

# **FINAL PERFORMANCE REPORT**



**Federal Aid Grant No. F18AF00933 (T-110-R-1)**

**Status of the Regal Fritillary in Oklahoma**

**Oklahoma Department of Wildlife Conservation**

**January 1, 2019 through June 30, 2021**

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**State:** Oklahoma

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**Grant Program:** State Wildlife Grants

**Grant Title:** Status of the Regal Fritillary in Oklahoma

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**Principal Investigator:** Dr. Kristen A. Baum, Associate Dean for Research and Facilities, College of Arts and Sciences, Professor, Department of Integrative Biology, Oklahoma State University

### **Executive Summary/Abstract:**

The goal of this project was to assess the current status, geographic range, and habitat needs for regal fritillaries (*Speyeria idalia*) in the tallgrass prairie region of Oklahoma. Surveys focused on counties where *S. idalia* have been previously documented. We surveyed 13 sites in 2019, 20 sites in 2020, and seven sites in 2021. Some surveys in 2019 were delayed because of limited site access due to flooding. Surveys were not originally proposed for 2021 and sampling was limited in 2021 compared to 2019 and 2020. We observed seven adult *S. idalia* during the 2019 field season, all of which occurred at The Nature Conservancy's Tallgrass Prairie Preserve in Osage County. Three females and two males were observed on June 20, 2019, one female on July 5, 2019, and one male on July 10, 2019. No regal fritillaries were observed in 2020. Two female regal fritillaries were observed in different units of The Nature Conservancy's Tallgrass Prairie Preserve in 2021; one on June 22<sup>nd</sup> and one on June 25<sup>th</sup>. Of the nine observations, only one occurred on a randomly located transect, indicating the importance of non-random transects for providing supplementary information on the distribution and abundance of rare butterfly species. No egg laying activity was observed over the duration of this project. Additional research at broader spatial and temporal scales may provide more insight into the status of *S. idalia* in Oklahoma.

### **Objectives:**

We will assess the current status, geographic range, and habitat needs for *S. idalia* in the tallgrass prairie region of Oklahoma. Surveys will be focused in counties where *S. idalia* has been previously documented: Craig, Osage, Pawnee, Rogers, Tulsa. We will conduct surveys for adult *S. idalia* during the period of adult activity (late May through early October), and larval surveys (April through mid-May) in areas where females were observed ovipositing. To identify potential habitat and management associations, we will record site-level characteristics at each location, including management practices, plant community data (species richness and abundance of nectar plants and *Viola* spp.), and pollinator community data (particularly *S. diana*, *S. cybele*, *Danaus plexippus*, and rare skippers).

## **Background:**

*Speyeria idalia* historically occurred from Oklahoma to North Dakota and east to the Atlantic Coast. It is critically imperiled to vulnerable in all states where it occurs, except for Kansas. Oklahoma represents the southern edge of its distribution in the Central United States, but little is known about the population trend of *S. idalia* in Oklahoma. *Speyeria idalia* is univoltine. Males start emerging in late May, followed by females a couple of weeks later. Most males die by mid-July and females enter reproductive diapause until they lay eggs on dead leaves and other debris in the vicinity of *Viola* spp. in late August through early October (Selby 2007). Eggs hatch after three to four weeks and the first instars overwinter in a diapause state. In the spring when their host plants emerge, they complete development and pupate on or near the soil surface (Selby 2007). Adults are large and mobile, with maximum movement distances reported to range from approximately 1.5 km (Nagle et al. 1991, Selby 1992, as cited in Selby 2007) to 16 km (Barton 1993, 1994, as cited in Selby 2007), but daily movements average less than 200 m (Selby 1992, as cited in Selby 2007). *Speyeria idalia* also avoids crossing habitat boundaries, which could increase isolation and contribute to population declines (Ries and Debinski 2001).

## **Approach:**

### Compilation of Existing Records

We compiled existing spatially referenced records for *S. idalia*, and a list of host plants (*Viola* species) and nectar plants known to be used by *S. idalia*. Most existing records were observations of *S. idalia* and only a few vouchered specimens have been preserved from within Oklahoma. Many of these observational records are associated with The Nature Conservancy's Tallgrass Prairie Preserve where a summer butterfly count has been held annually since the mid-1990s.

### Study Sites

Thirteen sites were visited in 2019, 20 sites in 2020, and seven sites in 2021 (Tables 1-4). Access to some sites was limited in 2019 due to flooding in May. We were not able to obtain permission to visit Woolaroc Museum and Wildlife Preserve due to the presence of bison, zebras, ostriches, and other animals at the site. Surveys were not originally proposed for 2021 but because ovipositing females were not located in 2020, we did not conduct larval surveys in the spring of 2021 and shifted those resources to adult surveys in June. Because of the limited timeframe for sampling, the relative sampling effort was limited in 2021 as compared to 2019 and 2020. Some sites, including The Nature Conservancy's Tallgrass Prairie Preserve and several state wildlife management areas, were surveyed each year of the project, but other sites were surveyed during a single field season.

### Surveys for Adult *S. idalia*

We used three approaches to study adult *S. idalia*. First, we used distance sampling along randomly-placed line transects to assess population density. Three, 200 m transects were randomly located within each site. Modified Pollard walks were conducted along each transect and observations were recorded at 100 m intervals. The number of *S. idalia* and species of interest (*S. diana*, *S. cybele*, *D. plexippus*, and rare skippers) were recorded within 2.5 m of the transect line (5 m total) and outside of that window. The second approach involved using non-random transects to provide supplementary information on *S. idalia*, since rare species may be

missed by random sampling. Across the three field seasons, 330 random transects and 137 non-random transects were completed. The third approach involved returning to sites where *S. idalia* had been observed during distance sampling or supplemental non-random transects to search for ovipositing females and record any egg laying activity.

#### Additional Site Characteristics

Additional site characteristics were recorded after every Pollard walk on randomly-placed transects in 2019 and 2020, including vegetation height and cover data using a modified Daubenmire cover class system (1 = <5%, 2 = 5-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = >95%) for bare ground, litter, forb (divided into blooming and non-blooming), grass, and woody cover. The original intent was for these data to be used to evaluate if measured characteristics were associated with the presence or absence of *S. idalia*, but only one *S. idalia* was observed on randomly-placed transects during this study. Based on sample sizes for monarchs (*D. plexippus*) and arogos skippers (*Atrytone arogos*) from the randomly-placed transects (Tables 2, 3), we used these species as ecological surrogates and evaluated if measured characteristics were associated with their presence or absence.

#### Project Personnel

In addition to PI Baum, Emily Geest and Ray Moranz also worked on the project. Emily and Ray conducted the field surveys. Emily also conducted the field season preparation, data entry, literature reviews, compilation of existing records, etc.

### **Results and Discussion:**

#### Compilation of Existing Records

Fifty-three records were compiled for observations of *S. idalia* in Oklahoma, including the records from this project (Table 5). Violet species recorded from the literature included *V. bicolor*, *V. lanceolata*, *V. nuttallii*, *V. papilionacea*, *V. pedata*, *V. pedatifida*, *V. sagittata*, *V. sororia*. Bolded species are known to occur in Oklahoma, and the presence of violets near transects is presented in Table 1, although species identifications were not possible and violets were only observed on transects twice. No additional host plant species were recorded, and no ovipositing was observed during this study. Documented nectaring plant preferences from the literature included *Asclepias* spp., *Cirsium* spp., and *Monarda* spp. No additional nectar plant records were added from this project, although three of the female *S. idalia* observed were nectaring on *Asclepias* species, including two on *A. sullivantii* and one on *A. syriaca*.

