Effects of invasive plant patch size and distance on the pollination and reproduction of native boreal plants

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In pollinator-limited ecosystems in the earliest stages of the invasion process, the effects of invasive plants on the pollination and reproduction of co-flowering native plants may be particularly sensitive to the distance between native and non-native plants. Our study experimentally tested how the distance from invasive plant patches affects the pollination and reproduction of two native boreal shrubs. We established circular sites with flowering *Vaccinium vitis-idaea* and *Rhododendron groenlandicum* plots spanning from 1 to 40 m from the site center. In 2011 and 2012, we added flowering non-native *Melilotus albus* to the center of sites in small patches (40 individuals) or large patches (120 individuals) and left other sites as controls. In some cases, the effects of *M. albus* were uniform across the 40 m distance, such as the change in *V. vitis-idaea* seed production when large patches of *M. albus* were added. In other cases, relationships with distance were found, and changes in percent pollination or seed production occurred most rapidly over the first 10 m from the patch. Our data supports the hypothesis that the detectable impact an invasive species has on the pollination of native species is affected by the spatial scale over which it is evaluated.

Effects of invasive plant patch size and distance on pollination and reproduction in two boreal shrubs

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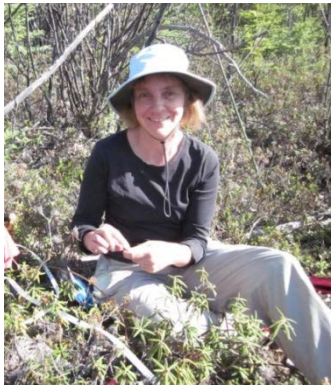

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Melilotus albus invasion in boreal forest

- Up to 350,000 flowers per plant
- Nectar and pollen resource for insects
- Widespread in boreal Alaska

Boreal shrubs with high interaction potential

Vaccinium vitis-idaea

Rhododendron groenlandicum (formerly *Ledum*)

- Share pollinators, flowering times & habitat with *M. albus*
- Dominant understory species
- Circumboreal distributions
- Cultural, subsistence, and economic importance
- Partially self-incompatible

Does *M. albus* addition alter *V. vitis-idaea* and *R. groenlandicum* pollination and seed production? 0.5 hectare scale

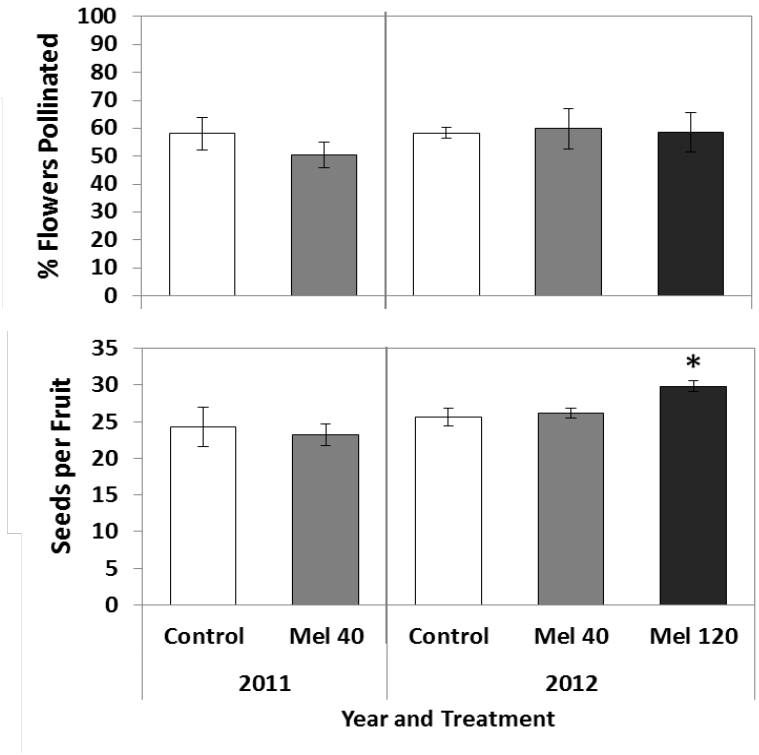
2011:

