Camas Monitoring at Big Hole National Battlefield

2015 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2017/1077
ON THE COVER
Photograph of Big Hole National Battlefield, Montana.
Photograph by Devin Stucki, NPS.
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Contents

Figures...................................................................................................................................................iii
Tables ....................................................................................................................................................iii
Abstract .................................................................................................................................................. v
Acknowledgments ................................................................................................................................. vi
Introduction ............................................................................................................................................ 1
Methods .................................................................................................................................................. 5
Results .................................................................................................................................................... 9
Literature Cited .................................................................................................................................... 11

Figures

Figure 1. The sampling frame along the Big Hole River floodplain in BIHO, with 2015 quadrat locations (red points) and predicted patterns of camas density based on a kriging interpolation from 2015 established camas plant counts. .................................................................6

Figure 2. 2015 water year monthly temperature and precipitation departures from 30-year averages (1981-2010). ................................................................................................................................. 7

Figure 3. “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 2006-2015. ................................................................. 10

Figure 4. “Conformance” or control chart that plots annual established flowering camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, over the monitoring period 2006-2015. ................................................................. 10

Tables

Table 1. Estimated means and 90% confidence intervals for established camas plant density and flowering plant density. ...................................................................................................................... 9
Abstract

As part of the Upper Columbia Basin Network’s long-term vital signs monitoring, we completed monitoring of camas lily (*Camassia quamash* (Pursh) Greene) in 2015 in Big Hole National Battlefield (BIHO). This is the tenth year of camas monitoring in BIHO.

In 2015, 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 1.4 (90% confidence interval 0.9-2.1). This was considerably lower than the 2014 estimate of 3.4 plants/m$^2$ and represents the lowest estimated density since monitoring began at BIHO in 2006. Estimated mean density of flowering camas plants/m$^2$ was 0.6 (90% confidence interval 0.3-0.9), also down from 2014. Canada thistle was found in 8 plots (~5% frequency of occurrence) in 2015. Canada thistle was found in 3 plots in 2013 and was not found in any plots in 2014.

Weather patterns in the Big Hole Valley have been warmer and drier than average. Monthly average temperatures during the 2015 water year were mostly above average, especially during the winter and spring months. Monthly average precipitation totals were more variable with a wetter than average fall and a drier than average winter and spring. It is unclear what has led to the decline in camas density. A further trend analysis investigating these declines in camas density, as well as accounting for the effects of average monthly temperature and precipitation on camas populations and flowering rates, will be available in 2017.
Acknowledgments

Funding for this project was provided through the National Park Service Natural Resource Challenge and the Inventory and Monitoring Program. 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 surveys to be conducted very efficiently in a short amount of time. This document relies heavily on previous versions of this annual report, as well the Camas Lily Monitoring Protocol (Rodhouse et al. 2007).
Introduction

Common 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 genus Camassia 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 BIHO and Weippe Prairie, 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 BIHO and Weippe Prairie 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 2015 sampling results from BIHO, and include results from 2006-2014 to
provide context for current estimates of camas density, which were also reported by Stucki and
Rodhouse (2015). 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 2006-2015. A companion report will be available for Weippe Prairie covering the same time period.
Methods

The UCBN initiated camas monitoring at BIHO, located near Wisdom, Montana, in 2006. Figure 1 shows the sampling frame and 2015 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 m² 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, 151, 152, and 151 for the years 2006-2015 (Table 1). 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 remained 150 plots 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).
Figure 1. The sampling frame along the Big Hole River floodplain in BIHO, with 2015 quadrat locations (red points) and predicted patterns of camas density based on a kriging interpolation from 2015 established camas plant counts.
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) (Figure 2). 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). Ordinary kriging (Fortin and Dale 2009) was used to produce an interpolated density map for BIHO using 2015 data. Predictive density maps provide useful interpretive tools to illustrate density patterns across the floodplain. Finally, we summarize recent weather patterns from the Calvert Creek SNO-TEL weather station located approximately 24 miles northeast of the Battlefield using the capabilities of the Climate Analyzer (www.climateanalyzer.org) developed by NPS contractor Dr. Mike Tercek. All analyses and associated 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 2. 2015 water year monthly temperature and precipitation departures from 30-year averages (1981-2010). This figure illustrates that winter temperatures were considerably warmer than average and precipitation totals from January-June 2015 were below average. N/A represents missing precipitation values. Data from the Wisdom, Montana National Weather Service Cooperative Observer Network, located 10 miles east of the Battlefield.
Results

