# Monarch and Regal Fritillary Behaviors in Grasslands with Restored Fire Regimes

**Brooke Karasch and Torre Hovick**
**School of Natural Resource Sciences, North Dakota State University, Fargo, N.D.**

*We evaluated the behavior of two butterfly species under two types of management: grazing and fire and grazing alone. Our focal species were monarchs (Danaus plexippus) and regal fritillaries (Speyeria idalia), and the management types were grazing and fire and grazing only.*

*The main goals of this study were to describe species' behavior generally and to determine species' use of the landscape. We observed a total of 64 monarchs and 32 regal fritillaries in the summers of 2018 and 2019. We found no significant differences in time budgets between treatments for monarchs or regal fritillaries, but we caution that our sample sizes may have influenced this result.*

*We also found that monarchs' nectaring and foraging behaviors were influenced positively by native forb cover, and regal fritillaries' patrolling behavior was influenced negatively by smooth brome (Bromus inermis) cover. We suggest that managers implement strategies to support a robust floral community and mitigate smooth brome to support these species.*

**Introduction**

Conservation management research typically focuses on species richness and abundance. However, behavior also can be an important component in assessing the efficacy of management for conservation purposes. The way an animal uses the landscape contributes to determining if that landscape is a valuable area for conservation.

Butterflies are a good organism to examine to determine the effects of conservation actions. Butterflies often are considered indicators because of their short generation times and wide life history requirements (Samways, 2007). Additionally, researchers rarely study butterfly behavior in the field, but this could provide important insight into their use of the landscape (Carleton and Schultz, 2013).

We have chosen to monitor the behavior of two species of butterfly: the monarch (*Danaus plexippus*) and the regal fritillary (*Speyeria idalia*). These are species of conservation concern but may differ in their behavior due to differing life histories and habitat requirements. Monarchs are generalist butterflies and may occur in many habitats, while regal fritillaries are grassland specialists, which require grasslands for their entire life cycle.

The main objectives of this study are to describe butterfly behaviors in the field and to determine correlations between behavior and landscape variables on landscapes managed with different fire and grazing regimes.

**Procedures**

Our research takes place in the Missouri Coteau ecoregion. The region is primarily mixed-grass prairie with a semiarid climate. Specifically, we used the Central Grasslands Research Extension Center managed by North Dakota State University in central North Dakota.

The study area was subject to a set of experimental treatments. In one treatment, season-long grazing, the pastures were stocked with cow-calf pairs for the duration of the growing season. In the second treatment, the pastures were stocked similarly but also had a 40-acre patch burned each spring.

The third treatment also had moderately stocked cow-calf pairs, and had a 20-acre burn each spring, followed by a 20-acre burn each summer. In the fourth treatment, the cattle stocking rate varied in each paddock within each pasture.

Stocking rates varied from idle to heavy, and these rates rotated such that a heavy pasture became idle the following year, and so on. For the purposes of this study, we have categorized treatments as "grazing only" or "grazing and fire."

We conducted time-budget surveys to collect data on butterfly behavior. Whenever an individual of the target species was located, the observer followed it and recorded each behavior as it occurred for 10 minutes.

Behaviors include resting, basking, ovipositing, nectaring, mating, patrolling, foraging, chasing and fleeing (Table 1). We also recorded the plant during events of resting, basking, ovipositing or nectaring, and we recorded the other organism in events of mating, chasing and fleeing.

*Statistics*
We calculated total proportions of time spent in each behavior by averaging the time in each behavior across individuals. We categorized groups by species and treatment, and after calculating means for each behavior, we performed multivariate analyses of variance (MANOVAs) to determine difference in overall time budgets between treatments for each species.

We also created ordination plots to visualize how behaviors relate to one another, as well as to vegetation variables. We used the binomial similarity index. Our maximum allowable stress was 0.15 and we used three dimensions. We used vegetation variables as vectors and kept any with a $p \leq 0.05$.

We performed all analysis using R (R Core Team, 2019). We used the package *vegan* for ordinations (Oksanen 2015).

