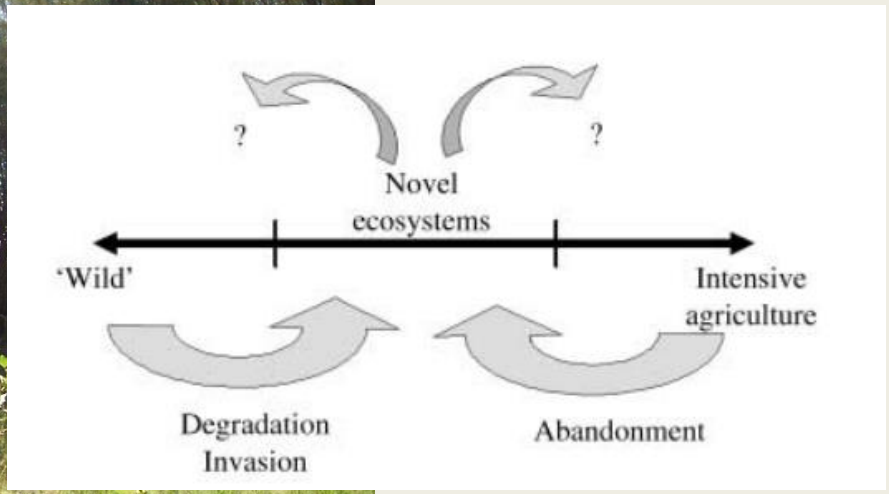
PREDICTORS OF PLANT FUNCTIONAL TRAITS IN A NOVEL ECOSYSTEM

Alexander R. B. Goetz, Annie L. Henry, Eduardo González, and Anna A. Sher

UNIVERSITY of DENVER

Background



Hobbs et al. 2006

Main research question

Do abiotic site conditions affect habitat suitability for the Southwestern willow flycatcher, as measured by functional traits?

