U.S. Department of Agriculture
Agricultural Research Service

Forage and Range Research Laboratory

Legumes for Rangeland Restoration in the Semi-arid Western USA

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PLANTS FOR THE WEST

Need for North American Legumes

Important for:

- Seeding diversification
- Nitrogen fixation
- Native pollinators
- Wildlife food and habitat

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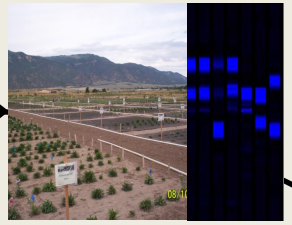
Pipeline for germplasm development

1. Seed collection



2. Evaluation

3. Select appropriate releases

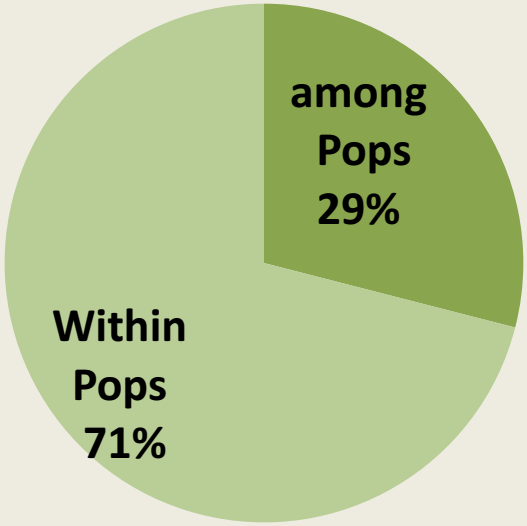
4. Germination and establishment protocols

5. Seed production

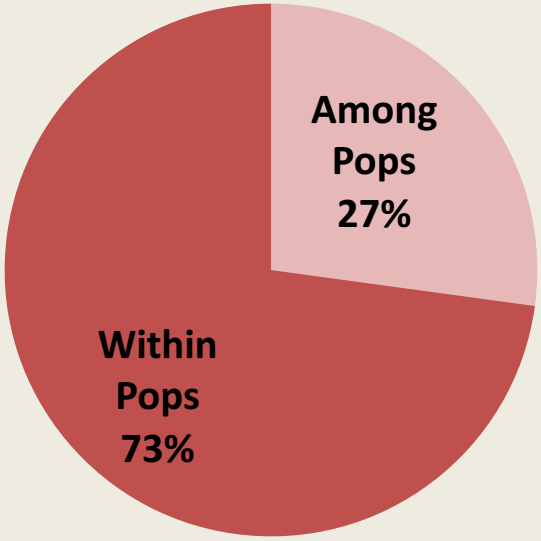
6. Release for seeding

Collection Variation

Dalea searlsiae



Lotus utahensis



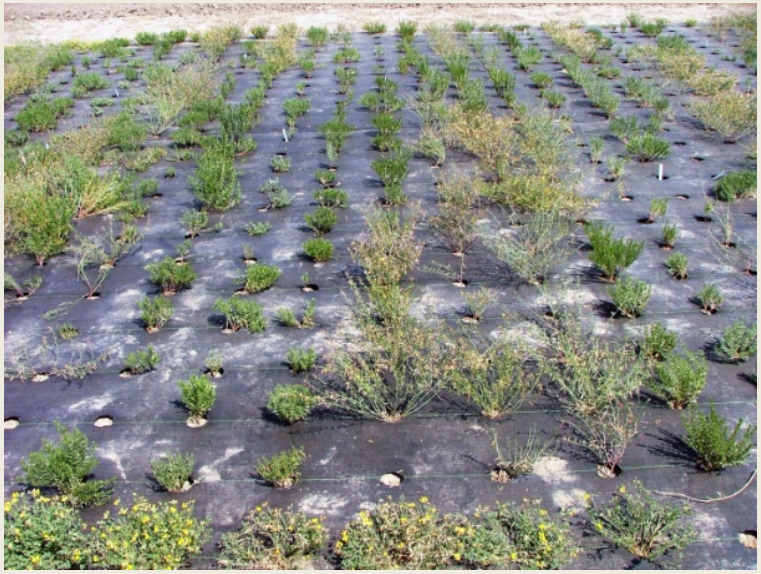
Assessing variation

***Dalea searlsiae*:**

- 2 common-gardens.
- 20 collections transplanted.
- RCB design, 6-plant plots, 5 reps.
- Two years post-establishment.

***Lotus* species:**

- 3 common-gardens.
- 19 collections transplanted.
- RCB design, 6-plant plots, 5 reps.
- Two years post-establishment.



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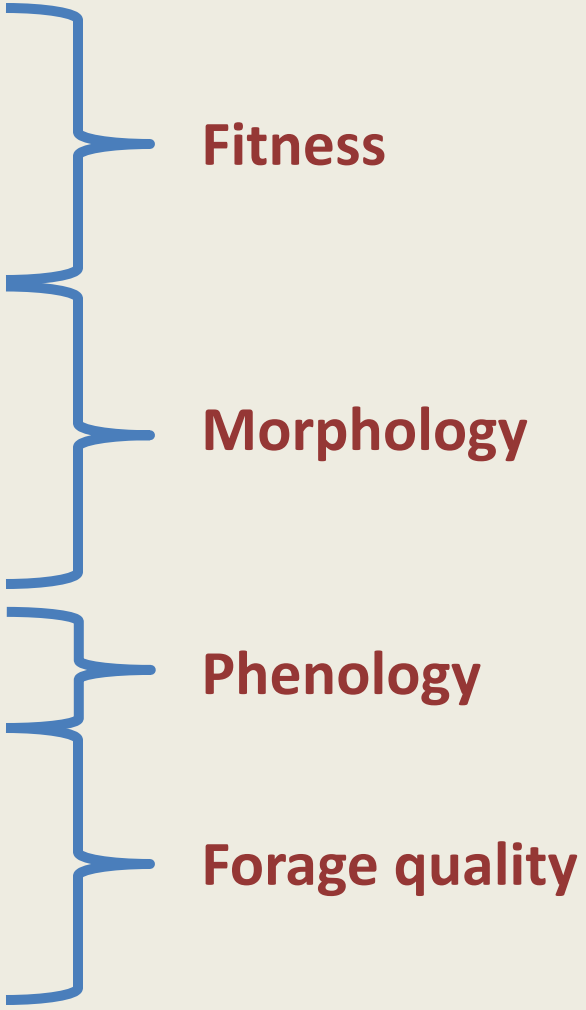
Measured Plant Traits

