

QUANTIFYING NECTAR TRAIT RESPONSES TO NATURAL VARIATION
IN WATER AVAILABILITY IN SUBALPINE PLANT COMMUNITIES

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IN WATER AVAILABILITY IN SUBALPINE PLANT COMMUNITIES

By

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A study conducted during the Independent Research Program at the Rocky
Mountain Biological Laboratory (RMBL) and the STEM Scholars Program at
Agnes Scott College, under the direction of Dr. Paul CaraDonna, Dr. Jane
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Abstract

Floral rewards are crucial for plant reproductive success and pollinator survival. Although nectar volumes and sugar concentrations have been quantified for many species of flowering plants, many questions remain regarding sources of intraspecific and interspecific variation, including the effects of abiotic factors, such as temperature and precipitation, on community nectar production. Many of these abiotic factors are being altered under climate change, limiting our ability to predict the production of the important resource. To help address this knowledge gap, I quantified nectar traits (volume, sugar concentration, and total sugar content) for 24 pollinator-visited plant species in subalpine meadows varying in water availability. This allowed me to quantify interspecific variation in nectar traits, and to compare nectar traits at both the community and species levels, (1) between dry and wet meadow habitats, and (2) between a dry, early-snowmelt year and a wet, late-snowmelt year. I observed considerable variation in nectar traits among species. When comparing community nectar traits across dry and wet meadows for the entire summer growing season, I observed that nectar volume was greater in wet meadows. When comparing nectar traits across years, I found no overall differences in nectar traits between years, but a variety of patterns for individual species considered. Taken together, this research provides an image of the nectar resource landscape, and how this resource landscape may continue to respond to climate change.

Introduction

Floral rewards are important for plant reproductive success and for pollinator survival. The majority of plant species rely on pollinators for reproduction, and floral rewards represent a critical component of pollinators' diets (Ollerton et al. 2011). Many pollinators, such as bees, depend *exclusively* upon floral rewards for their nutritional needs. For example, adult bees subsist on nectar from flowers and feed floral nectar and pollen to their developing larvae (Willmer, 2011). Yet, despite the importance of floral rewards for both plants and pollinators, we know very little about their quantity and quality, as well as their distribution in natural landscapes, including how they are influenced by abiotic environmental variation. Floral abundance is often used as a proxy for floral reward availability (eg. Aldridge et al., 2011; Ogilvie et al. 2017; Thomson, 2016), but since there is both intraspecific and interspecific variation in floral rewards (e.g., Leiss & Klinkhamer, 2005; Petanidou, 2005), floral abundance may not accurately reflect reward availability in many cases. Instead, we need to quantify the floral reward landscape as a combination of floral abundance and floral reward availability. Understanding how this floral reward landscape changes with variation in abiotic factors is increasingly important for understanding the effects of climate change on plants and pollinators.

Climate change-induced alterations of abiotic factors—e.g., temperature and precipitation patterns—can have a multitude of effects on individual plants and entire plant communities (e.g., Gornish & Tylianakis, 2013; Scaven & Rafferty, 2013; Thomson, 2016). Yet, the effects of changes in abiotic factors on floral nectar production at a community scale are not known. For individual plant species (or small numbers of species), studies have found effects of water availability and temperature on both nectar volume (Carroll, Pallardy, & Galen, 2001; Gallagher & Campbell, 2017; Leiss & Klinkhamer, 2005; Petanidou et al., 1999; Terzić, Miklič, & Čanak, 2014; Waser & Price, 2016) and total nectar sugar content (Descamps, Quinet, Baijot & Jacquemart, 2018; Petanidou et al., 1999; Waser & Price, 2016). However, most pollinators interact with these rewards at the community level (Wilmer, 2011) — foraging from multiple species across a meadow, for example — making it important to understand nectar variations at this scale.

Under dry conditions (i.e., in drier habitats or in drought years), water availability may limit the amount of water allocated to nectar production, thus limiting nectar volume. Nectar sugar concentration may then increase, with the same amount of sugar excreted in a lower volume of water, or sugar concentrations may remain the same, if the plants have a mechanism for moderating their nectar concentration (e.g., Phillips et al., 2018). Alternatively, dry conditions may place additional stress on the plants that could reduce the amount of sugar they are able

to allocate to nectar, thereby decreasing nectar sugar concentration (e.g., Waser and Price, 2016; Descamps et al., 2018). Under wet conditions, in contrast, water availability and drought stress limitations are likely to be released, and higher volumes and greater sugar concentrations may be expected. Total nectar sugar content per flower depends on both nectar volume and nectar sugar concentration, and may be reduced under dry conditions both by limited volume excreted and lower sugar concentration due to drought stress. Variation in all three nectar traits at the community level will result from the combination of intraspecific effects on these nectar traits and differences in plant community composition.

My senior thesis research, conducted at the Rocky Mountain Biological Laboratory in Gothic, CO, USA, addresses how natural variation in water availability affects nectar volume, nectar sugar concentration, and total nectar sugar content (hereafter collectively referred to as “nectar traits”). I quantified these nectar traits for 24 common flowering species (see Table 1) in a series of subalpine meadows varying in water availability. Specifically, I quantified interspecific variation in nectar traits, and compared nectar traits at both the community and species levels, (1) between dry and wet meadow habitats, and (2) between a dry, early-snowmelt year and a wet, late-snowmelt year.