#### Surveys for Adult *S. idalia*

During the project only one female *S. idalia* was observed during the distance sampling surveys (July 5, 2019 at The Nature Conservancy's Tallgrass Prairie Preserve; Table 2). No *S. idalia* were observed during the distance sampling surveys during 2020 or 2021 (Tables 3, 4). Eight *S. idalia* (3 females and 2 males on June 20, 2019, 1 male on July 10, 2019, 1 female on June 22, 2021, and 1 female on June 25, 2021) were observed on non-random transects, all of which were located at The Nature Conservancy's Tallgrass Prairie Preserve (Tables 2, 4). No *S. idalia* were observed during non-random sampling surveys during 2020 (Table 3). The low numbers of *S. idalia* observed during this project require additional research to identify the factors driving the observed patterns. It would be valuable to broaden the spatial and temporal scope of surveys to

include the Flint Hills region of Kansas over multiple years to identify if individuals may be moving into Oklahoma from Kansas during favorable years. This study also illustrates the importance of including non-random transects in rare butterfly surveys to document presences that may not be observed through random sampling.

For the nine *S. idalia* observed during this study, three were observed nectaring (two on *A. sullivantii* and one on *A. syriaca*), four were observed flying, and two were observed resting. For the seven observed on the Nature Trail at The Nature Conservancy's Tallgrass Prairie Preserve, six were located in large patches of *A. sullivantii* and one was located in a large patch of *A. syriaca*. *Asclepias tuberosa* also occurred throughout the Nature Trail area where *S. idalia* were observed. The individual observed in the Sand Creek Pasture was located in a small patch of *A. sullivantii*, and the individual observed in the West John Lee Pasture was observed near *Vernonia baldwinii*, although it was not blooming at the time.

In 2019, we returned to sites where *S. idalia* had been observed during distance sampling and supplemental non-random transect sampling to search for ovipositing females. No egg laying activity was observed, and we were unable to conduct meaningful searches for larvae at these sites during the spring of 2020. Because no *S. idalia* were observed in 2020, we were unable to document ovipositing females and did not search for larvae in the spring of 2021. Thus, no ovipositing females were observed during this project and no larval *S. idalia* surveys were conducted. It is not clear if Oklahoma supports a breeding population of *S. idalia*.

#### Additional Site Characteristics

Sites with higher average grass cover were associated with monarch presence (GLM:  $z = 2.330$ ,  $p = 0.020$ ,  $SE = 0.011$ ,  $\beta = 0.025$ ; Fig. 1) and arogos skipper presence (GLM:  $z = 2.028$ ,  $p = 0.043$ ,  $SE = 0.017$ ,  $\beta = 0.034$ ; Fig. 2). Increasing average litter cover was associated with monarch absence in sites (GLM:  $z = -2.930$ ,  $p = 0.003$ ,  $SE = 0.012$ ,  $\beta = -0.035$ ; Fig. 3). The relationship between average blooming forb cover and monarch presence was not significant ( $p = 0.143$ ; Fig. 4) and no other site characteristics were associated with monarch or arogos skipper presence or absence ( $p > 0.05$ ; Table 6). The single record of a *S. idalia* from a random transect during this study was not sufficient to allow for site characteristics associated with the presence of *S. idalia* to be evaluated.

#### Anecdotal Observations Provided by R. Moranz

Regals are less abundant in northeastern Oklahoma than in various Missouri sites or the Flint Hills of northern Kansas. This could be due to lower violet abundance in Oklahoma compared to other regions. At sites in southern Iowa/northern Missouri, *S. idalia* abundance seems to be positively correlated with violet abundance, and "really good" sites for this species in southwestern Missouri have high densities of violets and in some places these densities approach 500 violet plants per square meter. Violet densities are much lower in Oklahoma and violets were not visible along many of the survey transects (see Table 1). Many Oklahoma sites also seemed to have a lower abundance of the nectar plants preferred by regal fritillaries, with a few exceptions.

**Recommendations:**

Only nine *S. idalia* were observed over the duration of this project, including seven in 2019 and two in 2021. Only one *S. idalia* was observed on a random transect during modified Pollard walks, indicating the importance of non-random transects for providing supplementary information on the distribution and abundance of rare butterfly species. Because there was only one *S. idalia* record from a random transect during this study, we were not able to evaluate site characteristics associated with the presence of *S. idalia*. Additional research over broader spatial (including the Flint Hills region of Kansas) and temporal (multiple years) scales is needed to identify factors driving the abundance of *S. idalia* in Oklahoma.

**Significant Deviations:**

There were no significant deviations from the objectives of this grant. We did not observe any *S. idalia* during the summer and fall of 2020 and therefore we were unable to conduct meaningful surveys for larvae during the spring of 2021. We used the time and resources that would have been used to conduct spring larval surveys to conduct a previously unplanned series of adult surveys during the final weeks of the grant in June 2021. These resulted in two additional observations of *S. idalia* (females) on The Nature Conservancy's Tallgrass Prairie Preserve.

**Equipment:**

No equipment was purchased.

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**Approved by:** Russ Horton, Assistant Chief of Wildlife  
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Table 1. Sites visited each year, including the type of transect used, datum, latitude, longitude, number of times revisited, and if violets were present. Violets were only observed on transects twice, but the presence of violets near transects are provided here.

Year	County	Site	Random Transect #	Non-random Transect #	Datum	Latitude	Longitude	Times Revisited	Violets Present?	Notes
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	1	NA	WGS84	36.77251	-96.39384	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	2	NA	WGS84	36.77601	-96.40050	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	3	NA	WGS84	36.75602	-96.37602	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	1	NA	WGS84	36.78736	-96.39546	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	2	NA	WGS84	36.79010	-96.39361	3	Yes	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	3	NA	WGS84	36.75551	-96.38017	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	1	NA	WGS84	36.86467	-96.42275	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	2	NA	WGS84	36.86644	-96.42150	3	Yes	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	3	NA	WGS84	36.86649	-96.42385	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	4	NA	WGS84	36.87376	-96.42250	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	5	NA	WGS84	36.89580	-96.41111	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	6	NA	WGS84	36.89624	-96.40751	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Mary L.)	7	NA	WGS84	36.86935	-96.40650	3	No	



2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Mary L.)	8	NA	WGS84	36.86656	-96.38946	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	9	NA	WGS84	36.89561	-96.38191	3	Yes	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	10	NA	WGS84	36.86123	-96.37544	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	11	NA	WGS84	36.86261	-96.37010	3	Yes	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	12	NA	WGS84	36.85162	-96.36373	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (East Stish)	13	NA	WGS84	36.85553	-96.35291	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (East Stish)	14	NA	WGS84	36.85276	-96.34972	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	15	NA	WGS84	36.84432	-96.34560	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	16	NA	WGS84	36.84577	-96.35909	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	17	NA	WGS84	36.87748	-96.42495	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	18	NA	WGS84	36.83790	-96.36332	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	19	NA	WGS84	36.84282	-96.36816	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	20	NA	WGS84	36.83967	-96.37273	3	Yes	