- Seed pod weight
- Dry matter yield
- Survival
- Plant height
- Number of stems
- Foilage diameter
- Flowering date
- Acid detergent fiber
- Neutral detergent fiber
- Crude protein



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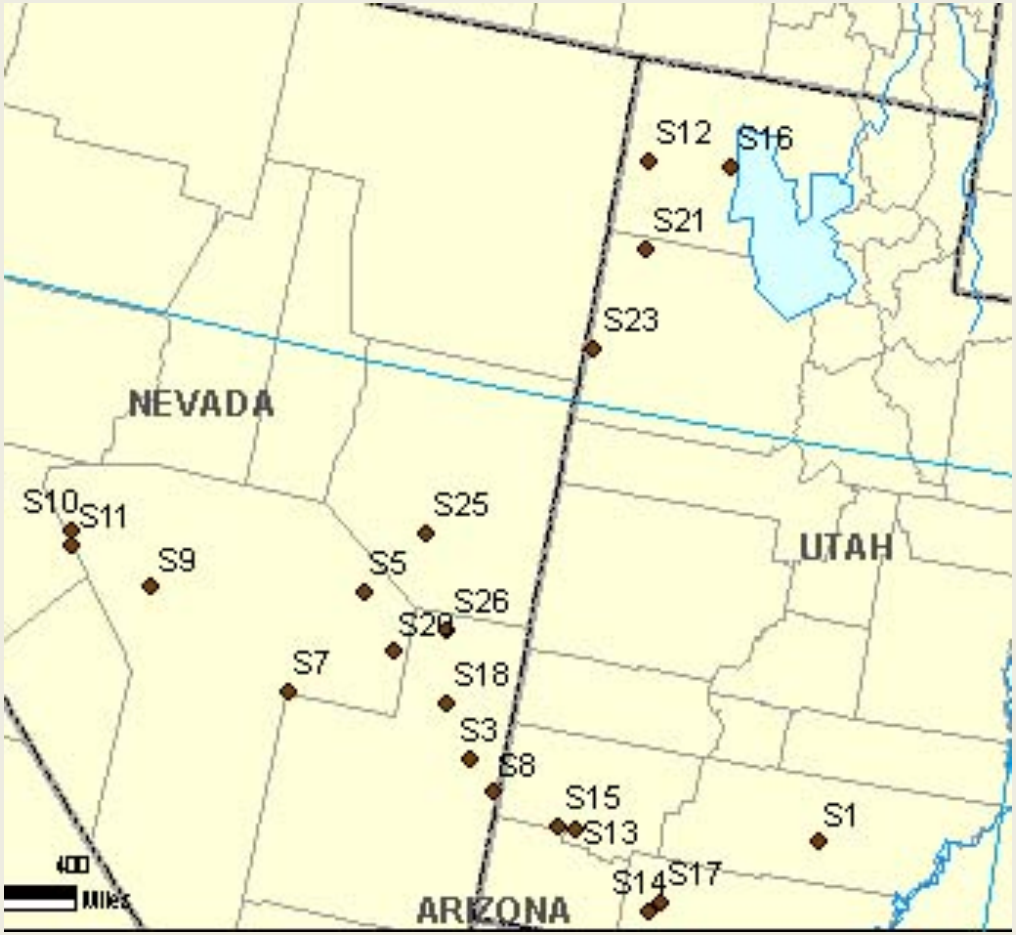
Dalea searlsiae



Trait Variation – *D. searlsiae*

Trait	*P* value
Dry matter yield, g/plot	**
Plant height, cm	**
No. of stems	**
No. of inflorescences	**
Foliage diameter (cm)	**
ADF%	**
NDF%	*
Crude protein (CP), %	**
Inflorescence weight, g/plot	**
Flowering date	*

[1]* = $P < 0.05$, ** = $P < 0.01$

Traits	PC1	PC2	PC3
Eigenvalue	4.28	2.54	2.32
Cumulative proportion	0.63	0.76	0.87
Dry matter yield, Hyde Park	0.78	0.25	-0.33
Dry matter yield, Millville	0.86	0.25	0.17
Inflorescence weight	0.95	0.16	-0.19
No. of inflorescences, Millville	0.76	0.10	-0.57
No. of inflorescences, Hyde Park	0.61	0.26	-0.64
Flowering date	-0.07	-0.26	0.92
Plant height	0.48	0.45	0.17
No. of stems	0.46	0.20	-0.37
Foliage diameter	0.69	0.18	-0.39
Acid detergent fiber	0.29	0.75	-0.45
Neutral detergent fiber	0.08	0.94	-0.11
Crude protein	-0.24	-0.72	0.20

PC1 loadings high for: DMY & seed yield
PC2 loadings high for: Forage quality traits
PC3 loadings high for: Flowering date

Trait variation and collection site – *D. searlsiae*

	Elev	Temp	Precip
PC1	0.26^{ns1}	0.17^{ns}	0.76**
PC2	0.11^{ns}	0.15^{ns}	0.31^{ns}
PC3	-0.50*	0.50*	-0.11^{ns}

Recall that PC1 ~ DMY and seed yield.

Precipitation helped to shape the genetic variation for these traits on the landscape.

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Precipitation structure - *D. searlsiae*

~12”

~14”