Methods

Study site description

This work was conducted around the Rocky Mountain Biological Laboratory (RMBL), in Gothic, Colorado, USA (38°57.5'N, 106°59.3'W). This high elevation ecosystem (2891 m above sea level in the Gothic townsite) is surrounded by aspen and conifer forests and dry and wet meadow habitats (Langenheim, 1962). The plants used by pollinators in these habitats are almost entirely native to the area; with the exception of *Taraxacum officinale*, *Trifolium pratense*, and *Trifolium repens*; meaning that the pollinator-flower community and its reward structure have been stable in these environments for a very long time. The RMBL has established floral and bumble bee surveys, as well as a long-term weather data set, that allows for extrapolation from relatively short-term nectar collection to estimate patterns of reward availability over time and space, as well as the potential to compare aspects of nectar quality with bumble bee usage.

Nectar collection and quantification

I collected nectar from 24 plant species common within subalpine meadows at six study sites near the RMBL (Jane Ogilvie, *unpublished data*). The plant species and sample sizes are listed in Table 1. Nectar data from the 10 species sampled in 2018 was provided by Atticus Murphy, Justin Bain, and Paul CaraDonna. The year 2018 had earlier snowmelt and less water accumulation than 2019 (Water

accumulation 1 May through 9 Aug: 2018, 7.75 cm; 2019, 17.27 cm. Weather data courtesy of billy barr.).

Nectar was collected using 1, 2, 5 or 10 μ l Drummond brand microcapillary tubes. For species with florets too small to fit a microcapillary tube (*E. flagellaris*, *E. speciosus*, *H. multiflora*, and *H. villosa*) or with nectar spread too thinly (*P. pulcherrima*), a nectar droplet was obtained by centrifuging the flower heads for one minute at 5000 rpm (*E. speciosus* and *E. flagellaris*) or 3000 rpm (*H. multiflora*, *H. villosa*, and *P. pulcherrima*). This droplet was then collected with a microcapillary tube, as in the other flowers.

The nectar volume was determined by measuring the proportion of the microcapillary tube that is filled and multiplying by the total volume the tube could contain. Nectar sugar concentration in degrees Brix (percent sucrose by mass) was then determined using a hand refractometer (Eclipse low-volume and No. 11654 0~92%) and converted to sugar content as described in Hicks et al. (2016). Plants were covered with pollinator exclusion bags (Midco Pollination Seed Hybridization Bags, 366 micro pore diameter; and sand-weighted insect nets, BioQuip, 1mm mesh, as in Thomson, Forrest, & Ogilvie, 2011) for 12 to 24 hours (with one exception at 48 hours) prior to nectar collection to prevent depletion of nectar stores. Samples thus included the standing crop of nectar plus

Table 1. Species and samples sizes from nectar sampling

Species	2018			2019		
	Number of nectar volume samples	Number of nectar concentration samples	Number of total nectar sugar content samples	Number of nectar volume samples	Number of nectar concentration samples	Number of total nectar sugar content samples
<i>Aconitum columbianum</i>	22	10	10	20	22	19
<i>Claytonia lanceolata</i>	-	-	-	48	37	37
<i>Delphinium barbeyi</i>	63	60	57	40	41	39
<i>Delphinium nuttallianum</i>	9	8	8	65	58	58
<i>Erigeron flagellaris</i>	-	-	-	17	17	17
<i>Erigeron speciosus</i>	-	-	-	19	19	19
<i>Erythronium grandiflorum</i>	-	-	-	28	25	25
<i>Frasera speciosa</i>	-	-	-	19	49	18
<i>Helianthella quinquenervis</i>	22	16	16	11	9	9
<i>Helimeris multiflora</i>	-	-	-	10	10	10
<i>Heterotheca villosa</i>	3	1	1	46	46	44
<i>Hydrophyllum capitatum</i>	-	-	-	21	16	16
<i>Hydrophyllum fendleri</i>	3	3	3	54	37	37
<i>Ipomopsis aggregata</i>	52	51	51	31	23	23
<i>Lathyrus leucanthus</i>	16	16	16	34	16	16
<i>Ligularia biglovii</i>	-	-	-	20	13	12
<i>Linum lewisii</i>	-	-	-	38	3	3
<i>Mertensia ciliata</i>	33	30	30	43	37	37
<i>Mertensia fusiformis</i>	-	-	-	35	23	23
<i>Potentilla pulcherrima</i>	-	-	-	23	21	21
<i>Salix spp</i>	-	-	-	14	3	3
<i>Taraxacum officinale</i>	-	-	-	53	40	40
<i>Vicia americana</i>	24	23	23	37	35	35
<i>Viola praemorsa</i>	-	-	-	10	5	5

the accumulation while bagged. Air temperatures did not differ between the inside and outside of the pollinator exclusion bags (Figure S1; T-test, $T = -0.58478$, $P = 0.5605$).

Samples were taken per flower, stalk, or bag, depending on the species, as necessary to acquire enough volume of nectar to get a clear refractometer reading (approximately 0.06 μl in bright light conditions). For any batch-collected samples, the total volume was divided by the number of flowers in the sample, giving a mean volume; the concentration was by necessity that of the mixture of their nectar. The total number of flowers sampled and the number of flowers with nectar were recorded.

For each species, I took nectar samples over a minimum of two separate sampling days, getting a minimum of fifteen nectar volume and concentration readings (except for following species: *Linum lewisii*, *Helimeris multiflora*, *Helianthella quinquenervis*, *Ligularia biglovii*, *Salix spp.*, and *Viola praemorsa*.) For species that exist in both dry and wet meadow habitats, I took a minimum of ten nectar sugar concentration readings per meadow type (dry and wet).

Floral abundance quantification

I quantified floral abundance available to bees at six study sites established by Jane Ogilvie, spaced ~1 km apart through the East River valley (Figure 1).