**Results**

In the summers of 2018 and 2019, we observed 64 monarchs (29 females and 35 males) and 32 regal fritillaries (13 females and 19 males).

*Proportion of Time in Behaviors*
We observed 37 monarchs in grazing and fire pastures and 26 in grazing-only pastures. When we performed a MANOVA to determine differences in time budgets between these two treatments, we found no significant differences (Figure 1).

For regal fritillaries, we observed 31 individuals in grazing and fire pastures, and one in a grazing-only pasture. We were not able to compare time budgets by treatment, but instead we compared by time since fire (year of fire, one year since fire and unburned). We saw no significant difference in time budgets between the different times since fire (Figure 2).

*Ordinations*
For monarchs, we found no significant vegetation vectors. However, floral richness and native forb cover all were nearly significant ($p$-value≤0.06; Figure 3).

The significant vegetation variables for regal fritillaries were introduced forb cover and smooth brome cover (Figure 4).

*Foraging Behaviors*
We observed monarchs nectaring on a total of 12 floral species and regal fritillaries on a total of eight, for an overall total of 16 floral species (Figure 5). Their nectar choices did not appear to be related solely to floral abundance because we never observed either species nectaring on the most common flower at our site (yellow sweet clover, about 30% of all flowering stems), and we observed them on the next three most common flowers (prairie coneflower, western snowberry and stiff goldenrod) only rarely.

**Discussion**

Our study focused on quantifying monarch and regal fritillary behaviors in the field under different disturbance regimes. We found no significant differences in overall time budgets between the two regimes for monarchs. We also found no differences in time budgets between three different times since fire for regal fritillaries, and sample size constraints precluded testing between the two disturbances regimes for regal fritillaries.

However, we believe what is worth noting is that we were able to capture only one complete observation of a regal fritillary in a grazing-only pasture, as compared with 31 complete observations in grazing and fire pastures. We believe this indicates that regal fritillaries are not occupying these pastures but instead using them as corridors.

Our ordinations showed that monarch behaviors are influenced by native forb cover and floral richness. Native forb cover and floral richness were related to nectaring and foraging behaviors, which indicates that monarchs are attracted to areas with abundant flowers for nectaring purposes, even if they nectar on relatively few species of flower.

Regal fritillary behaviors were influenced by smooth brome cover and introduced forb cover. Smooth brome cover was correlated negatively with flight behaviors, including patrolling, fleeing and chasing. Male regal fritillaries tend to patrol close to the vegetation canopy and occasionally dip below the canopy level (Kopper et al. 2001).

Smooth brome tends to grow in dense, tall patches at our field site, and male regal fritillaries may not be able to patrol in their preferred manner in this type of structure. In support of this idea, we also found that smooth brome cover and visual obstruction – a measure of structure – were correlated.

Throughout our study, we observed monarchs and regal fritillaries nectaring on a total of 16 species of flowers. Although these two species may appear to have several preferred species of flowers, we caution managers in interpreting our results this way. We instead suggest that managers implement a strategy that encourages and supports a diverse floral community that persists throughout the butterfly flight season.

Our results are largely inconclusive as to whether behaviors differ between grazing-only and grazing and fire pastures for monarchs or regal fritillaries. The opportunistic nature of our observations may have contributed to our small sample size, so we suggest future studies implement a more systematic approach. The results that we did find indicate that managers should promote diverse, robust floral communities to support monarchs and regal fritillaries, and should mitigate invasive species that may otherwise dominate the landscape.

**Literature Cited**


Carleton, A., and Schultz, C.B. (2013). Restoration action and species response: Oviposition habits of Plebejus icarioides fenderi (Lepidoptera: Lycaenidae) across a restoration chronosequence in the Willamette Valley, Oregon, USA. *Journal of Insect Conservation*, *17*(3), 511–520. https://doi.org/10.1007/s10841-012-9535-7

Clench, H.K. (1966). Behavioral thermoregulation in butterflies. *Ecology*, *47*(6), 1021–1034.

