



Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network

Data Quality Standards

Natural Resource Report NPS/APHN/NRR—2018/1828



ON THE COVER

Clockwise from top left: large-flowered trillium (*Trillium grandiflorum*), American ginseng (*Panax quinquefolius*), bloodroot (*Sanguinaria canadensis*), and black cohosh (*Actaea racemosa*)

Photographs by: Nora Murdock, Appalachian Highlands Inventory and Monitoring Network, National Park Service; Gary Kauffman, National Forests in North Carolina, USDA Forest Service .

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Introduction and Summary

The purpose of this report is to document the standards used by the Appalachian Highlands Network (APHN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018). The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the Appalachian Highlands Network and supplement the National Inventory and Monitoring Division Quality Management Plan (in development). The plan also serves as a guide for all APHN personnel who are involved in protocol or program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

Commercial-scale illegal harvesting of plants for sale in medicinal and floral markets is a growing concern in many parks. The Appalachian Highlands Inventory and Monitoring Network is monitoring several plant species that grow in rich cove habitats and are known to be significant commercial poaching targets on the Blue Ridge Parkway, including black cohosh (*Actaea racemosa*), bloodroot (*Sanguinaria canadensis*), trilliums (*Trillium* spp.), and American ginseng (*Panax quinquefolius*).

Black cohosh is used in U.S. and European medicinal supplement markets primarily in formulations for treating the symptoms of menopause. Demand for black cohosh has increased in the wake of recent research indicating the health risks associated with hormone replacement therapy. Although cultivated sources of black cohosh are being developed, most of the black cohosh currently used in commercial products comes from wild populations. Estimated worldwide consumption of dried black cohosh root exceeded 500,000 pounds (226,796 kilograms) in 2003, a 25% increase from the previous year, and demand has continued to rise. The harvest pressure on wild populations has led to the species being considered for addition to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list.

Bloodroot, which has antibiotic properties, is currently harvested primarily for use as a cattle feed supplement in countries where synthetic antibiotics have been banned in livestock feed. Bloodroot is principally exported to Germany, where projected demand exceeds 300,000 pounds (136,077 kilograms) of dried root per year. While bloodroot is not currently considered a threatened species, annual harvest levels of this magnitude could rapidly deplete its numbers throughout the southern Appalachians, as well as across a significant portion of its range. At present there is no cultivated source of bloodroot which can supply such a large demand.

Trilliums, which are native only to North America and Asia, are in demand by collectors in the form of live plants. In Europe, where trilliums are not native, the demand is so great there have been cases of extensive thefts from large botanical gardens, and the rarer species command high prices. Individual flowering plants of common species are routinely offered for sale in the United States for \$10–\$20 apiece. At least one species (*Trillium erectum*, or “bethroot”) is also in demand for its

medicinal properties, with Southern Appalachian buyers purchasing as much as 500 pounds (227 kilograms) of dried root at a time from wild-harvesters.

American ginseng has been harvested from the wild for over 250 years to supply traditional medicinal markets. Demand for the root of this species, particularly from China, has driven prices to unprecedented levels in recent years, with associated increases in harvest pressure. The early results from APHN monitoring plots are alarming—ginseng was found in less than 25% of sites surveyed in suitable habitat on the Blue Ridge Parkway. Essentially all sites where ginseng was found showed signs of heavy poaching, and more than 70% had 15 or fewer plants, far short of the 200–500 individuals estimated to be the minimum necessary for long-term survival. Non-native invasive plants pose an additional threat to species monitored with this protocol. They can grow in dense patches and outcompete target species for light and other resources.

The overall goal of this long-term monitoring effort is to determine whether populations of ginseng, bloodroot, black cohosh, and trilliums on the Blue Ridge Parkway are changing in population density or overall distribution within the park, in response to poaching activity. This monitoring program is specifically designed to document:

1. Long-term trends in population densities of black cohosh, bloodroot, trilliums, and ginseng, within monitoring plots, with detection of at least a 30 percent total change in numbers of individuals over eight years, with 80 percent power ($\beta=0.20$). Ginseng numbers may already be too low to achieve 80 percent power.
2. Temporal (year-to-year) and spatial patterns in poaching incidence within monitoring plots.
3. Invasive exotic plant species presence and cover within monitoring plots.

This long-term monitoring program for detecting status and trends of exploited plant populations at Blue Ridge Parkway will serve as a central information source to assist park staff in making management decisions. It will also provide essential feedback on law enforcement actions, plant-marking efforts, and other protective measures for these heavily-poached plants.