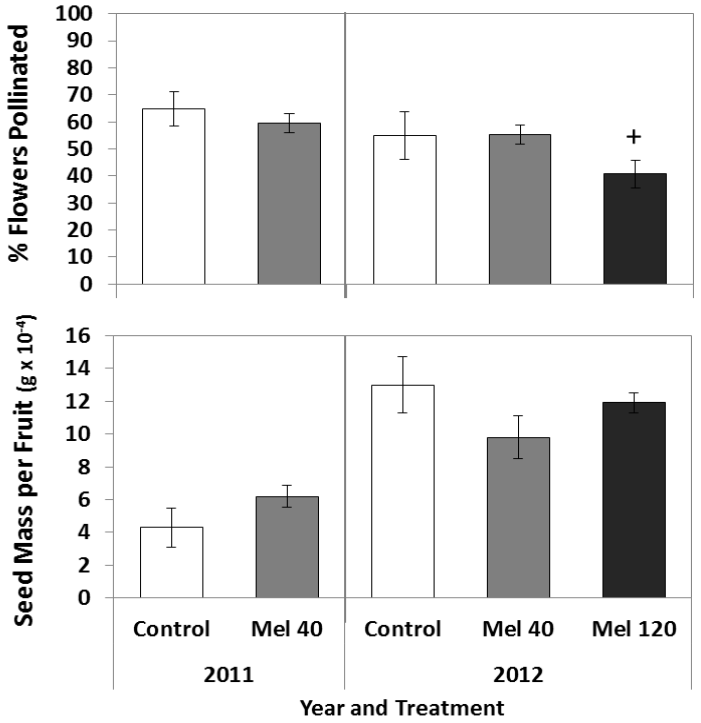
- 6 control sites
- 11 sites with small patches (40 plants/30,000 flowers)

2012:

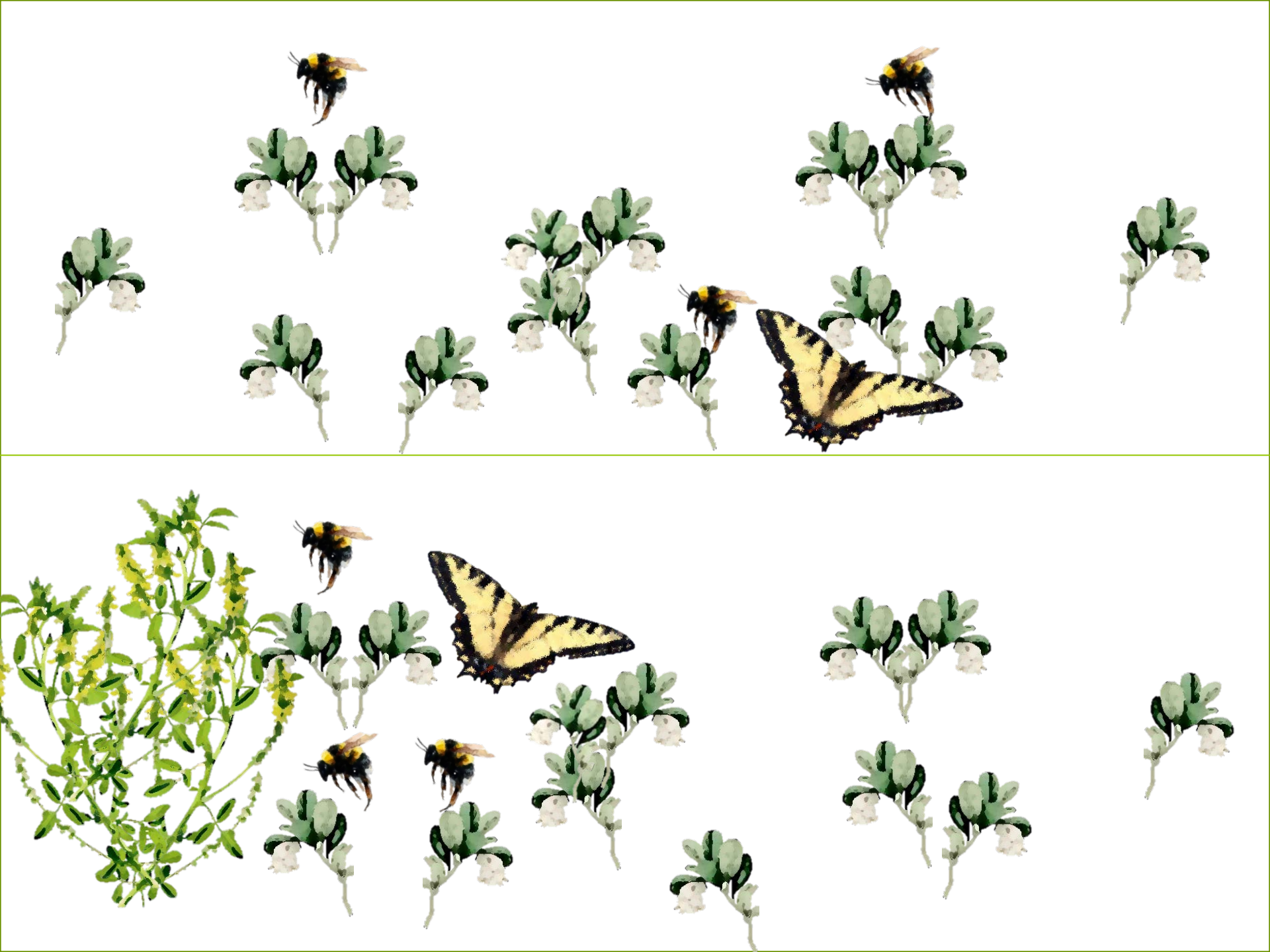
- 6 Control sites
- 6 sites with small patches (40 plants)
- 6 sites with large patches (120 plants/60,000 flowers)