Functional traits

	A	B	C	D	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1					CHFR3	CHTE2	CHLI3	CHNA2/ERNAN	CIIN	CIAR4	CIVU	CLLI2	COUM	COAR4	COCA5	COSE16	DACA7	CYDA
2					Che_fre	Cho_ten	Chr_lin	Chr_nau	Cic_int	Cir_arv	Cir_vul	Cle_lin	Com_umb	Con_arv	Con_can	Cor_ser	Dal_can	Cyn_dac
11				Family	Chenopodiacea	Brassicacea	Asteraceae	Asteraceae	Asteraceae	Asteraceae	Asteraceae	Ranunculacea	Santalaceae	Convolvulaceae	Asteraceae	Cornaceae	Fabaceae	Poaceae
12				Genus	Chenopodium	Chorispora	Chrysothamn	Chrysothamnus	Cichorium	Cirsium	Cirsium	Clematis	Comandra	Convolvulus	Conyza	Cornus	Dalea	Cynodon
13				Species	fremontii / rubr	tenella	linifolius	nauseosus	intybus	arvense	vulgare	ligusticifolia	umbellata	arvensis	canadensis	sericea	candida	dactylon
14				Common	Fremont's goos	Crossflower	Spearleaf rabl	Rubber rabbitb	Chicory / Cornf	Canada thistle	Bull thistle	Western whit	Bastard toadfl	Field bindweed	Canadian horse	Redosier dogw	White prairie cl	Bermudagrass
15				Nativity	Native	Exotic	Native	Native	Exotic	Exotic	Exotic	Native	Native	Exotic	Native	Native	Native	Exotic
24	Traits I would really			Duration	Annual	Annual	Perennial	Perennial	Perennial	Perennial	Annual	Perennial	Perennial	Perennial	Annual	Perennial	Perennial	Perennial
25	Trait not found after si			USDA cod	CHFR3	CHTE2	CHLI3	CHNA2/ERNAN	CIIN	CIAR4	CIVU	CLLI2	COUM	COAR4	COCA5	COSE16	DACA7	CYDA
26	will need more attentio			Species co	Che_fre	Cho_ten	Chr_lin	Chr_nau	Cic_int	Cir_arv	Cir_vul	Cle_lin	Com_umb	Con_arv	Con_can	Cor_ser	Dal_can	Cyn_dac
27				**Search Co**	Alex	Kayleigh	Kayleigh	Kayleigh	Alex	Kayleigh	Kayleigh	Sarah	Alex	Sarah & Kayleig	Palmquist	Alex	Alex	Palmquist
30	SLA2	Specific	centim	cm2g-1					368.321					172.15	270.2702703		81.28	250
31	RGR	Relative	grams	g g-1day-1				0.0037	0.1725	0.11	0.124			0.107	0.26	0.097		
32	Salin_r	Maxim	deciSie	dS/m			10	6						16	4	100		6.9
33	Seed_\	Weight	Weigh	grams	0.395	1.2	1.8	1.176	1.2	1.3	2.6	2.62	112.523	15.1	0.08	27.0963	1.3	0.2
34	rt_dpt_	Maxim	Maxim	meters					0.2	6.75	3.25			3	0.33		2.1336	1.5
35	HT_ma	Averag	Averag	meters	0.54	0.35	2.5	1.22	0.6096	0.825	0.9	0.305	0.2	0.048	1.52	2	0.43	0.43
36	Anae_	Anaer	Anaer	1 - None,	1	4		1	2	2		1		2	2			4
37	Drgt_T	Drough	Drougl	1 - None, 2	4			4	3	1	2	3	4	4	2	4	4	3
38	Fire_tc	Fire tol	Fire to	1 - None, 2	4			2	3	3		3	4	4	2	4	4	4
39	Mois_t	Moistu	Moistu	2 - Low, 3 -				3	4	4		3		2	3	4		4
40	Salin_t	Salinity	Salinit	1 - None, 2	4		4	3	1	4		2		4	2	3		3
41	Shade_	Shade t	Shade	1 - Low, 2 -	3	1		1	1	1	1	2		1	1	1	1	1
42	Growth	Growth	Growt	1 - Slow, 2 -		3		1	3	3		2			3	3		3
43	Lifespa	Lifespa	Expect	1 - Annual,	1	1		4	2	3	2	4	2	3	1	2	3	4
44	Sex_re	Ability	Sexual	1 - Yes, 2 - I	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	Veg_re	Ability	Vegeta	1 - Yes, 2 - I	2	2	2	2	2	1		1	1	1	2	1	1	1
46	Spread	Spread	Vegeta	1 - None, 2	1	1	1	1	1	4		3		4	1	3		4
47	Respro	Respro	Respro	1 - Yes, 2 - I	2			1	2	2	2	1		1	2	1	1	2
48	Actual_	Bloom	Range	Beginning	Spring-summer	Mar-May	Aug-Sep	Jul-Oct	Mid Summer	Jun-Aug	Jun - Sep	Mid Summer	May-?	Jun-Sep	Apr-Nov	May-June	July-Sep	Mar-Oct
49	numeric bloom period				3-8	3-5	8-9	7-10	6-8	6-8	6-9	6-8	5	6-9	4-11	5-6	7-9	3-10

See: Palmquist et al. 2016, Henry et al. *in prep*

Specific Leaf Area (SLA)

- Area per dry mass of leaf
- Considered one of the most important functional traits
- Reflects relative growth rate, stress tolerance, leaf longevity
- Correlates with temperature, light availability, water availability

Weiher et al. 1999
Poorter et al. 2009

Branching structure

- Most important functional trait for SWFL habitat
- SWFL requires:
  - *Dense branches 4-6 m above ground*
  - *Intact canopy*