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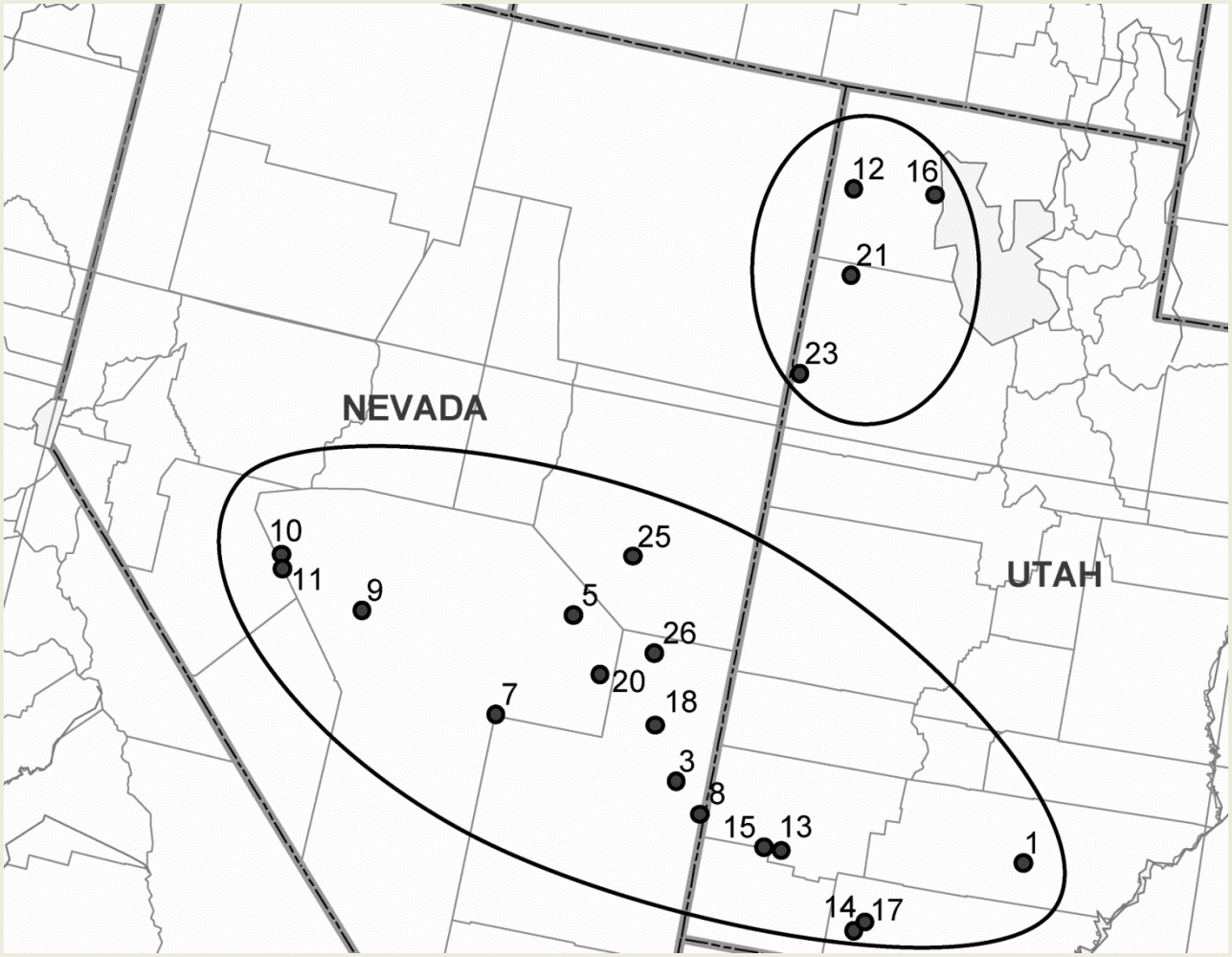
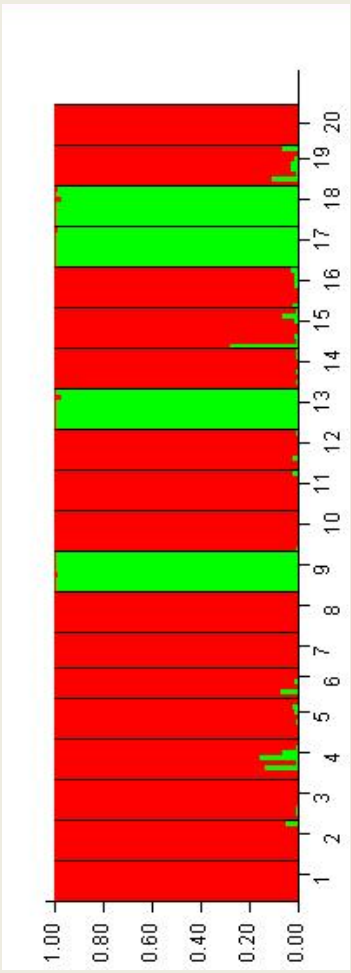
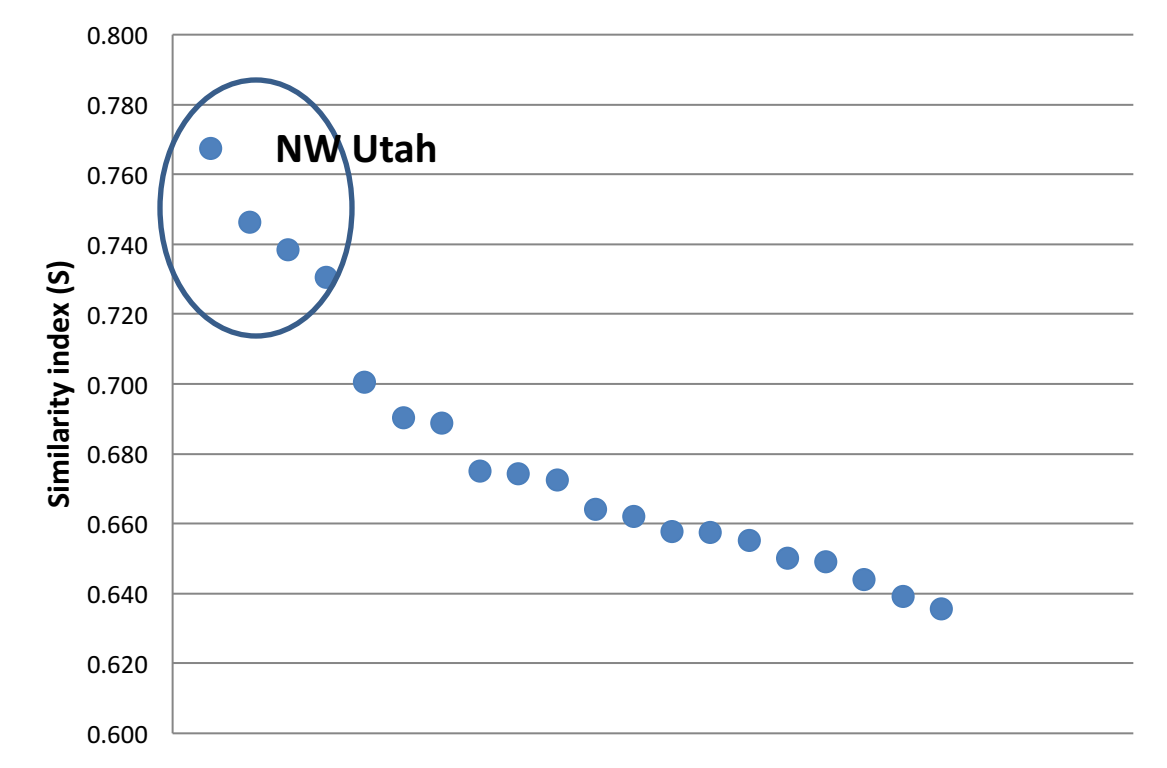
Molecular variation and structure - *D. searlsiae*





