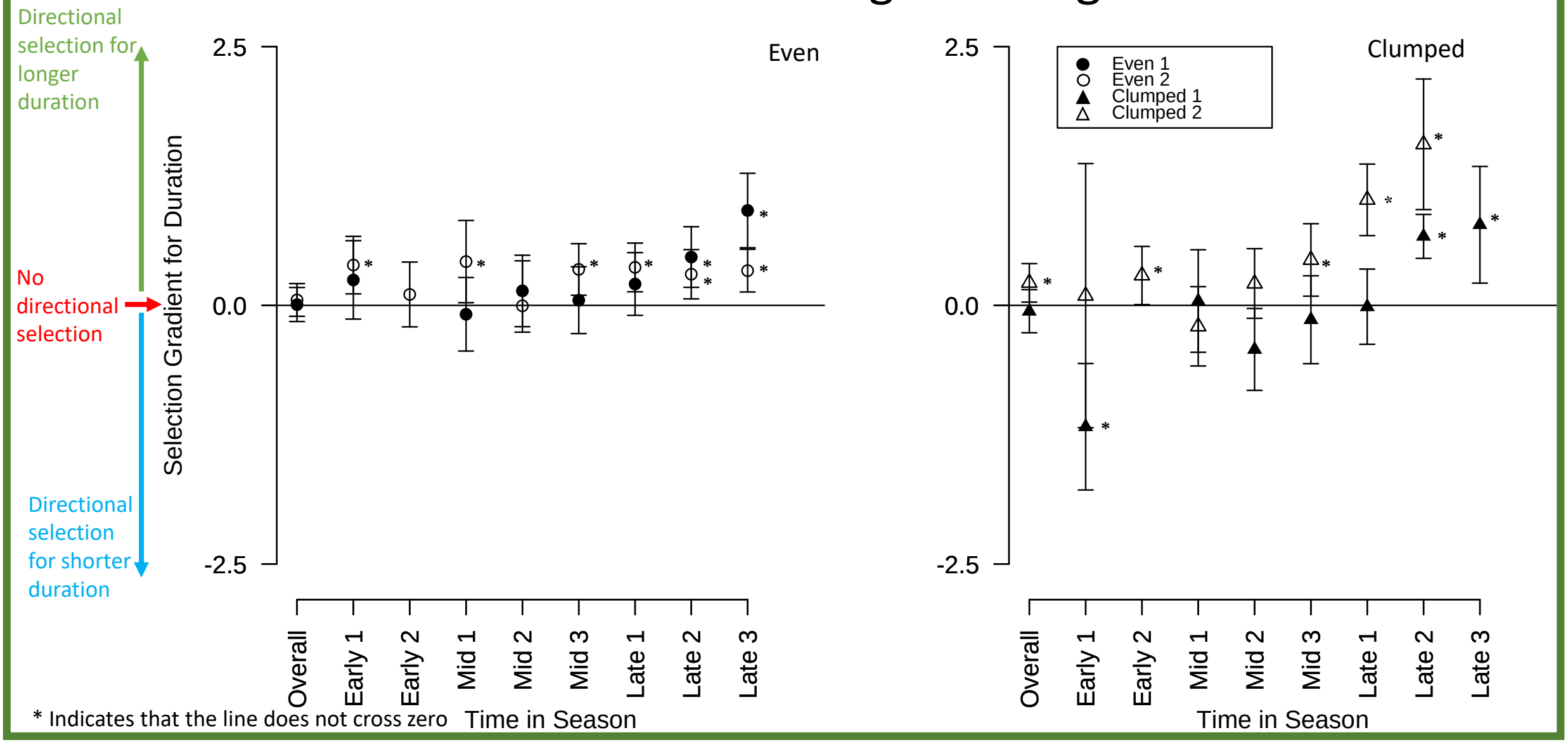
Directional selection on duration changes throughout the season



