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Natural Resource Stewardship and Science

Camas Monitoring at Big Hole National Battlefield

2013 Annual Report

Natural Resource Technical Report NPS/UCBN/NRTR—2013/826

ON THE COVER
Illustration of *Camassia quamash* (Pursh) Greene.
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Abstract

As part of the Upper Columbia Basin Network's effort to conduct vital signs monitoring, we completed monitoring of camas (*Camassia quamash*) in 2013 in Big Hole National Battlefield (BIHO). This is the eighth year of camas monitoring in BIHO. Camas is a unique resource for BIHO because it is both culturally and ecologically significant. Camas was and remains one of the most widely utilized indigenous foods in the Pacific Northwest and it is strongly associated with the wet prairie ecosystems of the region that have been degraded or lost due to historic land use practices. A long-term monitoring program for detecting status and trends in camas populations at BIHO serves as a central information source for park adaptive management decision making and will provide essential feedback on any eventual restoration efforts of park wet prairie habitats.

This annual report details findings from 2013, and puts these findings within the context of the entire 8-year monitoring program. Trend analysis for the BIHO camas population over the period 2006-2010 was provided by Rodhouse et al. (2011), who reported an overall estimate of 3% per year increase, on average, in the median number of established camas plants/ m^2, excluding seedlings, but with a relatively wide 95% Bayesian credible interval (CRI) of -2% – 7%, indicating uncertainty in both the direction and magnitude of the trend. Based on the 2013 survey, overall trends in camas density continue to be stable or slightly increasing in BIHO. In 2013, based on counts of camas in one-hundred-fifty-one 0.6 m^2 quadrats, mean density of established camas plants/m^2 was estimated to be 6.1 (90% confidence interval 3.9-8.6). This was very similar to the 2012 estimate. Based on a regression modeling technique developed by Rodhouse et al. (2011), the trend in the median of established camas plant density over the 8-year period was 3% (95% CRI 0-5%), down slightly from the trend estimate in 2012. Estimated mean density of flowering camas plants/m^2 was 1.3 (90% confidence interval 0.9-2.0), up slightly from 2012. Flowering plant density is more variable than overall established plant density. Unfortunately, Canada thistle (*Cirsium arvense*), has notably increased in the meadow. In 2013, Canada thistle was found in 3 plots (~2% frequency of occurrence). This was the first year that this invasive species was encountered in plots, although observations outside of plots have been increasing in recent years. Weather patterns in the upper Big Hole Valley have been wetter than average, and this may be influencing the positive trends for camas as well as for Canada thistle. However, the winter and spring of 2013 were much drier than the last several years. Historical camas densities in some high-quality Pacific Northwest sites available from anthropological sources were estimated to be 100 plants/m^2 or more. These would have been highly-prized by indigenous peoples as camas bulb digging grounds. It is not clear whether these exceptional historical conditions apply to the BIHO population, which was historically more of a pass-through area for Nez Perce hunters (J. Lyon, personal communication), but it does provide some context for interpreting the current findings.

Acknowledgments

This project is made possible by the strong support of both Big Hole National Battlefield and Nez Perce National Historical Park staff. Each year since 2006, staff from these parks has joined the Upper Columbia Basin Network I&M staff to survey for camas. This teamwork allows for camas surveys to be conducted very efficiently in just 2 days.

Introduction

Camas (*Camassia quamash* [Pursh] Greene) is a perennial bulb-producing lily (Family Liliaceae; alternatively Agavaceae, APG 2003) 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 Big Hole National Battlefield (BIHO) and Nez Perce National Historical Park (NEPE). 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 which 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*) and sulfur cinquefoil (*Potentilla recta*), invasive plants in Idaho, are present at Weippe Prairie and part of the focus of current park weed management. Canada thistle (*Cirsium arvense*) is an emerging invader along the floodplain where the BIHO camas population is now being monitored. Competition from invasive weed species, including the aforementioned forbs as well as thatch-building grasses such as timothy (*Phleum pratense*), 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 BIHO and NEPE, 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 BIHO and Weippe Prairie 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 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 2013 sampling results from BIHO, and include results from 2006-2012 to provide context for current estimates of camas density, which were also reported by Rodhouse and Stucki (2013a). 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 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 BIHO camas population over the period 2006-2013. A companion report is available for Weippe Prairie for the same time period as well (Rodhouse and Stucki 2013b). We consider the trends reported here to be encouraging but preliminary estimates that should be interpreted cautiously. A more in depth trend analysis report will be provided after the 2015 field season.