Bumble bee activity and floral rewards have been continuously monitored at these

study sites since 2015. Each site contains transects representing three habitats (dry meadow, wet meadow, and aspen forest), totaling 100 x 0.5 m in each of the three habitats. I visited the sites weekly from shortly after snowmelt until senescence or livestock trampling of all flowers (2018: 27 April - 15 September; 2019: 1 June - 7 October), to count the open flowers of bee-visited species within each transect. Early spring and late summer 2019 floral counts and 2018 floral abundance data was provided by Jane Ogilvie.



Figure 1. Locations of floral count sites in the East River valley.

Data analysis

I analyzed interspecific, intraspecific, and community-level differences in nectar traits using non-parametric tests, since the majority of the nectar data was not normally distributed. For the purpose of these analyses, for species in the family *Asteraceae* “flower” refers to the flower head. All statistics were conducted in the R statistical computing framework (R Core Team, 2019).

I examined interspecific variation in nectar traits among the study species sampled using a Kruskal-Wallis test. Species for which any samples were batch-collected were excluded from this analysis, since their volumes and concentrations were approximated, and the distribution of small volumes and the associated concentrations was not accurately captured.

Values for each nectar trait were scaled to the community level using the weekly floral counts from six pairs of dry and wet meadows. A mean value for each species was calculated for each nectar trait, and was then multiplied by the estimated number of flowers per square meter for that species at a given site per week. This calculation assumes that all open flowers contained nectar. Only species for which I have nectar data from every habitat type (dry and wet meadows) where it was observed were used, which includes: *Aconitum columbianum*, *Claytonia lanceolata*, *Delphinium barbeyi*, *Delphinium*

nuttallianum, *Erythronium grandiflorum*, *Heterotheca villosa*, *Hydrophyllum fendleri*, *Ipomopsis aggregata*, *Mertensia ciliata*, and *Taraxacum officinale*.

I used a Wilcoxon rank sum test to compare scaled nectar values for the entire year between dry and wet meadows in 2019, and between the means for each nectar trait of all seven species (*Aconitum columbianum*, *Delphinium barbeyi*, *Delphinium nuttallianum*, *Helianthella quinquenervis*, *Hydrophyllum fendleri*, *Ipomopsis aggregata*, and *Mertensia ciliata*) sampled in both the drought year 2018 and the wet year 2019. I also divided the 2019 habitat comparison for nectar volume, total nectar sugar content, as well as floral abundance, by season (early spring, late spring, early summer, and late summer), and again applied a Kruskal-Wallis test, as well as pairwise Wilcoxon rank sum tests.

I examined intraspecific nectar trait variation, between habitats in 2019 (including species: *Erythronium grandiflorum*, and *Taraxacum officinale*), and between 2018 and 2019 (including species: *Aconitum columbianum*, *Delphinium barbeyi*, *Delphinium nuttallianum*, *Helianthella quinquenervis*, *Hydrophyllum fendleri*, *Ipomopsis aggregata*, and *Mertensia ciliata*), using a Wilcoxon rank sum test.

Beta-diversity between the paired dry and wet meadows was calculated using the vegan package in R (Oksanen et al., 2019).

Results

Interspecific variation in nectar traits

There was variation across species in volume (a. Kruskal-Wallis $X^2(7) = 19.0$, $P < 0.01$, N ranges from 11- 65), concentration (b. Kruskal-Wallis $X^2(7) = 14.9$, $P < 0.05$, N ranges from 9 - 58), and total sugar content (c. Kruskal-Wallis $X^2(7) = 16.3$, $P < 0.05$, N ranges from 9 - 58) of nectar (Figure 2). See Table 1 for all sample sizes.

Figure 2. Interspecific variation in nectar traits in 2019.

Community-level variation between meadow habitats

Nectar volume per meter was higher in wet meadows (Wilcoxon Sign Rank Sum Test: $W = 42$, $P < 0.05$, $N = 10, 17$), and nectar sugar was marginally higher in wet meadows (Wilcoxon Sign Rank Sum Test: $W = 46$, $P = 0.0520$, $N = 10, 17$) (Figure 3).

Nectar production did not differ across seasons (nectar volume: Kruskal-Wallis $X^2(3) = 5.81$, $P = 0.121$, nectar sugar: Kruskal-Wallis $X^2(3) = 5.53$, $P = 0.137$, $N = 8, 8, 6, 1$) or pairwise between habitats in any season (Wilcoxon Sign Rank Sum Tests. Nectar volume [early spring: $W = 4$, $P = 0.343$, $N = 4, 4$; late spring: $W = 2$, $P = 0.114$, $N = 4, 4$; early summer: $W = 2$, $P = 0.533$, $N = 2, 4$; late summer: NA, $N = 0, 1$], nectar sugar [early spring: $W = 5$, $P = 0.486$, $N = 4, 4$; late spring: $W = 2$, $P = 0.114$, $N = 4, 4$; early summer: $W = 2$, $P = 0.533$, $N = 2, 4$; late summer: NA, $N = 0, 1$]) (Figure 4.)

