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Natural Resource Stewardship and Science

Camas Monitoring in Nez Perce National Historical Park's Weippe Prairie

2014 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2017/1079

ON THE COVER
Common camas in bloom at Weippe Prairie, Idaho.
Photograph by Devin Stucki, NPS.

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Abstract

As part of the Upper Columbia Basin Network's long-term vital signs monitoring, we completed monitoring of camas (*Camassia quamash* (Pursh) Greene) in 2014 in Nez Perce National Historical Park's (NEPE) Weippe Prairie. This was the tenth year of camas monitoring in Weippe Prairie.

Density counts were down in 2014 compared with recent years in all zones and seem to reflect the lower numbers found during the 2012 survey. Conversely, 2014 estimates of mean density of flowering camas plants/m^2 were higher than recent years in all zones. The ratios of flowering stem density to camas plant density for nearly all zones were the highest recorded since monitoring began, except zone C which had a higher flowering ratio only in 2008.

Orange hawkweed frequency of occurrence continued to be highly variable among zones but in general had declined since 2013. An increase in reed canary grass was reported with over 9% of all plots in 2014 containing reed canary grass and 39% of plots in zone D containing the plant. Oxeye daisy occurrence also increased from 2013 with the plant found in 22% of plots in 2014. Sulfur cinquefoil plot frequency showed a decline from 2013 in most plots, though an increase was seen in zone C.

Monthly precipitation and temperature averages were variable near Weippe Prairie during 2014. In general, late-winter and early-spring were wetter and cooler than usual. Summer temperatures were generally warmer than usual and summer precipitation monthly averages were less than usual.

Acknowledgments

This project is made possible by the strong support of Nez Perce National Historical Park staff and high school students and their teachers from Lapwai High School, Timberline High School, and Nezperce High School. Students from the Oregon Museum of Science and Industry Salmon Camp Program helped launch the program in 2005 and 2006. Each year since 2005, staff and students from the park and schools have joined the Upper Columbia Basin Network I&M staff in the field at Weippe Prairie to survey for camas. This teamwork allows for camas surveys to be conducted very efficiently in just 1 week. This document relies heavily on previous versions of this annual report, as well as the Camas Lily Monitoring Protocol (Rodhouse et al. 2007).

Introduction

Camas (*Camassia quamash* [Pursh] Greene) is a perennial bulb-producing lily (Family Liliaceae; alternatively Asparagaceae, APG 2009) that was and remains one of the most widely utilized plant foods of the Nez Perce people (Harbinger 1964, Hunn 1981, Turner and Kuhnlein 1983, Thoms 1989, Mastrogiuseppe 2000). Camas was also a focal resource at many of the significant historical events memorialized by Nez Perce National Historical Park (NEPE) and Big Hole National Battlefield (BIHO). It was during the camas harvest at Weippe Prairie, a subunit of NEPE, that the Lewis and Clark Corps of Discovery first encountered the Nez Perce. The battle at Big Hole occurred at a traditional Nez Perce camas harvesting campsite. It is also noteworthy that the botanical “type” specimen for the *Camassia* genus as well as for *C. quamash* itself was collected by the Lewis and Clark expedition returning through the Weippe Prairie during the spring of 1806 (Meehan 1898, Gould 1942).

Camas is considered a facultative wetland species (Reed 1988) that is strongly associated with the seasonal wet prairie ecosystems of the interior Columbia Plateau and northern Rocky Mountains which are represented at the Weippe Prairie and along the North Fork of the Big Hole River, where BIHO is located. Large expanses of camas in bloom were noted by numerous explorers and botanists that entered the Pacific Northwest in the 19th century, including the Lewis and Clark expedition, and were frequently described as “blue lakes” when viewed from a distance (Havard 1895, Leiberg 1897, Murphey 1987, Thoms 1989). The extent of the wet prairie ecosystem type has been drastically reduced throughout the Pacific Northwest as a result of agricultural conversion, irrigation and flood control development, and other land use practices (Thoms 1989, Dahl 1990, Taft and Haig 2003). Remaining wet prairies in the region are often structurally altered and compromised by non-native and woody native invasive species. The NPS-owned portions of Weippe Prairie and the Big Hole valley are no exception. Both sites have historic agricultural developments that have altered site hydrology, are impacted by invasive weeds, and Weippe Prairie has also been used for intensive haying and grazing. Orange hawkweed (*Hieracium aurantiacum* L.) and sulfur cinquefoil (*Potentilla recta* L.), invasive plants in Idaho, are present at Weippe Prairie and part of the focus of current park weed management. Oxeye daisy (*Leucanthemum vulgare* Lam.) and reed canary grass (*Phalaris arundinacea* L.) are two other invasive plants currently being monitored at Weippe Prairie. Canada thistle (*Cirsium arvense* [L.] Scop.) is an emerging invader along the floodplain where the BIHO camas population is now being monitored. Competition from invasive weed species, including the aforementioned species as well as thatch-building grasses such as timothy (*Phleum pretense* L.), may impact camas populations within the UCBN through competition. Herbicide applications at Weippe Prairie, and to a lesser extent at BIHO, continue as part of the parks’ integrated weed management programs.

Despite the continued impacts of modern anthropogenic stressors on what appear to be markedly reduced camas populations, the wet prairies of NEPE and BIHO, like their better studied analogues in Oregon’s Willamette Valley, are highly productive ecosystems that exhibit a good potential for restoration (Pendergrass et al. 1998, Taft and Haig 2003). A long-term monitoring program for detecting status and trends in camas populations at Weippe Prairie and BIHO serves as a central

information source for park adaptive management decision making and will provide essential feedback on any eventual restoration efforts (Rodhouse et al. 2011). Camas monitoring is particularly important at Weippe Prairie because it is the focal resource for the site, and because invasive plant treatment is an ongoing management concern there. The site is also a target of park restoration efforts. The National Park Service acquired the Weippe Prairie property in 2003 and does not yet have a developed management plan. The implementation of camas monitoring early in the process of NPS management at Weippe Prairie is timely and is greatly facilitating science-based decision making. Park management has considerable latitude in the strategies and tools employed there. At BIHO, where management is less intense and opportunities for restoration are few, given the cultural sensitivity of the battlefield, camas monitoring still provides a valuable indication of overall status and trend of the camas population and its supporting wetland over time.