2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	21	NA	WGS84	36.83560	-96.37311	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	22	NA	WGS84	36.83203	-96.37520	3	Yes	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	23	NA	WGS84	36.83066	-96.38338	3	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	24	NA	WGS84	36.83527	-96.38264	3	No	
2019	Osage	John Dahl WMA	1	NA	WGS84	36.86781	-96.54459	3	No	
2019	Osage	John Dahl WMA	2	NA	WGS84	36.86695	-96.54023	3	No	
2019	Osage	John Dahl WMA	3	NA	WGS84	36.86441	-96.54172	3	No	
2019	Osage	Osage WMA Rock Creek Unit	1	NA	WGS84	36.83384	-96.22423	3	No	
2019	Osage	Osage WMA Rock Creek Unit	2	NA	WGS84	36.82434	-96.21869	3	No	
2019	Osage	Osage WMA Rock Creek Unit	3	NA	WGS84	36.83527	-96.22288	3	No	
2019	Osage	Osage WMA Western Wall Unit	1	NA	WGS84	36.83919	-96.32093	2	No	
2019	Osage	Osage WMA Western Wall Unit	2	NA	WGS84	36.84091	-96.31499	2	No	
2019	Osage	Osage WMA Western Wall Unit	3	NA	WGS84	36.84252	-96.29558	2	No	
2019	Washington	Copan WMA	1	NA	WGS84	36.96958	-95.95823	1	No	
2019	Osage	Hulah WMA	1	NA	WGS84	36.92759	-96.18948	1	No	
2019	Osage	Hulah WMA	2	NA	WGS84	36.90187	-96.19326	1	No	
2019	Osage	Hulah WMA	3	NA	WGS84	36.90239	-96.19109	1	No	
2019	Kay	Kaw WMA	1	NA	WGS84	36.86075	-96.75840	2	No	
2019	Kay	Kaw WMA	2	NA	WGS84	36.85347	-96.76815	2	No	
2019	Kay	Kaw WMA	3	NA	WGS84	36.85395	-96.76990	2	No	
2019	Kay	Farmer's Home Tract	NA	1	WGS84	36.85460	-96.85165	1	No	

2019	Osage	Wa-Sha-She State Park	NA	1	WGS84	36.92129	-96.09650	1	No	
2019	Osage	Roadside 1	NA	1	WGS84	36.81502	-96.29210	1	No	
2019	Kay	Roadside 1	NA	1	WGS84	36.86165	-96.75812	1	No	
2019	Osage	Roadside 2	NA	2	WGS84	36.76670	-96.38695	1	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	1	WGS84	36.76956	-96.39397	2	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	2	WGS84	36.77877	-96.40161	2	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	3	WGS84	36.75894	-96.37924	2	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	1	WGS84	36.84685	-96.43009	1	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	2	WGS84	36.84452	-96.42762	1	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	3	WGS84	36.84809	-96.42156	1	No	
2019	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	4	WGS84	36.84880	-96.43916	1	No	
2019	Osage	John Dahl WMA	NA	1	WGS84	36.86895	-96.54595	1	No	
2019	Osage	John Dahl WMA	NA	2	WGS84	36.86843	-96.53964	1	No	
2019	Osage	John Dahl WMA	NA	3	WGS84	36.86559	-96.54460	1	No	
2019	Osage	Osage WMA Rock Creek Unit	NA	1	WGS84	36.82603	-96.21741	2	No	
2019	Osage	Osage WMA Rock Creek Unit	NA	2	WGS84	36.80824	-96.23291	2	No	
2019	Osage	Osage WMA Rock Creek Unit	NA	3	WGS84	36.83367	-96.23028	1	No	
2019	Osage	Osage WMA Rock Creek Unit	NA	4	WGS84	36.82275	-96.21371	1	No	
2019	Osage	Osage WMA Rock Creek Unit	NA	5	WGS84	36.82462	-96.21866	1	No	
2019	Osage	Osage WMA Western Wall Unit	NA	1	WGS84	36.83680	-96.32011	1	No	
2019	Osage	Osage WMA Western Wall Unit	NA	2	WGS84	36.84432	-96.31378	1	No	
2019	Osage	Osage WMA Western Wall Unit	NA	3	WGS84	36.84105	-96.29706	1	No	

2019	Osage	Osage WMA Western Wall Unit	NA	4	WGS84	36.84005	-96.31767	1	No	
2019	Washington	Copan WMA	NA	1	WGS84	36.97092	-95.92588	1	No	
2019	Washington	Copan WMA	NA	2	WGS84	36.96542	-95.92338	1	No	
2019	Osage	Hulah WMA	NA	1	WGS84	36.95698	-96.18894	1	No	
2019	Osage	Hulah WMA	NA	2	WGS84	36.92046	-96.18606	1	No	
2019	Osage	Hulah WMA	NA	3	WGS84	36.92200	-96.18520	1	No	
2019	Osage	Hulah WMA	NA	4	WGS84	36.92671	-96.18844	1	No	
2019	Osage	Hulah WMA	NA	5	WGS84	36.92364	-96.18827	1	No	
2019	Kay	Kaw WMA	NA	1	WGS84	36.85360	-96.76595	1	No	
2019	Kay	Kaw WMA	NA	2	WGS84	36.85223	-96.77071	1	No	
2019	Kay	Kaw WMA	NA	3	WGS84	36.84851	-96.77547	1	No	
2019	Kay	Kaw WMA	NA	4	WGS84	36.86083	-96.75306	1	No	
2019	Kay	Kaw WMA	NA	5	WGS84	36.85127	-96.77373	1	No	
2019	Kay	Kaw WMA	NA	6	WGS84	36.85028	-96.78749	1	No	
2021	Osage	Osage County Private Property A	14 transects total	NA	WGS84			1	No	NRCS site*
2021	Osage	Osage County Private Property B- Pasture 1	14 transects total	NA	WGS84			1	No	NRCS site*
2021	Osage	Osage County Private Property B- Pasture 2	14 transects total	NA	WGS84			1	Yes	NRCS site*
2021	Osage	Osage County Private Property B- Pasture 3	14 transects total	NA	WGS84			1	No	NRCS site*
2021	Pawnee	Pawnee Private Property	14 transects total	NA	WGS84			1	No	NRCS site*
2021	Osage	Lake Pawhuska	NA	1	WGS84	36.64923	-96.39527	2	No	
2021	Osage	Lake Pawhuska	NA	2	WGS84	36.65026	-96.39580	2	No	
2021	Osage	Lake Pawhuska	NA	3	WGS84	36.65163	-96.39551	2	No	
2021	Osage	Lake Pawhuska	NA	4	WGS84	36.64903	-96.40069	2	No	
2021	Osage	Lake Pawhuska	NA	5	WGS84	36.64617	-96.39939	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	1	WGS84	36.84685	-96.43009	1	No	
2021	Osage	TNC Tallgrass Prairie	NA	2	WGS84	36.84452	-96.42762	1	No	

		Preserve: Nature Trail								
2021	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	3	WGS84	36.84809	-96.42156	1	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	4	WGS84	36.84880	-96.43916	1	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	1	WGS84	36.87515	-96.42136	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	2	WGS84	36.87629	-96.42135	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	3	WGS84	36.87562	-96.41997	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	4	WGS84	36.87773	-96.42127	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	NA	1	WGS84	36.87684	-96.41587	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	1	WGS84	36.81111	-96.46390	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	2	WGS84	36.80261	-96.40746	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	3	WGS84	36.78501	-96.39763	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	4	WGS84	36.78599	-96.39755	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	5	WGS84	36.81242	-96.46728	2	No	
2021	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	6	WGS84	36.81137	-96.46491	2	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	1	NA	WGS84	36.77251	-96.39384	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	2	NA	WGS84	36.77601	-96.40050	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	3	NA	WGS84	36.75602	-96.37602	3	No	