Prior results

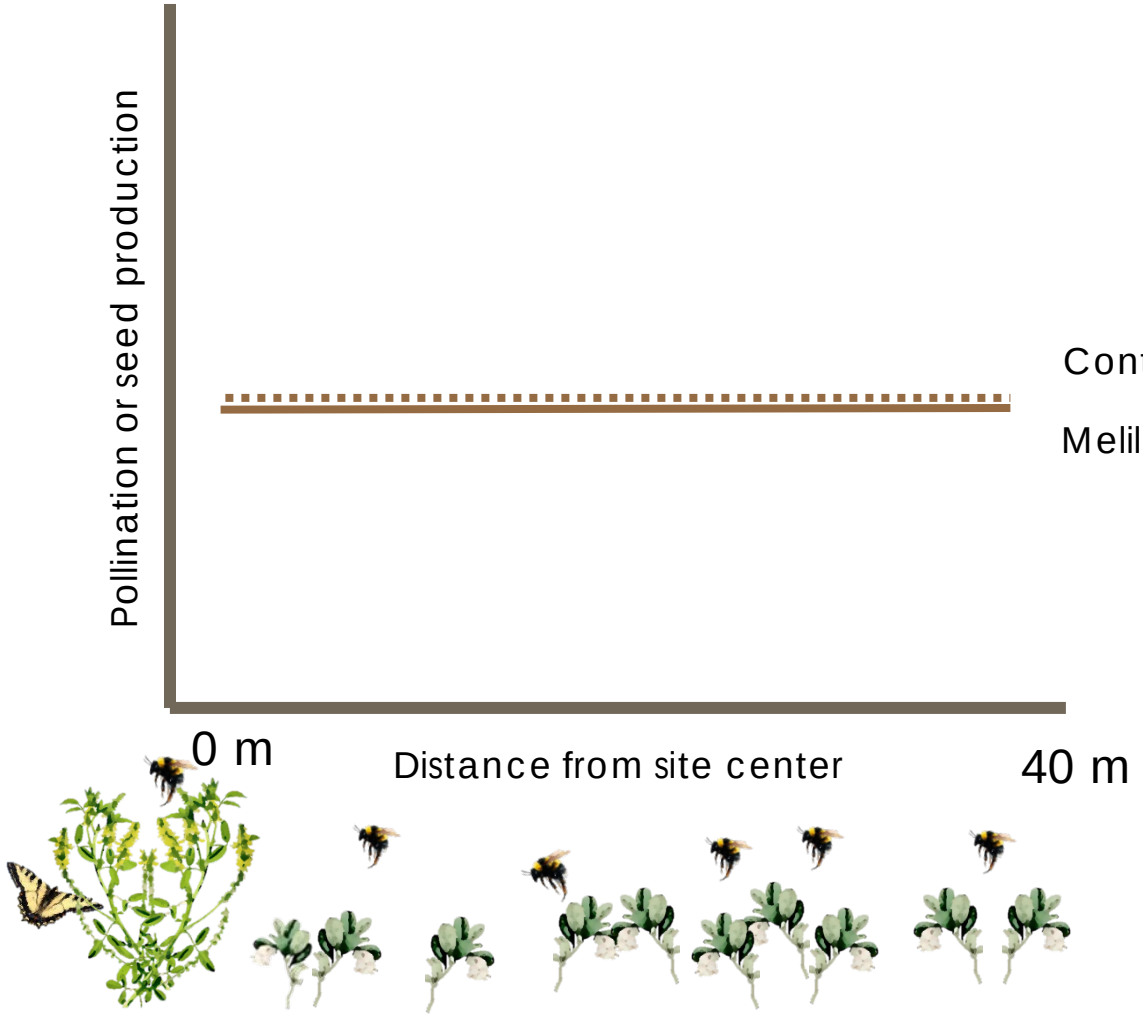




Spellman et al. 