It is hoped that the UCBN camas monitoring program will deliver timely and helpful information to park managers. Both park sites are managed to preserve the historic landscapes of which camas is a central component. Camas is a facultative wetland species that should respond conspicuously to perturbations in the wet prairie ecosystems of Weippe Prairie and BIHO, thus making it an effective indicator of overall ecological condition. An initial restoration-oriented trend assessment was published by Rodhouse et al. (2011) for both Weippe Prairie and BIHO over the 2005-2010 monitoring period, which provided encouraging evidence of increasing trend. We have adopted the recommendations made by Bennetts et al. (2007) and begun the identification of early-warning assessment points. Our first assessment point is a 25% decline in mean camas density. A concomitant 25% increase is also an assessment point, but one better described as an initial desired future condition benchmark rather than an early-warning sign (Bennetts et al. 2007). These were arrived at as starting points in the face of considerable uncertainty concerning camas synecology, were logistically and statistically feasible, and inherently conservative. We will look to add new assessment points as our knowledge about camas and the wet prairie ecosystem grows. Annual reports such as this are important elements in this process.

The National Park Service initiated a camas monitoring program at NEPE in 2005 and at BIHO in 2006, assisted in large part by student “citizen scientists” who participate in annual spring field data collection. The field effort involves counting all established camas plants within quadrats, as well as those plants that flower during that growing season. Thatch depth and the presence of target invasive weeds have also been measured in each quadrat, although thatch depth measurements were discontinued in 2010 following recommendations made by Rodhouse and Jocius (2009). Weather is an additional important driver of camas population dynamics, and summaries from weather stations near each of the parks will be used in modeling long-term trends. The monitoring protocol developed by Rodhouse et al. (2007) was reviewed and approved for implementation by the Pacific West Regional I&M Program Coordinator in October 2007.

We report here on the 2014 sampling results from Weippe Prairie, and include results from 2005-2013 to provide context for current estimates of camas density, which were also reported by Rodhouse and Stucki (2013). Changes were made in design and methodology of the sampling protocol during the first three years. We have made some adjustments to the data from these early

years, enabling preliminary comparisons among years and identification of baseline patterns of density. Some interesting patterns are emerging in these data, which will serve to stimulate new hypotheses and assessment points. With the protocol complete and the design and methodology stabilized, we have begun to accumulate a robust long-term data set. Given the predictions of climate change in the Pacific Northwest and the legacy of past land use, monitoring UCBN camas prairies over time is sure to shed new light on the important issues of ecosystem recovery and ecological resilience.

Objectives

The monitoring objectives for this program are:

- Estimate mean established plant and flowering stem densities (status) in the camas populations of Weippe Prairie and within the targeted portion of BIHO.
- Determine trends (net trend, as reviewed by MacDonald 2003) in the densities of established camas populations in Weippe Prairie and BIHO.
- Determine trends in the proportion of flowering to non-flowering camas plants in Weippe Prairie and BIHO.
- Determine trends in the frequency of occurrence of targeted invasive plants (currently these are orange hawkweed, reed canary grass, oxeye daisy, and sulfur cinquefoil at Weippe Prairie and Canada thistle at BIHO).
- Determine the magnitude and direction of camas density response to measurable explanatory variables such as winter precipitation and specific management activities.

Note: "Established camas plants" are those plants expressing 2 or more leaves and excludes single-leaved seedlings. The significance of this distinction is discussed in greater detail in the UCBN camas monitoring protocol (Rodhouse et al. 2007).

This report summarizes estimates of established camas density and flowering plant density in the Weippe Prairie camas population over the period 2005-2014. A companion report for camas monitoring in BIHO over the period 2006-2014 is also available. We consider the trends reported here to be encouraging but somewhat preliminary, given the highly variable nature of population fluctuations of camas and the target weed species. A second formal trend analysis report following the one provided by Rodhouse et al. (2011) will be conducted soon and will take into account the effects of average monthly temperature and precipitation on camas populations and flowering rates.

Methods

The UCBN initiated camas monitoring at Weippe Prairie, located near the town of Weippe, Idaho, in 2005. The site was subdivided into 5 management zones for purposes of both park management and for monitoring in 2007 (Rodhouse et al. 2007). Figure 1 shows the sampling frame, with each of the management zones labeled, and the 2014 quadrat locations. Sampling methods followed those detailed by Rodhouse et al. (2007). The approach is quadrat-based and involves the measurement of camas plant density, camas flowering stem density, and the presence of targeted invasive plant species in a random sample of 0.6 m^2 quadrats from within a sampling frame that captures the entire site camas population. Quadrats are 4 m long x 15 cm wide, designed to reach across the patchy distribution of camas in the prairie and reduce the number of plots without camas. Quadrats were placed at randomly-selected locations, and locations were generated from the Generalized Random Tessellation Stratified (GRTS) sampling design algorithm. This sampling design results in a well dispersed, spatially-balanced sample (Figure 1). Sample sizes for each year beginning in 2009 were set at 70 per zone (350 total). Prior to 2009, sample sizes varied somewhat as methods were finalized (Table 1). All camas plants were included in camas density counts in 2005 and 2006, but a protocol change beginning in 2007 led to the exclusion of single-leaved seedlings. Camas seedlings are ephemeral and highly variable in their germination, and this led us to focus the protocol on *established* camas plants beginning in 2007. This is the most significant methodological change and one that requires careful and cautious consideration when comparing data collected during the first 2 years of monitoring with subsequent data.

Camas flowering stem density was also measured at each quadrat beginning in 2006. Mature camas plants can produce one conspicuous and persistent inflorescence each year (see cover illustration), making flowering stem counts reliable and direct. Not all mature plants flower in a given year, however, and variability in flowering is of interest to the UCBN.

Early monitoring results indicated that density counts were extremely skewed and required alternative analytical procedures that did not require assumptions of normality (Rodhouse et al. 2007). Rodhouse used a non-parametric bootstrap computer-intensive method to conduct power analyses with 2006 and 2007 data following methods outlined by Hamilton and Collings (1991). For this report, 90% confidence intervals around means were calculated using the simple bootstrap percentile method described by Efron and Tibshirani (1993) and Manly (2001). We used ordinary kriging (Fortin and Dale 2009) to produce an interpolated density map for Weippe Prairie using 2014 data (Figure 2). Predictive density maps provide useful interpretive tools to illustrate density patterns across the site. Finally, we summarize recent weather patterns from the Pierce, Idaho NOAA co-op weather station (station # 107046, western regional climate center) using the capabilities of the Climate Analyzer (www.climateanalyzer.org) developed by NPS contractor Dr. Mike Tercek. All analyses and graphics were prepared in the R software and computing environment (R version 3.1, http://www.r-project.org/) and ArcGIS (ESRI, Inc., Redlands, California).