Kus et al. 2000
Raynor et al. 2017

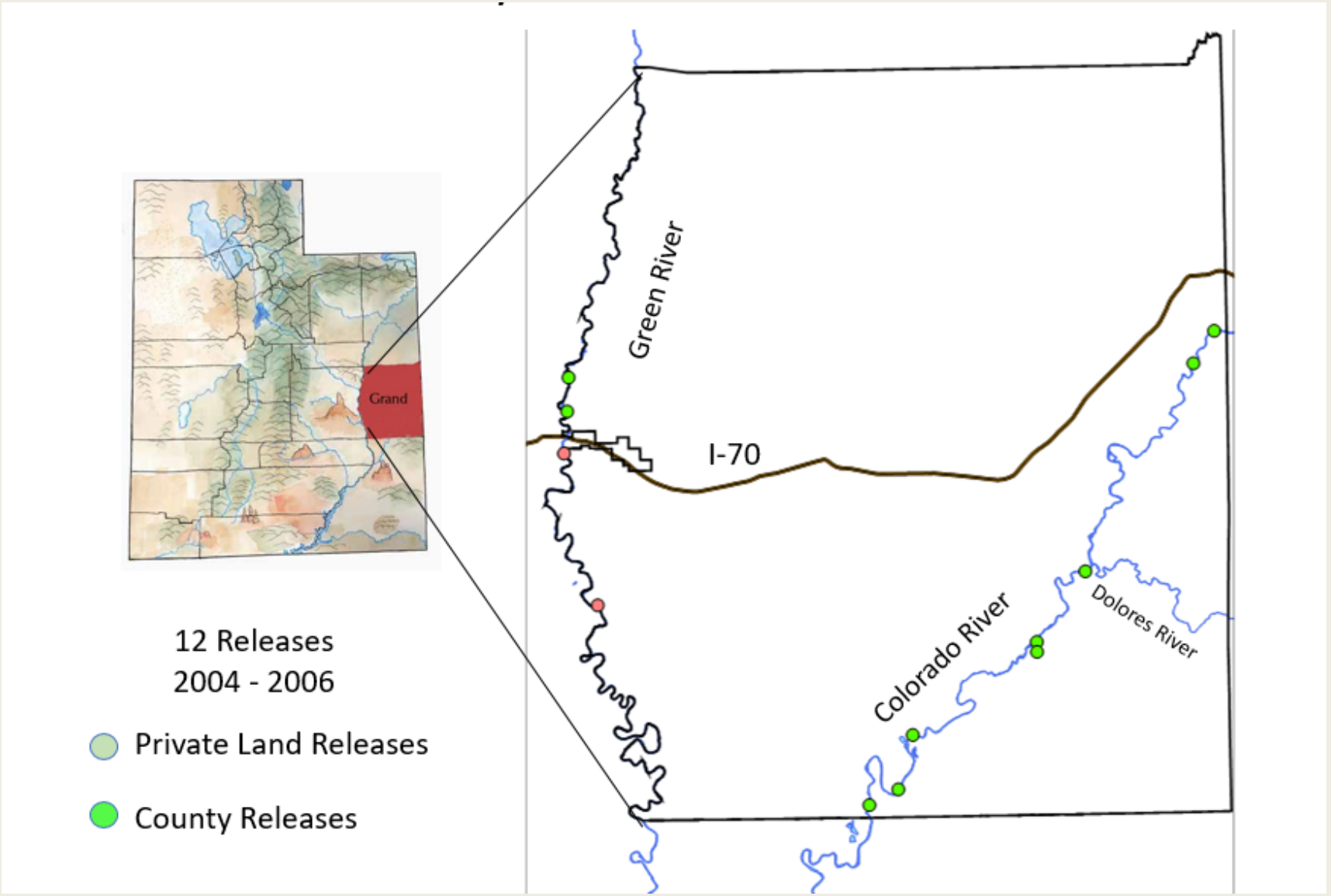
To address today

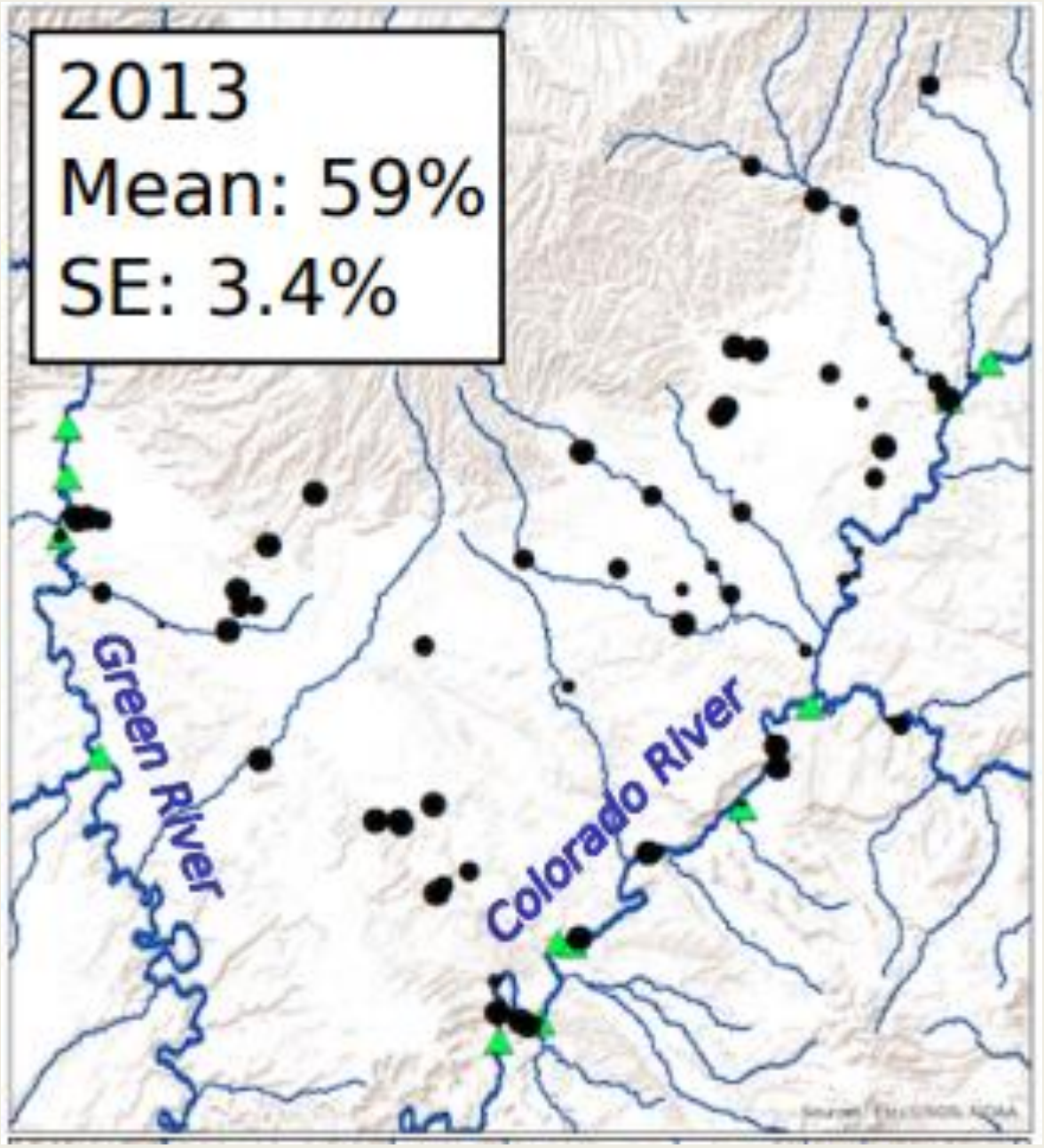
Does specific leaf area and branching structure of *Tamarix* vary with site environmental conditions?

Can we use published literature values for specific leaf area of *Tamarix*?

Methods

- Sampled 34 sites in and around Grand County, UT
- Collected 10 leaves per 10m transect, 5 transects per site
- Measured branching structure at each transect
- In lab, measured leaf area and mass using methods from Perez-Harguindeguy et al. 2013
- Branching structure compared using Gower dissimilarity


Grand
12 Releases
2004 - 2006
Private Land Releases
County Releases
Green River
I-70
Colorado River
Dolores River