2015. *Oecologia*



Potential relationships



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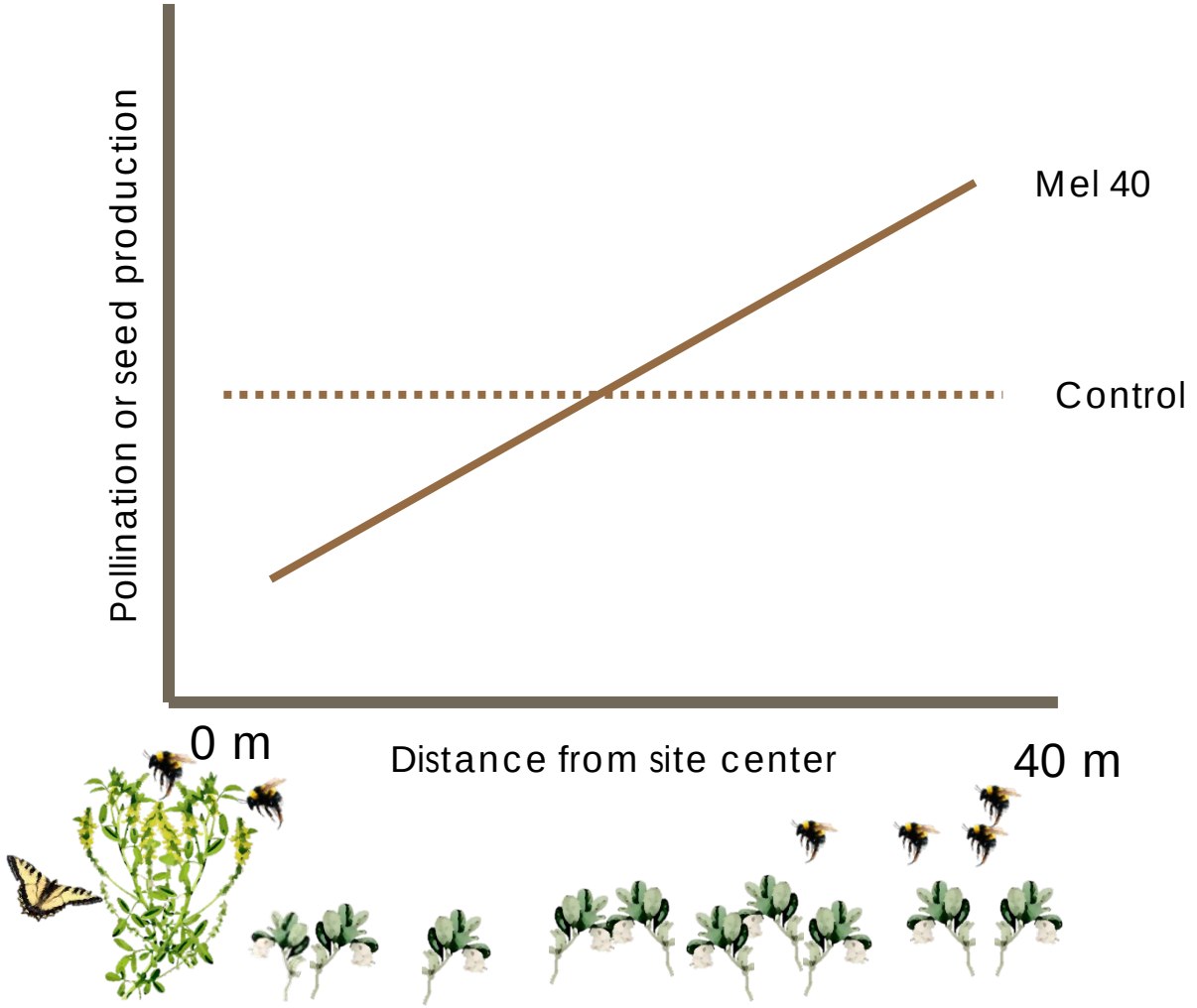