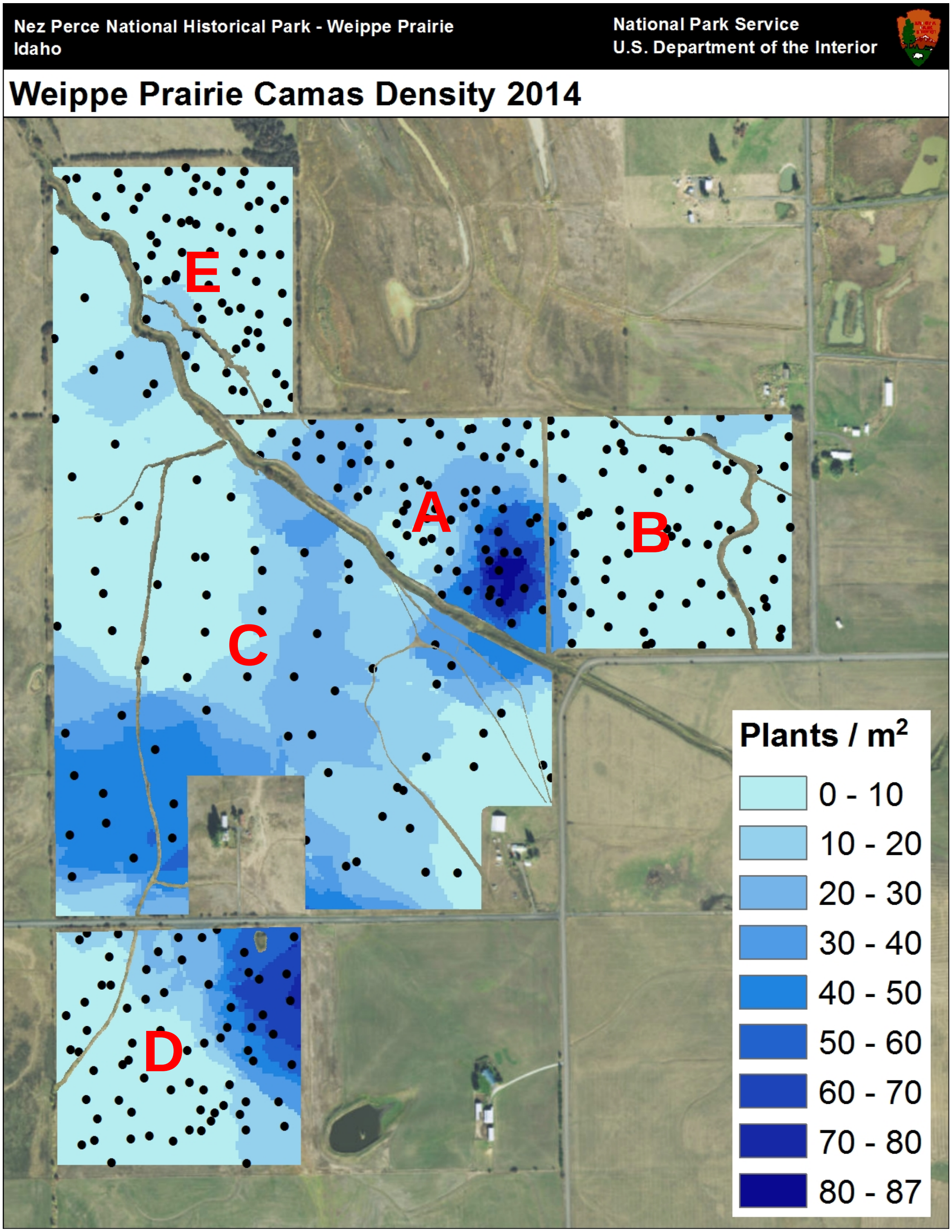


Figure 1. The sampling frame for monitoring camas, divided into 5 management zones labeled A-E, with 2014 quadrat locations (black points) and predicted patterns of camas density based on a kriging interpolation from 2014 established camas plant counts.

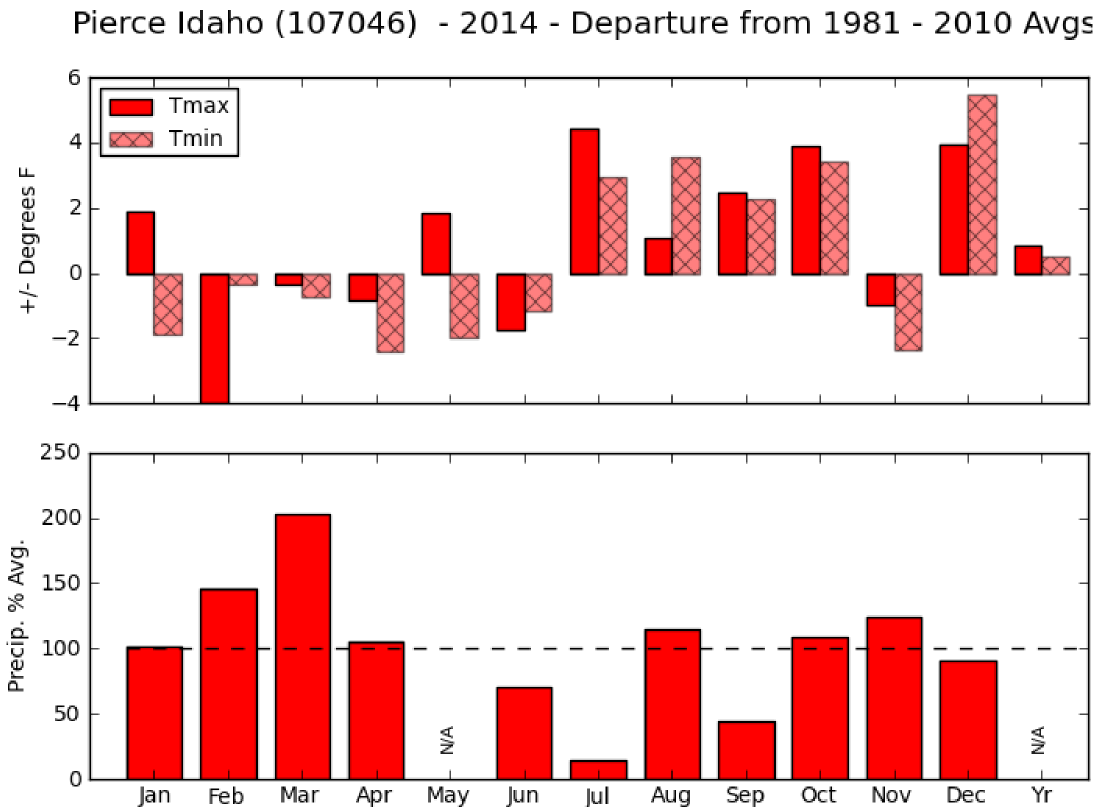


Figure 2. 2014 precipitation and temperature departures from 30-year averages. This figure illustrates that late winter and early spring were colder and wetter than average. June was drier than average with below average temperatures. N/A represents missing precipitation values.

