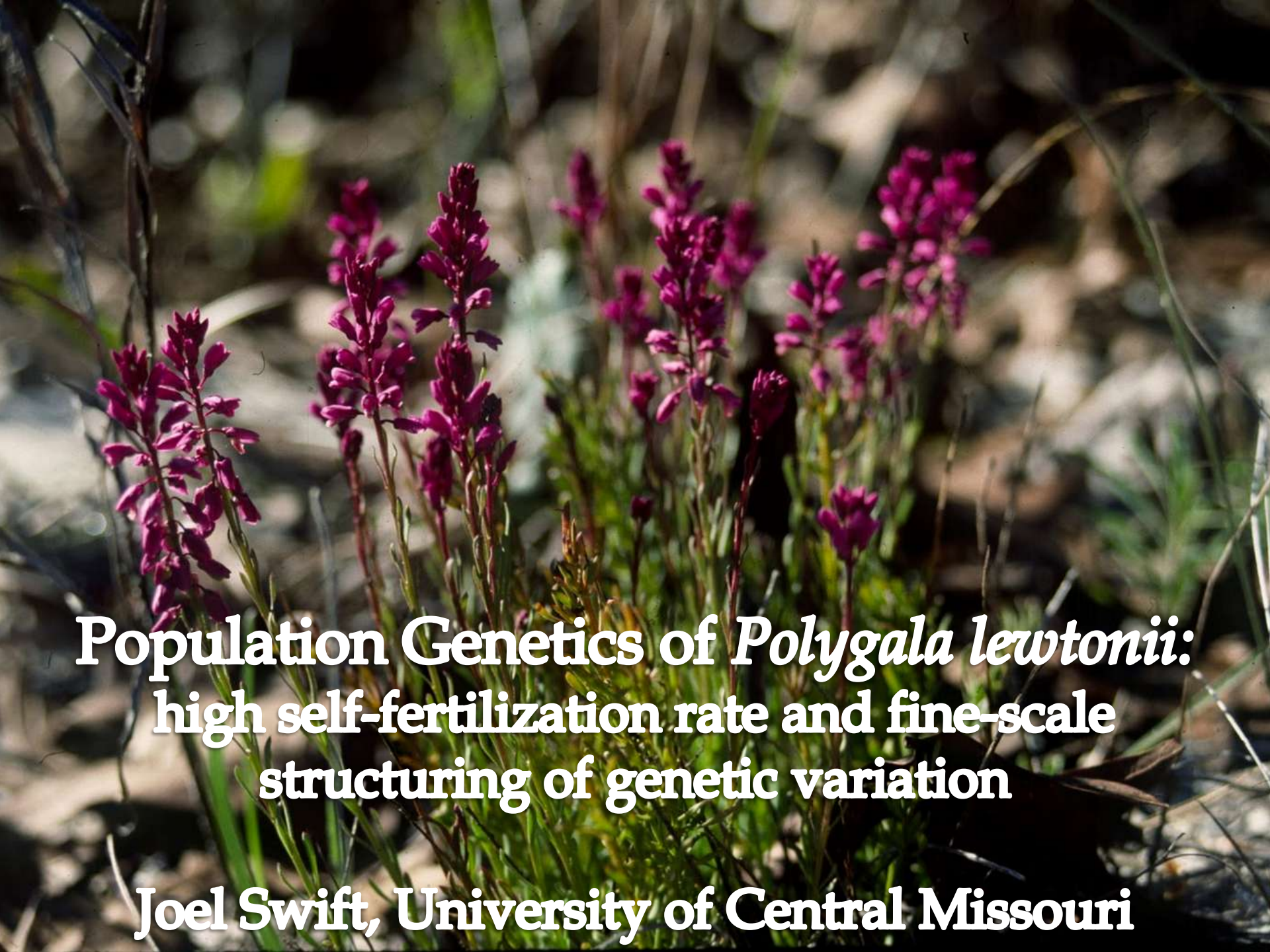


Population Genetics of *Polygala lewtonii:* high self-fertilization rate and fine-scale structuring of genetic variation

Joel Swift, University of Central Missouri

Refugia in Florida

- 11 major glaciations occurred during the Pleistocene.
- As glaciers advanced and receded the sea level globally decreased and rose accordingly.
- This rising of sea levels caused plants and animals to move to higher elevations such as Lake Wales Ridge.