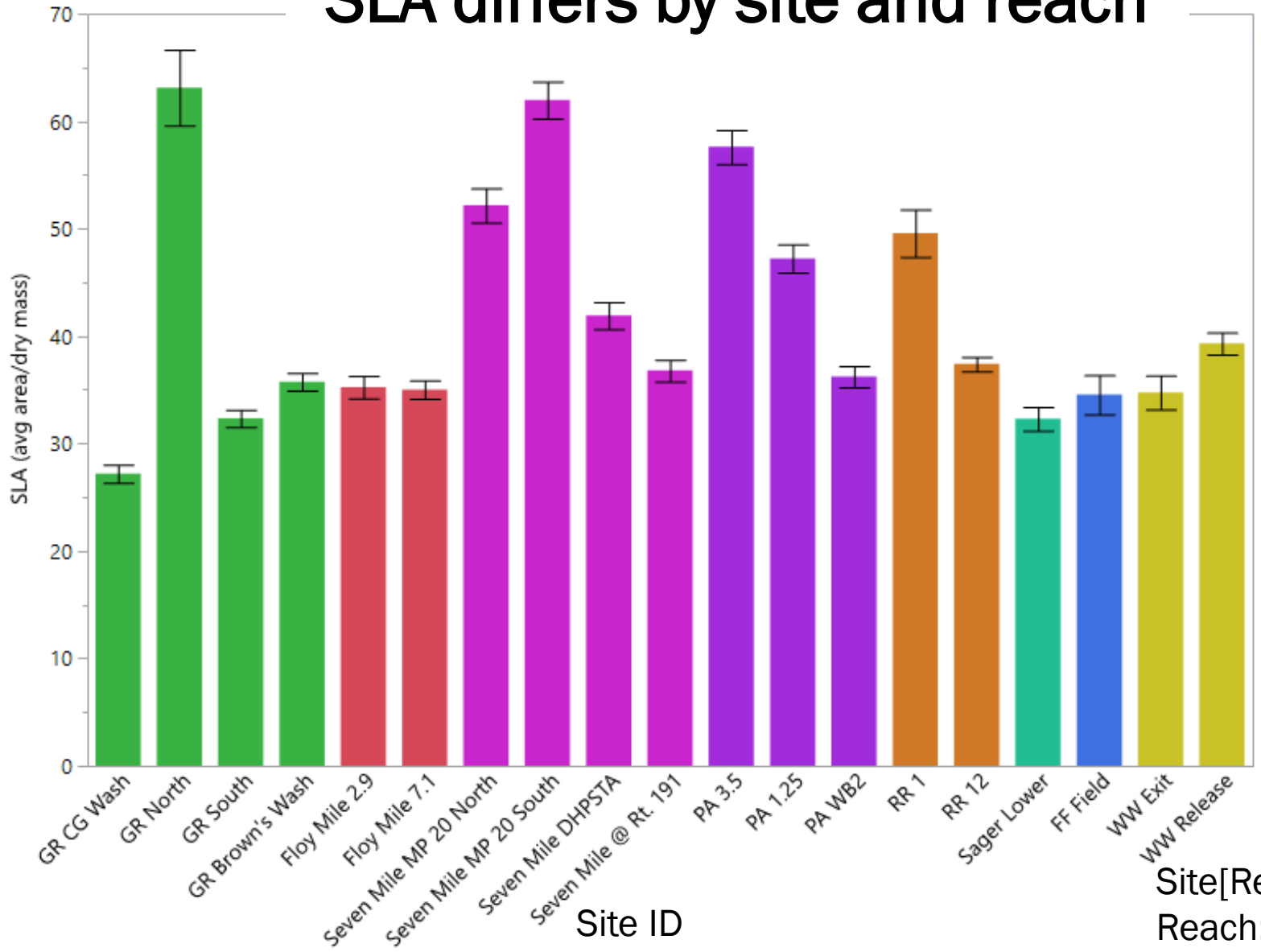


Henry et al. 2017

Environmental variables

- Soil
  - *Electrical conductivity*
  - *pH*
  - *Percent sand*
- Distance to water
- Elevation above sea level
- Longitudinal slope
- Grazing intensity
- Beetle presence
- Cover of standing dead *Tamarix* (estimate of biocontrol intensity)