Results

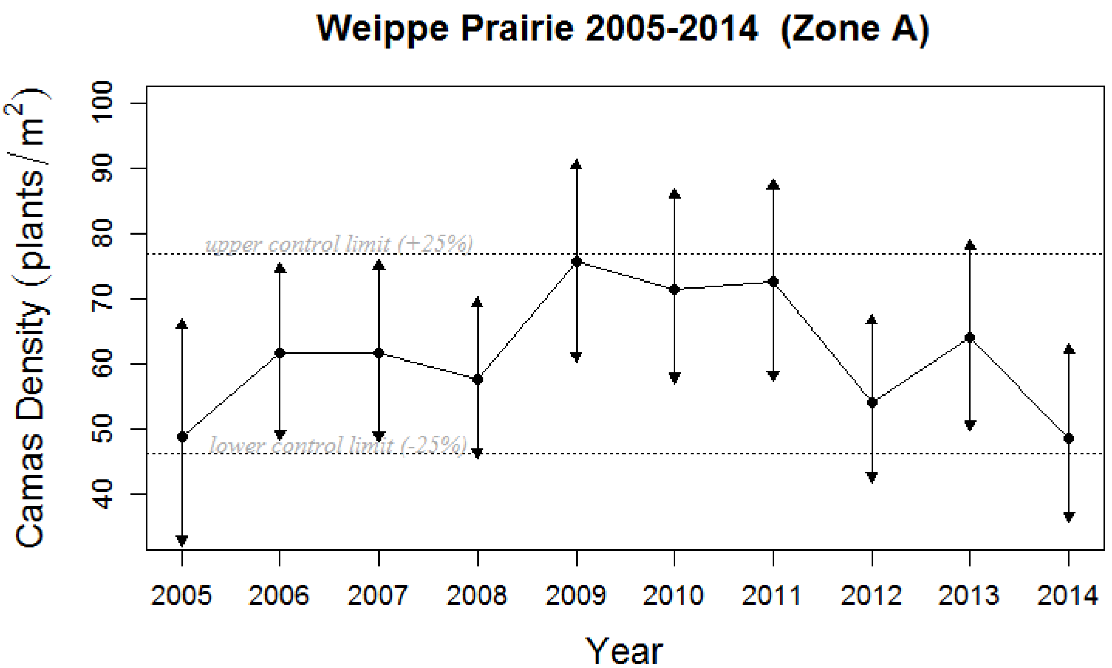
In 2014, based on counts of camas in three-hundred-seventy-four 0.6 m^2 quadrats, estimated mean density of established camas plants/m^2 at Weippe Prairie was down from 2013 counts in all zones and more closely resembled the counts of 2012, another year with low estimated camas densities. Table 1 and Figure 3 show the density counts for each year. Zones A, B, C, and E all appear to have generally increased in camas densities over the study period until 2012. Zone D continues to experience decline since camas density peaked in 2007. While camas plant density is down, flowering plant density appears to be increasing across all zones. Flowering stem density estimates were the highest recorded for zones B and E since 2011, and zones A and C showed the highest flowering stem densities since 2010. The flowering stem density for zone D was the highest recorded since 2008. The ratios of flowering stem density to camas plant density for nearly all zones was the highest recorded since monitoring began, except zone C which had a higher flowering ratio only in 2008.

Table 1. Estimated means and 90% confidence intervals for established camas plant density and flowering plant density by management zone.

Zone	Year	n	Density (Plants/m^2)	90th percentile CI		Flowering Stems	90th percentile CI		Flowering Ratio
A	2014	75	48.65	36.56	62.13	11.97	9.85	14.17	0.41
B	2014	74	6.05	3.72	8.70	1.52	1.00	2.20	0.41
C	2014	75	26.03	17.91	35.17	6.30	4.40	8.45	0.26
D	2014	75	31.84	21.60	43.14	7.03	4.98	9.30	0.34
E	2014	75	7.38	4.54	10.85	2.41	1.57	3.39	0.41
A	2013	75	63.93	50.76	78.05	8.70	6.79	10.19	0.17
B	2013	75	7.27	4.22	10.71	1.46	0.70	2.34	0.13
C	2013	75	30.54	22.59	39.24	5.35	4.02	6.81	0.19
D	2013	75	33.86	23.99	44.95	5.86	4.27	7.60	0.21
E	2013	73	9.68	4.83	15.59	1.63	0.90	2.49	0.23
A	2012	70	54.07	42.69	66.73	8.73	6.81	10.81	0.21
B	2012	70	6.17	3.44	9.44	1.30	0.64	2.06	0.22
C	2012	70	25.56	18.97	32.65	4.43	3.15	5.81	0.19
D	2012	70	36.92	25.78	49.45	2.87	1.99	3.82	0.10
E	2012	70	7.07	4.60	9.75	1.68	1.09	2.32	0.31
A	2011	70	72.68	58.36	87.46	10.79	8.37	13.37	0.20
B	2011	70	8.80	5.38	12.71	1.97	1.19	2.92	0.23
C	2011	70	27.44	20.11	35.55	5.07	3.65	6.62	0.17
D	2011	70	43.90	30.78	58.55	4.86	3.56	6.24	0.20
E	2011	70	10.88	7.56	14.39	2.58	1.68	3.58	0.30
A	2010	70	71.40	57.96	86.01	13.87	11.24	16.58	0.25
B	2010	70	5.74	2.94	9.06	1.64	0.81	2.68	0.37
C	2010	70	45.74	34.81	57.27	8.94	6.19	12.17	0.22
D	2010	70	30.07	21.03	39.86	5.53	3.98	7.23	0.20
E	2010	70	6.40	4.39	8.58	1.57	0.95	2.25	0.24

Table 1 (continued). Estimated means and 90% confidence intervals for established camas plant density and flowering plant density by management zone.