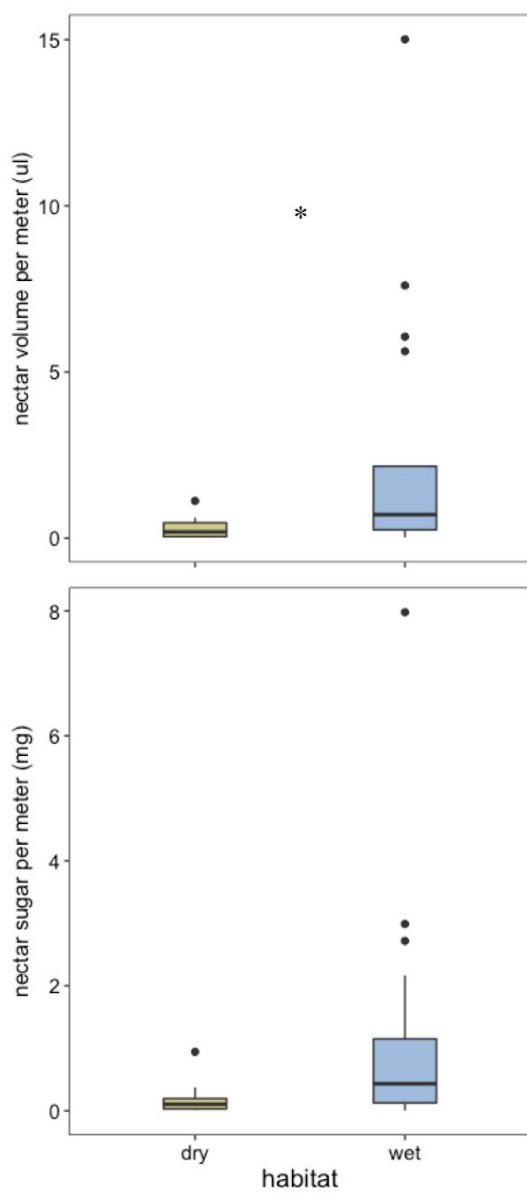


Figure 3. Nectar provision variation between dry and wet meadow habitat communities in 2019, using nectar values scaled to the meter level using floral transect counts. * < 0.05

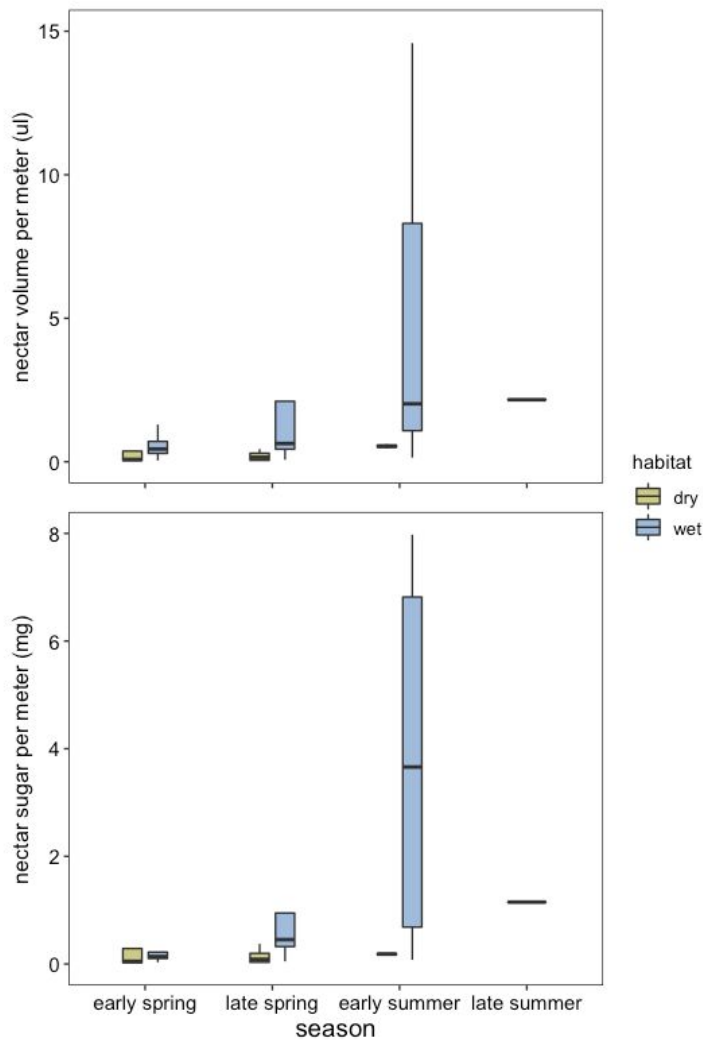


Figure 4. Relative nectar production across seasons.

Community-level variation between years

Nectar trait means did not differ between 2018 and 2019 (Figure 6). (Wilcoxon Sign Rank Sum Tests. Nectar volume: $W = 12$, $P = 0.394$, $N = 7, 7$; nectar sugar concentration: $W = 27$, $P = 0.180$, $N = 7, 7$; nectar sugar: $W = 11$, $P = 0.310$, $N = 7, 7$).

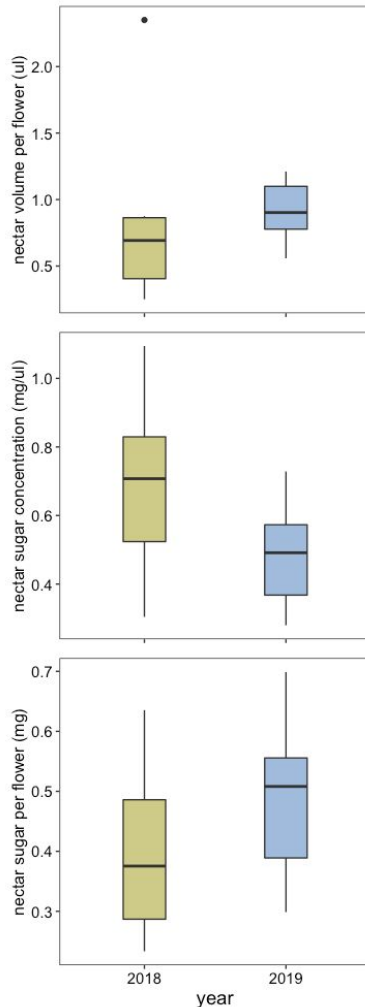


Figure 6. Mean nectar trait values for seven species sampled in 2018 and 2019

Intraspecific variation between meadow habitats

Nectar traits did not vary between habitats for *E. grandiflorum* (Wilcoxon Sign Rank Sum Tests.