Lake Wales Ridge

- The Lake Wales Ridge acted as a refuge for plant and animal species.
- 20 plant species endemic to the ridge are classified as federally endangered.
- Since the colonization of Florida the ridge's ecosystems have been degraded and fragmented by human development. (Only 15% remains)
- "Sculpted by the sea and maintained by fire"

Polygala lewtonii

- Perennial herb.
- Multiple stems with a bushy appearance.
- Found only on yellow sandy soils on the ridges of Florida.
- Adapted to frequent burning of its habitat.
- Federally endangered.

Inflorescences

- *P. lewtonii* possesses three types of flowers:

1. Above-ground , open, cross pollinated (chasmogamous)
2. Above-ground , closed, self pollinated (cleistogamous)
3. Below-ground, closed, self pollinated (cleistogamous)

Cliestogamous below-ground Flowers and Fruit, *Polygala Polygama*

Chasmogamous flower, *Polygala lewtonii*

Amphicarpy

- Plant that produce two types of offspring with different ecological roles.

1. Dispersal
2. Recovery from stochastic disturbance

- *P. lewtonii* uses two types of seeds to fit these ecologic roles.

1. Above-ground seeds, available to be dispersed.
2. Below-ground seeds, remain viable in seed bank.

Aboveground seeds, *Polygala lewtonii*

Research Goal

- To investigate the primary mode of reproduction in *Polygala lewtonii* and it effects on fine-scale and rangewide patterns of genetic structure.

