

Prepared in cooperation with the NORTH COAST AND CASCADES NETWORK, NATIONAL PARK SERVICE

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Chapter 8 of

Section A, Biological Science

Book 2, Collection of Environmental Data



Techniques and Methods 2-A8

Cover: Trillium (center), Maidenhair fern (right), Juniper haircap moss (lower left).
Cover graphic design: Sandra Arbogast

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

By Andrea Woodward and Karen M. Hutten, U.S. Geological Survey;
John R. Boetsch and Steven A. Acker, Olympic National Park; Regina M.
Rocheport and Mignonne M. Bivin, North Cascades National Park; and
Laurie L. Kurth, U.S. Forest Service

Chapter 8 of

Section A, Biological Science

Book 2, Collection of Environmental Data

Prepared in cooperation with the
North Coast and Cascades Network, National Park Service

Techniques and Methods 2–A8

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2009

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment, visit <http://www.usgs.gov> or call 1-888-ASK-USGS

For an overview of USGS information products, including maps, imagery, and publications, visit <http://www.usgs.gov/pubprod>

To order this and other USGS information products, visit <http://store.usgs.gov>

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted materials contained within this report.

Suggested citation:

Woodward, Andrea, Hutten, K.M., Boetsch, J.R., Acker, S.A., Rochefort, R.M., Bivin, M.M., and Kurth, L.L., 2009, Forest vegetation monitoring protocol for national parks in the North Coast and Cascades Network: U.S. Geological Survey Techniques and Methods 2-A8, 228 p.

Contents

Narrative.....	1
Acknowledgments.....	1
1. Background and Objectives.....	1
2. Sampling Design.....	4
3. Field Methods.....	14
4. Data Handling, Analysis, and Reporting.....	17
5. Personnel Requirements and Training.....	26
6. Operational Requirements.....	27
References Cited.....	30
SOP 1: Workspace Setup and Project Records Management.....	33
SOP 2: Hiring Guidelines and Procedures.....	35
SOP 3: Preparation of Information Packets, Schedules, Equipment, and Supplies.....	37
SOP 4: Preparation of Reports, Datasheets, Maps, and Images.....	41
SOP 5: Orientation of Field Crew: Park Buildings, Field Preparation, and Safety.....	43
SOP 6: Training Field Crews.....	49
SOP 7: Preparing for a Field Tour.....	57
SOP 8: GPS Use: Navigation, Data Collection, and Downloading.....	61
SOP 9: Reconnaissance Form: Evaluation and Reconnaissance for Plot Selection.....	65
SOP 10: Establishing and Marking Permanent Monitoring Plots.....	73
SOP 11: Establishment Form: Recording Physical and Biotic Characteristics.....	77
SOP 12: Event Log: Recording Plot Visit Details and Taking Digital Photographs.....	87
SOP 13: Data: Measuring and Mapping Live and Standing Dead Trees.....	95
SOP 14: Vegetation Quadrats: Percent Cover and Tree Sapling Measurements.....	111
SOP 15: Herbivory: Estimating Herbivory on Shrubs in 5-m Quadrats.....	121
SOP 16: Down Woody Material: Measuring CWD, FWD, Duff, and Litter.....	127
SOP 17: Lichen Survey: Timed Survey of Epiphytic Lichens.....	139
SOP 18: Field Form Handling Procedures.....	147
SOP 19: Procedures Following a Field Tour.....	149
SOP 20: Photographic Image Processing and Management.....	151
SOP 21: Voucher Specimen Identification and Processing.....	155
SOP 22: Data Entry and Verification.....	157
SOP 23: End of Field Season Debriefing and Close-Out.....	159
SOP 24: Data Quality Review and Certification.....	161
SOP 25: Metadata Development.....	169
SOP 26: Product Delivery Specifications.....	171
SOP 27: Sensitive Information Procedures.....	175
SOP 28: Product Posting and Distribution.....	179
SOP 29: Revising the Protocol.....	181
Appendix A. Cover Estimation Method Comparison.....	183
Appendix B. Forest Vegetation Monitoring Protocol Database Documentation.....	187
Appendix C. Template for Forest Monitoring Annual Report.....	211
Appendix D. Guidelines for Collecting Botanical Specimens.....	223
Appendix E. Conifer Forest and Woodland Plant Associations of Mount Rainier, Cascades, and Olympic National Parks.....	225

Figures

Figure 1. Example of selecting locations for permanent plots after visiting all points in the GRTS sample for a hypothetical 300 m elevation band	7
Figure 2. Locations of permanent plots in Mount Rainier National Park by elevation band identified to date	8
Figure 3. Locations of permanent plots in North Cascades National Park by elevation band identified to date	9
Figure 4. Locations of permanent plots in Olympic National Park by elevation band identified to date	10
Figure 5. One-ha macroplot showing location of 50-m intensive plot divided into 10-m subplots	12
Figure 6. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out	17

Tables

Table 1. Characteristic forest types in the three large national parks of the North Cascades National Park	2
Table 2. Hierarchical set of vegetation monitoring projects with data available to North Cascades National Park	11
Table 3. Panel design for monitoring forest vegetation in North Cascades National Park ...	11
Table 4. Data collection schedule within panel	14
Table 5. Potential occurrence of herbivores that are known to browse the sampled vegetation	16
Table 6. Yearly Project Task List	18
Table 7. Functional comparison of the master project database and the working database	21
Table 8. Roles and responsibilities for Forest Vegetation Monitoring in the North Cascades National Park	26
Table 9. Forest monitoring protocol projected budget	28
Table 10. Potential ways to reduce the effort of the forest monitoring protocol	29

Conversion Factors

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)
Area		
square meter (m ²)	10.76	square foot (ft ²)
hectare (ha)	2.471	acre
square kilometer (km ²)	0.3861	square mile (mi ²)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32.$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C}=(^{\circ}\text{F}-32)/1.8.$$

This page left intentionally blank

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

By Andrea Woodward¹, Karen M. Hutten¹, John R. Boetsch², Steven A. Acker², Regina M. Rochefort³, Mignonne M. Bivin³, and Laurie L. Kurth⁴

Narrative

Version 1.0

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Acknowledgments

The authors would like to acknowledge the hard work performed by many field crews involved in collecting data to support the creation of this protocol. This includes the crews that worked on the pilot study in Olympic National Park, the crew that collected the first plot data, and the crews that made the heroic effort to locate and evaluate the potential plots. Members of the North Coast and Cascades Network (NCCN) Vegetation working group were instrumental in developing this protocol: Mignonne Bivin, Karen Kopper, and Catharine Thompson. Katherine Bierne and Roger Hoffman provided all of our GIS needs from drawing the GRTS sample to preparing maps. Paul Geissler helped us with the challenges of developing an effective sample frame. We also would like to thank the many people who provided consultation on various parts of the protocol: Linda Geiser and Sarah Jovan for epiphytic lichens; Andy Gray for FIA data and answers to miscellaneous questions regarding the FIA and FHM protocols; Bruce McCune for lichen monitoring information; Carl Roland for the Denali vegetation protocol; Vicente Monleon for coarse woody debris advice; and Patti Happe and Kurt Jenkins for advice on monitoring herbivory. Finally, we would like to thank Richard Condit, Paul Geissler, Andy Gray, David L. Peterson, Carl Roland, and Nathan Stephenson for their helpful reviews.

1. Background and Objectives

A. Background and History

Plant communities are the foundation for terrestrial trophic webs and animal habitat, and their structure and species composition are an integrated result of biological and physical drivers (Gates, 1993). Additionally, they have a major role in geologic, geomorphologic and soil development processes (Jenny, 1941; Stevens and Walker, 1970). Throughout most of the Pacific Northwest, environmental conditions support coniferous forests as the dominant vegetation type. In the face of anthropogenic climate change, forests have a global role as potential sinks for atmospheric carbon (Goodale and others, 2002). Consequently, knowledge of the status of forests in the three large parks of the NCCN [that is, Mount Rainier (MORA), North Cascades (NOCA), and Olympic (OLYM) National Parks] is fundamental to understanding the condition of Pacific Northwest ecosystems.

Diverse climate and soil properties across the Pacific Northwest result in a variety of forest types (Franklin and Dyrness, 1973; Franklin and others, 1988; Henderson and others, 1989, 1992). The mountainous terrain of Mount Rainier, North Cascades, and Olympic National Parks create steep elevational and precipitation gradients within and among

¹ U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Olympic Field Station, 600 E. Park Ave., Port Angeles, WA 98362.

² Olympic National Park, 600 E. Park Ave., Port Angeles, WA 98362.

³ North Cascades National Park Complex, 810 State Route 20, Sedro Woolley, WA 98284.

⁴ U.S. Forest Service, Rocky Mountain Research Station, 5575 W. U.S. Highway 10, Missoula, MT 59808..

2 Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

the parks: collectively, these parks span from sea level to more than 4,200 m; and include areas with precipitation from 90 to more than 500 cm. The resulting forests range from coastal rainforests with dense understories and massive trees draped with epiphytes; to areas with drought-adapted Ponderosa pines; to high-elevation subalpine fir forests interspersed with meadows just below treeline (table 1). These forests, in turn, are the foundation for other biotic communities constituting Pacific Northwest ecosystems.

Wood products have long been central to the region's economy, resulting in at least a five-fold decrease in the late successional and old-growth forests in the range of the northern spotted owl (northern California to southern British Columbia) from early historic times (Forest Ecosystem Management Assessment Team, 1993). Much of what is left is located at mid- and high elevations and in national parks and other protected areas such as U.S. Department of Agriculture (USDA) Forest Service wilderness areas (Lehmkuhl and Ruggiero, 1991). The effects of diminishing late successional and old-growth forest on endangered species, recreational opportunities, and aesthetic values have led to greater legal challenges to Federal land management policies (Thomas, 1997). Monitoring to understand changes in unmanipulated forests in national parks will help Federal managers of harvested lands to practice sustainable management of those lands in the face of increasing environmental threats. Specifically, better understanding of how natural systems are responding to climate change will help these managers to set realistic management targets.

In order to determine whether present forest management practices are sustainable, the USDA Forest Service conducts the Forest Inventory and Analysis (FIA) monitoring program, which is a continuous forest census on Federal and private lands, with the record for national parks beginning in 2002. The FIA sample frame is a grid having 5 km spacing between plots, and a rotating panel design in which one-tenth of the plots are sampled each year. The goal is to project how

forests are likely to appear in 10 to 50 years to evaluate whether current management practices are sustainable (<http://fia.fs.fed.us>). Although the program was traditionally focused on trees, more comprehensive data (for example, lichen survey, understory data) are now being collected on every twelfth plot according to the Forest Health Monitoring protocol (FHM or Phase 3 plots). As explained below, the FIA program alone does not meet the needs of national parks for interpretability of environmental effects, comprehensive information, or timely trend detection. However, it is important that national park monitoring methods produce data that are compatible with those of the FIA program so that data collected in both programs contribute to greater understanding and context for the other.

Several global and regional stressors (for example, anthropogenic climate change, atmospheric and precipitation chemistry, introduced pests, pathogens, invasive species and forest harvest) threaten forest structure, species composition and abundance, thereby threatening the quality and quantity of habitat for terrestrial birds and wildlife. We expect that climate change and air quality, in particular, are the greatest threats to national parks in the Pacific Northwest (Freilich and others, 2005). Changes in forest structure and composition also will alter the chemistry of water moving from terrestrial to aquatic systems (Edmonds and others, 1998; McClain and others, 1998). Consequently, forest monitoring is a fundamental part of the overall monitoring plan for the parks of NCCN.

Potential changes in vegetation due to anthropogenic threats include migration of species ranges within and outside parks, loss of suitable habitat, and competitive exclusion by invasive exotic species. Developing management responses to these changes will require the National Park Service to take a more active role (for example, moving seeds) in managing resources than current policy describes. The purpose of monitoring vegetation change is to provide early warning of the types and severity of future changes so that management options can be developed and evaluated in time to be effective.

Table 1. Characteristic forest types in the three large national parks of the North Coast and Cascades Network.

[The dominant species within each elevation zone is a consequence of the precipitation gradient in each park]

Elevation zone, approximate	Forest types by national park		
	Mount Rainier (200–300 cm precipitation)	North Cascades (100–500 cm precipitation)	Olympic (75–500 cm precipitation)
Low (0–300 m)	Western hemlock	Western hemlock	Sitka spruce
Mid (300–1,000 m)	Western hemlock	Western hemlock or Ponderosa pine	Western hemlock or Douglas-fir
Lower Montane (1,000–1,500 m)	Pacific silver fir	Pacific silver fir or Lodgepole pine	Pacific silver fir
Upper Montane (> 1,500 m)	Mountain hemlock or Subalpine fir	Mountain hemlock or Subalpine fir	Mountain hemlock or Subalpine fir

Monitoring of forests is only one aspect of vegetation monitoring included in the NCCN monitoring program (Weber and others, 2005). Other protocols include using satellite-based imagery to detect the size and frequency of disturbance events, the distribution of conifer versus deciduous tree species, and changes in treeline position. Special interest communities targeted for monitoring include subalpine meadows, prairie/coastal vegetation, and whitebark pine stands.

B. Rationale for Selecting Forest Communities to Monitor

Forest structure and composition are physical manifestations of cumulative biological and physical processes that are difficult to measure directly. Changes in forest composition will occur when driving factors such as climate change reduce suitability for particular plant species and enhance suitability for others (Davis, 1981; Barnosky, 1984). Changes in forest structure and composition consequently affect a wide range of resource properties and processes such as habitat quality, biodiversity, the hydrologic cycle, and carbon storage (Pastor and Post, 1986, 1988).

Forest structure can be described at a variety of spatial scales. At the landscape scale, distribution of overstory species reflects topographic gradients of elevation and aspect, and their effect on temperature and precipitation (Stohlgren and others, 2000). Shifts in tree species distribution at large spatial- and slow temporal scales will be driven by global climate change (Davis, 1989; Stohlgren and others, 2000) and tree communities have a lagged response to environmental change (Pacala and Hurtt, 1993) in the absence of stand-replacing disturbance. The capacity of trees to tolerate significant ecological changes is evidenced by life spans measured in centuries. Forests of the Pacific Northwest are dominated by relatively few species, making detection of changes in species composition additionally difficult. However, tree recruitment, growth, and mortality are sensitive indicators of ecological change (Perry, 1992), which can only be documented and understood through detailed, long-term observations (Franklin, 1989). Increases in tree mortality have recently been reported for western North America (van Mantgem and Stephenson, 2007, and van Mantgem and others, 2009). It also is possible that the size and frequency of catastrophic events will increase and dramatically change the landscape. In either event, we will be positioned to detect them, either with this protocol or with a satellite-based landscape change protocol.

In contrast, it is possible that the relatively species-rich understory layer, in which plants and plant parts turn over more rapidly than trees, to have higher ecological sensitivity than the tree layer (Davis, 1989; Graham and others, 1990). This may be especially true of species with restricted distributions (Stohlgren and others, 2000). Consequently, we may see relatively rapid changes in understory vegetation. Therefore, we will establish permanent forest plots for monitoring forest structure, composition, and selected processes to detect biologically significant changes that are too subtle to monitor remotely and are not adequately collected by FIA and FHM monitoring programs at the scale of individual national parks.

Our general approach is to focus on coniferous forest zones that represent the range of climatic and elevational regimes in the large Pacific Northwest national parks ([table 1](#)). We will be sampling relatively warm and wet conditions in the Sitka spruce zone, cold and dry conditions in the subalpine fir zone, plus the mid-elevation western hemlock zone, which is represented in all three parks. Limited resources and the need for sample replication require that we further focus on particular plant associations within forest zones. Details of the sample frame we use to achieve replication without stratifying our sample on criteria we expect to change are given below. The specific plant associations we have chosen in the context of everything that is available are shown in [Appendix E: Conifer Forest and Woodland Plant Associations of Mount Rainier, North Cascades, and Olympic National Parks](#).

C. Measurable Objectives

Our objectives are to monitor trend in forest structure, composition, and the processes of tree mortality, tree recruitment, and herbivory. Because we are interested in direct responses to ecological change, we want to minimize the effects of succession by focusing on mature forests, which have not experienced recent stand-replacing disturbance. However, we recognize that changes in disturbance patterns are an important component of forest change and we will monitor those changes under a separate protocol using remotely sensed images. We also will measure a select number of environmental parameters in the permanent plots to help with interpretation. Finally, the plots will provide the opportunity for periodic targeted investigations (for example, tree growth) that will not be funded as part of the monitoring program, but that we recognize will be important to study.

4 Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Specifically, we will monitor the following parameters:

Structure and Composition

- Vascular understory plants – we will monitor changes in cover, frequency, and species composition of understory vascular plant communities as indicators of the biological response to environmental change.
- Non-vascular plants – We will monitor changes in cover of non-vascular cryptogams inhabiting soil and coarse woody debris because the relative structural simplicity of non-vascular plants may make them sensitive to ecological change (Hawksworth and Hill, 1984; McCune and Lesica, 1992; Hallingback and Hadgetts, 1999), perhaps more so than vascular plants.
- Epiphytic lichens – We will detect changes in species lists and abundance categories. These data can be entered into a mathematical model which calculates multi-variate indices of climate and air pollution developed for the Pacific Northwest (Geisser and Neitlich, 2007). We will use the indices to examine potential trends in air pollution or climatic shifts over time.
- Trees – We will monitor dimensions, canopy cover, indicators of health, and indicators of wildlife habitat by species to detect changes in the structural framework of forests upon which the other inhabitants depend. Wildlife habitat indicators will link this protocol with wildlife monitoring protocols.
- Snags, large woody debris and forest litter – We will monitor changes in density and size as indicators of forest structure and carbon cycling.

Processes

- Tree recruitment – We will monitor cover of seedlings and dimensions of saplings to track changes in establishment success and species composition as indicators of changing forest structure.
- Tree mortality – We will monitor numbers of deaths per time interval by species to detect changes in rate and cause (if possible) as indicators of changing forest structure and composition.
- Herbivory – We will collect data to create an index of relative ungulate browsing pressure on selected palatable species to help interpret vegetation changes and to link this protocol with the elk monitoring protocol.

Environment (some of these are static and need to be measured only once)

- Landscape position of plot including slope, aspect, terrain position.
- Soil properties (descriptive attributes such as texture and soil series).
- Physical characteristics (for example, gap formation, water distribution on plot).

These parameters will be monitored in a network of permanent plots designed to intensively sample forest types selected to represent regional environmental extremes and a common type across the three large parks. Specifically, we will be limited by budget constraints to three forest types representing warm-wet (west side of Olympic National Park) and cold-dry environments (high elevations in Mount Rainier and North Cascades National Parks), and a vegetation community common to all three parks (mid-elevation type in all three parks) by budget constraints.

2. Sampling Design

A. Rationale for Selecting This Sampling Design Over Others

Basic Principles

It was necessary to reconcile several basic, sometimes contradictory, principles and assumptions in developing our sample frame:

- We wanted to monitor shifts in understory community structure and composition caused by long-term ecological change with this protocol rather than succession or stand replacing disturbance.
- Our sample needed to have replicates of communities defined by understory vegetation because our ability to detect change in community composition is dependent on replicate observations of individual species.
- Interpretation of changes depends on understanding species-environment relations that are best known in the context of communities.
- Understory vegetation shows high levels of interannual variability due to annual weather patterns distinct from long-term trends (Lindh and Muir, 2004).

- Communities will change, and therefore should not be the basis for sample stratification. Rather, we should stratify on static landscape characteristics such as elevation.
- An inferential statistical design is necessary.
- We must consider crew safety and accessibility of plots because we are sampling large wilderness parks with hazards including steep terrain and dangerous rivers among others.

Evaluation of FIA Sample Frame

We evaluated the sample frame and methods for FIA/FHM plots as to their usefulness given these principles and assumptions. FIA data usually are summarized by State with one number for each parameter (for example, forested acres, harvested acres, acres by ownership), and the data could easily be summarized by park. However, statistics for an entire park may not be particularly informative because they may conceal opposing trends within a park (for example, a positive change in a parameter in a drier area of a park versus a negative change in wetter areas). Instead, detecting trends in biologic data within parks requires partitioning temporal change from change along environmental gradients. Grouping individual plot data by vegetation community is one reasonable approach. However, the systematic grid sample used by FIA does not evenly sample all communities—common types have a greater chance of being included than rarer ones. Consequently, only common types are likely to have sufficient replication to produce statistical power for detecting trends.

To test this assumption, we conducted a power analysis of data from two common communities using data from the first 2 years that the FIA program included national parks. We found that the communities labeled TSHE and PSME by FIA are the only ones with at least two plots in each year of data collection across all three large parks. Only one other type had at least one plot in each panel across the parks (ABLA). The FIA community definitions are broader than ours and encompass more variability in species composition. Nevertheless, power analysis of these data showed at least 80 percent power at $\alpha=0.10$ to detect a positive or negative 4 percent annual change over 20 years for cover estimates of most species and tree basal area (TerraStat Consulting Group, 2006). Twenty years is the time required to revisit every plot according to the FIA sample frame.) Seedling counts also achieved this power for TSHE communities but required 30 years of data for PSME communities. Mortality estimates had at least 76 percent power after 30 years (the plots have

to be visited at least three times to estimate a change in mortality). These results are very encouraging and suggest that other communities that are not sampled every year also may have higher power than anticipated.

Although FIA data will have the power to detect trends in some vegetation communities aggregated across the network, there is not enough community replication to meet the needs of individual NCCN parks. In addition to insufficient replication, the data do not describe non-vascular plants or any species with less than 3 percent cover. This reduces the information available for rare species, encroaching exotics, and species with particular sensitivity to climate change and air quality. Although these needs are better met by FHM plots (the intensively monitored subset of FIA plots), there will be only one FHM plot measured per year on average in Olympic National Park and less in the other two parks. Network staff will make the best possible use of FIA and FHM data but see the need for more intensive plot-level monitoring.

NCCN Sample Frame

We expect changes in tree species distributions to be facilitated by catastrophic events (which we will be monitoring in the satellite-based remote sensing protocol). While in the shorter term, we may think of the tree component of forests as the relatively stable context for the changes that may occur more rapidly in the understory, mortality of trees occurs throughout the life of any forest stand (Franklin and others, 1987, 2002). In early stages, tree mortality results more from competition with other trees than from external factors (Franklin and others, 1987, 2002; Oliver and Larson, 1990). Consequently, we want to work in mature forests that are not undergoing rapid successional changes and where the primary drivers of forest structure are external to the stand. When some permanent plots inevitably experience stand-replacing disturbance, we will substitute new plots. We define ‘stand-replacing’ as an event that leaves less than 25 percent tree cover on the plot.

We have several options for taking a random sample of our target populations. Simple random samples have desirable statistical properties, but usually have an unsatisfactory clumped distribution. Systematic samples are spatially dispersed, but may have the same frequency as natural patterns on the ground. A third option is a Generalized Random Tessellation Stratified sample (GRTS) (Stevens, 1997). GRTS samples have the advantage of being spatially dispersed but without a repeating interval. Unlike systematic samples, they have an excellent variance estimator and they allow for excluding sites when some selected sites cannot be sampled or are not within the population of interest.

6 Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Our fixed strata in each park will be 300 m-wide elevation bands, of which we can only afford to sample two in each park at present (2008). We will randomly sample the selected strata using GRTS to get a spatially balanced sample. Within the random sample for each stratum, we will intensively sample mature or old-growth examples of a specific vegetation community to have a biologically interpretable sample. In addition to stand age and vegetation community, we also will include criteria for safe accessibility and financial feasibility. We will be using two-stage sampling for stratification (Thompson, 2002). The stage 1 GRTS sample for a stratum is evaluated using GIS and becomes the population for the stage 2 sample that further stratifies the population into mature or old-growth examples of a specific vegetation community and other vegetation types. The second stage is evaluated by field reconnaissance. The Forest Service's FIA survey uses a similar approach, where the stage 1 sample is stratified into forest and not forest using remote sensing and the stage 2 sample is observed on the ground. Therefore, our target populations and range of inference for intensive sampling will be two examples of a specific vegetation community within a specific elevation bands within each park (see #1 below). For example, our range of inference in the western hemlock forest zone will be plant associations with Oregon grape or salal in the understory, between 600 and 900 m elevation, in stands greater than 80 years old, within 1.5 km of roads or trails, on less than 35° slope and not requiring dangerous river crossings to access. (A few additional criteria can be found in [SOP 9: Reconnaissance Form](#).)

We recognize that we will not be sampling the entire elevation range of each vegetation community, all vegetation within an elevation band, nor all of any community within an elevation band. **Nevertheless, we will have a biologically interpretable sample within fixed strata that will be robust to future shifts in vegetation pattern.** This sample can be easily expanded to other elevation bands, other vegetation communities, or even newly formed vegetation communities in the future without compromising the statistical integrity of our sample.

The specific vegetation communities we have selected exemplify the extremes and the middle of the environmental gradient for forests in our network. In addition, the community in the middle of the gradient is present in all parks and common elsewhere allowing for comparison across parks and producing information that is relevant to the region as a whole.

1. Warm and wet—Sitka spruce from 0 to 300 m in Olympic National Park. These forests also are important winter feeding grounds for Roosevelt Elk and are mentioned prominently in the Park's enabling legislation. We chose a plant association with an oxalis understory because it is common in inland Sitka spruce forests.

2. Cold and dry – Subalpine fir from 1,500 to 1,800 m in North Cascades and Mount Rainier National Parks. High elevation ecosystems are expected to be sensitive to climate change (Giorgi and others, 1997; Mote and others, 2003) and we will have two examples for comparison.
3. Common among parks – Western hemlock with salal and/or Oregon grape understory from 600 to 900 m in Olympic, North Cascades, and Mount Rainier National Parks. This elevation band appears to occur near the center of the elevational distribution of western hemlock forests in these parks according to GIS analysis of vegetation maps. These plant associations are common in the region and are present in all three parks. Results from these forests will provide benchmark information for many of the managed forests in the region.

A complete list of coniferous plant communities occurring in the three large NCCN parks as described by the Washington National Heritage Association are shown in [Appendix E: Conifer Forest and Woodland Plant Associations of Mount Rainier, North Cascade, and Olympic National Parks](#). The associations sampled in this protocol are indicated.

B. Site Selection

To avoid subjectivity in plot selection, we use the quantitative key to vegetation communities developed by the Washington Natural Heritage Program for determining the community at each point (Chappell, 2005). To avoid being arbitrary, we used the published definition of 80 years to be the stand age when Pacific Northwest forests can be considered mature (Franklin and others, 2002). Using this definition, we will only sample plots where the main cohort is at least 80 years old. However, our experience indicates that 80 years is very young for forests to develop mature characteristics in our area. We cored plots that were questionable and know that our final sample consists largely of plots older than 120 years.

In addition to selecting plot sites based on vegetation community and stand age for interpretability, we also have criteria for crew safety and sampling feasibility. First, we limit our sample to accessible regions of the parks by excluding areas more than 1.5 km away from roads and trails. We exclude plots in areas having greater than 35° slope for safety reasons and because significant damage to soils and understory vegetation occurs when crews work on steep slopes. We also take dangerous river crossings and other hazards into account when we determine accessible areas. We exclude points closer than 100 m to roads and trails to minimize vandalism and visual impacts to park visitors (see [SOP 9: Reconnaissance Form](#)).

Stage 1 sample points within the chosen elevation bands and meeting the above criteria are randomly selected using the variable density grid-based sampling method GRTS (Stevens, 1997). GRTS produces a spatially balanced design if points are used in the order they are chosen by GRTS. Because we lack a map of vegetation at the plant community scale, we need to visit each point and apply the classification key to stratify the stage 1 sample into mature or old-growth examples of a specific vegetation class and other vegetation types (stage 2 population). A 100 percent sample of the first stratum will be observed, but we will establish permanent plots at points having the target vegetation community. The stage 1 sample will be re-evaluated every cycle (7 years) with revisits to plots that may have matured enough to be sampled. Stage 2 plots that no longer meet the definition

(for example, fire) will be removed and another plot will be selected from the original GRTS sample using the above procedure. In addition to identifying locations for permanent plots, this reconnaissance step also provides an estimate of the relative distribution of plant associations within each 300-m elevation band sampled. This information will be valuable in the future, perhaps decades hence, when the points can be revisited and re-evaluated (fig. 1). The process of site selection is nearly complete for all three parks (figs. 2, 3, 4) with the exception of the 1,500–1,800 m elevation band at NOCA. In addition to identifying plots to initially fill our panels, we also will identify nine extra plots per vegetation type and park combination so we will have a pool of replacement plots should any plots experience stand-replacing events (that is, events leaving < 25 percent canopy cover).

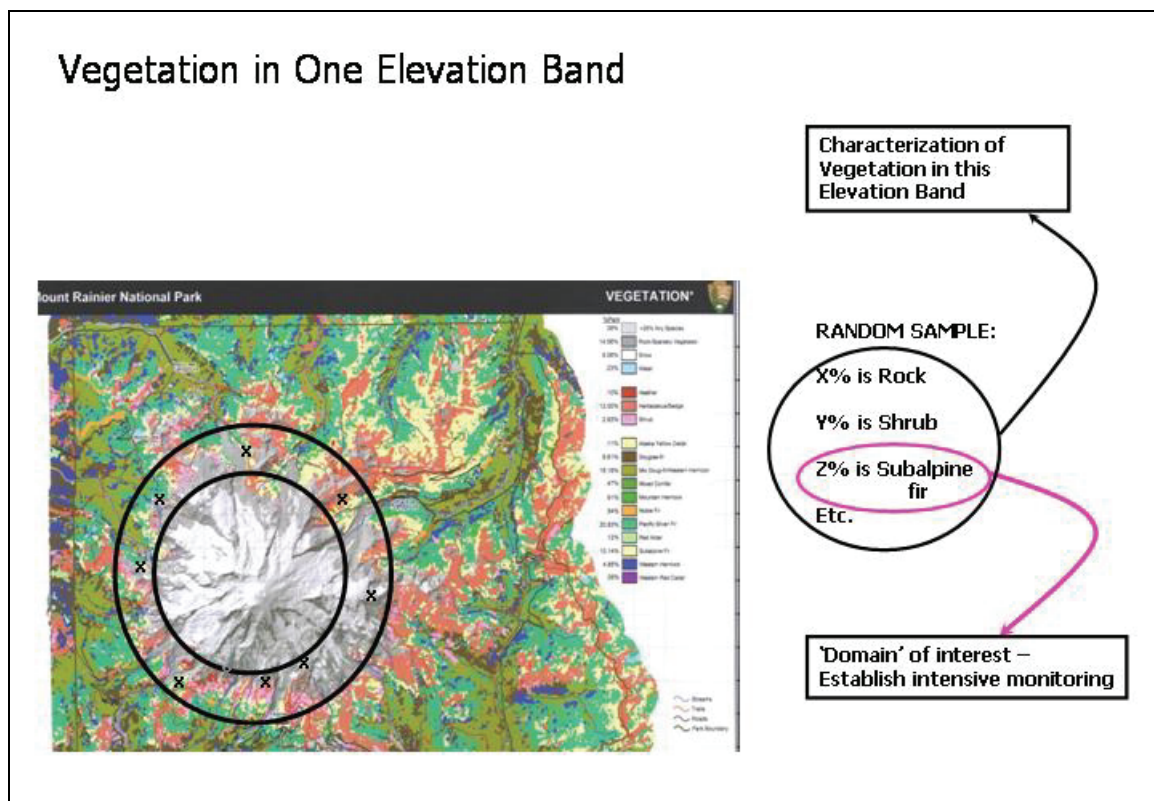
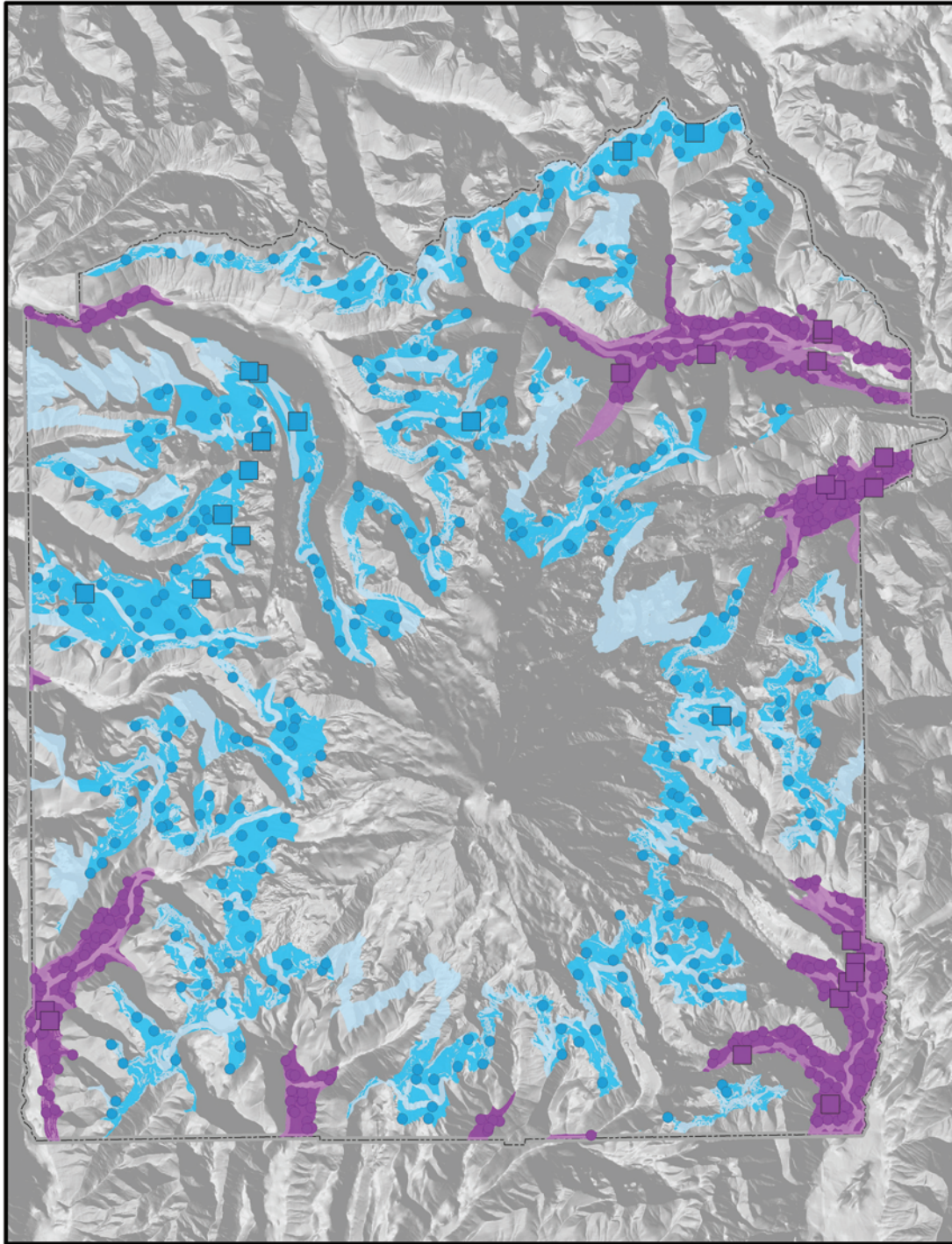


Figure 1. Example of selecting locations for permanent plots after visiting all points in the GRTS sample for a hypothetical 300 m elevation band. In addition to identifying sites for permanent plots, the process also provides a characterization of the elevation band that can be compared with results from a future revisit of the points.



MORA Forest Monitoring Strata and Selected Plot locations









	1500-1800m Elevation		1500-1800m Strata		1500-1800m Recons		1500-1800m Plots
	600-900m Elevation		600-900m Strata		600-900m Recons		600-900m Plots

Figure 2. Locations of permanent plots in Mount Rainier National Park by elevation band identified to date. The complete sample will include 18 plots in each elevation band.

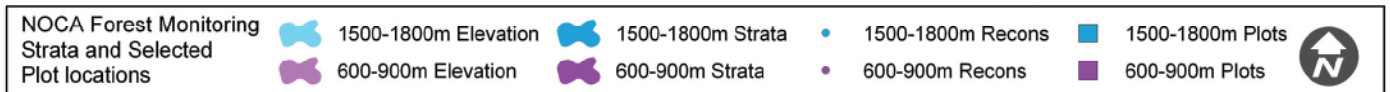
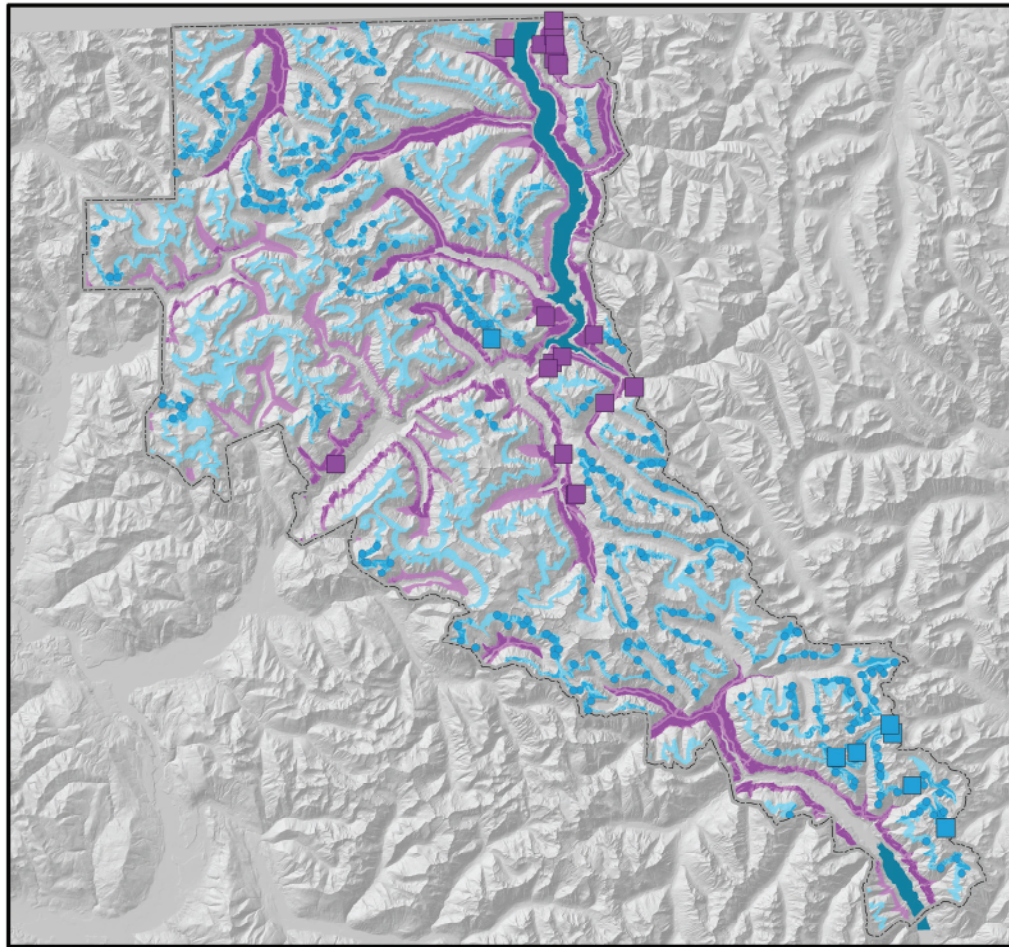


Figure 3. Locations of permanent plots in North Cascades National Park by elevation band identified to date. The complete sample will include 18 plots in each elevation band.

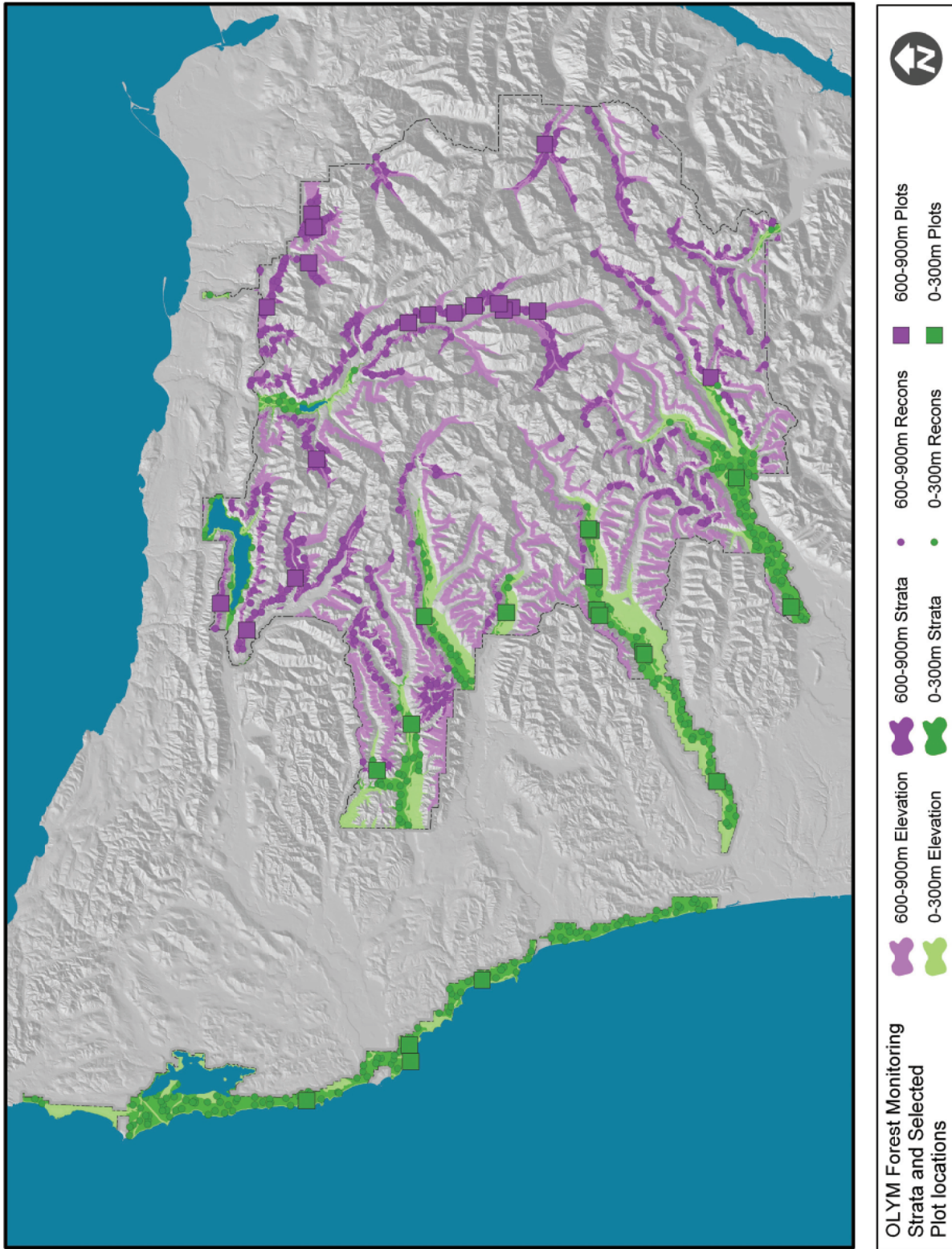


Figure 4. Locations of permanent plots in Olympic National Park by elevation band identified to date. The complete sample will include 18 plots in each elevation band.