2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	1	NA	WGS84	36.78736	-96.39546	5	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	2	NA	WGS84	36.79010	-96.39361	5	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	3	NA	WGS84	36.75551	-96.38017	6	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	1	NA	WGS84	36.86467	-96.42275	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	2	NA	WGS84	36.86644	-96.42150	3	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	3	NA	WGS84	36.86649	-96.42385	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	4	NA	WGS84	36.87376	-96.42250	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	5	NA	WGS84	36.89580	-96.41111	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	6	NA	WGS84	36.89624	-96.40751	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Mary L.)	7	NA	WGS84	36.86935	-96.40650	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Mary L.)	8	NA	WGS84	36.86656	-96.38946	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	9	NA	WGS84	36.89561	-96.38191	3	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	10	NA	WGS84	36.86123	-96.37544	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	11	NA	WGS84	36.86261	-96.37010	3	Yes	

2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West Stish)	12	NA	WGS84	36.85162	-96.36373	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (East Stish)	13	NA	WGS84	36.85553	-96.35291	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (East Stish)	14	NA	WGS84	36.85276	-96.34972	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	15	NA	WGS84	36.84432	-96.34560	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	16	NA	WGS84	36.84577	-96.35909	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	17	NA	WGS84	36.87748	-96.42495	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Middle John Lee)	18	NA	WGS84	36.83790	-96.36332	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	19	NA	WGS84	36.84282	-96.36816	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	20	NA	WGS84	36.83967	-96.37273	3	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	21	NA	WGS84	36.83560	-96.37311	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	22	NA	WGS84	36.83203	-96.37520	4	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	23	NA	WGS84	36.83066	-96.38338	4	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	24	NA	WGS84	36.83527	-96.38264	4	No	

2020	Osage	John Dahl WMA	1	NA	WGS84	36.86781	-96.54459	3	No	
2020	Osage	John Dahl WMA	2	NA	WGS84	36.86695	-96.54023	3	No	
2020	Osage	John Dahl WMA	3	NA	WGS84	36.86441	-96.54172	3	No	
2020	Osage	Osage WMA Rock Creek Unit	1	NA	WGS84	36.83384	-96.22423	3	No	
2020	Osage	Osage WMA Rock Creek Unit	2	NA	WGS84	36.82434	-96.21869	3	No	
2020	Osage	Osage WMA Rock Creek Unit	3	NA	WGS84	36.83527	-96.22288	3	No	
2020	Osage	Osage WMA Western Wall Unit	1	NA	WGS84	36.83919	-96.32093	3	No	
2020	Osage	Osage WMA Western Wall Unit	2	NA	WGS84	36.84091	-96.31499	3	No	
2020	Osage	Osage WMA Western Wall Unit	3	NA	WGS84	36.84252	-96.29558	3	No	
2020	Kay	Kaw WMA	1	NA	WGS84	36.86075	-96.75840	3	No	
2020	Kay	Kaw WMA	2	NA	WGS84	36.85347	-96.76815	3	No	
2020	Kay	Kaw WMA	2	NA	WGS84	36.85395	-96.76990	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	1	WGS84	36.81111	-96.46390	1	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	2	WGS84	36.80261	-96.40746	1	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	3	WGS84	36.78501	-96.39763	1	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	4	WGS84	36.78599	-96.39755	1	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Bison Unit	NA	5	WGS84	36.81242	-96.46728	1	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	1	WGS84	36.84685	-96.43009	2	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	2	WGS84	36.84452	-96.42762	2	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Nature Trail	NA	3	WGS84	36.84809	-96.42156	2	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	1	WGS84	36.87515	-96.42136	3	No	



2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Sand Creek)	NA	1	WGS84	36.87629	-96.42135	3	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (Greeley)	NA	1	WGS84	36.87684	-96.41587	1	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	NA	2	WGS84	36.84075	-96.37156	1	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	NA	3	WGS84	36.84762	-96.36499	1	Yes	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	NA	4	WGS84	36.84686	-96.35872	2	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	NA	5	WGS84	36.83944	-96.38198	1	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Cattle Units (West John Lee)	NA	6	WGS84	36.83879	-96.38985	2	No	
2020	Osage	TNC Tallgrass Prairie Preserve: Stucco House	NA	1	WGS84	36.84503	-96.42086	3	No	
2020	Osage	Hulah WMA	NA	1	WGS84	36.95595	-96.19170	1	No	
2020	Osage	Hulah WMA	NA	2	WGS84	36.92009	-96.18651	1	No	
2020	Osage	Hulah WMA	NA	3	WGS84	36.92120	-96.18441	1	No	
2020	Kay	Kaw WMA	NA	1	WGS84	36.85186	-96.76793	1	No	
2020	Craig	TNC White Oak Prairie	NA	1	WGS84	36.62538	-95.27732	1	No	
2020	Craig	TNC White Oak Prairie	NA	2	WGS84	36.62062	-95.27245	1	No	
2020	Pawnee	Feyodi Creek	NA	1	WGS84	36.28132	-96.43462	1	No	
2020	Pawnee	Feyodi Creek	NA	2	WGS84	36.27894	-96.43900	1	No	
2020	Pawnee	Feyodi Creek Roadside	NA	1	WGS84	36.27637	-96.43916	1	No	
2020	Pawnee	Feyodi Creek Roadside	NA	2	WGS84	36.27849	-96.44051	1	No	
2020	Payne	Roadside	NA	1	WGS84	36.06046	-97.03079	1	No	
2020	Payne	Roadside	NA	2	WGS84	36.06248	-97.02973	1	No	
2020	Osage	Lake Pawhuska	NA	1	WGS84	36.64923	-96.39527	2	Yes	

2020	Osage	Lake Pawhuska	NA	2	WGS84	36.65026	-96.39580	2	Yes	
2020	Osage	Lake Bluestem	NA	1	WGS84	36.70679	-96.41245	1	No	
2020	Osage	Lake Bluestem	NA	2	WGS84	36.70724	-96.41305	1	No	
2020	Osage	Lake Bluestem	NA	3	WGS84	36.70100	-96.40075	1	No	
2020	Osage	Wa-Sha-She State Park	NA	1	WGS84	36.92129	-96.09650	1	No	
2020	Osage	Wa-Sha-She State Park	NA	2	WGS84	36.92472	-96.09193	1	No	
2020	Rogers	Roadside	NA	1	WGS84	36.56674	-95.32980	1	No	
2020	Rogers	Roadside	NA	2	WGS84	36.55815	-95.34565	1	No	
2020	Tulsa	Oxley Nature Center	NA	1	WGS84	36.22532	-95.90220	1	No	
2020	Tulsa	Oxley Nature Center	NA	2	WGS84	36.22563	-95.90103	1	No	
2020	Tulsa	Oxley Nature Center	NA	3	WGS84	36.22486	-95.90333	1	No	
2020	Osage	Roadside 3	NA	1	WGS84	36.31952	-96.51336	3	No	
2020	Osage	Roadside 4	NA	1	WGS84	36.86933	-96.53909	2	No	

\* private property, no coordinates available

Table 2. Summary of activities and observations for the 2019 field season.