Curtis, R.J., Brereton, T.M., Dennis, R.L.H., Carbone, C., and Isaac, N.J.B. (2015). Butterfly abundance is determined by food availability and is mediated by species traits. *Journal of Applied Ecology*, *52*(6), 1676–1684. https://doi.org/10.1111/1365-2664.12523

Kemp, D.J. (2000). Contest behavior in territorial male butterflies: does size matter? *Behavioral Ecology*, *11*(6), 591–596. https://doi.org/10.1093/beheco/11.6.591

Kopper, B.J., Charlton, R.E., and Margolies, D.C. (2000). Oviposition site selection by the regal fritillary, Speyeria idalia, as affected by proximity of violet host plants. *Journal of Insect Behavior*, *13*(5), 651–665. https://doi.org/10.1023/A:1007887809621

Kopper, B.J., Margolies, D.C., and Charlton, R.E. (2001). Life history notes on the regal fritillary, speyeria idalia (Drury) (Lepidoptera: Nymphalidae), in Kansas tallgrass prairie. *Journal of the Kansas Entomological Society*, *74*(3), 172–177.

Ladner, D.T., and Altizer, S. (2005). Oviposition preference and larval performance of North American monarch butterflies on four. *Entomologia Experimentalis et Applicata*, 9–20.

Peixoto, P.E.C., and Benson, W.W. (2009). Seasonal effects of density on territory occupation by males of the satyrine butterfly Paryphthimoides phronius (Butler 1867). *Journal of Ethology*, *27*(3), 489–496. https://doi.org/10.1007/s10164-008-0147-3

Pliske, T.E. (1975). Courtship behavior and use of chemical communication by males of certain species of ithomiine butterflies (Nymphalidae: Lepidoptera), *Annals of the Entomological Society of America*, *68*(6), Pages 935-942. https://doi.org/10.1093/aesa/68.6.935

Rutowski, R.L. (1982). Mate choice and Lepidopteran mating behavior. *The Florida Entomologist*, *65*(1), 72–82.

Samways, M.J. (2007). Insect conservation: A synthetic management approach. *Annual Review of Entomology*, *52*(1), 465–487. https://doi.org/10.1146/annurev.ento.52.110405.091317

Table 1. The behaviors we observed in monarch and regal fritillary time budgets. With the exception of mating, which we only observed in monarchs, we recorded all behaviors in both species at least once.

| Behavior | Description | Citation |
|---|---|---|
| Resting | Sitting on vegetation or substrate; wings closed | Clench 1966 |
| Basking | Sitting on vegetation or substrate; wings open | Clench 1966 |
| Foraging flight/nectaring | Flight above vegetation canopy, occasionally stopped to sit on open flower with proboscis extended | Curtis et al. 2015 |
| Mating | Two butterflies, typically in flight, connected at the abdomen | Rutowski 1982 |
| Ovipositing: monarchs | Female on *Asclepias* spp., occasionally paused to flex her abdomen and deposit an egg | Ladner and Altizer 2005 |
| Ovipositing: regal fritillaries | Female in low flight, occasionally dipping below the vegetation canopy, walked through senesced vegetation occasionally flexing her abdomen to deposit an egg | Kopper et al. 2000 |
| Chasing | Flighted pursuit of any organism; separated into conspecific, misc. Lepidoptera, other insect, or vertebrate | Kemp 2000 |
| Fleeing | Flight closely followed by any organism; will be separated into conspecific, misc. Lepidoptera, other insect, or vertebrate | Kemp 2000 |
| Patrolling | Flight that appeared to follow a pattern and cover a specific area; likely to be broken up by bouts of chasing | Peixoto and Benson 2009 |