These intensive monitoring plots fit in a larger hierarchical context of forest vegetation monitoring (table 2).

This protocol also is linked to other NCCN monitoring protocols. Sitka spruce forests provide summer and winter habitat for elk. Elk will possibly be monitored by the NCCN monitoring program; if not, they are at least periodically monitored by Mount Rainier and Olympic National Parks. By monitoring herbivory specifically and forest structure in general, these two protocols will link elk numbers with elk effects on forest structure. Likewise, change in forest structure will inform monitoring of landbirds by describing changes in breeding and feeding habitat. Finally, the climate protocol will describe changes in what we expect to be the strongest driver of forest change.

C. Sampling Frequency and Replication

Choosing a temporal sample frame for monitoring involves a trade-off between describing status and detecting trend (Urquhart and others, 1998; McDonald, 2003). Status is best described by visiting as many sites as possible in a given time, while trend is best detected by visiting the same plots repeatedly. Our emphasis is on detecting trends; however, we also want to have a sample large enough to represent each vegetation community. We also must minimize consecutive annual visits to any one plot to avoid trampling damage (Cole and Monz, 2002). We balanced these considerations with a panel design involving six panels of three plots where each panel is visited for 2 consecutive years and rested for 4 years (table 3). Each panel is delayed by 1 year from the previous panel.

Table 2. Hierarchical set of vegetation monitoring projects with data available to the North Coast and Cascades Network.

Protocol	Spatial extent	Frequency	Data intensity
Remote sensing	<ul style="list-style-type: none"> Entire park (all 3) Complete sample 	Annual	<ul style="list-style-type: none"> Conifer/deciduous distribution Disturbance regime Treeline movement
FIA	<ul style="list-style-type: none"> Entire park (all 3) 5 × 5 km grid 	10 yr panel repeat	<ul style="list-style-type: none"> Structure, composition of canopy, coarse understory description, few replicated communities
Vegetation class analysis using FIA data	<ul style="list-style-type: none"> One or two vegetation communities across NCCN 	10 yr panel repeat	<ul style="list-style-type: none"> Structure, composition of canopy, coarse understory description
Reconnaissance	<ul style="list-style-type: none"> 300 m elevation bands GRTS sample 	Decades	<ul style="list-style-type: none"> Vegetation classification
Permanent plots	<ul style="list-style-type: none"> Vegetation community within elevation band GRTS sample 	6 yr panel repeat	<ul style="list-style-type: none"> Detailed structure and composition of canopy and understory, processes

Table 3. Panel design for monitoring forest vegetation in the North Coast and Cascades Network.

[Each X represents three plots. The design will be repeated for each park/elevation band/vegetation community combination]

Panel	Year																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	X	X					X	X					X	X					X
2		X	X					X	X					X	X				
3			X	X					X	X					X	X			
4				X	X					X	X					X	X		
5					X	X					X	X					X	X	
6						X	X					X	X					X	X

This design will be repeated for each combination of park, elevation band, and vegetation community. Each X stands for 3 plots, meaning that there would be 18 plots total per combination. In this design, *change* (the difference between two points in time) can be detected in 13 years (after all plots have been visited twice) and *trend* (a sustained directional change) in 19 years (after all plots have been visited three times).

Having the panels overlap in time (that is, panel 1 in years 1 and 2, 7 and 8; panel 2 in years 2 and 3, 8 and 9, etc.; see [table 3](#)) creates a ‘connected’ design, which gives us three advantages over an unconnected design (that is, plots are measured once per panel repeat) (Urquhart and others, 1998). First, we will eventually be able to develop weather variables as covariates, to explain some of the annual variation in vegetation cover. This is possible because data in a connected design are available to directly compare any 2 consecutive years, or indirectly compare any non-consecutive years. Second, the points eventually distributed along the regression line describing trend will be in pairs representing each sampling period. Differences between consecutive years will express variation due to high-frequency events (for example, annual weather), with little expression of long-term trend; single points distributed along a line would reflect both trend and annual variation. A more accurate description of each sample period based on 2 years of data will likely increase our power to detect trend while minimizing the noise of interannual variation. Finally, a connected design will enable us to describe the trajectory (for example, linear, exponential, stepped) of change as well as overall trend. These advantages will be important for understory measurements, but not for slowly changing tree measurements, therefore, only the understory measurements will be taken in both of the 2 consecutive years. Tree dimensions will be measured in only one of each pair of years at each plot ([table 4](#)).

Table 4. Data collection schedule within panel.

Data collected	1st year	2nd year
Tree data	X	
Tree mortality data (not collected 1st year of 1st cycle)	X	X
Check witness trees	X	X
Vegetation quadrats	X	X
Saplings	X	X
Herbivory	X	X
Down woody material	X	
Duff and litter	X	
Epiphytic lichens	X	X

D. Recommended Number and Location of Sampling Units

Our permanent plots are slope-corrected 1-hectare squares with edges oriented along cardinal directions ([fig. 5](#)). This total area is consistent with FIA and other permanent monitoring plots in the Pacific Northwest (Acker and others, 1998). This size is adequate to sample enough large trees for a statistically adequate estimate of mortality (Gray, 2003). We permanently mark the corners and center of the plot with rebar. Circular plots have been recommended because they have less edge per unit area than rectangles (Elzinga and others, 1998) and they require only one permanent monument for relocation. Oblong rectangular plots have been recommended over squares because they increase the within-plot variation, thereby decreasing between plot variation (Elzinga and others, 1998). Nevertheless, we concluded that these advantages were over-ridden by the relative ease of laying out a square plot by following a compass sighting in areas with potentially dense vegetation, topographic obstructions and large downed woody debris, which can make it impossible to see the center of the plot from other parts. Other situations we wished to avoid were laying out a slope-corrected circular plot and the need to run tapes from the plot center to locate the plot boundary. Finally, having more than one permanently marked point will enable us to map trees from several vantage points in forests where we are unlikely to see all trees from the center of the plot.

Sample units are a hierarchy of subplots for different measurements recognizing the efficiency of scaling plot size and number to the vegetation stratum they are meant to describe (Greig-Smith, 1983; Elzinga and others, 1998). We centrally locate a 50-m intensive plot divided into 25 10-m subplots within the 1-ha macroplot ([fig. 5](#); lengths represent one side of a square plot or subplot). We then nest 5-m, 1-m, and 0.5-m (50 cm) quadrats within 20 of the 10-m sections. The center and corner sections (shown in gray in [fig. 5](#)) will not be measured because they are expected to experience the most trampling. The 1-m subplots are inset 1 m in each direction from the northwest corner of each 5-m subplot to minimize the risk from trampling. The outer corners of the 50-m intensive plot are marked with rebar and the corners of the 10-m subplots are marked with cedar stakes. The cedar stakes help minimize the visual impact of permanent markings in wilderness areas and can be replaced as they decay.

E. Level of Change That Can Be Detected for the Amount/Type of Sampling Being Instituted

A pilot study to provide data for power analyses was conducted in Olympic National Park from 1998 to 2000. Six permanent plots of 50 × 70 m were monitored using twenty-

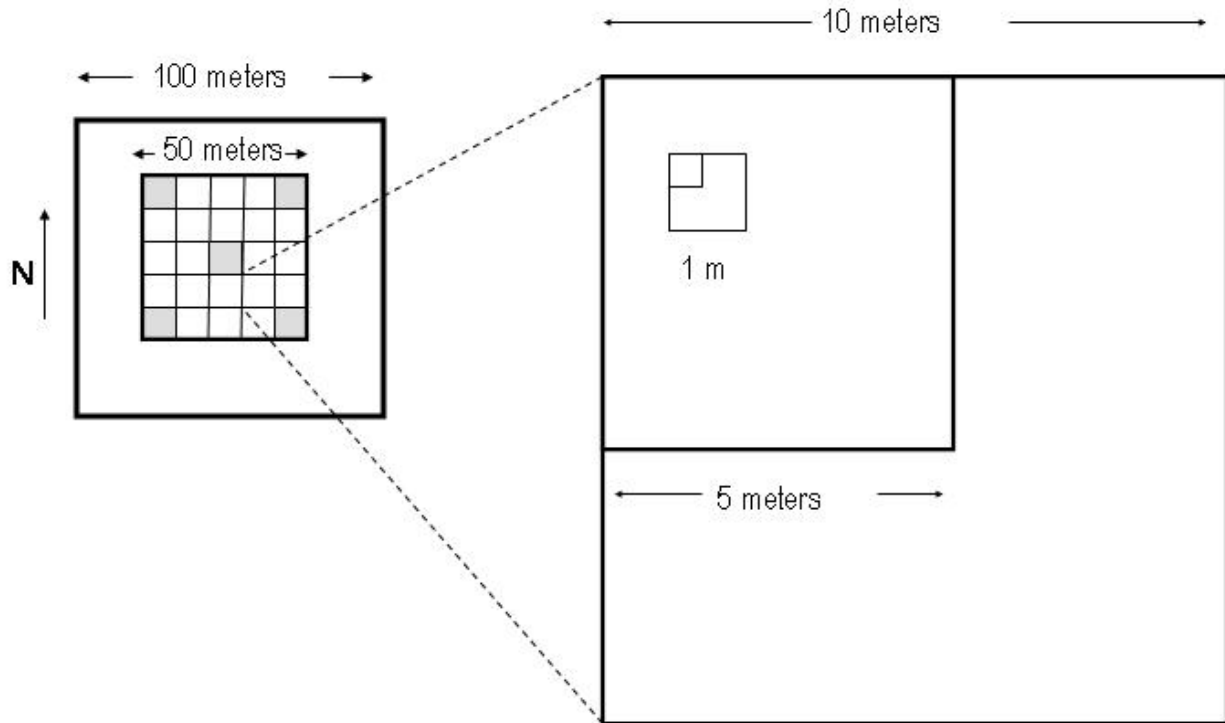


Figure 5. One-ha macroplot showing location of 50-m intensive plot divided into 10-m subplots. All plots are oriented along cardinal directions. One m quadrats are inset 1 m in each direction from the northwest corner of each 10-m subplot to protect the vegetation from high levels of traffic expected on grid lines.

four 1×1 m quadrats for cover of low stature vegetation (< 0.3 m height) and twenty 5×5 m quadrats for cover of shrubs and ferns. We also collected tree allometry and cover data, and described non-vascular cryptogams growing on the ground, and on tree boles and large woody debris. Three plots were established each in the Douglas-fir zone and the Sitka Spruce zone to represent relatively extreme positions along the precipitation gradient characteristic of Olympic National Park. Variation in observations due to observers and annual differences in phenology are inherent in this analysis, though not individually quantified.

We obtained power analyses for cover of species in 1-m and 5-m quadrat sizes, and for abundance of cryptogams on logs and tree boles from point intercept transects. We analyzed the data by simulating a simple temporal sample plan where plots are measured for 3 consecutive years, rested for 7, and then repeat this sequence for each vegetation community (TerraStat Consulting Group, 2002). We also investigated a panel design having five panels of plots sampled for 2 years, rested for 3 years and repeated, where each panel starts 1 year after the previous panel (TerraStat Consulting Group, 2005). Our goal was to detect a positive or negative 4 percent annual exponential trend with 80 percent power and $\alpha=0.10$ after 10 years for the major species that define the vegetation community. The trend is equivalent to an approximately

50 percent change over 10 years. Achieving this result requires a total of 20 plots per vegetation type (4 per panel) having twenty 1-m quadrats and twenty 5-m quadrats.

After wrestling with budget constraints, we selected a design that differs from the design we used for power analysis. Specifically, we rest plots for 4 years instead of 3 years and add one panel. Compared with the design used for power analysis, this design reduces the annual work load and total number of plots, which decreases power and lengthens the time to detect trend; but we have increased the time between successive measurement cycles, which increases power and perhaps reduces damage to plots from repeat visits.

Our highest priority objective of monitoring trends in composition, structure, and forest processes over time will be accomplished using regression analysis where each plot is a replicate of its vegetation community-elevation band combination. We will obtain some results in every year, but our power to detect change will increase greatly after we complete the second cycle through all plots (year 13). After the third cycle (year 19), we will have even higher power to detect trend. Eventually our connected panel design will allow us to determine if weather covariates can explain a significant part of interannual variation. (See [Appendix C: Template for Forest Monitoring Annual Report](#) for example analyses and results.)

3. Field Methods

A. Field Season Preparations and Equipment Setup (Including Permitting and Compliance Procedures)

The first step in the field season is to recruit and hire a well-qualified crew. In addition to having botanical experience, preferably with the flora of the Pacific Northwest, the crew should be very physically fit and comfortable spending extensive time in the backcountry. Every reasonable effort should be made to rehire the previous year's crew members, but it seems more than likely that at least some new hires will be required every year. We recommend beginning the recruiting process in December to ensure that maximally experienced, qualified observers can be found and background checks completed by the beginning of the field season. Once the crew has been hired, they should be sent species lists and other materials that will enable them to be as familiar as possible with the flora prior to training. (See [SOP 2: Hiring Guidelines and Procedures](#) and [SOP 3: Preparation of Information Packets, Schedules, Equipment, and Supplies](#).)

Beginning in February or March, equipment should be inventoried, including testing of breakable items such as GPS units, radios, and water filters, and any needed items should be purchased. Data forms and task lists from the previous year should be copied on rain-proof paper and topographic maps for the year's targeted plots should be printed and assembled. Crew housing must be secured at each of the parks, and housing, campsites, and other logistic arrangements for the training session must be made. It is especially important to coordinate with the trail crew mule packers to arrange for possible caching of food and equipment. NPS personnel knowledgeable about backcountry conditions in each park should be consulted to determine whether conditions such as washed out bridges, road or trail closures, or unusually heavy snowpack may present logistical problems. This may be done in concert with staff planning logistics for other monitoring projects involving backcountry travel. (See [SOP 3: Preparation of Information Packets, Schedules, Equipment, and Supplies](#).)

This monitoring protocol requires evaluation by the parks where it is implemented for compliance with laws, regulations and policies defining appropriate activities within national parks in general, and particularly in wilderness areas. Each park has a slightly different procedure for evaluating compliance, but all parks will evaluate the establishment of permanent vegetation plots regarding wilderness impacts, impacts on the visiting or non-visiting public, and impacts on cultural resources. This process has been completed in advance of protocol initiation for all three parks, and must be repeated if there are significant changes to how the plots are marked and measured. We recommend that compliance always be re-visited at the beginning of each full cycle of panel repeats (years 2013, 2019, etc.)

B. Sequence of Events During Field Season

Note: Refer to [table 6](#) for a schedule of annual tasks.

Field crew training will be conducted for this project each year during the last half of May. Crew members also will be encouraged to participate in parts of the seasonal training programs conducted by NOCA and OLYM for other seasonal staff, which usually occurs during mid-June. Data collection will occur from June through September in usually 4- or 8-day tours, including 1 office day every 8 work days for data management and equipment maintenance. One crew each will be stationed at NOCA and OLYM, and they will both work at MORA. Plots will be grouped into geographic tours and will be visited beginning at low elevations and working up to high elevations. The Project Lead (OLYM) or NPS plant ecologist (NOCA) will be available at the beginning and end of each tour to hear feedback, answer questions, and address concerns.

C. Details of Taking Measurements with Example Field Forms

In general, we adopted the methods of the FIA monitoring program whenever possible. In particular we used FIA size classes for tree categories (for example, sapling, small trees, large trees) and categories of types and amounts of damage, wildlife habitat indicators, etc. Data-collection procedures and example field forms are included in the Standard Operating Procedures and Appendixes.

In order to reduce trampling of plots and to speed plot measurement. We will measure relatively stable variables only once during a panel repeat. However, if something dramatic happens to the plot between the first and second year of the panel repeat, that will be captured on the event log and appropriate data collection will be repeated.

Species Composition and Abundance of Understory Vegetation

Pairs of observers will make ocular estimates of cover in 1 percent increments for ground-dwelling non-vascular cryptogams (50-cm quadrats); vascular species whose normal growth form is less than 50 cm high (1-m quadrats); shrubs, ferns, and species normally greater than 50 cm (5-m quadrats); and non-vascular cryptogam on logs (50 × 20 cm quadrats). We chose ocular estimates over other estimates of abundance (that is, point intercept and line intercept methods) for several reasons. Cover estimates have the advantages of ease, speed, and greater effectiveness for locating and recording rare species (Meese and Tomich, 1992; Dethier and others, 1993). In addition, transect lines are difficult to mark permanently, especially in forests with the potential for dense shrubbery, uneven topography and obstructions such as boulders and large woody debris (Elzinga and others, 1998). We also were concerned about the potential for trampling along transects. Finally, ocular estimates have been shown to be less variable than point intercepts in some cases (Dethier and others, 1993).

The biggest drawback with ocular estimates is variation among observers. This may be more pronounced when estimating in cover classes (Grieg-Smith, 1983; Bonham, 1989). We attempt to minimize observer effects by using quadrat frames gridded into 1-percent increments in the 1-m quadrats as recommended by Sykes and others (1983), using pairs of observers, and estimating cover to 1 percent. Using 1-percent increments potentially lessens the differences between observers when compared to using cover classes where a small difference in their estimates puts their answers into different classes. Data in 1-percent categories can be analyzed using standard statistical analyses for continuous data; these analyses are inappropriate for categorical data. However, we recognize that estimates to 1 percent are most precise when cover is high (95–100 percent) or low (0–5 percent) and that we cannot expect estimates to be precise at 1 percent in any part of the range. We are using estimates to 1 percent solely to reduce the variance among observers.

We address the potential for observer bias (that is, observers consistently under or over-estimating cover) in two ways. First, we use pairs of observers who can challenge each others estimates. We also will test observers on plots with known cover at the beginning and middle of the field season to identify anyone who may be making biased estimates.

We questioned the ability of observers to estimate cover of shrubs and ferns to 1 percent in 5-m quadrats. Using the available personnel, who had botanical experience but minimal training in cover estimation, we compared their results for three plant species in six plots using 1 percent categories versus classes of 0–1, 2–5, 6–15, 16–25, ... 86–95, 96–100 percent. We found that for two of the three species and when data were summarizing across all three species, variation from the plot mean was lower for 1 percent estimates than for class estimates but not significantly ($p > 0.05$; [Appendix A: Cover Estimation Method Comparison](#)). The third species was sword fern, a species with dissected leaves and sometimes widely separated fronds for which we need to revisit our definition of cover. Given these results, we found no reason to reject 1 percent cover estimates. If a different decision is made in the future, we will have the ability to convert historic data to classes.

In addition to estimating cover, we also are making species lists for non-vascular cryptogams in the 1-m subplots, and low-growing vascular plants in the 5-m subplots (one size larger than where cover estimates are made for each). This will give us two plot sizes to estimate frequency for each class of plants, and a better representation of the species richness of each plot. (See [SOP 14: Vegetation Quadrats: Percent Cover and Tree Sapling Measurements](#).)

Epiphytic Lichens

We will use the FHM method for epiphytic lichens. This involves searching a 3,782 m² plot for at least 45 minutes and no more than 2 hours for new species of lichens on tree boles,

intact branches, and fallen branches. Searching stops when no new species have been found for 10 minutes, or after 2 hours. Abundance is not estimated. Epiphytic lichens are sensitive to climate and air pollution, and indices for both have been developed using multivariate analysis of data from 1,549 plots in Oregon and Washington. By adopting these methods, we will be able to calculate the same indices and put each of our plots into a regional context of climate and air pollution. In addition, calculating the indices has been shown to be robust to incomplete collection (Geiser and Neitlich, 2007), a problem that may arise even after seasonal training if our crews have varying lichen experience. (See [SOP 17: Lichen Survey](#).)

Tree Characteristics, Including Wildlife Habitat Indicators

Trees will be monitored in areas commensurate with their size. Seedlings (> 15 cm tall, conifers; > 30 cm, deciduous) will be counted in 1 × 1 m quadrats; saplings (2.5 to 12.6 cm dbh) in twenty 5 × 5 m quadrats, small trees (12.7 to 76.2 cm dbh) and snags in eight 10 × 10 m quadrats within the 50 × 50 m intensive plot; large trees (> 76.2 cm dbh) and snags in the 1-ha macroplot. Definitions for these categories of trees follow FIA.

We will take several dimensional measurements on small and large trees (that is, species, height, diameter at breast height, canopy ratio, canopy class). We also will note the type, severity, and location of damage when present, degree of lean and cause(s) of mortality if appropriate. Wildlife habitat indicators include mistletoe, platforms, and cavities. All measurements, categories, criteria, and methods will be according to FIA so that our measurements will be comparable. Measurement of tree height is time consuming and less informative than other measurements. We will take exact measurements on as many trees as time allows, while requiring that the height of at least one representative of each canopy layer be measured. (See [SOP 13: Tree Data: Measuring and Mapping Live and Standing Dead Trees](#).)

Coarse Woody Debris, Litter, and Duff

We will use the FIA methods for coarse woody debris. The procedure involves measuring the size and noting the decay class of logs intercepted by transects originating from the center of the plot. Smaller pieces are counted in two size classes when they intercept subsets of the log transects. (See [SOP 16: Down Woody Material: Measuring CWD, FWD, Duff, and Litter](#).)

Litter and duff are fire fuels. We will measure the depth of each at eight points in each plot by making small excavations. (See [SOP 16: Down Woody Material: Measuring CWD, FWD, Duff, and Litter](#).)

Herbivory

Herbivory by elk, deer, and mountain goats is an important process in coniferous forests of the Pacific Northwest (Bunnell and others, 1999) and is especially pronounced in Mount Rainier and Olympic National Parks. Changes in browsing strongly affect forest structure (Leslie and others, 1984; Woodward and others, 1994; Schreiner and others, 1996). Any interpretation of observed change in vegetation must take into account a possible relationship with changes in herbivory.

Herbivore species expected to be browsing on the selected vegetation are elk, deer, and goats. Elk are most abundant in the low-elevation band (0–300 m) at Olympic National Park, but also travel into the mid-elevation band (600–900 m). During the summer at Mount Rainier, North Cascades, and Olympic National Parks, elk browse in the high-elevation band (1,500–1,800 m) and occasionally venture into the mid-elevation band. In winter months, elk pass through the mid-elevation band as they migrate to lower elevations. Deer browse in all three elevation bands. Goats browse in the high-elevation band and occasionally venture into the mid-elevation band (Kurt Jenkins and Paii Happe, U.S. Geological Survey oral commun., 2007) (table 5).

We will monitor herbivory for several fern and shrub species chosen because they are ubiquitous, palatable to ungulates, easy to measure, and used historically to indicate herbivory. The list also includes at least one fern and one shrub present in each vegetation type across the parks. Consumption of these species will be monitored in 12 of the 20 5-m quadrats by counting total individuals, browsed individuals and estimating percentage of the browsed individuals affected. These data will be summarized as an index of browse pressure

for each plot. These data will create an important linkage between this protocol and the elk monitoring protocol to give a more integrated view of changes in park forests. (See [SOP 15: Herbivory: Estimating Herbivory on Shrubs in 5 × 5 m Quadrats.](#))

D. Post-Collection Processing of Samples (for example, Lab Analysis, Preparing Voucher Specimens)

Preparation of voucher specimens for both vascular and non-vascular plants are described in [SOP 21: Voucher Specimen Identification and Processing](#). These specimens will become part of each park’s herbarium collection and can be used to train future field crews.

E. End-of-Season Procedures

End of season procedures are described in [SOP 23: End of Field Season Debriefing and Close-Out](#). Basically they entail putting away equipment and noting anything that is damaged or missing. In addition, Crew Leads will prepare a brief field season report that enumerates which plots were completed and describes any logistic difficulties that arose and explains how they were addressed. The report must clearly document and explain any diversions from established protocols. Finally, the report should point out include any interesting observations and provide suggestions for improving the training or field season procedures for the future. These reports will be archived for future field Crew Leaders and Data Analysts.

Table 5. Potential occurrence of herbivores that are known to browse the sampled vegetation in the three large parks of the North Coast and Cascades Network.

[X indicates highest specific herbivore use; –, indicates less intensive browsing. The high-elevation range was not included for Olympia National Park because it is not currently being sampled]

Herbivores	Mount Rainier		North Cascades		Olympic	
	Western hemlock	Subalpine fir	Western Hemlock	Subalpine fir	Sitka spruce	Western hemlock
Elk	–	X	–	X	X	–
Deer	–	–	–	–	–	–
Goat	–	X	–	X	None	–

4. Data Handling, Analysis, and Reporting

This chapter describes the procedures for data handling, analysis, and report development. Additional details and context for this chapter may be found in the NCCN Data Management Plan (Boetsch and others, 2005), which describes the overall information management strategy for the network. The NCCN website also contains guidance documents on various information management topics (for example, report development, GIS development, GPS use).

A. Project Information Management Overview

Project information management may be best understood as an ongoing or cyclic process, as shown in [figure 6](#). Specific yearly information management tasks for this project and their timing are described in [table 6](#). Readers also may refer to each respective chapter section below for additional guidance and instructions.

The stages of this cycle are described in greater depth in later sections of this chapter, but can be briefly summarized as follows:

- *Preparation* – Training, logistics planning, print forms and maps.
- *Data acquisition* – Field trips to acquire data.

- *Data entry and processing* – Data entry and uploads into the working copy of the database, GPS data processing, etc.
- *Quality review* – Data are reviewed for quality and logical consistency.
- *Metadata* – Documentation of the year's data collection and results of the quality review.
- *Data certification* – Data are certified as complete for the period of record.
- *Data delivery* – Certified data and metadata are delivered for archiving and uploaded to the master project database.
- *Data analysis* – Data are summarized and analyzed.
- *Product development* – Reports, maps, and other products are developed.
- *Product delivery* – Deliver reports and other products for posting and archival.
- *Posting and distribution* – Distribute products as planned and/or post to NPS clearinghouses.
- *Archival and records management* – Review analog and digital files for retention (or destruction) according to NPS Director's Order 19. Retained files are renamed and stored as needed.
- *Season close-out* – Review and document needed improvements to project procedures or infrastructure, complete administrative reports, develop work plans for the coming season.

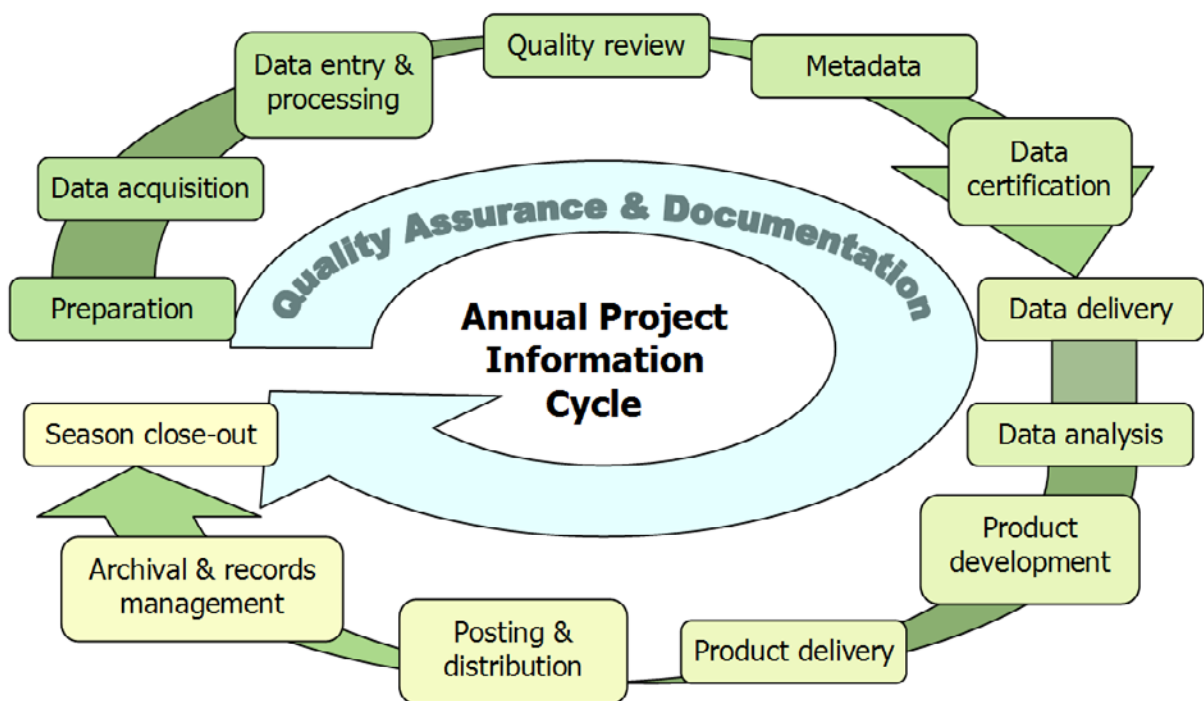


Figure 6. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out.

Note: Quality assurance and documentation are thematic and not limited to any particular stage.

18 Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Table 6. Yearly Project Task List.

[Protocol sections and SOPs are referred to as appropriate]

Project stage	Task description	Responsibility	Timing
Preparation (Sections 3A and 4B)	Initiate announcement for seasonal field crew positions	Project Lead	Dec.
	Notify Data Manager and GIS Specialist of needs (field maps, GPS support, training)	Project Lead	By Dec. 1
	Plan schedule and logistics, including ordering any needed equipment and supplies	Project Lead	By Jan. 15
	Ensure all project compliance needs are completed for the coming season	Park Plant Ecologists	Jan.–Feb.
	Provide names of field crew to Park Plant Ecologists	Project Lead	mid-Feb.
	Hire seasonal field crew positions	Project Lead and Park Plant Ecologists	By Mar. 15
	Inform GIS Specialist and Data Manager of specific needs for upcoming field season	Project Lead	By Mar. 31
	Update and load data dictionary, background maps, and target coordinates into GPS units	GIS Specialist	By Apr. 15
	Prepare and print field maps	GIS Specialist	By Apr. 15
	Ensure that project workspace is ready for use and GPS download software is loaded at each park (SOP 1)	Project Lead, Data Manager and GIS Specialist	By May 1
	Implement working database copy	Data Manager	By May 1
	Generate field visit reports and pre-printed data forms	Project Lead	By May 1
	Initiate computer access and key requests (may need park-specific dates)	Park Plant Ecologists	May
	Provide field crew email addresses and user logins to Data Manager	Park Plant Ecologists	May
	Provide database/GPS training as needed	Data Manager and GIS Specialist	May
	Train field crew in plant identification, voucher collection, cover estimation, use of equipment, field sampling protocols, safety, and backcountry travel; evaluate cover estimation ability at beginning and mid-season to identify crew members with bias	Project Lead	May
Data Acquisition (Section 3C)	Collect field data and voucher specimens during field trips	Technicians	May–Sept.
	Review data forms after each day	Technicians	Daily
	Process voucher specimens, and if possible identify species and update data forms with correct names (SOP 21)	Technicians	After each tour
	Regular review of field forms for completeness and accuracy	Field Crew Lead	Bi-weekly
	De-brief crew on operations, field methods, gear needs	Project Lead and Park Plant Ecologists	Monthly
Data Entry and Processing (Section 4C and 4D)	Download GPS data and email files to GIS Specialist for correction (SOP 8)	Technicians	After each tour
	Download and process digital images (SOP 20)	Technicians	After each tour
	Enter vegetation and site data into working copy of the database (SOP 22)	Technicians	After each tour
	Verification of accurate transcription as data are entered	Technicians	After each tour
	Correct GPS data and send screen capture to Field Lead and Project Lead for review	GIS Specialist	After each tour
	Periodic review of GPS location data and database entries for completeness and accuracy	Field Crew Lead	Monthly
	Merge, correct, and export GPS data. Upload processed and verified coordinates to database	GIS Specialist	August

Table 6. Yearly Project Task List.—Continued

[Protocol sections and SOPs are referred to as appropriate]

Project stage	Task description	Responsibility	Timing
Product Development (Section 4I)	Complete field season report	Field Crew Lead	By Sept. 15
Product Delivery (Section 4J; SOP 22)	Send field season report to Project Lead, Park Plant Ecologists, Data Manager, and GIS Specialist	Field Crew Lead	By Sept. 15
	Deliver mounted specimens to park curatorial facility (SOP 21)	Technicians, Project Lead, and Park Plant Ecologists	By Sept. 15
Quality Review (Section 4E; SOP 24)	Quality review and data validation using database tools (SOP 22)	Project Lead	Aug.–Oct.
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review	GIS Specialist	By Sept. 15
	Joint quality review of GIS data, determine best coordinates for subsequent mapping and field work	Project Lead and GIS Specialist	Sept.–Oct.
Metadata (Section 4F)	Identify any sensitive information contained in the data set (SOP 27)	Project Lead	By Oct. 31
Data Certification and Delivery (Section 4G)	Update project metadata records (SOP 25)	Project Lead	By Oct. 31
	Certify the season’s data and complete the certification report (SOP 24)	Project Lead	Nov.
	Deliver certification report, certified data, and updated metadata to Data Manager (SOP 26)	Project Lead	By Nov. 30
	Upload certified data into master project database, store data files in NCCN Digital Library ¹ (SOP 26)	Data Manager	Dec.–Jan.
	Notify Project Lead of uploaded data ready for analysis and reporting	Data Manager	By Jan. 15
	Update project GIS data sets, layers and associated metadata records	GIS Specialist	Dec.–Jan.
	Finalize and parse metadata records, store in NCCN Digital Library ¹ (SOP 26)	Data Manager and GIS Specialist	By Mar. 15
Data Analysis (Section 4H)	TBD after analysis SOPs are written	Data Analyst	Feb.–Mar.
Reporting and Product Development (Section 4I)	Export automated summary queries and reports from database	Data Analyst	Feb.–Mar.
	Generate report-quality map output for reports	GIS Specialist	Feb.–Mar.
	Acquire the proper report template from the NPS website, create annual report	Data Analyst and Project Lead	Feb.–Apr.
	Screen all reports and data products for sensitive information (SOP 27)	Project Lead and Park Plant Ecologists	Feb.–Apr.
	Prepare draft report and distribute to Park Plant Ecologists for preliminary review	Project Lead	By Apr. 1
Product Delivery (Section 4J; SOP 26)	Submit draft I&M report to Network Coordinator for review	Project Lead	By Apr. 30
	Review report for formatting and completeness, notify Project Lead of approval or need for changes	Network Coordinator	May
	Upload completed report to NCCN Digital Library ¹ submissions folder, notify Data Manager (SOP 26)	Project Lead	Upon approval
	Deliver other products according to the delivery schedule and instructions (SOP 26)	Project Lead	Upon completion
	Product check-in	Data Manager	Upon receipt
Posting & Distribution (Section 4J; SOP 28)	Submit metadata to NPS Data Store ²	Data Manager	by Mar 15
	Create NatureBib ³ record, post reports to NPS clearinghouse	Data Manager	upon receipt
	Update NPSpecies ⁴ records according to data observations	Data Manager	Dec.–Mar
	Submit certified data and GIS data sets to NPS Data Store ²	Data Manager	June (after 2-year hold)

Table 6. Yearly Project Task List.—Continued

[Protocol sections and SOPs are referred to as appropriate]

Project stage	Task description	Responsibility	Timing
Archival and Records Management (Section 4K; SOP 1 and SOP 28)	Store finished products in NCCN Digital Library ¹	Data Manager	Upon receipt
	Review, clean up and store and/or dispose of project files according to NPS Director's Order 19 ⁵	Project Lead	Jan.
Season Close-out (Section 3E, 4L)	Inventory equipment and supplies	Field Crew Lead	By Sept. 15
	De-brief field crew concerning safety, logistics, and data concerns	Project Lead, Technicians	By Sept. 15
	Meet to discuss the recent field season, and document any needed changes to field sampling protocols or the working database	Project Lead, Park Plant Ecologists, Data Manager, and GIS Specialist	By Nov. 30 of the same year
	Discuss and document needed changes to analysis and reporting procedures	Project Lead, Data Analyst, and Data Manager	By Apr. 30

¹ The NCCN Digital Library is a hierarchical digital filing system stored on the NCCN file servers (Boetsch and others, 2005). Network users have read-only access to these files, except where information sensitivity may preclude general access.

² NPS Data Store is a clearinghouse for natural resource data and metadata (<http://science.nature.nps.gov/nrdata>). Only non-sensitive information is posted to NPS Data Store. Refer to [SOP 27: Sensitive Information Procedures](#) for details.

³ NatureBib is the NPS bibliographic database (<http://www.nature.nps.gov/nrbib/index.htm>). This application has the capability of storing and providing public access to image data (for example, PDF files) associated with each record.

⁴ NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data (<http://science.nature.nps.gov/im/apps/npspp>).

⁵ NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: <http://data2.itc.nps.gov/npspolicy/DOrders.cfm>.

B. Pre-Season Preparations for Information Management

Set Up Project Workspace

A section of the networked file server at each host park is reserved for this project, and access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the NPS Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. Additional details may be found in [SOP 1: Workspace Setup and Project Records Management](#).

GPS Loading and Preparation

The GIS Specialist and Project Lead should work together to ensure that target coordinates and data dictionaries are loaded into the GPS units prior to the onset of field work, and that GPS download software is available and ready for use. Additional details on GPS use and GPS data handling may be found in [SOP 8: GPS Use: Navigation, Data Collection, and Downloading](#), and in NCCN GPS Guidelines (North Coast and Cascades Network, 2006).

Implement Working Database Copy

Prior to the field season, the Data Manager will implement a blank copy of the working database and ensure proper access on the part of the project staff. Refer to [Section 4C, Overview of Database Design](#) for additional information about the database design and implementation strategy.

Table 7. Functional comparison of the master project database and the working database.

Project database functions and capabilities	Working database	Master database
Software platform for back-end data	Microsoft® Access	Microsoft® SQL Server
Contains full list of sampling locations and taxa	X	X
Portable for remote data entry	X	
Forms for entering and editing current year data	X	
Quality assurance and data validation tools	X	X
Preliminary data summarization capabilities	X	
Full analysis, summarization, and export tools		X
Pre-formatted report output		X
Contains certified data for all observation years		X
Limited editing capabilities, edits are logged		X
Full automated backups and transaction logging		X

C. Overview of Database Design

We maintain a customized relational database application to store and manipulate the data associated with this project. The design of this database is consistent with NPS I&M and NCCN standards (see the data dictionary and other documentation in [Appendix B: Forest Vegetation Monitoring Protocol Database Documentation](#)). The Data Manager is responsible for development and maintenance of the database, including customization of data summarization and export routines.

The database is divided into two components—one for entering, editing, and error-checking data for the current season (that is, the “working database copy”), and another that contains the complete set of certified data for the monitoring project (that is, the “master project database”). A functional comparison of these two components is provided in [table 7](#).

Each of these components is based on an identical underlying data structure (tables, fields, and relationships, as documented in [Appendix B: Forest Vegetation Monitoring Protocol Database Documentation](#)). The working database is implemented in Microsoft® Access to permit greater flexibility when implementing on computers with limited or unreliable network access. The master database is implemented in Microsoft® SQL Server to take advantage of the backup and transaction logging capabilities of this enterprise database software.

Both components have an associated front-end database application (“user interface” with forms, queries, etc.) implemented in Microsoft® Access. The working database application has separate screens for data entry, data review, and quality validation tools. The master database application contains the analysis and summarization tools, including pre-formatted report output and exports to other software (for example, for analysis and graphics production).

During the field season, each project crew will be provided with its own copy of a working database into which they enter, process, and quality-check data for the current season (refer to [Section 4D, Data Entry and Processing](#) and [SOP 22: Data Entry and Verification](#)). Once data for the field season have been certified they will be uploaded into the master database, which is then used to inform all reporting and analysis. This upload process is performed by the Data Manager, using a series of pre-built append queries.

D. Data Entry and Processing

After each field trip, technicians should enter data in order to keep current with data entry tasks, and to catch any errors or problems as close to the time of data collection as possible. The working database application is in the project workspace. For enhanced performance, it is recommended that users copy the front-end database onto their workstation hard drives and open it there. This front-end copy may be considered “disposable” because it does not contain any data, but rather acts as a pointer to the data that reside in the back-end working database. Whenever updates to the front-end application are made available by the Data Manager, an updated front-end database should be copied from the project workspace to the workstation hard drive.

The functional components for data entry into the working database are described in [SOP 22: Data Entry and Verification](#). Each data entry form is patterned after the structure of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use these pre-built forms as a way of ensuring the maximum level of quality assurance.

