Attack of the clones! Growth patterns and genetic diversity of Hill's thistle populations in the Midwest

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Introduction

Genetic diversity is critical for a population to adapt to changes and threats in its environment. Small and isolated remnant populations are at a higher risk of losing genetic diversity to drift and limited gene flow. Species that undergo clonal growth and self-incompatibility can exasperate this, further limiting successful sexual reproduction.

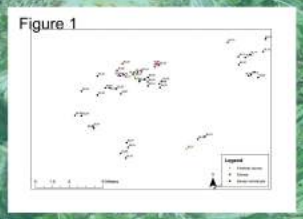
The perennial thistle, *Cirsium hillii*, is endemic to the Great Lakes region and is globally listed as a vulnerable species. It occurs in sandy prairie and gravel hill coarse soil types within geographically isolated populations. Unfortunately, individuals experience a low seed set, hence many Hill's thistle populations may persist through asexual reproduction.

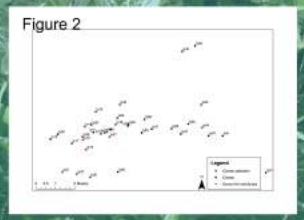
As an understudied species, the extent to which asexual reproduction occurs is largely unknown and is essential for comprehending the population genetic structure so that census numbers can be critically evaluated in conservation. To answer this question, we have investigated how Hill's thistle may be experiencing clonal growth to varying extents between populations in sandy prairie and gravel hill environments.

Basal rosette on gravel hill

Sexually active individual

Basal rosette on sandy prairie





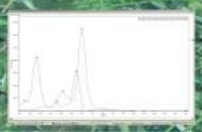
Figures 1, 2. GIS showing distinct clonal patches highlighted among other individuals

Methods

Leaf samples assigned a GPS unit

DNA extracted with CTAB protocol

PCR on four primers



Beckman allele analysis

Comparison with GPS points for clonal assay

Results

	N_a	H_O	H_E	F	Average distance between clones	Maximum distance between clones
Sandy prairie	4.75	.486	.547	.273	3.77m	10.58m
Gravel hill	2.75	.288	.331	.239	2.44m	8.72m

Table 1. Comparison of allele frequencies between both populations

N_a – average number of alleles
H_O – observed heterozygosity
H_E – expected heterozygosity
F – fixation index

Discussion

The sandy prairie ecotype was found to have greater sexual and asexual reproduction and clones spread over greater distances compared to the populations on gravel hill. This difference in clonal range may be primarily due to the physical aspects of each soil type, since it would be easier for an adventitious root to grow and move through sand than in gravel. The sandy prairie also had higher genetic diversity, which may potentially correlate with greater frequencies of "S" incompatibility alleles that explain why it is reproducing more and why it is experiencing a more successful seed set. Although there is a lower number of clones in the sandy soil, where 2/5 individuals are unique compared to 1/5 in gravel, the level of inbreeding is comparable and high in both populations.

Restoration and conservation efforts may benefit from this knowledge by making it explicit that many Hill's thistle populations may be performing differently than conventional consensus counts would suggest, due to the possibility of a large proportion of clonal individuals in a population. This information could also be used in deciding where to source and reintroduce plants, as sandy prairies seem to respond differently and contain greater genetic diversity than gravel hills. Finally, we can elucidate that most populations may be experiencing a bottleneck and be comprised of a handful of founder plants. Just as interesting is the implication that the clones that cover extensive ranges may all have originated from an individual plant, having taken over the habitat's soil with its impressive root system.

References

Warburton, Cindy L., et al. "Clonality and sexual reproductive failure in remnant populations of *Santalum lanceolatum*." *Biological Conservation* 96 (2000) 45—54.
Fant, Jeremie., et al. "Investigating the Reproductive Health of Hill's thistle (*Cirsium hillii*) populations in the Chicago Region." *Chicago Wilderness* Volume 5. Issue 1 (2007): 29-40

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