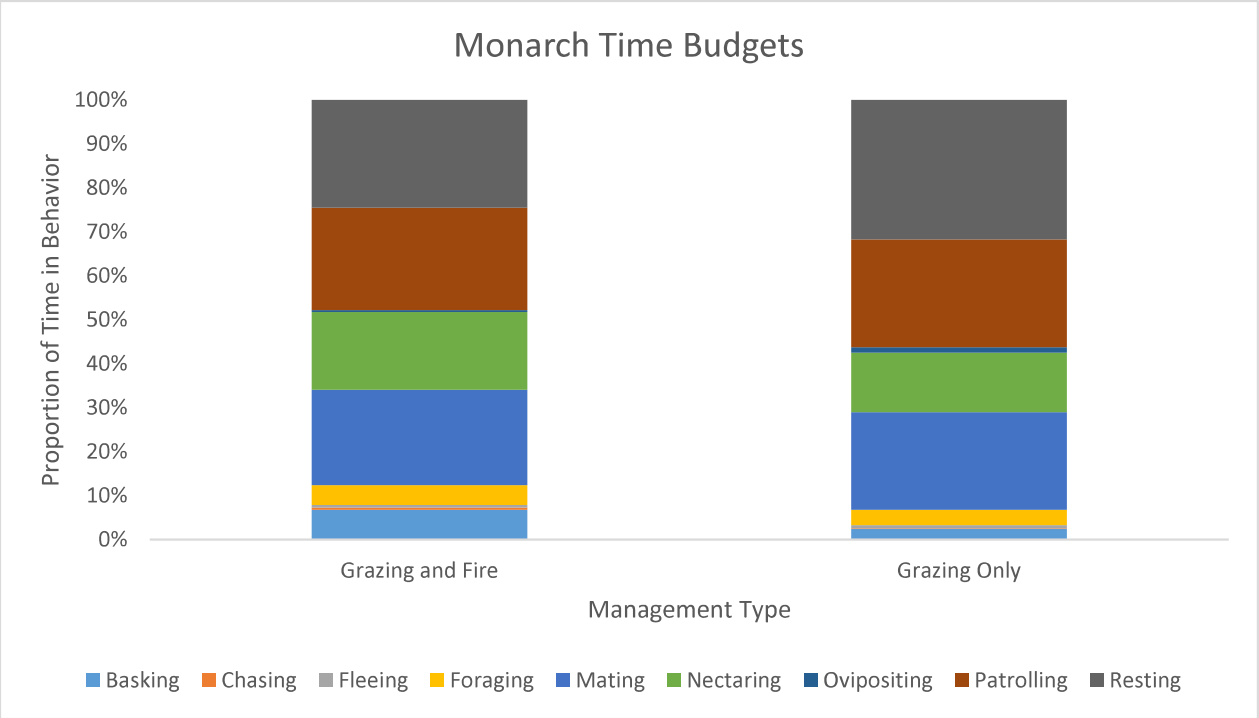


Figure 1. Mean percent time in each behavior for all monarch butterflies. We performed a MANOVA to quantify statistical differences in time budgets between these groups but found no differences (n = 37 for grazing and fire; n = 26 for grazing only).

