

Foraging efficiency of insect pollinators of the Pitcher's Thistle, *Cirsium pitcheri*, an endangered plant at the Indiana Dunes, IN

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VISITATION PATTERNS INFLUENCE SEED PRODUCTION

Cirsium pitcheri Torr. (Eaton) T. & G., Asteraceae) is a monocarpic perennial plant endemic to the shoreline of the Great Lakes. Habitat fragmentation due to human activities has created small habitat islands in which plant population become isolated from each other by barren land. As a result, the endangered *C. pitcheri* is at great risk of becoming extinct. The plant has no capacity for vegetative spread¹. Therefore, seed dispersal and frequent recruitment of new seedling cohorts are required for viable populations to exist². However, seed production by sexual reproduction depends on insect pollinators, which are their primary pollen vectors. The pollinator's visitation patterns and abundance will influence seed production because transferring pollen between plants is indicative of successful sexual reproduction³. In addition, the proportion of plants per fragment visited by pollinators may influence progeny vigor, and may increase seed production.

This preliminary study explores the foraging efficiency of insect pollinators of the Pitcher's Thistle, *Cirsium pitcheri*.

My objectives were to

- elucidate whether habitat type (protected versus open sand dunes) may influence insect visitation patterns, and
- explore pollinator foraging behavior using simulations that may generate expectations about pollen flow within and between populations.

I assumed that higher visitation rates promoted higher pollen flow and seed production.

METHODS: CHASING INSECTS IN THE DUNES



Figure 1. Pitcher's thistle, *Cirsium pitcheri*, with insects foraging for nectar and pollen. I recorded the number of flowers visited, the length of time on each flower, time and directionality of flight between flowers, and used it to generate 1000 simulations on foraging efficiency.

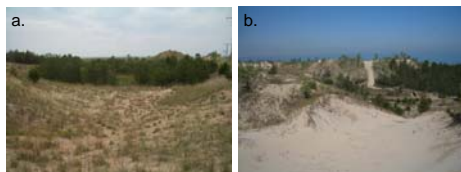


Figure 2. Protected (a) and Open (b) Dunes. Flowering plants were identified, and 50 insects landing on them were observed for 15 minutes at different times of the day during flowering, summer 2008.

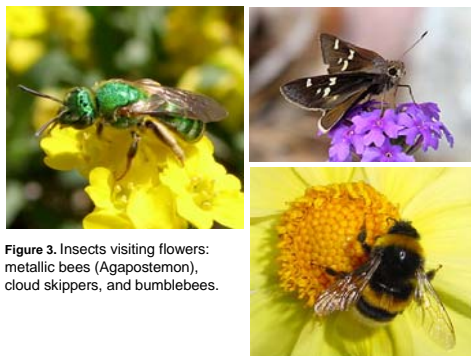


Figure 3. Insects visiting flowers: metallic bees (Agapostemon), cloud skippers, and bumblebees.

RESULTS

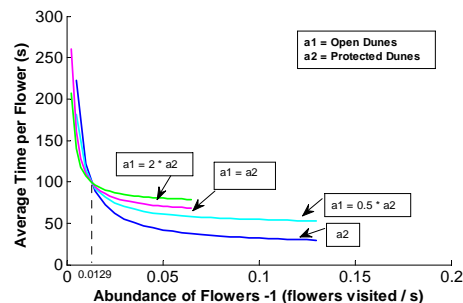


Figure 4: Average time per flower from foraging strategies in open (a1) and protected (a2) dunes. If the abundance of flowers foraged per time exceeds 0.0129, the strategy of taking flowers from Open dunes (a1) is superior to foraging flowers from the protected Dunes (a2). Below a foraging strategy of 0.0129 flowers / s, the best strategy is to forage in protected dunes (blue line)

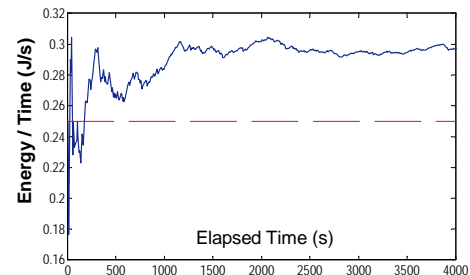


Figure 5. Cumulative energy per time for the simulation of 1000 flower encounters. After 200 s of elapsed time (foraging), when $a1 = 0.5$ flowers / s, and $a2$ has any value, the rate of energy reaches a yield of 0.25 J/s (red line) which constitutes the expected optimal strategy.

Table 1. Variables evaluated

Variable	Protected	Open
Flowers visited / s	0.50 ± 0.47 a	0.13 ± 0.10 a
Foraging Time (s)	18.63 ± 11.05 c	45.50 ± 15.15 b
Distance Traveled (cm)	1004.69 ± 355.21 e	90.00 ± 65.2 f

Means within rows followed by different letters are significantly different ($P < 0.05$, Mann-Whitney U-test)

CONCLUSIONS

The best strategy was to forage in Open Dunes

The optimal energy yield was obtained in open dunes 200 s after a foraging bout began, while in protected dunes, this yield was not reached, regardless of the rate of flower visitation.

Foraging time and distances traveled differed

Insects foraged more time and shorter distances in Open dunes than in Protected dunes.

In Protected Dunes, plants must be sparse, compared to open dunes, and insects have to travel longer distances between plants to find nectar or pollen. Even though in theory insects chose Open dunes to Protected ones, the best strategy that will help gene flow will be to have pollinators traveling longer distances between plants and plant population fragments.

FUTURE STUDIES ...

Longer distances traveled by insect pollinators in protected dunes will increase gene flow and connectivity between fragmented plant populations. This hypothesis is being tested in the lab using genetic methods of parentage analysis.

LITERATURE CITED

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ACKNOWLEDGEMENTS

We thank Dr. Joy Marburger from the Great Lakes Research and Education Center at the Indiana Dunes National Lakeshore for invaluable help on these experiments.

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