Protocol Activities and Modules

Data are collected or derived as a part of the *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018) in eight different activities or modules (Table 1).

Table 1. Protocol activity matrix for *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018).

Activity Type	Activity Number	Activity	Description
Site, Recon, Establishment and Maintenance	1	Site Recon/Plot Validation	Determination of which site within each block will be used for quantitative monitoring, based on GRTS (generalized random tessellation stratified) order, field validation of rich cove status, & other plot requirements.
	2	Quantitative Plot Establishment	Site description, location of permanent baseline and sampling transects, geolocation and establishment of witness trees.
	3	Quantitative Plot Maintenance	Re-establishment/replacement of witness trees & re-establishment of rebar baseline markers, as needed.
Field Observations	4	Belt Transect Sampling	Collection of count (abundance) data for black cohosh, bloodroot, trilliums, and ginseng along 2 x 30 m belt transects (see SOP3 Belt Transect Count Methods for Quantitative Plots [APHN 2018]).
	5	Ginseng Counts	Count, including determination of leaf number & reproductive condition, of ginseng plants in permanent 15 x 30 m subplots (see SOP4 Ginseng Count/Subplot Assessment [APHN 2018]).
	6	Subplot Assessments	Qualitative monitoring for poaching evidence, diseases of target plants, herbivory on target plants, cover class of non-native invasive plants, canopy closure class, as well as cover class for bloodroot, black cohosh, and trilliums, in permanent 15 x 30 m subplots (see SOP 4).
Sensor Data	7	Photo Monitoring	Photo points established at 0 and 60-meter points along baseline as well as from the origin and terminus of each transect (see SOP5 Photo Monitoring [APHN 2018]).
QA/QC Data	8	Repeat Measures	Belt transect count data are collected a second time for 10% of plots. This occurs within 2 days of original count. During crew training, two observers will make separate subplot assessments & compare results.

Sampling Design

Information regarding the sampling design is provided in Table 2.

Table 2. Activity-level sample design matrix for *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018).

Activity Type	Activity Number	Activity	Sampling Design	Revisit Design
Site Recon, Establishment, and Maintenance	2	Quantitative Plot Establishment	Predictive GIS modeling of rich cove habitat; predicted habitat divided into 64 blocks with roughly equal area of predicted habitat; points from each block selected using GRTS methodology; plot established at first site in GRTS order that meets sampling criteria (from within first 20 GRTS-ordered points). If no appropriate sites found within first 20, block excluded from sampling.	Not applicable.
Field Observations	4	Belt Transect Sampling	60m baseline runs approximately perpendicular to contours, with origin at uphill end. Permanent transect origin selected at random from within each 15m section of baseline (4 total). If origin of first transect is an odd number, transect runs to the left of baseline (looking downhill along baseline, from origin to terminus). If even, first transect runs to the right of baseline. Remaining transects alternate sides. Transects 30m long, 2m wide, perpendicular to baseline.	Rotating panel; four panels and a two-year cycle with panels 1 and 2 monitored in even years, and panels 3 and 4 monitored in odd years. One half of the plots are sampled on any given year. Option for four-year cycle if resources are limited.
	5	Ginseng Counts	60 x 60 m plot divided into eight 15 x 30 m subplots	Same as activity 4
	6	Subplot Assessments	(15m along baseline & 30m to each side).	Same as activity 4
Sensor Data	7	Photo Monitoring	Photos taken along & perpendicular to baseline from origin and terminus; perpendicular to baseline from the origin and terminus of each transect	Same as activity 4

Data Quality Objectives

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

Table 3. Data Quality Values (DQVs) for *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018).

Data Quality Category	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	All plants are properly identified to the species level for all observations (except <i>Actaea</i> spp. and <i>Trillium</i> spp.). Counts represent the true number of individuals of target species within each belt (and subplot, for ginseng). Reproductive condition and leaf number correctly reported for ginseng; presence of wilt correctly reported for trilliums and black cohosh. Cover classes assessed accurately and consistently for subplot assessment. All non-native invasive plants listed in protocol Appendix J detected & properly identified. Any and all signs of herbivory and poaching identified and noted.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Block design provides spatial balance of sites within study area; transects placed using restricted-random methods.
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	All sample locations are monitored following the schedule and methods outlined within Murdock et al. 2018. Data are collected consistently to permit comparisons among and between years and locations.

