



Data Quality Standards for Population Monitoring Protocol for Lemhi Penstemon (*Penstemon lemhiensis*) and Spotted Knapweed (*Centaurea stoebe*) in Big Hole National Battlefield

Data Quality Standard Version 1.0

Natural Resource Report NPS/UCBN/NRR—2017/XXX



ON THE COVER

Photograph of NPS ecologists surveying Lemhi penstemon and spotted knapweed along transect.
Photograph courtesy of Diana Popp, Oregon State University - Cascades

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Introduction

The purpose of this report is to document the standards used by the Upper Columbia Basin Network (UCBN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in the UCBN Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018). The policies and procedures documented in this quality-assurance plan for these activities complement the quality-assurance plans for other monitoring activities conducted by the UCBN and supplement the National Inventory & Monitoring Division Quality Management Plan (Citation to be added later). The plan also serves as a guide for all UCBN personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

The mission of the National Park Service (NPS) is “to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations” (National Park Service 1999). To uphold this goal, the Director of the NPS approved the Natural Resource Challenge to encourage national parks to focus on the preservation of the nation’s natural heritage through science, natural resource inventories, and expanded resource monitoring (National Park Service 1999). Through the Challenge, 270 parks in the national park system were organized into 32 inventory and monitoring (I&M) networks, each tasked with designing and implementing a “vital signs” monitoring program for its respective constituent parks (Fancy et al 2009).

The Upper Columbia Basin Network (UCBN) has identified priority park vital signs, indicators of ecosystem health that represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales (Garrett et al. 2007). Our intent is to develop a balanced and integrated suite of vital signs that meets the needs of current park management, and addresses unanticipated management questions in the future. Invasive weeds, including spotted knapweed (*Centaurea stoebe*), and rare and peripheral native populations, including Lemhi penstemon (*Penstemon lemhiensis*), were identified as important vital signs for the Network (Garrett et al. 2007). This document describes the details for implementing and sustaining long-term monitoring of Lemhi penstemon and spotted knapweed populations in Big Hole National Battlefield (BIHO). It is organized into a summary narrative and detailed standard operating procedures, following guidelines outlined by Oakley et al. (2003).

Lemhi penstemon was identified as a vital sign for BIHO because it is a rare regional endemic flowering plant thought to be at risk of extinction from habitat loss stemming from weed invasion and altered fire regimes, and, over a longer time frame, from accelerated climate change. The Lemhi penstemon species inventory and pilot monitoring conducted in the Battlefield by the NPS has provided clear evidence that BIHO supports the largest reported population of Lemhi penstemon anywhere within its restricted range, making the park globally significant in terms of Lemhi penstemon conservation. Unfortunately this early survey effort has also established that spotted knapweed invasion poses a growing threat.

Lemhi penstemon is thought to be dependent on early-seral, bare-soil microsites for successful seed germination and therefore possibly easily lost from ecosystems in which fire or other soil-disturbing

processes are interrupted. This dependency creates both an opportunity and a challenge for aligning Battlefield cultural and natural resource management. Prescribed fire has been used in the past to maintain the open hillslopes of the Battlefield cultural landscape. These hillslopes host the core of the Lemhi penstemon population but, in the absence of fire, they are also prone to encroachment from the adjacent lodgepole pine forest and densification of native sagebrush and bunchgrasses. More recently, the invasive spotted knapweed has heavily infested some portions of these hillslopes, creating an additional threat to Lemhi penstemon persistence and to the historical and ecological integrity of the Battlefield in general. This infestation complicates the potential utility of using prescribed fire in the future if this invader also responds vigorously to fire.