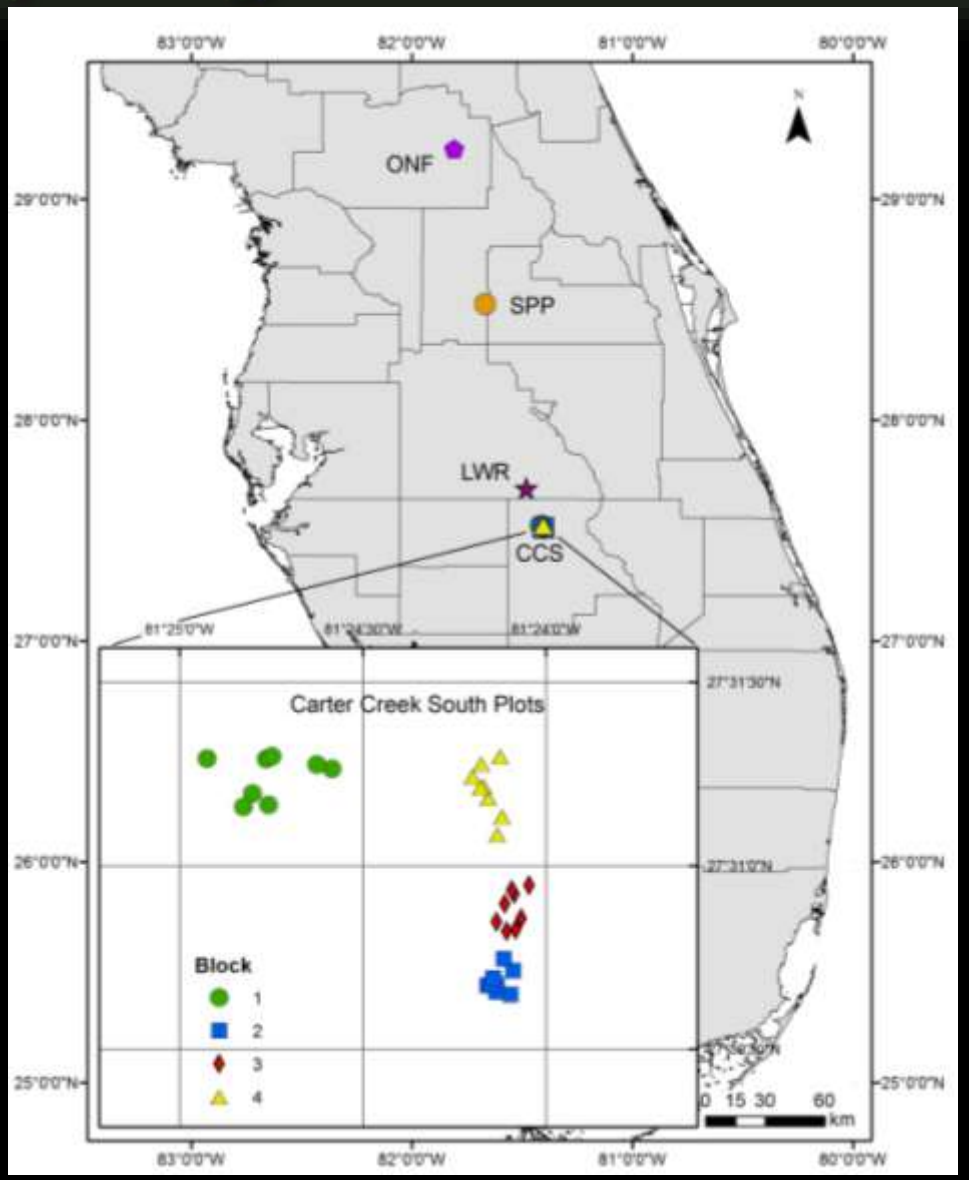
Hypotheses

1. If *P. lewtonii* is reproducing primarily via self-fertilization then we should see tight clusters of highly similar individuals with most genetic variation among populations.

2. If *P. lewtonii* is primarily reproducing via outcrossing then, we should see greater genetic variation across the landscape.