Methods

The UCBN initiated camas monitoring at BIHO, located near Wisdom, Montana, in 2006. Figure 1 shows the sampling frame and 2013 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 most important portion of the BIHO camas population. Cultural concerns led to the development of a targeted sampling frame with arbitrary boundaries that encompassed the largest and most abundant portion of the camas population in the park (Figure 1). Therefore, the scope of inference from monitoring is strictly limited to this core area rather than to the entire population in the Battlefield. Quadrats are 4 m long x 15 cm wide, designed to reach across the patchy distribution of camas in the meadow 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 at BIHO were 81, 124, 150, 150, 160, 154, 150, and 151 for the years 2006-2013. Sample sizes were increased following power analysis in 2007 (Rodhouse et al. 2007) and as field capacity increased through the support of park staff. The target sample size has been 150 since 2008, although oversamples have been picked up during some surveys. All camas plants were included in camas density counts in 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 of comparisons among the first 2 years.

Camas flowering stem density was also measured at each quadrat. 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. Graminoid thatch depth was measured at each quadrat beginning in 2006 as well. Thatch depth was measured in three pre-established locations along the quadrat long axis and averaged. This practice was discontinued in 2010 due to lack of evidence of any relationship between thatch depth and density (Rodhouse and Jocius 2009). Canada thistle infestation in the BIHO camas meadow has increased in recent years and is now being included in the monitoring program.

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). We 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). All six years of data are displayed graphically using a control or "conformance" chart approach following recommendations by Beauregard et al. (1992) and Morrison (2008). Because of our initial interest in "assessment points” ± 25% of a baseline mean value, the charts displayed here are a-statistical in the sense that control or “action” limits are not based on an underlying probability distribution but arbitrarily established at assessment point values. We used the 8-year mean as a preliminary baseline, but note that baseline decisions will be updated as additional years of data become available. We used ordinary kriging (Fortin and Dale 2009) to produce an interpolated density map for BIHO using 2011 data. Predictive density maps provide useful interpretive tools to illustrate density patterns across the floodplain. We used a Bayesian regression modeling technique previously developed by Rodhouse et al. (2011) to provide an estimate of trend in established camas plant density. Finally, we summarize recent weather patterns from the Calvert Creek SNO-TEL weather station located approximately 30 miles northwest of the Battlefield 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 2.8, http://www.r-project.org/) and ArcGIS (ESRI, Inc., Redlands, California).