Monitoring the Lemhi penstemon and spotted knapweed populations in BIHO over time will provide information critical to effective Battlefield resource management decision-making. It also provides an important opportunity for NPS to contribute knowledge about biological conservation in protected-area cultural landscapes more generally. This program is targeted and hypothesis-driven monitoring, closely integrated with Battlefield management. The fundamental working hypothesis is that Lemhi penstemon population persistence in the Battlefield is dependent upon recruitment of germinants, and increased survival and reproductive vigor of established plants in bare-soil microsites where sunlight, water, and soil nutrients are available in adequate supply. The corollary is that encroachment of lodgepole pine and increasing density of native steppe vegetation and spotted knapweed will reduce the number and size of these microsites and cause a decline in the penstemon population through resource competition. When natural processes and Battlefield management activities (e.g., fire, downslope soil movement, and herbicide application) create microsites and suppress competitive vegetation, we expect that the Lemhi penstemon population will respond with increased reproduction and survival. We have developed monitoring objectives and corresponding survey methods that will allow us to test these hypotheses. Both the monitoring itself and Battlefield management will be adaptive and incorporate knowledge about the ecological system as it is acquired through monitoring over time, reflected in updated versions of this protocol. There are several important sources of uncertainty that may obfuscate some of the clarity of information generated through monitoring. Most importantly, monitoring will be done against a complex backdrop of varying climatic processes. Initial results from the inventory and pilot monitoring suggest that fluctuations in precipitation and temperature patterns prior to and during the growing season may influence variation in spotted knapweed and Lemhi penstemon counts from year to year. Climate information from weather stations near the Battlefield will be used to account for some of this variation. Also, some of the mechanisms hypothesized to drive population change, such as competition among Lemhi penstemon and other vegetation for soil resources and sunlight, will not be measured directly. Rather, proxy measures of vegetation and bare soil cover will be used instead. In general, the design of this monitoring program reflects trade-offs between information content and logistical and financial costs; we believe the balance struck will satisfy both the objectives of the long-term monitoring program and the information needs of park resource managers.

Protocol Activities and Modules

Data are collected or derived as a part of the Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018) as three (intensive, extensive and census) concurrent efforts in eight different activities or modules (Table 1).

Table 1. Protocol activity matrix for extensive and intensive Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018).

Activity		Description
Site Recon, Establishment, and Maintenance		
1	Extensive Plot Selection & Documentation	Generation of sampling locations using GRTS design and appropriate selection criteria. Locations potentially rejected and replaced (with documentation) upon inspection in the field.
2	Intensive Plot Establishment	Installation of rebar monuments, GPS location. Note that baseline groundcover data are collected at time of plot establishment as in activity 6.
Field Observations		
3	Sampling Event Data Collection	Date, time, collectors, and the azimuth of the transect (in degrees) of each plot is recorded with a compass at the plot origin.
4	Extensive Plot Surveys	All established Lemhi penstemon and spotted knapweed plants are counted in extensive plots, as well as the number of penstemon rosettes and inflorescences. The location of the penstemon plant along the transect is collected as distance from transect origin (meters) and side (left or right) side of the transect centerline.
5	Intensive Plot Vegetation Surveys	All mature Lemhi penstemon are tagged and counted, along with the number of basal rosettes and inflorescences on each plant. Live/dead status is recorded. Lemhi penstemon seedlings are also counted, as well as spotted knapweed plants. In each plot, it is noted if any Lemhi penstemon corollas have opened or not, a practice that if continued over the long-term could help to define the phenology of the species at BIHO. Inflorescences that have been browsed are also noted.
6	Intensive Plot Physiognomic Ground Cover Measurements	Percent ground cover is estimated using the point interception technique (Elzinga et al. 2001) at 98 positions within the 2-m ² plot; values for physiognomic ground cover categories are totaled and converted to a percentage for each intensive plot.
7	Visitor Center Subpopulation Census	Tag number, rosette count, and inflorescence count.
Derived Data		
8	Extensive Site Physiographic Data	Derive slope and aspect along extensive plot transect using UCBN LinearExtract tool (SOP 6 (Rodhouse et al. 2018))

Sampling Design

Table 2. Activity-level sample design matrix for Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018).