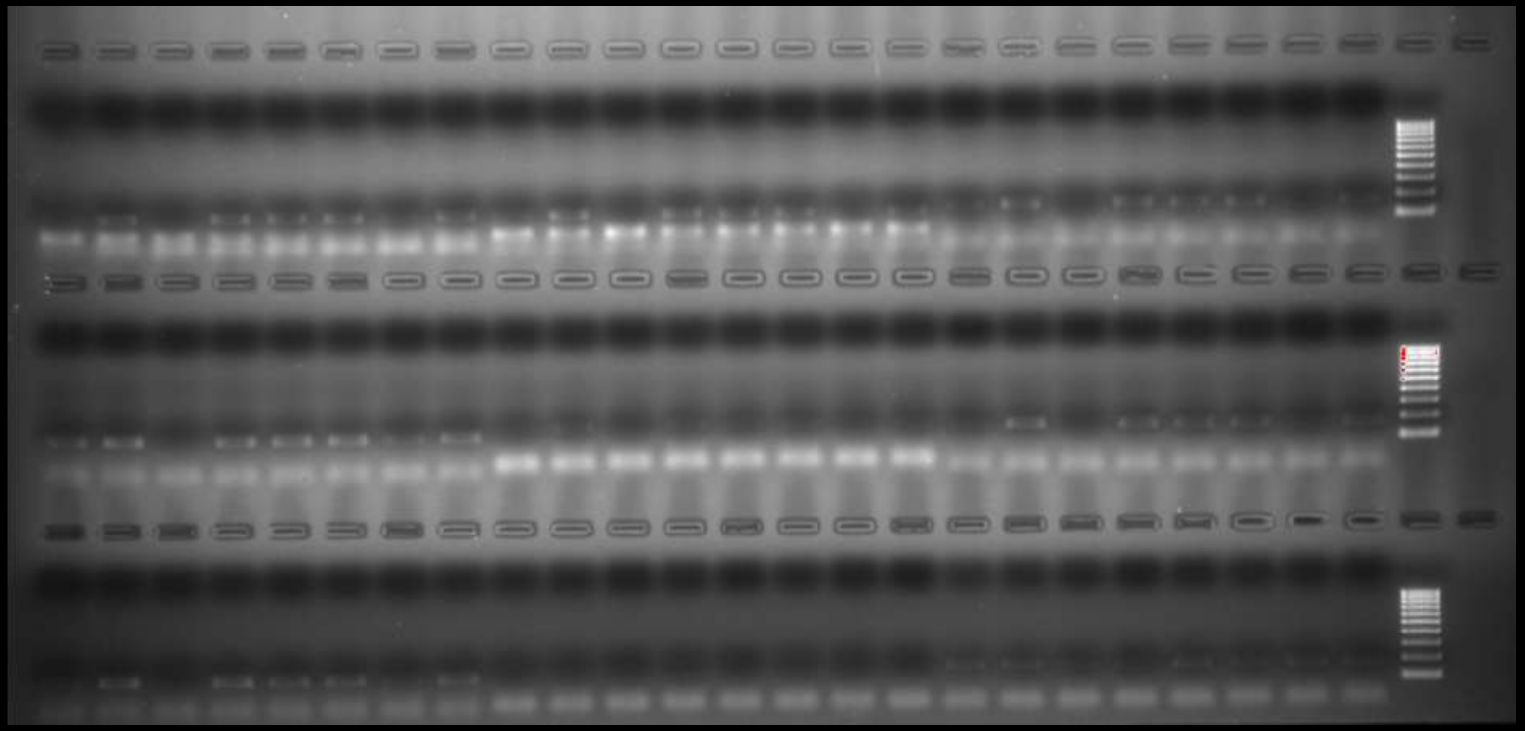
Sampling

- Fine scale genetic structure was assessed with 4 blocks with 72 individuals each, broken down into 8 plots.
- Rangewide genetic structure was assessed with an additional 3 Blocks with 24 individuals each.
- In total 360 tissue samples were collected.