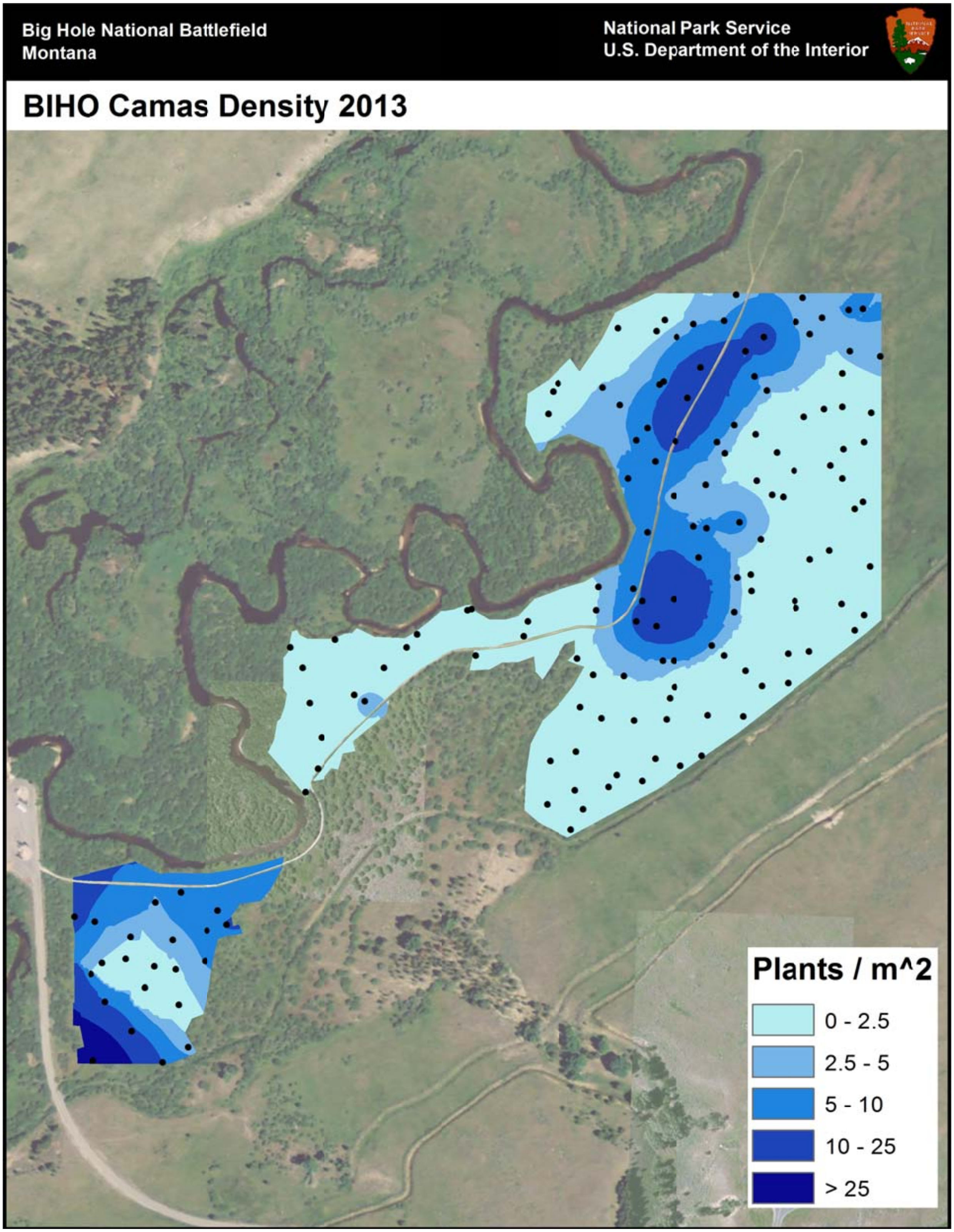

Figure 1. The sampling frame along the Big Hole River floodplain in BIHO, with 2013 quadrat locations (black points) and predicted patterns of camas density based on a kriging interpolation from 2013 established camas plant counts.