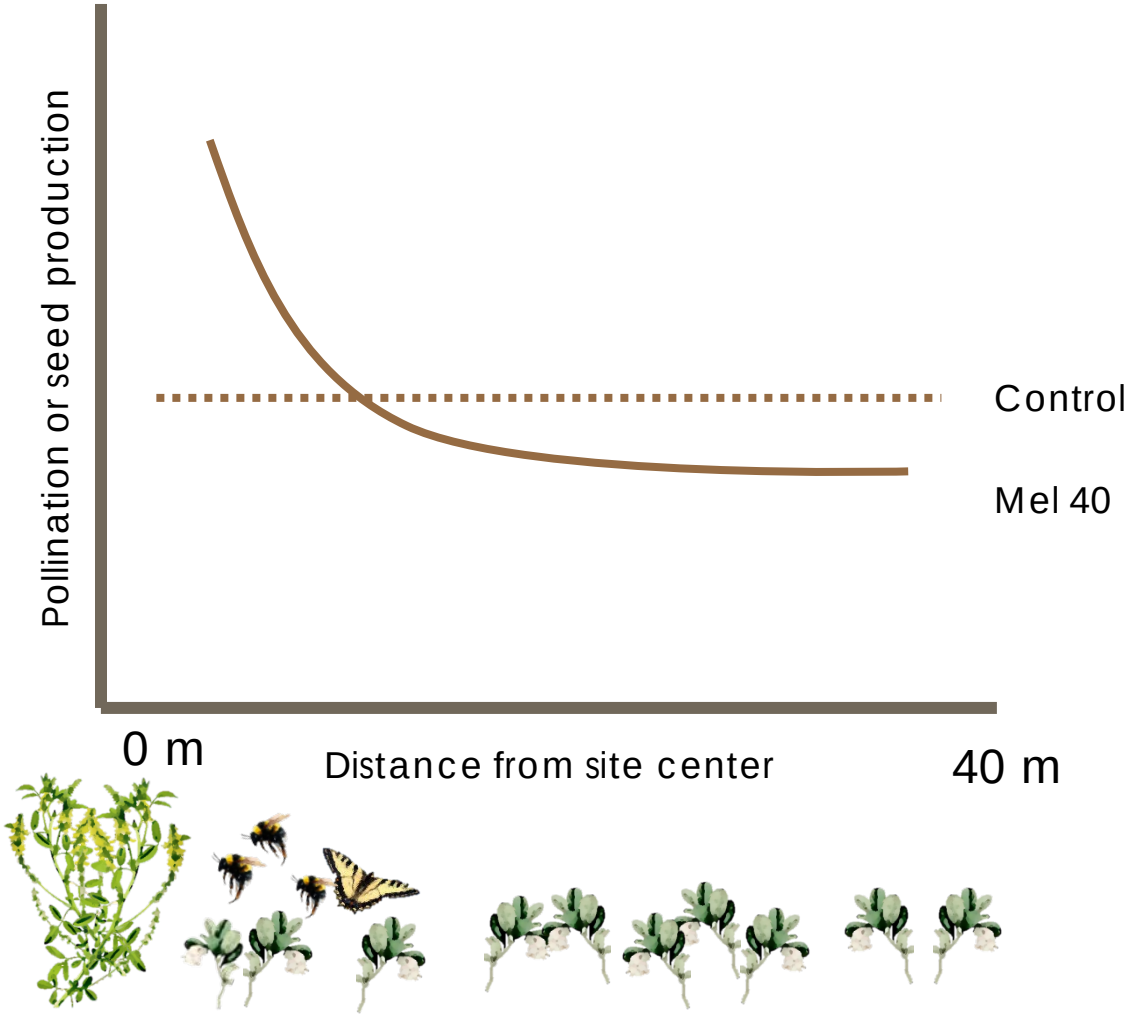
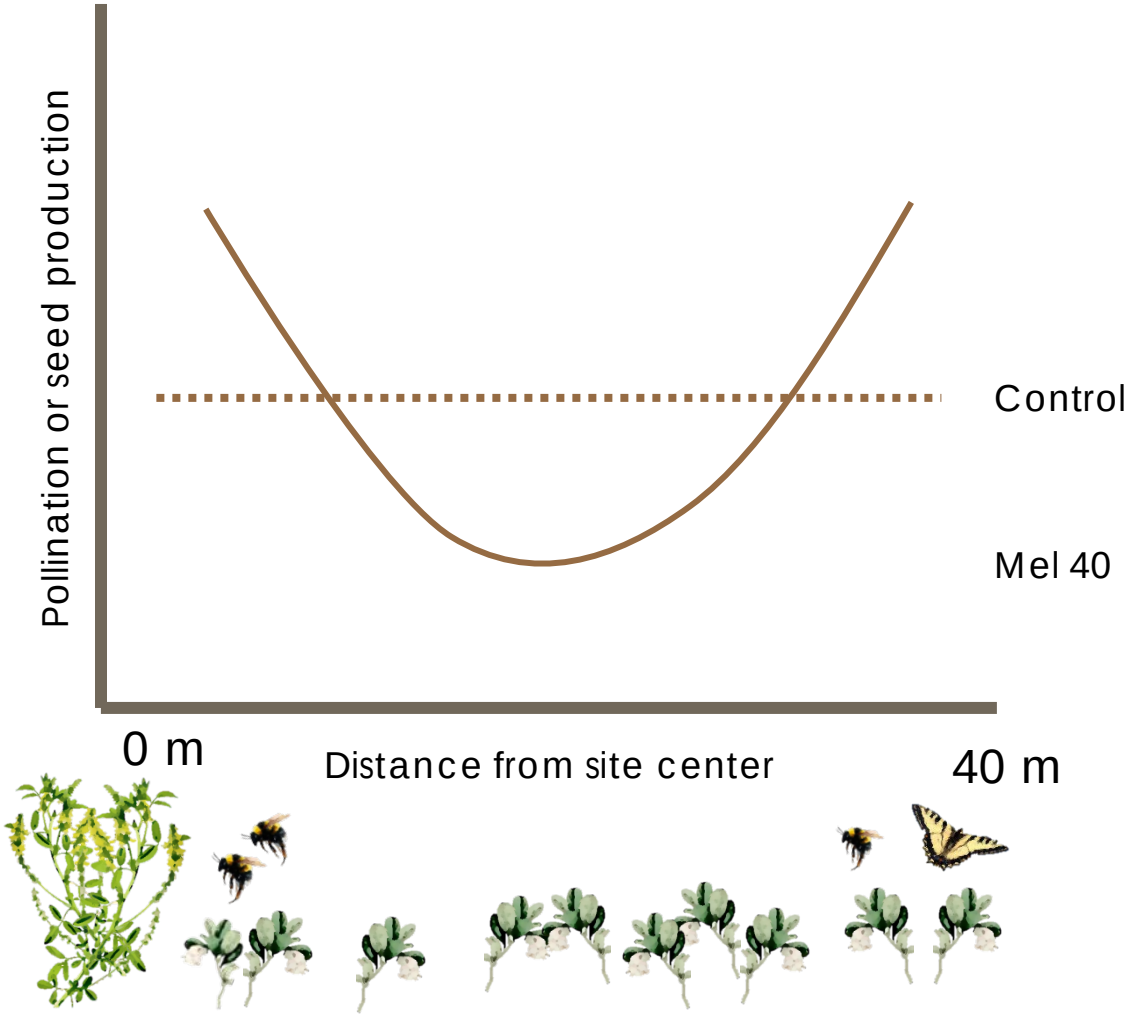