In 2015, based on counts of camas in one-hundred-fifty-one 0.6 m² quadrats, mean density of established camas plants/m² at BIHO was estimated to be 1.4 (90% confidence interval 0.9-2.1). This was considerably lower than the 2014 estimate and represents the lowest camas density estimate in BIHO since camas monitoring was initiated in 2006 (Table 1 and Figure 3). Estimated mean density of flowering camas plants/m² was 0.55 (90% confidence interval 0.3-0.9), also representing the lowest flowering camas density estimate (Table 1 and Figure 4). Spatial variation in camas density is described by the predicted density map (Figure 1).

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

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Plants/m² Density</th>
<th>90% percentile lower</th>
<th>90% percentile upper</th>
<th>Stems/m² Flowers</th>
<th>90% Percentile lower</th>
<th>90% Percentile upper</th>
<th>Flowering Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>151</td>
<td>1.44</td>
<td>0.87</td>
<td>2.11</td>
<td>0.55</td>
<td>0.30</td>
<td>0.85</td>
<td>0.49</td>
</tr>
<tr>
<td>2014</td>
<td>152</td>
<td>3.39</td>
<td>2.32</td>
<td>4.58</td>
<td>0.82</td>
<td>0.57</td>
<td>1.10</td>
<td>0.32</td>
</tr>
<tr>
<td>2013</td>
<td>151</td>
<td>6.14</td>
<td>3.98</td>
<td>8.65</td>
<td>1.33</td>
<td>0.86</td>
<td>1.83</td>
<td>0.26</td>
</tr>
<tr>
<td>2012</td>
<td>150</td>
<td>6.18</td>
<td>4.33</td>
<td>8.27</td>
<td>1.16</td>
<td>0.75</td>
<td>1.63</td>
<td>0.26</td>
</tr>
<tr>
<td>2011</td>
<td>154</td>
<td>6.79</td>
<td>4.80</td>
<td>9.00</td>
<td>1.53</td>
<td>1.08</td>
<td>1.99</td>
<td>0.22</td>
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<tr>
<td>2010</td>
<td>160</td>
<td>5.40</td>
<td>3.82</td>
<td>7.14</td>
<td>0.56</td>
<td>0.38</td>
<td>0.76</td>
<td>0.1</td>
</tr>
<tr>
<td>2009</td>
<td>150</td>
<td>5.78</td>
<td>4.18</td>
<td>7.52</td>
<td>1.58</td>
<td>1.06</td>
<td>2.16</td>
<td>0.27</td>
</tr>
<tr>
<td>2008</td>
<td>150</td>
<td>5.71</td>
<td>3.97</td>
<td>7.67</td>
<td>2.69</td>
<td>1.83</td>
<td>3.69</td>
<td>0.47</td>
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<tr>
<td>2007</td>
<td>124</td>
<td>3.86</td>
<td>2.53</td>
<td>5.52</td>
<td>1.90</td>
<td>1.25</td>
<td>2.68</td>
<td>0.49</td>
</tr>
<tr>
<td>2006</td>
<td>81</td>
<td>4.22</td>
<td>2.19</td>
<td>6.58</td>
<td>0.68</td>
<td>0.37</td>
<td>1.02</td>
<td>0.16</td>
</tr>
</tbody>
</table>

In 2013, Canada thistle (*Cirsium arvense*) 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. In 2014, no Canada thistle plants were encountered within plots. In 2015, Canada thistle was recorded in 8 plots (~5% frequency of occurrence).

Weather patterns in the Big Hole Valley have been warmer and drier than average (Figure 2). Monthly average temperatures during the 2015 water year were mostly above average, especially during the winter and spring months. Monthly average precipitation totals were more variable with a wetter than average fall and a drier than average winter and spring. A second formal trend analysis report following the one provided by Rodhouse et al. (2011) will be available in 2017 and will take into account the effects of average monthly temperature and precipitation on camas populations and flowering rates at BIHO.
Figure 3. "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 2006-2015.

Figure 4. "Conformance" or control chart that plots annual established flowering camas plant densities and 90% confidence intervals relative to control limits that are ±25% of the average density, over the monitoring period 2006-2015.
Literature Cited


The Department of the Interior protects and manages the nation’s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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