Similarity within collections – *D. searlsiae*

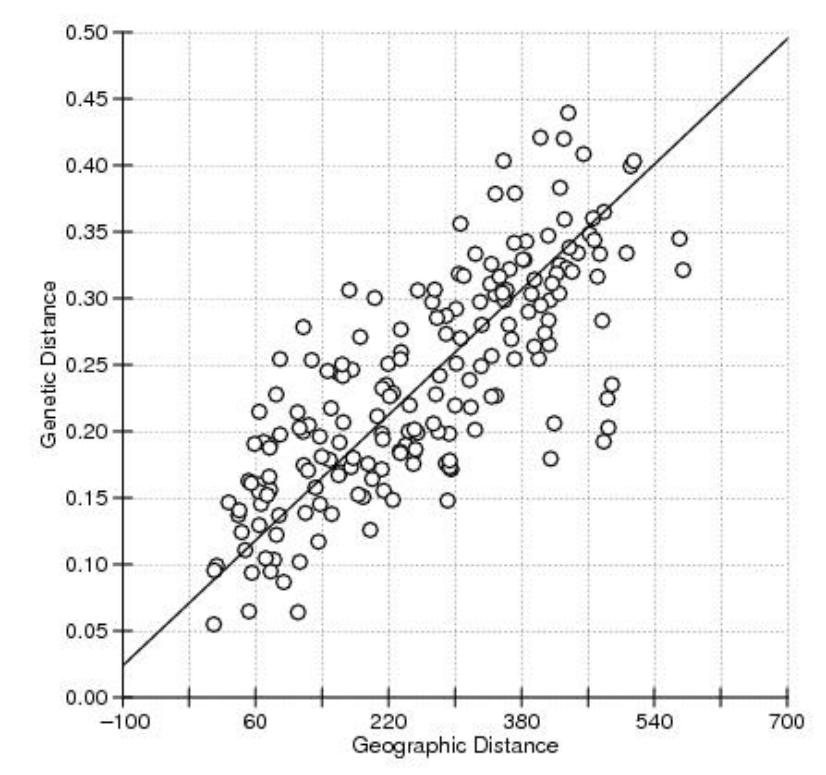
Under lake Bonneville



How molecular variation relates - *D. searlsiae*

Comparison	r
Genetic vs. Geographic	0.76**
Genetic vs. Phenotypic	0.37**
Genetic vs. Elevation	0.30*
Genetic vs. Precipitation	0.01ns
Genetic vs. MA Temp.	0.16ns

Differences in precip. did not Correspond to genetic differences.



Strong isolation by distance.

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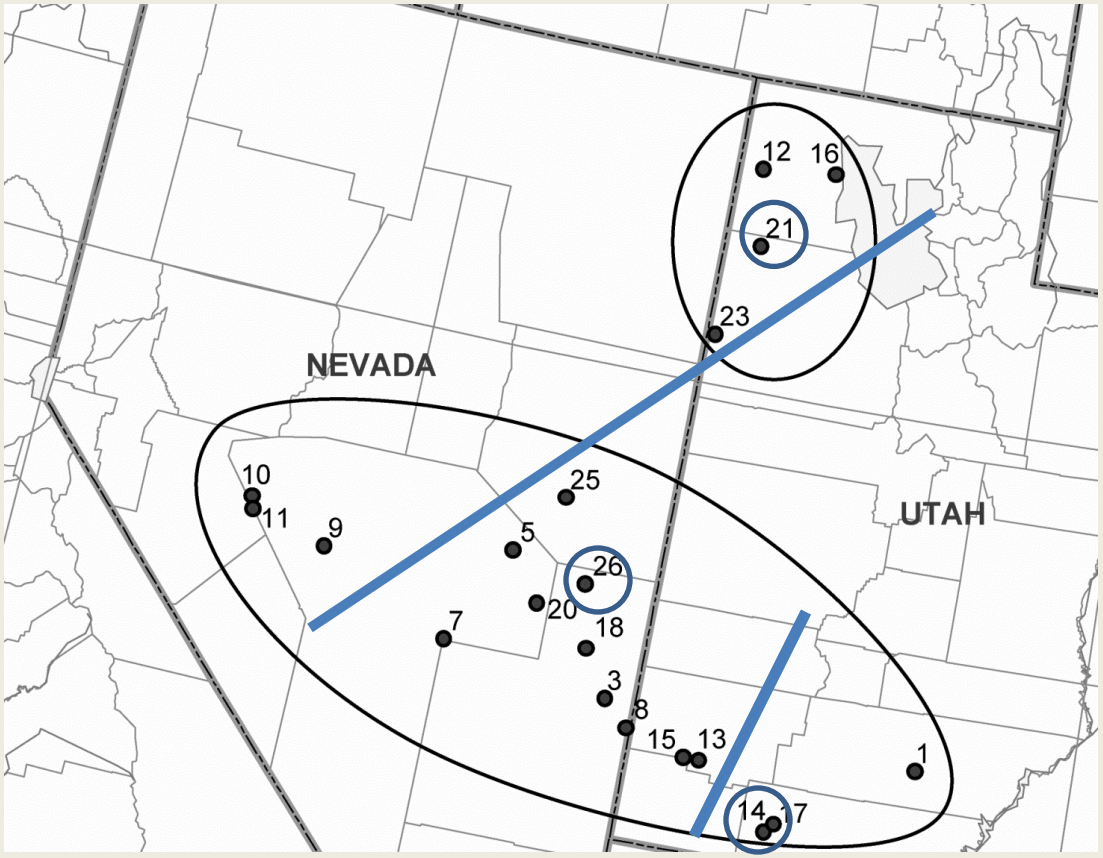
Release strategy - *D. searlsiae*



Two common-garden and molecular marker supported releases.

A third was requested because some collections officially reside in the Colorado Plateau.