Nectar volume: $W = 70$, $P = 0.279$, $N = 17, 11$;
nectar sugar concentration: $W = 72$, $P = 0.890$, $N = 15, 10$;
nectar sugar: $W = 70$, $P = 0.807$, $N = 15, 10$). For *T. officinale*, nectar volumes did not differ between habitats, but nectar sugar concentrations and total nectar sugar content were

both higher in wet meadows than dry meadows

(Wilcoxon Sign Rank Sum Tests. Nectar volume: $W = 255.5$, $P = 0.212$, $N = 34, 19$;
nectar sugar concentration: $W = 11.5$, $P < 0.0001$, $N = 24, 16$;
nectar sugar: $W = 88$, $P < 0.005$, $N = 24, 16$).

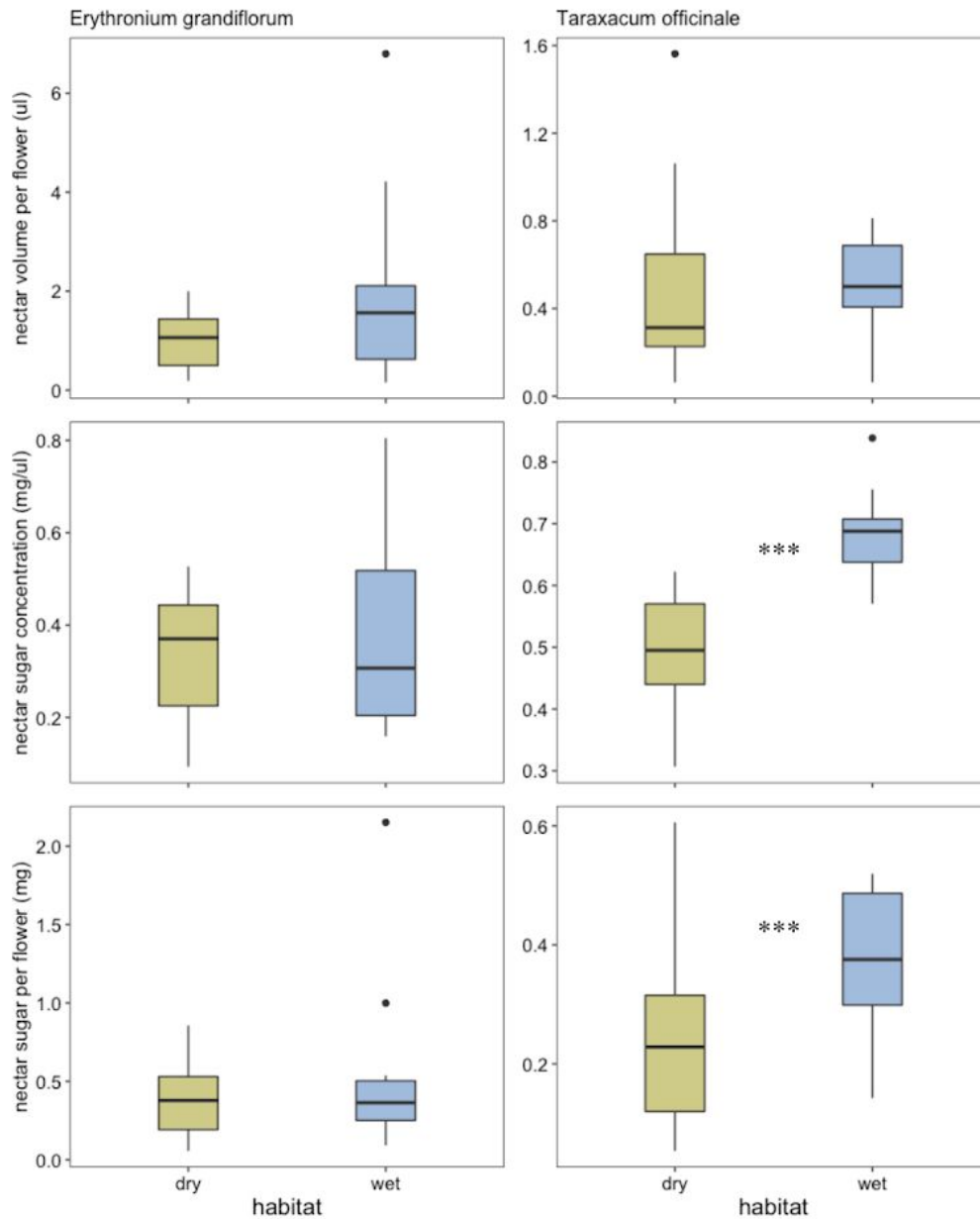


Figure 5. Intraspecific nectar variation between habitats in 2019. *** < 0.005

Intraspecific variation between years

Nectar traits varied between 2018 and 2019 for many species, with a variety of patterns (Figure 7). *A. columbianum* had higher nectar volumes and total nectar sugar contents in 2019; nectar sugar concentration did not differ (nectar volume:

$W = 74, P < 0.0005$; nectar sugar concentration: $W = 135.5, P = 0.308$; nectar sugar: $W = 37, P < 0.01$). *D. barbeyi* had higher nectar volumes and lower nectar sugar concentrations in 2019, resulting in no difference in total nectar sugar provided (nectar volume: $W = 923, P < 0.05$; nectar sugar concentration: $W = 1712, P < 0.001$; nectar sugar: $W = 1222.5, P = 0.410$). *D. nuttallianum* had higher nectar volumes and lower nectar sugar concentrations in 2019, resulting in no difference in total nectar sugar provided (nectar volume: $W = 119, P < 0.005$; nectar sugar concentration: $W = 441, P < 0.0005$; nectar sugar: $W = 143, P = 0.0821$). *H. quinquenervis* nectar volumes and concentrations did not differ between years, but less nectar sugar was provided in 2019 (nectar volume: $W = 161.5, P = 0.125$; nectar sugar concentration: $W = 81, P = 0.629$; nectar sugar: $W = 114, P < 0.05$). *H. fendleri* produced similar volumes of nectar at lower concentrations in 2019, with no difference in total nectar sugar (nectar volume: $W = 68, P = 0.654$; nectar sugar concentration: $W = 111, P < 0.005$; nectar sugar: $W = 56, P = 1$). *I. aggregata* produced lower nectar volumes and higher nectar sugar concentrations in 2019, resulting in less total nectar sugar provided (nectar volume: $W = 1164.5, P < 0.0005$; nectar sugar concentration: $W = 259.5, P < 0.0005$; nectar sugar: $W = 988, P < 0.0005$). *M. ciliata* produced higher nectar volumes and lower nectar sugar concentrations in 2019, resulting in more total nectar sugar provided (nectar volume: $W = 347.5, P < 0.0005$; nectar sugar concentration: $W = 934.5, P < 0.0005$; nectar sugar: $W = 375, P < 0.05$).

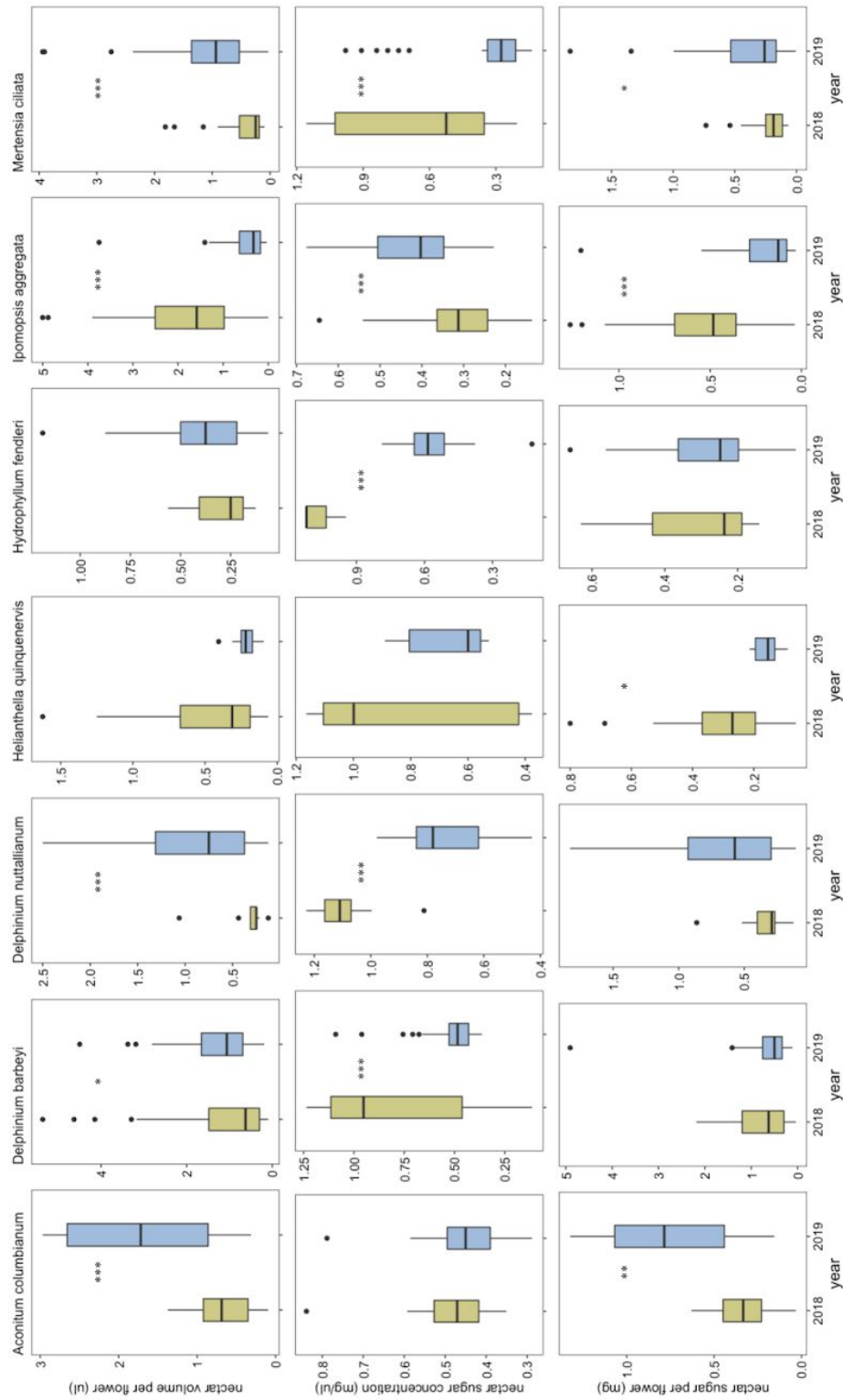


Figure 7. The patterns of intraspecific variation in nectar traits between 2018 and 2019 varied by species. * < 0.05, ** < 0.01, *** < 0.005

Floral abundance

Floral abundance did not differ across seasons (Kruskal-Wallis $X^2(3) = 1.093$, $P = 0.779$, $N = 8, 8, 6, 1$) or pairwise between habitats in any season (Wilcoxon Sign Rank Sum Tests. Early spring: $W = 4$, $P = 0.343$, $N = 4, 4$; late spring: $W = 4$, $P = 0.343$, $v = 4, 4$; early summer: $W = 2$, $P = 0.533$, $N = 2, 4$; late summer: NA, $N = 0, 1$).