Regular Data Backups

Upon opening the working database, the user will be prompted to make a backup of the underlying data (see [SOP 22: Data Entry and Verification](#)). It is recommended that backups be done on a regular basis—perhaps every day that new data are entered—to save time in case of mistakes or database file corruption. These periodic backup files should be compressed to save drive space, and may be deleted once enough subsequent backups are made. All such backups may be deleted after the quality review and certification of the data.

Data Verification

As data are being entered, the person doing the data entry should visually review them to make sure that the data on screen match the field forms. This should be done for each record prior to moving to the next form for data entry. At regular intervals and at the end of the field season, the Field Lead should inspect the data being entered to check for completeness and perhaps catch avoidable errors. The Field Lead also may periodically run the Quality Assurance Tools that are built into the front-end working database application to check for logical inconsistencies and data outliers (this step is described in greater detail in [Section 4E, Data Quality Review](#) and also in [SOP 24: Data Quality Review and Certification](#)).

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. Refer to [SOP 18: Field Form Handling Procedures](#) for details on how to handle these forms.

Image Handling Procedures

Photographic images may be considered a type of data, and as such should be handled and processed with care. Refer to [SOP 20: Photographic Image Processing and Management](#) for details on how to handle and manage these files.

GPS Data Procedures

The following general procedures should be followed for GPS data (see [SOP 8: GPS Use: Navigation, Data Collection, and Downloading](#) and [table 6](#)):

1. GPS data should be downloaded by the field crew from the units at the end of each field trip and stored in the project workspace (see [SOP 1: Workspace Setup and Project Records Management](#)).
2. Raw files should be sent in a timely manner to the GIS Specialist for processing and correction.
3. The GIS Specialist will process the raw GPS data and store the processed data in the project workspace.
4. The GIS Specialist will upload corrected coordinate information into the database and create any GIS data sets.

The Field Lead should periodically review the processed GPS data to make sure that any problems are identified early on.

E. Data Quality Review

After the data have been entered and processed, they need to be reviewed by the Project Lead for quality, completeness, and logical consistency. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers, and missing and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report (see [Sections 4F, Metadata Procedures](#) and [4G, Data Certification and Delivery](#), and [SOP 24: Data Quality Review and Certification](#)).

Data Edits after Certification

Due to the high volume of data changes and/or corrections during data entry, it is not efficient to log all changes until after data are certified and uploaded into the master database. Prior to certification, daily backups of the working database provide a crude means of restoring data

to the previous day's state. After certification, all data edits in the master database are tracked in an edit log (refer to [Appendix B: Forest Vegetation Monitoring Protocol Database Documentation](#)) so that future data users will be aware of changes made after certification. In case future users need to restore data to the certified version, we also retain a separate, read-only copy of the original, certified data for each year in the NCCN Digital Library (refer to [SOP 26: Product Delivery Specifications](#)) for specific instructions.

Geospatial Data

The Project Lead and GIS Specialist may work together to review the surveyed coordinates and other geospatial data for accuracy. The purpose of this joint review is to make sure that geospatial data are complete and reasonably accurate, and also to determine which coordinates will be used for subsequent mapping and field work.

F. Metadata Procedures

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition, and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all NCCN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized.

At the conclusion of the field season (according to the schedule in [table 6](#)), the Project Lead will be responsible for providing a completed, up-to-date metadata interview form to the Data Manager. The Data Manager and GIS Specialist will facilitate metadata development by consulting on the use of the Metadata Interview Form, by creating and parsing metadata records from the information in the interview form, and by posting such records to national clearinghouses. Refer to [SOP 25: Metadata Development](#) for specific instructions.

G. Data Certification and Delivery

Data certification is a benchmark in the project information management process that indicates that: (1) data are complete for the period of record; (2) data have undergone and passed the quality assurance checks ([Section 4E, Data Quality Review](#)); and (3) data are appropriately documented and in a condition for archiving,

posting, and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies that may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is primarily responsible for completing an NCCN Project Data Certification Form, available on the NCCN website. This brief form should be submitted with the certified data according to the timeline in [table 6](#). Refer to [SOP 24: Data Quality Review and Certification](#) and [SOP 26: Product Delivery Specifications](#) for specific instructions.

H. Data Reduction and Analysis

Note: Refer to [table 6](#) for the specific analysis tasks and their timing.

Data Reduction

For most measurements, data reduction consists of averaging values across sample units within macroplots. For tree measurements, the sample unit is individual trees; for cover measurements it is quadrats; for coarse and fine woody debris it is transects; for litter and duff it is points.

Several types of data are used to create indices or other composite descriptions of the plot without intra-plot replication. Specifically, the epiphytic lichen data are used to create indices of air quality and climate using a multivariate procedure developed by the USDA Forest Service (Geiser and Neitlich, 2007). Herbivory also is presented as an index describing ungulate browsing pressure on targeted species ([SOP 15: Herbivory: Estimating Herbivory on Shrubs in 5 × 5 m Quadrats](#)). Finally, tree canopy cover and tree mortality are presented as a plot-wide percents based on frequency from 96 points collected on each macroplot (cover) or number of deceased trees (mortality).

Trend Detection

Our sample design assumes that plant abundance estimates are sensitive to annual variations in weather (that is, growing season conditions), and these variations may not be indicative of long-term trend. To minimize the influence of annual variation on an estimate of abundance in a given year, we measure plots in 2 consecutive years before resting the plots for 4 years. We reason that 2 years of data give a more accurate estimate of plant abundance than either year alone. Eventually repeat measurements will enable us to develop weather co-variables to increase the power and interpretability of our data.

After the first panel rotation, park-specific changes (two panel repeats) and trends (three panel repeats) will be assessed for each monitored parameter using a profile-summary approach for the repeated measurements on macroplots. The transect profile will be summarized by the slope of the linear regression line between years and individual parameters. The transect slope estimates will be treated as replicate measurements of park-specific trends, and tested for differences from zero using a modified *t*-test approach.

After each 7-year panel repeat, a summary report will include an assessment of park-specific and Network trends in forest vegetation parameters. After 13 years, all panels will be included in the analysis and it should have the predicted power to detect change. Although some information will be available regarding rare species, we expect to have adequate power to describe change in more common species.

Example data analyses are shown in [Appendix C: Template for Forest Monitoring Annual Report](#) and described in Terrastat Consulting Group (2005).

I. Reporting and Product Development

Refer to [SOP 26: Product Delivery Specifications](#) for the complete schedule for project reports and other deliverables and the people responsible for them.

Report Content

A detailed annual summary report and a cumulative 7-year summary report will be produced after each complete rotation of the panel design. Information for annual summary reports will be extracted from the NCCN Forest Monitoring Database, graphed in the statistical program R by the Data Analyst. The finished report will be posted to the NPS Data Store.

The annual report will:

- Summarize changes in species lists for plots in the panel completed in the year of the report and longer-term changes in that panel beginning in 2014 (when first panel has completed the second panel rotation).

- Summarize variation in cover of understory vegetation and non-vascular cryptogams on logs for the panel completed in the year of the report and trend for that panel beginning in 2014.
- Report the climate and air quality indices determined from epiphytic lichen data for the panel completed in the year of the report, and trend in those indices beginning in 2014.
- Summarize indices of herbivore pressure for the panel completed in the year of the report and trend beginning in year 2014.
- Present a graphical representation of stand structure, composition, and litter and duff depths for plots in the panel completed in the year of the report.
- Compare changes in stand structure, composition, and litter and duff depths beginning in year 2014.
- Identify data quality concerns and/or deviations from protocols that affect data quality and interpretability.
- If any annual report finds a change of more than 50 percent in any indicator, and analysis as described for the 7-year report will be triggered.

The 7-year report will:

- Summarize and elucidate patterns and trends in the plot data; inter-annual variation can be described in the first report; trend will be reported in the second and subsequent 7-year reports;
- Evaluate operational aspects of the monitoring program, such as whether the panel design should be modified to spread the effort over more years, etc.;
- Be published in NPS Technical Reports and peer reviewed journals.

Detailed reporting guidelines and table structures for the annual report are provided in [Appendix C: Template for Forest Monitoring Annual Report](#). Guidance for the structure and analysis in the 7-year report will be developed.

Standard Report Format

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft® Word template document based on

current NPS formatting standards. Annual reports will use the Natural Resource Report template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report template. These templates and documentation of the NPS publication standards are available at: <http://www.nature.nps.gov/publications/NRPM/index.cfm>.

Review Products for Sensitive Information

Certain project information related to the specific locations of rare or threatened taxa may meet criteria for protection and as such should not be shared outside NPS except where a written confidentiality agreement is in place prior to sharing. Before preparing data in any format for sharing outside NPS—including presentations, reports, and publications—the Project Lead should refer to the guidance in [SOP 27: Sensitive Information Procedures](#). Certain information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

J. Product Delivery, Posting, and Distribution

Refer to [SOP 26: Product Delivery Specifications](#) for the complete schedule for project deliverables and the people responsible for them. Upon delivery, products will be posted to NPS websites and clearinghouses (for example, NatureBib, NPSpecies, NPS Data Store) as appropriate.

Holding Period for Project Data

To permit sufficient time for priority in publication, certified project data will be held upon delivery for a period not to exceed 2 years after it was originally collected. After the 2-year period has elapsed, all certified, non-sensitive data will be posted to the NPS Data Store.

Note: This hold only applies to raw data, and not to metadata, reports or other products which are posted to NPS clearinghouses immediately after being received and processed.

Special Procedures for Sensitive Information

Products that have been identified upon submission by the NPS/Project Lead as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources, or withheld from posting and distribution. When requests for distribution of the unedited version of products are initiated by the NPS, by another Federal agency, or by another partner organization (for example, a research scientist at a university), the unedited product (for example, the full data set that includes protected information) may only be shared after a confidentiality agreement is established between NPS and the other organization. Refer to [SOP 27: Sensitive Information Procedures](#) for more information.

All official FOIA requests will be handled according to NPS policy. The NPS Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

K. Archival and Records Management

All project files should be reviewed, cleaned up, and organized by the NPS/Project Lead on a regular basis (for example, annually in January). Decisions on what to retain or destroy should be made following guidelines stipulated in NPS Director's Order 19, which provides a schedule indicating the amount of time that the various kinds of records should be retained. Refer to [SOP 1: Workspace Setup and Project Records Management](#).

L. Season Close-Out

After the conclusion of the field season, the Project Lead, Data Manager, and GIS Specialist should meet to discuss the recent field season, and to document any needed changes to the field sampling protocols, the working database application, or to any of the SOPs associated with the protocol. Refer to [Section 3E, End-of-Season Procedures](#) for additional close-out procedures not specifically related to project information management.

5. Personnel Requirements and Training

A. Roles and Responsibilities (table 8)

Table 8. Roles and responsibilities for Forest Vegetation Monitoring in the North Coast and Cascades Network.

Role	Responsibilities	Name / Position
Project Lead	<ul style="list-style-type: none"> • Project administration, operations, and implementation • Track project objectives, budget, requirements, and progress toward meeting objectives • Coordinate and ratify changes to protocol • Lead training of field crews • Maintain and archive project records • Certify each season's data for quality and completeness • Complete reports, metadata, and other products according to schedule 	Supervisory Botanist/Plant Ecologist, OLYM
Data Analyst	<ul style="list-style-type: none"> • Perform data summaries and analysis, assist interpretation and report preparation 	
Park Plant Ecologists	<ul style="list-style-type: none"> • Facilitate logistics planning and coordination • Review reports, data and other project deliverables • Train and ensure safety of field crew • Insure compliance is up-to-date 	MORA, NOCA, and OLYM plant ecologists/botanists
Field Crew Lead	<ul style="list-style-type: none"> • Assist in training and ensuring safety of field crew • Plan and execute field visits • Acquire and maintain field equipment • Oversee data collection and entry, verify accurate data transcription into database • Complete a field season report 	Seasonal technicians (GS-7)
Technicians	<ul style="list-style-type: none"> • Collect, record, enter and verify data • Prepare plant and lichen voucher specimens 	Seasonal technicians, volunteers and interns
Data Manager	<ul style="list-style-type: none"> • Consultant on data management activities • Facilitate check-in, review and posting of data, metadata, reports, and other products to national databases and clearinghouses according to schedule • Maintain and update database application • Provide database training as needed 	Data Manager, OLYM ¹
GIS Specialist	<ul style="list-style-type: none"> • Consultant on spatial data collection, GPS use, and spatial analysis techniques • Facilitate spatial data development and map output generation • Work with Project Lead and Data Analyst to analyze spatial data and develop metadata for spatial data products • Primary steward of GIS data and products 	GIS Specialist, OLYM ¹
Network Coordinator	<ul style="list-style-type: none"> • Review annual reports for completeness and compliance with I&M standards and expectations 	NCCN Network Coordinator
Park Curator	<ul style="list-style-type: none"> • Receive and catalogue voucher specimens • Receive and archive copies of annual reports, analysis reports, and other publications • Facilitate archival of other project records (e.g., original field forms, etc.) 	Park Curators and Collections Managers at MORA, NOCA, and OLYM
USGS Liaison	<ul style="list-style-type: none"> • Consultant on technical issues related to project sampling design, statistical analyses, or other issues related to changes in protocol and SOPs 	USGS-FRESC staff member

¹ These individuals act as coordinators and primary points of contact for this project. Their responsibility is to facilitate communication among network and park staff and to coordinate the work which may be shared among various staff to balance work load and to enhance the efficiency of operations.

B. Qualifications

The Crew Lead should have experience with plant identification, preferably in the Pacific Northwest. Familiarity with one or more of the NCCN parks also is desirable. Ideally, the Crew Lead will have supervised backcountry field crews before and/or previously served as an NCCN forest monitoring crew member. Finally, s/he must be physically fit and prepared to spend extended periods of time in the backcountry.

The other crew members should have prior botany experience, including substantial experience with the Pacific Northwest flora or with demonstrated ability to quickly learn plant identification. They also must be physically fit and prepared to spend extended periods of time in the backcountry. Substantial backpacking experience is desirable. (See [SOP 2: Hiring Guidelines and Procedures](#).)

C. Training Procedures

Training will be accomplished during the first 2 weeks of the field season. The following general topics will be covered (See [SOP 5: Orientation of Field Crew: Park Buildings, Field Preparation, and Safety](#) and [SOP 6: Training Field Crews](#) for details):

- Safety – including vehicle safety, equipment safety, backcountry travel, packing for the backcountry, etc.
- Flora – vascular and non-vascular
- Tree diseases
- Cover estimation
- Other plot methods
- Orienteering
- Office procedures – administrative procedures, data entry, IT security, voucher processing, handling of data forms, etc.

Training will be accomplished by conducting a number of training exercises including setting up and measuring a practice plot. A minimum acceptable deviation from the mean for cover estimates was determined during a pilot project and all crew members will be required to meet this standard ([Appendix A: Cover Estimation Method Comparison](#)).

6. Operational Requirements

A. Annual Workload and Field Schedule

A detailed schedule for project activities is found in [table 6](#). In brief, hiring of field crews is conducted from December through March. The two crews of four members conduct data collection, entry and download from mid-May until early September. Some crew members may be employed longer if funds allow. In preparation for the field season, new or replacement equipment orders will be placed in January each year, and the computer workspace and database set-up will be completed by May 1. Field crew training will occur

during the last 2 weeks of May, with field work conducted for the rest of the field season. Following the field season, the Project Lead and other NPS staff members will evaluate the protocol and assess whether changes are needed. The Project Lead is responsible for data certification by the end of November so that the Data Manager can upload the data during December and January, and complete metadata by March. Data will be analyzed and a report generated by the Project Lead during February to April, to be delivered to the NCCN Coordinator by April 30. The project will require help from GIS staff for training crew in the use of GPS units, creation of some maps (probably very few after all plots have been established), and downloading of GPS units during the field season.

B. Facility and Equipment Needs

This project requires a moderate amount of special facilities and equipment. The crew will require housing in the vicinity of each large park for the duration of the field season (early May to mid-September). They also will require transportation to plots or trailheads while on the job. Crew members will provide their own backpacking gear. Computer access is necessary during the training session, and throughout the season for crew members to enter data. Equipment requirements for each task in the protocol are listed in each SOP.

C. Startup Costs and Budget Considerations

This project has relatively low start-up costs because most equipment needs have already been paid for in the pilot stage of protocol development. However, there will be some replacement costs each year as equipment is damaged or wears out, amounting to \$1,000 to \$2,000. Although the annual effort will be constant, the cost of personnel escalates each year leading to increasing annual funding needs ([table 9](#)).

A project with perennially escalating costs to be paid with a fixed budget is obviously not sustainable. This situation is endemic to the NPS monitoring program and must eventually be addressed at both the network and national levels. We can not address the larger problem, but we can discuss the pros and cons of reducing the cost of this protocol in various ways ([table 10](#)).

This protocol was designed to be comprehensive and statistically powerful over the largest possible area of inference allowed by the original budget estimate. Given the high cost of access in these national parks, our approach was to collect thorough data at each site and minimize travel among sites. The cost of this protocol could be reduced by adopting a new strategy by reducing the area of inference, taking data on fewer aspects of the vegetation, and/or taking fewer replicate measurements on given aspects ([table 10](#)). These are difficult choices that may be required in the near future.

Table 9. Forest monitoring protocol projected budget.

Project Stage/Budget Category	Personnel	Grade	PPs	Cost 2008	Cost 2009	Cost 2010
Preparation	Project Lead	GS-12	4.1	15,604	16,072	16,554
	Park Plant Ecologists (2)	GS-12	1	6,170	6,355	6,546
	Data Manager	GS-11	0.5	1,540	1,586	1,634
	GIS Specialist	GS-9	0.5	1,459	1,503	1,548
Data Acquisition, Entry, and Processing	Field Crew Lead (2)	GS-7	9	34,778	35,821	36,896
	Technicians (4)	GS-5	9	45,540	46,906	48,313
	Project Lead	GS-12	0.5	15,604	16,072	16,554
	Park Plant Ecologists (2)	GS-12	0.5	3,085	3,178	3,273
	Data Manager	GS-11	0.1	308	317	327
	GIS Specialist	GS-9	0.4	1,168	1,203	1,239
Product Development and Delivery	Field Crew Leads (2)	GS-7	1	3,864	3,980	4,099
	Technicians (4)	GS-5	1	5,060	52,12	5,368
	Park Plant Ecologists (2)	GS-12	0.05	308	317	327
Quality Review	Project Lead	GS-12	0.25	952	981	1,010
	Data Manager	GS-11	0.5	1,540	1,586	1,634
	GIS Specialist	GS-9	0.3	876	902	929
Metadata	Project Lead	GS-12	0.15	571	588	606
	Data Manager	GS-11	0.1	308	3,217	327
Data Certification and Delivery	Project Lead	GS-12	0.1	381	392	404
	GIS Specialist	GS-9	0.3	876	902	929
	Data Manager	GS-11	0.6	1,849	1,904	1,962
Data Analysis	Project Lead/Analyst	GS-12	1	3,806	3,920	4,038
	Data Manager	GS-11	0.2	616	634	654
	GIS Specialist	GS-9	0.25	616	638	654
Reporting and Product Development	Project Lead/Analyst	GS-12	0.2	761	784	807
	GIS Specialist	GS-9	0.2	584	602	620
	Park Plant Ecologists (2)	GS-12	0.05	308	317	327
	NCCN Coordinator	GS-12	0.05	222	229	236
	Data Manager	GS-11	0.1	308	317	327
Product Delivery, Posting, and Distribution	Data Manager	GS-11	0.3	924	952	980
Archival and Records Management.	Data Manager	GS-11	0.1	308	317	327
	Project Lead	GS-12	0.1	381	392	404
Season Close-Out	Field Crew Lead	GS-7	above	0	0	0
	Project Lead	GS-12	0.1	381	392	404
	Data Manager	GS-11	0.3	924	952	980
	GIS Specialist	GS-9	0.05	146	150	155
Travel				9,150	9,425	9,707
Vehicles				4,000	4,120	4,244
Materials				1,015	1,045	1,077
Total				\$166,291	\$171,280	\$176,418

Table 10. Potential ways to reduce the effort and cost of the forest monitoring protocol.

Change to Protocol	Pros	Cons
Add more SCAs	<ul style="list-style-type: none"> Total cost of employees is reduced 	<ul style="list-style-type: none"> Employees will likely be less experienced; two more would be the limit (4 total) SCAs require park housing, which is in short supply
Drop herbivory measurements	<ul style="list-style-type: none"> Save time spent at each plot 	<ul style="list-style-type: none"> Cost savings is small compared with cost of accessing plot Almost no savings at NOCA where herbivory is minor Sacrifices integration with wildlife monitoring
Drop down woody material measurement	<ul style="list-style-type: none"> Save time spent at each plot 	<ul style="list-style-type: none"> Compromises ability to detect trend in important descriptor of forest environment Cost savings is small compared with cost of accessing plot
Drop lichen survey	<ul style="list-style-type: none"> Save time spent at each plot 	<ul style="list-style-type: none"> Compromises ability to detect trend in important descriptor of forest environment, especially climate and air quality
Reduce the tree measurements	<ul style="list-style-type: none"> Save time at plots 	<ul style="list-style-type: none"> We have already minimized the number of tree heights measured Trees are the context and environment for the rest of the data
Focus on trees only	<ul style="list-style-type: none"> Changes in tree dynamics will be most significant for managers and public 	<ul style="list-style-type: none"> Lose comprehensive view May miss early warning
Reduce the number of quadrats	<ul style="list-style-type: none"> Save time at the plots Less negative effect on power than reducing the number of plots 	<ul style="list-style-type: none"> Loss of power to detect change
Do not repeat plots in two consecutive years	<ul style="list-style-type: none"> This would halve the workload in any year 	<ul style="list-style-type: none"> Effect of interannual variation on trend detection would increase, decreasing power to detect trend Loss of connected design for developing co-variables
Measure only two plots/vegetation community/year	<ul style="list-style-type: none"> This would cut the workload by 1/3 per year 	<ul style="list-style-type: none"> Two replicates are a poor estimate of variance Loss of power to detect change The design is more vulnerable to loss of plots due to disturbance Reduce ability to develop co-variables
Change design to nine panels of 2 plots	<ul style="list-style-type: none"> Annual workload is reduced by 1/3 but total number of plots is constant Some power is restored over previous suggestion 	<ul style="list-style-type: none"> Still have only 2 plots to estimate annual variance A longer time is required to detect long-term trend
Drop Sitka-spruce stratum at OLYM	<ul style="list-style-type: none"> Significant time savings This stratum is not replicated 	<ul style="list-style-type: none"> Stratum represents the extreme of a regional environmental gradient Management is more interested in SS than WH at OLYM
Drop Western Hemlock stratum from one park	<ul style="list-style-type: none"> Significant time savings WH will be covered somewhat by FIA WH at MORA is in the middle of regional precipitation gradient so less critical 	<ul style="list-style-type: none"> Regional description of any vegetation community would be lost WH is benchmark for manipulated lands outside parks Less time would be gained by dropping MORA than the others Dropping OLYM and NOCA remove ends of regional climatic gradient
Drop Subalpine fir stratum from one park	<ul style="list-style-type: none"> Significant time savings, especially at NOCA Treeline and herbaceous changes are covered by other protocols 	<ul style="list-style-type: none"> This community is predicted to be most sensitive to climate change Will lose replication Important to management especially at MORA
Adopt new (quicker) methods as they are developed	<ul style="list-style-type: none"> Photographic methods for cover estimation are being investigated (Luscier and others, 2006) 	<ul style="list-style-type: none"> Method not effective at species level

References Cited

- Acker, S.A., McKee, W.A., Harmon, M.F., and Franklin, J.F., 1998, Long-term research on forest dynamics in the Pacific Northwest: A network of permanent plots *in* Dallmeier, F. and Comiskey, J.A., eds., *Forest biodiversity in the North, Central and South America, and the Caribbean: Research and monitoring*: Paris, United Nations Educational, Scientific, and Cultural Organization, p. 93-106.
- Barnosky, C.W., 1984, Late Pleistocene and early Holocene environmental history of south-western Washington, U.S.A: *Canadian Journal of Earth Sciences*, v. 21, p. 619-629.
- Boetsch, J.R., Christoe, B., and Holmes, R.E., 2005, Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program: Port Angeles, Washington, U.S. Department of the Interior, National Park Service, available only online at <http://www1.nature.nps.gov/im/units/nccn/datamgmt.cfm>. (Accessed March 12, 2007.)
- Bonham, C.D., 1989, *Measurements for terrestrial vegetation*: New York, John Wiley and Sons.
- Bunnell, F.L., Kremsater, L.L., and Wind, E., 1999, Managing to sustain vertebrate richness in forests of the Pacific Northwest: Relationships within stands: *Environmental Reviews*, v. 7, p. 97-146.
- Chappell, C., 2005, Key to draft preliminary plant associations of North Cascades, Olympic and Mount Rainier National Parks, Unpublished report on file at Olympic National Park.
- Cole, D.N., and Monz, C.A., 2002, Trampling disturbance of high-elevation vegetation, Wind River Mountains, Wyoming, U.S.A.: *Arctic, Antarctic, and Alpine Research*, v. 34, p. 365-375.
- Davis, M.B., 1981, Quarternary history and stability of forest communities, *in* West, D.C., Shugart, H.H., and Botkin, D.B., eds., *Forest Succession: Concepts and Application*: New York, Springer-Verlag, p. 132-177.
- Davis, M.B., 1989, Lags in vegetation response to greenhouse warming: *Climatic Change*, v.15, p. 75-82.
- Dethier, M.N., Graham, E.S., Cohen, S., Tear, L.M., 1993, Visual versus random-point percent cover estimations: "Objective" is not always better: *Marine Ecology Progress Series*, v. 96, p. 93-100.
- Edmonds, R.L., Blew, R.D., Marra, J.L., Blew, J., Barg, A.K., Murray, G., Thomas, T.B., 1998, Vegetation patterns, hydrology, and water chemistry in small watersheds in the Hoh River Valley, Olympic National Park: Washington, D.C., Scientific monograph NPSD/NRUSGS/NRSM-98/02, National Park Service.
- Elzinga, C.L., Salzer, D.W., and Willoughby, J.W., 1998, *Measuring and monitoring plant populations*, Bureau of Land Management, Technical Reference, p. 1730-1.
- Forest Ecosystem Management Assessment Team, 1993, *Forest ecosystem management: and ecological, economic, and social assessment*: Washington, D.C., Report of the Forest Ecosystem Management Team, 1993-793-071.
- Forest Inventory and Analysis Program, 2004, *Field instructions for the annual inventory of Washington, Oregon, and California*, Pacific Northwest Research Station, U.S. Department of Agriculture, Forest Service.
- Franklin, J.F., 1989, Importance and justification of long-term studies in ecology, *in* Likens, G.E., ed., *Long-term studies in ecology*: New York, Springer-Verlag, p. 1-19.
- Franklin, J.F., and Dyrness, C.T., 1973, *Natural vegetation of Oregon and Washington*: Eugene, University of Oregon Press.
- Franklin, J.F., Moir, W.H., Hemstrom, M.A., Greene, S.E., and Smith, B.G., 1988, *The forest communities of Mount Rainier National Park*: Washington, D.C., Scientific Monograph Series 19, National Park Service, Washington, D.C.
- Franklin, J.F., Shugart, H.H., and Harmon, M.E., 1987, Tree death as an ecological process: *BioScience*, v. 37, p. 550-556.
- Franklin, J.F., Spies, T.A., Van Pelt, R., Carey, A.B., Thornburgh, D.A., Berg, D.R., Lindenmayer, D.B., Harmon, M.E., Keeton, W.S., Shaw, D.C., Bible, K., and Chen, J., 2002, Disturbance and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example: *Forest Ecology and Management*, v. 155, p. 399-423.
- Gates, D.M., 1993, *Climate Change and its Biological Consequences*: Sunderland, Massachusetts, Sinauer Associates, Inc.
- Geiser, L.H., and Neitlich, P.N., 2007, Air pollution and climate gradients in western Oregon and Washington indicated by epiphytic macrolichens: *Environmental Pollution*, v. 145, p. 203-218.
- Giorgi, F., Hurrell, J.W., Marinucci, M.R., and Beniston, M., 1997, Elevation dependency of the surface climate signal: A model study: *Journal of Climate*, v.10, p. 288-296.
- Goodale, C.L., Apps, M.J., Birdsey, R.A., Field, C.B., Heath, L.S., Houghton, R.A., Jenkins, J.C., Kohlmaier, G.H., Kurz, W., Liu, S., Nabuurs, G.-J., Nilsson, S., and Shvidenka, A.Z., 2002, Forest carbon sinks in the northern hemisphere: *Ecological Applications*, v. 12, p. 891-899.

- Graham, R.L., Turner, M.G., and Dale, V.H., 1990, How increasing CO₂ and climate change affect forests: *BioScience*, v. 40, p. 575-587.
- Gray, A., 2003, Monitoring stand structure in mature coastal Douglas-fir forests: Effect of plot size: *Forest Ecology and Management*, v. 175, p. 1-16.
- Greig-Smith, P., 1983, *Quantitative Plant Ecology*, 3rd Edition: London, Blackwell Scientific.
- Hallingback, T. and Hadgetts, N.G., eds., 1999, Status Survey and Conservation Action Plan for Mosses, Liverworts and Hornworts, International Union of Conservation of Nature and Natural Resources/Species Survival Commission Bryophyte Specialist Group Report.
- Hawksworth, D.L., and Hill, D.J., 1984, *The Lichen Forming Fungi*: New York, Chapman and Hill.
- Henderson, J.A., Peter, D.H., Leshner, R.D., and Shaw, D.C., 1989, Forested plant associations of the Olympic National Forest, U.S. Department of Agriculture, Forest Service Pacific Northwest Region. R6, Ecological Technical Paper 001-88.
- Henderson, J.A., Peter, D.H., Leshner, R.D., and Shaw, D.C., 1992, Field guide to the forested plant associations of the Mt. Baker-Snoqualmie National Forest, U.S. Department of Agriculture, Forest Service Pacific Northwest Region, R6, Ecological Technical Paper 028-91.
- Jenny, H., 1941, *Factors of Soil Formation—A System of Quantitative Pedology*: New York, McGraw-Hill, 109 p.
- Lehmkuhl, J.F., and Ruggiero, L.F., 1991, Forest fragmentation in the Pacific Northwest and its potential effects on wildlife, in Ruggiero, L.F., Aubry, K.B., Carey, A.B., and Huff, M.H., eds., *Wildlife and Vegetation of Unmanaged Douglas-fir Forests: Portland, Oregon*, General Technical Report PNW-GTR-285, U.S. Department of Agriculture, Forest Service, p. 35-46.
- Leslie, D.M., Starkey, E.E., and Vavra, M., 1984, Elk and deer diets in old-growth forests in western Washington: *Journal of Wildlife Management*, v. 48, p. 762-775.
- Lindh, B.C., and Muir, P.S., 2004, Understory vegetation in young Douglas-fir forests: Does thinning help restore old-growth compositions?: *Forest Ecology and Management*, v. 192, p. 285-296.
- Luscier, J.S., Thompson, W.L., Wilson, J.M., Gorham, B.E., and Dragut, L.D., 2006, Using digital photographs and object-based image analysis to estimate percent ground cover in vegetation plots: *Frontiers in Ecology and the Environment*, v. 4, p. 408-413.
- McClain, M.E., Bilby, R.E., and Triska, F.J., 1998, Nutrient cycles and responses to disturbance, in Naiman, R.J. and Bilby, R.E., eds., *River Ecology and Management, Lessons from the Pacific Coastal Ecoregion*: New York, Springer.
- McCune, B. and Lesica, P., 1992, The trade-off between species capture and quantitative accuracy in ecological inventory of lichens and bryophytes in forests in Montana: *The Bryologist*, v. 95, p. 296-304.
- McDonald, T.L., 2003, Review of environmental monitoring methods: Survey designs: *Environmental Monitoring and Assessment*, v. 85, p. 277-292.
- Meese, R.J. and Tomich, P.A., 1992, Dots on the rocks: A comparison of percent cover estimation methods: *Journal of Experimental Marine Biology and Ecology*, v. 165, p. 59-73.
- Mote, P.W., Parson, E.A., Hambet, A.F., Keeton, W.S., Lettenmaier, D., Mantua, N., Peterson, D.W., Peterson, D.L., Slaughter, R., and Snover, A.K., 2003, Preparing for climatic change: The water, salmon, and forests of the Pacific Northwest: *Climatic Change*, v. 61, p. 45-88.
- North Coast and Cascades Network, 2006, GPS Guidelines, U.S. Department of the Interior, National Park Service, available only online at http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm . (Accessed March 12, 2007.)
- Oliver, C.D., and Larson, B.C., 1990, *Forest Stand Dynamics*: San Francisco, McGraw-Hill, 467 p.
- Pacala, S.W. and Hurtt, G.C., 1993, Terrestrial vegetation and climate change: integrating models and experiments, in Kareiva, P.M., Kingsolver, J.G., and Huey, R.B., eds., *Biotic Interactions and Global Change*: Sunderland, Massachusetts, Sinauer and Associates.
- Pastor, J. and Post, W.M., 1986, Influence of climate, soil moisture and succession on forest carbon and nitrogen cycles: *Biogeochemistry*, v. 2, p. 3-27.
- Pastor, J. and Post, W.M., 1988, Response of northern forests to CO₂-induced climate change: *Nature*, v. 334, p. 55-58.
- Perry, D.A., 1992, Key processes at the stand to landscape scale, in Wall, G. ed., *Implications of Climate Change for Pacific Northwest Forest Management*: Waterloo, B.C., Department of Geography Publication Series, Occasional Paper No. 15, University of Waterloo, BC.
- Peters, R.L., and Lovejoy, T.E., eds., 1992, *Global Warming and Biological Diversity*: New Haven Connecticut, Yale University Press.

- Schreiner, E.G., Krueger, K.A., and Happe, P.J., Houston, D.G., 1996, Understory patch dynamics and ungulate herbivory in old-growth forests of Olympic National Park, Washington: *Canadian Journal of Forest Research*, v. 26, p. 255-265.
- Stevens, P.R., and Walker, T.W., 1970, The chronosequence concept and soil formation: *Quarterly Review of Biology*, v. 45, p. 333-350.
- Stevens, D.L., Jr., 1997, Variable density grid-based sampling design for continuous spatial populations: *Environmetrics*, v. 8, p. 167-195.
- Stohlgren, T.J., Owen, A.J., and Lee, M., 2000, Monitoring shifts in plant diversity in response to climate change: A method for landscapes: *Biodiversity and Conservation*, v. 9, p. 65-86.
- Sykes, J.M., Horril, A.D., and Mountford, M.D., 1983, Use of visual cover assessments as quantitative estimators of some British woodland taxa: *Journal of Ecology*, v. 71, p. 437-450.
- Terrastat Consulting Group, 2002, Detecting changes in vegetation and wildlife populations: simulation study, Objective 2, Task4/Objective3 report, Unpublished report.
- Terrastat Consulting Group, 2005, Protocols for analyzing and reporting trends in forest understory vegetation in NCCN parks, Unpublished report.
- TerraStat Consulting Group, 2006, Power analyses of Forest Inventory and Analyses (FIA) data. Unpublished report.
- Thomas, J.W., 1997, Foreward, in Kohm, K.A., and Franklin, J.F., eds., *Creating Forestry for the 21st Century*: Washington, D.C., Island Press, p. ix-xii.
- Thompson, S.K., 2002, *Sampling*: New York, Wiley.
- Urquhart, N.S., Paulsen, S.G., and Larsen, D.P., 1998, Monitoring for policy-relevant regional trends over time: *Ecological Applications*, v. 8, p. 246-257.
- van Mantgem, P.J., and Stephenson, N.L., 2007, Apparent climatically induced increase of tree mortality rates in a temperate forest: *Ecology Letters*, v. 10, p. 909-916.
- van Mantgem, P.J., Stephenson, N.L., Byrne, J.C., Daniels, L.D., Franklin, J.F., Fule, P.Z., Harmon, M.E., Larson, A.J., Smith, J.M., Taylor, A.H., and Veblen, T.T., 2009, Widespread increase of tree mortality rates in the Western United States: *Science*, v. 323, no. 5913, p. 521-524.
- Wiens, J.A., Crawford, C.S., and Gosz, J.R., 1985, Boundary dynamics: a conceptual framework for studying landscape ecosystems: *Oikos*, v. 45, p. 421-427.
- Woodward, A., Schreiner, E.G., Houston, D.B., and Moorhead, B.B., 1994, Ungulate-forest relationships in Olympic National Park: retrospective exclosure studies: *Northwest Science*, v. 68, p. 97-110.
- Weber, S., Woodward, A., and Freilich, J., 2005, North Coast and Cascades Network vital signs monitoring report: http://science.nature.nps.gov/im/units/nccn/Reports/Monitoring/NCCN_Phase3_Revised.pdf. (Accessed February 6, 2009.)

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 1: Workspace Setup and Project Records Management

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Project Workspace Setup

A section of the networked file server at each host park is reserved for this project, and access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the NPS Lead should make sure that network accounts are established for each new staff member and that the Data Manager is notified to ensure access to the project workspace and databases.

The recommended file structure within this workspace is shown in [figure 1.1](#). The workspace folder name is ‘VCa02_Forest_Veg’, the NCCN project code. Data and images from the current year should be retained in a separate folder (year_field_crew). This will make it easier to identify and move these files to the project archives at the end of each season.

Each major subfolder is described as follows:

- Analysis – Contains working files associated with data analysis.

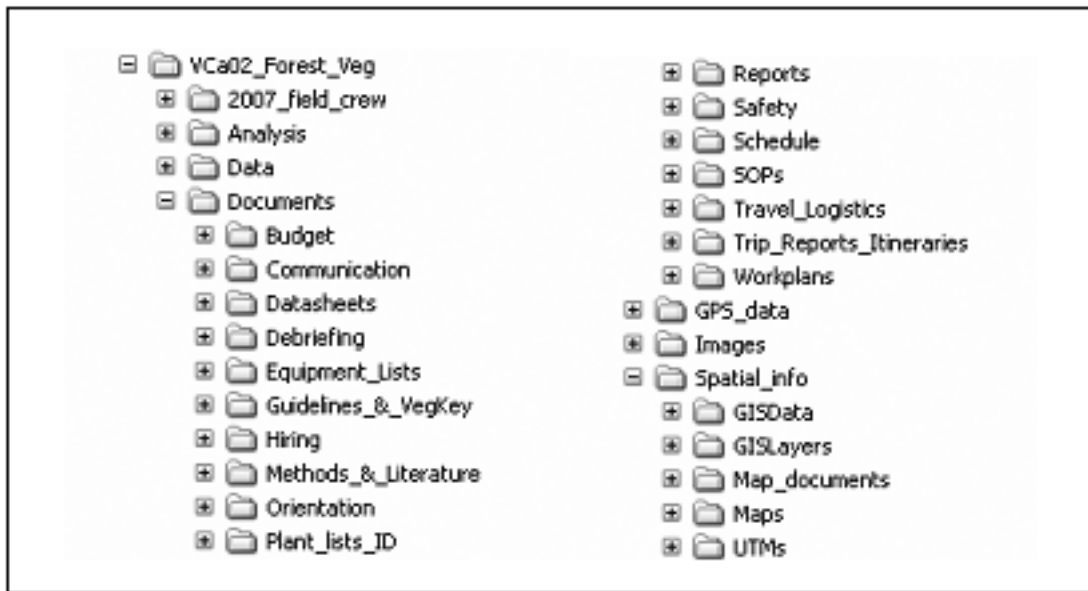


Figure 1.1 Recommended file structure for project workspace.

- Data—Contains the working database file for the season. The master database for the project is stored in the enterprise data management system (Boetsch and others, 2005).
- Documents—Contains subfolders to categorize documents as needed for various stages of project implementation.
- GPS data—Contains GPS data dictionaries, and raw and processed GPS data files.

Note: This folder contains subfolders to arrange files by year. Each of these subfolders also contains the project code (that is, 'VCa02') to make it easier to select the correct project folder within the GPS processing software (refer to [SOP 8: GPS Use: Navigation, Data Collection, and Downloading](#)).

- Images – For storing images associated with the project, refer to [SOP 20: Photographic Image Processing and Management](#).

Note: This folder contains subfolders to arrange files by year.

- Spatial information – Contains files related to visualizing and interacting with GIS data.
 - GIS data – New working shapefiles and coverages specific to the project.
 - GIS layers – Pointer files to centralized GIS base themes and coverages.
 - Map documents – Map composition files (.mxd).

Naming Conventions

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name.
- Use the underbar (“_”) character to separate folder name components.
- Try to limit folder names to 20 characters or fewer.
- Dates should be formatted as YYYYMMDD.

File Naming Standards

- In all cases, file names should follow these guidelines:
- No spaces or special characters in the file name.
- Use the underbar (“_”) character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.

Archival and Records Management

All project files should be reviewed, cleaned up and organized by the Project Lead and the Plant Ecologist for each park on a regular basis (for example, annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director’s Order 19, which provides a schedule indicating the amount of time that the various kinds of records should be retained. Many of the files for this project may be scheduled for permanent retention, so it is important to isolate and protect them rather than lose them in the midst of a large, disordered array of miscellaneous project files. Because this is a long-term monitoring project, good records management practices are critical for ensuring the continuity of project information. Files will be more useful to others if they are well organized, well named, and stored in a common format. In addition, it is important that files containing sensitive information be stored in a manner that will enable quick identification. Refer to [SOP 27: Sensitive Information Procedures](#) for more information.

To help ensure safe and organized electronic file management, NCCN has implemented a system called the NCCN Digital Library, which is a hierarchical digital filing system stored on the NCCN file servers (Boetsch and others, 2005). The typical arrangement is by project, then by year to facilitate easy access. Network users have read-only access to these files, except where information sensitivity may preclude general access.