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Release strategy - *D. searlsiae*

	Collection	Infl. weight (g.plot^{-1})	No. of infl.	No. of infl.
	Ds-12	29.6^{EFG}	32.2^{CDEFG}	25.4^{BCDE}
	Ds-16	21.7^{G}	26.8^{EFG}	8.8^{G}
*	Ds-21	22.7^{G}	22.3^{G}	9.8^{FG}
	Ds-23	30.2^{DEFG}	27.8^{DEFG}	16.3^{DEFG}
	Ds-03	57.6^{BCD}	44.0^{ABCDE}	32.9^{ABC}
	Ds-05	20.7^{G}	26.1^{DEFG}	15.3^{EFG}
	Ds-07	22.1^{FG}	23.9^{FG}	18.2^{DEFG}
	Ds-08	49.1^{BCDE}	45.2^{ABCDE}	35.5^{AB}
	Ds-09	32.6^{DEFG}	33.8^{CDEFG}	20.4^{BCDE}
	Ds-10	33.5^{CDEFG}	43.1^{ABCDEF}	24.6^{BCDE}
	Ds-11	27.9^{EFG}	35.2^{CDEFG}	24.1^{BCDE}
	Ds-13	65.4^{AB}	52.3^{ABC}	45.0^{A}
	Ds-15	82.5^{AB}	60.5^{AB}	45.9^{A}
	Ds-18	51.3^{BCD}	44.6^{ABCDE}	35.2^{AB}
	Ds-20	29.5^{DEFG}	33.6^{CDEFG}	32.6^{ABC}
	Ds-25	46.3^{BCDEF}	44.7^{ABCDE}	32.5^{ABC}
*	Ds-26	61.3^{ABC}	46.7^{ABCD}	35.2^{AB}
	Ds-01	20.7^{G}	29.9^{DEFG}	-
*	Ds-14	72.7^{AB}	42.0^{BCDEF}	25.8^{BCDE}
	Ds-17	58.4^{BCD}	34.1^{CDEFG}	21.1^{CDEF}

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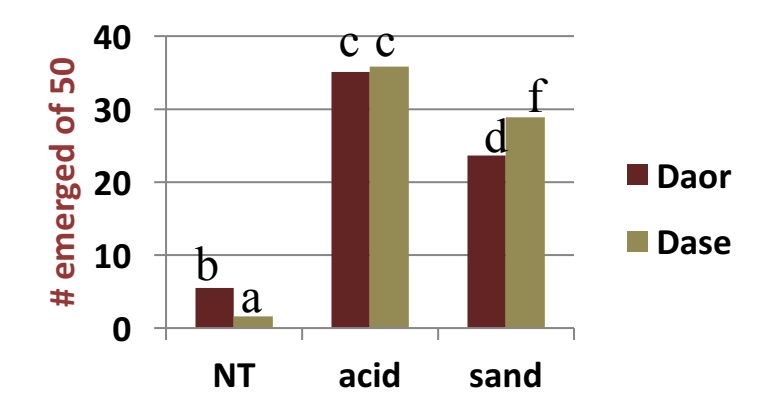
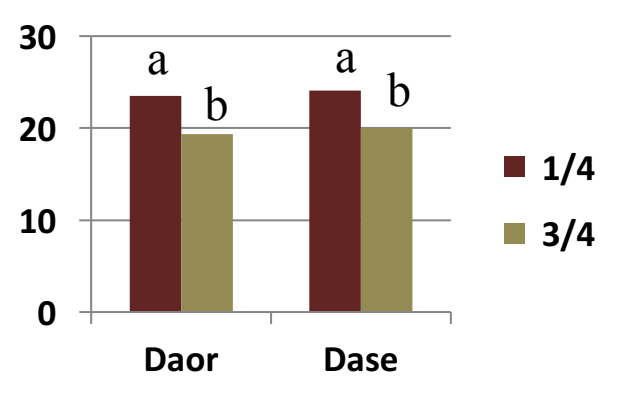
Germination and establishment

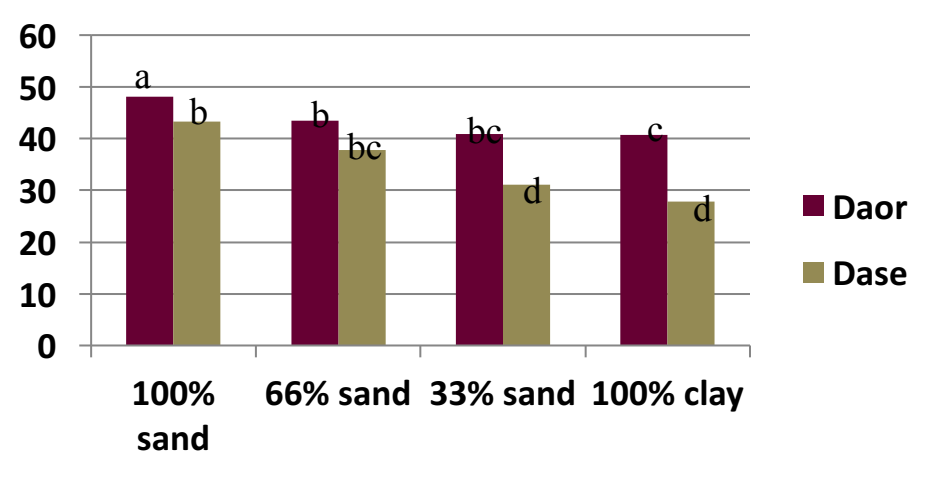
Germination and establishment



Acid scarification best, emergence at ~70%.



¼" depth better than ¾".



Sandy soils work best in both species, emergence near 100% for ornata and near 85% for searlsiae.