Activity		Sampling Design	Revisit Design
Field Observations			
4	Extensive Plot Surveys	- <u>Probability (Equal)</u>: GRTS-based sample of Howitzer Hill and Horse Pasture Lemhi penstemon and spotted knapweed sub-populations within battlefield (excluding Visitor Center sub-population). - A sampling frame was created which encompasses the two hillslope sub-populations. An equal probability GRTS draw is conducted using these two sub-populations (Horse Pasture and Howitzer Hill) as strata. - 200 points and 10 oversamples are drawn for Horse Pasture while 100 points and 10 oversamples are drawn for the smaller Howitzer Hill. - The defined sampling unit of measurement (2 x 50 m) for estimating established penstemon and knapweed population sizes. Plot boundaries are framed temporarily by fixing a 50-m reel tape down the centerline from the origin to the end and using a 2-m long guide while sampling to determine plot edges and simultaneously reading the plot. The plot is anchored by a surveyor's pin at the GRTS sample point's UTM coordinates. The long axis of the plot is oriented perpendicular to the slope.	Revisit every 1 year
5	Intensive Plot Surveys	- <u>Probability (Conditional)</u>: Conditional GRTS sample of 41 random locations with ≥ 1 penstemon plant (hence conditional) in the two hillslope extensive frames. - <u>Non-probability (Targeted)</u>: 1 additional intensive plot was located in the visitor center sub-population <u>Summary:</u> - 42 plots (41 probabilistic, 1 targeted) in total were selected. 23 plots on Horse Pasture, 18 plots on Howitzer Hill, 1 plot at the visitor center. - The defined sampling unit of measurement (1 x 2 m) for estimating change in penstemon and knapweed densities (plants/m²), and penstemon demographic vital rates. The two bottom (downhill side) plot corners are permanently marked with rebar and a PVC pipe quadrat used to frame subplots during surveys. These plots are oriented perpendicular to the slope.	Revisit every 1 year
7	Visitor Center Subpopulation Census	- <u>Census</u>: - An annual census of all penstemon plants is conducted in the small visitor center subpopulation concentrated along the banks of an irrigation canal that bisects the middle of the west-facing slope below the visitor center. Extensive searches in each year beginning in 2010 through 2014 have confirmed that the subpopulation is small and does not extend away more than ~ 10 m from the portion of the canal that bends sharply to the northeast. Each year beginning in 2011 we have utilized all available staff and volunteers to spend the final afternoon of the week-long field effort locating, tagging and recording attributes of every established plant. Plants are temporarily marked with pin flags during survey before the final tally to ensure visibility. Plant rosettes and inflorescences are recorded.	Revisit every 1 year
Sensor Data			
4,5	GPS waypoints	<u>Targeted (ancillary)</u> : Waypoints are collected for incidental spotted knapweed plants observed while moving from one plot to another. These data are not stored, but are immediately uploaded to park databases for timely weed management activities.	Revisit every 1 year

Data Quality Objectives

Data quality values and standards for implementation are provided in Table 3 through 6.

Table 3. Data Quality Values (DQVs) for Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018).

Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality		
Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (count, direction, position) or classes (species, types, or categories).	The protocol requires identification of only two conspicuous and easily identifiable plant species. Accuracy of extensive plot class data is achieved by training field crew personnel in all standard operating procedures and basic plant identification at the beginning of each field season as well as by using expert resources, such as botanists, when available. Special care is taken to ensure intensive plot observers are trained botanists (e.g., Project Lead <i>not</i> untrained park staff who assist with extensive plot surveys) to differentiate mature plants from seedlings, identify individual basal rosettes and flowering stalks, and to recognize 'lookalike' species found in the area.
Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy and representative statistical sampling design, leads to repeatable data collection and known, quantifiable scope of inference and uncertainty assessment.	Representativeness is achieved by conducting equal probability (for extensive plots) and conditional probability (for intensive plots) spatially-balanced GRTS samples from geographically large defined sampling frames that encompass the core (but not entire) Lemhi penstemon and spotted knapweed populations in the Battlefield. At the visitor center site, rather than a representative sample, the entire population is censused.
Contextual Data Quality		
Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	Data comparability is ensured through time with repeatable replication using identical methods. No automated equipment subject to change (e.g., computer loggers) is used. Observations are simple (2 plant species) and new observers easily trained and calibrated by following the guidelines laid out in the SOPs for staff training and field methods.
Timeliness / Currency	How recent the data need to be to be considered valid for their intended use. Data represents conditions and/or is available and in a format for use at the appropriate time in the decision-making process.	Certification of data occurs on an annual basis. Where certified data cannot be provided for resource management decisions in a timely manner, requirements for provisional use of data are defined and documented prior to data dissemination and use.
Completeness	All data/ measures required to evaluate accuracy and representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	All GRTS points must be sampled each year. Should sites be rejected (following pre-established criteria), oversamples will be surveyed in sequential order. If a full survey is unlikely, a subset of plots will be targeted for completion following the GRTS order as to not leave 'holes' in the coverage.
Representational Data Quality		
Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	The Data Processing Level of all data will be tracked using the nomenclature described in

			"Certification Guidelines for Inventory and Monitoring Data Products" (2016).
Data Accessibility			
	Secure	Access to data, products, and systems limited to appropriate audiences.	No protected data will be collected as part of this protocol.