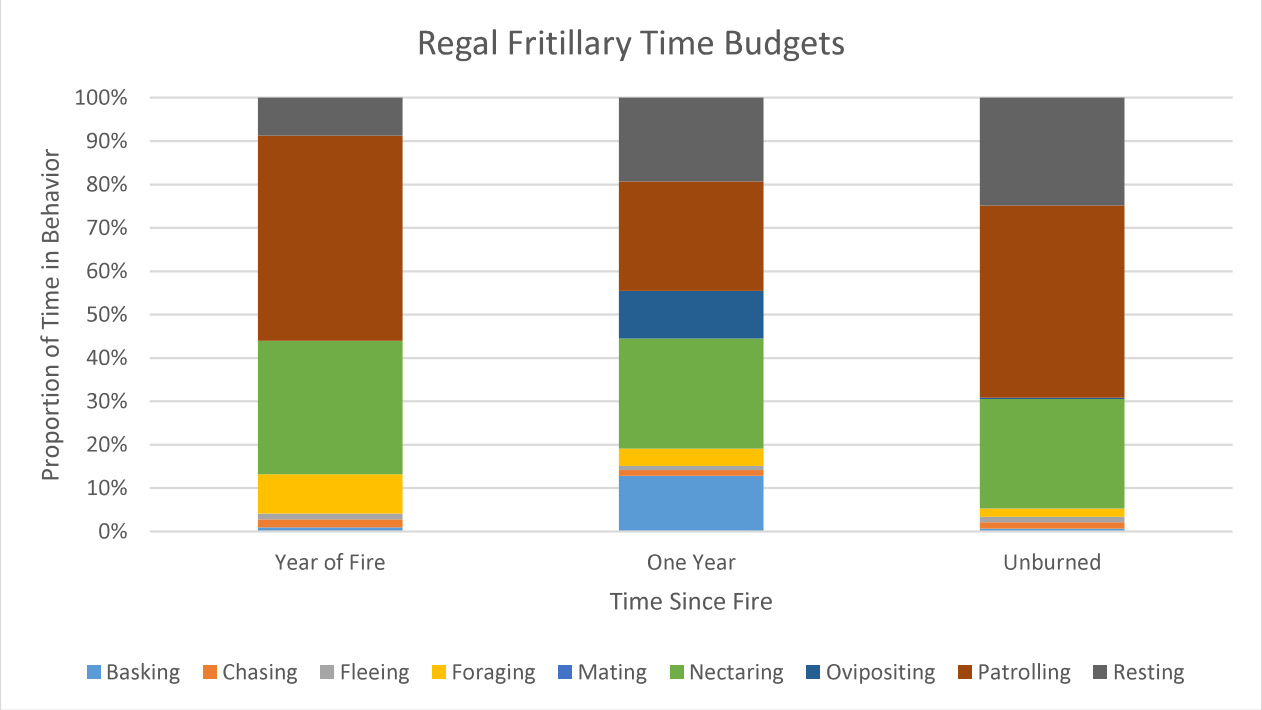


Figure 2. Mean percent time in each behavior for regal fritillaries. We performed a MANOVA to quantify statistical differences in time budgets between these groups but found no differences (n = 5 for year of fire; n = 10 for one year since fire; n = 17 for unburned).