Seed production

shattering

>150 lbs/ acre

2017 seed requests thus far:
61 lbs
4 entities

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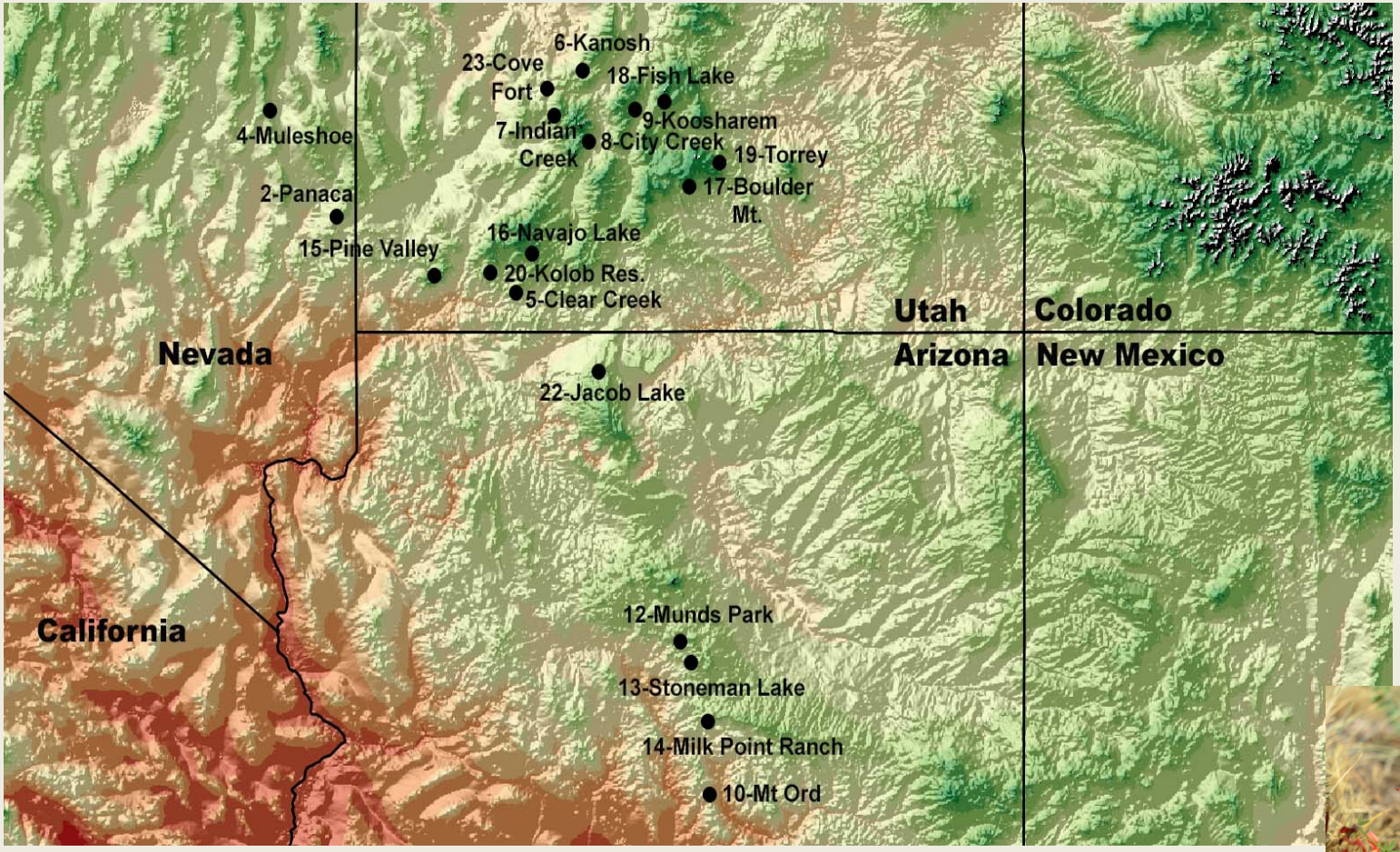
Lotus utahensis & wrightii



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Trait variation – *L. utahensis*

Trait	P value
Dry matter yield, g/plot	**
Plant height, cm	**
No. of stems	**
No. of inflorescences	*
Inflorescence weight, g/plot	**
Foliage diameter (cm)	**
ADF %	--
NDF%	*
Crude protein (CP), %	**
Flowering date	*

[1]* = P < 0.05, ** = P < 0.01

Variable	Factor1	Factor2	Factor3
Eigenvalue	3.33	1.05	0.41
Cumulative	0.67	0.88	0.96
Morphology (C)	-0.48	0.79	0.28
Forage Quality (C)	-0.14	0.89	0.35
Condensed Tannins (D)	-0.11	0.34	0.93
Survival (D)	0.97	-0.10	-0.08
Phenology (C)	0.84	-0.49	-0.13

Factor 1: survival and flowering time
Factor 2: DMY, morphology, forage qual.
Factor 3: tannins

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Trait variation and collection site – *L. utahensis*

	phenology & survival	morphology & quality	tannins
	Factor 1_{LU}	Factor 2_{LU}	Factor 3_{LU}
Latitude	0.17 ns	0.08 ns	0.15 ns
Longitude	0.02 ns	-0.01 ns	0.1 ns
Elevation	0.32 ns	0.11 ns	-0.17 ns
Mean Ann Temp	-0.22 ns	-0.17 ns	0.17 ns
Diurnal Temp Range	-0.25 ns	0.18 ns	0.05 ns
Warmest Month High	-0.27 ns	-0.09 ns	0.18 ns
Coldest Month Low	-0.22 ns	-0.21 ns	0.1 ns
Mean Ann Precip	-0.35 ns	0.22 ns	-0.22 ns

Factors were not even moderately correlated with any environmental characteristic, so no indications of strong local adaptation.