SLA differs by site and reach

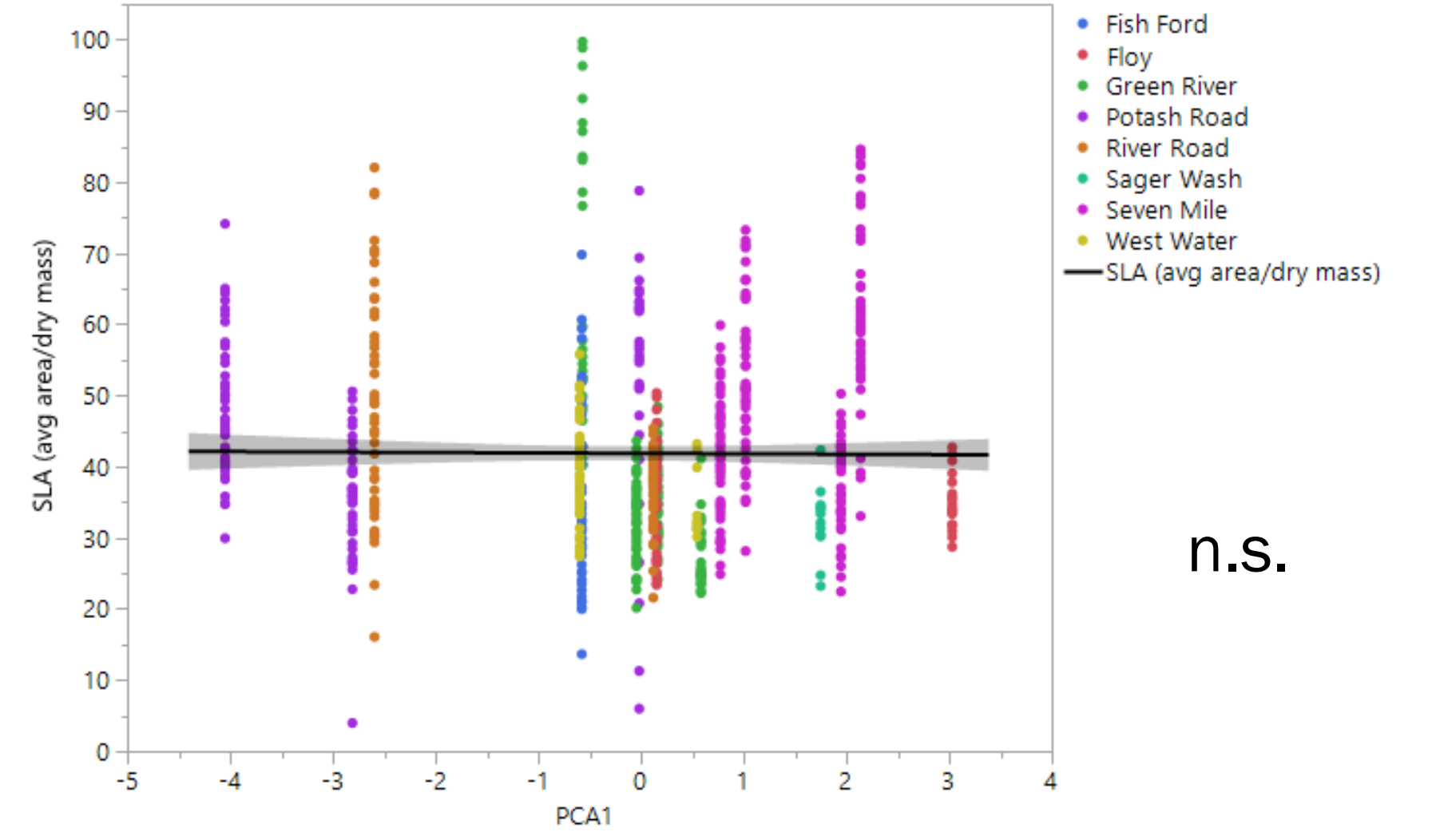


F = 38.71
p < .0001

Site[Reach]: F = 46.06, p < .0001
Reach: F = 24.16, p < .0001