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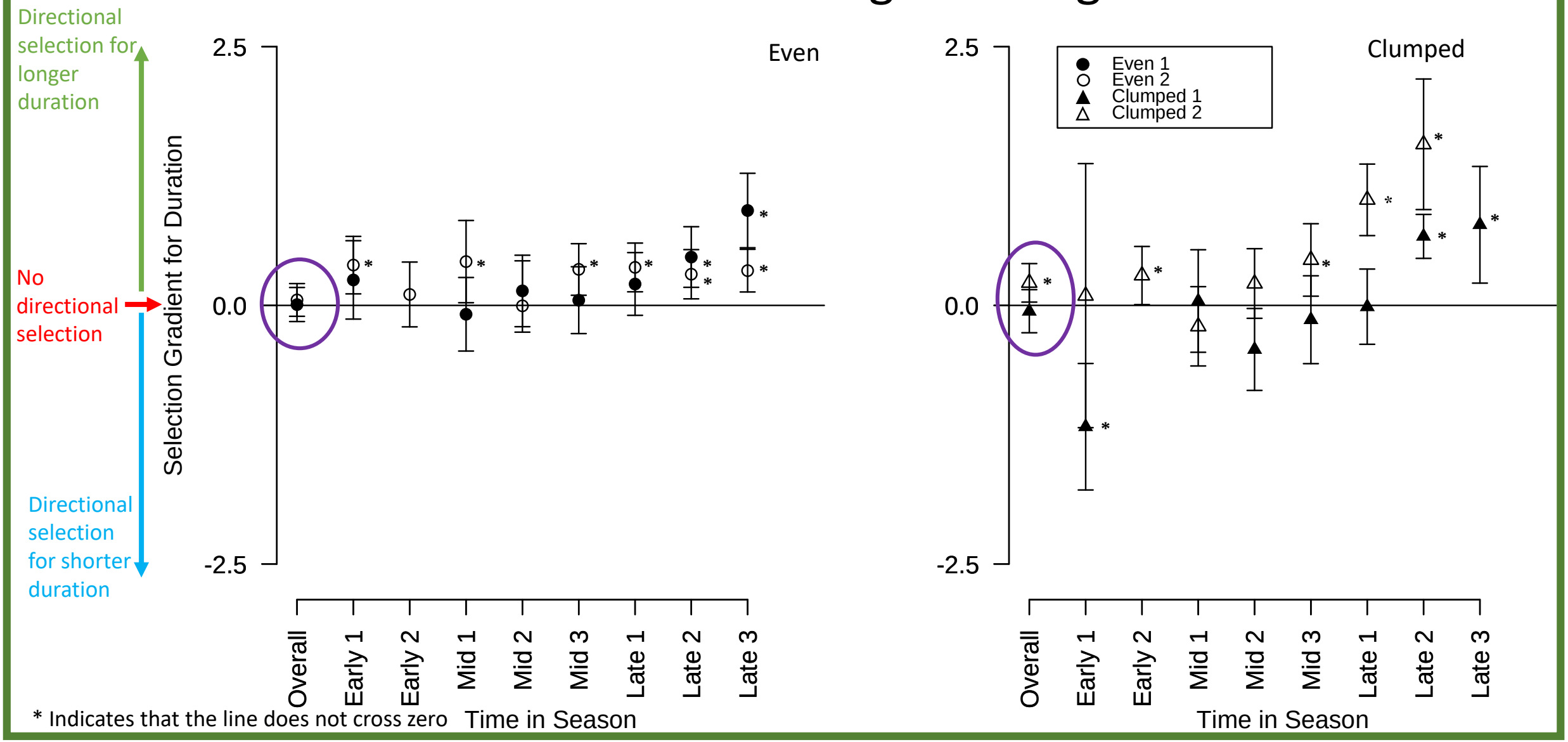