County	Site name	Random transects surveyed	Non-random transects surveyed	<i>S. idalia</i> observed	<i>S. cybele</i> observed	<i>S. diana</i> observed	<i>D. plexippus</i> observed	<i>A. arogos</i> observed	<i>P. byssus</i> observed	<i>H. attalus</i> observed
Osage	TNC Tallgrass Prairie Preserve: Bison Unit	9	6	0	0	0	25	2	0	0
Osage	TNC Tallgrass Prairie Preserve: Nature Trail	9	4	5 (3 females & 2 males) on June 20; 1 (male) on July 10	4	0	29	1	0	0
Osage	TNC Tallgrass Prairie Preserve: Cattle Units (7 pastures)	72	0	1 (female) on July 5, West John Lee Pasture	0	0	17	3	0	0
Osage	John Dahl WMA	9	3	0	0	0	23	4	0	0
Osage	Osage WMA Rock Creek Unit	9	7	0	0	0	3	0	0	0
Osage	Osage WMA Western Wall Unit*	6	4	0	0	0	6	0	0	0
Washington	Copan WMA*	1	2	0	1	0	3	0	0	0
Osage	Hulah WMA*	3	5	0	0	0	0	1	0	0
Kay	Kaw WMA*	6	6	0	0	0	13	3	0	0

Kay	Farmer's Home Tract	0	1	0	0	0	2	0	0	0
Osage	Wa-Sha-She State Park	0	1	0	0	0	0	0	0	0
Osage	Roadside 1	0	2	0	0	0	1	2	1	1
Kay	Roadside 2	0	1	0	0	0	0	0	0	0
<b>2019 Field Season Totals</b>		<b>124</b>	<b>42</b>	<b>7</b> (4 females, 3 males)	<b>5</b>	<b>0</b>	<b>122</b>	<b>16</b>	<b>1</b>	<b>1</b>

\*Due to flooding in May, access to Copan WMA, Hulah WMA, and Kaw WMA was impeded at the start of June. Excessively wet/muddy roads delayed surveys at Osage WMA Western Wall Unit.

Table 3. Summary of activities and observations for the 2020 field season.

County	Site name	Random transects surveyed	Non-random transects surveyed	<i>S. idalia</i> observed	<i>S. cybele</i> observed	<i>S. diana</i> observed	<i>D. plexippus</i> observed	<i>A. arogos</i> observed	<i>P. byssus</i> observed	<i>H. attalus</i> observed
Osage	TNC Tallgrass Prairie Preserve: Bison Unit	9	5	0	0	0	6	3	0	0
Osage	TNC Tallgrass Prairie Preserve: Nature Trail	16	6	0	1	1 (male)	34	3	0	0
Osage	TNC Tallgrass Prairie Preserve: Cattle Units (7 pastures)	75	14	0	0	0	58	6	0	0
Osage	John Dahl WMA	9	0	0	0	0	6	0	0	0
Osage	Osage WMA Rock Creek Unit	9	0	0	0	0	6	1	0	0
Osage	Osage WMA Western Wall Unit	9	0	0	0	1 (male)	2	3	0	0
Osage	TNC Tallgrass Prairie Preserve: Stucco House	0	3	0	1	0	0	0	0	0
Osage	Hulah WMA	0	3	0	0	0	0	0	0	0
Kay	Kaw WMA	9	1	0	0	0	7	14	0	0

Craig	White Oak Prairie	0	2	0	0	0	1	3	0	0
Pawnee	Feyodi Creek	0	2	0	0	0	0	0	0	0
Pawnee	Feyodi Creek Roadside	0	2	0	1	0	1	0	0	0
Payne	Roadside	0	2	0	0	0	0	0	0	0
Osage	Lake Bluestem	0	3	0	1	0	0	0	0	0
Osage	Osage County Roadside 1	0	3	0	0	0	0	0	0	0
Osage	Osage County Roadside 2	0	2	0	1	0	0	4	0	0
Osage	Lake Pawhuska	0	4	0	1	0	0	1	0	0
Osage	Wah-Sha-She State park	0	2	0	0	0	0	0	0	0
Rogers	Rogers County Roadside	0	2	0	0	0	0	0	0	0
Tulsa	Oxley Nature Center	0	3	0	0	0	0	0	0	0
<b>2020 Field Season Totals</b>		<b>136</b>	<b>59</b>	<b>0</b>	<b>6</b>	<b>2 (both males)</b>	<b>120</b>	<b>38</b>	<b>0</b>	<b>0</b>

Table 4. Summary of activities and observations for the 2021 field season.

County	Site name	Random transects surveyed	Non-random transects surveyed	<i>S. idalia</i> observed	<i>S. cybele</i> observed	<i>S. diana</i> observed	<i>D. plexippus</i> observed	<i>A. arogos</i>	<i>P. byssus</i>	<i>H. attalus</i>
Osage	TNC Tallgrass Prairie Preserve: Bison Unit	0	12	0	0	0	15	0	0	0
Osage	TNC Tallgrass Prairie Preserve: Nature Trail	0	4	1 (female)	7	3 (males)	103	0	0	0
Osage	TNC Tallgrass Prairie Preserve: Cattle Units (2 pastures)	0	10	1 (female) Sand Creek Pasture	0	0	6	0	0	0
Osage	Lake Pawhuska	0	10	0	3	0	10	0	0	0
Osage	Osage County Private Property A (1 pasture)	14	0	0	0	0	6	2	0	0
Osage	Osage County Private Property B (3 pastures)	42	0	0	4	0	7	0	0	0
Pawnee	Pawnee Private Property	14	0	0	2	0	2	0	0	0
<b>2021 Field Season Totals</b>		<b>70</b>	<b>36</b>	<b>2</b> (both females)	<b>16</b>	<b>3</b> (all males)	<b>148</b>	<b>2</b>	<b>0</b>	<b>0</b>

Table 5. Records of the regal fritillary (*Speyeria idalia*) in Oklahoma included in the attached Excel spreadsheet. Records include county, date, count, location, observers, sex, record source, record type, latitude, and longitude when available.

County	Scientific Name	Date	Num.	Location	Latitude	Longitude	Observers	Record Source	Record Type
Craig	<i>Speyeria idalia</i>	6/10/1961	1	7 miles north of Vinita, SH 2 ROW	36.7578	-95.1433	JR Heitzman	B&M of NA	Pinned Specimen
Osage	<i>Speyeria idalia</i>	7/10/1973	1 F	Bowring, OK	36.87806	-96.1197	P Loy	OMNH	Pinned Specimen
Osage	<i>Speyeria idalia</i>	7/10/1973	1 M	Bowring, OK	36.87806	-96.1197	P Loy	ONNH	Pinned Specimen
Osage	<i>Speyeria idalia</i>	7/11/1980	1 M	Hulah Lake, Stroms Ranch	36.92674	-96.0836	C Loy	OMNH	Pinned Specimen
Osage	<i>Speyeria idalia</i>	6/ ?/1993	1	T27N, R08E, Sec 3, SW/4; Nature Trail	36.84302	-96.4352		ONHI Database	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/25/1994	3	T27N, R08E, Sec 3, SW/4; Nature Trail	36.84302	-96.4352		ONHI Database	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/22/1996	1	TNC Tallgrass Prairie Preserve			J. Nelson, et al	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/24/2000	1	TNC Tallgrass Prairie Preserve			J. Deming, et al	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/23/2001	3	TNC Tallgrass Prairie Preserve			J. Fisher, J. McMahan	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/15/2002	7	TNC Tallgrass Prairie Preserve			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/22/2002	3	TNC Tallgrass Prairie Preserve			Edwards, et al	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/12/2002	2	TNC Tallgrass Prairie Preserve			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/14/2002	1	TNC Tallgrass Prairie Preserve			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/21/2003	1	T27N, R08E, Sec 11	36.88384	-96.4111		ONHI	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/21/2003	6 or 7	TNC Tallgrass Prairie Preserve			W. Gerard, J. Nelson, D. Edwards S. & C Ruby	J. Fisher State Records	Visual Sighting