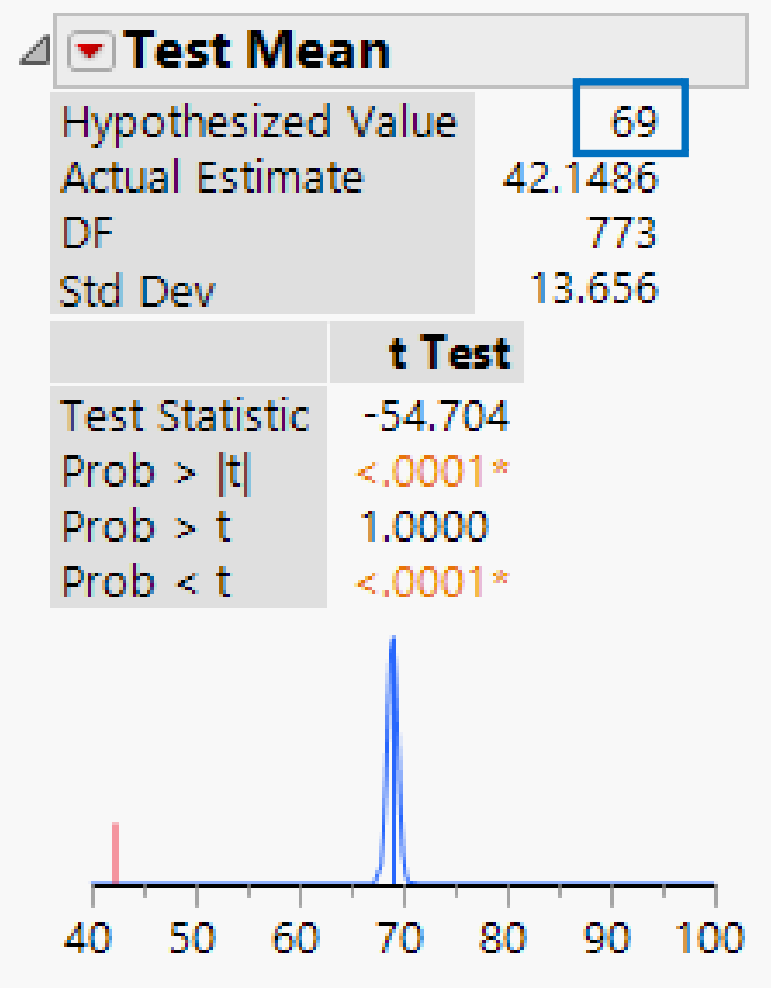
South ← → North

Environmental variables do not explain SLA

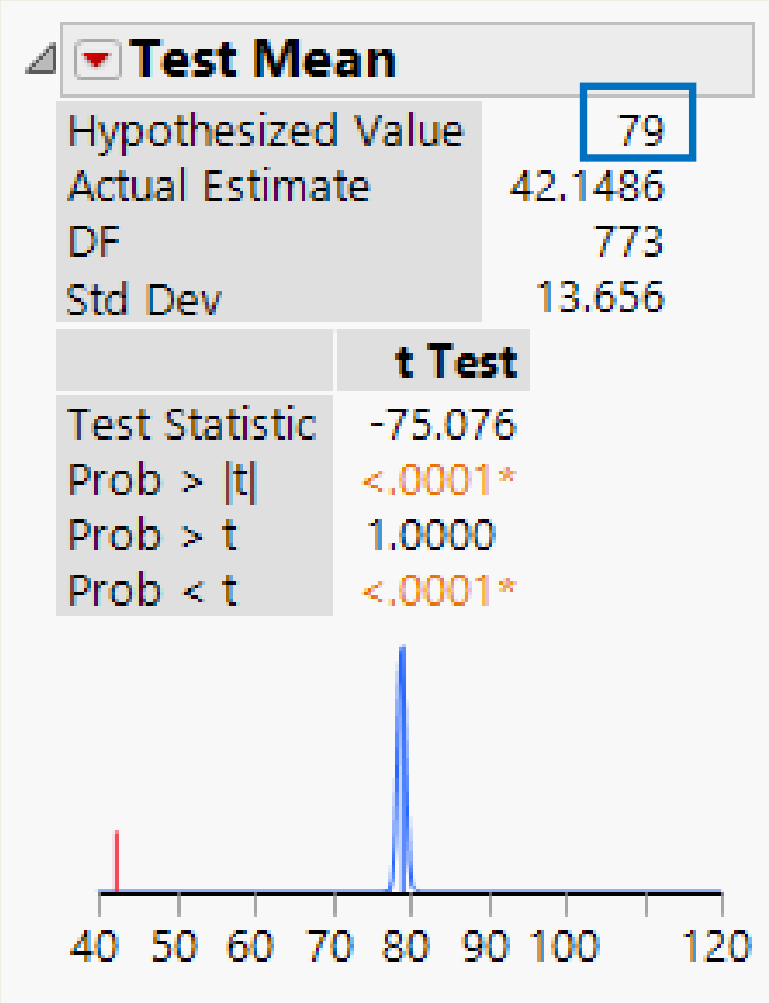


n.s.