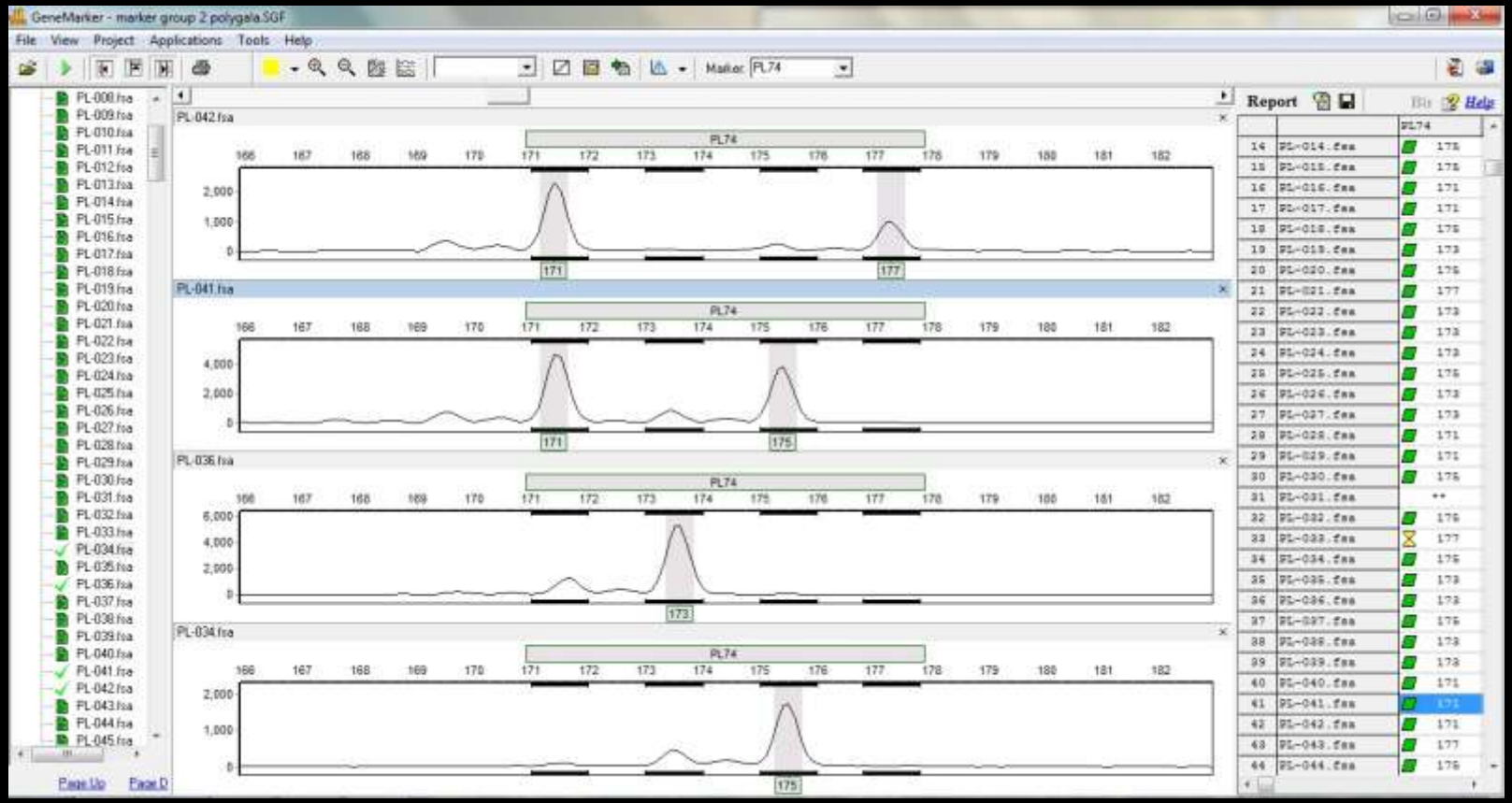
Methods

- DNA was extracted using a CTAB extraction method.
- Utilized 12 microsatellite loci to look for variation among individuals.



Data

- Fragment analysis and scoring was carried out to call the alleles (Bp size repeats) with the program Genemarker.



Analysis

- Summary analyses of the data looked at diversity within populations and patterns of genetic structure among populations.