As digital products are delivered for long-term storage according to the schedule in [SOP 26: Product Delivery Specifications](#), they will be catalogued in the NCCN project tracking database and filed within this the NCCN Digital Library. Analog (non-digital) materials are to be handled according to current practices of the individual park collections.

Reference Cited

Boetsch, J.R., Christoe, B., and Holmes, R.E., 2005, Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program: U.S. Department of the Interior National Park Service, Port Angeles, Wash., 88 p. Available at: <http://www1.nature.nps.gov/im/units/nccn/datamgmt.cfm>.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 2: Hiring Guidelines and Procedures

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes procedures for hiring the seasonal field crew for the NCCN's Long-Term Ecological Monitoring of Forest Vegetation. Job announcements must be completed in December and posted in early January. Certifications are to be completed in early February so that the applications can be viewed at this time, crews can be selected, and background check paperwork can be submitted by the end of February. Adherence to this time schedule will increase the ability to hire a quality field crew, and to complete the required paperwork before the field season begins in May.

I. Hiring the Field Crew

Once the certifications have been completed, the Project Lead and Park Plant Ecologists will arrange a time to meet, review the applications, and begin or arrange interviews with potential hires and their references. The following forms or documents offer guidelines and allow documentation for interviewing:

- Interview Questionnaire for Seasonal Biotech Position** (*I:\NRM\Working\Vegetation\VCa02\Documents\Hiring\Questions_Interview*): Documents interviews with potential crew hires and suggests interview questions.
- Questionnaire for Biotech References** (*I:\NRM\Working\Vegetation\VCa02\Documents\Hiring\Questions_References*): Documents interviews with references and supervisors of crew members and suggests interview questions.
- Hiring Contact Record Form** (obtain from Personnel): Documents contact with biotech and their response to a job offer or availability request.
- Interview Guidelines from the U.S. Department of the Interior** (available on the web):
 - Selection Interview:** To provide a supervisor with job-related information upon which a selection can be made. <http://www.doi.gov/hrm/pmanager/st13c1.html>.

- Ranking Interview:** To evaluate and reduce the number of qualified applicants: <http://www.doi.gov/hrm/pmanager/st13c2.html>.
- Inappropriate Interview Questions:** <http://www.doi.gov/hrm/pmanager/st13c3>.
- Interview Subjects:** Guidelines for interview topics <http://www.doi.gov/hrm/pmanager/st13c4.html>.

II. Field Lead Qualities

The Field Lead will work with the Park Plant Ecologist for the park at which they are stationed. The Park Plant Ecologist will be the key contact for planning and logistics. Qualities to seek in potential Field Leads include the following:

- Proficiency at identifying vascular and non-vascular plants of the Pacific Northwest.
- Ecological survey experience, preferably conducting repeated vegetation sampling and tree stand measurements.
- Experience with scientific field equipment.
- Substantial backcountry orienteering and backpacking experience.

- High level of physical fitness.
- Familiarity with one or more of the NCCN parks.
- Leadership experience.
- Strong organizational skills.
- Ability to get along well with others in a field crew setting.
- Knowledge of (or preferably, certification in) wilderness first aid.
- Ability to drive a vehicle.

If at all possible, priority consideration should be given to previous years' Field Leads or Field Technicians, to maximize year-to-year consistency in field operations and methods. Once selected, the Field Lead, especially if new, should review the entire protocol and discuss any questions with the Project Lead.

III. Field Technician Qualities

The Field Technicians do not need to have the same level of experience nor all required skills as the Field Lead, however, similar general qualities should be sought:

- Proficiency at identifying vascular plants of the Pacific Northwest. Ability to also identify non-vascular plants will be highly valued. Successful candidates should at least be able to identify common plant species, and be able to demonstrate enthusiasm and ability to learn to identify new species.
- High level of physical fitness.
- Ability to get along well with others in a field crew setting.
- Ecological survey experience, preferably conducting repetitive vegetation sampling and tree stand measurements.

- Backpacking experience and proficiency at backcountry orienteering. Because orienteering will be emphasized during training, the orienteering requirement may be waived keeping a balance of required skills within the crew.
- Familiarity with one or more of the NCCN parks (desirable but not required).
- Knowledge of (or preferably, certification in) wilderness first aid (desirable but not required).

Although the first three of the above qualities should be considered mandatory, the others are desirable but not strictly required, as long as there is a balance of required skills within the crew. As with selection of the Field Lead, priority consideration should be given to returning crew members, to maximize year-to-year consistency in field operations and methods.

IV. Informing New Hires

Soon after being hired, Field Technicians should be sent the following (see [SOP 3: Preparation of Information Packets, Schedules, Equipment, and Supplies](#)):

1. A written description of job expectations, duties, and responsibilities.
2. Supervisor contact information.
3. Start date, time, and location.
4. Proposed season schedule.
5. Maps of headquarters, each park, and local towns, plus local information.
6. List of all plant species likely to be encountered during the field season (see [SOP 6: Training Field Crews](#)).
7. List of camping and hiking gear recommended and/or supplied by LTEM.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 3:

Preparation of Information Packets, Schedules, Equipment, and Supplies

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP provides instructions for preparations prior to field crew arrival and the ensuing field season for the three national parks: Mount Rainier (MORA), North Cascades (NOCA), and Olympic (OLYM), as part of the NCCN's Long-Term Ecological Monitoring of Forest Vegetation. Preparations for orientation, field training, personnel coordination, season scheduling, and for assessing and ordering equipment and supplies are covered herein. This procedure will begin in March and continue through the start of orientation in May.

I. Scheduling and Coordinating with Personnel

1. Update the season schedule ([table 3.1](#)). A minimum of 10 pay periods is required for two 4-person field crews to sample two panels each season; this includes 2 weeks training, but may not cover all data entry tasks. When planning field tours, keep in mind the time constraints listed below. Once plots have been visited, a logistics record at the bottom of each Event Form will help with time assessments. Consider the following:
 - a. Transportation time to and from campsite or housing
 - b. Hiking to and from plot each day
 - c. Approximate time to complete plots:
 - i. Elevation Band 1 (0–300 m): 4 days
 - ii. Elevation Band 3 (600–900 m): 3 days
 - iii. Elevation Band 6 (1,500–1,800 m): 3 days
 - d. Crews may take up to twice as long to complete a plot on their first tour.
 - e. A full office day at the end of each tour is essential to the well-being of the crew and the data. The crews need time to download photographs, GPS points, maintain equipment, identify plants, and enter data while it is still fresh in their minds.
2. Create a map for each park with the plot locations to be visited that year.
3. Send copies of the schedule and map to:
 - a. Project Lead
 - b. Park Plant Ecologist/Botanists at each park
 - c. Crew hires
 - d. Optional: Trail packers, Dispatch/ComCenter, Wilderness Information Center (WIC)
4. Secure plans to pick up the vehicles that will be used by the crews during the field season.
5. When the vehicles arrive, make a duplicate set of keys to keep in a designated key drawer or key board should the original set be lost or misplaced.
6. Arrange and confirm scheduled orientation and field training dates with Project Leads and training personnel (that is, Safety Officer, radio personnel, Database Manager, GPS Specialist, Botanists, Pathologist, and others).
7. Arrange for introduction of crew to key personnel for the first week the crew arrives (as outlined in section III. Tour of Headquarters in [SOP 5: Orientation of Field Crew](#)). This sets the groundwork for cooperation among park personnel.
8. Contact radio personnel and coordinate radio use and protocol for that season for each park.
9. Contact trail maintenance packing crews to coordinate the transportation of plot gear and some food and supplies. Information on packers available at each park can be found at: *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Travel_Logistics\Packers*. The packers may bring in I&M gear either while packing for trail maintenance crews, or at our convenience for a cost.

For most situations, the packers would like I&M gear in advance, placed in a bag for each destination, and labeled with the destination, our name and phone number. The packers can then take the gear into the backcountry at their convenience. Ask them where to store the bags prior to the packing trip. Obtain a copy of their schedule and follow up with a phone call prior to each packing trip that goes near our destinations to assure that our gear will be transported. In the future, I&M may be asked to contribute funds for packer use.

10. Contact the aviation office at each park to inquire about helicopter flights in the parks. If helicopters are flying to locations near LTEM plots, supplies could be transported by helicopter and left at a designated site.
11. Speak with the WIC office at each park to let them know that our crews will be contacting them for backcountry permits.
12. Speak with the dispatch office at each park. Let them know our plans for the season, crew member names, and the crew call number. Inquire about current dispatch protocol, and operating hours. Obtain current guidelines and tracking documents to be filled out by crew before each tour.
13. Reserve seasonal housing for:

- a. SCA at OLYM
- b. SCA at NOCA
- c. Three NOCA crew members (OLYM crew must secure own housing)
- d. Housing for 2 weeks training at OLYM (NOCA crew only)

14. Reserve housing, ranger stations, and/or campsites for the season’s field tours at all three parks (*I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Travel_Logistics\Housing*).
15. Reserve the following for the 2 weeks of orientation and training:
 - a. Conference room
 - b. Powerpoint projector
 - c. Laptop computer

II. Informing Field Crew

1. Print orientation documents and prepare welcome packets to be mailed to new crew members. Include the information sheets in [table 3.1](#). Items are located in *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Orientation\Orientation_Package*. Some items, such as park maps and supervisor contact information, must be obtained or updated at the beginning of each season.

Table 3.1 Information documents for new seasonal field crew.

File name	Document description
Cover_Letter.doc	Cover letter
(Update each year)	Complete job description (copied from USA Jobs)
(Update each year)	Supervisor contact info (name, phone, email)
(Announce each year)	Start date, time, and location
2007_Season_Schedule.doc	Season Schedule – Proposed
Orientation_Schedule.doc	Orientation Schedule
Year_Park_Plot_Map.doc	Map of plots for the current year at assigned park
Map_ONP_Headquarters.doc	Map of headquarters (highlight the meeting location)
(Obtain each year)	Map of each National Park (MORA, NOCA, OLYM)
(Obtain each year)	Map of local town
(Update each year)	List of items required to fill out employment forms on first day (for example, driver’s license, social security card)
Local_Info_PA.doc	Local information about housing, camping, stores, pet care, library, recycling centers, etc.
Gear_Recommended.doc	Gear recommended for camping/hiking in Pacific Northwest
Gear_supplied_NPS.doc	Gear supplied by NPS for the field season

III. Ordering Supplies

In March, inventory project supplies and determine what needs to be ordered for the upcoming field season. Reference the crew lead's inventory report completed at the end of the previous year's field season. [Refer also to the list of gear supplied by NPS ([table 3.2](#)).] Check that enough gear is available for the planned number of crew members and the planned number of plots at each park. Restock the First-Aid Kits using the checklist ([table 3.3](#)), and consider what safety supplies may be needed in vehicles ([table 3.4](#)). Contact information for companies and stores that have stocked equipment is located in *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Equipment_Lists\Company_List*. Label all new supplies with "LTEM forest Veg" and the 4-letter abbreviation for the park that purchased the supplies (MORA, NOCA, OLYM). Number the gear if there is more than one of a particular item (that is, hand lenses, compasses, tents, etc.)

Table 3.2. Gear supplied by National Park Service for the field season.

Gear	
Day pack (limited supply)	Compass
Pack cover	Bear barrel
Trekking poles	Water filter
3 person tent, with ground cloth and fly	Raingear
MSR camp stove	Hand lens
Fuel bottles and fuel	Bug net
MSR cooking pots	

Table 3.3. First-Aid Kit item list.

Item	Qty	Item	Qty
Moleskin	1 p.	Antihistamine	10
Second skin	1	Cold pack	1
Ace Bandage	2	Gloves	Pair
Cleaning wipes	10	Duct Tape	1 m
Antibiotic ointment	1	Tweezers	1
Iodine	1	Scissors	1
Sterile bandages		Triangular bandage	1
Sterile gauze		Microshield mask	1
Tape	1		
Pain reliever	20	CA-1 accident report form	3

Table 3.4. Vehicle gear.

[Keep the following equipment secured in the vehicle]

Vehicle Gear	
Washington atlas and gazetteer	Extra field gear that might come in handy: <ul style="list-style-type: none"> ◦ 50 m tape ◦ Pin flags ◦ Spare camp stove ◦ Extra data sheets ◦ Plant press ◦ Binoculars
First-Aid Kit	
Fire extinguisher	
Flashlight, warning markers or reflectors	
Car jack and lug nut wrench	
Jumper cables	
Spare tire	
Space blanket	
Camera	
CA-1 Form	
Motor Vehicle Accident Report Form	

IV. Preparing Camping Supplies

1. Refer to the Crew Lead's inventory report from the previous year. At the end of last season, the field and camping gear was checked and properly stored after noting and presenting any problem gear to the Project Coordinator. Make sure that non-functioning camping gear is fixed or replaced.
2. It is essential that the **field crew** take time to inventory and check the gear that they will use themselves (rain gear, stoves, filters, First-Aid Kit, etc.). This should be done on the first day of orientation, or the first day of arrival at their home park, so that any problem gear can be addressed before field work begins. Consider having gear from the other park(s) organized into large plastic tubs and brought to orientation.
3. Each tent should be set up and fully checked over. Examine the tents to determine whether they require additional seam sealer on the rain fly and around the bottom of the tent.
4. Test the camp stoves to make sure they are in working order, and that each crew knows how to safely use and maintain them. Replace the repair kits if necessary.
5. Be sure that enough new white gas (or canisters for other stove types) is on hand to cover the crews for the field season. By law, the fuel is required to be stored in a "fire safe" location. OLYM fuel is contained in gallon tin containers labeled LTEM and is kept at all times in the fire shed—the stone building beside fire management. Inquire at NOCA where fuel is to be stored.

6. Fuel canisters are stored with the fuel. Two 22 oz. canisters are usually enough for a crew for an 8-day tour. For each stove set, make sure there are two working lighters and matches in a water tight container. Neither work well in a heavy down pour or when they are wet.
7. Test the water filters and make sure that the crew knows how to properly use and clean them.
8. Inspect and clean the bear-resistant food containers (BRFC) – one food container per person. The large, light-weight, composite bear canisters are 900 in³ (9-in. base × 14 in. length), and recommended for 8-day tours. Some crew members prefer the smaller hard plastic canisters.
2. Check that there are enough field sets of dichotomous botanical keys and/or field guides that are up-to-date and appropriate for each park location for both vascular and nonvascular plants. Additionally, inspect the field keys for condition and repair or replace as necessary.
3. Prepare a plant press for each crew with adequate newspaper, blotters, and cardboard pieces.
4. Check that there is a working radio, battery, spare battery, and charger for each crew, and that the radio is programmed for the parks in which the crew will be working.
5. Charge all batteries that will be used in the field, including batteries for the GPS unit, digital camera, laser range finder, and radios.

V. Preparing Field Supplies

1. Determine needs for ordering (and constructing) plot marking gear, either for initial set up or replacement of missing parts.
 - a. Rebar – 9 per new plot
 - b. Cedar stakes – 72 per new plot
 - c. Tree tags – 100 per new plot
 - d. Temporary tree tags – for initial replacement of missing tags
 - e. Aluminum nails – 100 per new plot

VI. NPS Provided Gear

The Project Coordinator and Park Plant Ecologist/Botanists will inventory gear at each park to see what is available for the current year's crews ([table 3.2](#)). Crew members will be notified upon hire as to what gear will be provided. Gear needs should be assessed at the end of each season, and included in budget considerations for the following year.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 4: Preparation of Reports, Data Sheets, Maps, and Images

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes instructions for preparing reports, datasheets, maps, and images needed for the survey of forest monitoring plots in three National Park units (Mount Rainier (MORA), North Cascades (NOCA), and Olympic (OLYM)), as part of the NCCN's Long-Term Ecological Monitoring of Forest Vegetation. This procedure is carried out prior to the beginning of the field season, and materials should be organized for each plot visit, and placed into respective plot envelopes. The materials described herein are valuable for route-finding through the study area, locating plots, interpreting the landscape, completing tasks, and sampling at each plot. Each crew must have the following maps and documents with them in order to effectively install or measure a set of sampling plots.

I. Preparation of Printouts

For each plot being visited during the ensuing field season, print the following documents and place each set into a large envelope (approximately 11 × 12 inches; one per plot), labeled with the plot identification code (for example, NOCA3-007) and a site name (for example, Rocky Point). Remove the sticky adhesive on the envelope flap to prevent accidental sticking in the field.

1. Visit Report.

A photocopy of the last Event Log from the plot you plan to visit will serve as the visit report (see [SOP 12: Event Log](#)). This report contains information about the plot, including navigational directions, tasks that must be completed, extra equipment or supplies needed, logistics, and helpful tips. The Event Log should be reviewed before heading into the field, and brought along into the field. If you are setting up a new plot, obtain the corrected UTM coordinates (differentially corrected after the reconnaissance visit), and write them on the photocopied Plot Event Log. Prior to plot establishment and set up, compare corrected UTM coordinates to target UTM coordinates to determine if plot center should be moved, and by what distance and direction (azimuth).

2. Mortality Assessment Datasheet. (*I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Reports\Field_Reports*).

The Mortality Assessment Datasheet is created by the Data Manager, and located in the Field_Reports folder. It is produced from the Tree Datasheet of the previous year, listing only trees with Tree Status "L" (live, or those that need checking), and leaving empty the columns for tree attribute data that are to be collected. Mortality assessment will be conducted every visit year, at each plot, after the initial plot sampling year ([SOP 13: Tree Data](#), section VI: Mortality Assessment).

3. Stem Map. (*I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Reports\Field_Reports*). The stem map is produced by the GIS Specialist, and located in the Field_Reports folder. The map shows tagged tree locations.

4. Site Map. (see [SOP 11: Establishment Form](#).) The site map is a diagram with environmental features hand-drawn by crews during previous visits to the plot. Completed site maps should be photocopied and placed into appropriate plot folders. A copy is taken on future plot visits for adding environmental features or corrections. The site maps may be scanned and maintained in VCa02 Field_Reports folder.

5. Plot Layout. (see [SOP 11: Establishment Form](#)) This useful reference diagrams the plot layout with subplot number locations and distances. It is helpful to have a quick reference of the numbering system to find your way around the plot. These also can be diagrammed into your field notebook.

6. Datasheets. ([SOPs 12–17](#)) Assemble complete sets of datasheets for each plot being sampled in the coming season per instructions in [table 4.1](#). The Reconnaissance Datasheet ([SOP 9: Reconnaissance Form](#)) is used only for initial reconnaissance, not for plot sampling. Photocopy all datasheets onto 2-sided Rite-in-the-Rain® paper and collate into sets. Place a set into each plot envelope.

7. Images sheet. Print in color using “Print Screen” the thumbnail view of images previously taken at each plot so the crew will have a reference frame for taking plot photographs.

8. Voucher Envelopes.

Note: There are separate voucher envelopes for the lichen survey and the cryptogam surveys ([SOP 17: Lichen Survey](#)). The lichen sample packets should be kept separate from the Cryptogam voucher envelopes and never mixed up.

Table 4.1. Number of each datasheet needed to sample a single permanent plot.

Number	Datasheet	Details	SOP
1	Plot Layout	1 sided	10
1	LTEM Forest Plot Establishment Form (initial visit)	2 sided	11
1	LTEM Forest Plot Event Log	2 sided	12
3	LTEM Forest Plot Tree Data	2 sided	13
20	LTEM Forest Plot Quadrat Data	2 sided	14
1	Downed Woody Material	2 sided	16
1	LTEM Forest Plot Epiphytic Lichens	1 sided	17
30	Lichen Sample Packet	1 sided	17
~30	Cryptogam Voucher Envelopes	1 sided	14

Permanent plot maps may be laminated in plastic for field use in inclement weather. To make a new map:

- Go to *I:\NRM\Working\Vegetation\VCa02\Spatial_info\MapDocuments* and select the file labeled with your parkcode (that is, OLYM-field-maps). All shape files you need should be there for making maps of plot locations.
- Set scale as prescribed
- Add a map title
- Add plot UTM's
- Adjust the scale length (click and drag)
- Determine whether or not to include the grid
- Always include the North arrow, and Datum information
- Orthophoto images should be clearly visible and the background themes should be clear and not over-pixelated.
- Maps made ahead of time are stored in *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Spatial_Info\Maps*.
- Maps that have been pre-made and laminated are in the plot envelopes.

II. GIS Maps and Orthoquads

Plot Maps. Print topographic maps of the area on waterproof paper. Use a 1:25,000 scale to show the plot in the larger context of travel and its relationship to important map features, roads, and trails. Use a 1:10,000 scale to show in detail the area in which the plot lies. Use 1:10,000 or 1:6,000 scale for orthophotographs. Print four copies at 1:25,000, one for each crew person, and one copy of the other maps.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 5:

Orientation of Field Crew: Park Buildings, Field Preparation, and Safety

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes instructions for preparing new crew members upon their arrival at their National Park job site for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. Some paperwork will be sent ahead of time so that crew members know what to expect and feel prepared from day one. The goal is a successful field season with a satisfied crew that is well informed, able to work cooperatively with other park personnel, and prepared to follow the guidelines expected of park employees. Activities that should be completed in the first week of the 2-week training period are outlined below. These may be followed immediately by the field training outlined in the [SOP 6: Training Field Crews](#). The Project Lead will ensure that orientation requirements are met.

I. Orientation Supplies

Upon arrival the crew hires will be supplied with:

1. An orientation schedule
2. A 3-ring binder for organizing handouts (access to a 3-hole punch)
3. Lined paper for taking notes
4. Pencils
5. A copy of the LTEM Forest Vegetation protocol and a set of datasheets. Crews will **not** need a complete copy of the appendixes.
6. A complete copy of the LTEM Forest Vegetation protocol is available in the office for each crew to reference, and also available on the park drive:
 - At Olympic at *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\SOPs\SOP_FOREST_VEGETATION*.
 - At North Cascades NP at *T:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\SOPs\SOP_FOREST_VEGETATION*

II. Paperwork and Personnel Logistics

The Project Lead will address the following items with hired employees in the first few days of employment.

1. W-4 form, emergency contacts, bank deposit information, etc. to be completed with administrative personnel.
2. Details of seasonal appointment including the work schedule, holidays, Sunday pay, annual leave pay, and leave and earnings statements.
3. Unemployment and rehire status.
4. How timesheets should be handled, who will fill them out, and where they are turned in.
5. How to use annual leave or sick leave, who needs to be notified, where to get a form, and where to turn it in.
6. Travel per diem, travel forms, to whom and where travel forms are turned in.
7. Performance evaluation procedures. The crew will be given a written document of expectations and evaluation criteria to read, ask questions about, and sign. Work performance will be evaluated by the Project Lead half way through the season and at the season's end.

Crew members should expect some suggestions for improvement, as well as recognition for hard work and accomplishments. Crew members may bring up questions and concerns with their supervisors at this time, however, crew members are encouraged to communicate with the Crew Leader, Supervisor, and/or Project Lead throughout the project as needed.

8. Accident forms and procedures: Paperwork, time frame, and procedure for notification.

III. Tour of Headquarters

The Project Lead and/or local Park Plant Ecologist/Botanist, will lead a tour of the buildings, and introduce key personnel for new employees at their designated park. Visit the following buildings at each park if applicable:

1. LTEM crew office building
2. Administration Building: Human Resources
3. Computer support office: *Supply handout on how to use the web-based helpdesk*
4. Dispatch building
5. USGS building
6. Radio shop
7. Herbarium and Collections, Cultural Resources
8. Fees and Regulations: *Acquire Park Pass*, discuss any essential park rules and guidelines with personnel
9. Fire shed: Location of LTEM fuel and fuel bottles
10. Maintenance building
11. Procurement: *Acquire keys*, where to pick up supplies and packages
12. Natural Resources Management building(s): meet office manager, chief of NRM, GIS support, database support, and other personnel
13. Greenhouse: Tour of facility and program by greenhouse coordinator
14. Visitor Center
15. Wilderness Information Center: Inquire about any available resources, how to attain a wilderness permit, and any recommended guidelines from WIC personnel
16. Other important locations not mentioned above (may differ by park).

IV. Office Training

The Project Lead and/or Park Plant Ecologist/Botanist will give new crew members a tour of the office including files, maps and gear storage, and what phone is available for their use. Following computer IT Security Awareness Training, the Project Lead will assure that crew members become familiar with local computer usage, email, resource information, the local park drive, location of project files, etc., and that the crew knows which computers are available for their use. Crew members are responsible for completing the IT Security Awareness Training in the first week of employment, and checking that their email account is working properly. They are further responsible for reading their NPS email before and after each tour. Because of closely shared office space, it is *critical* that the crews know what space is designated for their gear, storage, and work, and to be considerate with noise and placement of belongings.

V. Crew Gear and Packing

The Project Lead will distribute LTEM individual gear to crew members for the season. Crew members will check out the equipment as outlined below. A backpack packing demonstration is highly recommended so that crew (new crew *especially*) will be prepared for 8 days in the backcountry, catering to weather conditions in the Pacific Northwest.

Sign-In and Sign-Out Procedure

Individual Gear: Includes pens, pencils, field notebooks, hand lenses, compasses, flagging, and a limited number of daypacks/backpacks. Each crew person must sign their name on the “Individual Equipment Checkout Form” and include the equipment type, I.D. number and the date checked out (*I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Equipment_Lists\Gear_checklist_individual*). This form must be filled out before project gear goes into the field. If crew prefer to use personal gear in place of provided project equipment NPS **can not** be responsible if it is lost, stolen, or broken. At the end of the field season, a Supervisor will check to see that the equipment is returned. This procedure is used to identify lost, inoperative, or consumed equipment.

Group Gear: is checked out to the crew at the beginning of the field season (*I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Equipment_Lists\Gear_checklist_group*). The crew will care for the team equipment making sure to return it to the equipment box cleaned and dried at the end of each sampling tour. Specific equipment is maintained as follows:

- Water filters** backflushed with clean water
- Tents** cleaned and dried
- First-Aid Kits** restocked (and dried if necessary)
- Batteries** recharged or replaced
- Stoves** cleaned and burn tested
- Cook kits** washed
- Fuel bottles** filled and returned to fire safe location

The Equipment Form can be kept on a clipboard beside the gear storage area. Comments regarding broken or lost gear, or any problems with gear, can then be recorded with date on this form. Bring gear issues to the attention of a Supervisor.

Miscellaneous Equipment

Batteries: Batteries are required for (1) Radios, (2) Camera, (3) GPS, and the (4) Laser Range Finder. Radio batteries are rechargeable; inquire about their ability to hold a charge before leaving them on the charger for several days. Check for the best batteries to use for your camera, Laser Range Finder, and GPS unit. Rechargeable AA batteries are an option, but sometimes not the best for field instruments. With so many batteries to keep track of, it is essential that the crew keep on top of battery recharging and replacement needs. First always carry a spare set in the equipment case for each piece of equipment. Upon return from the field, recharge all rechargeable batteries and replace spent batteries. If someone is going to be around the office who can reliably recharge the batteries, batteries may be placed in the **TO BE RECHARGED** box. Place dead batteries (alkaline or lithium) in the **DEAD BATTERY** box, to be properly disposed of at the end of the season. Notify the Project Manager or Supervisor before you get dangerously low on disposable batteries.

VI. Safety

Safety in the Woods

- **Clothes.** Wear protective clothing: Long-sleeved shirts, long pants, and gloves may protect you from contact with brush, rocks, and stinging insects. Trouser legs should be loose enough to avoid binding or cramping, and should not have cuffs. Hats, protective glasses, and head nets also may be helpful.
- **Boots.** Wear good quality boots that provide good support and traction, and can be water-proofed.
- **Walk.** Do not run in the woods. Take your time and plan your route. Avoid plunging through the brush. The best route of travel may not be the shortest. Routes across brushy, irregular terrain with rocks and down logs is hazardous. Keep at least one foot on the ground at all times; beware of bark sloughing from logs. Walking while reading instruments is hazardous.
- **Eyes.** Be watchful of twigs and branches, which may cause eye injury. Be especially alert when stepping up to trees that retain their small dead twigs. Keep a sufficient distance behind the person ahead of you.
- **Buddy system.** Always work in crews of at least two people.

Job Hazard Awareness and Safety Analysis

The project lead will go over the “Job hazard awareness and safety analysis form,” located in *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\Documents\Safety*, with crew members, discussing each item. The crew is encouraged to share their experiences, and new items may be added to the form.

Vehicle Use and Safety

The Project Lead will go over vehicle use and safety with crew members as follows:

1. Vehicle use
 - Key drawer or board: Where keys (and spares) will be kept at all times when not in use
 - How to use government credit card for purchasing gas – **Note:** Save receipts
 - Other items covered by government credit card (car wash, tire repair, unexpected needs such as motor oil and windshield wipers) – **Note:** Save receipts
 - Ferry Travel: Obtaining fee waiver slips, if need be
 - How to schedule if using shared vehicle

- 2. Vehicle Safety
 - Safety checklist ([table 5.1](#))
 - Location and use of vehicle safety equipment (tire gauge, jumper cables, camera, etc.)
 - Emergency procedures
 - Procedure and equipment for changing a flat tire
 - Defensive driving video, if required
- 3. Safety on the Road
 - **Seat belt.** Use is required in all government-owned or leased vehicles and is required by law in the State of Washington for driver and all passengers. Do not ride in the back of pickups.
 - **Drive defensively.** Expect the other person, whether a vehicle operator or a pedestrian, to do the worst things and be prepared. Observe all speed regulations and traffic signs.
 - **Alert and in control.** Do not drive when sleepy, taking medication, or when other personal conditions make it unsafe to drive a vehicle. Get someone else to drive or, if alone, stop driving and nap (out of public view).
 - **Hands on the wheel.** Keep both hands available for driving at all times. Using a handheld cell phone is illegal in Washington.
 - **Headlights.** Always drive with headlights on to increase the visibility of the vehicle. It is particularly important when driving in fog, on dusty roads, traveling in and out of shadows, and any other low light/visibility situations. Turn lights off when parking the vehicle.
 - **Conditions.** Do not operate a vehicle in an unsafe condition. Check the vehicle frequently to keep it in good mechanical condition. Lights, horn, steering, and brakes should be kept in proper adjustment at

- all times. Make necessary repairs as soon as unsafe condition develops. Report any unsafe conditions to your Supervisor.
- **Keep the vehicle clean.** Windows, mirrors, and lights should be kept clean and free of obstructions to increase visibility. Keep the cab and driver area clean so material is not rolling under pedals or distracting the driver.
- **Downhill.** Shift to a lower gear at the beginning of a downhill grade, if the grade is a long, steep descent. This will save the brakes.
- **Speed.** Adjust vehicle speed to the driving conditions. Wet, icy, or snowy roads and decreased visibility require decreased speed. Be aware of speed when changing from one type of road to another, that is, freeway to secondary highway to gravel and adjust speed accordingly.
- **Tail-gating.** Allow at least 3 seconds of travel distance between yourself and the vehicle ahead. Under slippery road conditions and poor visibility, allow more distance.
- **Be aware of your vehicle’s idiosyncrasies** and adjust your driving accordingly.
- **Back up safely.** Walk around your vehicle to check for hazards before backing and use a spotter to guide you.
- **Navigation.** Do not drive and navigate at the same time. If the driver needs to look at maps and photographs, stop at a safe place, then look at them.
- **Watch for animals on the road.** Most hoofed animals travel in groups, so where there is one, assume there are many, all just itching to jump out in front of your vehicle. Stop and let the animal move off the road, look for others to follow, then proceed on. If you cannot stop in time to avoid hitting an animal, it is generally better to hit it, than to swerve, drive off the road, or hit another vehicle.
- **Oncoming vehicles.** Be especially alert for on-coming vehicles, when driving on single-lane roads. Vehicles may be moving at high speeds in a shared lane and not paying attention when coming around corners.
- **Blind curves.** Keep as far right as is safely possible on blind curves on single-lane roads. If the curve is blind and less than two lanes wide, slow way down and be ready to take evasive action. You also may honk as you approach a blind curve on a single lane road.
- **Yield.** Yield to *uphill* vehicles on roads wide enough for only one vehicle.
- **Parking.** Park the vehicle so that it is not a hazard to other drivers. Do not park where dry grass or other potential fuels can come in contact with your vehicle’s hot exhaust system.

Table 5.1. Vehicle safety checklist.

Check the following on your vehicle at the beginning of the field season and before each tour:
(a) Tires: Pressure (do tires look low?) and tread condition
(b) Fluids: Coolant, motor oil, transmission, and other under-the-hood fluid levels
(c) Gas: Check that the tank is full. When traveling across park, fill the tank before leaving the last available gas station.
(d) Lights: Brake, turn signals, tail lights, headlights
(e) Horn
(f) Windshield (GSA pays for repairable chips)
(g) Windshield wipers: Condition
(h) Body damage: Dents or scratches, etc.
(i) All items secure: Secure items so that they are not able to fly at passengers in the event of an accident.

4. Backcountry Basic First Aid – How to treat common backcountry injuries with First-Aid Kit and backcountry equipment available, using a hands-on approach.
 - **Ankle sprain:**
Use Ace bandage wrap or triangular bandage.
 - **Fractures:**
Control serious bleeding, treat for shock, check for pulse of injured extremity, remove or cut clothing from injury site, if possible gently move fractured limb to splinting position, splint extremity, immobilize joints above and below the fracture site, leave fingers and toes exposed to monitor circulation and nerve function.
 - **Leg fracture:**
Splint in place; if open fracture, bandage to stop bleeding. A splint can be made from hiking or tent poles wrapped with triangular bandage and/or rope to keep splint in place.
 - **Arm fracture:**
Bandage open fracture wounds. Splint with arm to body using triangular bandage. Splint with section of trekking pole or tent pole.
 - **Hand fracture:**
Check for circulation and nerve impairment; splint with ruler, pencil, or stick.
 - **Joint dislocation:**
Common dislocations are of the shoulder; check for pulse in injured extremity; splint with triangular bandage.
DO NOT attempt to straighten any dislocated joint (serious nerve and blood vessel damage may occur).
 - **External Bleeding** - Methods to control: direct pressure, elevation
DO NOT elevate extremity if there is a possible fracture, dislocation, impaled object, or spinal cord injury. Pressure points (use only if direct pressure and elevation fail): Brachial and femoral, are the most important to know.
NEVER remove a dressing that is in place, apply more dressing on top if needed.
 - **Laceration:**
Use butterfly bandages to close the wound then dress with 4 × 4 sterile pads, bandage with gauze, and triangular bandage.
 - **Puncture:**
DO NOT remove an impaled object, dress and bandage around it, stabilizing the object. Treat for shock.
 - **Hypothermia:**
Keep person dry and warm, remove wet clothing, place person in sleeping bag.
NEVER allow a person to remain in or return to a cold environment.
 - **Heat exhaustion or stroke:**
Cool the person, get in shade, treat for shock check vital signs.
 - **Shock:** Metabolic (loss of body fluids) and Anaphylactic (allergic reaction). Treatment: ABC (Check for Airway, Breathing, Circulation), control bleeding, splint fractures, elevation of legs, be alert for vomiting, keep victim warm, check vital signs often.
 - **Animal attacks:** Cougar and bear, what to do: Stand up, **DO NOT RUN**, look as tall as you can.
 - **Choking:** Heimlich Maneuver and abdominal thrust (when person is lying down).
 - **Field Equipment that can be used in First-Aid procedures:**
Trekking Pole: The collapsible trekking pole can be used to splint leg fractures and can be pulled apart to serve as a splint for an arm fracture.
Bandana: can be used as a bandage or dressing material.
Other: Tent poles used as splints; sleeping pad can also be used as a splint.
5. What to do if injured
 - Keep a CA-1 Form, a Vehicle Accident Report Form, and a disposable camera for photographing vehicle accidents in the glove box of your vehicle at all times.
 - If injured, treat promptly. If immediate medical attention is required, go directly to a hospital emergency room. Try to make contact with your Supervisor or the office to get instructions and assistance. Make sure the doctor fills out his/her part on the CA-1 Form.
 - Inform your supervisor of all injuries and ask which, if any, forms need to be filled out. Supervisors must complete the Accident Reporting Forms at the earliest opportunity (NPS Office Order #9).
 - Fill out Federal Accident Forms completely with signatures. **ALWAYS** make a copy for your personal records. Give the completed forms to your Supervisor. Have the Supervisor check your entries for mistakes, fill out their section, and forward the completed forms to the appropriate person.
 - Gather information. If you are in a multi-vehicle accident, provide the other parties with enough written information so that they can easily get in touch with you, your Crew Supervisor, and the office. In turn, you must get the following information from all involved parties and witnesses—names, addresses, phone numbers, vehicle license numbers, driver’s license numbers, insurance company names, policy numbers, and police report numbers. If possible, do not admit responsibility without first contacting your Supervisor.

VII. Radio Use

The Project Lead and/or Park Plant Ecologist/Botanist will go over radio use protocol for the assigned park. The most recent radio information may be obtained from park telecommunications staff. Crew members will be shown:

- How to use the type of radio assigned to them (with handout).
- Where radios and batteries are to be kept when not on tour.
- Proper handling in the backcountry.
- How to maintain radios and radio batteries with specifics about battery longevity on the shelf and in the backcountry.
- How to contact dispatch.
- Which repeater to use in each region of the park.
- What type of radio communication is acceptable for the assigned park.
- Acceptable radio lingo for each park.
- Who to contact if radio malfunctions.

VIII. Wilderness, Backcountry, and Front Country Camping Etiquette

The Project Lead will go over “Leave no trace” camping practices and wilderness ethics, and park regulations applicable to front country camping. Crews are expected to read and follow posted NPS camping regulations and cooperate with NPS Rangers.

IX. Park Housing

Occasionally crews will be able to stay in temporary park housing or ranger stations during a tour. Because these are shared spaces, it is essential that the crews be considerate of the space and belongings of others. Recognize that some ranger stations are people’s homes for the summer and you are a guest. Upon arriving, introduce yourselves to others in building as crew of LTEM Forest Vegetation Project. Bring your own gear for cooking, eating, sleeping, and bathing etc. as this will usually not be supplied at the housing unit. Pick up after yourselves, always leave the space cleaner than when you arrived, and make sure that lights are turned off, heat is returned to the original setting, and the doors are locked. Return the keys as per your agreement with your Supervisor and/or the park staff.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 6: Training Field Crews

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP contains instructions for training crew members to perform the sampling procedures to monitor vegetation structure and composition for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. This procedure is carried out prior to the beginning of the field season, and commences in late May. Training needs will be determined by the program Project Lead each year once hiring has been completed. NCCN Park Plant Ecologists are encouraged to attend as much of the training as possible, so that they may become familiar with the crews and refreshed in the methods of plot sampling. Training may alternate between parks from year to year.

In addition to the set of procedures outlined below, each crew member may attend NPS seasonal training. This occurs in mid-June (OLYM: Monday-Tuesday; NOCA: Wednesday-Thursday). Two days of seasonal training is sufficient to introduce biotechnicians to park issues, current research, and park safety concerns. Crew members may attend a CPR/First Aid course if it is offered by the park.

I. General Procedures

1. Presentations. Training will begin with a PowerPoint presentation given by the Project Lead outlining the objectives of NCCN's Long-Term Ecological Monitoring (LTEM) project, and the project design. The presentation will cover the history of LTEM, the formation of NCCN, and the study plan, including the plot selection process, and the crew's role for the current field season and beyond. Toward the end of June, after the crews have had some time in the field, the Project Lead will again discuss the project, giving the crew an opportunity to ask questions and better understand the field work they have experienced. A crew that understands the project they are working on will be more interested and better able to collect quality data.

Additional PowerPoint presentations are available and may be used by the project coordinator to introduce:

- Vascular plant species occurring in plots
- Nonvascular plant species occurring in plots
- Common tree diseases and insect pests
- Clinometer method for measuring tree height

These topics will be further addressed with hands-on training.

Note: Crew members consistently prefer and benefit from hands-on training more than what is presented in the conference room.

2. Reading the Protocol. Each member of the vegetation sampling crew should read and become thoroughly familiar with the entire vegetation monitoring protocol at the start of each season. This may be accomplished in daily increments, facilitated by training. The Project Lead may choose to assign each person on the crew "Lead" status for a subset of the SOPs for this program.

Note: Individual skills and interests will become more evident as training progresses.

The crew member should become thoroughly familiar with the methods and materials required for their assigned procedures. Crew members may rotate through different tasks (with the exception of the lichen survey), but the Lead is responsible to see that their assigned task is being carried out correctly. Time will be provided for Leads of the different SOPs to undertake specialized training, if necessary. Crew members also are expected to indicate where they may need additional training.

3. **Training Plot.** In the second week of training, the Project Lead, and experienced crew will lead the crew in a mock reconnaissance, establishment, and sampling of a plot. Plan to spend no less than 3 days on this activity. Even with an experienced crew, review of correct methods is critical. Datasheets for each sampling activity can be introduced just prior to the activity. Experienced observers then guide crew members through the sampling techniques, first allowing new members to record data and then to take the actual measurements. Upon return from the field, the data can be entered into the database as would occur at the end of each field tour. Doing a complete trial plot allows for technicians to become thoroughly familiar with the datasheets, the individual SOPs, and the order in which these procedures are carried out. If the crew is new, it also will be necessary for the Project Lead or Park Ecologist to accompany the crew on their first sampling tour.
4. **Assessment.** Throughout the training of observers, the Project Lead must assess the accuracy and precision of the measurements being taken by the crew, discuss discrepancies, and correct mistakes that are being made. Field sampling for the program must not commence until the Project Lead is satisfied that measurements are being done in an accurate, consistent, and precise manner by all crew members. Ability to determine percent cover of vegetation will be assessed following the training session by having crew members assess vegetation cover in teams of two. Their results will be compared with those of the Project Lead and discussed while viewing the subplot. Error must be within 10 percent before cover estimation training can be concluded. Ability to conduct other measurements can be assessed during the in-field training.
5. **Returning Crew.** A key element for training will be to maximize the duration of each crew member's tenure with the program. Reducing turnover of staff is an important way to increase the efficacy of time spent in training each year. New crew members are essentially in "training" for the whole first half of the season. Experienced crew members will require less general training than new crew members, they will be able to help train new staff to the program, and they will increase the consistency of data from year to year. Consider who may be interested in remaining on the project for multiple years and provide them with additional training, direction, and incentive. Consider also cooperating with nearby universities that may be conducting similar sampling methods as part of their coursework.