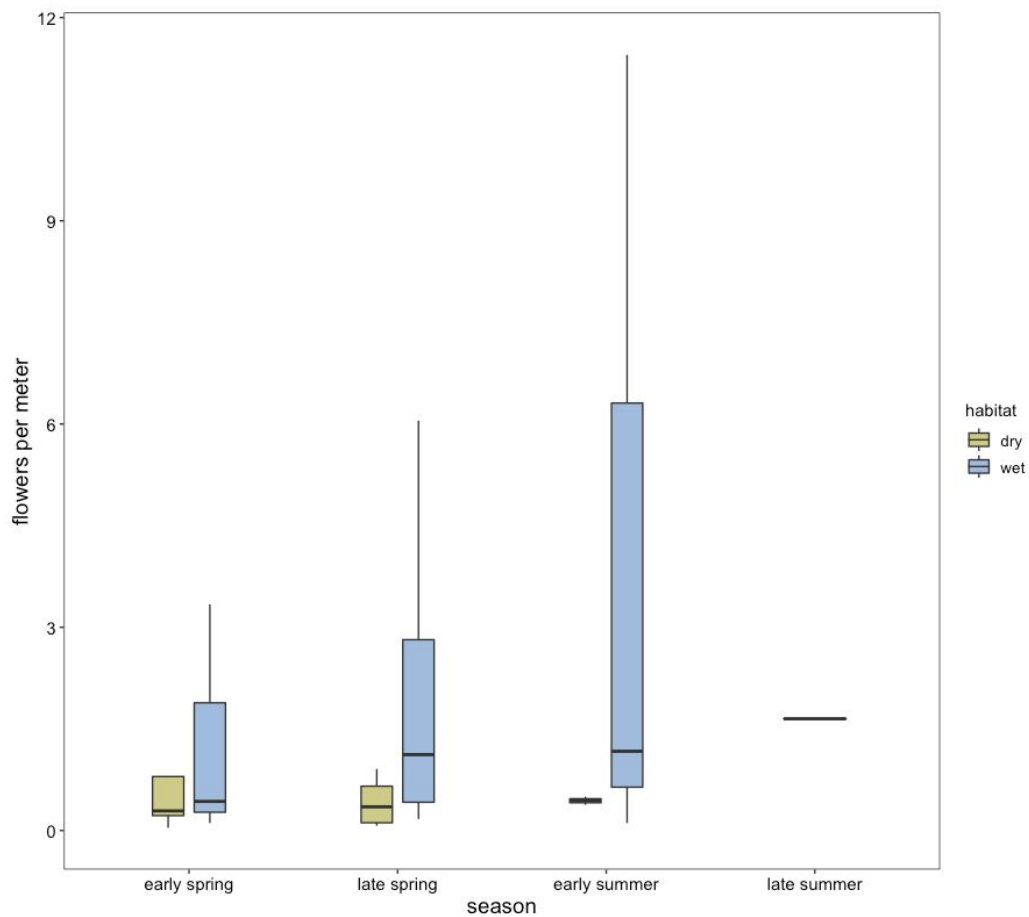


Figure 8. Relative floral abundance across seasons.

Community composition

Bray-Curtis dissimilarity between pairs of dry and wet meadows was high throughout the year, and did not differ by season (Kruskal-Wallis $X^2(3) = 0.719$, $P = 0.869$, $N = 18, 18, 18, 18$).

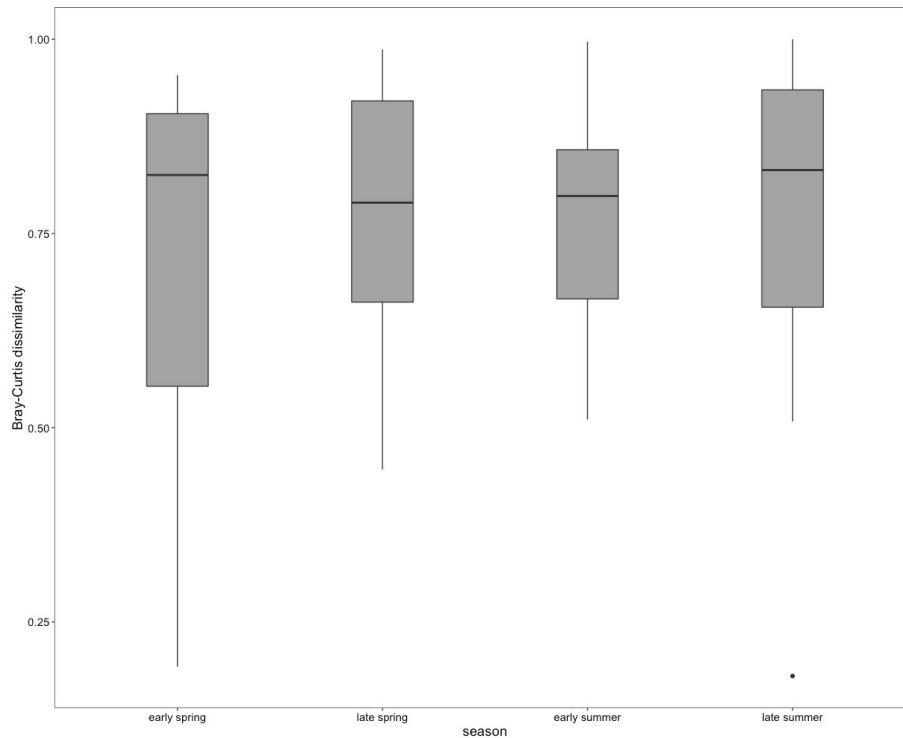


Figure 9. Beta-diversity between paired dry and wet habitat floral survey sites in 2019.