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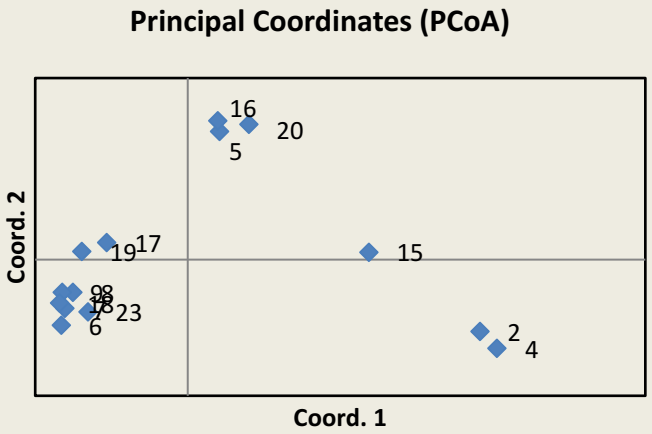
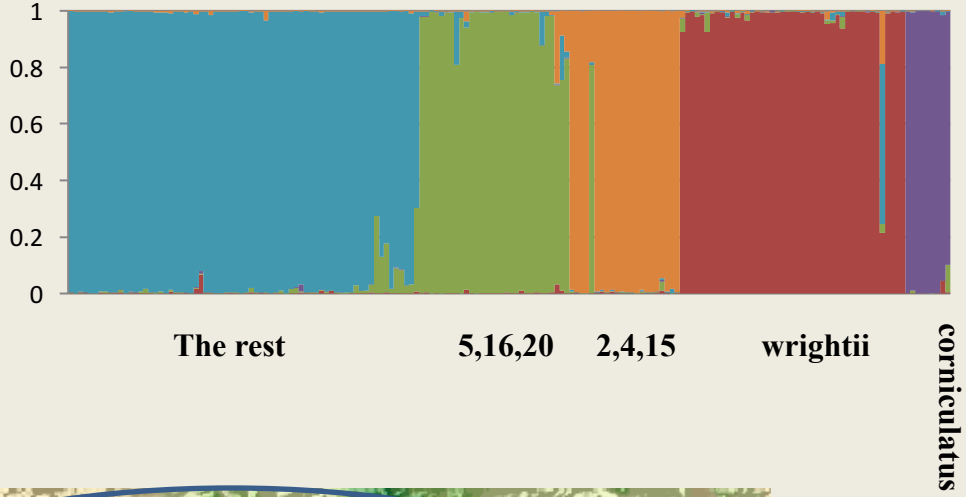
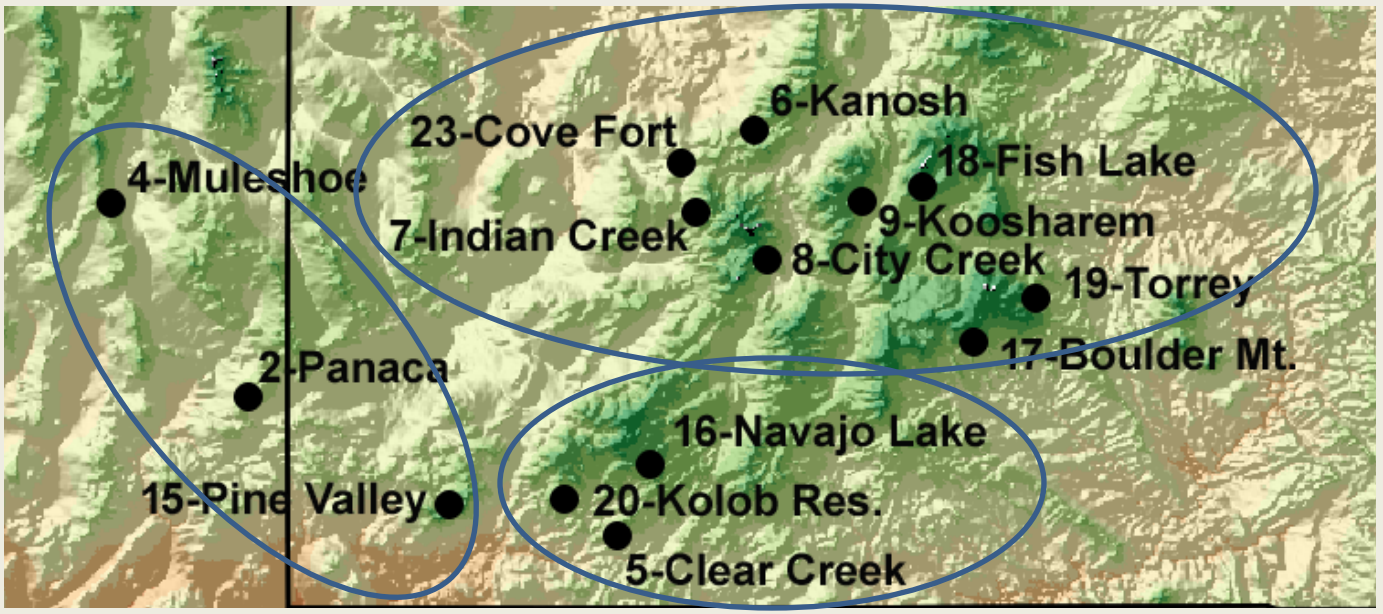
Molecular variation and structure – *Lotus*







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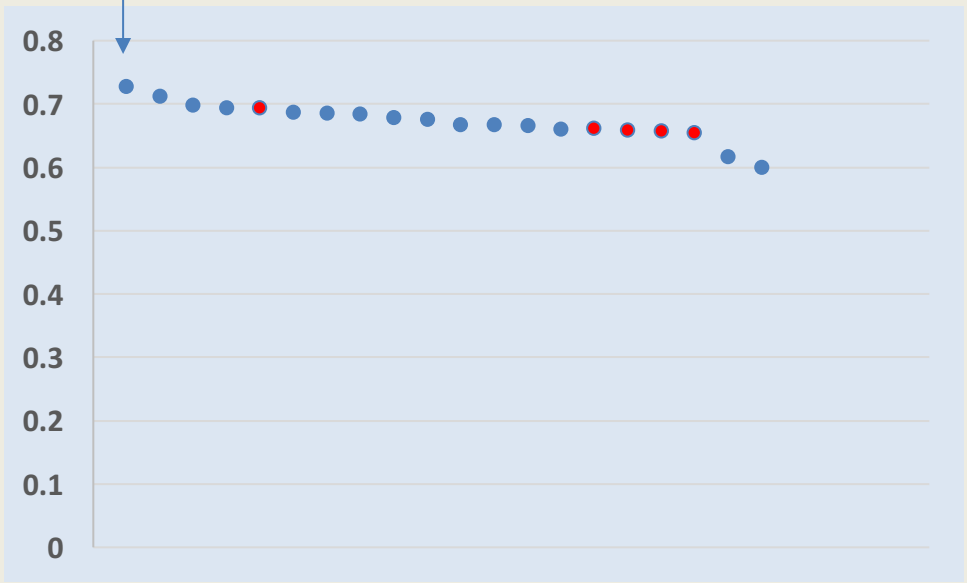
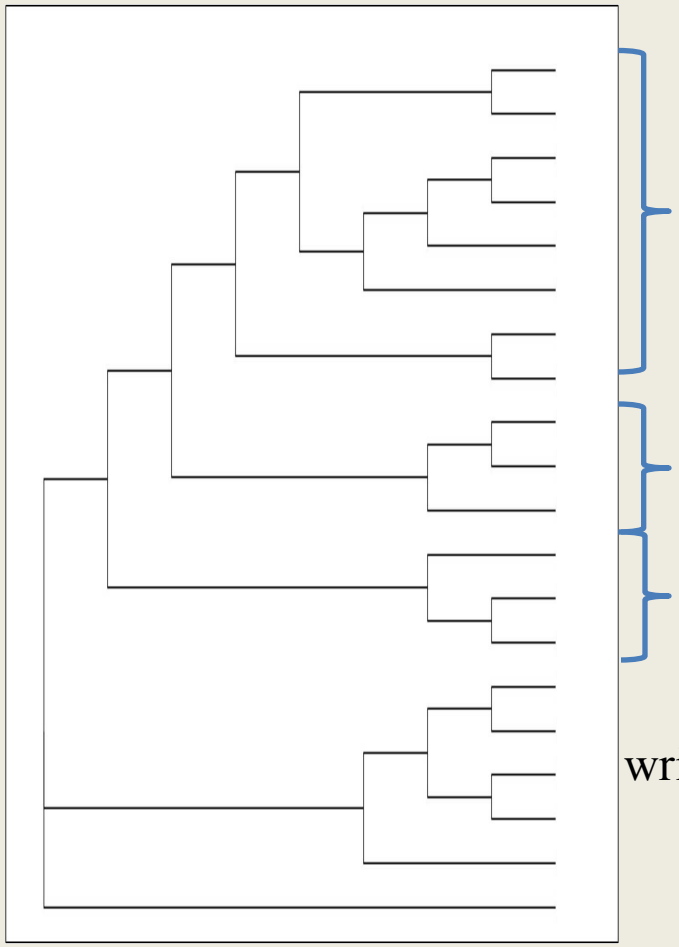
Similarity within collections – *Lotus*