II. Compass and Orienteering

Crew members will receive hands-on training with the Silva® Ranger 360°, or similar compass provided by NPS. Crew members will be instructed in the following:

1. **Safety.** Before heading into the field always bring one or more maps with you, and always have your own compass. Never assume this has been taken care of for you. Know where you are going, and notify another person of your plans.
2. **Tools.** Maps, orthophotographs, satellite availability chart ([SOP 7: Preparing for a Field Tour](#)), compass, altimeter, GPS, calculator, field notebook.
3. **Maps.** Use 7 ½ minute quads and orthophotographs at the same scale (1:24,000). Maps and orthophotographs should be printed on Rite-in-the-Rain® paper.
4. **Declination.** You will need to set the declination on your compass specifically for each park and the current year. Do not use the declination indicated on a topographic map; this will not be accurate for the current year. There are websites available for determining declination using zip code or longitude-latitude, and date. The Silva® Ranger type compasses can be set by inserting the attached metal screwdriver into the small brass screw on the front or the back of the compass and rotating until the north arrow points to the appropriate degrees. To do this most accurately, check that the south tail points to the correct degrees on the clinometer part of the compass. Declination can be checked at this and other websites: <http://www.thecompassstore.com/decvar.html>
5. **Azimuth.** Keep compass level, and away from metal. Hold the compass at eye level, adjust the mirrored lid so that the face of the compass is visible in the reflection. Use the sighting notch to position the compass. Turn the dial until the magnetic needle is within the box (put red in the shed); align other lines and center points to increase accuracy; read the degrees. It is important to practice proper positioning and alignment of the compass for accurate azimuth measurements. For less accurate readings, the compass can be held out in front with the lid flat. Use hands-on practice to familiarize yourself with your field compass. Check your assumptions against sun direction, etc. Intelligent people have been off by 180 degrees.
6. **Bearing.** To take a bearing from a map, lay the map down on a flat stable surface using the compass to orient the map N-S. Align the edge of the compass with the imaginary or penciled line that adjoins your present location to your target location. Your bearing can be read directly from the compass.

7. **Following a bearing.** Because we rely on the GPS for giving intermittent locations, it is usually enough to sight on an object (that is, large tree or snag) and walk to that object before sighting again. For more accurate sighting, two people can be used: check that the compasses are synchronized. One person takes sighting and walks, then back sights to the stationary person, and leap frogs. This method is time consuming.
8. **Distance.** You may want to record the distance traveled, for example, down a trail before turning into the woods, or you may want to know how far you need to walk to reach a point on a map. Horizontal or slope distance can be measured with a Laser Range Finder. Distance also can be estimated with pacing. To determine paces (a pace = 2 steps) lay out a 100-m tape and count paces. Record in field book for future reference. Two people can average their paces for greater confidence in the field. Keep in mind the great difference between horizontal and slope distance on steep slopes. You will need to adjust your estimates if you are reading from a horizontal map view and pacing on a steep slope. A slope correction table will help ([table 6.1](#)).
9. **Map distance.** Use the scale below each map. Some maps also are gridded with a set distance (that is, every 500 m). As a general reference, section lines when present are 1 mi apart, and UTM lines are 1 km apart.
10. **Contouring.** It is sometimes easiest to reach a point by contouring. Hike along a maintained trail until you are at the same elevation as the target point and then, staying at the same elevation, contour the hillside to the target point. Again, we often use the GPS to read and record our point of entry, but if you have a precise altimeter, this can be used to indicate when to begin contouring. Remember an altimeter needs to be adjusted several times a day at trail heads or other known elevation points to maintain accuracy under changing barometric pressures.

Table 6.1. Slope correction factors.

[Slope distance = horizontal distance * Expansion factor (EF); %, percentage]

% Slope	EF	% Slope	EF	% Slope	EF	% Slope	EF
5	1.000	42	1.085	79	1.275	116	1.532
6	1.001	43	1.089	80	1.281	117	1.539
7	1.002	44	1.093	81	1.287	118	1.547
8	1.003	45	1.097	82	1.293	119	1.554
9	1.004	46	1.101	83	1.300	120	1.562
10	1.005	47	1.105	84	1.306	121	1.567
11	1.006	48	1.110	85	1.312	122	1.578
12	1.007	49	1.114	86	1.319	123	1.585
13	1.008	50	1.118	87	1.325	124	1.593
14	1.009	51	1.123	88	1.332	125	1.601
15	1.010	52	1.127	89	1.338	126	1.609
16	1.012	53	1.132	90	1.345	127	1.617
17	1.014	54	1.136	91	1.352	128	1.624
18	1.016	55	1.141	92	1.359	129	1.621
19	1.018	56	1.146	93	1.365	130	1.64
20	1.020	57	1.151	94	1.372	131	1.648
21	1.022	58	1.156	95	1.379	132	1.656
22	1.024	59	1.161	96	1.386	133	1.664
23	1.026	60	1.166	97	1.393	134	1.672
24	1.028	61	1.172	98	1.400	135	1.68
25	1.031	62	1.177	99	1.407	136	1.688
26	1.034	63	1.183	100	1.414	137	1.696
27	1.036	64	1.188	101	1.421	138	1.704
28	1.039	65	1.194	102	1.428	139	1.712
29	1.041	66	1.199	103	1.436	140	1.72
30	1.044	67	1.205	104	1.443	141	1.728
31	1.047	68	1.210	105	1.450	142	1.736
32	1.050	69	1.216	106	1.457	143	1.745
33	1.054	70	1.221	107	1.464	144	1.753
34	1.057	71	1.227	108	1.472	145	1.761
35	1.060	72	1.233	109	1.479	146	1.769
36	1.063	73	1.238	110	1.486	147	1.778
37	1.067	74	1.244	111	1.494	148	1.786
38	1.070	75	1.250	112	1.501	149	1.795
39	1.074	76	1.256	113	1.509	150	1.803
40	1.077	77	1.262	114	1.516		
41	1.081	78	1.269	115	1.524		

11. **Triangulation.** You can determine your position on a topographic map using a compass to triangulate between three points (**Note:** This works best from a vantage point, and does little good in dense forest). Pick three topographic features that you can see and identify on your map. Determine the bearing between you and each feature. Using a protractor, draw a pencil line through the topographic feature at the measured angle. The three lines should intersect at your current location. Some measuring error may result in an imperfect intersection. If the location does not make sense, or the three lines do not intersect, check your assumptions.

12. Location/direction indicators. To double check your location, you can check the azimuth of lines on a map (that is, roads, trails, streams, gullies, ridges). If you are heading directly north up a trail, but thought you were in a spot on the map where the trail heads east, check your previous assumptions. Other indicators of location or direction include slope angle, aspect, and sun position. Orthophotographs also can help by showing, for example, open patches in forest and large trees in openings. Always keep other location possibilities in the back of your mind as you are figuring out your location. If there is any doubt in your mind, or in the mind of another crew member, refer again to the map and direction indicators. It takes less time to stop and take another look at the map and compass, than to back-track several miles.
13. Map error. There will be map errors in trail lines and topographic contour lines. Rivers also may have changed course. Use other topographic features to verify location: elevation, gullies, peaks, ridges, etc.
14. Notes. It is a good idea to take orienteering notes. Write down GPS waypoints, target points, and distances, etc. It may help you get back to the trail, remember the decisions you made, give you a backup of data collected on the GPS, and/or make it easier to write the description for a plot location.
 - d. Interpret PDOP, and learn to adjust (if possible)
 - e. Check battery power
 - f. Make selections:
 - Use arrow buttons to scroll and highlight your selection
 - Press ENTER to select the highlighted option
 - Press ESC to back out of a selection
 - g. Navigate to a selected target
 - h. Name and log a navigation feature (NavPt)
 - i. Name and log a plot center location (PlotCtr)
 - j. Measure and record an offset
 - k. Delete files
 - l. Change configuration settings if necessary
 - m. Record GPS data on the data sheet
 - n. Download points
 - o. Maintain the GPS unit and batteries
2. Laser Range Finder. The Laser Range Finder will be used for measuring horizontal distance and tree heights. For accurate height measurements, the pivot must be set to match the manner in which the observer tilts the device when measuring angles to tree top and base. The pivot can be changed, but crew members should be aware of the pivot point and pivot method for which the device is set, and aim to be consistent. Method accuracy can be tested by measuring a tower or building of known height. The Laser Range Finder also can be used to measure slope angle, and slope distance.

III. Equipment Training

The crew will receive hands-on training with the GPS, Laser Range Finder, clinometer, digital camera, DBH tape, and increment borer. Training for DBH sampling can take place during the mock sampling plot.

1. GPS. Lead the crew through the procedures required to locate plots and to record and retrieve data for center points and navigation points. Provide them with a map and UTM's and have them locate nearby points, practicing data collection and retrieval. Crew members who have not used a GPS will need additional exercises to feel comfortable using the unit in the field. Those with previous GPS experience may not be familiar with the particular GPS, data dictionary or settings, or methods used in this protocol. Review at the beginning of the field season is important for crew safety, confidence, and the collection of quality data.

Use [SOP 8: GPS Use](#). Crew members shall be given a copy of the GPS operating instructions for their designated unit. During training, the crew should understand and practice the following:

- a. Power on the unit
- b. Use control buttons to move through each menu and display screen
- c. Observe settings

3. Clinometer. The clinometer is a simple device for measuring the degree or percent slope. It also can be used to calculate tree heights or horizontal slope distance, but the Laser Range Finder is much simpler to use. The clinometer can serve as a backup. If you only plan to measure **slope**, the clinometer is much lighter to carry. Look through the small glass window and you will be able to read degrees on the left, and percent on the right. If you forget this, you can tilt the device up or down to see the percent symbol on the right (if you do not see any numbers you probably are holding it upside down). When measuring slope hold the clinometer to your eye, focus one eye on the degree or percent, and the other eye down or up slope to eye height of a second person. Make sure to record the units as degrees or percent.

Tree Height

Measure tree height using this equation: $a = b \tan A_1$

1. It is usually helpful to be upslope from the tree. In this case, you will use the equation twice, once to measure the height from your level up to the tree top, and the second to measure the height from your level down to tree base. To get the total tree height, add the two results.

Note: If you are downslope for some reason, you will need to subtract a_2 from a_1 .

2. Stand far enough away from the tree to be able to see the top and the base, and to keep the angle to the top less than 45 degrees if possible (increasing angle increases measurement error).
3. Measure and record distance from you to tree: b
4. With the clinometer measure and record the angle in degrees to tree top (A_1)
5. With the clinometer measure and record the angle to the tree base (A_2).
6. Calculate height from eye level to tree top:
 $a_1 = b \tan A_1$
7. Calculate height from eye level to tree base:
 $a_2 = b \tan A_2$
8. Add the two lengths together for total tree height:
 $ht = a_1 + a_2$

Length of Leaning Tree

Measure the length of a leaning tree using the equation:

$length = EF(ht)$.

EF is an expansion factor found in [table 6.1](#).

1. Calculate tree height as outlined above, standing perpendicular to the plane in which the tree is leaning so that you can see the top and base of the tree.
2. Standing at the base of the tree and sighting up the bole with your clinometer, measure the slope of the bole in degrees.
3. Subtract the degrees of lean from 90 degrees.
4. Convert this angle from degrees to percent by looking through the clinometer to see the conversion.
5. Using this percent angle and the slope corrections table, determine EF.
6. Multiply the tree height (ht) by EF to calculate the actual tree $length$.

Horizontal Distance (b)

Measure horizontal distance using this equation:

$b = c \cos A$ by measuring the slope distance (c) and slope angle (A):

1. Digital Camera. Refer to [SOP 12: Event Log](#) and [SOP 20: Photographic Image Processing and Management](#).
2. DBH Tape. Demonstrate the correct measurement of tree diameter at breast height per instructions in [SOP 13: Tree Data](#)
3. Increment borer. Refer to [SOP 9: Reconnaissance Form](#), section IV. Taking and Preparing Increment Cores.

IV. Datasheets

Before beginning each sampling activity in the field, the Project Coordinator will go over the field datasheet. The Field Reference Sheet in [SOP 11: Establishment Form](#) contains all term definitions and will be given to the crew first. Each of the datasheet fields will be explained giving the crew the opportunity to take notes and ask questions.

1. Reconnaissance Form
2. Plot Layout
3. Site Map
4. Plot Establishment Form
5. Event Log
6. Tree Data
7. Vegetation Quadrat
8. Down Woody Materials
9. Epiphytic Lichens

V. Vegetation Training

1. Skilled and Enthusiastic Crew. Training the crew to recognize the differences among hundreds of different plant taxa in the field can be one of the most difficult aspects of this program, and also one of the most critical. In fact, we cannot rely solely upon training observers to meet the standard of quality required in this protocol. The importance of hiring talented field botanists who have a strong foundation in taxonomy cannot be over-emphasized. It is essential that each crew has a skilled vascular plant botanist and a skilled nonvascular plant botanist (bryophytes and lichens). These technicians need not be experts in the Pacific Northwest flora, but it is crucial that they have the ability to differentiate species in the field, and be experienced in doing so either as a result of academic training or professional experience. For learning the flora, there is no substitute for two things: (1) a strong interest and desire to learn on the part of the trainee; and (2) the opportunity to learn by being in the field and observing the species that occur in different assemblages.
2. Plant Lists. Crew members will be given plant species lists with space for writing notes. Three types of lists will be provided (1) a list of vascular plant species previously recorded from LTEM forest vegetation surveys in each vegetation type: western hemlock, subalpine fir, and Sitka spruce forest; (2) a nonvascular plant species list from each vegetation type; and (3) an up-to-date list of plants that occur in each park.

3. **Field Recognition.** A minimum of 2–3 days should be spent on plant identification in the field. This may be coordinated with other training activities. Identification training will begin with local guided walks focusing on common species on the plant lists. If there is time, visit sites with the project vegetation types. Crew members are encouraged to keep notes on their species lists as the instructor teaches field recognition characteristics. Remind the crew members that, though they have lists of species encountered in the park and in specific vegetation types, the goal of the project is to detect change, not only in abundance and frequency, but also in species presence; new species may be encountered during a survey, and having a good knowledge of the species already recorded for these areas will help the crew differentiate new species. Spend extra time on problem species such as those mentioned in #5: “PowerPoint Presentations.” Subalpine species should be addressed later in the summer with a special training session. The training should be prepared ahead of time by the Park Plant Ecologist and conducted just prior to plot sampling at a park where subalpine forests will be sampled. At this time, snow will be melted from plots and newly learned subalpine plants will remain fresh in the minds of the crew.
4. **Categorizing:** Beyond determining species identification, there are several requirements for vegetation categorization in this protocol. From decay classes to browsing form class, size differentiation, and tree damage, separating into groups can at times be difficult. Address each category when going over individual field data-collection methods. Spend extra time on problem categories such as log decay class 4 and 5, and determining the length of CWD for broken or semi-broken logs.
5. **PowerPoint Presentations.** Between plant walks, PowerPoint presentations will be used to review plants seen, and to introduce species not occurring in the training area. This is a good time to go over difficult to identify species, allowing the crew to take notes on key differentiating characteristics. Species that have given crews trouble in the past include, but are not limited to *Abies*, *Vaccinium*, forest *Saxifragaceae*, subalpine *Apiaceae*, not to mention *Poaceae*, *Cyperaceae*, *Juncaceae*, *Bryophyta* and lichens. Teaching plant parts and key characteristics to note when differentiating plants during plot data collection will help crews recognize different species even if they cannot name them at first.
6. **Herbarium.** In addition to in-field training, the crews will be introduced to the resources available to them in the herbarium, including reference texts, pressed plants, microscopes, and dissecting tools. Dried herbarium specimens may be used to show identifying characteristics or important species that were not observed in the field.
7. **Taxonomic Keys.** An entire day should be spent on the use of taxonomic keys. This can be coordinated with the visit to the herbarium. Working in groups of two to four, crews will identify fresh specimens brought back from the field. An experienced botanist should work with each group, or at a minimum move between the groups offering identification tips and definitions of difficult botanical descriptors. Plant names and key characteristics will be written on a card and displayed beside the specimen for others to observe. Results and obstacles encountered by each group will be discussed with the whole group.
8. **Percent Cover Estimation.** As discussed in [SOP 14: Vegetation Quadrats](#), estimation of percent cover in a manner that is repeatable from year to year is critical for this project. There are some pitfalls to be aware of, as well as techniques that will help you. Begin training by having crews estimate percent cover of circular pieces of material laid out in a 5 × 5 m plot. The material circles represent plant polygons. They are pre-measured and cut so that the precise area covered by the polygons is known. As many as three different colors and three different polygon sizes are recommended. Consider setting up as many as three plots. Have each crew member estimate and record the area for each color or “plant species” on their own before estimation techniques are discussed. It will be eye-opening for the crew to see how much their estimates differ from each other and from the calculated percentages. Announce the calculated percentages and discuss the results. Then go over in detail the methods in [SOP 14: Vegetation Quadrats](#), focusing on estimating cover in 5 × 5 m quadrats. Once the crews are comfortable with these methods, address techniques for estimating cover in the 1 × 1 m quadrat and the 0.5 × 0.5 m quadrat. Sample a complete set of quadrats using the data form.
 - Estimating percent cover of large areas also is important for conducting reconnaissance of potential permanent plot sites. Address how to measure and calculate the percentage area covered by an inclusion and a tree or shrub species in a 50 × 50 m plot. Discuss the commonly encountered “cut-off” percentages of 25, 10, and 5, and what area each covers in a 50 × 50 m plot.
9. **Non-Vascular Plant Training.** The crews may be split into two intensive training groups focusing separately on (1) epiphytic lichens and (2) bryophytes.

Scientists who developed the epiphytic lichen survey method recommend a minimum of 3 days training for this method. Select two crew members per crew, one principal surveyor, and one substitute. The training should be conducted in the field by a Botanist trained in the FHM survey method. The Botanist will teach the methods outlined in [SOP 17: Lichen Survey](#), then conduct a practice survey to assess the ability of crews to collect different species. Crews need not know every species, but they must be able to differentiate species and collect at least 70 percent of the species found by the expert.

10. Voucher Collecting. Crew members will be instructed on the protocol of collecting voucher specimens. Items to address include:
 1. Purpose of a voucher
 2. When to collect
 3. Where to collect
 4. How to best to collect a vascular plant ([Appendix D: Guidelines for Collecting Botanical Specimens](#))
 5. How to collect a nonvascular plant voucher
 6. The numbering system
 7. Information to collect with each voucher
 8. Transportation of vouchers
 9. Storage upon return from the field
 10. Identification and preservation plan of voucher specimens
 11. How unidentified plants are linked to the voucher number in the database

how a page in a field notebook should be organized. Develop a system so that information is always in a similar format, easy to see, and find. Keeping dates, locations, tasks, and other repeat information in the same place will help you relocate that information later. Supervisors will rely on the Crew Leader’s ability to quickly access information in these notes as questions arise regarding logistics or data that needs clarification. Your notes also will help you to write a trip report at the end of each tour, and to write the end of season report. Photocopy your notes after each tour and place in the specified folder in the filing cabinet. This is important for two reasons: (1) If the notebook is lost in the field, not everything is lost; (2) If someone needs to access that information it will be on file. Create a contact list on a back page of your notebook with all phone numbers (and email) for Supervisors and crew.

VI. Taking Field Notes

All members of the crew should keep a field notebook with hours worked, tasks completed, observations, and topics that need addressing. The main responsibility for this task, however, falls to the Crew Leader. The Crew Leader must be ready with pencil and notebook in hand at all times to take notes: (1) for every day of work summarizing who did what, where, when, why, and how; (2) in the office when communicating with supervisors and others about field plans, data issues, etc. (3) in the field for everything that is planned, discussed, partially completed, or completed; (4) any time there is an issue that needs to be addressed whether it regards data collection, hiking routes, camp sites, field gear, an injury, or other concerns. Include dates, times, locations, names and other pertinent information. [Figure 6.1](#) shows an example of

VII. Crew Assignments

Each crew member will be solely responsible for a specific set of tasks. These will be assigned according to the crew member’s skill and interest. Depending on the number of crew members, an individual may have 2–4 (or more) specific tasks assigned to them. Divide the tasks so that each person has something to do before and after a field tour. It is the responsibility of each specific task leader to read the applicable SOPs at the onset, and then again as the season progresses. Any needed corrections, additions or improvements should be written down and presented to the project coordinator for review. We expect methods to continue to improve, but these should be tracked during the field season, and written down while they are fresh in mind. Task responsibilities for the Project Lead and a four person crew are outlined in [table 6.2](#). Rearrange as seems fit for each individual crew.

Table 6.2. Task responsibilities.

Crew member	Pre-tour and tour	Post-tour
Project Lead	Preparation of site maps and orthoquads. Planning logistics: housing, pack animals, road closures, etc., ferry permits. Coordination with other Project Coordinators or Rangers.	Review and discuss recent tour with crew. Update crew about next tour.
Crew Lead	Note-taking, crew logistics, contacting Supervisors, overseeing data collection.	Contact, oversee; pick up the slack.
Crew member #1	Wilderness permits, current backcountry information; Maintaining and tracking technical gear (GPS, radios, Laser Range Finder); vehicle	Maintenance of batteries and technician gear; Downloading GPS data.
Crew member #2	Gear organization and distribution (see SOP 5: Orientation of Field Crew)	Gear organization; travel voucher forms.
Crew member #3	Datasheets: packing, and tracking. Maps: packing and tracking; Digital camera and photography (see SOP 12: Event Log: Recording Plot Visit Details and Taking Digital Photographs)	Datasheets: photocopying, tracking. Downloading and labeling photographs (SOP 20: Photographic Image Processing and Management)

general location & task

MORA PLOT: MORA3-033

Day of week: Tues. Date: 6/4/06 Day 2 of 8 day tour

Total Hours Worked: **11 hrs.** (keep track on back page: comp time = 1 hr)

7:00am – 6:30pm

Weather: overcast, cool in morning; downpour from 4 pm on; freezing at night

- Maps used.
- What each person did.
- Observations about plot or interesting sightings.
- Circle every plot number done that day and write simple determination in bold capital letters, for example:

33 DONE (or "TREES NOT FINISHED" or "STAKE 13 NEEDED")

- Important GPS file #s (good to have them in more than one place)
- What was completed each day and how long it took for each part: hiking to the site, completing a form ...
- Trails, water sources, campsites, including those noted for future reference
- Asterisk by any notes that need to be communicated to supervisor
- Notes to yourself for next tour or for future surveyors
- Plot or trail conditions
- Any concerns
- Any mistakes
- Anything that needs clarification
- Any issues
- Any suggestions
- Have a thought? WRITE IT DOWN

Create a contact list on a back page of your field book (phone numbers, etc. of supervisor and crew)

Figure 6.1. Field notes example.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 7: Preparing for a Field Tour

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes preparations for field tours for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. These procedures are carried out prior to departure to the field.

I. One Week in Advance

The following tasks are to be conducted approximately 1 week (or earlier) before crews depart for a field tour. Tasks may be conducted at the end of the previous tour by Crew Lead and crew, or by the Park Plant Ecologist during the week prior to departure.

1. Check Road Access. Park roads are often damaged by winter flooding events, blocked by downed logs, or subject to scheduled repairs. Access roads that are owned or maintained by other agencies are subject to the same hazards. Check the park road report on the web, contact the Park Liaison if traveling to another park, and consider inquiring with the Road Foreman and other agencies in advance if you plan to use their roads.
2. Determine Campsite, or Housing. Review the plot Event Log for campsite suggestions. Park housing accommodations should be reserved at the beginning of the season if possible, but housing may still be available at mid-season. Ranger station cabins may be available to the crew if approved by the ranger for that area. Designated campsites may be within hiking distance from the plot; some require reservations through the WIC office. Consider camping near the plot if (1) it is within park guidelines, (2) there is a water source, and (3) it will not impact the plot.
3. Verify Packers. Verify with the packers that gear has been transported to the site.
(I:\NRM\Working\Vegetation\VCa02\Documents\Travel_Logistics\Packers)

4. Going to Another Park? Contact the Park Liaison to let them know of your plans, inquire about roads and trails, gain permission to restricted areas if necessary, and arrange to pick up keys to housing or to gated roads. If going into the backcountry, contact the WIC well in advance for camping reservations. Make sure that the crew has access to a road atlas, park-wide map, park plant lists, and other references.

II. Pretour Crew Tasks

The following tasks are to be conducted by crews on the day they depart for the field.

1. Arrive on Time, Ready and Packed for the Field. It is imperative that all crew members arrive on time and ready for the tour. When prepared, crew members are able to help with crew tasks, they can be relaxed, and positively influence the attitude of the crew.
2. Check email. Read work related email only, for messages from Supervisor.
3. Check Weather. If it has not been done already, check on the weather so that you know what to expect, and consider alternative plans. There are several weather websites available – simply search on “weather” to find them. The NOAA weather site can be accessed at: <http://www.wrh.noaa.gov/sew/>.

4. Obtain Wilderness Permit. Wilderness permits can be obtained from the Wilderness Information Center (WIC – located behind the Visitor Center at Olympic National Park, within the Visitor Center at North Cascades National Park, or at the closest ranger station for Mount Rainier National Park), and are required for overnights in the backcountry. Contact the WIC office as early as possible once you know your trip plans; they will be better able to accommodate your needs, especially in areas of high use where reservations need to be made well in advance. The WIC also is a good place to check on current backcountry conditions, recent trail or road washouts, common concerns for the area, weather forecasts, or camping options. Be sure to ask for information. **Note:** The campsite should be reserved early, at the end of the previous tour if possible.
5. Send Itinerary. Send a tour itinerary to Dispatch or the Communication Center if required. Include crew names, dates, routes, destination locations, and overnight sites as outlined in *Wilderness_Tracking_Itinerary_Form.doc*. (*I:\NRM\Working\Vegetation\VCa02\Documents\Travel_Logistics\Forms*).
6. Look Over Datasheets. Datasheets are pre-printed on waterproof paper as outlined in [SOP 4: Preparation of Reports, Maps, Datasheets, and Images](#), and stored in an envelope labeled with the plot name. Check that all required data sheets and reference documents are present.
7. Gather Visit Reports, Maps and Orthoquads. These were pre-printed on waterproof paper before crew arrival (or laminated) as outlined in [SOP 4: Preparation of Reports, Datasheets, Maps, and Images](#), and are stored in the plot folder.
8. Satellite Availability Charts. Satellite charts are available from the ONP home page. Satellite charts are available from park GIS staff.
9. Check New Gear. If taking gear that is new to you, check to see that it is in working order and that you know how to use it. Ask for help if you need it. Make sure that any battery-operated gear has fresh batteries and a spare set.
10. Pack Gear. All personal gear should be packed and ready to go prior to the morning of departure ([table 7.1](#)). Group and plot gear should be organized so that packing can be accomplished quickly that morning. See section III for packing tips. If some of the crew bring their own camping gear, make sure it is clear what is being shared, and that everyone has a water filter, stove, tent, etc. for their use. The Crew Lead is ultimately responsible for assuring that the crew has essential gear, but the entire crew is responsible to communicate on these matters. Use a scale to check that you are not carrying more than your capacity (recommended: < 1/3 your body weight).
11. Check the Visit Report. Check the visit report for each plot you plan to visit that tour, and determine if there are any logistics, additional items, concerns, or tasks to prepare for. If establishing and setting up a plot, determine whether or not the corrected UTM's indicate that the plot center needs to be adjusted.
12. Fold Envelopes. Voucher envelopes are to be pre-printed as outlined in [SOP 4: Preparation of Reports, Datasheets, Maps, and Images](#) and kept in the filing cabinet. Crew members that have completed field preparation can take a stack of voucher paper and begin folding envelopes. This task also can be done in the car on the way to the site.
13. Check the Vehicle. Give the vehicle a safety check. Walk around the vehicle looking for low tires or other problems, check the oil level, and fuel gauge, and test the head lights and blinkers.
14. Double Check the Equipment List. Make sure that you have everything on the equipment list by checking it twice.
15. Going to Another Park? Check the following:
 - Road atlas in vehicle
 - Park-wide map
 - Radio protocol
 - Radio repeater for your location
 - GPS is set for Datum: NAD83, Zone: 10N (if borrowing a GPS)
 - Change in declination
 - Plant lists
 - Additional field references
 - Keys to pick up
 - Personnel to meet?

Table 7.1 Gear recommended for camping and hiking in Pacific Northwest.

[NPS, National Park Service)

PERSONAL GEAR (*supplied by NPS)	
Large capacity backpack	Toothbrush, etc.
Compass*	Iodine capsules (in case water filter breaks)
Map of route*	
Whistle*	<i>Optional:</i> your own tent, water filter, or stove if preferable to NPS supplied gear
Headlamp or flashlight (spare batteries)	
Notebook, 3 pencils, 2 permanent markers*	
Hand lens* (10 × for each crew person, and up to 30 × for crypt specialist)	<i>Other ideas:</i> Bug repellent, bug net*, chapstick, sunscreen, sunglasses, hat/visor, spare shoes/sandals, hiking poles*, gators, camp clothes, daypack or field vest, lightweight long-sleeved shirt or windbreaker, parachute cord for bear wire, etc., towel, bandana, personal First-Aid Kit with moleskin, ace bandage, etc., hot chocolate, cards, book, chocolate chip cookies.
Bear barrel* (full of food)	
Water bottle: 1 nalgene, plus spare or bladder	
Bowl, cup, spoon, knife	
Pack cover*	
2-3 Garbage bags* for inside pack, always	
Sleeping bag (pack in garbage bag – no holes!)	
Sleeping mat	
Tent * (NPS 3 man tents)	
Raingear * <i>always</i>	
GROUP GEAR (supplied by NPS)	
Waterproof boots	Scale (at office) for weighing backpack
Hat and gloves	Water filter (recommend 1 per two people)
Long underwear	Stove
Fleece jacket	Fuel (2 × 22 oz for two people 8 days)
Quick dry clothes: Nylon zip-off pants, polyester shirt	Lighter/matches
Spare: socks, dry clothes	Cooking pot with handle
	Tent with ground cloth
	Trowel
	First Aid Kit

*Essential, every trip.

III. Packing Gear

Each person is in charge of maintaining, packing, and carrying their own personal gear as listed below. Some of this gear will be available on loan from the LTEM project. All other gear (including group gear and required field equipment) is the responsibility of the assigned crew person to set out and distribute evenly amongst the crew before each tour. If you choose to take your own equipment in place of “group gear,” you are responsible to work this out with the rest of the crew. Tour preparation and packing should be done quickly so that the crew is able to depart from the office approximately 1 hour from the meeting time.

Tips for Packing Gear:

- Consider whether you will be packing for one or *possibly more* than one activity (that is, plot recon *and* plot set-up; or plot set-up *and* survey).
- Consider whether the crew will be splitting into two 2-person crews at any time, requiring two GPS units, two maps, two radios, two plant association keys, two First-Aid Kits, two tents, separate food, etc.
- If you will be car camping, or staying in park housing, you may want to pack some extra amenities.
- Always assume that the nice warm sunshine is going to be gone tomorrow, replaced by torrential down pours or a sudden dive in temperature.

- Consider whether you need maps of an alternate escape route (for river crossings especially).
- For backcountry hiking, you should carry about one-third of your body weight, or less.
- Make sure you cover all safety precautions and keep all crew members in mind.

Gear Lists:

Print and keep a copy of the camping list ([table 7.1](#)) and equipment for plot setup and sampling ([table 7.2](#)) posted in the office so that they can be checked when packing before a tour.

Table 7.2 Plot setup equipment.

- | |
|---|
| <ul style="list-style-type: none">- Field vest or day pack- Compass- GPS with spare battery- Radio with spare battery- Laser Range Finder with spare batteries- Range pole with reflector (optional)- Orange hat- 50 m measuring tape- 10 m tape strips (pre-cut)- Other pre-cut sizes may be handy (21.21 m)- Clinometer- Calculator with slope equations- 2 lb metal hammer (or claw hammer)- Plumb bobs (light weight)- Flagging- 32 Pin flags- 9 rebar- 72 cedar stakes (32 for subplot, 40 for quad)- 5 metal 2 inch round shiners + 5 nails- Numbered blue metal tags + short nails- 7 ½ minute quad, custom correct, or similar map- ArcMap of plot locality- Template/Map of plot layout- Satellite availability chart |
|---|

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 8:

GPS Use: Navigation, Data Collection, and Downloading

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP explains the methods for using a GPS receiver to navigate to plot target locations, and to collect geographic coordinates at reconnaissance and permanent plots for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. We use the Universal Transverse Mercator (UTM) coordinate system and North American Datum of 1983 (NAD83). Randomly located plots that have met the criteria for safe access, slope, tree cover, and distance from roads, trails and boundaries, are visited during reconnaissance to further assess stand age and vegetation type. Those with mature stands (> 80 years) and selected vegetation types become permanent plots.

Use this SOP as a guide for navigating to plots during reconnaissance or permanent plot sampling and for determining and recording other locations of interest.

I. General Practices for GPS Data Collection

Regardless of GPS receiver type, certain data collection standards must be followed. Most of the quality control measures below can be employed by the user and should be followed whenever possible to produce the most accurate data possible.

- Satellite availability and satellite geometry (PDOP): Acquiring at least four satellites will give you a 3-D position. Satellites that are spread out have better geometry and will give a more accurate reading than when they are clustered together. GPS users can increase mapping accuracy by using planning charts and targeting their data collection to the times of day when satellite availability and geometry are best. Such timing does not always work in the field, however. PDOP (Positional Dilution of Precision) is an option on some GPS receivers. PDOP can be adjusted to allow the taking of points at different levels of accuracy, but it should be set to no higher than 8 (PDOP of 6 is preferred). The user should not increase the allowable PDOP value to higher than 8 unless collecting a position overrides accuracy concerns.

- Length of time GPS data file is open
Positional accuracy will be better the longer a file is open and the more GPS positions are collected and averaged. Trimble® recommends a minimum of 60 positions for each point or feature to attain a high degree of accuracy.
- Multipath error, or signal interference
Although mostly beyond a user's control, some adjustments can be made to minimize multipath error. These include positioning the GPS in the most unobstructed view of the sky as possible, using offsets from better satellite reception areas to the target location, and using an external antenna.
- Signal to noise ratio (SNR)
This is out of a user's control, although Trimble® units allow a minimum ratio value to be set in the configuration such that positions with SNR below that value are not logged. A value of 4 is recommended for SNR values in Trimble® units.
GPS file names, GPS field coordinates (coordinates shown on a GPS receiver while a GPS is receiving satellite signals), and datum should be recorded on hardcopy datasheets. In the event a GPS file is lost or corrupted, the coordinates recorded in the field from the GPS unit display window will become the best measure of location. Be aware that these coordinates cannot be differentially corrected and are in the coordinate system and datum that were chosen for the unit's display.

II. Training

Training with the GPS receiver is covered in [SOP 6: Training Field Crews](#), Section III. Equipment Training.

III. Data Collection

During reconnaissance and establishment of permanent monitoring plots, the field crew will need to take an accurate GPS reading of plot center. Coordinates are collected as appropriate for available GPS unit. These data are later downloaded onto the computer, differentially corrected, sent to the GIS Specialist, and entered into the database.

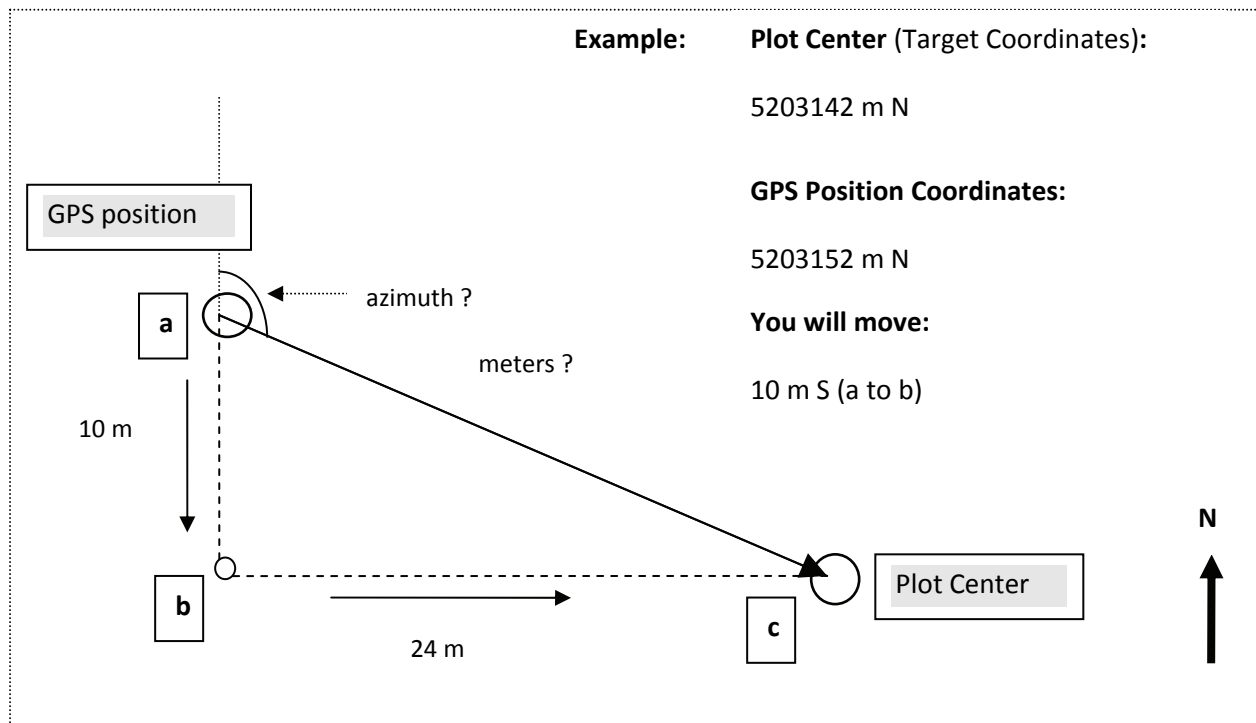
1. Measuring Offset:

If you are unable to get a reading close to the target (preferably four satellite signals with PDOP < 8.0):

- Move to the nearest location at which you can obtain satellite coverage **GPS position (a)** ([table 8.1](#)).
- Temporarily mark this location (you will later need to measure distance and azimuth from here to the target, and enter this into the GPS unit and onto the data sheet).
- Open a GPS file and record the file name and your current location as described above.

- Determine your distance** from plot center by subtracting the GPS position coordinates from the Plot center target coordinates.
 - Calculate meters North or South (a to b):** subtract the current northing coordinate from the target northing coordinate to determine the distance south or north to plot center. Since the coordinate numbers increase to the North, a positive number indicates that plot center is that distance to the North of your current location, whereas a negative number indicates it is to the South (UTM numbers increase to the North).
 - Calculate meters East or West (b to c):** subtract the current easting coordinate from the target easting coordinate to determine the distance East or West to plot center. Since the coordinate numbers increase to the East, a positive number indicates that plot center is that distance to the East of your current location, whereas a negative number indicates it is to the West (UTM numbers increase to the East).
- Move to Plot Center (c)** with your compass and measuring tape. First move from **a to b**; then move from **b to c** ([table 8.1](#)). Be sure to use horizontal distance. You may account for slope by keeping the measuring tape level, using a laser range finder to measure distance, or measuring the slope with the clinometer and using a slope corrections table ([SOP 6: Training Field Crews](#)) to calculate horizontal distance from slope distance.

Table 8.1. Measuring and recording offset.



- f. **Measure directly** the distance and azimuth from the GPS location to the newly determined plot center. Record this offset distance and azimuth on the data sheet.
- g. **Record this offset in the GPS.** Make sure that you enter the distance and azimuth **from** the GPS location to the newly determined plot center (**a to c**). Offsets entered into the GPS unit file are preferable because the software will incorporate it during post-processing.

2. Adjusting Plot Center.

When the plot is being set up (permanently marked with rebar and stakes), you may need to first adjust the location of plot center from the previously marked location. This will be necessary if the corrected UTM coordinates for the plot center, as recorded during reconnaissance, are significantly off from the target UTM coordinates (> 10 m).

- a. Observe the visit report ([SOP 4: Preparation of Reports, Datasheets, Maps, and Images](#)) that you have brought with you into the field.
- b. If the corrected UTM coordinates are > 10 m off from the target UTM coordinates, measure the horizontal distance and azimuth to plot center with compass, measuring tape, and/or laser, and remark with flagging
- c. Open a file and log the new plot center location.

IV. Navigation

Waypoints are a quick navigational tool because there is no need to open a job file, and less accurate, because they are not averaged over time, nor are they differentially corrected back at the office. Waypoints can aid you in navigation by allowing you to record where your camp site or vehicle is located, or where you leave the trail. This can be helpful for return trips and for writing directions on the data sheet. If you need accurate locations for permanent descriptions use NavPt instead.

Note: The GPS should not be exclusively relied upon for navigation. It gives straight line azimuth and distance to targets and will not show the safest navigation routes, for example, following ridge lines, safely crossing rivers or circumnavigating cliffs. At times the GPS receiver may not function due to location (for example, in a canyon), low satellite coverage, low power, or forgotten batteries. Always use a map, and compass (and altimeter if available), with GPS as an adjunct.

1. Strategy for Locating Plot Center.

Target coordinates will be downloaded onto each GPS receiver and as part of a background map on the Thales MobileMapper. Providing the settings are not changed, the background map will automatically be displayed on one of the navigation screens of your GPS receiver. Depending on the GPS receiver, the background map may or may not have additional features such as contour lines, trails and boundaries (contact the GIS support person to inquire if additional features would be helpful).