Zone	Year	n	Density (Plants/m^2)	90th percentile CI		Flowering Stems	90th percentile CI		Flowering Ratio
A	2009	70	75.71	61.27	90.50	12.90	10.23	15.84	0.20
B	2009	70	16.38	11.50	21.70	3.12	2.27	4.05	0.26
C	2009	70	27.66	19.14	38.13	5.59	3.92	7.32	0.26
D	2009	70	44.22	30.78	59.00	5.66	3.92	7.59	0.17
E	2009	70	5.03	3.17	7.09	0.50	0.32	0.68	0.23
A	2008	60	57.65	46.48	69.31	9.32	7.25	11.56	0.18
B	2008	80	7.14	4.13	10.54	1.22	0.64	1.97	0.24
C	2008	80	35.46	27.47	43.74	9.52	7.10	12.14	0.29
D	2008	60	56.94	37.02	79.18	9.43	6.45	12.81	0.34
E	2008	80	5.94	4.09	8.01	0.17	0.06	0.29	0.06
A	2007	65	61.65	48.96	74.93	7.81	6.00	9.76	0.13
B	2007	84	6.76	4.26	9.60	0.82	0.38	1.15	0.11
C	2007	60	29.63	20.28	39.92	6.03	3.90	8.52	0.21
D	2007	40	64.16	40.63	89.31	8.30	5.40	11.54	0.22
E	2007	30	0.44	0.11	0.83	0.17	0.06	0.33	0.58
A	2006	43	61.73	49.22	74.58	2.55	1.66	3.51	0.05
B	2006	17	2.64	0.39	5.27	0.68	0.00	1.46	0.12
C	2006	115	17.44	13.16	22.06	1.88	1.41	2.38	0.14
D	2006	30	33.31	17.76	51.68	3.65	2.05	5.42	0.15
E	2006	15	2.77	1.22	4.76	0.11	0.00	0.33	0.06
A	2005	25	48.67	32.93	65.87	NA	NA	NA	NA
B	2005	40	4.48	1.66	6.39	NA	NA	NA	NA
C	2005	87	20.78	14.18	28.07	NA	NA	NA	NA
D	2005	0	NA	NA	NA	NA	NA	NA	NA
E	2005	25	5.51	2.32	9.30	NA	NA	NA	NA



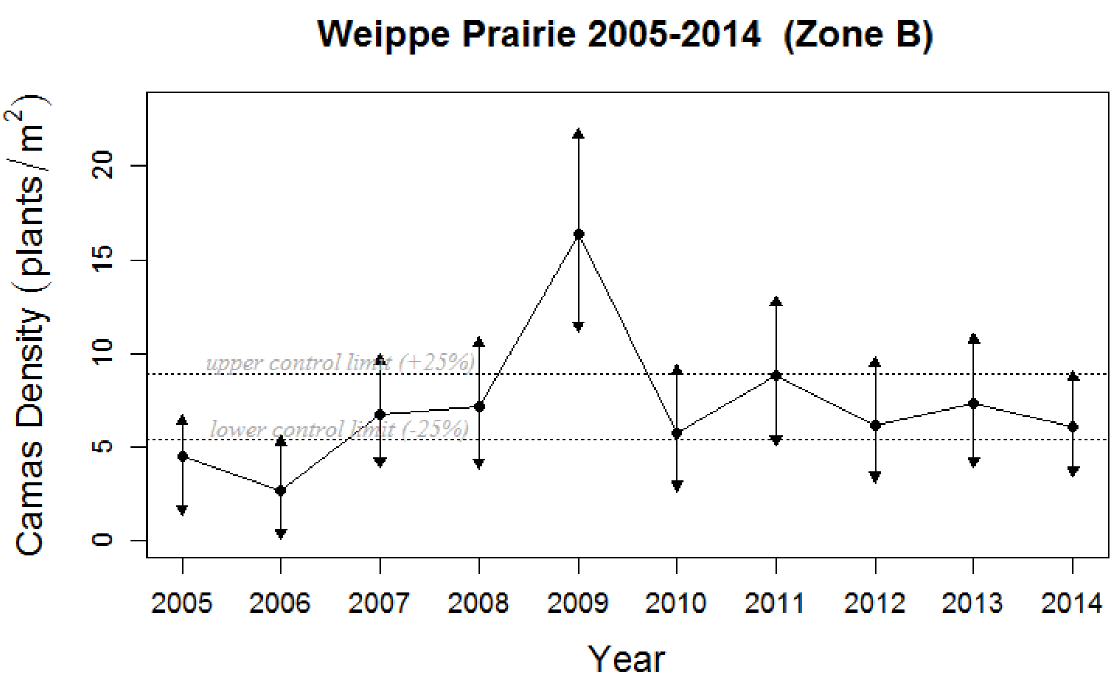
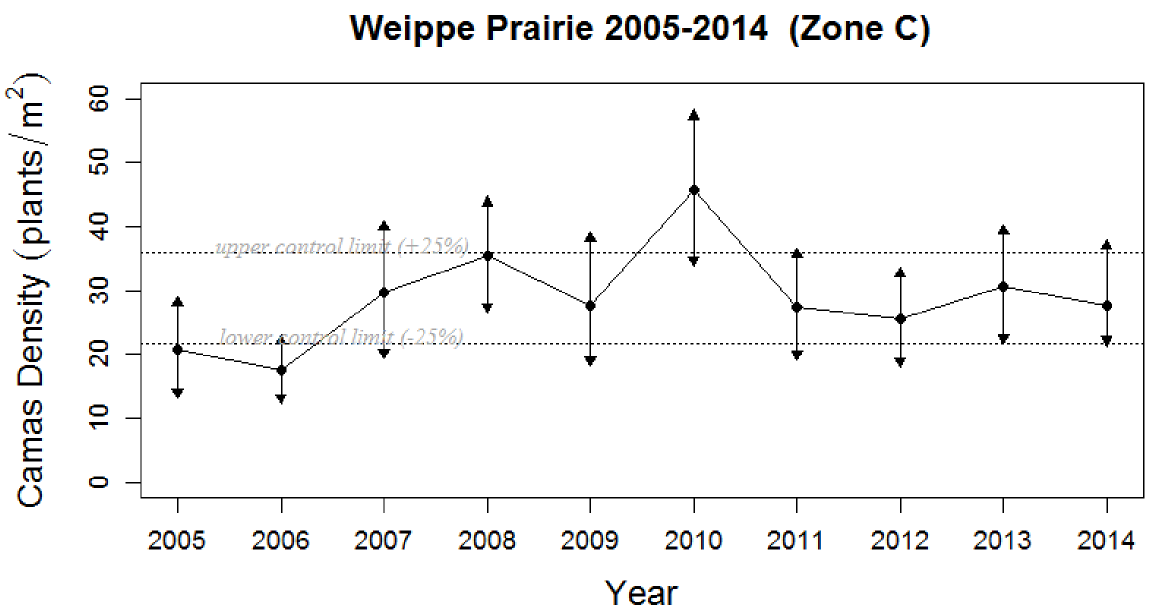


Figure 3. "Conformance" or control charts that plot annual established camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, for each of the 5 management zones.