Discussion

I found that floral nectar is variable in predictable, interesting, and important ways. My findings show trends that plants in habitats and years with greater water availability produced a greater volume of nectar containing a higher total sugar content when compared to plants in drier conditions. However, I observed considerable temporal and interspecific variation in nectar production responses.

These differences in nectar production are likely to have major implications for both plant and pollinator reproductive success, especially as the study area is experiencing increasing periods of drought (Sloat et al., 2015; Wainwright et al., 2020).

Communities in wet meadows overall produced a greater volume of nectar, and provided a marginally greater mass of sugar, than those in dry meadow habitats. This is likely a combined effect of floral abundance, community composition, and intraspecific differences in nectar traits between habitats. This calculation assumes that the same proportion of flowers in each meadow type produce nectar, but those proportions could potentially differ also. Broken down by season, I did not observe pairwise differences in nectar production between dry and wet meadows. However, median nectar volume and sugar became increasingly higher in wet meadows compared to dry meadows through the year, as soil moisture becomes more dependent on rain than snowmelt.

Communities produced the same amount of nectar in the wet year (2019), as in the drought year (2018). This finding indicates that significant variation in intraspecific responses to water availability might dampen any overall decrease in nectar provision with increased periods of drought occurring and escalating in this region (IPCC, 2013; Sloat et al., 2015; Wainwright et al., 2020). However, the species included in these calculations are a relatively small subset of those found

throughout the meadow plant communities, and were those which produced large volumes of nectar (allowing them to be sampled in the drought year, 2018); it is possible that this is not representative of broader trends.

I found some evidence of intraspecific variation in nectar production between dry and wet meadow habitats. *T. officinale* provided an equivalent volume of nectar at a higher sugar concentration, providing more sugar overall in the wet meadow than the dry meadow. *E. grandiflorum* did not show intraspecific differences in nectar production between the habitats. This may be due to a low difference in soil moisture between habitats during very early spring when *E. grandiflorum* is blooming. Both habitats receive water from snowmelt in early spring. Other studies have found intraspecific variation in nectar traits with reduced water availability for species found in the region, including *I. aggregata* (Waser & Price, 2016) and *M. ciliata* (Gallagher & Campbell, 2017). I predict that examination of other species would find a range of magnitudes of differences in nectar production with water availability.

Species showed a variety of nectar trait responses between the dry year and the wet year. The variation in total sugar is driven by a combination of both the volume and concentration of the nectar. Some species, such as *Helianthella quinquenervis* and *I. aggregata*, showed the opposite difference between years than was predicted, with lower nectar volume and total nectar sugar, and higher

nectar sugar concentrations, in the wet year compared to the dry year. These species may be better adapted to dry conditions, and may be able to allocate more resources to nectar production under drought conditions. However, the pairs of species sampled in these years were not from the same sites, or in some cases the same times of year, which introduces many possibilities for confounding variables. I also do not know how the proportions of flowers with nectar differed between these two years; it is possible that in dry conditions there were fewer flowers with nectar, producing more nectar per flower.

The monument plant, *Frasera speciosa*, contributed an exceptional resource pulse in the wet year, 2019. The nectar volumes and sugar content provided by individual *F. speciosa* flowers were one to two orders of magnitude larger than those of other species sampled. This is particularly interesting due to their masting reproductive strategy, and the hundreds of flowers that each plant produces (Taylor & Inouye, 1985). This combination seems to have the potential to dramatically change the nectar landscape in masting years, which may have important effects on pollinator population dynamics (Roulston and Goodell 2010).

The variation in nectar production documented here has implications for both plants and pollinators, especially under climate change, with warmer and drier conditions predicted for many parts of the Western USA (IPCC, 2013). Floral rewards attract pollinators, aiding in plant reproduction (Ollerton et al. 2011).

Thus, changes in nectar production could have profound effects on pollinator foraging and plant reproduction. Additionally, most pollinators depend heavily on floral rewards for a majority—if not all—of their diets (Willmer, 2011), making any decreases a threat to population dynamics (Roulston and Goodell 2010).

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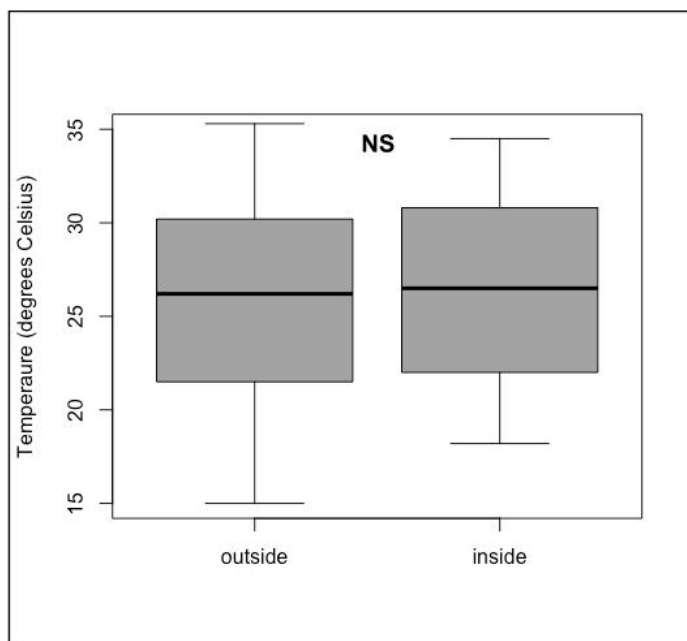
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Appendix



Supplemental figure S1. Temperatures inside and outside of pollinator exclusion

bags. T-test: $T = -0.58478$; $P = 0.561$; $N = 38, 38$.