1. First look at a hardcopy map marked with the plot location and determine your route.
2. When leaving camp and/or the trail turn on the GPS receiver to verify your location, the target location, and to mark a navigation point.
3. Navigate to within the vicinity of the target point or plot center using map and compass.
4. Turn on the GPS if you need to check your location. Established plots may have rebar, flagging, and/or tagged trees as additional clues.
5. If you are establishing the center point for a new plot, turn on the GPS as you near the plot. Continue to move toward plot center, getting as close as you can.
6. Within a few meters of the point you will find that the UTM coordinates, as detected by the GPS unit, are continually changing and you cannot get to the exact location. This is because satellite signals are often blocked or bounced around by terrain and trees. It is best to stop and log a point at this time. This will give you more accurate UTM coordinates for your location and you can determine whether you need to move closer to plot center from here.
7. Open a GPS job and/or file to record your current location as outlined in Data Collection: [Logging a point](#). Using the data dictionary prompt you will name each location "PlotCtr" and give it a number (1,2...) to identify each subsequent attempt to locate plot center. The highest number recorded will later be interpreted as plot center.
8. If the current UTM coordinates are within 10 meters of target UTM coordinates you may consider this "plot center."
9. Record this file # on the data sheet.
10. Record coordinates from the GPS display screen as "field UTM coordinates" on the data sheet.
11. If you are greater than 10 meters off, you may calculate the distance and direction to plot center, move to this location, and log another point [go to step (8)].

V. Downloading and Processing GPS Files

Refer to owner's manuals for appropriate GPS for downloading GPS files.

Processing differentially correctable GPS rover files requires a computer, a data transfer cable, GPS software, and internet access. GPS receivers typically come with manufacturer-specific software and data transfer cables. Each software package operates differently, but the basic process is the same.

It is extremely important that whenever field crews return from the field, GPS files are transferred from GPS receivers to computers or network folders that are routinely backed-up. Files should be transferred to an appropriately-named folder (such as "Raw" or "Backup"). Communicate with the GPS support person to determine how these files should be stored, differentially corrected, and entered into the database.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 9:

Reconnaissance Form: Evaluation and Reconnaissance for Plot Selection

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes plot selection criteria and instructions for filling out the data form used to conduct reconnaissance for plot selection in three national park units: Mount Rainier (MORA), North Cascades (NOCA), and Olympic (OLYM), as part of the NCCN's Long-Term Ecological Monitoring of Forest Vegetation. This procedure was carried out during the 2005 and 2006 field seasons to identify plots for the 6-year sampling cycle, prior to establishment and sampling of permanent monitoring plots. Remaining reconnaissance will be conducted as needed prior to the field season. Reconnaissance plots of low firing order have greatest priority; however, plots occurring in the same area also should be inspected if time allows. Equipment for conducting reconnaissance is listed in [table 9.1](#). The datasheet is shown in [figure 9.1](#) (at back of SOP).

I. Equipment

Table 9.1. Equipment for conducting reconnaissance.

Equipment	
Pencils	Radio, spare battery
Field notebook	Digital camera, spare batteries
Flagging and permanent marker	Calculator
Meter tape	Satellite PDOP graph
Increment borer, paper straws, tape	List of UTMs
WD-40 and wax	Field reference sheet
GPS, spare batteries	Reconnaissance form
Compass	Ocular form
Clinometer	Key to plant associations
Altimeter	Plant descriptions
Maps and digital orthoquadss	Collection bags and envelopes

II. Plot Selection Criteria

- Point Distribution:** Using the Generalized Random Tessellation Stratified (GRTS) program, points are randomly distributed in the parks by GIS staff using the following constraints:
 - Within a designated 300 m elevation band ([table 9.2](#)).

Table 9.2. Strata, elevation, and target vegetation.

Strata No.	Elevation (meter)	Target vegetation
1	0–300	Sitka spruce
2	300–600	Not used
3	600–900	Western hemlock
4	900–1,200	Not used
5	1,200–1,500	Not used
6	1,500–1,800	Subalpine fir

- < 1.5 km from a maintained and/or established trail
- No river barriers
- No points falling on > 35° slope

2. **Office Evaluation:** ArcMap is used to view GRTS generated points. It draws a buffer ring, which is a circle touching the corners of a 1-ha plot (100 × 100 m) centered on the selected point.

Layers in ArcMap include:

Topographic Map
 Orthoquad
 PAG (Plant Association Group)
 PMR (Pacific Meridian Resources) vegetation.
 PMR size
 Trails (includes maintained trails and some trails well-established by use)
 Roads
 Major streams and rivers
 Park boundaries
 Slope > 35° (shaded red)

The point is accepted for field evaluation if:

- It is accessible (no physical barrier): There is an access route < 1.5 km from a trail that does not cross major rivers, cliffs, glaciers, or slopes > 35°.
- The plot is not too steep: There is < 10 percent area with > 35° slope within the plot buffer ring.
- The plot edge is > 100 m from a road or trail.
- The point is < 1.5 km from a trail.
- The plot area does not cross a park boundary
- The plot area does not contain private land or a development (for example: campground, parking lots, clearings, clear-cuts, gravel pits)
- The plot does not contain a river: A major river or stream should not pass within the buffer, regardless of percent area,
- Tree cover is > 25 percent within the buffer ring.
- Inclusions are < 10 percent of the area within the buffer ring: Inclusions may include meadows, avalanche chutes or other natural disturbance visible on the orthoquad as treeless areas. If in doubt, these should be ground-truthed.

Note: PAG, PMR, and PMR size are noted but not used as rejection criteria.

3. **Field Evaluation**

Points that meet the above criteria are further evaluated in the field. The reconnaissance plot evaluation is conducted within the 50 × 50 m inner plot where understory vegetation will be intensively sampled during monitoring of the 100 × 100 m (1 ha) permanent plot. The sides of the plot run directly N-S and E-W. The plots are evaluated according to the above criteria with changes and additions including:

- Slopes must not exceed 35° for more than 10 percent of the 50 × 50 m plot.

- Cover of trees must be > 25 percent within the 50 × 50 m plot. The 25 percent tree cover must consist of trees > 12.7 cm DBH.
- Inclusions of non-target vegetation types must not exceed 10 percent of the 50 × 50 m plot. An inclusion is defined as a discernible change in plant species composition that may result, for example, from the presence of streams, rocky outcrops, or standing water. A young stand of trees does not qualify as an inclusion if the vegetation association remains the same.
- Stand age must be > 80 years old.
- Vegetation type must be one of the selected types for the elevation band.

A reconnaissance data sheet is completed for each point visited in the field. If the plot is accepted, the point is flagged.

Because of the time and effort to reach a reconnaissance site, crews should take the time to thoroughly investigate potential plots and reach a conclusion with certainty, if possible, especially for plots that may meet permanent plot criteria. Crews should walk through the entire 50 × 50 area. If inclusions are encountered or if percent cover of a tree or other plant species is between two categories, crews shall measure the area, calculate the percentage covered, and take thorough notes.

III. LTEM Forest Plot Reconnaissance Form

Identification and Location

Park: Enter the 4 letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
 The code is created by using:

- Single digit elevation stratum: 1, 3, or 6
 (1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash; and
- Three digit plot number: The original firing-order number given to that location prior to reconnaissance.

Watershed: The name of the major watershed in which the plot lies.

Site Name: A local name that describes the area where the plot lies, usually something easily found on a map such as the name of a creek, a crossing, a ranger station, etc.

Date: Enter the date that the reconnaissance point was visited.

Crew: Enter the last names and first initials of all crew members that are part of this sampling event.

GPS File Name: The job file name created by the observer on a Thales MobileMapper®, or the automatic file name given when a location file is recorded on a GeoExplorer®. A job file name on the Thales should begin with the letter that identifies the unit being used, followed by two digits each for year, month, and day. It is critical that the file name be recorded in addition to the UTM's, because it is the reference used for entering the corrected UTM's later.

GPS Device: Record the make and model of the GPS device used to acquire coordinates for the plot, for example, Trimble GeoExplorer® 3, Thales MobileMapper®, or Garmin® eTrex.

Declination: The magnetic declination or angle (degrees) that must be added or subtracted from an azimuth to convert between the needle direction on a compass (magnetic north) and longitude (true north). The Silva® Ranger compass dial can be rotated to adjust for declination with a small screw in the back, so true north is read directly without needing to calculate the difference. Declination must be checked and reset each year for each park. Declination can be checked at this and other websites: <http://www.thecompassstore.com/decvar.html>.

Field UTM X (mE): The latitude of plot center, also known as easting, recorded in the field with the GPS.

Field UTM Y (mN): The longitude of plot center, also known as northing, recorded in the field with the GPS.

Datum: The datum is the basis for a planar coordinate system and indicates which map projection and coordinates are being used. There are more than 100 datums in use throughout the world. The North American Datum of 1983 (NAD83) will be used by LTEM in all three parks. Some topographic maps are still in NAD27, but we rarely read UTM's directly from these topographic maps. ArcMap produced maps and target UTM's will be in NAD83. Consequently, the GPS unit should be set for NAD83. This should be checked on the GPS unit at the beginning of each field season, and when borrowing or sharing a GPS unit. New, borrowed, or fill-in crew members must be notified that we are using NAD83.

Zone: MORA, NOCA, and OLYM are all in zone 10N.

Offset Direction to Plot Center: The azimuth from the location where UTM's were recorded to actual plot center. When you are unable to pick up satellites with the GPS at plot center, it may become necessary to record UTM's at a different location and then calculate the meters and azimuth to reach plot center.

Offset Distance to Plot Center: The meters from the location where UTM's were recorded to actual plot center.

Offset may be entered into the GPS unit directly (refer to [SOP 8: GPS Use Navigation, Data Collection, and Downloading](#)).

Elevation: The elevation at plot center measured in meters. If possible read the elevation from a topographic map or calibrated altimeter. The elevation also can be read from the GPS, but this may be less accurate. Check that the units are in meters, not feet; if in feet, change the GPS setting (if this proves difficult: change the units to feet on the data sheet until you can change the GPS).

Source: The source used to get the elevation data. Check whether it is from a map, the GPS, an altimeter, or another source. Identify the other source if used.

Directions to Plot: Starting from a road, known trail head, or other mapped landmark, give detailed directions to aid an entirely new crew returning to the plot, possibly 6 years later. Include distances in meters or 0.1 miles and use compass directions. For extremely difficult routes, consider including GPS locations on a marked map in a separate trip report. Include key information such as river crossings, other difficulties, and advice.

Evaluation

Circle yes (Y) or no (N) to answer each of the questions below. Offer numbers and explanations where needed. Evaluation guidelines are in shaded boxes on the data sheet.

Plot Safely Accessible? Circle 'Y' if the plot is safely accessible. Circle 'N' if the plot is not safely accessible and write in the unsafe factor (for example, too steep, cliffs, major river, or glacier crossing).

Slope in Plot < 35°? Circle 'Y' if the slope is < 35° for at least 90 percent of the plot. Circle 'N' if the slope is > 35° then write the steepest slope and percent area in the plot that has slope steeper than 35°.

Plot Edge > 125 m, and Plot Corner > 135 m from an Official Trail or Road? The trail must be established and maintained. This distance for the 50 × 50 m plot is to assure that the larger 1 ha plot is > 100 m from any trail. The distance will need to be measured directly if there is any uncertainty. Circle 'Y' if the plot is of sufficient distance. Circle 'N' if the plot is not of sufficient distance and write in the distance and position of the trail or road relative to the inner plot boundary.

Tree Cover > 25 percent? Circle 'Y' if the tree cover is greater than 25 percent. Circle 'N' if the tree cover is less than or equal to 25 percent.

Target Vegetation Association? Indicate if the vegetation is the type being targeted for that elevation band. Targeted vegetation types for each elevation band are listed in [table 9.3](#).

Table 9.3. Targeted plant associations for each of three elevation bands.

Elevation band 1: 0–300 meter
PICSIT-TSUHET/POLMUN-OXAORE
PICSIT-(ALNRUB)/RUBSPE/POLMUN
PICSIT-TSUHET/POLMUN
Elevation band 3: 600–900 meter
TSUHET-THUPLI-(ABIAMA)/GAUSHA/BLESPI
TSUHET-(ABIAMA)/GAUSHA/BLESPI
TSUHET-ABIAMA-PSEMEN/GAUSHA
TSUHET-ABIAMA-PSEMEN/MAHNER
TSUHET-(PSEMEN)/VACALA-MAHNER-(GAUSHA)
PSEMEN-TSUHET/GAUSHA/POLMUN
PSEMEN-TSUHET/MAHNER-POLMUN
PSEMEN-TSUHET/GAUSHA/XERTEN
PSEMEN-TSUHET/GAUSHA-MAHNER
PSEMEN-TSUHET/GAUSHA-VACPAR
PSEMEN-TSUHET/MAHNER
TSUHET-PSEMEN/MAHNER-CHIMEN
Elevation band: 1,200-1,500 meter
ABILAS/VACDEL
ABILAS-(ABIAMA)/VACMEM/VALSIT
ABILAS/VALSIT
ABILAS-(PICENG)/VALSIT
ABILAS/LUZGLA
ABILAS-(PSEMEN)/VACMEM

Vegetation Association (keyed in 50 × 50): Write the vegetation type in the box. To key out the vegetation type for the 50 × 50 m inner plot, use the *Preliminary Plant Associations Key.doc*, and *Preliminary Plant Associations Descriptions.doc (I:NRM\Working\Vegetation\VCa02\Documents\Guidelines_&_VegKey)*.

Non-Target Inclusions (streams, cliffs, disturbance, wetlands, etc.): Inclusions are often evident as changes in vegetation type and may be a result of the presence of streams, rocky outcrops, disturbance, wetlands, etc. Indicate ‘N’ if there are no inclusions. Indicate ‘Y’ if inclusions are present within the plot and describe the inclusion in the explanation box.

Proportion of 50 × 50 m Plot in/containing the Inclusion(s): List the percent area of the 50 × 50 m plot that contains the inclusion.

Number of Rings in Core from dom/codom Tree Base: Use an increment borer to core a **codominant** tree as close to the tree base as possible (see “Increment Boring” at end of this SOP). You will get a better estimate of tree age if the core is taken toward the base of the tree rather than at breast height. Do not core emergent or open-grown outliers; their tree age will not represent the stand age. Count the rings in your core. If there is some confusion or uncertainty, core another tree. Write the number of tree

rings counted; this should be expressed as the highest number you are able to count. If the number is just under or right at 80, another tree can be cored to verify this number; these cores should be collected by placing them in a paper straw and labeling them with the park, forest type, plot number, species, and date.

Appropriate for Permanent Plot? If the 50 × 50 m area passes all evaluation criteria (a ‘Y’ answer in all boxes except Non-target inclusions, and > 80 rings) circle ‘Yes.’ If the area does not qualify, circle ‘N’ and write in the disqualifying condition. If you are uncertain, circle ‘Uncertain,’ take very descriptive notes explaining your dilemma, and if possible, discuss the uncertainty with the project manager or Project Lead on return from the field.

If accepted, is plot center flagged? If the plot meets the criteria for a permanent monitoring plot, hang a piece of flagging at the location that you recorded plot center with the GPS unit. The flag (1) identifies the center point for your plot evaluation, (2) allows the plot center to be moved, if need be, after GPS differential correction and before plot establishment, and (3) will make it easier to find plot center when returning to the plot. Tear off a meter long piece of surveyors flagging, label it with *NPS-VCa02, Project lead name, phone number, plot # and date*, and hang it double from a live, visible branch.

Plot Description 50 × 50: Describe the terrain, vegetation, and environmental features of the 50 × 50 m plot. Include tree, shrub, and herbaceous species, size, and relative abundance.

Photographs:

Plot photographs allow us to view a plot if questions arise after the field visit. Photographs depict aspects of the vegetation, the landscape context of each plot, and features that might prove significant in understanding evaluation determinations. Take three or more photographs as indicated on the data sheet.

Image Description (the first three are required)

Upslope: Take one photograph looking upslope from plot center.

Downslope: Take one photograph looking downslope from plot center.

Across plot: Take one photograph looking across the plot.

Additional photographs: Additional photographs may be taken at the crew’s discretion.

Photograph No.: Write in the photograph No. as indicated on the camera.

Brief description: Write a brief description of the view, such as “large log lower left.” This will help you to differentiate images if there is some confusion.

Image File Name. The image name will be used to label the image after it is downloaded onto the computer (for more information see [SOP 12: Event Log Recording Plot Visit Details and Taking Digital Photographs](#) and [SOP 21: Photographic Image Processing and Management](#)). The image file name is made up of:

- Four letter park code (MORA, NOCA, OLYM)
- Elevation strata number (0–300 m = **1**, 600–900 m = **3**, 1,500–1,800 m = **6**)
- <Underscore>
- Three digit plot number (firing order)
- <Underscore>
- Description or descriptive code
- <Underscore>
- Year the photograph was taken (two digits)

In 2006 and 2007, a Classification Plot Survey Form and Ocular Form were completed at some reconnaissance points, in collaboration with the Vegetation Mapping Project. Because this is not part of the LTEM Forest Vegetation Monitoring Project, it will not be described here.

IV. Taking and Preparing Increment Cores

Guidelines

A cylindrical piece of wood can be extracted from the sample tree and used to determine tree age. This piece of wood, called an increment core, is taken using a hollow steel drill bit called an increment borer. The borer consists of three parts: a handle, a borer bit, and an extractor. When not in use, the borer bit and extractor fit inside the handle. The bit can be sharpened to cut a fine edge, but it is easily damaged by misuse. The bit should be protected from rust and pitch with a squirt of WD40 before and after use. Beeswax is used on the threads to reduce friction. Flag the extractor so that it can be easily seen when it is set aside.

Increment cores are usually taken near the same place as the dbh nail, at a height of 1.37 m above the ground, and on the uphill side of the tree. For determining stand age, however, the core should be taken as low on the tree bole as possible. Inspect the tree, and do not bore the tree through known knots, scars, conks, blisters, or any irregularity that may suggest a problem. If sampling a leaning tree, avoid boring into tension or pressure wood, and bore from the side of the tree instead.

To assemble the increment borer, unscrew the extractor and place safely aside. Pull the borer bit from the handle, place the square end perpendicular to the mid point on the handle (making a 'T'), insert into the hole, and lock into place.

Before coring the tree, inspect the borer for dirt, plugged wood, bark in the bit, or damage to the borer. Carefully remove any jammed wood or bark from previous use (carry a chopstick for this purpose. You may apply WD40 and beeswax to the threads to reduce coring friction. Make a rough estimate of the distance to the center of the tree and make a mental note of this length on the increment borer so you know how far to bore into the tree. Select a place on the bole between bark ridges, and align the borer bit and handle so that the bit will penetrate towards the center of the tree. In any other alignment, the annual growth rings seen in the extracted core will be distorted. Using a brisk and controlled motion, push the borer straight into the bark far enough for the bit threads to bite into the wood. Turn the handle clockwise while still applying pressure to the bit. Try not to allow the borer to rotate or wobble; this could result in a corkscrew core that may be difficult to handle later. Continue turning the borer handle until the bit reaches the desired depth.

Next, insert the extractor into the hollow end of the borer, being careful to slide the extractor alongside the core. Do not use excessive force – this could bend the extractor. With the extractor fully inserted in the shaft, turn the borer counter-clockwise one turn to break the core from its connection with the tree. Make sure that the resulting position of the extractor is beneath the core so the extractor will support the core when the extractor is pulled out of the borer. Carefully remove the extractor making sure the spoon is right-side-up. Use both hands to prevent the core from falling from the extractor or springing from it as it is removed from the borer.

Use the core to determine approximate stand age by counting tree rings. One year is represented by one dark line (winter growth) followed by one light line (spring/summer growth).

The rings usually get thicker as you get closer to the center of the tree. Check that the core has dissected or nearly dissected the center of the tree by observing the curvature of the rings. Count the rings from the cambium/bark layer to the tree center. For this project if you are able to determine without a doubt that the stand is greater than 80 years old, the age may be recorded and the tree core discarded. If in doubt, save the core in a labeled straw and bring to the attention of the Project Lead upon returning to the office.

Paper straws will be used to contain and protect the cores. These can be made as needed or ahead of time by rolling paper diagonally around a pencil and using tape to hold the shape. Insert the core into a paper straw, then fold and tape the straw ends to keep the core inside. Label the straw with the park code, strata#, and plot number (ex. MORA3-018), tree number, tree species (6-letter code), dbh, date, and corers initials. If the core is longer than the straw, mark the break point with a single longitudinal sharpie line, break the core, place in two straws, and label

the straws “1 of 2” and “2 of 2” accordingly. Cores can be contained in a protective quiver. Spare straws can be rubber-banded to the increment borer. Cleaning the borer with isopropyl alcohol between trees will reduce the risk of spreading pathogens among trees.

Clean the increment borer with WD40 at the end of each tour, and sharpen the borer when needed. This will add life to the borer and make increment boring easier and more efficient.

Trouble Shooting

- If the core has jammed in the borer, remove it in pieces to prevent further jamming or compression of the core.
- If the borer went through more than 2 inches of bark, the bark can curl and jam in the borer.
- If the borer is dirty or has pitch on the inside of the shaft, this can prevent the core from sliding freely down the inside of the borer.
- If the bit cut a corkscrew core, it can jam in the borer as it slides down the inside of the shaft of the borer.
- If the borer went through a knot, the knot wood may not slide freely and cause the core to jam.
- If the extractor wasn't fully inserted, the core could become jammed into the bit leaving a plug in the borer bit.
- If the tree center is rotten, choose another tree. It is important to get a core with a long, intact record of annual growth.
- Also, if you encounter rot in the course of boring, it may be very difficult to withdraw the bore because the rotten wood is too soft to allow the threads to catch. If this happens, you will have to pull very hard while turning the borer in order to extract the borer from the tree.

<i>Office use only (use initials and mm/dd/yy)</i>			
Entered by _____	date: _____	Updated by _____	date: _____
Verified by _____	date: _____	Certified by _____	date: _____

Figure 9.1 Reconnaissance form

LTEM FOREST PLOT RECONNAISSANCE FORM
IDENTIFICATION & LOCATION

Park _____ Recon No. __-____ (stratum # - firing order #) Watershed _____ Location name _____
Strata: 1 = 0-300m; 3=300-600m; 6=1500-1800m

Date: M ___ D ___ Y _____ Crew _____

Datum: NAD83 Zone: 10N (check these on GPS unit) Declination: ___°

GPS File Name _____ GPS Model _____

Target UTM X _____ m E
Target UTM Y _____ m N
(Corrected UTM's will be available in the db)

Field UTM X _____ m E Field UTM Y _____ m N GPS Error _____

Field Offset Direction to Plot Center ___° Field Offset Distance to Plot Center ___ m

Elevation ___ m Source: ___Map ___GPS ___Altimeter ___GIS theme

Directions to Plot: _____

EVALUATION of 50 x 50 m plot

Plot safely accessible? <i>(unsafe=too steep, cliffs, major river or glacier x-ing)</i>	circle		Explanation:	[Reject and abandon if unsafe]
	Y	N		
Slope in plot < 35°? <i>(for at least 90% of plot)</i>	Y	N		[Reject if >10% of plot has 35°]
Plot edge > 125m, and plot corner > 135m from an official trail, road or park bndry?	Y	N		[Reject if < 125 m]
Tree cover > 25%?	Y	N		[Reject if < 25% tree cover]
Target Vegetation Association?	Y	N		[Reject if not target veg-type]
Vegetation Association (keyed in 50x50):				
Non-target inclusions <i>(streams, cliffs, disturbance, wetlands, etc.)</i>	Y	N		
Proportion of 50x50 m plot in/containing the inclusion(s):			%	[Reject if >10% of 50 x 50 m plot]
No. of rings in core from dom/codom tree base <i>(do not core emergent or open-grown outliers - Label core with park, forest type, plot number, species, date)</i>			rings	[Reject if < 80 rings]
Appropriate for Permanent Plot?	Yes	No	Uncertain	notes
If accepted, is plot center flagged?	Y	N	[label: NPS-VCa02, S. Acker 565-3073, plot #, date]	

Plot description 50 x 50: _____

PHOTOS – for 11.3 m or 8 m radius plot

Image description	Photo #	Notes: brief description of view	Image file name
Upslope			____UP_07.jpg
Downslope			____DW_07.jpg
Across plot			____AC_07.jpg
Additional photos			_____07.jpg

Image file name consists of: PARKstrata#_plot#_descrip_yr.jpg

This page intentionally left blank.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 10:

Establishing and Marking Permanent Monitoring Plots

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP contains instructions for establishing and marking permanent monitoring plots for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. Plots are established and setup once the corrected plot center is located and before the first iteration of sampling. Each plot is a 1 ha square with 100 m on each side. The sides of the plot run directly N-S and E-W. The plot will be marked with rebar at plot center and at outside corners. Centered within the hectare plot is a 50 × 50 m area of subplots marked every 10 m with a cedar stake, except for the four outer corners that are marked with rebar. Refer to [figure 10.1](#) for plot layout (at back of SOP). The cedar stakes are labeled with small round numbered tags. Equipment for establishing and marking permanent plots is listed in [table 10.1](#). During this visit, the Plot Establishment Form is filled out ([SOP 11: Establishment Form: Recording Physical and Biotic Characteristics](#)).

I. Equipment

Table 10.1. Equipment for establishing and marking a permanent plot.

Equipment	
Laser range finder	Hammer (2 lb. or claw)
Reflector (consider range pole)	GPS
50 m measuring tape	Compass
Pre-cut tape strips: two 10 m and two 21.21 m (recommended)	Clinometer
32 cedar Stakes (40 more required for 1st sampling)	Calculator
(Use 12" stakes for OLYM strata 1 plots; 10" for all others)	Flagging
9 rebar	Slope equation table
Pin flags or tall garden stakes with flagging	Lot layout diagram
5 shiners, 5 nails (if stakes cannot be inserted)	Plot establishment form
36 blue metal numbered tags, 36 short nails	Plot maps

II. Plot Setup Procedure

This procedure can be accomplished with a two to four person crew in about 5 hours. You will begin marking the plot from the center and move outward. Tread lightly, keeping in mind that this will be a permanent sampling plot and should be disturbed as little as possible. Vegetation sampling quadrats will eventually be located to the SE of each subplot stake, but offset 1 m S and E so as to avoid trampled areas at stake placement (do not walk to the SE of a subplot stake). Center and corner subplots in the inner 50 × 50 m plot will not be sampled. Consequently, gear may be stored at plot center, or outside the inner plot if working near corners. Keep a plot diagram handy for reference and notes. Alternative marking methods are described in section III. An error of 1 percent is acceptable (for example, 0.10 m for every 10 m).

1. **Find and Mark Plot Center.** Find plot center and place rebar (or pin flag) in the most open area (with clearest view in all directions) that is still < 5 m from the corrected plot center. This will keep the center rebar from being hidden in a stump, or the middle of a dense shrub, and will make relocating easier. This is now plot center. Take a GPS reading. Hang and label a strip of flagging.
2. **Compass Use.** Choose your best compass and most practiced compass user for the next step. A box-type compass with a level bubble will give you best results, but for our purposes, a Silva® Ranger, used correctly, will do. Be sure the compass is held level, away from metal objects, and correctly aligned.
3. **Set 4 Stakes.** With a measuring tape and compass, measure 7.07 m to the NW. This will be subplot stake 15. Put in a red pin flag. Compensate for slope by raising or lowering the measuring tape at one end to keep the tape level. In the past, we have used a measuring tape rather than the laser range finder, because of carrying weight, and greater overall confidence in the measuring tape for short distances. Set each corner, 7.07 m to the NE, SE, and SW, in this same manner. These will eventually be replaced with subplot stakes 16, 21, and 22, but it is best to set the stakes after you have trued the corners in the next step. Where stakes cannot be inserted (that is, due to logs or trees), points may be marked with 2-in. round aluminum shiners nailed in place.
4. **True up Corners.** It is critical that these center four points be true. Measure the distance between each corner stake: 15 to 16, 16 to 22, 22 to 21, and 21 to 15. You can use four pre-cut 10 m tapes and leave them in place. **Record these measurements on your plot map** (fig. 10.1). The plot map is useful for recording progress and any oddities. Do not move pin flags until all lengths are measured and you have a strategy. The points should be 10 m apart, but usually range somewhere between 9 and 11 m, despite careful placement. A difference of 0.10 m is acceptable (1 percent error). Adjust as needed, or use this second truing method first: pull the tape measure diagonally, straight across the plot from 15 to 22, and then 16 to 21. Placing 0 m at one corner, the tape should cross directly over plot center at 7.07 m and the opposite corner at 14.14 m. With these two sets of measurements, you should be able to see which points are off. Adjust accordingly to true up the corners (occasionally it is easier to move the center rebar).
5. **Pound in Stakes and Numbered Tags.** Once the pin flag locations are true, pound in the center rebar (if not already done), and the four cedar stakes, labeling each with its respective numbered tag. Leave pin flags beside stakes to aid in visibility.
6. **Set Four Hubs.** With compass and a 21.21 m pre-cut measuring tape, carefully put in each of the pin flags and stakes that lie 14.14 m diagonally out from the last four stakes to the NW, NE, SE, and SW, namely stake numbers 8, 11, 29, and 26. To help with azimuth alignment, you can measure 21.21 m from plot center instead. As before, use proper compass methods and adjust for slope. It is critical that these be measured accurately, because these points will become the “hubs” for measuring all subplot corners around them (except the 50 × 50 m corner stakes).
7. **True up Hubs.** Measure the distance between the hubs to check that there is no more than 1 percent error (< 0.3 m between hubs). Adjust as necessary. Pound in cedar stakes, and numbered tags.
8. **Set Stakes around Hub.** With four hub centers set at 8, 11, 29, and 26, two groups of two people can easily work on different quarters of the plot at the same time thus increasing efficiency. Check that your compasses are aligned. Set all stakes that are 10 m away from the hub center. Then set the two stakes that are 14.14 m diagonally from the hub, leaving the corner stake for the next step. By setting all 10 m stakes together, and then all 14.14 m stakes together, you avoid confusing the distances. Remember that the corners 1, 6, 31, and 36 are set with rebar.

9. **Set Corner Stakes.** The corner rebar are set by aligning with four stakes, two on either side of the 50×50 m plot. For example, to put in corner #1 you would use stake #s 13, 7, 3, and 2. Run a measuring tape 20 m down each side and place the pin flag where the two measurements meet, adjusting as necessary to compromise between them. Put in rebar and flag for visibility.
10. **Set Outermost Corners.** Locate the outer corners of the 1 ha plot from the outer corners of the 50×50 m plot. Carefully shoot an azimuth of 315° (NW) for a distance of 35.36 m. You may need to do this in 2–4 steps to adjust for slope and visibility problems. Put in and flag the corner rebar. Repeat this step for each corner NE (45°), SE (135°), and SW (225°).

NOTE:

If you arrive at a plot and find that it does not meet the criteria for a permanent plot as outlined in [SOP 9: Reconnaissance Form](#), immediately contact your supervisor. Do not proceed with the plot set up until the discrepancy is resolved.

III. Alternative Marking Methods

Occasionally you will not be able to insert a rebar or stake due to a log, tree, rock, or rocky soil. A metal shiner or washer can be nailed to a log or tree to mark a plot or subplot corner, and this noted on the Plot Establishment Form. When rock is encountered, you may offset the stake or rebar. Set the stake as near to the corner as possible and clearly record the offset direction and distance to that corner, both on flagging attached to the stake and on the Plot Establishment Form. When a cedar stake cannot be inserted into rocky soil, rebar may be used instead.

IV. Measuring Horizontal Distance

These plots are to be set up using horizontal (H) distance. The laser range finder can be used to measure H distance in plots that are relatively open. At times, the laser range finder has not been taken for plot setup because pack weight is critical when the crew is carrying rebar, cedar stakes, and other gear into the back country. In this situation, horizontal distance can be calculated using slope distance (sd) and slope (s°) as measured with a clinometer ($H = sd \cos s^\circ$), or by using percentage of slope and the slope correction factor from [table 6.2](#) in [SOP 6: Training Field Crews](#). For setting up relatively flat plots, the crew may opt to use a measuring tape, keeping the tape level to measure H distance.

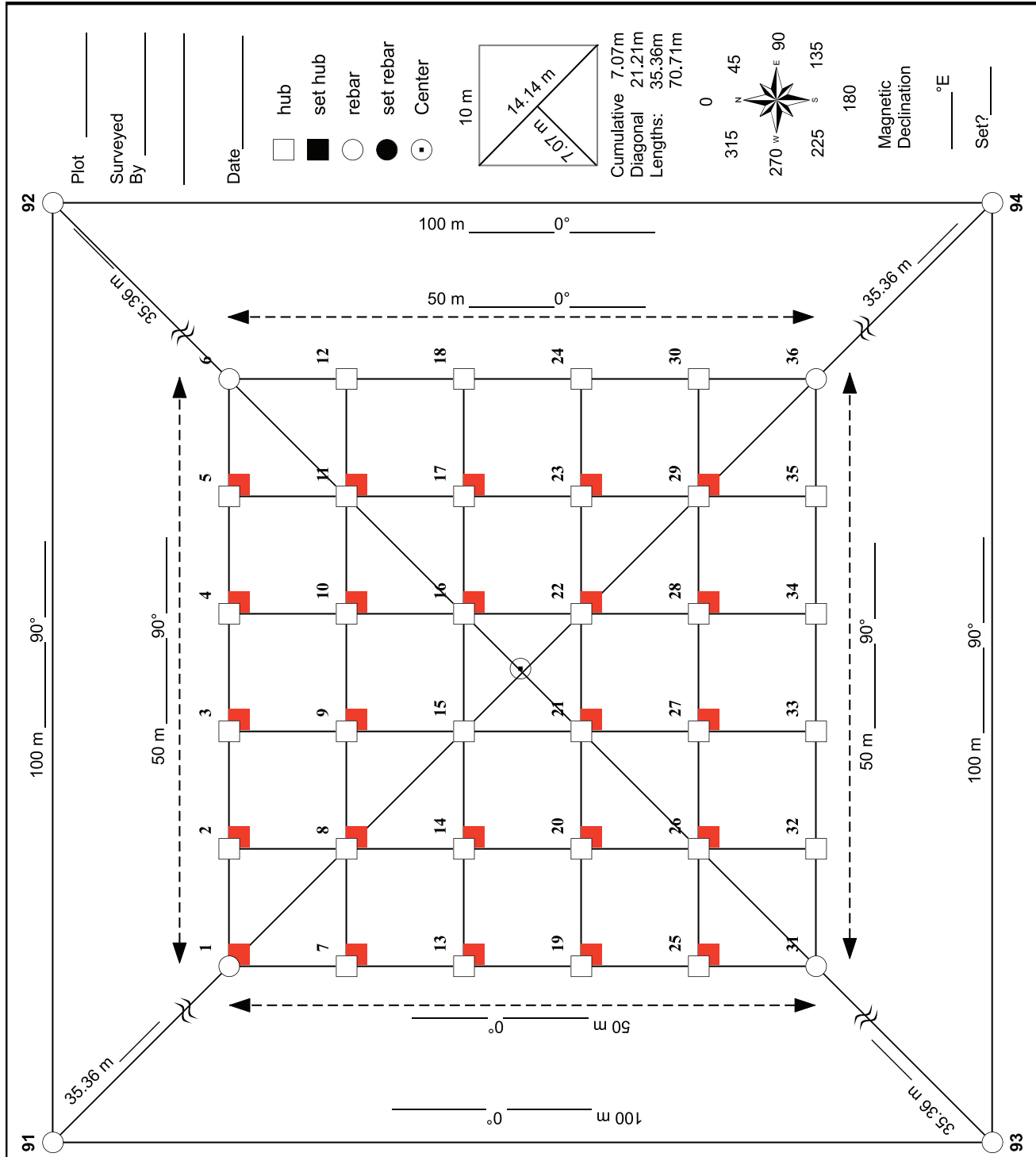


Figure 10.1 Plot map.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 11:

Establishment Form: Recording Physical and Biotic Characteristics

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP contains instructions for recording physical and biotic characteristics of permanent monitoring plots on the Plot Establishment Form for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. The data will be entered into a database later in the season and it is imperative that the data fields be completed with full attention to detail and without gaps. Any questions about the parameters must be addressed prior to going into the field. Any blanks on the data sheets must be filled before leaving the field. The data sheet is shown in [figure 11.1](#) (at back of SOP).

Procedures

I. Plot Establishment Form

The Plot Establishment Form is to be completed by the crew that sets-up the plot. One technician in each crew (usually the lead technician) will be responsible for ensuring that these data are completely recorded. Fields labeled "office use only" are to be completed in the office and do not need to be filled out in the field. Fill out the form as follows:

Park: The 4 letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

The code is created by using:

- **Single digit elevation stratum:** 1, 3, or 6 (1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash; and
- **Three digit plot number:** The original firing-order number given to that location prior to reconnaissance.

Watershed: The name of the major watershed in which the plot lies.

Site Name: A local name that describes the area where the plot lies, usually something easily found on a map such as the name of a creek, a crossing, a ranger station, etc.

Date: The month, day, and year that the plot was set up and established.

Crew: The last names and first initials of crew members that participated in the plot set-up and establishment.

GPS File Name: As indicated on the GPS unit when a location file is recorded. It is critical that the file name be recorded in addition to the UTM's, because it is the reference used for entering the corrected UTM's later.

GPS Device: Record the make and model of the GPS device used to acquire coordinates for the plot, for example, Trimble GeoExplorer® 3, Thales MobileMapper®, or Garmin® eTrex.

Declination: The magnetic declination or angle (degrees) that must be added or subtracted from an azimuth to convert between the needle direction on a compass (magnetic north) and longitude (true north). The Silva® Ranger compass dial can be rotated to adjust for declination with a small screw in the back, so true north is read directly without needing to calculate the difference. Declination must be checked and reset each year for each park. Declination can be checked at this and other websites: <http://www.thecompassstore.com/decvar.html>.

Field UTM X: The latitude of plot center, also known as easting, recorded in the field with the GPS.

Field UTM Y: The longitude of plot center, also known as northing, recorded in the field with the GPS.

Datum: The datum is the basis for a planar coordinate system and indicates which map projection and coordinates are being used. There are more than 100 datums in use throughout the world. The North American Datum of 1983 (NAD83) will be used by LTEM in all three parks. Some topographic maps are still in NAD27, but we rarely read UTMs directly from these topographic maps. ArcMap produced maps and target UTMs will be in NAD83. Consequently, the GPS unit should be set for NAD83. This should be checked on the GPS unit at the beginning of each field season, and when borrowing or sharing a GPS unit. New, borrowed, or fill-in crew members must be notified that we are using NAD83.

Zone: MORA, NOCA, and OLYM are all in zone 10N.

Offset Direction to Plot Center: The azimuth from the location where UTMs were recorded to actual plot center. When you are unable to pick up satellites with the GPS at plot center, it may become necessary to record UTMs at a different location and then calculate the meters and azimuth to reach plot center.

Offset Distance to Plot Center: The meters from the location where UTMs were recorded to actual plot center. Offset may be entered into the GPS unit directly (refer to [SOP 8: GPS Use](#)).

Elevation: The elevation at plot center measured in meters. If possible read the elevation from a topographic map or calibrated altimeter. The elevation also can be read from the GPS, but this may be less accurate. Check that the units are in meters, not feet; if in feet, change the GPS setting (if this proves difficult: change the units to feet on the data sheet until you can change the GPS).

Source: The source used to get the elevation data. Check whether it is from a map, the GPS, an altimeter, or another source.

Directions to Plot: Starting from a road, known trail head, or other mapped landmark, give detailed directions to aid an entirely new crew returning to the plot, possibly 6 years later. Include distances in meters or 0.1 miles and use compass directions. For extremely difficult routes, consider including GPS locations on a marked map in a separate trip report. Include key information such as river crossings, other difficulties, and advice.

Task list: Plot needs, special instructions, or adjustments to consider before plot revisit. These notes will be printed in the visit report to review and take with when revisiting a plot. This may include notes about bringing stakes or rebar that were short during plot setup, or a need for boots, or bug nets, etc.

ENVIRONMENTAL FEATURES (of 50 × 50): All data collected below this section pertains to the inner 50 × 50 m plot unless otherwise specified.

Slope: The steepness of the slope at plot center in degrees. Standing at plot center measure the steepness of the slope (both upslope and downslope) with a clinometer. Record these two values as [up]/[down] in the margin and then record the average of these two measurements in the space provided. Slope degrees are read on the left side of the clinometer (tilt to see degrees sign).

Aspect: The compass direction of the downward slope of land at plot center; this azimuth is perpendicular to and facing away from the slope plane (think of the direction water would flow). ‘True’ simply indicates that the declination adjustment has been made.

Soil Texture: The soil texture of the top soil layer (below the duff layer, where mineral soil begins) at plot center as determined with the dichotomous key in [figure 11.2](#).

Parent Material: Material from which the soil is derived. The descriptions below also are given in [figure.11.2](#).

Bedrock: Solid rock underlying soil or unconsolidated superficial material.

Loess: Homogeneous deposit of windblown silt, with some clay and sand that is non-stratified, friable, angular, fine-grained, buff-colored, and loosely held together.

Colluvium: Loose heterogeneous mass of soil material and/or rock fragments deposited via rainwash or downslope creep, collecting at the base of a hillside;

Alluvium: Stream deposited, unconsolidated, mineral material.

Till: Unsorted, glacially deposited rock and mineral materials.

Lacustrine sediment: Mineral material deposited in a lake or along the lake margin.

Other: Description of parent material that does not fit any of the above selections.

Microconfiguration: The general landform shape of the 50 × 50 m plot (see [figure 11.2](#)).

Microtopographic Position: Also called microposition; the landscape in the near vicinity of the 50 × 50 m plot. Refer to the Microposition diagram in [figure 11.2](#).