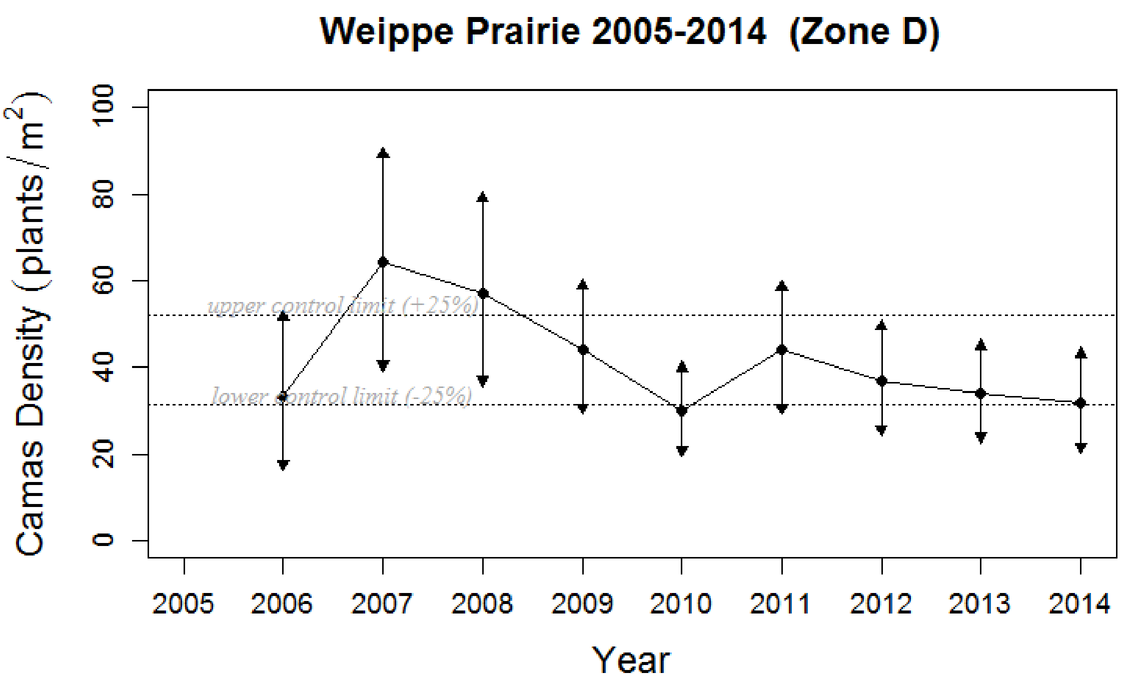


Figure 3 (continued). "Conformance" or control charts that plot annual established camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, for each of the 5 management zones.

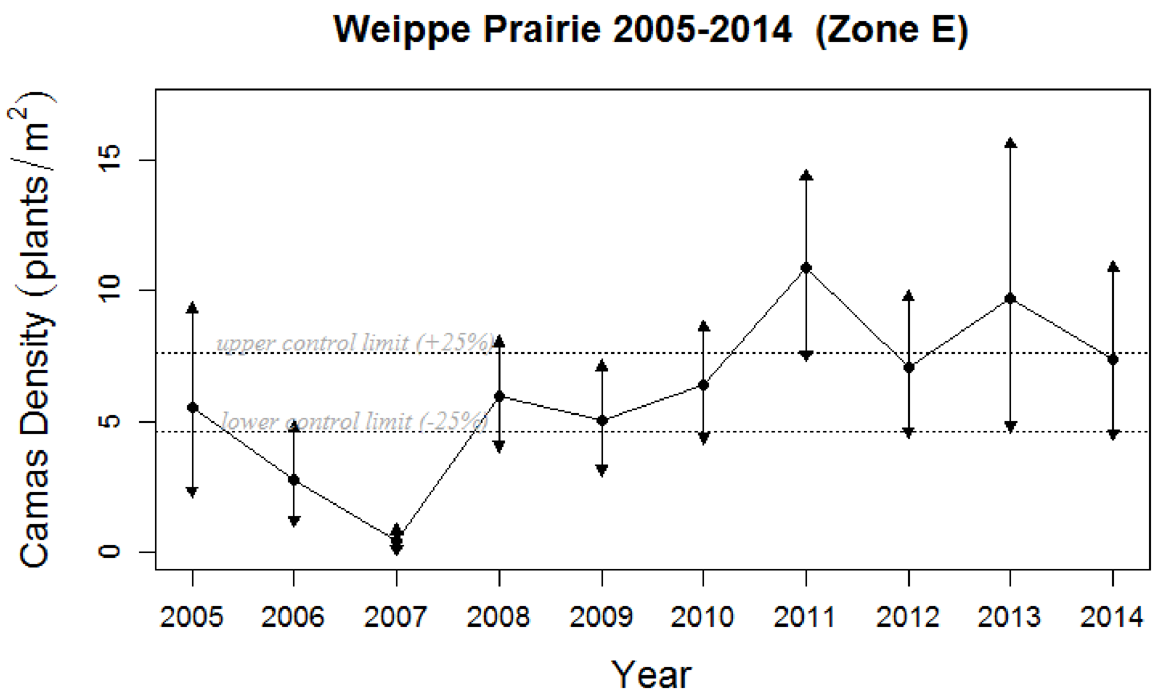


Figure 3 (continued). "Conformance" or control charts that plot annual established camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, for each of the 5 management zones.

The frequency of occurrence of orange hawkweed continued to be highly variable, but generally declining slightly from 2013 among zones, occurring in 7.5% of all plots (Figure 4). Sulfur cinquefoil frequency across all plots showed a decline from nearly 10% in 2013 down to 7% in 2014, though the frequency in zone C nearly doubled over that same period (Figure 5). Oxeye daisy frequency increased from 14% of plots in 2013 to 22% of plots in 2014. An increase in reed canary grass was recorded in all zones in 2014, with a large increase in zone D from 11% in 2013 to 39% in 2014. However, this grass can be difficult to identify in a vegetative stage and the reported increase may have been due to misidentification of grasses by field crews. Future emphasis will be placed on thoroughly training observers on the identification of target plant species to keep potential occurrences of misidentification to a minimum.

Monthly precipitation and temperature averages were variable near Weippe Prairie during 2014 (Figure 2). In general, late-winter and early-spring were wetter and cooler than usual. Summer temperatures were generally warmer than usual and summer precipitation was less than usual. The effects of temperature and precipitation on camas plant and flowering stem density, as well as frequency of occurrence of weeds, will be analyzed in the upcoming long-term camas monitoring trend report for Weippe Prairie. A further trend analysis including camas densities, frequency of occurrence of weeds, and influence of temperature and precipitation on camas density and camas flowering will be conducted using past camas monitoring data at Weippe Prairie.