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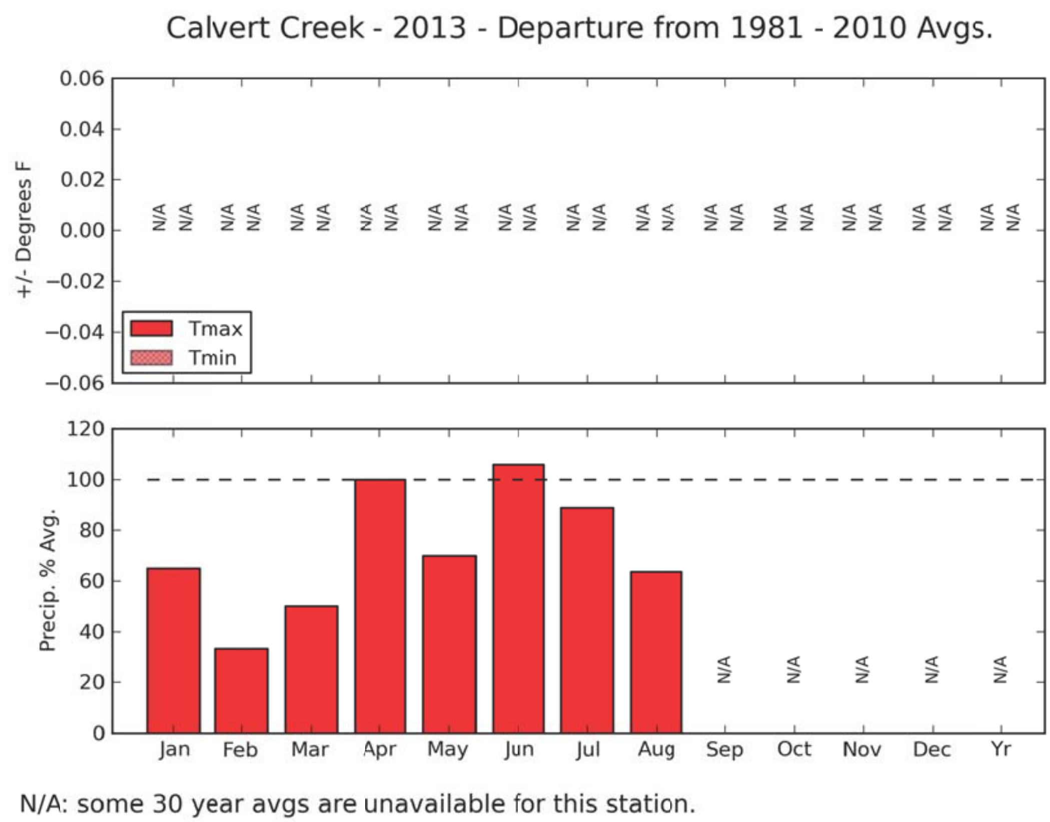

http://mtercek.webfactional.com/graphers/30dep.py?station=calvert_creek&yr=2013&title=Calvert Creek&norm_per=1981_2010&pub=true [9/15/2013 4:14:11 PM]

Figure 2. 2013 precipitation departures from the 30-year average, showing that later winter 2013 was much drier than average. Data from the Calvert Creek SNO-TEL station, 30 miles NW of the Battlefield.

Results and Discussion

In 2013, based on counts of camas in one-hundred-fifty-one 0.6 m^2 quadrats, mean density of established camas plants/m^2 at BIHO was estimated to be 6.1 (90% confidence interval 3.9-8.6). This estimate was slightly lower than the one made in 2012, but still indicates a stable to slightly increasing trend (Table 1). Estimated mean density of flowering camas plants/m^2 was 1.3 (90% confidence interval 0.9-2.0), up slightly from 2012 (Table 1). Flowering plant density is more variable than overall established plant density (Table 1 and Figures 3 and 4).

Using Bayesian regression analysis, the overall estimated mean trend in the median established camas plant density was estimated to be 3% (95% CRI 0-5.4%).

Figures 3 and 4 provide a graphical description of the yearly variation in camas density and flowering density over the 8-year period, relative to the 8-year average. A slowly increasing trend in camas density is apparent from Figure 3. Spatial variation in camas density is described by the predicted density map (Figure 1). This pattern has been relatively consistent over time (Rodhouse and Jocius 2009, 2011; Rodhouse and Stucki 2013a) and indicates that the area of highest density is along the trail in the northern portion of the frame, near the Nez Perce encampment area. Unfortunately, Canada thistle has notably increased in the meadow. In 2013, Canada thistle was found in 3 plots (~2% frequency of occurrence). This was the first year that this invasive species was encountered in plots, although observations outside of plots have been increasing in recent years. Weather patterns in the upper Big Hole Valley have been wetter than average, and this may be influencing the positive trends for camas as well as for Canada thistle. However, in 2013, winter and spring was much drier. In 2015, after 10 years of monitoring, a second formal trend analysis will be conducted that will investigate the relationship between weather patterns and these trends.