Topographic Moisture: Used to describe and analyze the movement or redistribution of water by gravity through the soil and bedrock (Henderson and others, 1992). For any mountain slope, precipitation falls more or less evenly as dew or rain. Any unevenness of precipitation is due mostly to wind and the orographic effect of mountains. However, this effect is small relative to the redistribution of water once it is intercepted by the ecosystem. As precipitation is absorbed by litter or soil, it is immediately affected by the downward pull of gravity. The water in the soil that is free to move is therefore redistributed downward from ridge tops, steep slopes, and convex surfaces to lower slopes, toe slopes, and valley bottoms. We use a scale from 1–9 to quantify the relative effects of this redistribution of soil water, where a “1” represents a very dry site from which water immediately begins moving downhill. At the other extreme, code “9” represents a body of open water. TM code 5 represents a site where the effect of topography results in neither an accumulation nor deficit of soil water. This coding system is illustrated in the [figure 11.2](#). Record values to 0.1 units, but do not use even halves (for example, 4.5, 5.5). Refer to Topographic Moisture table in [figure 11.2](#).

Topographic Position: Also called Macroposition; the landscape containing the plot relative to the features at the mountain scale. Refer to the Macroposition diagram in [figure 11.2](#).

Landform: The landform that best describes the 50 × 50 m inner plot. Options are listed in the Landform table in [figure 11.2](#).

Drainage: Choose the category (listed below) that most closely describes the drainage characteristics of the soil in a site. Steep slopes are well drained due to water running off the inclined surface; whereas the drainage characteristics of gently sloping sites and flat areas are mostly a function of the permeability of the substrate. Permeability ranges from very well-drained on coarse gravels to extremely impeded drainage on high clay content soils that restrict the flow of water through the soil column.

- **Rapid – runoff/hillslope:** if it appears that water would run off quickly due to a relatively steep slope.
- **Rapid – coarse, permeable surface:** if it appears that water would drain quickly due to a permeable (rocky or sandy) substrate;
- **Impeded** – low permeability: if there is evidence that water collects or drains slowly due to a substrate of low permeability;
- **Aquatic:** if there is standing water year-round.

Comments to Clarify Choices Above: This is not a required field. If you have trouble choosing from the options in the boxed fields, or feel there is not a perfect fit, you may offer an explanation here.

Site Map

During plot set-up, take a mental note of the biological and landscape features. After plot set-up, walk through the plot again if necessary, and mark the features on the Site Map ([fig. 11.1](#)). Include streams, boggy areas, drop offs, large rocks, a change in vegetation type, blow-down gaps, and other significant features. Draw and label items clearly. The site map will be scanned into the computer and taken into the field during each plot visit so that the crew can document further observations.

Notes

A notes section is provided for the crew to write descriptions, clarifications, or questions.

Reference Cited

- Brewer, R., and McCann, M.T., 1982, Laboratory and field manual of ecology: Saunders, Philadelphia, 269 p.
- Henderson, J.A., Peter, D.H., Leshner, R.D., and Shaw, D.C., 1992, Field guide to the forested plant associations of the Mt. Baker-Snoqualmie National Forest, U.S. Department of Agriculture, Forest Service Pacific Northwest Region, R6, Ecological Technical Paper 028-91.

This page intentionally left blank.

<i>Office use only (use initials and mm/dd/yy)</i>			
Entered by _____	date: _____	Updated by _____	date: _____
Verified by _____	date: _____	Certified by _____	date: _____

Figure 11.1. Plot Establishment Form

LTEM FOREST PLOT ESTABLISHMENT FORM

IDENTIFICATION & LOCATION

Park _____ Plot No. ____-____-____ (Park, Veg class, Plot #) Watershed _____ Site name _____

Date: M ____ D ____ Y _____ Declination (E): ____°

Crew: _____ (last name, first initial)

GPS File Name _____ GPS Device _____

Field UTM X _____ m E Field UTM Y _____ m N Datum: nad83 Zone: 10N (check these on GPS unit)

Field Offset Direction to Plot Center ____° Field Offset Distance to Plot Center ____ m

Elevation ____ m Source: __Map __GPS __Altimeter __Other: _____

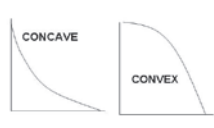
Directions to plot:

Target UTM X _____ m E
Target UTM Y _____ m N
(Corrected UTM's will be available in the db)

Task list - Plot needs, special instructions, or adjustments to consider before plot revisit:

ENVIRONMENTAL FEATURES (of 50 x 50) – evaluated at plot center

Slope ____ (°) Aspect ____ (true)

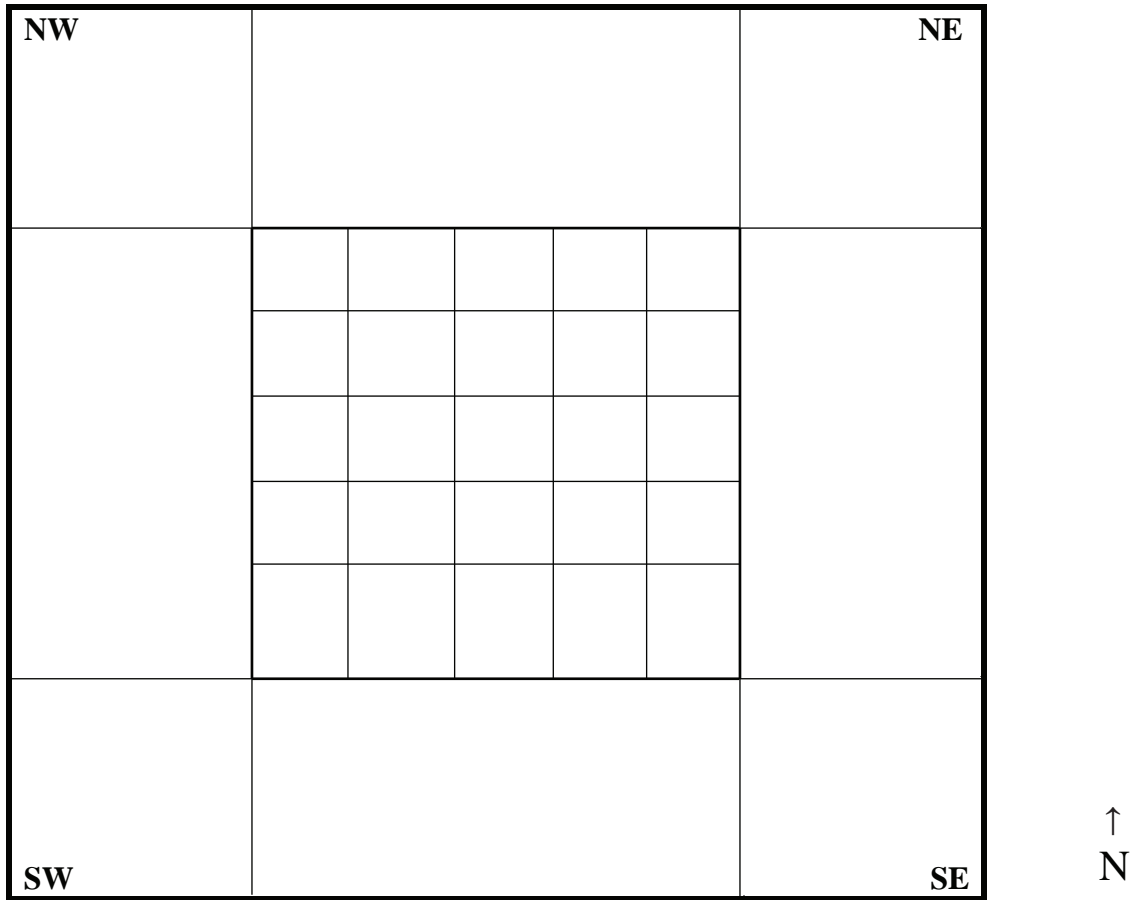
Soil Texture __Clay __Clay Loam __Silty Clay __Sandy Loam __Silt __Loamy Sand __Silt Loam __Sand If unknown – bring sample	Microconfiguration __Convex __Concave __Straight __Undulating		Topographic Moisture: _____
			Landform _____
Parent Material __Bedrock __Colluvium __Till __Lacustrine sediment __Loess __Alluvium __Other: _____	Microtopographic Position __Ridgetop __Toe of slope __Upper 1/3 __River bottom __Middle 1/3 __Hydric __Lower 1/3 __Bench, flat __Draw, intermittent stream bottom	Topographic Position __Ridge or peak > 130' wide __Narrow ridge or peak <130' __Side hill – upper 1/3 __Side hill – middle 1/3 __Side hill – lower 1/3 __Canyon bottom < 660' wide __Bench, terrace, or dry flat __Alluvial flat > 660' wide __Swamp or wet flat	Drainage __Rapid – runoff/hillslope __Rapid – coarse, permeable surface __Impeded – low permeability __Aquatic

Comments to Clarify Choices Above: _____

Site map

Features will be marked on this map during plot set up. In the office the site map will be photocopied. A copy of each plot's site map, marked during the previous visit, will be brought with and updated in the field during subsequent sampling visits.

(Mark features on map – blow-down gaps, boggy areas, etc.)



Azimuths (° true): C→1 = 315° C→6 = 45° C→31 = 225° C→36 = 135°

NOTES:

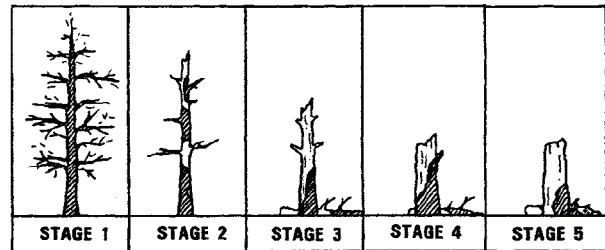
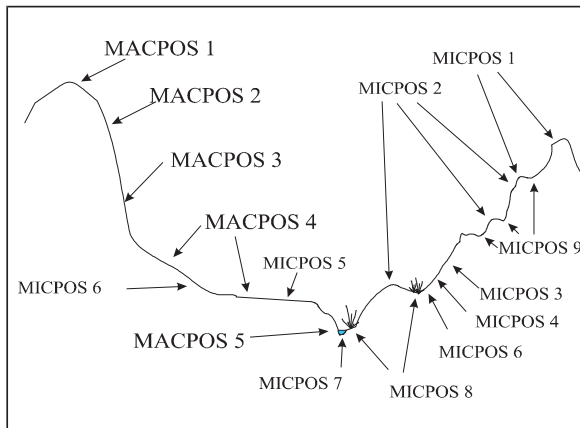
Figure 11.2 Field Reference Sheet

Help for estimating cover:

Plot Size	1% cover		5% cover		10% cover	
	square	diameter	square	diameter	Square	diameter
50mx50m (2500 m ²)	5mx5m	5.6m	11.2mx11.2m	12.6m	15.8mx15.8m	17.8m
11.3m radius (400 m ²)	2mx2m	2.26m	4.5mx4.5m	5.05m	6.3mx6.3m	7.14m
10mx10m (100 m ²)	1mx1m	1.13m	2.2mx2.2m	2.52m	3.2mx3.2m	3.57m
5mx5m (25 m ²)	.5mx.5m	0.56m	1.1mx1.1m	1.26m	1.6mx1.6m	1.78m
1mx1m	1 square (10cm ²)	11.3cm	5 squares	25.2cm	10 squares	35.7cm
0.5mx0.5m	¼ of a square	5.6cm	1.25 squares	12.6cm	2.5 squares	17.8cm

Lengths: finger _____ hand _____ hand to elbow _____ hand to shoulder _____

LOG DECAY CLASS	SNAG DECAY CLASS
1=small twigs present, sound log, wood original color	1=pointed top, limbs present, bark left, wood hard
2=starting to rot but bark resists being pulled off, twigs with peeling bark	2=few limbs, no fine branches, sapwood sloughing, wood decayed
3=sapwood spongy, bark falls off when disturbed, bole maintains its own shape	3=limb stubs only, broken top, sapwood sloughing, wood fibrous
4=does not support its own weight, a little round on top, lumps on side indicating the start of collapse, brown rot, branch stubs will move (they will not on Class 3)	4=few or no stubs, broken top, cubical, reddish wood
5=heap with bark underneath, barely recognized as being a log	5=no stubs, broken top, <20% of bark left, wood mostly gone
	Tree Height = (cosA2*Ds)(tanA1+tanA2)



Macroposition (MACROPOS) – the landscape containing the plot relative to the features at the mtn scale

- 1 = ridgetop
- 2 = upperslope
- 3 = midslope
- 4 = lower slope
- 5 = bottom
- 6 = plain

Microposition (MICROPOS) the landscape in the near vicinity of the plot

- 1 = ridgetop
- 2 = upper 1/3
- 3 = mid 1/3
- 4 = lower 1/3
- 5 = bench, flat
- 6 = toe of slope
- 7 = river bottom
- 8 = edge of or in basin or wetland (hydric)
- 9 = draw, intermittent stream bottom (V&H)

Microconfiguration (MCONFIG_v) = vertical which is the same direction as the aspect and the slope measurements and **MCONFIG_h** = horizontal is perpendicular to the slope and parallel to the contour.)

- 1 = convex
- 2 = straight
- 3 = concave
- 4 = undulating

ENVIRON. FEATURE	DEFINITION
Parent rock	rock from which other sediments or rock are derived
Soil texture	proportion of sand, silt, and clay in a soil as estimated in the field by hand
Microconfiguration	configuration of land within the plot
Vertical	goes with the slope
Horizontal	goes against the slope
Microtopographic position	position of the plot within the immediate landscape that includes the plot and the near vicinity
Parent material	material from which the soil derives
Bedrock	solid rock underlying soil or unconsolidated superficial material
Loess	homogeneous deposit of windblown silt, w/ some clay and sand, that is, non-stratified, friable, angular, fine-grained, buff-colored, and loosely held together
Colluvium	loose heterogeneous mass of soil material and/or rock fragments deposited via rainwash or downslope creep, collecting at the base of a hillside
Alluvium	stream deposited, unconsolidated, mineral material
Till	unsorted, glacially deposited rock and mineral materials
Lacustrine sediment	mineral material deposited in a lake or along the lake margin
Topographic position	position of the plot relative to large scale topographical features
Drainage	water drainage at the site
Hydrologic type	site hydrology, expressed as whether water is observed on the plot
Topographic moisture	topographic moisture index indicates the likely movement or redistribution of water by gravity through the soil and bedrock as influenced by site topography

<p>LANDFORM (from J. Reidel) - High elevation landforms (primarily erosional in genesis) H = <u>Horn</u>, summit ringed by cirques with no evidence of overriding by Cordilleran Ice Sheet A = <u>Arete</u>, ridge with jagged form, not modified by CIS C = <u>Cirque</u>, glacial landform with flat floor and amphitheater shape O = <u>Other</u>, lower summit modified by CIS R = <u>Ridge top</u>, lower elevation with rounded form, modified by CIS P = <u>Pass</u>, low point between horns and aretes LM = <u>Little Ice age moraine</u>. Ridge of till deposited by glacier movement from 700-100 yrs bp. PG = <u>Patterned ground</u>. PK = <u>Parkland</u> (MORA only) gentle terrain surrounded by steeper. -Valley slope landforms (primarily erosional genesis) VW = <u>Valley Wall</u> RC = <u>River Canyon</u>- Vshaped valley incised in bedrock BB = <u>Bedrock Bench</u>, glacial landform found along lower valley walls at junctions of glaciated valleys, ass. with small rock falls and topples -Transitional landforms between valley slope (erosion) and valley floor (deposition). MM-A = <u>Debris avalanche</u>, large landslide includes rock and debris MM-F = <u>Rock Falls or Topple</u>- accumulation of falling rock in single events. Usually void. MM-DA = <u>Rock and debris avalanches</u> (large size, rapid) MM-S = <u>Slumps and Creeps</u>- landslide of saturated ground material.</p>	<p>MM-SG= Sackung- fissures or spreading at ridgetops MM-DT = Debris Torrents- channelized debris flow, usually void. DA = Debris Apron- zone of debris accumulation at base of slope DC = Debris Cones (inactive part of debris torrent, slopes >10°, often have levees, large boulders, on 1st and 2nd order tributaries Elwha specific: PD= Perched delta- relict delta formed under past Lake Elwha conditions. PDC- perched debris cone. PDCT- Perched debris cone terrace -Valley bottom landforms (primarily depositional genesis) FP = Floodplain, valley floor to elevation 4000 ft. VB = Valley Bottom, valley floor 'flats' above 4000 ft., where floodplain and associated cut and fill terraces are absent T = Terraces- flat surface that grades downstream. FT = Alluvial Fan Terrace, relict parts of alluvial fans that stand above the active fan surface SAIL= snow avalanche impact landform L= Lahar DF= debris fan-located where stream gradient decreases D= delta- fan shaped deposit where stream meets still water SH= shoreline AF = Alluvial Fan, large tributaries, surface slopes < 5° M = Glacial Moraines PM = Pleistocene Moraine- ridge of till deposited by glacier -Other landforms U = Undifferentiated, usually glacial drift</p>
--	--

TOPOGRAPHIC MOISTURE

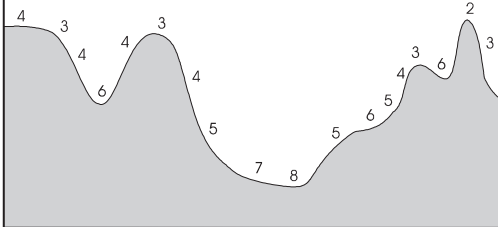
POSITION	<u>Convex</u>				
	0//5%	6//30%	31//65%	65//120%	>120%
Cliff/Rock	2-3	1-3	1-2	1-2	1-2
Ridgetop	3-4	3-4	3	2-3	1-2
Upperslope	3-4	3-4	3-4	2-3	1-2
Midslope		4	3-4	2-3	2
Lowerslope	4-5	4-5	3-4	3-4	2-3
Bench/flat	4	4			
Valley bottom	5	4-5			
Draw,creek,cove					
Wetland		7-8			
Lake/pond/river					

POSITION	<u>Straight</u>				
	0//5%	6//30%	31//65%	65//120%	>120%
Cliff/Rock	2-3	1-3	1-2	1-2	1-2
Ridgetop	3-4	3-4	2-4	1-3	1
Upperslope	4-5	4-5	3-4	2-3	1-2
Midslope	4-5	4-5	4-5	3-4	1-2
Lowerslope	5-6	5-6	5-6	4-5	2-3
Bench/flat	5-6	5-6	5-6		
Valley bottom	5-7	5-6	5-6		
Draw,creek,cove	6-7	6-7	6-7		
Wetland	7-8	7-8	7-8	7-8	
Lake/pond/river	9				

POSITION	<u>Concave</u>				
	0//5%	6//30%	31//65%	65//120%	>120%
Cliff/Rock		1-3	1-2	1-2	1-2
Ridgetop	5	5-6	5-6		
Upperslope	5	5-6	5-6	5	4
Midslope	5-6	6	6	5	4
Lowerslope	6-7	6-7	6	5	4
Bench/flat	5-7	6-7	6		
Valley bottom	6-7	6-7	6-7		
Draw,creek,cove	6-7	6-7	6-7	5-6	
Wetland		7-8	7-8	7-8	
Lake/pond/river	9				

TM= redistribution of water by gravity, as **unaffected by aspect, vegetation type or soil type**. TM code “1” represents a very dry site where water immediately begins moving downhill, code “9” represents a body of open water, code 5 represents a modal site where the effect of topography results in neither an accumulation nor deficit of soil water. This coding system is illustrated in the figure above, and examples are shown in the table below. Record values to 0.1 units, **but don’t use even halves** (e.g. 4.5, 5.5).

TOPOGRAPHIC MOISTURE



- 1 = extremely dry (rocky ridgetop)
- 2 = very dry
- 3 = dry, well-drained
- 4 = dry mesic
- 5 = mesic
- 6 = moist mesic
- 7 = moist, well-watered
- 8 = wet
- 9 = standing water

Simplified Key to Soil Texture (adapted from Brewer and McCann, 1982)

- A1 Soil does not remain in a ball when squeezed.....sand
- A2 Soil remains in a ball when squeezed.....B
- B1 Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Soil makes no ribbon.....loamy sand
- B2 Soil makes a ribbon; may be very short.....C
- C1 Ribbon extends less than 1 inch before breaking.....D
- C2 Ribbon extends 1 inch or more before breaking.....E
- D1 Add excess water to small amount of soil. Soil feels at least slightly gritty.....sandy loam
- D2 Soil feels smooth.....silt loam
- E1 Soil makes a ribbon that breaks when 1 2 inches long; cracks if bent into a ring.....F
- E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring.....G
- F1 Add excess water to small amount of soil; soil feels at least slightly gritty.....clay loam
- F2 Soil feels smooth.....silt
- G1 Add excess water to a small amount of soil; soil feels at least slightly gritty.....sandy clay or clay
- G2 Soil feels smooth.....silty clay

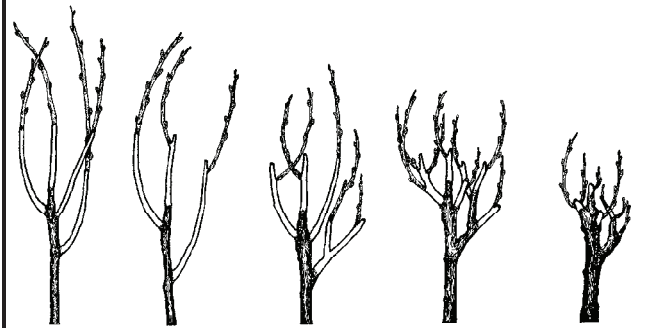
Type	Specifics	0.5 x 0.5 m	1 x 1 m	5 x 5 m
Non-vascular plants	Lichens and bryophytes; does not include litterfall or species on logs that do not contact the ground inside the quadrat	% cover	P	No Record
Herbs	Forbs, graminoids and ferns (except large ferns listed with shrubs below)	No record	% cover	P
Shrubs	Shrubs (not including low growing woody species); and large ferns (e.g. POMU, PTAQ, ATFE)	No record	P or NP	% cover
Seedlings	Trees < 2.5 cm dbh and ≥ 15 cm tall; rooted in quadrat	No record	count #	No Record
Small trees	All trees < 2.5 dbh, any height; do not have to be rooted in quadrat	No record	% cover	P
Saplings	2.5 cm to 12.6 cm dbh; fill box on page 2 of data sheet	No record	No record	dbh, ht, % cover

% = percent cover to the nearest 1% P = Present NP = Not Present

Shrubs that should definitely be done in 5x5: AMEALN, GALSHA, MENFER, Mahonia spp., RHOALB, ROSGYM, PAXMYR, Spiraea spp., Vaccinium spp.; **Ferns**: POLMUN, ATHFIL, PTEAQU, (estimate other shrubs and big ferns in the 5x5 also, even if they aren't on this list! Examples of a **low-growing woody species** that should be done in the 1x1 include: LINBOR, RUBPED, CHIUMB, CHIMEN). If there is ever confusion, talk to supervisor and add to this list.

Herbivory

In every other plot: S2, S4, S7, S9, S11, S14, S16, S19, S 21, S23, S26, S28

	Form Class Code	Description – based on length and appearance of previous year’s wood
	0	No past use – no visible sign of herbivory
	1	1-25% removal of leader growth
	2	26-50% removal of leader growth
	3	51-75% removal of leader growth
	4	> 75% removal of leader growth

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 12:

Event Log: Recording Plot Visit Details and Taking Digital Photographs

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP gives direction for filling out the event log and photo-documenting permanent plots for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. The datasheet is shown in [figure 12.1](#) (at back of SOP).

I. Plot Event Log

Park: The 4 letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

- **Single digit elevation stratum:** 1, 3, or 6 (1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash; and
- **Three digit plot number:** The original firing-order number given to that location prior to reconnaissance.

Watershed: The name of the major watershed in which the plot lies.

Site name: A local name that describes the area where the plot lies, usually something easily found on a map such as the name of a creek, a crossing, a ranger station, etc.

Start date: Enter the date sampling commences.

Crew: Enter the last names and first initials of all crew members that are part of this sampling event.

Sample cycle: Indicate in which sample cycle this sampling event lies. A sample cycle consists of a 6-year time period during which a series of plots (six panels) are sampled. Each panel of plots is sampled for two consecutive field seasons, and a new panel is begun in the second sampling year of the previous panel. The next cycle begins 6 years after the initial sampling event. Thus cycle 1 will occur 2007–13; cycle 2 will occur 2013–19.

Visit within cycle: Circle the year 1 or 2, indicating if this is the first or second season that the plot is being sampled in this cycle.

Directions to plot: Starting from a road, known trail head, or other mapped landmark, give detailed directions to aid an entirely new crew returning to the plot, possibly 6 years later. Include distances in meters or 0.1 miles and use compass directions. For extremely difficult routes, consider including GPS locations on a marked map in a separate trip report. Include key information such as river crossings, other difficulties, and advice.

Task list: Plot needs, special instructions, or adjustments to consider before plot revisit. These notes will be printed in the visit report to review and take with when revisiting a plot. This may include notes about bringing stakes or rebar that are missing, or a need for boots, or bug nets, etc.

COMMENTS

Weather conditions: Briefly describe the weather conditions during the sampling event (clear skies, overcast, rain, snow, freezing, high winds, foggy). Weather can affect the plot environment, as well as the performance and endurance of the crew. Knowing the weather conditions may help to explain why certain decisions or observations were made.

Logistic problems: List any logistical problems here. These notes will help future crews prepare for visits to this plot. It also may be possible for some problems to be addressed back at the office with the help of supervisors.

Note: If you arrive at a plot and find that it does not meet the criteria for a permanent plot as outlined in [SOP 9: Reconnaissance Form](#), immediately contact your supervisor. Do not proceed with the plot set up until the discrepancy is resolved.

Collected:

Indicate if the following data were completed (Y), not completed (N), or partially completed (Partial). This information becomes part of the Visit Report that is printed and taken to the plot during each return visit. Data that are not collected the first year must be collected the second year, except for mortality data, which are collected every year after the initial measurement. Data not listed below are collected every year.

Tree Data? Indicate if the tree data sheet was completed (Y), not completed (N), or partially completed (Partial). Were all trees tagged and recorded, or was there only time to do part of the plot, or none of the plot? At least the witness trees should be recorded.

DWM Data? Indicate whether all (Y), none (N), or part (Partial) of the downed woody material (DWM) data were collected. This includes coarse woody debris (CWD), fine woody debris (FWD), duff, and litter.

Mortality Data? Indicate whether all (Y), none (N), or part (Partial) of the mortality data were taken. This data will not be taken the first year of sampling, but will be completed each year thereafter. A tree data sheet will be printed that includes previous tree measurements with shaded title columns left blank to accept mortality information.

Site Map Updated? Indicate if the site map was updated (includes corrections or added details). An updated photocopy shall be placed in the plot file folder at the end of each tour. The new site map may be scanned and given a new file name in the office at the end of the tour.

Name the site map file as follows:
YEAR_PARKstrata-Firing#_SiteMap.pdf
For example:
2007_MORA3-098_SiteMap.pdf

Tree Tags Replaced? Indicate if any tree tags were replaced. Tags may need to be replaced if they are missing or damaged, or if a mistake was made in the numbering system. The tags are first replaced with a temporary aluminum tag that can be written on in pencil, and may be replaced with a permanent aluminum tag on the next visit. Use the original tree number. Use the tree stem map and tree size and species data to verify the tree identity. Write in the tree tag number(s) of those replaced.

Tree Tags Added? Indicate if any tree tags were added to the plot. Trees that were missed initially or that have grown to qualifying size will need to be tagged in subsequent years. Write in the tree tag number(s) of those added.

Stakes Replaced: Indicate if any stakes were replaced. Write in the stake number for those replaced. Stakes may need to be replaced if they are missing or have rotted.

Observed Changes to Plot: Notes regarding changes that have occurred to the plot may be recorded here.

Evidence of Animals: Describe animal evidence that has been observed in the plot. Include trails, tracks, herbivory, scat, hair, bones, or antlers.

Significant Events: Use this space to record sightings of rare or exotic species, tagged bears, accidents, or other significant events.

Phenology: Describe phenology of common plants, at least one herb, shrub, and fern by noting stage of leaf, flower, and fruit development (as appropriate).

Disturbance Indicators Since Last Visit: Use this space to indicate new indicators of disturbance that have been observed in the plot. Include fire scars, broken tips or limbs, cankers, witch's broom, conks, pitch, flagged branches, insect holes, insects, avalanche, and rock slides.

Water on Plot: The hydrologic regime within the 50 × 50 m plot.

- None: There is no evidence of water standing (or moving) on the plot.
- Permanent stream/pond: Water appears to cover the land surface at all times of the year in all years.
- Permanent swamp/bog: Substrate shows evidence of being saturated to the surface at all times of the year in all years, and contains wetland species. Trees may or may not be present.
- Temporary stream: A stream that flows only part time because it receives water from seasonal sources such as springs and bank storage as well as precipitation.
- Flood zone: Area shows evidence that flooding (water exceeding natural banks) has occurred at some time during the year.
- Other: Description of water on the plot that does not fit any of the above selections.

II. Photograph Documenting Permanent Plots

The crew photographer should take all photographs as outlined in the photographs table on the datasheet. However, photographs of diseased vegetation, landscape disturbances, or wildlife evidence can clarify a description, and the crew is encouraged to photo-document other plot observations. Photo-documentation provides the following benefits to the program:

1. A graphical depiction of aspects of the vegetation and the landscape context of each plot—a snapshot in time.
2. A graphical depiction of any nearby features that might prove significant in understanding changes that could occur within a plot, such as ecotones, potential sources of disturbance, and conspicuous landmarks.
3. Once out of the field, plot photographs allow us a way to ‘revisit’ a plot if questions arise during data entry or analysis.
4. A method to actually analyze and graphically display apparent changes in the vegetation cover of a plot—sometimes a photograph will capture changes that have occurred when other sampling measurements do not capture the change.

One technician will be assigned the lead role for photo-documentation. Often other technicians will take some of the required photographs, but the lead technician for this role is responsible for ensuring that all required photographs are taken, and any good photograph opportunities to illustrate the plot condition or landscape are utilized. The lead technician should become familiar with the camera manual and guidelines for downloading and processing images ([SOP 20: Photographic Image Processing and Management](#)).

1. Responsibilities of the Lead Technician

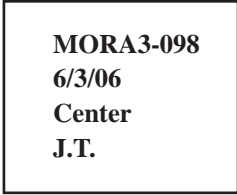
The lead technician for the photo-documentation protocol will need to:

- a. Become proficient in the operation and features of the digital camera prior to going into the field, and must be skilled at the following functions of the camera: image resolution, image file size, zoom or wide-angle capabilities, and the ‘macro’ feature.
- b. Make sure that the datasheet is completely and correctly filled out, which is crucial to the photo-documentation process, and that any notes are entered into the project data base at the end of each tour.
- c. Check that the correct date and time are entered in the camera.
- d. Ensure that a sufficient number of charged batteries and storage cards are brought into the field each day.
- e. Ensure that the equipment is well-cared for, and that the camera is stored in dry conditions during inclement weather.
- f. Be familiar with the methods and hardware and software required to download the images following a trip.

- g. Ensure that the images get correctly downloaded, copied, renamed, sorted, and entered into the database at the end of each tour, as described in “Guidelines for Taking and Recording Photographs.”
- h. Be responsible for recharging the batteries such that they will be ready for use during subsequent field excursion.
- i. Make recommendations at the end of the field season about lessons learned and improvements to this procedure.

2. Guidelines for Taking and Recording Photographs

- a. **Before Sampling.** Plot photographs are taken before sampling the plot. It is essential that you take the plot photographs before the measurements are made, so that images of the plot represent its most natural, undisturbed state.
- b. **Consider Time of Day.** On sunny days, earlier or later in the day is best. Photographs should not be taken into the glaring sun.
- c. **Weather.** If it is raining, do not risk getting the camera wet to take photographs. Take advantage of any break in the rain to get images of the site.
- d. **Check View.** Before taking the photograph, check that the zoom is all the way open giving you the widest view. Attempt to hold back any small branches directly in front of the camera (get assistance if necessary). With automatic focus, the resulting image could otherwise be a close-up of the branch rather than a view of the forest.
- e. **Position.** Take photograph from a standing position.
- f. **Resolution.** Use a medium resolution format for photographs. The typical file size of photographs ranges from 400 KB – 1 MB. You will rarely need to store images in the highest resolution format for routine photo-documentation. Most often, field excursions last for 8 days, and you must not exceed the storage capacity for images. There should be storage capacity for the required photographs for three plots, at 25 photographs per plot, plus storage capacity for additional photographs.
- g. **Identify the Plot.** The first photograph for each plot should frame a sign with plot information. Use a permanent black pen to write in bold letters on blank paper: plot code, date, photograph descriptor, and photographer’s initials like the example below. This will help to separate the photographs between plots and help to prevent confusion.



- h. **Image #.** Every photograph that is taken must be recorded on the data sheet. The camera automatically assigns a number to each image. Record this number beside the photograph code on the data sheet. If the photograph is not represented by a code, write an abbreviated description of the view being photographed. Avoid deleting images in the field. If
- b. Standing at plot center and facing outward toward the designated corner, take two photographs: (1) a horizontal view that focuses on ground details, and (2) a vertical view that best captures the trees. This equals eight images per plot.
- c. Standing at each of the four inner plot corners (1, 6, 36, 31), facing plot center, take two photographs as before (horizontal and vertical). This equals eight images per plot.
- d. From these four inner plot corners, take one photograph (horizontal), facing away from the plot toward the outermost corner. This equals four images per plot.
- e. Standing at each of the outermost plot corners (NW, NE, SE, SW) facing plot center, take one photograph. This equals four images per plot.

you delete a photograph for any reason, record it as a deleted image next to the associated number, so that all numbers in the sequence are accounted for.

- i. **Description of View.** In just a few words, describe the image view, for example: large cedar left, small snag center. This will help identify the photograph if a mix-up occurs.
- j. **Image File Name.** This is the file name that will be given to the image back in the office. The name ending is already typed onto the data sheet for each photograph. Fill in the park, strata, and plot # on the data sheet, at least for the first photograph. This will help facilitate image naming back in the office.
- k. **Images.** Total number of required photographs is 25 (see “Photograph Views”).

3. Photograph Views ([table 12.1](#))

- a. First, take a low horizontal photograph of the area surrounding plot center, with the center rebar in view. This shows the location of the center rebar relative to trees and logs and may help with relocating the center rebar in the future. Frame the plot identity sign in the lower left corner.

Table 12.1. Required photographs.

Photo-graph	Code	Description	Perspective
1	C	View of center rebar in surroundings	Horizontal - low
2	C1_H	From center looking NW toward rebar #1	Horizontal - low
3	C1_V		Vertical - mid
4	C6_H	From center looking NE toward rebar #6	Horizontal - low
5	C6_V		Vertical - mid
6	C36_H	From center looking SE toward rebar #36	Horizontal - low
7	C36_V		Vertical - mid
8	C31_H	From center looking SW toward rebar #31	Horizontal - low
9	C31_V		Vertical - mid
10	1C_H	From corner #1 looking SE toward plot center	Horizontal - low
11	1C_V		Vertical - mid
12	1NW	From corner #1 looking NW to outer corner	Horizontal - mid
13	6C_H	From corner #6 looking SW toward plot center	Horizontal - low
14	6C_V		Vertical - mid
15	6NE	From corner #6 looking NE to outer corner	Horizontal - mid
16	36C_H	From corner #36 looking NW toward plot center	Horizontal - low
17	36C_V		Vertical - mid
18	36SE	From corner #36 looking SE to outer corner	Horizontal - mid
19	31C_H	From corner #31 looking NE toward plot center	Horizontal - low
20	31C_V		Vertical - mid
21	31SW	From corner #31 looking SW to outer corner	Horizontal - mid
22	NWC	From NW corner looking toward plot center	Horizontal - mid
23	NEC	From NE corner looking toward plot center	Horizontal - mid
24	SEC	From SE corner looking toward plot center	Horizontal - mid
25	SWC	From SW corner looking toward plot center	Horizontal - mid

4. Additional Photographs

Record location, image #, and description of each additional photograph. Whereas these are not required, take photographs if they help describe or clarify plot characteristics, or work being conducted.

- a. Photograph any ecotones that occur within the plot or very close to the plot and photo-document any noteworthy physiographic features in relation to the plot.
- b. If possible, take two to four photographs at some distance from the plot showing the landscape context and vegetation mosaic in the vicinity of the plot. This may only be practical in subalpine plots. The distance and direction of these photographs will obviously depend on what aspect gives the best overall picture of the area. Record aspect and position relative to the plot.
- c. Take photographs to illustrate interesting plant species, disease, or disturbance.
- d. Occasionally photograph crew members and work in progress.
- e. A GPS point can be recorded for photographs taken far from the plot. Record in your notebook: the image number, a brief description of the subject, azimuth of the image (what direction are you facing when the image was taken), and the GPS file number.

III. Logistics Record

The logistics record is a very valuable tool for planning future plot visits. Fill this out at the end of each tour, before arriving back at the office. Estimate the number of hours spent on transportation, hiking, and for each sampling activity. Then record the total days to complete that particular plot, and whether the data collection is complete. Indicate any special transportation needs such as boating, ferrying, shuttling, or travel across the International border. Indicate whether the crew stayed at a campsite, ranger station, or in park housing, and the location. There is a space for taking notes to clarify or detail the information.

This page intentionally left blank.

Figure 12.1 Plot Event Log

Office use only (use initials and mm/dd/yy)			
Entered by _____	date: _____	Updated by _____	date: _____
Verified by _____	date: _____	Updated by _____	date: _____

LTEM FOREST PLOT EVENT LOG

IDENTIFICATION & LOCATION

version 9/19/2008

Park _____ Plot No. __-____ (Park, Veg class, Plot #) Watershed _____ Site name _____

Start date: M __ D __ Y _____ End date: M __ D __ Y _____ Crew _____
(last name, first initial)

Sample Cycle _____ (6 year cycles) Visit w/in Cycle 1 2 (circle year 1 or 2)

Directions to plot (check one): Add Revise Replace Declination (E) ___o

Task list - Plot needs, special instructions, or adjustments to consider before next visit:

COMMENTS

Weather Conditions:							
Logistic Problems:							
Collected:		Circle:			Circle:		
Tree data?	Y	N	Partial	Site map updated?	Y	N	New site map file name (office):
DWM data?	Y	N	Partial	Tree tags replaced?	Y	N	Numbers:
Canopy cover data?	Y	N	Partial	Tree tags added?	Y	N	Numbers:
Mortality data?	Y	N	Partial	Stakes replaced?	Y	N	Numbers:
Observed changes to plot:							
Evidence of Animals:							
Significant events (e.g., sightings of rare/exotic species, accidents, tagged bears, etc.):							
Phenology:							
Disturbance indicators since last visit (fire scar, broken tops or limbs, cankers, witch's broom, conks, pitch, flagged branches, insect holes, insects, avalanche, rock slide, etc.):							
Water on Plot ___ None ___ Temporary Stream ___ Saturated (H2O table) ___ Permanent stream/pond ___ Flood zone ___ Other _____ ___ Permanent swamp/bog ___ Scattered standing H2O							

PHOTOS

Symbol	Image #	Description of view	Image file name (office) (PARKstrata#_plot#_sym_yr.jpg) Ex: OLYM1_001_C_06.jpg
C			_C_07.jpg
C1_H			_C1_H_07.jpg
C1_V			_C1_V_07.jpg
C6_H			_C6_H_07.jpg
C6_V			_C6_V_07.jpg
C36_H			_C36_H_07.jpg
C36_V			_C36_V_07.jpg
C31_H			_C31_H_07.jpg
C31_V			_C31_V_07.jpg
1C_H			_1C_H_07.jpg
1C_V			_1C_V_07.jpg
1NW			_1NW_07.jpg
6C_H			_6C_H_07.jpg
6C_V			_6C_V_07.jpg
6NE			_6NE_07.jpg
36C_H			_36C_H_07.jpg
36C_V			_36C_V_07.jpg
36SE			_36SE_07.jpg
31C_H			_31C_H_07.jpg
31C_V			_31C_V_07.jpg
31SW			_31SW_07.jpg
NWC			_NWC_07.jpg
NEC			_NEC_07.jpg
SEC			_SEC_07.jpg
SWC			_SWC_07.jpg

Additional photos (plant spp., view, plant disease, animal sign, disturbance, working, crew – include photo # and description)

Location	#	Description	Image file name (office)

Logistics Record: Fill out at end of each tour

Task or data form	Time to complete (hrs)	# persons	Notes
Transportation_office to trailhead			
Transportation_trailhead to office			
Hike_trailhead to campsite			
Hike_campsite to trailhead			
Hike_campsite to plot			
Taking plot photos			
Tree data sheet			
Vegetation quadrat data sheet			
Down woody material data sheet			
Canopy cover data sheet			
Epiphytic Lichen Survey			
TOTAL DAYS to complete plot			
Plot data collection complete?	Circle one: Y N		
Special Transportation needs:			
Campsite, ranger stn., or housing used:		Location:	

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 13:

Tree Data: Measuring and Mapping Live and Standing Dead Trees

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes how and where to measure live and dead trees for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. These data will yield information on tree volume, growth, and mortality; wildlife habitat; forest structure and composition; biomass; and carbon sequestration. Whether a tree is recorded depends on its size, condition, and location in the plot. Tree location reference information is recorded once during the initial tagging. Witness tree location and status are checked every visit. Mortality tree data are recorded every visit after the initial visit. Tree size data are collected once every 6-year cycle. Every 6 years, additional trees that reach qualifying size (ingrowth/recruitment) are tagged and recorded. Tree heights are only measured for one or a few live representatives of the stand due to time limitations; however, tree heights are recorded for every dead tree. A two-person team can efficiently record tree data. The tree datasheet is shown in [figure 13.4](#) (at back of SOP). Note: The terms "height" and "length" are used interchangeably to indicate distance along the trunk no matter its orientation to the ground (for example, vertical, leaning). Methods and terminology follow U.S. Department of Agriculture Forest Service (2007).