Potential relationships



Potential relationships



Research Questions

1) What pattern best describes the relationship between focal species pollination and distance from the site center in sites without *M. albus*, and sites with small or large patches of *M. albus* added?
2) Can the results we found for the impacts of invasive plant additions on mean pollination and seed production be explained by an interaction between *Melilotus* addition and distance from the patch?

Spellman et al. 2016. *Botany*

Methods

Explanatory Variables:

- Site (random effect)
- Distance from invasive plant patch (linear, $\log_{10}$, quadradic, uniform)
- Flower density

Response Variables:

- % flowers pollinated in each treatment
- Seeds or seed mass per fruit in each treatment

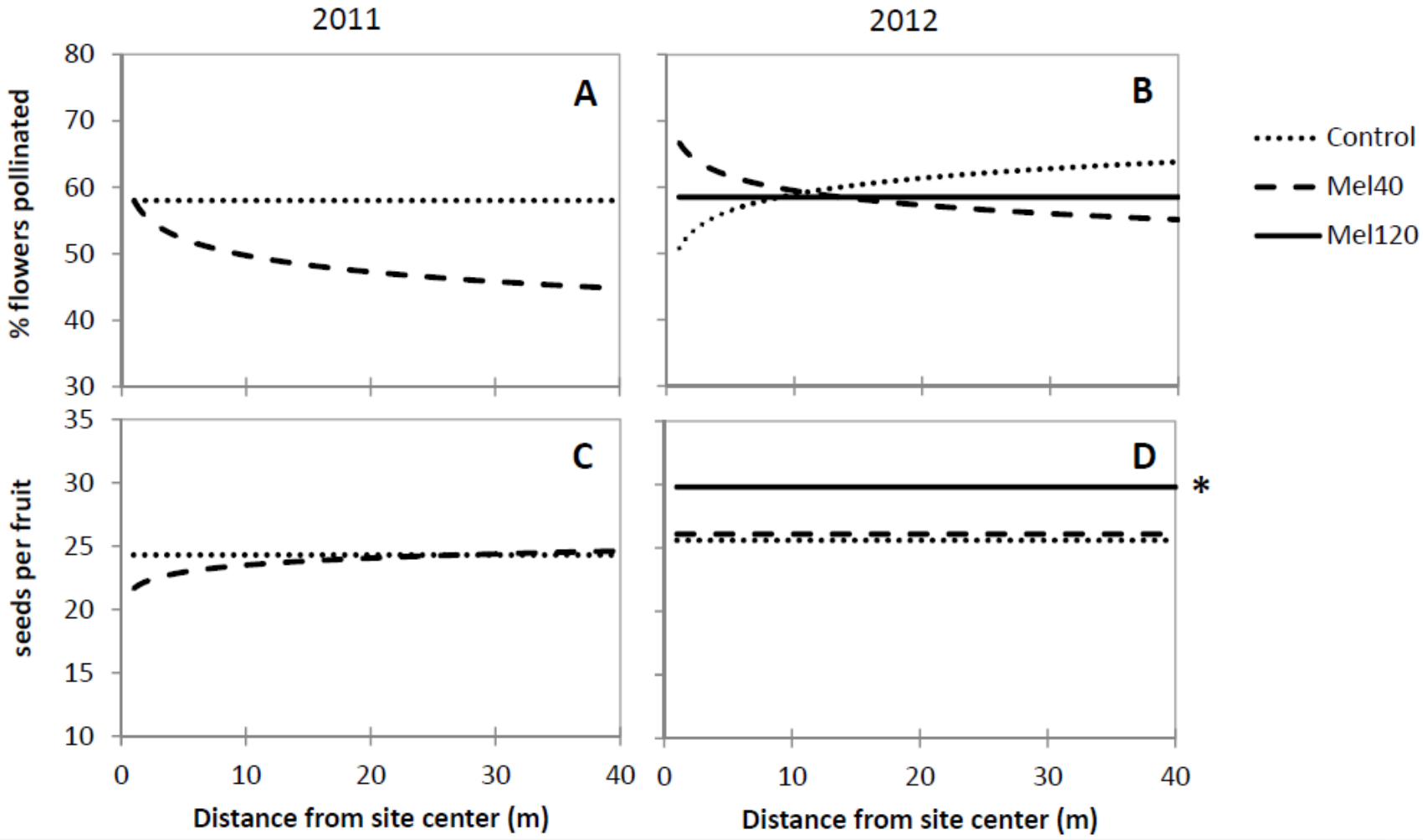

Stigmas collected for pollen analysis