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

Year	n	Plants/m^2 Density	90% percentile lower	upper	Stems/m^2 Flowers	90% Percentile lower	upper	Flowering Ratio
2013	151	6.14	3.98	8.65	1.33	0.86	1.83	0.26
2012	150	6.18	4.33	8.27	1.16	0.75	1.63	0.26
2011	154	6.79	4.80	9.00	1.53	1.08	1.99	0.22
2010	160	5.40	3.82	7.14	0.56	0.38	0.76	0.1
2009	150	5.78	4.18	7.52	1.58	1.06	2.16	0.27
2008	150	5.71	3.97	7.67	2.69	1.83	3.69	0.47
2007	124	3.86	2.53	5.52	1.90	1.25	2.68	0.49
2006	81	4.22	2.19	6.58	0.68	0.37	1.02	0.16

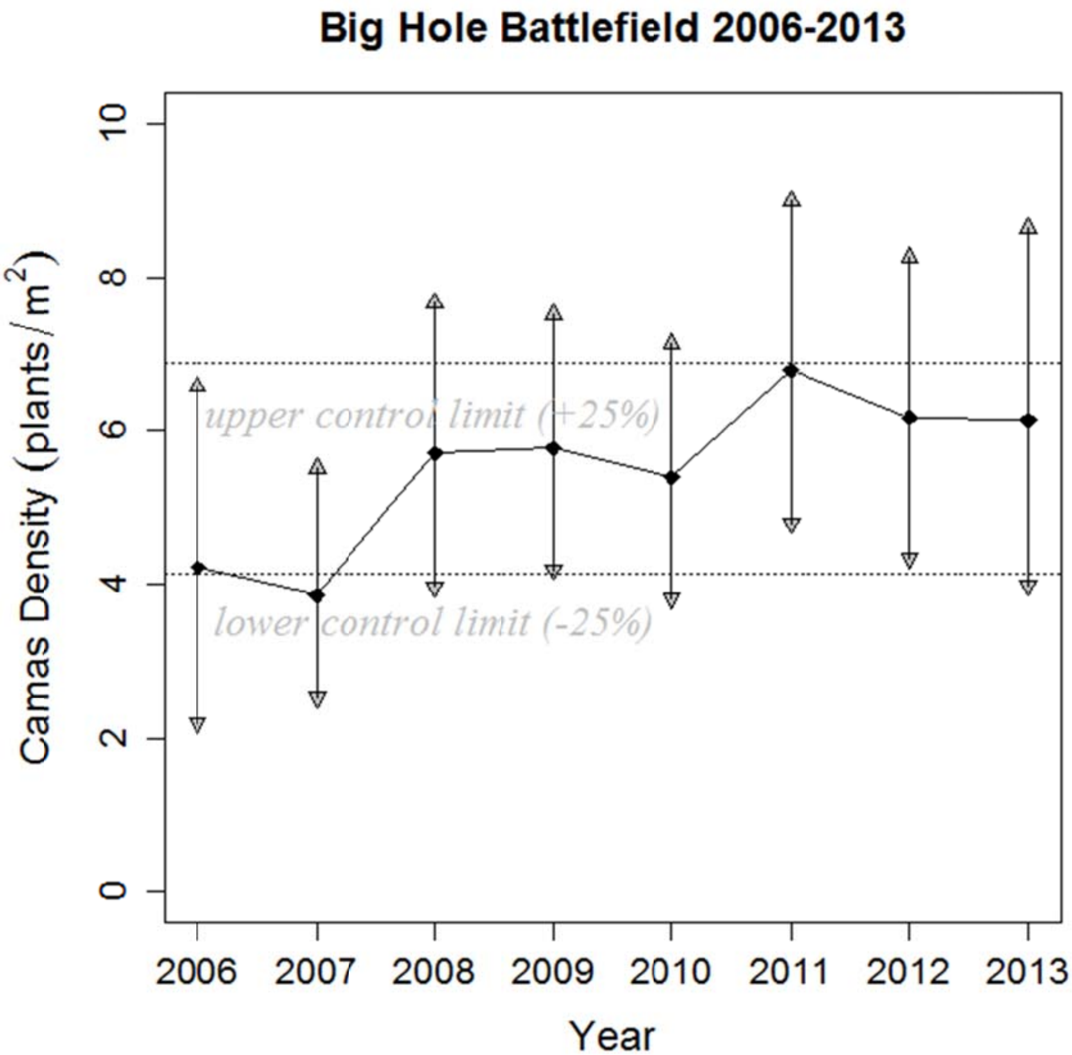

Figure 3. A “conformance” or control chart that plots annual established camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, over the monitoring period 2006-2013.