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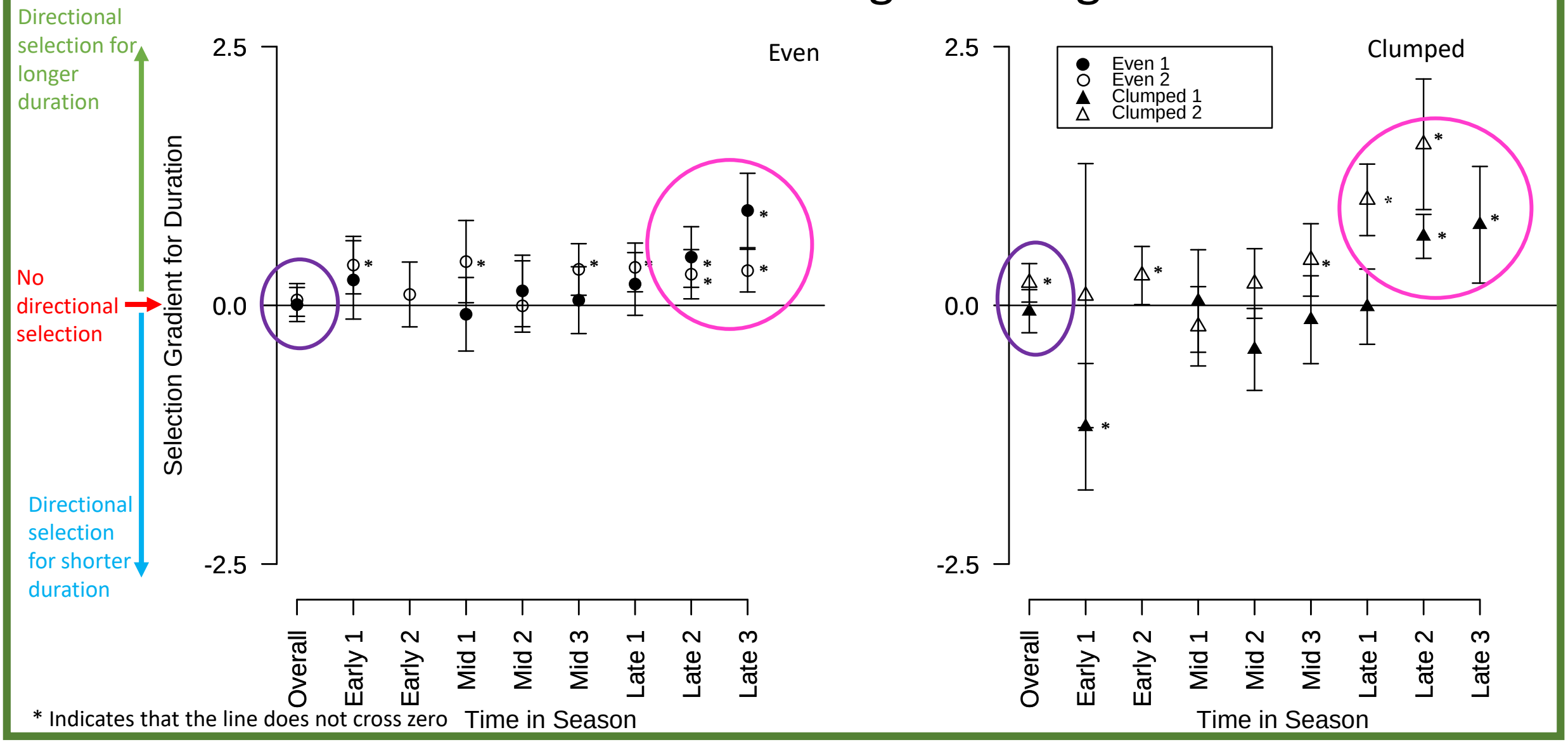