corniculatus



How molecular variation relates – *L. utahensis*

Discriminant Analysis: 3 groups within *utahensis*



DMY
Flowering date
Pod mass

distinguished the 3 *utahensis* groups.

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Seed Pod Weight in *Lotus* Collections

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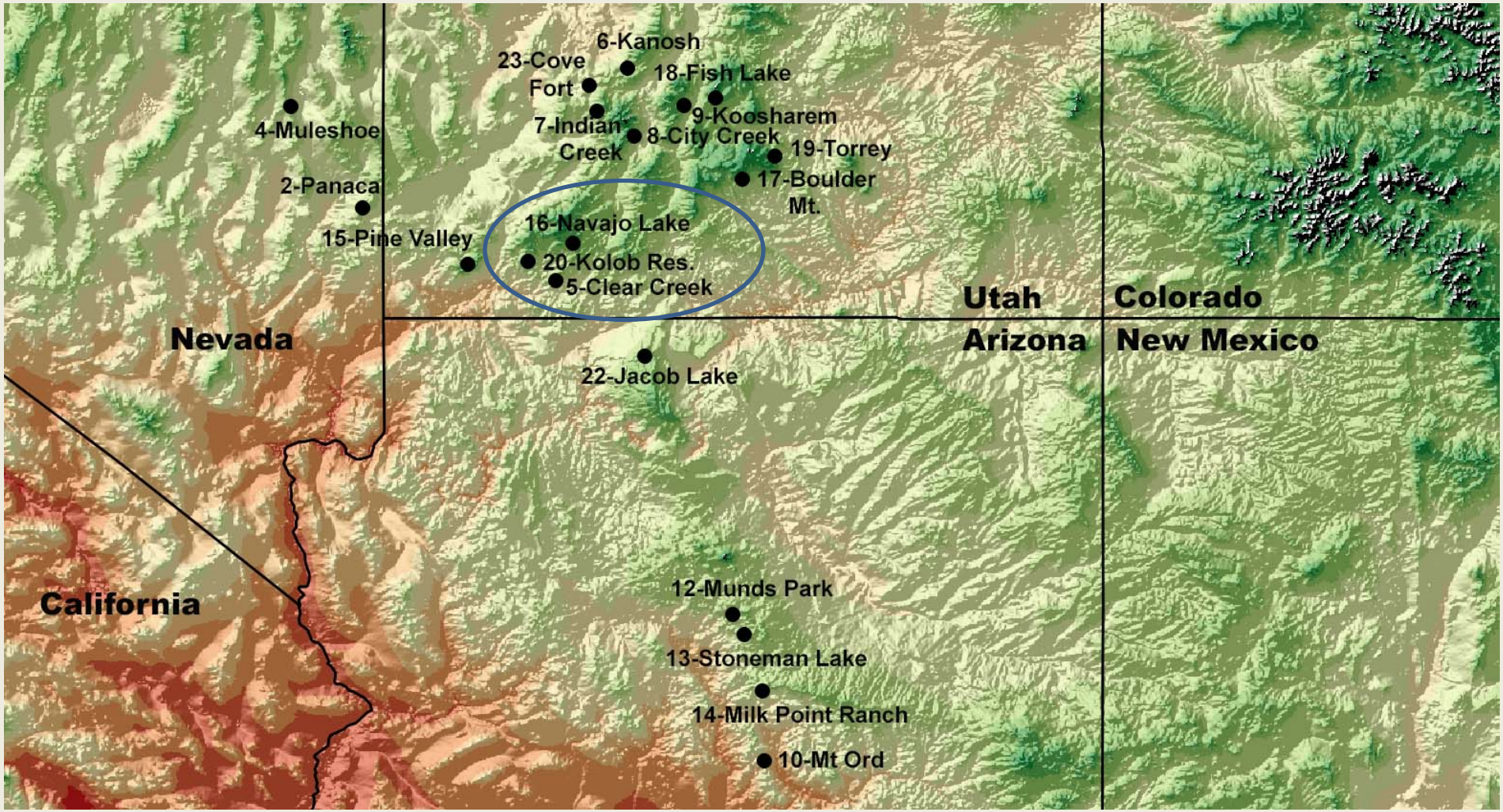
Release strategy – *L. utahensis*



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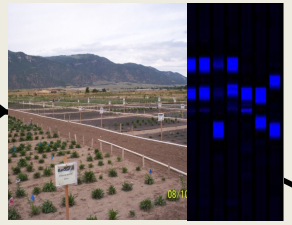
Pipeline for germplasm development

1. Seed collection



2. Evaluation

3. Select appropriate releases

4. Germination and establishment protocols

5. Seed production

6. Release for seeding

Other species

Astragalus filipes

Dalea ornata

Hedysarum boreale

Thank you!

Doug Johnson – 41 years
Kevin Connors – 30 years
Lisa Michaels
Kim Thorsted
Jason Stettler
Kishor Bhattarai

GREAT BASIN Native Plant PROJECT

The preceding presentation was delivered at the

2017 National Native Seed Conference

Washington, D.C. February 13-16, 2017

This and additional presentations available at http://nativeseed.info

NATIVE SEED NETWORK

Institute for Applied Ecology