Results

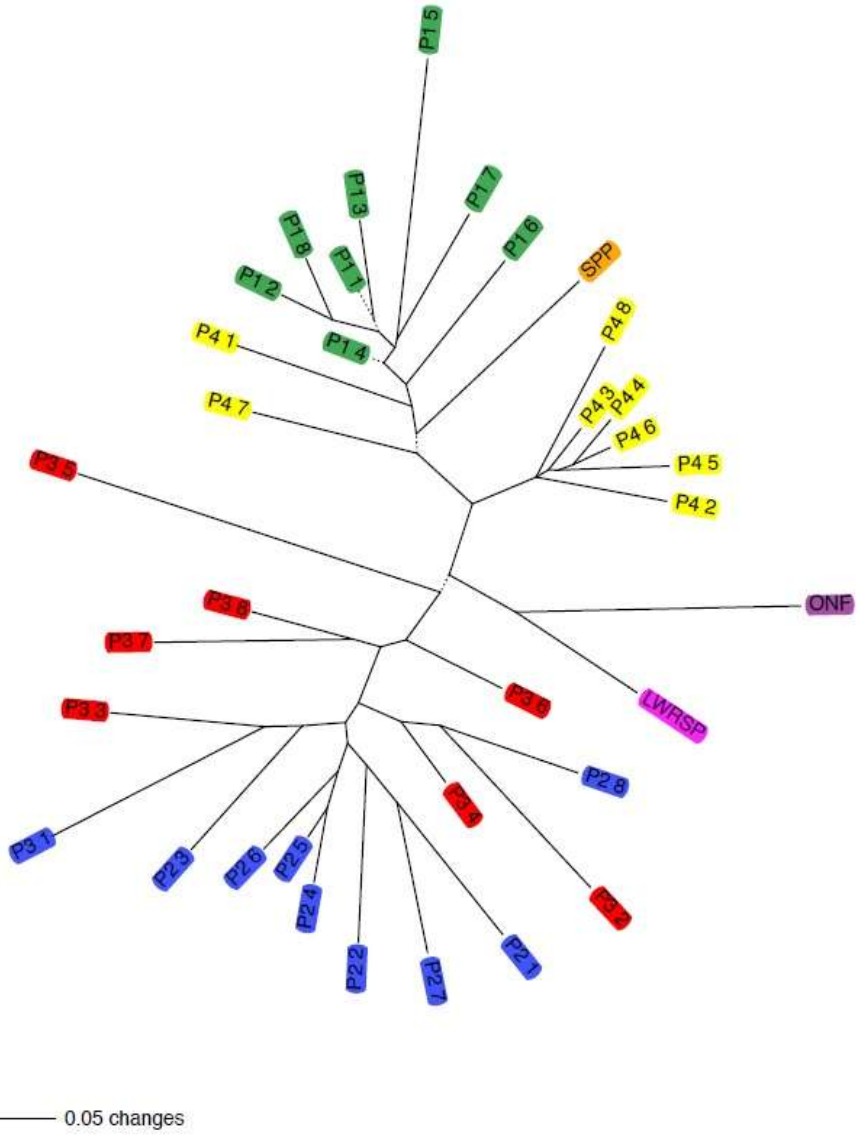
Carter Creek Populations	GPS	H_O	H_E	F_{IS}	A	A_R	n
Block 1	27.519924, -81.413333	0.006	0.016	0.593	2.833	2.005	70
Block 2	27.510796, -81.401603	0.008	0.016	0.689	3.083	2.271	68
Block 3	27.513677, -81.401779	0.006	0.024	0.572	3.5	2.494	69
Block 4	27.520696, -81.403335	0.004	0.016	0.746	3.417	2.031	70
Ocala National Forest	29.230831, -81.805428	0.108	0.474	0.779	3.75	2.986	24
Lake Wales Ridge	27.691486, -81.480602	0.049	0.421	0.885	3.833	2.998	23
Scrub Point Preserve	28.524682, -81.664801	0.085	0.247	0.661	2.333	1.962	23

- Low heterozygosity expected (0.016 to 0.474) and even lower heterozygosity observed (0.006 to 0.108).
- Very high F_{IS} values (0.572 to 0.885), average of 70% of reproduction through inbreeding.