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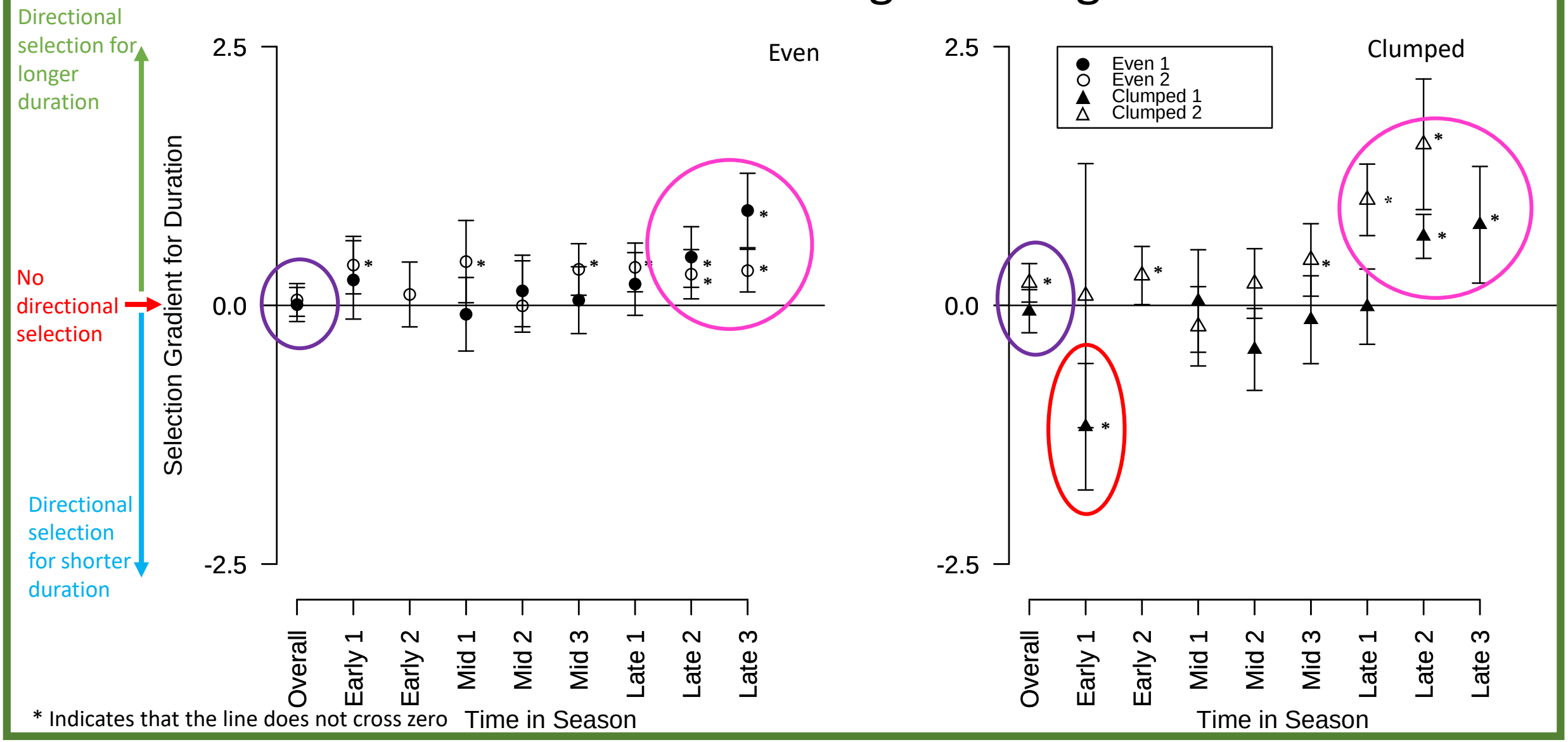
Directional selection on duration changes throughout the season