I. Equipment Needed

Table 13.1. Equipment for measuring and mapping trees.

Tagger (person 1)	Data Recorder (person 2)
Cloth DBH tape	Laser range finder
Tree tags (150 per plot)	Compass (declinated)
Aluminum nails (175 per plot)	50 m tape – if no laser
Temporary tags	Clinometer – if no laser
Claw hammer	Tree datasheet (water proof paper)
Reflector	Pencils
Visit Log*	Binoculars

*Check the Visit Log before going into the field to see if there are any special tasks or needs for this plot. Always bring temporary tags and nails to replace any missing tags. Use the original tag number and note the need for a permanent tag with the same number for the next plot visit.

II. Definitions

An individual tree is categorized as a live tree, a snag, a sapling, or a seedling based on the criteria in [table 13.2](#).

Table 13.2. Tally tree definitions.

Type	Diameter	Length
Live tree – dom/codominant <i>Measured throughout plot</i>	> 76.2 cm DBH	> 1.37 m
Live tree – smaller <i>Measured in specified subplots</i>	12.7 to 76.1 cm DBH	> 1.37 m (leaning < 45°)
Snag (standing dead) - large <i>Measured throughout plot</i>	> 76.2 cm DBH	> 1.37 m
Snag (standing dead) - smaller <i>Measured in specified subplots</i>	12.7 to 76.1 cm DBH	> 1.37 m
Sapling <i>Measured in 5×5 m subplots</i>	2.5 to 12.6 cm DBH	> 1.37 m
Seedling: conifers <i>Counted in 1×1 m quadrats</i>	< 2.5 cm DBH	> 15 cm
Seedling: hardwoods <i>Counted in 1×1 m quadrats</i>	< 2.5 cm DBH	> 30 cm

Live Tree: Trees are alive if they have any living parts (leaves, buds, cambium) at or above the point of diameter measurement (DBH). Trees that have been temporarily defoliated are still alive.

Dead Tree: To qualify as a standing dead tree (snag), dead trees must be at least 12.7 cm DBH, have a bole that has an unbroken actual length of at least 1.37 m, and lean less than 45° from vertical as measured from the base of the tree to 1.37 m. Broken pieces on dead trees that are attached by more than 50 percent of their wood are included in tree measurements; partially attached pieces, separated from the main bole by more than 50 percent, are not included, and are counted as Down Woody Material (DWM), if they cross a DWM transect. Live and dead standing trees do not have to be self-supported to be counted as tally trees, as long as they are leaning < 45° from vertical. They may be supported by other trees, branches, or their crown. Once tallied, dead trees >12.7 cm in diameter are tracked until they no longer qualify as standing dead. **Working around dead trees is a safety hazard – crews should exercise extreme caution! Trees that are deemed unsafe to measure should be estimated.**

III. Witness Trees

Witness trees reference the location of plot center and corner stakes and must be ≥ 12.7 cm DBH. Witness trees are recorded on the tree datasheet during plot setup. If they were not recorded during plot setup, they must be recorded during the first sampling visit. Witness trees are coded as ‘W’ (witness) in the ‘Tree Type’ column on the tree datasheet if they are used as witness trees only, or as ‘B’ (both) if they also qualify as data collection trees.

IV. Conducting the Tree Tally

Tree Selection: Trees or snags in the different size classes are treated in the manner and at the specified location outlined in [table 13.3](#). A tree is considered within the plot if the bole center falls within the plot or subplot boundary. For trees in question, it will be necessary to draw a string or tape between boundary markers to determine whether the tree is inside or out.

Table 13.3. Tally trees: size, sampling activity, and location.

Tree/Snag Size	Activity	Location
DBH: ≥ 76.2 cm diameter	Tagged, mapped, and measured:	Throughout 1 ha plot
Length: ≥ 1.37 m	Record data on datasheet	
DBH: 12.7 to 76.2 cm	Tagged, mapped and measured:	10 × 10 m subplots: 3, 9, 13, 14, 15, 16, 17, 21, and 27 only
Length: Not specified	Record data on datasheet	
Saplings: 2.5–12.6 cm DBH	See SOP 14: Vegetation Quadrats	5 × 5 m quadrats
Seedlings	See SOP 14: Vegetation Quadrats	1 × 1 m quadrats

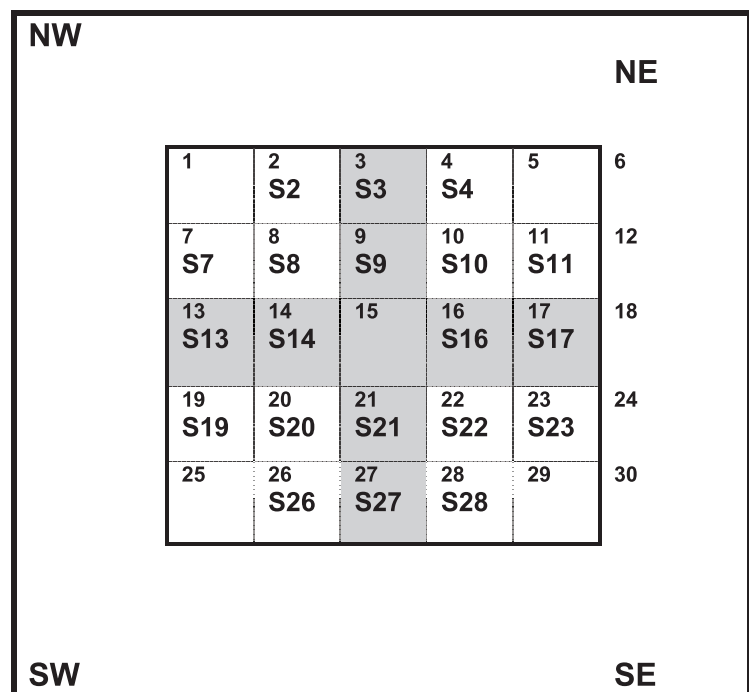


Figure 13.1. Map of 100 × 100 m plot.

Strategy. Work in a team of two. Begin at one outer corner of the 100 × 100 m plot (usually the NW corner) measuring all trees and snags ≥ 76.2 cm DBH and ≥ 1.37 m in length. Work only on those trees outside of the 50 × 50 plot. After completing the outer ring, then move into the 50 × 50 plot being aware of the subplots where the trees between 12.7 and 76.2 cm DBH are to be measured and mapped in addition to the trees ≥ 76.2 cm DBH.

Person 1: holds the DBH tape, tree tags, hammer, nails, and reflector, and finds a qualifying tree or snag.

Person 2: holds the clipboard, laser and compass, and stands at a reference stake (1 through 36 or the NW, NE, SW, SE corner).

Person 1 (measurer) uses the laser to calculate the tree height. That person records the height and canopy characteristics on the datasheet. Person 2 (finder) finds the tagged trees and directs person 1 to a potential line of sight. The finder also carries the reflector for cases where a clean bole shot is not possible; the laser can be set to use the reflector (filter on) and ensure an accurate reading when branches are in the way.

In most cases, it is possible to record canopy characteristics while mapping trees and measuring dbh. Measuring all components at the same time will decrease trampling, and eliminate the time and effort to find the trees again.

Encountering missed trees:

While conducting the tree survey, the crew should be aware that they may encounter a tally tree (live or dead) that was missed during a previous sampling event. Before proceeding, check that the tree has not simply lost its tag by looking around the tree base and by comparing its position to that of other trees on the datasheet. It is also possible that the tree has simply grown large enough to be tallied (in-growth). A tree that is >5 cm over the minimum dbh or a snag that is of decay class 3 or higher is a likely candidate for a missed tree, however, and this should be noted on the Visit Log. If there is no record of the tree, give it an unused number and a temporary tree tag. Collect all tree data as for other tally trees.

V. Data Collection

Park: The 4-letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

Single digit elevation stratum: 1, 3, or 6
(**1:** 0–300 m; **3:** 600–900 m; **6:** 1,500–1,800 m),
followed by a dash; and

Three digit plot number: The original firing-order number given to that location prior to reconnaissance.

Date: Enter the date that the reconnaissance point was visited.

Crew: Enter the last names and first initials of all crew members that are part of this sampling event.

Page __ of __: Enter the page number and total number of tree data pages for that plot.

Mapping Tree Species

Location:

Record the tree location as either the corner of the outer plot area (NW, NE, SE, SW), or the subplot number in which the tree stands. Witness trees that are located outside the plot may be recorded as OP (outside plot).

Tag Number:

All trees and snags that qualify for the tree tally, or as witness trees, must be marked with an aluminum, numbered tag attached to the tree by an aluminum nail. To satisfy wilderness objectives, the tag should be placed on the side of the tree facing away from the nearest trail or road when possible (steep slopes may prevent this). Hammer the tag to the tree bole at breast height (dbh). Breast height is at 1.37 m on the uphill side of a tree bole. This height can be pre-measured to a reference point on the surveyor (for example, top vest button or grommet), so that the height can be quickly determined at each tree. The nail should be driven in only as far as necessary to firmly anchor it in the wood; this leaves room for tree growth. Angle the nail so that gravity pulls the tag down toward the head of the nail, and the tree will less likely grow over the tag. Do not use a tree number more than once on the same plot. Record the tree tag number on the tree datasheet.

Note: If the side away from the trail is the downhill side of the tree place a nail (without a tag) on the uphill side at the correct place for measuring dbh. Then nail the tag on the side away from the trail, but at the same level as the dbh nail. Make a note on the data form.

When revisiting a plot that has already been tagged, bring spare tags and temporary tags. Spare tags can be used for trees that were missed in previous years. Before leaving for the tour, make sure the tag numbers you bring are different from numbers previously assigned to trees at your destination plot. Every tree in a plot must have a unique number. Temporary tags are made of soft aluminum allowing one to inscribe a number by pressing into the tag with a pen or pencil; these can be used on trees that have already been tagged, and therefore have a number, but lost their tree tag. Double check your assumptions, then write the previous number on the temporary tag, attach this to the tree with a nail, and note that a replacement tag is needed at the next plot visit.

Species:

Identify the tree species and record the 6-letter code that represents the first 3 letters of the genus and the species.

Tree Status:

Indicate whether the tree is living (L), dead (D), missing (M), or fallen (F). Missing and fallen trees can only be recorded when revisiting a previously sampled plot.

Tree Type:

Indicate whether the tree is

W – Witness tree only. The tree is used to reference center or corner locations in the permanent plot, but does not qualify as a tally tree due to size or location outside the plot. Data are recorded in the first nine columns only.

D – Data tree only. The tree qualifies for a tally tree, but is not used as a witness tree. Data are recorded in all columns.

B – Both a witness tree and data tree. The tree qualifies for a tally tree, and is used as a witness tree. Data are recorded in all columns.

Though rebar and cedar stakes monument plot locations, witness trees can be used to relocate these points should the rebar or stakes be lost or pulled. Because witness trees are often within the plot and qualify as tally trees, they are included on this datasheet. When the best witness tree stands outside the plot, you will record its location as OP, and collect the same data as for witness trees located inside the plot.

Reference Point:

Record the nearest or most convenient corner rebar or stake number to the tree. This will serve as the reference point from which the azimuth and distance to the tree are measured. Tree maps will be produced from these data to help relocate trees when resampling plots.

Azimuth (true):

Record the azimuth from the reference point to the center of the tree. Your compass declination must be accurately set for the year and the park location, as recorded on the Plot Event Log. If in doubt, get help to set your compass declination. Hold the compass level, sight the tree being measured, and make sure the metal clip board or laser range finder is not interfering with the compass reading. Take care that you also are reading the compass direction correctly from the reference point to the tree, and that you are not off by 180 degrees. You can use the sun or landmarks of known direction to double check your measurement assumptions.

Horizontal Distance (m):

Using the laser range finder, measure and record the horizontal distance (not slope distance) from the reference point to the center of the tree. Take this measurement with the laser range finder by standing to the side of the tree and holding the reflector in line with tree center.

Tree Attributes**Diameter (cm):**

Diameters are used in calculating volume, growth, and average stand diameter. Diameters will be measured only once every cycle (once every 6 years).

Record the diameter at breast height (dbh). Because the tree tag has been nailed at this height, you will always measure the diameter just above the tag nail. Reset the nail at subsequent visits as necessary to avoid tree growing over nail. Keep the dbh tape taut and level as you extend it around the tree, and measure to the nearest 0.1 cm, but always round down to the lower number rather than rounding up (rounding up can result in negative growth calculations). For trees on a steep slope, a hiking pole or forked stick may be used to adjust the diameter tape from the downhill side.

If a tree or snag is >81 cm diameter, affix an additional nail. Continue to add a nail for every additional 30 cm of diameter, distributing the nails evenly around the circumference of the bole. Set these nails while the diameter tape is girdling the tree at the point of diameter.

Incorrect or Abnormal Diameter Measurement: See **diameter check** below.

Special dbh Situations:

Forked tree: In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45° or less. Forks originate at the point of the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 30 cm, between 30 cm and 1.37 m, or above 1.37 m.

1. Tree forked below 30 cm: Trees forked in this region are treated as distinctly separate trees. Distances and azimuths are measured individually to the center of each stem where it splits from the stump. Dbh is measured for each stem at 1.37 m above ground. When stems originate from pith intersections below 30 cm, it is possible for some stems to be within the limiting distance of the microplot or subplot, and others to be beyond the limiting distance. If stems originating from forks that occur below 30 cm fork again above this point, see below.
2. Trees forked between 30 cm and 1.37 m: Trees forked in this region are also counted as separate trees, but only one distance and azimuth (to the central stump) is used for all. Although a single azimuth and distance applies to all, multiple stems should be recorded as they occur in clockwise order (from front to back when one stem is directly in front of another). The dbh of each fork is measured at a

point 1.37 m above the pith intersection. When forks originate from pith intersections between 30 cm and 1.37 m, the limiting distance is the same for all forks – they are either all on, or all off the plot.

3. Trees forked at or above 1.37 m: Trees forked in this region count as one single tree. If a fork occurs at or immediately above 1.37 m, measure diameter below the fork, just beneath any swelling that would inflate dbh.

Stump sprouts: Stump sprouts originate between ground level and 1.37 m on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 30 cm are measured at 1.37 m from ground line. Stump sprouts originating between 30 cm and 1.37 m are measured at 1.07 m above their point of occurrence. As with forks, rules for measuring distance and azimuth depend on whether the sprouts originate above or below 30 cm.

Tree with butt-swell or bottleneck: Measure these trees at 0.5 m above the end of the swell or bottleneck if the swell or bottleneck extends 1 m or more above the ground. If this is not possible, do what is practical and take notes.

Tree with irregularities at dbh: On trees with swellings, bumps, depressions, and branches at dbh, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

Tree on a slope: Measure diameter at 1.37 m from the ground along the bole on the uphill side of the tree.

Leaning tree: Measure diameter at 1.37 m from the ground along the bole. The 1.37 m distance is measured along the underside face of the bole.

Independent trees that grow together: If two or more independent stems have grown together at or above the point of dbh, continue to treat them as separate trees. Estimate the diameter of each, set the “Diameter Check” code to 1 (see section below), and explain the situation in the notes.

To estimate the diameter of a connected tree, set a diameter nail at dbh on opposite sides of the tree (the distance between the nails is essentially one-half the tree’s circumference). Measure the distance between the nails with a diameter tape. Multiply the measurement by 2 and record the result as the current diameter. Example: Distance measured = 44.8 cm (44.8×2) = 89.6 cm. Set Diameter Check = 7. Repeat for the other connected tree.

Missing wood or bark: Do not reconstruct the dbh of a tree that is missing wood or bark at the point of measurement. Record the diameter, to the nearest 0.1 cm,

of the wood and bark that is still attached to the tree. If a tree has a localized abnormality (gouge, depression, etc.) at the point of dbh, measure immediately above the irregularity at the place it ceases to affect normal stem form.

Live windthrown tree: Measure from the top of the root collar along the length to 1.37 m. Remember that trees are alive if they have any living parts (leaves, buds, cambium) at or above the point of diameter measurement (dbh).

Down live tree with tree-form branches growing vertical from main bole: When a down live tree, touching the ground has vertical tree-like branches coming off the main bole, first determine whether or not the pith of the main bole (averaged along the first log of the tree) is above or below the duff layer.

1. If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly.
2. If the pith intersection of the main down bole and vertical tree-like branch occurs below 1.37 m from the stump along the main bole, treat that branch as a separate tree, and measure dbh 1 m above the pith intersection for both the main bole and the tree-like branch.
3. If the intersection between the main down bole and the tree-like branch occurs beyond the 1.37 m point from the stump along the main bole, treat that branch as part of the main down bole.
4. If the pith of the main tree bole is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take dbh and length measurements from the ground, not necessarily from the top of the down bole. However, if the tip of the main tree bole curves out of the ground towards a vertical angle, treat that portion of the top as an individual tree originating where the pith leaves the duff layer.

Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree.

Diameter Check:

Record this code to identify any irregularities in diameter measurement positions (that is, abnormal swellings, diseases, damage, new measurement positions, etc.) that may affect use of this tree in diameter growth/change analyses. If both codes 1 and 2 apply (diameter is both estimated and moved), use code 2 and record the new diameter.

Diameter codes

- 0 – Diameter measured accurately at correct location.
- 1 – Diameter estimated for reason other than moss or vines.

- 2 – Diameter measured at different location than previous measurement (remove original d-nail) or previous diameter was obviously incorrect; value has been updated.
- 5 – Diameter estimated because of moss.
- 6 – Diameter estimated because of vines.
- 7 – Diameter estimated (double nail diameter).

If diameter is estimated because of moss/vine/obstruction etc., record an estimate of the diameter without the obstruction, and record the appropriate diameter code.

If diameter at the current inventory is measured at a different location than at the previous inventory, record code 2, and remove the d-nail(s) from the previous inventory.

If the previous point of diameter measurement cannot be found on a live tree (that is, nail fell out), or if the previous location is no longer accessible (that is, covered in a landslide), also record code 2.

If the nail is more than 30 cm away from where the diameter should be measured according to current protocols (that is, if previous crew made a mistake), then move the tag if possible, measure the diameter at the correct location, and assign a DIAMETER CHECK code of 2. If the old nail, marking a point of diameter measurement not used at the current inventory, cannot be removed, then pound it in flush with the tree.

The previous diameter can be estimated by doing one of the following:

1. Take an increment core at the location of the previous diameter measurement: Measure the increment length of most recent number of rings equivalent to the re-measurement period.
2. Measure the current diameter both at the correct diameter location and at the previous diameter location (Diameter Check = 2); determine the difference by adding or subtracting the difference to the previous diameter; use this value to adjust the previous diameter estimate.
3. Estimate the correct previous diameter based on the “best” information at hand (for example, the previous diameter of similar sized nearby trees of the same species).

Height:

Measure the height of all dead trees and snags. To conserve time and effort, live tree heights have been limited to the measurement of one typical tree in each of the following categories:

- Open growth
- Dominant
- Co-dominant
- Intermediate
- Over-topped

Record the length of the tree, to the nearest 0.3 m from the ground level to the top of the tree. If the tree is growing on a slope, measure from the uphill side of the tree.

This measurement will give a general idea of tree height for each category. If there is more time available at a plot, more trees heights may be measured. It will be up to the crew lead and the tree crew to assess the amount of time available and the approximate time to measure a tree height, and then to distribute this among the remaining trees (for example measuring height on every 10th tree or every 5th tree).

Should the heights of all trees in the plot become important in the future for determining carbon stores or for other analyses, feasibility can be reassessed or tree height measurements can be assigned to a special project.

Height also is measured during the **Mortality Assessment**. Inspect trees that have died in the last year for broken trunks. Measure the heights of broken mortality trees. If no breaks have occurred, proceed to the next assessment. If the tree height is < 1.37 m, the length will be recorded, but the tree will not be part of the live and dead tree tally in future visits.

Height Method:

You may measure the tree height by one of two methods: laser range finder (L), or clinometer (C).

1. Laser range finder (L):

Familiarize yourself with the instrument keys and laser range finder operation. Stand at a distance from the tree that gives you an angle **no more than 50 degrees** (and preferably less than 45 degrees) when shooting to the top of the tree; error increases with increasing angle. Make sure that the pivot point is calibrated for your use.

- i. When HT is visible on the instrument screen (top left), the laser is ready to take horizontal distance to the tree. Aim first at a reflector that is held directly beside the tree, at the center of its girth. Press fire button for horizontal distance (remember that the first push may simply reactivate the red dot).
- ii. A downward arrow indicates that you are ready to take an angle reading to the base of the tree. Aim and press the fire button.
- iii. An upward arrow indicates that you are ready to take an angle reading to the top of the tree/crown. Aim and press the fire button. (**Note:** Because this is an angle measurement, you may aim the laser where you think the top of the tree is, rather than where you can see it.)
- iv. Press the fire button again for calculation of tree height.

2. Clinometer (C):

Measure tree height using this equation: $a = b \tan A_1$

a. It is usually helpful to be upslope from the tree. In this case you will use the equation twice, once to measure the height from your level up to the tree top, and the second to measure the height from your level down to tree base. To get the total tree height, add the two results.

Note: If you are downslope for some reason, you will need to subtract a_2 from a_1 .

b. Stand far enough away from the tree to be able to see the top and the base, and to keep the angle to the top less than 45° if possible (increasing angle increases measurement error).

c. Measure and record distance from you to tree: b

d. Using the clinometer, measure and record the angle to tree top (A_1)

e. Using the clinometer, measure and record the angle to the tree base (A_2).

f. Calculate height from eye level to tree top: $a_1 = b \tan A_1$.

g. Calculate height from eye level to tree base:
 $a_2 = b \tan A_2$.

h. Add the two lengths together for total tree height:
 $ht = a_1 + a_2$.

Measure the length of a leaning tree using the equation:
 $length = EF(ht)$.

EF is an expansion factor found in [SOP 6: Training Field Crews](#).

a. Calculate tree height as outlined above, preferably standing perpendicular to the plane in which the tree is leaning so that you can see the top and base of the tree.

b. Standing at the base of the tree and sighting up the bole with your clinometer, measure the slope of the bole in degrees.

c. Subtract the degrees of lean from 90° .

d. Convert this angle from degrees to percent by looking through the clinometer to see the conversion.

e. Using this percent angle and the slope corrections table, determine EF .

f. Multiply the tree height (ht) by EF to calculate the actual tree $length$.

Compacted Crown Ratio:

Record the compacted crown ratio for each live tally tree. Compacted crown ratio is that portion of the tree supporting live foliage (or in the case of extreme temporary defoliation, should be supporting live foliage)

and is expressed as a percentage of the actual tree length (that is, include dead tops, but not missing tops in the ratio). To determine compacted crown ratio, visually transfer lower live branches to fill in large holes in the upper portion of the tree until a full, even crown is visualized, with branches evenly distributed on all sides. Try to picture the normal density of photosynthetic foliage and adjust for it (that is, some branches may be very sparse with needles/leaves). Do not over compact trees beyond their typical full crown situation. For example, if tree branches tend to average 1 m between whorls, do not compact crowns any tighter than the 1-m spacing. Include epicormic branches (branches originating from other branches) once they are 2.5 cm diameter.

Crown ratio is based on the ratio of foliage, not where the limbs attach to the tree bole.

Crown ratio is an indicator of a tree's vigor. In data analysis, trees with a crown ratio of 30 percent or less are considered less vigorous. For this reason, be particularly careful when deciding between codes greater or less than "30".

Crown Class:

Rate tree crowns in relation to the sunlight received and proximity to neighboring trees. Base the assessment on the position of the crown at the time of observation. Crown class codes and definitions are outlined in [table 13.4](#).

Crown class describes a tree's "social" position in the stand and may indicate how well the tree is competing for light. Crown classifications are easily applied in even-aged stands, but are more difficult to assign in uneven-aged stands or in plots where more than one age class is present. In these situations, classify the tree based on its immediate environment. In other words, base your classification on how much light the tree's crown is receiving, not its position in the canopy. These data are used to predict tree growth. The intermediate and overtopped crown classes are meant to include trees seriously affected by direct competition with adjacent trees.

For example, a young, vigorous tree that is considerably shorter than other trees in the stand, but that is not overtopped by other trees and that receives full light from above and partly from the side, is classified as dominant. The same principle applies to two-storied stands: understory trees should only be assigned subordinate crown classes if they are adjacent to overtopping trees. In plots with scattered residual overstory trees over younger trees, a considerable portion of the understory trees will be classified as dominant or codominant.

Table 13.4. Crown class definitions.

Code	Crown class	Definition
O	Open grown	Trees with crowns that have received full light from above and from all sides throughout most of its life, or during its early developmental period, as indicated by large branches low on the bole.
D	Dominant	Trees with crown extending above the general level of the crown canopy and receiving full light from above and partly from the sides. These trees are taller than the average trees in the stand and their crowns are well developed, but they could be somewhat crowded on the sides. Their crown form or shape appears to be free of influence from neighboring trees.
C	Codominant	Trees with crowns at the general level of the crown canopy. Crowns receive full light from above but little direct sunlight penetrates their sides. Usually they have medium-sized crowns and are somewhat crowded from the sides. In stagnated stands, codominant trees have small-sized crowns and are crowded on the sides.
I	Intermediate	These trees are shorter than dominants and codominants, but their crowns extend into the canopy of codominant and dominant trees. They receive little direct light from above and none from the sides. As a result, intermediate trees usually have small crowns and are very crowded from the sides.
T	Overtopped	Trees with crowns entirely below the general level of the crown canopy that receive no direct sunlight either from above or the sides.

Snag Decay Class:

Record the code for each standing dead tally tree that indicates the stage of decay. Decay class codes and definitions are outlined in [table 13.5](#).

It is unlikely that decay class 5 will apply to a tally tree; by the time a dead tree has reached decay class 5, it will have toppled over or have become too short to qualify for tally.

Characteristics are for Douglas-fir. Snags for other species may vary somewhat; use [figure 13.2](#) as a guide.

Tree Damage and Disease

Tree Damage:

Tree damage is characterized using three attributes:

1. Damage Location (on the tree)
2. Severity of Damage
3. Damage Agent

Table 13.5. Snag decay class codes and descriptions.

Code	Limbs and branches	Top	Percentage of bark remaining	Sapwood presence	Sapwood condition	Heartwood condition
1	All present	Pointed	100	Intact	Sound, incipient decay, hard, original color	Sound, hard, original color
2	Few limbs, no fine branches	Broken	Variable	Sloughing	Advanced decay, fibrous, firm to soft, light brown	Sound at base, incipient decay in outer edge of upper bole, hard, light to red brown
3	Limb stubs	Broken	Variable	Sloughing	Fibrous, soft, light to reddish brown	Incipient decay at base, advanced decay throughout upper bole, fibrous, hard to firm, reddish brown
4	Few or no stubs	Broken	Variable	Sloughing	Cubical, soft, reddish to dark brown	Advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark reddish brown
5	None	Broken	< 20%	Gone	Gone	Sloughing, cubical, soft, dark brown, OR fibrous, very soft, dark reddish brown, encased in hardened shell

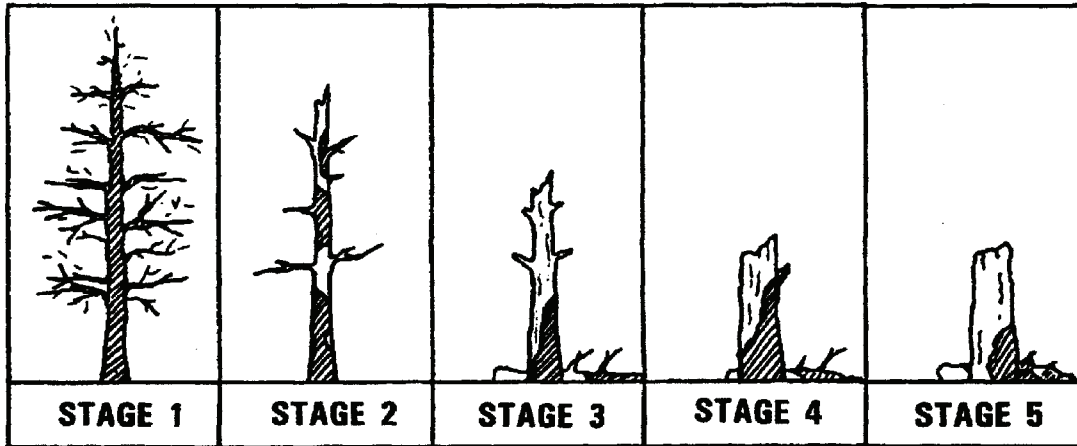


Figure 13.2. Douglas-fir decay class characteristics (Forest Inventory and Analysis, 2007).

The crew observes the tree roots, bole, branches, and foliage and records the codes for specific damage agent, damage location, and severity. When no damage is found '0' is entered. When damage is found the crew will indicate damage location, agent, and severity codes.

Damage Location

Record the predominant location on the tree of the damage agent ([table 13.6](#)).

Damage Severity

The severity code describes the extent or intensity of the damage. Possible severity codes are listed in the Severity column of [table 13.7](#).

Damage Agents

Damage agents are divided into two classes based on their impact on the trees. Only one damage code is recorded for each tree (the most predominant), and Class I Agents (aggressive insects, defoliators, and root rot) are given priority over Class II Agents (other insects, cankers, foliar disease, physical injury, etc.; [tables 13.7](#) and [13.8](#)). Additional damages may be recorded on a separate comments page if they are deemed important or extensive. The damage agents are grouped by broad category (the general agent), and further divided into specific agents,

with the codes listed for each agent, location, and severity rating. If the agent can only be identified to its general damage agent category (for example, root disease) then use the general code.

Unknown Damage Type:

Use "Unknown" only when the general damage cannot be identified. Record an Unknown Damage *Symptom* whenever the Unknown Damage Agent is used (describe on the comments page). This variable is only recorded for an UNKNOWN damage (Damage Agent 90), in addition to the Damage Location code (1, 2, 3, or 4), and Damage Severity rating (percent of affected location). The Damage Symptoms may be listed on the separate comments page beside the tree tag number. The following six categories may be used to describe damage symptoms:

1. **Canker, gall:** Cankers may be caused by various agents but are most often caused by fungi. The bark and cambium are killed, and this is followed by death of the underlying wood, although the causal agent may or may not penetrate the wood. This results in areas of dead tissue that become deeper and wider, or galling (including galls caused by rusts), on roots, bole, or branches. Due to the difficulty in distinguishing some abnormal swellings (for example, burls) from classic galls and cankers, all can be recorded as "Canker, gall." A canker may be: **Annual** (enlarges only once and does so within an interval briefer than the growth cycle of the tree, usually less than one year), **Diffuse** (enlarges without characteristic shape or noticeable callus formation at margins), or **Perennial** (enlarges during more than one year and often has a target appearance).
2. **Open wounds:** An opening or series of openings where bark has been removed or the inner wood has been exposed and no signs of advanced decay are present.
3. **Resinosis:** The origin of areas of resin or gum (sap) exudation on branches and trunks.

Table 13.6. Damage location codes.

Code	Definition
0	No damage found
1	Roots – Above ground up to 30 cm on bole
2	Bole – Main stem(s) starting at 30 cm above ground including forks up to a 10 cm top (A fork is at least equal to 1/3 diameter of the main stem, and occurs at an angle < 45° in relation to the main stem).
3	Branch – All other woody material. Primary branch(s) occur at an angle >45° in relation to the bole and are <1/3 the diameter of the bole.
4	Foliage – All leaves, buds, and shoots.

Table 13.7. Class I damage agents.

[Not in order of importance]

Category	Agent	Agent code	Location	Severity
BARK BEETLES	General	01	1-Roots 2-Bole	<p>1 – Successful current attack: foliage still green, boring dust, pitching</p> <p>2 – Last year’s successful attack: fading foliage (some green somewhere on crown), boring dust, pitching</p> <p>3 – Top kill: top of tree dead (no green needles remaining, completely red with no buds or dead buds, or “gray” because the needles have fallen off); green needles on lower live portion of tree.</p>
DEFOLIATORS	General Budworm	10 29	4-Foliage	<p>Divide live crown into thirds. Rate each third separately based on the following classes:</p> <p>0 – No detectable defoliation</p> <p>1 – Up to 33% of foliage (old and new) affected</p> <p>2 – 34 to 66 % of foliage affected</p> <p>3 – 67 to 100% of foliage affected</p> <p>Obtain severity rating by adding ratings for each third. Record total (1-9).</p>
ROOT DISEASE	General/other Annosus Armillaria Black stain Laminated root rot	60 61 62 63 65	1-Roots	<p>1 – Tally tree is within 10 m of a tree or stump that has a root disease to which the tally tree is susceptible.</p> <p>2 – Tally tree with root disease signs/symptoms such as characteristic decay, stain, ectotrophic mycelia, mycelial fans, conks, excessive resin flow at the root collar. No visible crown deterioration.</p> <p>3 – Tally tree with root disease signs/symptoms such as characteristic decay, stain, ectotrophic mycelia, mycelial fans, conks, excessive resin flow at the root collar, AND visible crown deterioration.</p>
WHITE PINE BLISTER RUST	White pine blister rust	36	2-Bole 3-Branches	<p>Record percent of affected location:</p> <p>percent of bole circumference (combine multiple affected locations), OR</p> <p>percent of branches affected.</p> <p>Note if branch infections are:</p> <p>1- more than 75 cm from tree bole</p> <p>2- 50 to 75 cm from bole</p> <p>3- within 15 cm of tree bole, or tree bole infected</p>
BALSAM WOOLY ADELGID (Hosts: true firs – that is, silver fir, subalpine fir, and grand fir)	Balsam woolly adelgid	24	2-Bole 3-Branches	<p>Record percent of affected area:</p> <p>percent of bole circumference (combine multiple affected locations), OR</p> <p>percent of branches (crown volume) affected.</p>

Table 13.8. Class II damage agents.

Category	Agent	Agent code	Location	Severity
OTHER INSECTS	General	20	2-Bole 3-Branches 4-Foliage	Record % of affected area: percent of bole circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), OR percent of branches (crown volume) affected, OR percent of foliage whose individual leaves or needles are damaged by more than 50 percent.
STEM BRANCH CANKERS	General Western gall rust	40 41	2-Bole 3-Branches	Record percent of affected area: percent of bole circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), OR percent of branches (crown volume) affected.
STEM DECAYS	General (white rot) Red ring rot Indian paint fungus Velvet top fungus Brown cubical rot (includes brown crumbly rot and brown trunk rot)	46 47 48 49 52	2-Bole	1 – One conk on the bole or present at ground level 2 – Two or more conks separated by < 5 m on bole 3 – Two or more conks separated by > 5 m on bole 4 – No conks. Visible decay in interior of bole. Do not include decay found only as a result of coring the tree.
FOLIAR PATHOGENS	General	55	3-Branches (brooming) 4-Foliage	Record percent of affected area: percent of branches (crown volume) affected. percent of foliage whose individual leaves or needles are damaged by > 50 percent
ANIMAL AGENTS	General/unknown Mountain beaver Deer or elk Porcupines Squirrels, mice, voles, rabbits, hares Beaver Bear Human (not logging)	70 71 73 74 75 76 77 78	1-Roots 2-Bole 3-Branches 4-Foliage	Record percent of affected area: percent of roots affected, OR percent of bole circumference, (combine multiple affected locations), OR percent of branches (crown volume) affected, OR percent of foliage whose individual leaves or needles are damaged by > 50 percent.
WEATHER AGENTS	Windthrow or wind breakage Snow/ice bending or breakage Lightning	81 82 87	2-Bole 3-Branches 4-Foliage	Record percent of affected area: percent of bole circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), OR percent of branches (crown volume) affected, OR percent of foliage whose individual leaves or needles are damaged by > 50 percent.
PHYSICAL INJURY	Fire: basal scars or scorch	92	1-Roots 2-Bole 3-Branches 4-Foliage	Record percent of affected area: percent of roots affected, OR percent of bole circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), OR percent of branches (crown volume) affected, OR percent of foliage whose individual leaves or needles are damaged by > 50 percent.

Table 13.8. Class II damage agents.—Continued

Category	Agent	Agent code	Location	Severity
PHYSICAL DEFECTS	Broken/missing top Dead top Forks and Crooks (only if caused by old top out or dead top) Checks or bole cracks	96 97 98 99	2-Bole 3-Branches	
SPECIAL AGENTS	Suppression Excessively deformed sapling	50 51	2-Bole	
UNKNOWN	Unknown	90	1-Roots 2-Bole 3-Branches 4-Foliage	Record percent of affected area: percent of roots affected, OR percent of bole circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), OR percent of branches (crown volume) affected, OR percent of foliage whose individual leaves or needles are damaged by > 50 percent.

4. **Broken:** This damage type includes: 1) broken roots; or 2) broken or dead branches. Dead or broken branches attached to the bole or crown stem outside the live crown area are not coded.

5. **Damaged or discolored foliage:** Insect feeding, shredded or distorted foliage, buds or shoots. This damage type also includes herbicide or frost-damaged foliage, buds or shoots.

6. **Other:** When no other explanation is appropriate.

Mistletoe Class:

Inspect live hemlock, true fir and pine tally trees for mistletoe. Do not inspect Sitka spruce (not a mistletoe host) or Douglas fir (not a host in our area) for mistletoe. Record a code indicating the extent and severity of dwarf mistletoe (*Arceuthobium* spp.) infection (table 13.9). Use the Hawksworth six-class rating system: divide the live crown into thirds, and rate each third using the scale below, then sum the three individual ratings to obtain a total mistletoe class (0 to 6) for the tree (figure 13.3).

Total score is: 0 + 1 + 2 = 3

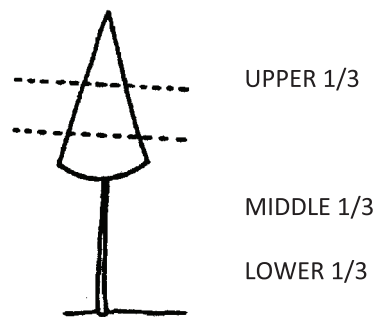


Figure 13.3. Example of the Hawksworth six-class rating system.

Wildlife Use

Platform Abundance:

Platform and Moss Abundance data are collected on live tally trees. A platform is a section or area of a live limb that is >15 cm diameter, located >10 m above the ground up to the top of a live crown of a tree, and not positioned at more than a 45° angle from horizontal. This includes limb areas where the diameter has been enlarged by effects of insects, mistletoe, disease, physical injury, or the accumulation of moss.

Table 13.9. Mistletoe codes and descriptions.

Code	Mistletoe	Description
0	No visible infection	None
1	Light infection	< 50 percent of the total branches infected
2	Heavy infection	> 50 percent of the total branches infected

Select a position, preferably on the uphill side of the tree that provides the clearest view of as much of the tree bole and crown area as possible to estimate platform and moss abundance. Count the number of limbs that contain one or more platforms. Each limb with one or more platforms is counted only once, regardless of the number of platform structures on that limb. Limb counts from 1 to 9 shall be tallied as individuals. A tree with 10 or greater limbs with one or more platforms shall be tallied as 10. Counts will be summarized into the groups: 0=0 limbs, 1=1-5 limbs, 2=6-9 limbs, 3=>10 limbs.

Moss Abundance:

For trees that have one or more platforms, estimate moss coverage on the horizontal surface of all visible limbs in the lower two thirds of the live tree crown. Standing at the same point used to estimate Platform abundance, estimate the percent cover of moss on the top of each limb, then average across ALL limbs within the lower two thirds of the crown. Estimate the percentage of moss ONLY; do not include other epiphytes, such as lichens. Record the result for each tallied tree to the nearest percent from 0 to 99.

Cavity Presence:

Record a code to indicate cavity presence ([table 13.10](#)). A cavity must be able to be used by wildlife (birds, small mammals, large mammals, etc.) to be coded. If more than one cavity is present, record the size of the largest one.

VI. Mortality Assessment

Before each plot visit (after the initial measurement) check that you have the Tree Tally data sheet containing tree data from the previous visit (V\Ca02_Forest_Veg\Documents\Reports\Field_Reports). Each tree that was alive the previous visit should be checked for mortality. The following columns will be empty and should be filled in during this visit:

- Tree Status
- Height
- Ht. Method
- Cause of Death
- Position
- Lean (°)

Tree Status:

Trees that are still living will receive Tree Status of ‘L’. No further assessments are required for live trees during this visit. For trees with a tree status change to ‘D’ (dead), record **height** and **snag decay class** as outlined above. Further inspect dead trees for **cause of death**, **position**, and **lean** as follows:

Cause of Death:

For dead trees, identify signs that indicate what may have caused or contributed to the death of the tree: Insect damage (I), Disease (D), Fire (F), Animal (A), Weather (W), Vegetation (V), Unknown (U). If ‘Unknown’ is recorded for cause of death, note any symptoms; using

Table 13.10. Cavity presence codes.

Code	Description
0	No cavity or den present
1	Cavity or den present < 15 cm diameter
2	Cavity or den present > 15 cm diameter

suggestions outlined in section, “[Unknown Damage Type](#).”

Position:

Indicate whether the dead tree is standing upright (S), broken (B), uprooted (U), or other (O). If the tree is leaning greater than 45° from vertical, the degrees will be recorded, but the tree will not be part of the live and dead tree tally in future visits. Such trees become part of the down woody materials measurements providing they intersect the transect.

Lean (°):

If the dead tree is leaning, indicate the degree of lean from vertical.

Encountering missed trees:

If the crew should happen to encounter a tree (live or dead) of qualifying size that was missed during a previous sampling event, the tree should be given an unused number and tagged with a temporary tag. Tree data shall be collected for this tree as for other tally trees. