

Natural History of Shortgrass Prairie Plant Species at The Pueblo Chemical Depot 2018-2019

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ABSTRACT

Undisturbed shortgrass prairie is a rich, diverse ecosystem that is becoming endangered due to disturbance by humans in the Midwest. We surveyed the effects of droughts and heavy precipitation years to analyze the plant composition on an undisturbed shortgrass prairie ecosystem located on the Pueblo Chemical Depot. We found that during drought years, there are few species of plants capable of growing, all plants were perennials, and there were few invasive species of plants. When comparing the floral compositions between a wet year and a dry year we found that wet years have higher diversity, more invasive species, more annual plants, and that most drought-year plants were not found again during the wet year. Our results demonstrate that drought years select for native perennial plants, wet years create more possibilities for annuals and invasive plants, and drought-year plants are most likely outcompeted by other plants during wet years.

El Rio: A Student Research Journal. Vol. 1, No. 1 (2018), pp. 43-50.

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Introduction

Shortgrass prairie is a native ecosystem in North America located east of the Rocky Mountains in the central part of the United States (Samson, 1996). Fires and heavy grazing by ungulates and small mammals (e.g. bison and prairie dogs) are natural processes in shortgrass prairie ecosystems (Samson, 1996). Thus, plants in shortgrass prairies have evolved with regular cycles of fire and grazing and tend to be highly resilient, perennial plants, such as *Bouteloua gracilis*, *Buchlōe dactyloides*, *Yucca glauca*, and prickly pear cactus (Dickinson, 1976).

Our study site is located on a 23,000-acre military installation, the U.S. Army Pueblo Chemical Depot, located east of Pueblo, CO (Rondeau, 2013). The Pueblo Chemical Depot is in the center of three different types of floristic zones (see Fig. 1) (Cronquist, 1982), including the Rocky Mountain zone, North American Shortgrass Prairie zone, and the Chihuahuan Desert zone. Each zone has very different compositions of plants; for example, the Rocky Mountain zone contains mainly trees, shrubs, and a few types of grasses, while the Chihuahuan Desert zone contains mostly cacti and prickly shrubs (Huenneke, 2001). Previous surveys at the Pueblo Chemical Depot has shown, that plant compositions from each zone at the Pueblo Chemical Depot follow the same pattern (Rondeau, 2013). The objectives of this study are to survey the plants located on shortgrass prairie at the Pueblo Chemical Depot. The results of this study will contribute to conservation of critically endangered grassland habitat and show that the habitat at the Pueblo Chemical Depot is unique in that it is a melting pot of North American floristic zones.

Methods

Location: This survey was conducted at the U.S. Army Pueblo Chemical Depot located in southeastern Colorado (Pueblo, Colorado). The habitat at the Pueblo Chemical Depot is either grassland, riparian or semidesert shrubland (Andrews and Righter 1992), with shortgrass prairie vegetative communities in grassland areas (Rondeau, 2013). We did not survey plants in the riparian woodland, northern sandhill prairie, greasewood shrub, or wetland on the Pueblo Chemical Depot (Rondeau, 2013).

Sampling: All surveys were conducted in the month of June 2018 and 2019. Southeastern Colorado suffered a severe drought during the summer of 2018, causing little diversity and density of plant growth (Weather Underground, 2020). 2019 proved to be a wetter year and was a more productive year for plants at the study site. To catalog the plants at the Pueblo Chemical Depot, we used the Modified Whittaker Plot method (Stohlgren, 1995) in 12 plots during 2018 and 14 in 2019.

In brief, Modified Whittaker Plots are 10x25 meter rectangular plots used for surveying plants (Stohlgren, 1995). Modified Whittaker Plots have 13 subplots within the 10 x 25 meter plot, with 10 subplots occupying 0.25 x 1 meters (for a total of 2.5 meters) located on the perimeter of the plot to maximize efficiency of sampling and used to gather data on plant composition. Three subplots, which add up to 30 meters, are used for finding plants that were not found within the other subplots.

Identification: We collected a sample for each plant species, pressed the sample in a plant press, and then identified it by using Ells (2012). We then used the USDA PLANTS database to find the floristic zone and growth habit of every plant (USDA, 2020). In this study we used North American shortgrass prairie, Chihuahuan desert, and Rocky Mountain floristic zones for reference.

Results

Annual precipitation in Pueblo, Colorado was lower in 2018 than 2019 by approximately 6 inches (see Fig. 2). In 2018 we found 6 total families of plants and in 2019 we found 20 total families of plants (see Tables 1 and 2). In 2018, we found a total of nine plant species including one invasive species and eight native species; all species found undergo the perennial growth habit. In 2019, we found 46 total plant species including six invasive species and 40 native species. There was a total of 24 perennial growth habit plants and 22 total annual growth habit plants. All invasive species found were annual plants (see Table 2). In 2019, we found only 5 similar plants that were found in 2018, which is over half of the total number of plants found in 2018 (see Fig. 2).

Discussion

In 2018, a major drought occurred in the shortgrass prairie located on the Pueblo Chemical Depot that decreased the number of plants surveyed and plant diversity (Weather Underground, 2020). All plants surveyed in 2018 were perennial i.e. plants that live for more than two years and invest growth in the roots and/or secondary growth to maintain life when undergoing drought, fires, grazing, or nutrient unavailability (Ehrlinger, 1985). This may be because perennial plants prefer not to exhaust their nutrient stores in creating flowering organs during drought events, instead investing their growth into organs that are important to staying alive for when flowering is beneficial rather than detrimental (Iwasa, 1989).

All plants surveyed in 2018 are native species, except one invasive species (*Bromus inermis*), and are native to harsh climates, such as those in shortgrass prairies (Otfinowski, 2007). *Bromus inermis* is an invasive perennial plant that can be found in areas with animal grazers, such as prairie dogs in shortgrass prairies.

In 2019, Southeastern Colorado experienced a higher amount of precipitation, with a total of 13.13 inches of rainfall during this year at the Pueblo Chemical Depot (Weather Underground, 2020). As a result, there was a higher amount of plant growth on the Pueblo Chemical Depot shortgrass prairie (Rondeau, 2013). The floral community completely shifted, due to the rain, from only perennials in 2018 to almost half of the species found being annuals in 2019. This is most likely due to the higher amounts of precipitation, which allowed annual plants to grow (Ehleringer, 1985). In addition, all invasive plants found in 2019 were annuals, likely because they rely on rainfall rather than being adapted to drought conditions.

One plant found in 2018 but not 2019 was *Astragalus inflexus*; this plant, when in full bloom, has a very conspicuous purple flower allowing it to be seen from even far away. *A. inflexus* is also a very small, herbaceous plant that is adapted to drought conditions (REFS). Given the high number of other plants, they may have outcompeted this species.

In 2019, we did not find *Bromus inermis*, a very turfey, drought-resistant plant. This plant was introduced to the United States from Eurasia for use as a pasture grass for livestock; it's used to high amounts of grazing and it undergoes the perennial growth habit by forming large clumps of populations that typically outcompete other plants (Otfinowski, 2007). We speculate that due to the large amount of rainfall during 2019, that most of the clumps of *B. inermis* populations were choked out by the new annuals outcompeting other plants. We also hypothesize that if another drought were to occur, we will see less of the annual plants and more of the perennial plants, perhaps even the same species found in 2018 during the drought.

The Pueblo Chemical Depot has a wide array of plants from many different floristic zones such as *Bouteloua gracilis*, which is native to the shortgrass prairie floristic zone, to the large species of cactus, *Cylindropuntia imbricata* (commonly called tree cholla), which is native to the Chihuahuan desert floristic zone. These plants are all native to different floristic zones in North America and were found at the Pueblo Chemical Depot, indicating that this military installation is a sort of "melting pot" of floristic zones. To achieve a better model for the types of plants on the shortgrass prairie of the Pueblo Chemical Depot, we could also conduct surveys at different times of the year to see what conditions certain plants grow under and the times of year they bloom or sprout. There is still much to be studied about this wonderfully diverse location with it being in the center of multiple floristic zones.

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Figures

Figure 1.

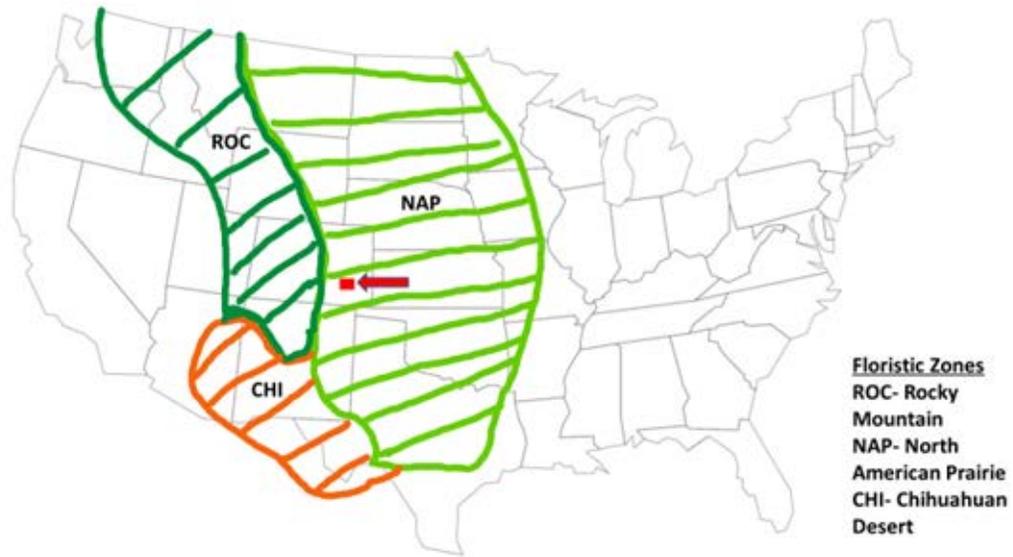


Figure 1. The floristic zones of South and the central United States, including Rocky Mountain (ROC), North American Prairie (NAP) and Chihuahuan Desert (CHI). The arrow indicates the general location of the study site, the U.S. Army Pueblo Chemical Depot, in Pueblo Colorado.

Figure 2.

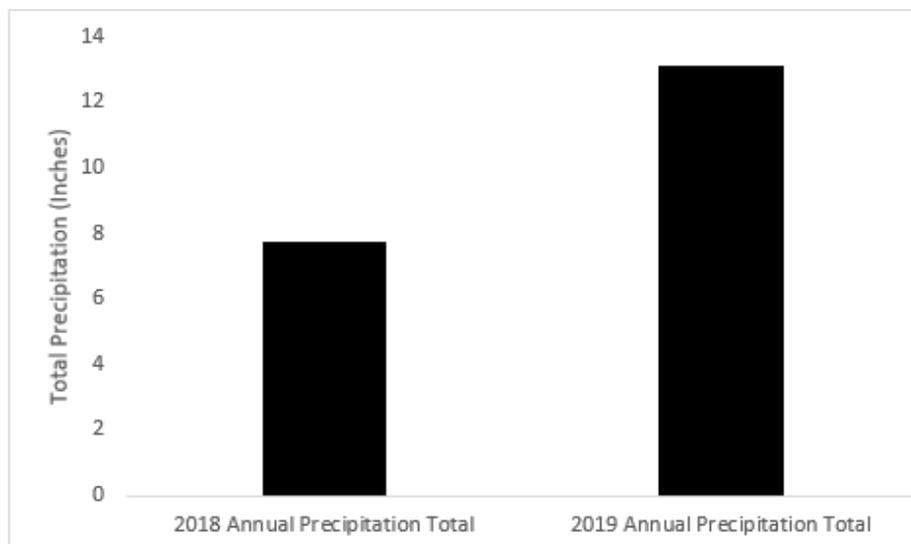


Figure 2. The total amount of precipitation in Pueblo, Colorado, during 2018 and 2019.

Figure 3.

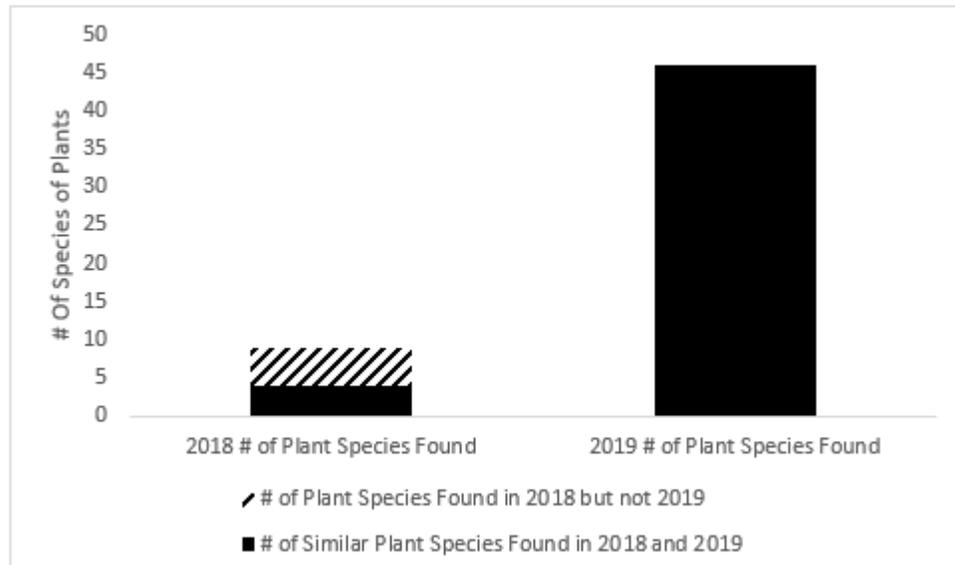


Figure 3. The total number of plant species found in 2018 and 2019. There were 9 plant species found in 2018 and 46 plant species found in 2019. Five species of plants were found in 2018 but not found in 2019.

Table 1.

Family	Genus	Species	Floristic Zone	Growth Habit
<i>Agavaceae</i>				
	<i>Yucca</i>	<i>glauca</i>	C,N,R	Perennial
<i>Asteraceae</i>				
	<i>Ericameria</i>	<i>nauseosa</i>	C,N,R	Perennial
	<i>Grindelia</i>	<i>squarrosa</i>	C,N,R	Perennial
<i>Boraginaceae</i>				
	<i>Cryptantha</i>	<i>crassisejala</i>	C,N,R	Perennial
<i>Fabaceae</i>				
	<i>Astragalus</i>	<i>inflexus</i>	N,R	Perennial
<i>Poaceae</i>				
	<i>Aristida</i>	<i>longiseta</i>	C,N,R	Perennial
	<i>Bromus</i>	<i>inermis</i>	Invasive	Perennial
	<i>Buchlœ</i>	<i>dactyloides</i>	C,N,R	Perennial
<i>Polygonaceae</i>				
	<i>Eriogonum</i>	<i>effusum</i>	C,N,R	Perennial

Table 1. The plant species and families found on the Pueblo Chemical Depot in 2018. There was one invasive plant found. All but one species of plant found were native to the three floristic zones described, *Astragalus inflexus* has not been known to be native to the Chihuahuan floristic zone. All plants found undergo the perennial growth habit. Floristic zones C,N,R stand for Chihuahuan zone, North American Prairie zone, and Rocky mountain zone, respectively.

Table 2.