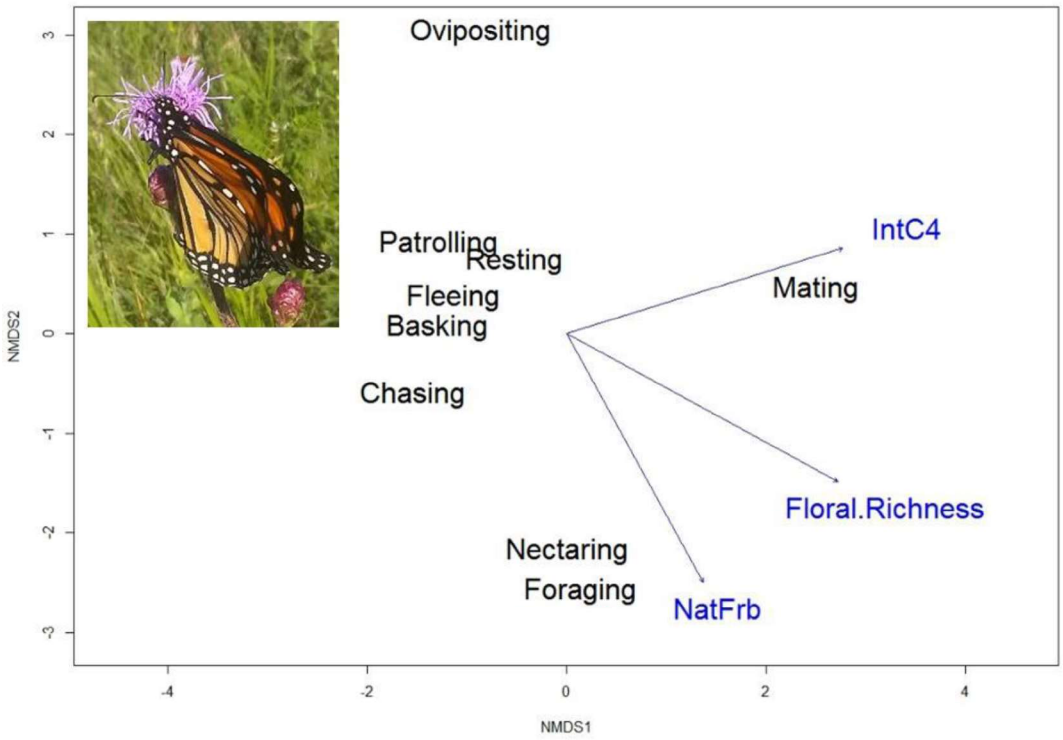


Figure 3. Ordination plot displaying monarch behaviors and explanatory vegetation variables.

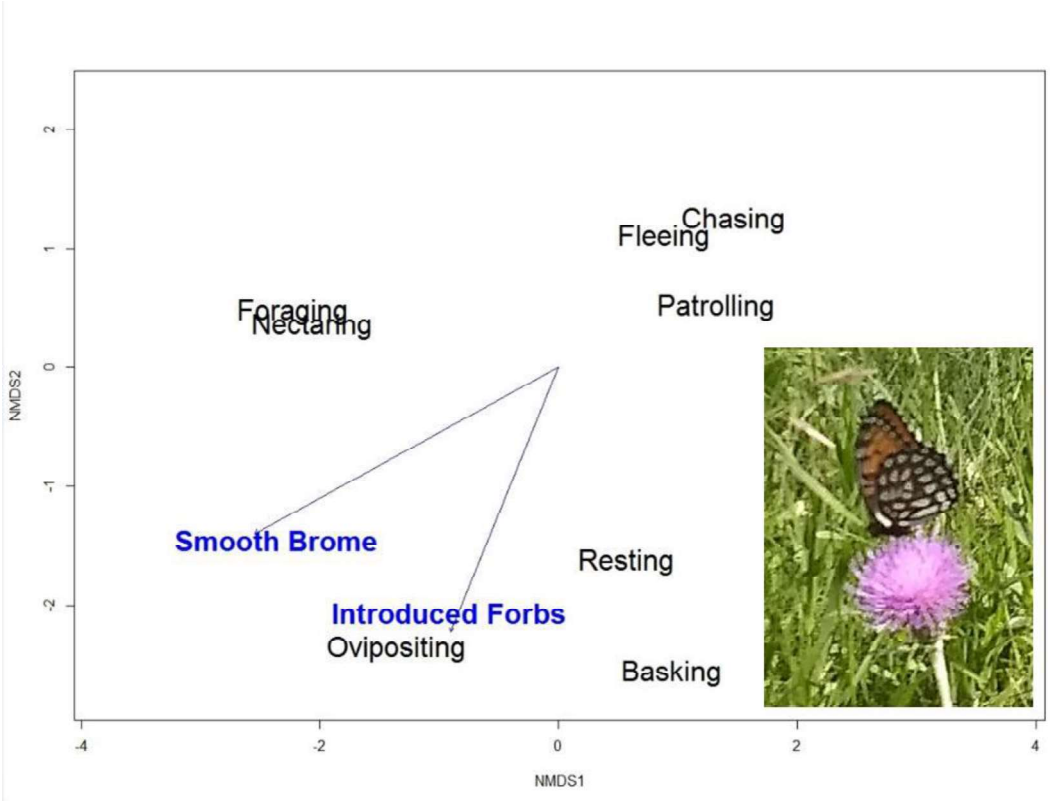


Figure 4. Ordination plot displaying regal fritillary behaviors and explanatory vegetation variables.