Flower density measured in each plot

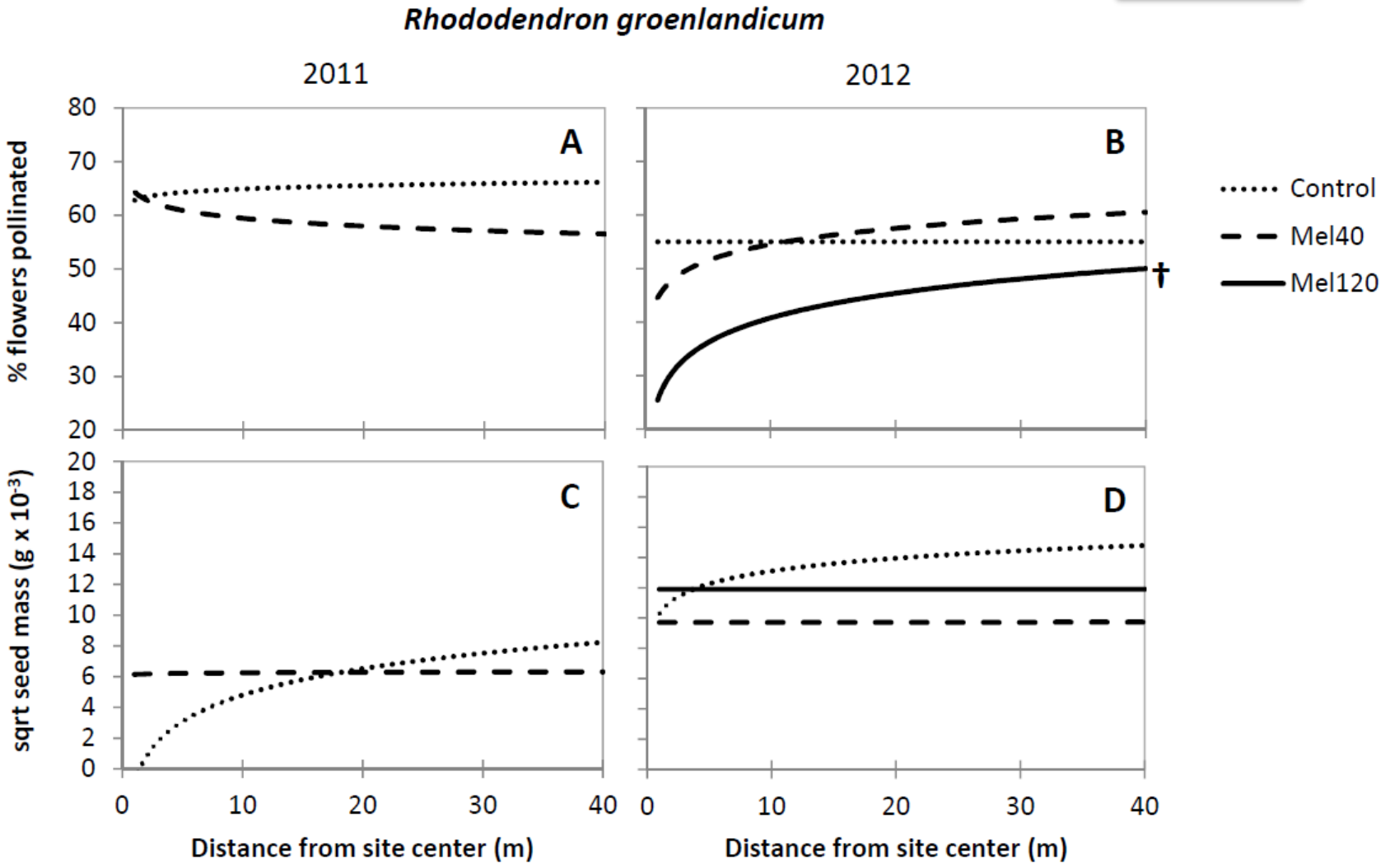

125 plants tracked per species per site for fruit and seed analysis

RESULTS

Vaccinium vitis-idaea



RESULTS


Rhododendron groenlandicum
2011
2012
A
B
C
D
% flowers pollinated
sqrt seed mass (g x 10-3)
Distance from site center (m)
Distance from site center (m)
Control
Mel40
Mel120
†

Conclusions

- Evaluating changes over space helped unmask some effects of the presence of *M. albus* that were hidden in our whole-site comparisons.
- Effects primarily in the first 10 m.
- In contrast, there was little support for a change in *V. vitis-idaea* seed production over space with the addition of *M. albus*.

Implications

- Detectable impact an invasive species has on native species is affected by the spatial scale over which it is evaluated.
- Assessment at multiple scales, if feasible, is warranted