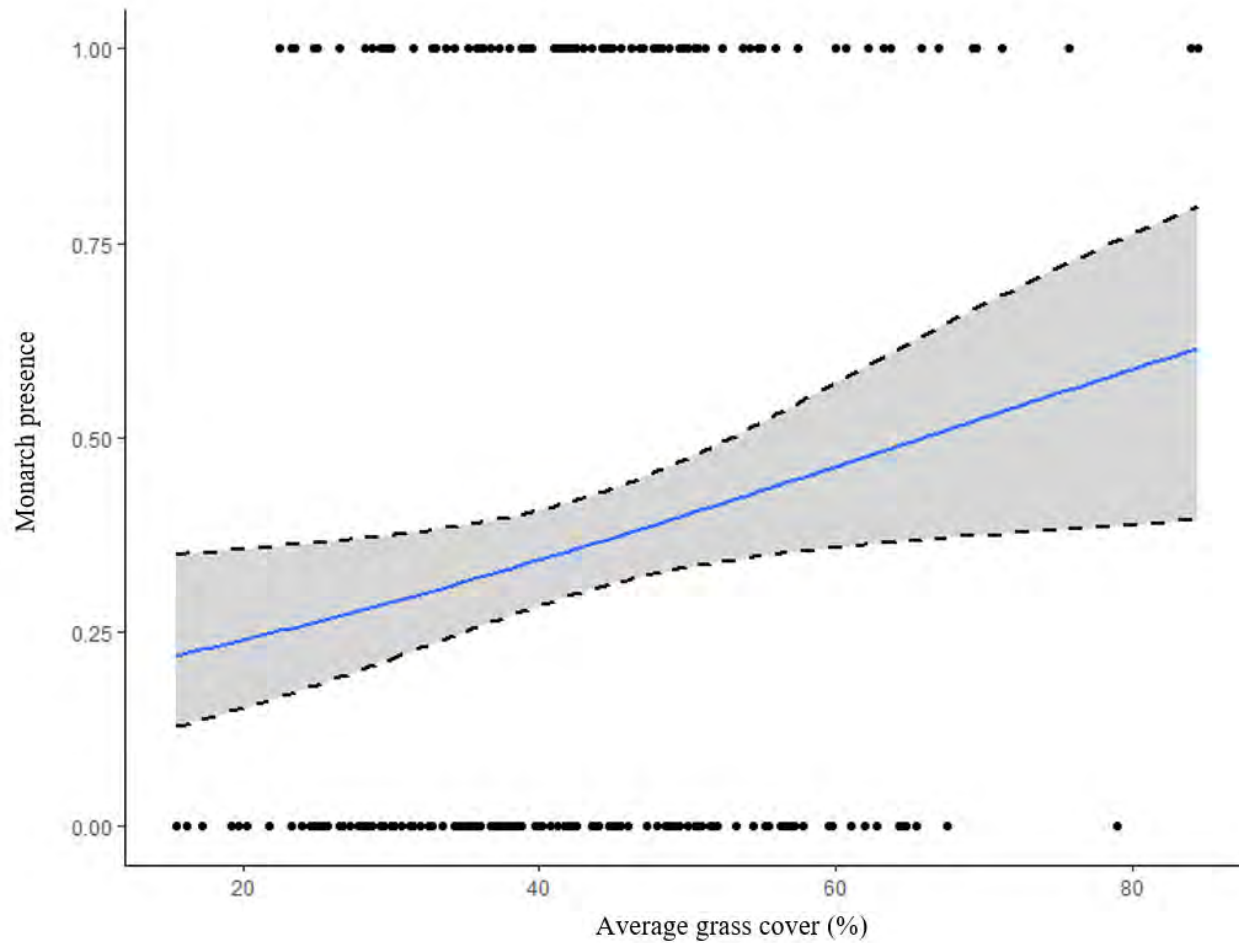
Pawnee	<i>Speyeria idalia</i>	7/30/2003	1	Feyodi Creek SP	36.27813	-96.4331	J. Fisher	J. Fisher State Records	Visual Sighting
Pawnee	<i>Speyeria idalia</i>	8/01/2003	1	Feyodi Creek SP			J. Fisher	J. Fisher State Records	Photograph
Osage	<i>Speyeria idalia</i>	8/16/2003	1	TNC Tallgrass Prairie Preserve			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/19/2004	3	TNC Tallgrass Prairie Preserve			J. Fisher, W. Gerard, J. Nelson	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/02/2005	1	TNC Tallgrass Prairie Preserve			W. Gerard, J. Thayer	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/02/2005	6	TNC TPP – Prairie Earth Trail			J. Fisher, J. Nelson	J. Fisher State Records	Visual Sighting
Craig	<i>Speyeria idalia</i>	6/08/2006	1	TNC White Oak Prairie Preserve	36.625	-95.277	J. Nelson, J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/01/2006	82 ?	TNC Tallgrass Prairie Preserve			J. Nelson, J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/08/2006	2	TNC TPP – Prairie Earth Trail			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/08/2006	2	TNC TPP – pond south of trails			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	8/30/2006	2	TNC TPP – ponds south of corrals	36.859867	-96.37416	J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/30/2007	1	TNC Tallgrass Prairie Preserve			J. Fisher, D. Edwards	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/05/2008	2	TNC Tallgrass Prairie Preserve			Mel White	J. Fisher State Records	Photograph; in copula
Osage	<i>Speyeria idalia</i>	6/26/2010	9	TNC Tallgrass Prairie Preserve			J. Fisher J. Pruett B Reynolds	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/18/2011	15	TNC TPP – Prairie Earth Trail			J. Fisher, T. Hovick	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/18/2011	3	TNC TPP – west of Blackberry Ridge	36.859867	-96.37416	J. Fisher, T. Hovick	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/18/2012	14	TNC Tallgrass Prairie Preserve			J. Fisher, et al	J. Fisher State Records	Visual Sighting