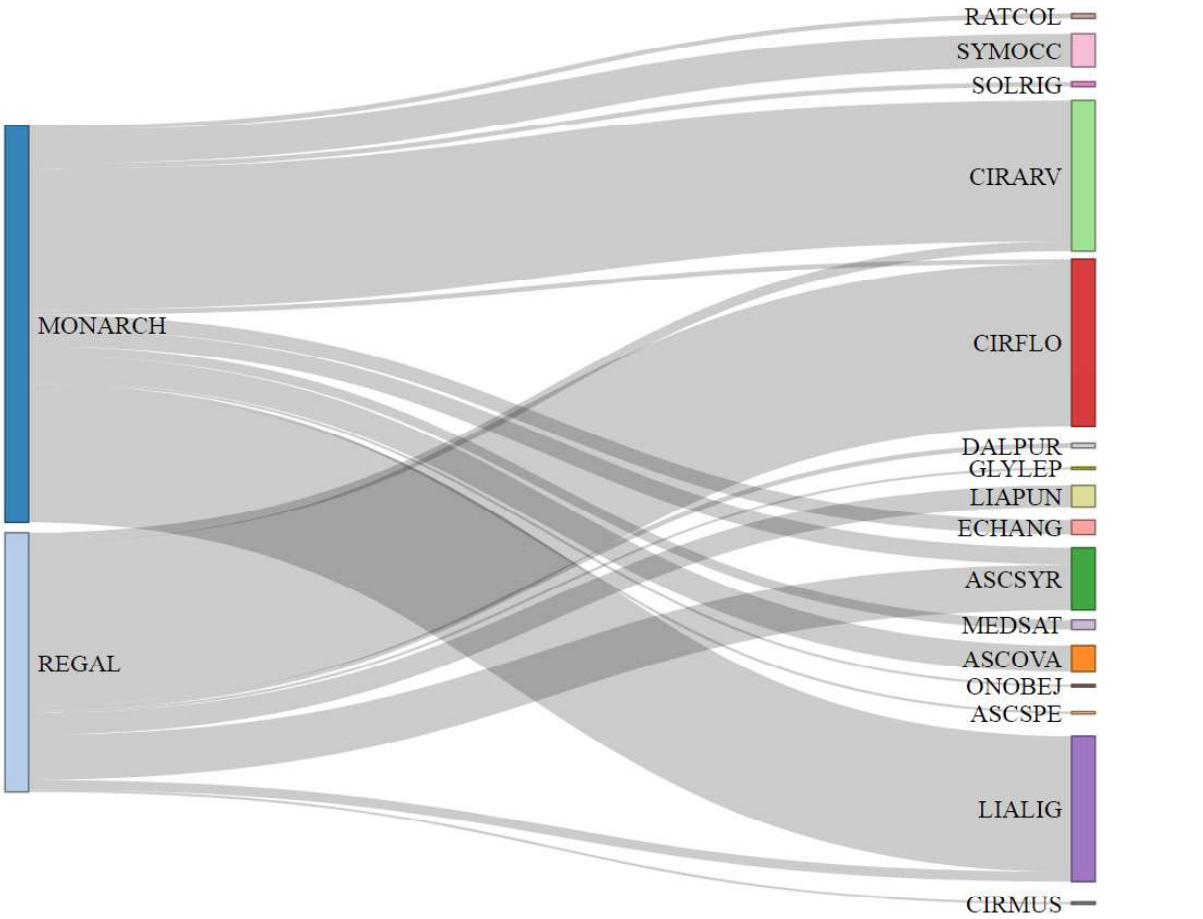


Figure 5. Monarch and regal fritillary nectaring events by floral species. Floral species are in order, top to bottom, of total abundance at our field site. (RATCOL = gray-headed coneflower; SYMOCC = western snowberry; SOLRIG = rigid-stem goldenrod; CIRARV = Canada thistle; CIRFLO = Flodman's thistle; DALPUR = purple prairie clover; GLYLEP = American licorice; LIAPUN = dotted blazing star; ECHANG = black Samson echinacea; ASCSYR = common milkweed; MEDSAT = alfalfa; ASCOVA = oval-leaf milkweed; ONOBEJ = false gromwell; ASCSPE = showy milkweed; LIALIG = Rocky Mountain blazing star; CIRMUS = musk thistle).