Family	Genus	Species	Floristic Zone	Growth Habit
<i>Apiaceae</i>				
	<i>lomatium*</i>			
<i>Asteraceae</i>				
	<i>Chrysothamnus</i>	<i>viscidiflorus</i>	C,N,R	Perennial
	<i>Cirsium</i>	<i>vulgare</i>	Invasive	Annual
	<i>Conyza</i>	<i>canadensis</i>	C,N,R	Annual
	<i>Ericameria</i>	<i>nauseosa</i>	C,N,R	Perennial
	<i>Erigeron</i>	<i>divergens</i>	C,N,R	Annual
	<i>Gaillardia</i>	<i>aristata</i>	C,N,R	Perennial
	<i>Helianthus</i>	<i>annuus</i>	C,N,R	Annual
	<i>Lactuca</i>	<i>serriola</i>	Invasive	Annual
	<i>Machaeranthera</i>	<i>pinnatifida</i>	C,N,R	Perennial
	<i>Machaeranthera</i>	<i>tanacetifolia</i>	C,N,R	Annual
	<i>Pectis</i>	<i>angustifolia</i>	C,N,R	Annual
	<i>Stephanomeria</i>	<i>pauciflora</i>	C,N,R	Perennial
	<i>Zinnia</i>	<i>grandiflora</i>	C,N,R	Perennial
<i>Boraginaceae</i>				
	<i>Cryptantha</i>	<i>crassisepala</i>	C,N,R	Perennial
<i>Brassicaceae</i>				
	<i>Brassica</i>	<i>nigra</i>	C,N,R	Annual
	<i>Descurainia</i>	<i>pinnata</i>	C,N,R	Annual
	<i>Lepidium</i>	<i>ramosissimum</i>	C,N,R	Annual
<i>Cactaceae</i>				
	<i>Cylindropuntia</i>	<i>imbricata</i>	C,N,R	Perennial
	<i>Opuntia</i>	<i>macrorhiza</i>	C,N,R	Perennial
<i>Chenopodiaceae</i>				
	<i>Chenopodium</i>	<i>album</i>	Invasive	Annual
	<i>Kochia</i>	<i>iranica</i>	Invasive	Annual
	<i>Salsola</i>	<i>collina</i>	Invasive	Annual
<i>Commelinaceae</i>				
	<i>Tradescantia</i>	<i>occidentalis</i>	C,N,R	Perennial
<i>Cucurbitaceae</i>				
	<i>Cucurbita</i>	<i>foetidissima</i>	C,N,R	Perennial

<i>Euphorbiaceae</i>				
	<i>Croton</i>	<i>texensis</i>	C,N,R	Annual
	<i>Euphorbia</i>	<i>maculata</i>	C,N,R	Annual
<i>Fabaceae</i>				Annual
	<i>Psoralea</i>	<i>argophylla</i>	C,N,R	Perennial
	<i>Psoralea</i>	<i>tenuiflora</i>	C,N,R	Perennial
	<i>Sophora</i>	<i>nuttalliana</i>	C,N,R	Perennial
<i>Malvaceae</i>				
	<i>Sphaeralcea</i>	<i>coccinea</i>	C,N,R	Perennial
<i>Nyctaginaceae</i>				
	<i>Abronia</i>	<i>fragrans</i>	C,N,R	Perennial
	<i>Tripterocalyx</i>	<i>micranthus</i>	C,N,R	Annual
<i>Onagraceae</i>				
	<i>Gaura</i>	<i>coccinea</i>	C,N,R	Perennial
	<i>Oenothera</i>	<i>albicaulis</i>	C,N,R	Annual
<i>Plantaginaceae</i>				
	<i>Plantago</i>	<i>patagonica</i>	C,N,R	Annual
<i>Poaceae</i>				
	<i>Aristida</i>	<i>purpurea</i>	C,N,R	Perennial
	<i>Bouteloua</i>	<i>gracilis</i>	C,N,R	Perennial
	<i>Buchlōe</i>	<i>dactyloides</i>	C,N,R	Perennial
	<i>Sitanion</i>	<i>hystrix</i>	C,N,R	Perennial
<i>Polemoniaceae</i>				
	<i>Phlox</i>	<i>longifolia</i>	C,N,R	Perennial
<i>Portulacaceae</i>				
	<i>Portulaca</i>	<i>oleracea</i>	Invasive	Annual
<i>Solanaceae</i>				
	<i>Quincula</i>	<i>lobata</i>	C,N,R	Perennial
	<i>Solanum</i>	<i>rostratum</i>	C,N,R	Annual
	<i>Solanum</i>	<i>triflorum</i>	C,N,R	Annual
<i>Verbenaceae</i>				
	<i>Verbena</i>	<i>ambrosifolia</i>	C,N,R	Perennial

Table 2. This table represents the plant species and families found on the Pueblo Chemical Depot in 2019. There were 46 total plants found, 6 invasive, 40 native, and 20 total families. Every plant native to North America fell under the three floristic zones described. There was a total of 24 perennial growth habit plants and 9 total annual growth habit plants, all invasive species found were annual plants. Floristic zones C,N,R stand for Chihuahuan zone, North American Prairie zone, and Rocky mountain zone, respectively.