Osage	<i>Speyeria idalia</i>	6/23/2012	14	TNC Tallgrass Prairie Preserve			J. Fisher, J. Pruett, S. Schwinn	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/23/2013	9	TNC Tallgrass Prairie Preserve			J. Fisher, J. Pruett	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/04/2013	9	TNC TPP – Prairie Earth Trail			J. Fisher, et al	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/07/2014	1	TNC TPP – Trail Area			J. Fisher, J. Pruett	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/04/2014	2	TNC TPP – Prairie Earth Trail			J. Fisher	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/06/2015	2	TNC TPP – Bison Loop			J. Fisher, G. Pierson	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	9/24/2016	1	TNC TPP – Prairie Earth Trail			J. Fisher, G. Pierson	J. Fisher State Records	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/20/2019	1 F	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/20/2019	1 F	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/20/2019	1 F	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/20/2019	1 M	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/20/2019	1 M	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/05/2019	1 F	TNC TPP – West John Lee Pasture	36.83967	-96.37273	E. Geest	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/10/2019	1 M	TNC TPP – Nature Trail	36.848797	-96.43915	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/22/2021	1 F	TNC TPP – Nature Trail	36.845325	-96.42629	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	6/25/2021	1 F	TNC TPP – Sand Creek Pasture	36.875145	-96.42135	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Osage	<i>Speyeria idalia</i>	7/05/2021	1 F	TNC TPP – West John Lee Pasture	36.8425	-96.36941	E. Geest, R. Moranz	OSU – T-110	Visual Sighting
Craig	<i>Speyeria</i>	Early	1	White Oak Prairie	36.625	-95.277	J. Nelson	J. Nelson –	Visual

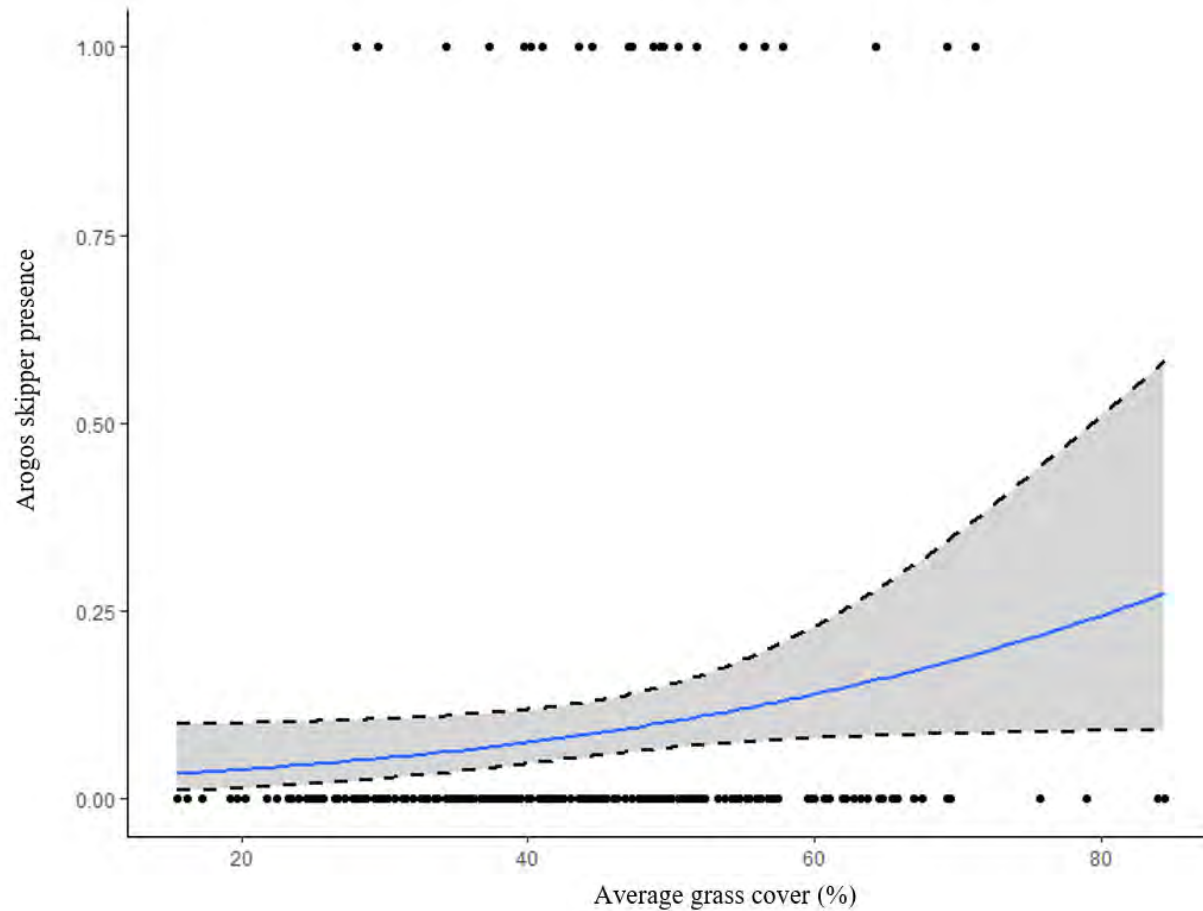
	<i>idalia</i>	1980s						pers. com.	Sighting
Osage	<i>Speyeria idalia</i>	Unk	1	Near Nelagoney Cemetery	36.6179	-96.2372	Unk Legacy Record	B & M of NA	Visual Sighting
Rogers	<i>Speyeria idalia</i>	Unk	1	2 miles south of Oolagah Dam	36.3902	-96.6458	Unk Legacy Record	B & M of NA	Visual Sighting
Tulsa	<i>Speyeria idalia</i>	Unk	1	Near University of Tulsa Campus			Unk Legacy Record	B & M of NA	Visual Sighting

Table 6. Site characteristics associated with presence or absence of arogos skippers (*Atrytone arogos*) and Monarch butterflies (*Danaus plexippus*) using generalized linear models (GLM) with a binomial distribution. SE = standard error. Presence/absence data are from modified Pollard walks conducted on randomly-placed transects in 2019 and 2020. To interpret the direction and significance of relationships the beta estimate ( $\beta$ ) of each GLM is reported.