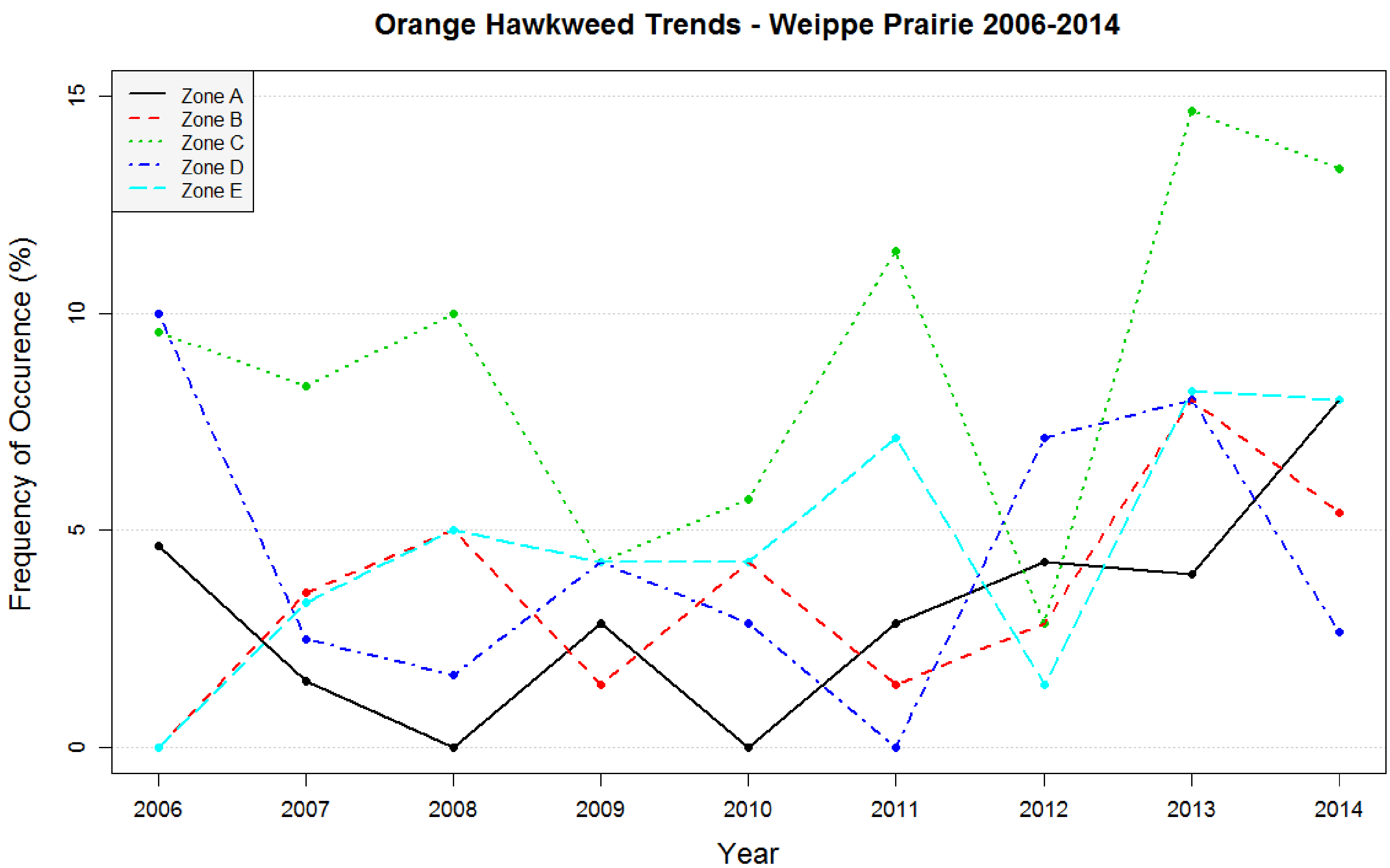


Figure 4. Orange hawkweed frequencies of occurrence (proportion of quadrats in which the species was found) from 2006-2014 for each of the 5 Weippe Prairie management zones. Note that weed data were not collected in 2005.