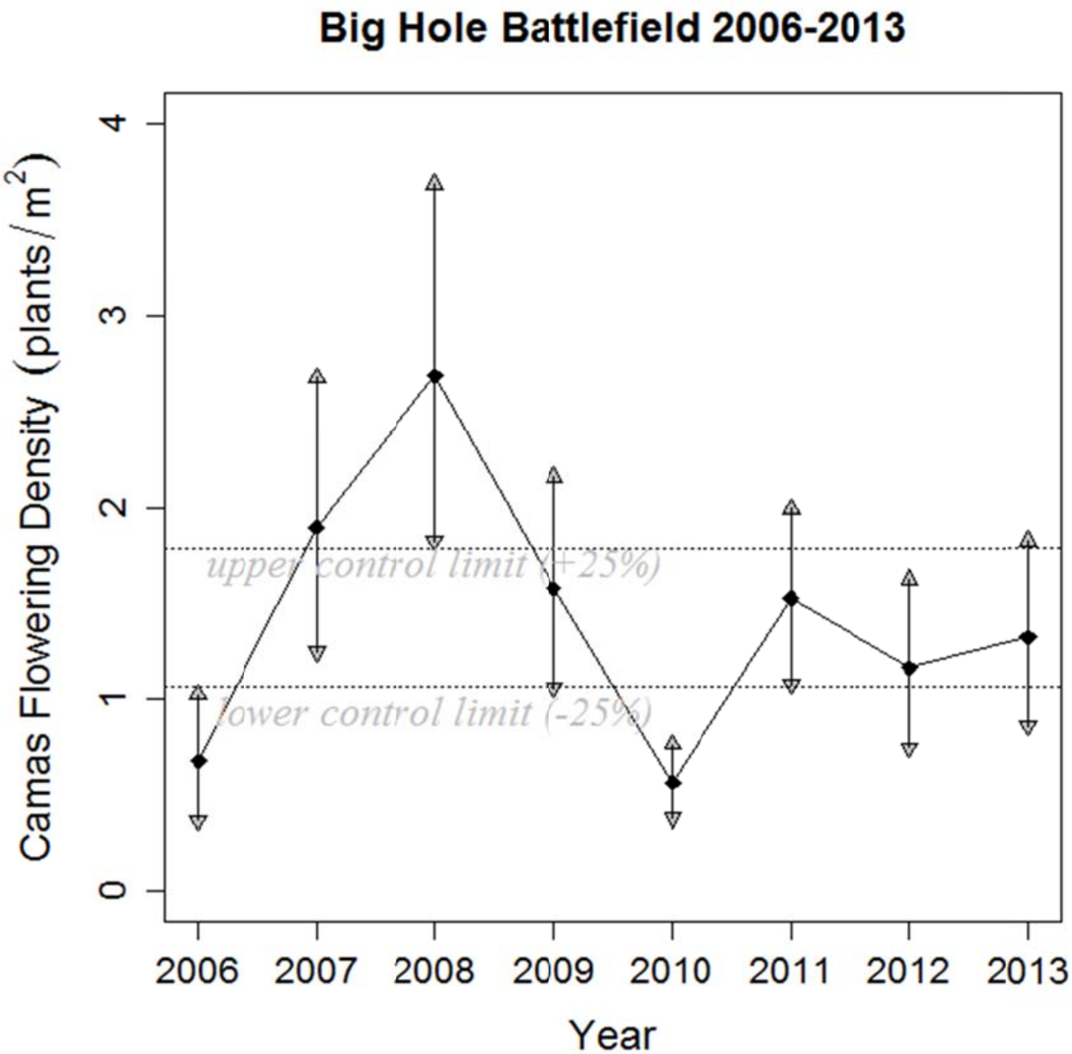

Figure 4. A “conformance” or control chart that plots annual flowering camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, over the monitoring period 2006-2013.

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