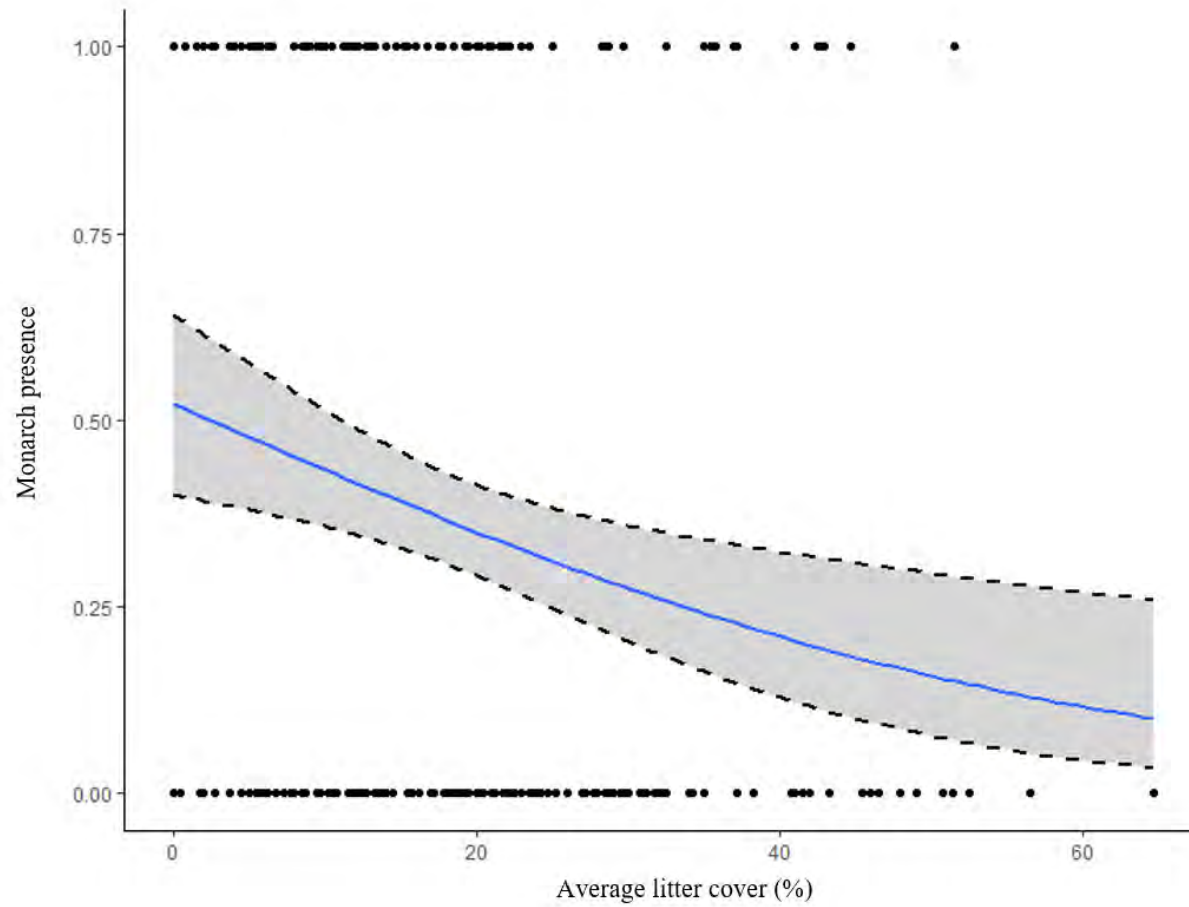
Variable	<u>Arogos skipper</u>				<u>Monarch</u>			
	z-value	p-value	Std. Err.	$\beta$	z-value	p-value	Std. Err.	$\beta$
Vegetation height	1.749	0.080	0.010	0.017	0.718	0.473	0.006	0.005
% Bare ground cover	-1.326	0.185	0.025	-0.033	0.489	0.624	0.012	0.006
% Forb cover	-1.262	0.207	0.020	-0.026	0.204	0.839	0.204	-0.035
% Grass cover	2.028	0.043	0.017	0.034	2.330	0.020	0.011	0.025
% Litter cover	0.271	0.786	0.018	0.005	-2.930	0.003	0.012	-0.035
% Blooming forb cover	0.609	0.543	0.356	0.022	1.363	0.143	0.024	0.033



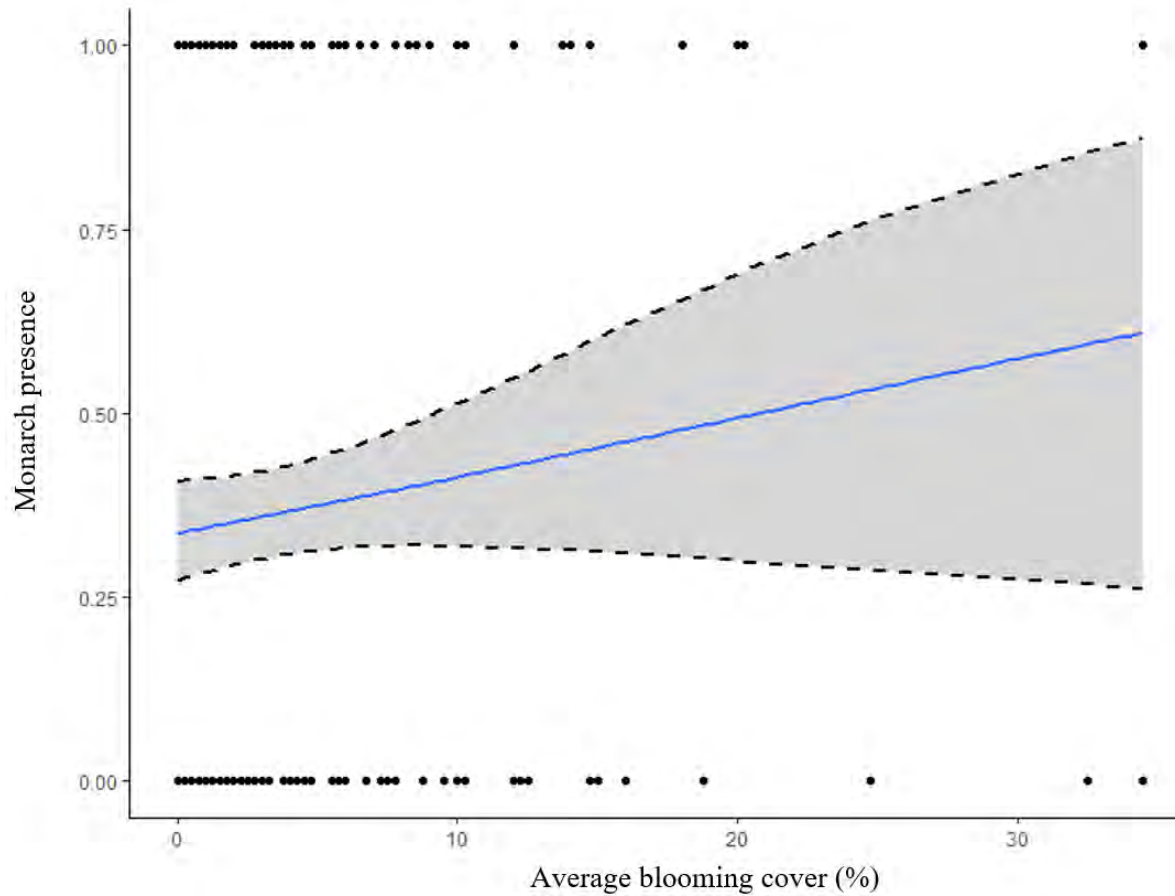
**Fig. 1** A line graph depicting a generalized linear model with a binomial distribution of presence of monarchs (*Danaus plexippus*) by average grass cover (%) in 2019 and 2020. Dashed lines indicate upper and lower 95% confidence intervals. Solid circles represent data points. There was a significant positive effect ( $p = 0.020$ ) of increasing grass cover on monarch presence.



**Fig. 2** A line graph depicting a generalized linear model with a binomial distribution of presence of arogos skippers (*Atrytone arogos*) by average grass cover (%) in 2019 and 2020. Dashed lines indicate upper and lower 95% confidence intervals. Solid circles represent data points. There was a significant positive effect ( $p = 0.043$ ) of increasing grass cover on arogos skipper presence.



**Fig. 3** A line graph depicting a generalized linear model with a binomial distribution of presence of monarchs (*Danaus plexippus*) by average litter cover (%) in 2019 and 2020. Dashed lines indicate upper and lower 95% confidence intervals. Solid circles represent data points. There was a significant negative effect ( $p = 0.003$ ) of increasing litter cover on monarch presence.



**Fig. 4** A line graph depicting a generalized linear model with a binomial distribution of presence of monarchs (*Danaus plexippus*) by average blooming forb cover (%) in 2019 and 2020. Dashed lines indicate upper and lower 95% confidence intervals. Solid circles represent data points. There was not an effect ( $p = 0.143$ ) of increasing blooming forb cover on monarch presence.