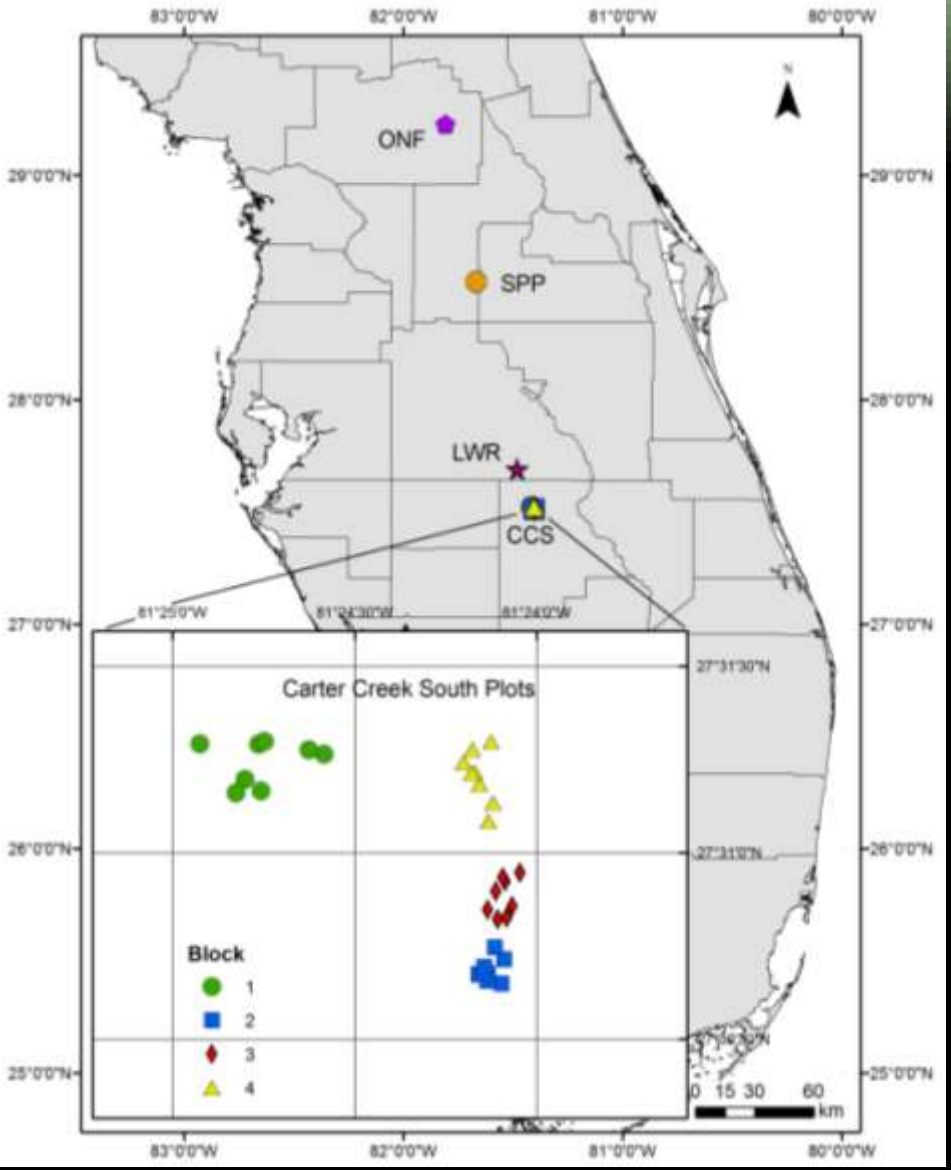
Results

Pairwise Genetic Differentiation							
	Block 1	**Block 2**	**Block 3**	**Block 4**	**ONF**	**LWR**	**SPP**
Block 1	-	0.634	0.604	0.436	0.692	0.511	0.506
Block 2	0.634	-	0.251	0.548	0.582	0.462	0.671
Block 3	0.604	0.251	-	0.498	0.498	0.417	0.621
Block 4	0.436	0.548	0.498	-	0.570	0.397	0.481
ONF	0.692	0.582	0.498	0.570	-	0.361	0.637
LWR	0.511	0.462	0.417	0.397	0.361	-	0.480
SPP	0.506	0.671	0.621	0.481	0.637	0.480	-

- High genetic differentiation among populations (0.251 to 0.671).
- These values are extremely large, higher than what is normally seen between different species.



Pairwise Genetic Distance Tree



Sampling Map

Conclusions

- *P. lewtonii* relies primarily on self-fertilization for its reproduction.
- Very fine scale structuring of genetic variation.
- The majority of the genetic variation of the species is among populations.
- Each population has a group of individuals that are very highly similar to one another and extremely different from geographically close neighbors.

Conservation Implications

- To protect the full range of genetic variation we have to protect every population.
- More efficient conservation efforts should focus on seed banking populations that are on unprotected land.
- Habitat loss remains the biggest threat to *P. lewtonii* as the ridge is developed for human use.

Acknowledgements

Thank you to everyone that helped make this project a success.

Dr. Christine E. Edwards

Dr. Burgund Bassüner

Archbold Biological Station:
Eric Menges
Stacy Smith
Carl Weekly

MBG staff
Dr. David Bogler
REU students

Funding:
MBG
NSF
FDACS


Thank you