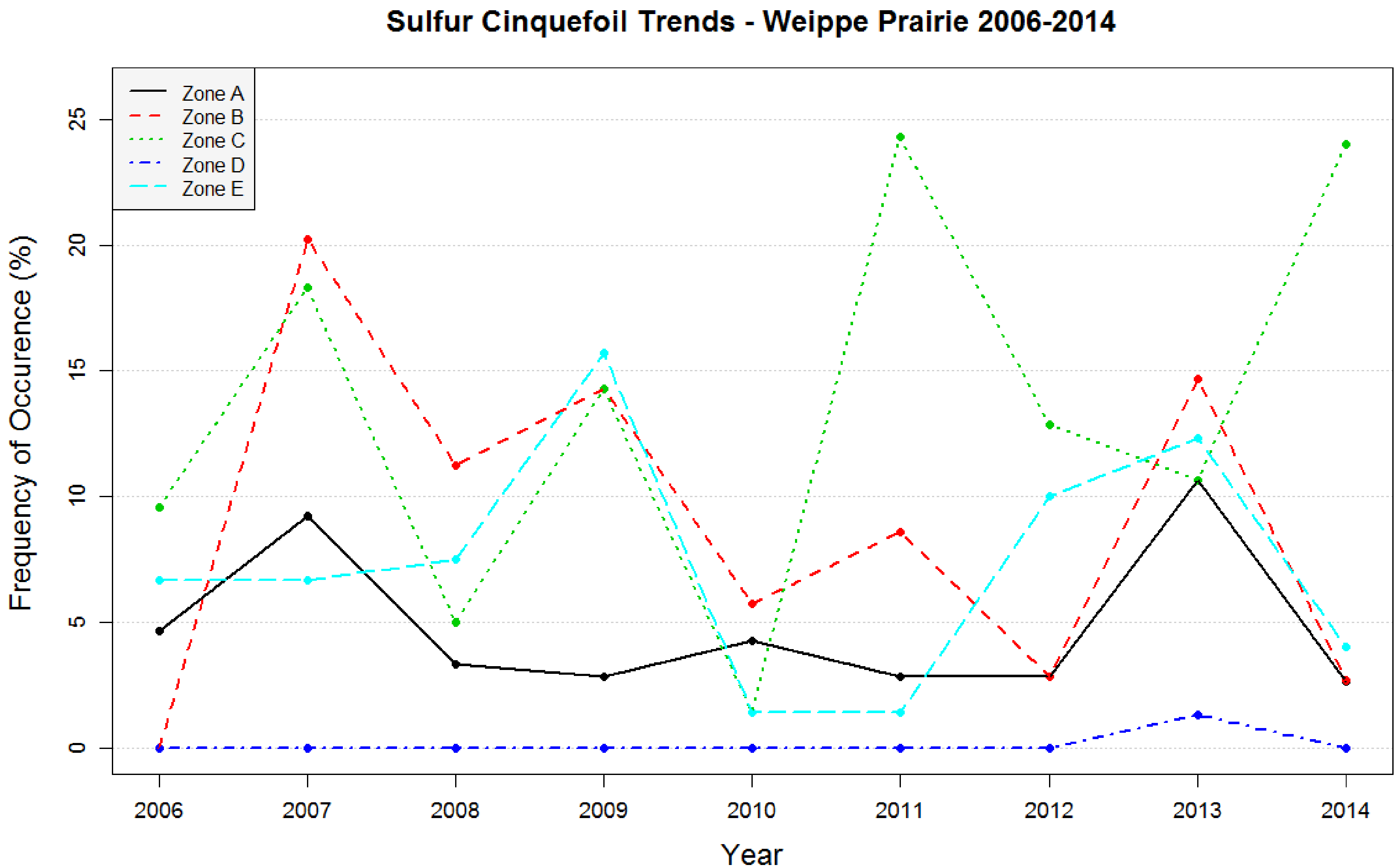


Figure 5. Sulphur cinquefoil frequencies of occurrence (proportion of quadrats in which the species was found) from 2006-2014 for each of the 5 Weippe Prairie management zones. Note that weed data were not collected in 2005.

Literature Cited

Angiosperm Phylogeny Group (APG). 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnaean Society 161:105-121.

Bennetts, R. E., J. E. Gross, K. Cahill, C. McIntyre, B. B. Bingham, A. Hubbard, L. Cameron, and S. L. Carter. 2007. Linking monitoring to management and planning: assessment points as a generalized approach. George Wright Forum 24:59-77.

Beauregard, M. R., R. J. Mikulak, and B. A. Olson. 1992. A practical guide to statistical quality improvement: opening up the statistical toolbox. Van Nostrand Reinhold, New York.

Dahl, T. E. 1990. Wetlands: losses in the United States: 1780's to 1980's. US Fish and Wildlife Service, Washington DC.

Efron, B., and R. Tibshirani. 1993. An introduction to the bootstrap. Chapman and Hall, London, England.

Fortin, M. J, and M. Dale. 2005. Spatial analysis: a guide for ecologists. Cambridge University Press, Cambridge, England.

Gould, F. W. 1942. A systematic treatment of the genus *Camassia* Lindl. American Midland Naturalist 28:712-742.

Hamilton, M. A., and B. J. Collings. 1991. Determining the appropriate sample size for nonparametric tests for location shift. Technometrics 33:327-337.

Harbinger L. J. 1964. The importance of food plants in the maintenance of Nez Perce cultural identity. Thesis. Washington State University, Pullman, Washington.

Havard, V. 1895. Food plants of the American Indians. Bulletin of the Torrey Botanical Club 22:98-123.

Hunn E. S. 1981. On the relative contribution of men and women to subsistence among hunter-gathers of the Columbia Plateau: a comparison with *Ethnographic Atlas* summaries. Journal of Ethnobiology 1:124-134.

Leiberg, J. B. 1897. General report on a botanical survey of the Coeur d'Alene mountains in Idaho. Contributions of the U.S. National Herbarium. Vol. V., No. 1., Washington DC.

MacDonald, T. 2003. Review of environmental monitoring methods: survey designs. Environmental Monitoring and Review 85:277-292.

Manly, B. F. J. 2001. Randomization, Bootstrap and Monte Carlo Methods in Biology. Chapman and Hall/CRC, Boca Raton, Florida. 19

Mastrogiuseppe, J. 2000. Nez Perce ethnobotany: a synthetic review. Report to Nez Perce National Historic Park, Spalding, ID. Project # PX9370-97-024.

Meehan, T. 1898. The plants of Lewis and Clark's expedition across the continent, 1804-1806. Proceedings of the Academy of Natural Sciences of Philadelphia 50:12-49.

Morrison, L. 2008. The use of control charts to interpret monitoring data. Natural Areas Journal 28:66-73.

Murphey, E. V. A. 1987. Indian Uses of Native Plants. Mendocino County Historical Society, Ukiah, California.

Pendergrass, K. L., P. M. Miller, and J. B Kauffmann. 1998. Prescribed fire and the response of woody species in Willamette Valley wetland prairies. Restoration Ecology 6:303-311.

Reed, P. B., Jr. 1988. National list of plant species that occur in wetlands: 1988 national summary. U.S. Fish and Wildlife Service. Biological Report 88 (24).

Rodhouse T. J. and D. S. Stucki. 2013. Camas monitoring in Nez Perce National Historical Park's Weippe Prairie: 2013 annual report. Natural Resource Technical Report. NPS/UCBN/NRTR—2013/816. National Park Service. Fort Collins, Colorado.

Rodhouse, T. J., K. M. Irvine, K. T. Vierling, and L. A. Vierling. 2011. Modeling temporal trend in the presence of spatial complexity: a Bayesian approach for a wetland forb population undergoing restoration. PLoS ONE 6:e28635.

Rodhouse, T. J., M. V. Wilson, K. M. Irvine, R. K. Steinhorst, G. H. Dicus, L. K. Garrett, and J. W. Lyon. 2007. Camas lily monitoring protocol. Version 1.0. Natural Resource Report NPS/UCBN/NRR—2007/011. National Park Service, Fort Collins, Colorado.

Rodhouse, T. J., and J. L. Jocius. 2009. Camas monitoring at Nez Perce National Historical Park and Big Hole National Battlefield: 2009 annual report. Natural Resource Technical Report NPS/UCBN/NRTR—2009/265. National Park Service, Fort Collins, Colorado.

Rodhouse, T. J., and J. L. Jocius. 2011. Camas monitoring at Nez Perce National Historical Park and Big Hole National Battlefield: 2010 annual report. Natural Resource Technical Report NPS/UCBN/NRTR—2011/430. National Park Service, Fort Collins, Colorado.

Taft, O. W., and S. M. Haig. 2003. Historical wetlands in Oregon's Willamette Valley: implications for restoration of winter waterbird habitat. Wetlands 23:51-64.

Thoms, A. 1989. The northern roots of hunter-gatherer intensification: camas and the Pacific Northwest. Dissertation. Washington State University, Pullman, Washington.

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