Measurement Quality Objective and Performance Standards

Table 4. Measurement Quality Objectives for Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018).

Measure / Quality Indicator		Quality Objective
Site Location		
	Location Accuracy	Sample location within +/- 5m (as standard for Garmin GPS devices) of predetermined randomly selected waypoint.
	Location Range	All UTM Zone 12N locations associated with this protocol will fall in the following ranges Easting (X): >759,000 and <763,000 and Northing (Y): >5,059,000 and <5,062,000
Vegetative Measurements		
	Taxonomic resolution	Identification made to species level (see table 5, taxonomic standards)
	Penstemon and spotted knapweed Identification accuracy	95% accuracy, accounting for experience level of observers.
	Penstemon rosette count	95% accuracy, accounting for experience level of observers.
	Penstemon seedling count	95% accuracy, accounting for experience level of observers.
	Penstemon flower count	100% accuracy, tall (e.g., 20 cm) and conspicuous showy stalks.
	Penstemon flowers bloomed	100% accuracy, yes or no, are flowers present
	Identify browsing of penstemon	95% accuracy, yes or no, have inflorescences been browsed. Accounting for similar damage such as trampling or clipping.
Extensive Plot Measurements		
	Distance along transect	+/- 0.1m using a reel tape
	Side of transect	100% accuracy, identified as left or right
	Azimuth	+/- 1 degree, direction (origin to terminus) of plot transect measured using compass
	Aspect	+/- 1 degree, average calculated in GIS along entire transect (SOP 6 (Rodhouse et al. 2018))
	Slope	+/- 1 degree, average calculated in GIS along entire transect (SOP 6 (Rodhouse et al. 2018))
Intensive Plot Measurements		
	Cover class category	100%, point intercept method used to identify bare ground, crust, forb, graminoid, Lemhi penstemon, litter, rock, shrub, tree or wood.
	Aspect	+/- 1 degree, measured with compass at time of plot establishment.
	Slope	+/- 1 degree, measured with compass inclinometer (compass turned on side) at time of plot establishment.

Taxonomic Standards

Table 5. Taxonomic standards to be used for Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018).

Activity		Standard to be Used	Reference / Authority
Collection of Observational Data			
4,5,7	Lemhi penstemon <i>Penstemon lemhiensis</i> (D. D. Keck) D. D. Keck & Cronquist	Scientific Publication	(Hitchcock & Cronquist 1973)
4,5,7	Spotted knapweed <i>Centaurea stoebe</i> L.	Scientific Publication	(Hitchcock & Cronquist 1973)
Reporting of Observational Data			
4,5,7	Lemhi penstemon <i>Penstemon lemhiensis</i> (D. D. Keck) D. D. Keck & Cronquist	Scientific Publication	(Hitchcock & Cronquist 1973)
4,5,7	Spotted knapweed <i>Centaurea stoebe</i> L.	Scientific Publication	(Hitchcock & Cronquist 1973)

Data Protection Standards

Table 6. Data Protection standards for Desert Springs monitoring in the Population Monitoring Protocol for Lemhi Penstemon and Spotted Knapweed in Big Hole National Battlefield (Rodhouse et al. 2018). With the exceptions noted, all data collected are to be made publicly available in a timely fashion.

Type of Data		Level of Protection	Rules for Dissemination
Resource Data and Information			
	Lemhi penstemon and spotted knapweed tabular observation data	Publicly available	No restrictions
Location Data and Information			
	Lemhi penstemon and spotted knapweed spatial data	Publicly available	No restrictions
Personally Identifiable Information			
	Non-NPS Staff Information	Publicly available	No restrictions. Only first name and last initial are collected.

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