Our results do not match literature values

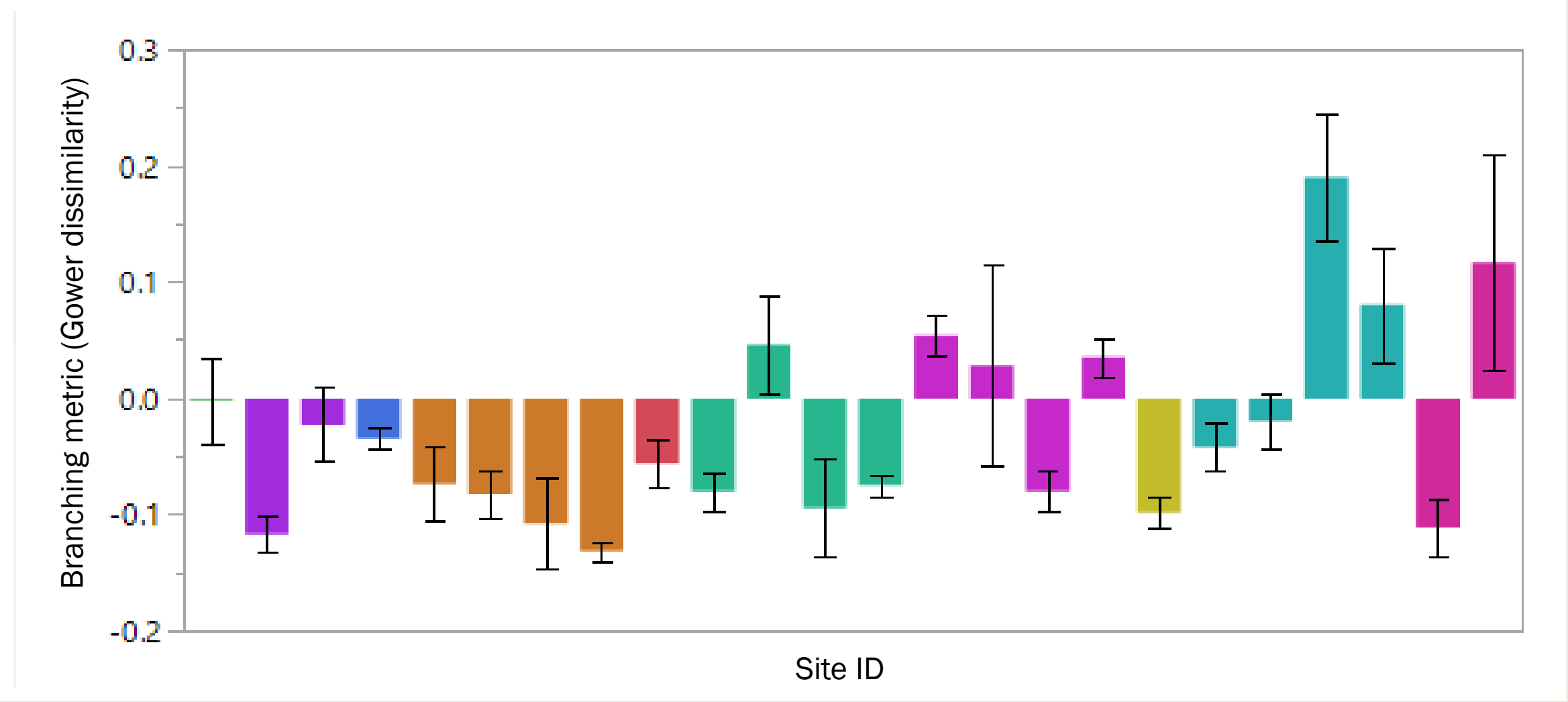


Horton et al. 2001



Nagler et al. 2009

Branching structure also differs by site and reach



Environmental variables partially explain branching structure

Variable	T	p
Soil electrical conductivity	-2.67	.009 *
River width	2.22	.029 *
Percent Tamarix dead per site	2.24	.028 *
Elevation above sea level	1.62	.108

Results of stepwise selection

$R^2 = .17$

What's going on?

- SLA is predicted by temperature, light availability, and water availability
- No clear gradient in environmental variables between sites
- Within this county, there is not much spatial variation in temperature and light availability
- Genetic variation is a possible explanation

Sher and Quigley 2013

What’s going on?

- Literature values were collected at different locations from our study - this suggests high interspecific variation
- Branching structure seems to be affected by these environmental variables, but the model does not explain much of the variation

Future directions

- Full series of traits
- Other species
- Additional abiotic variables
- More in-depth look at branching structure

Acknowledgements

- Funding:
  - *National Science Foundation CNH grant; University of Denver, Division of Natural Sciences and Mathematics, Partners In Science undergraduate research grant, NSM eSTEM fellowship, University of Rochester Intern fellowship*
- Collaborators:
  - *Dr. Anna Sher, Annie L. Henry, Dr. Eduardo González, W. Wright Robinson*
- Research Assistance:
  - *Emily Palmquist, Dr. Barbara Kus*
- Undergraduate field assistants:
  - *Kate Petty, Katie Newman, James Sheinbaum, Amy Sahud, Jack Bailey, Alexandra Harper, Jake Ryor*

Questions?

Alexander Goetz

alexander.goetz23@du.edu

alexgoetz.weebly.com

The Sher Lab