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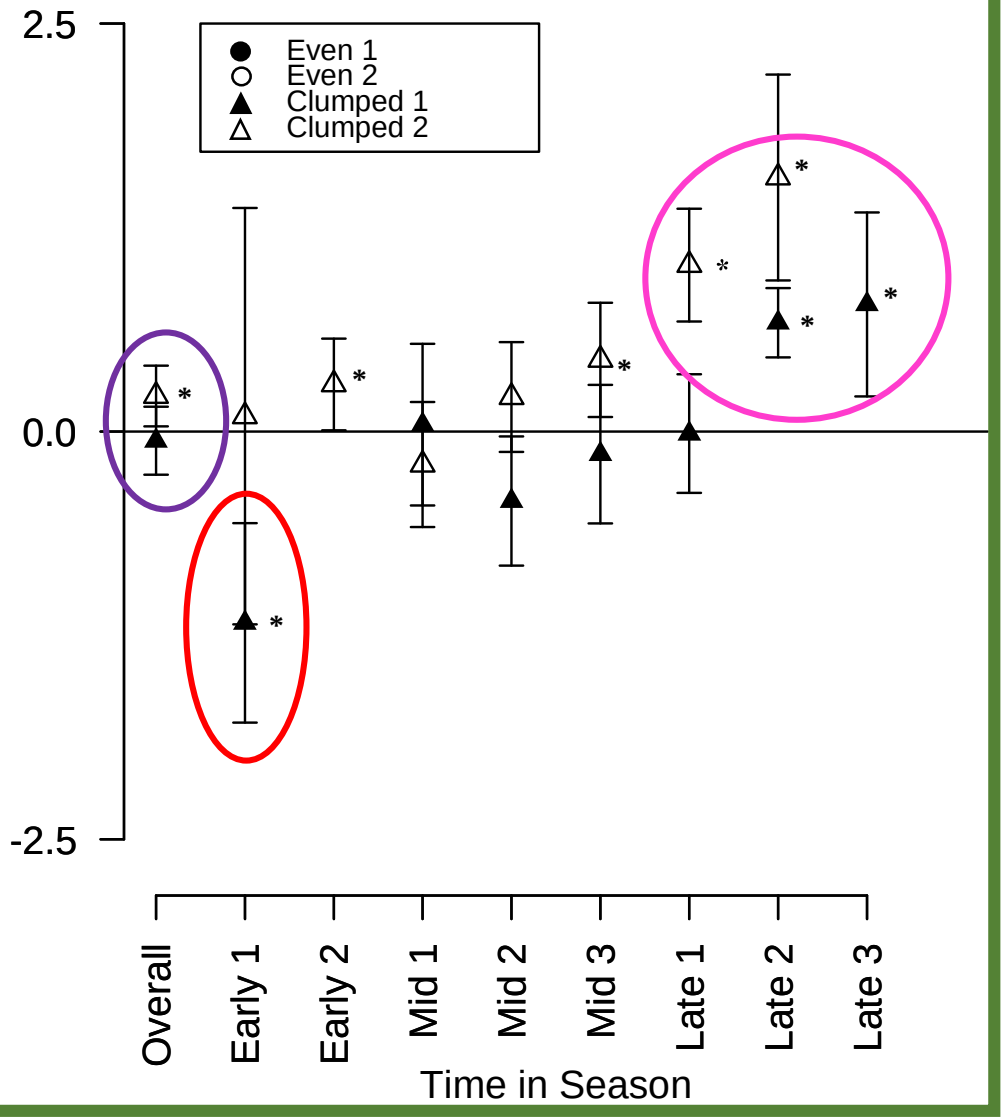
Directional selection on duration changes throughout the season

Take aways: A few selection events can inform the overall selection for the season.

Calculating overall selection can undermine the fine details of selection events within a single season.



* Indicates that the line does not cross zero

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Conclusions

The “genetrap” method provides a novel way to look at pollen movement and selection on phenological traits in several small intervals of time within a single reproductive season.

We do see difference in pollen movement in different spatial aggregations and at different points in time.

Directional selection on phenological traits can changes throughout the season and may interact with spatial aggregation.

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Madeline Peters

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