Table 3 (continued). Data Quality Values (DQVs) for Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative (Murdock et al. 2018).

Data Quality Category	Data Quality Value	Definition	Protocol Considerations
Contextual Data Quality (continued)	Completeness	All data/ measures required to evaluate accuracy 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 sampling locations are monitored following the schedule described in Murdock et al. 2018. Data are collected at all plots in the appropriate panel each year, but there is a chance that one or more plots in a given year will not be sampled due to safety or other considerations, or that data within a plot will be incomplete. The design and analysis methods can accommodate occasional missing data.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data.	No protocol specific considerations. Resource condition classes have not yet been defined.
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	Data are legally protected due to the commercial value of the resource. Protected data may be released in limited cases only with park Superintendent approval following park procedures.

Table 4. Measurement Quality Objectives *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018).

Activity	Measure/Quality Indicator	Quality Objective
Plot Establishment	Location Accuracy	UTM coordinates for plot origin & terminus accurate to $\pm 3\text{m}$ (horizontal) and $\pm 20\text{m}$ (vertical).
	Location Description Detail	Description provided with enough detail to relocate without use of GPS equipment.
	Distance Accuracy	Baseline $60\text{m} \pm 0.05\text{m}$. Witness tree distances accurate to $\pm 0.02\text{m}$.
	Azimuth Accuracy	Witness tree azimuths accurate to $\pm 2^\circ$.
	Identification Accuracy	$\geq 90\%$ of witness trees identified correctly.
Plot Setup and Maintenance	Witness Trees	All tags checked and replaced as needed. New witness tree established as needed.
	Rebar	All rebar located. Missing rebar replaced as needed.
	Baseline Length	$\pm 0.5\text{ m}$ of length recorded during initial plot establishment.
	Azimuth Accuracy	Transects & subplots laid out perpendicular to baseline $\pm 2^\circ$.
Belt Transect Sampling	Taxonomic Resolution	Identifications made to the species level (see taxonomic standards).
	Identification Accuracy	$\geq 90\%$ of species identifications are accurate.
	Count Accuracy	± 1 for counts of 20 or fewer plants, within 5% of true value for counts > 20 plants.
Ginseng Counts	Taxonomic Resolution	Identifications made to the species level (see taxonomic standards).
	Identification Accuracy	$\geq 95\%$ of species identifications are accurate.
Subplot Assessment	Taxonomic Resolution	Identifications made to the species level (see taxonomic standards).
	Identification Accuracy	$\geq 90\%$ of species identifications are accurate.
	Percentage Accuracy	$\geq 90\%$ of determinations of cover classes, reproductive (trilliums), wilted (trilliums and black cohosh), herbivory, and canopy closure reflect true value.
	Comprehensiveness of Detection	If one or more individuals of a target or non-native invasive plant, two or more signs of herbivory, or any clear signs poaching activity are present within a subplot, this will be detected $\geq 95\%$ of the time.
Photo Monitoring	Image resolution	10 megapixels or greater.
	Image format	TIFF w/ embedded EXIF metadata.

Table 5. Taxonomic standards to be used in *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018).

Activity Type	Activity Number	Activity	Standard to be Used	Reference / Authority
Collection of Observational Data	4	Belt Transect Sampling	Scientific Publication	Weakley (2015)
	5	Ginseng Counts	Scientific Publication	Weakley (2015)
	6	Subplot Assessment	Scientific Publication	Weakley (2015)
Reporting of Observational Data	4	Belt Transect Sampling	Scientific Publication	Weakley (2015)
	5	Ginseng Counts	Scientific Publication	Weakley (2015)
	6	Subplot Assessment	Scientific Publication	Weakley (2015)

Table 6. Data Protection standards for *Monitoring Exploited Plants of Rich Coves in the Appalachian Highlands Inventory & Monitoring Network: Protocol Narrative* (Murdock et al. 2018). With the exceptions noted, all data collected are to be made publicly available in a timely fashion.

Type of Information	Type of Data	Level of Protection	Rules for Dissemination
Resource Data and Information	Locations of Target Species	Legally Protected	Commercially valuable; presence of species reported at the park centroid level only.
Location Data and Information	Permanent Sampling Locations	Legally Protected	Sites contain commercially valuable species. Sample locations redacted from all dissemination.
Personally Identifiable Information	Non-NPS Staff Information	Legally Protected	All but first name and last initial redacted from public release.

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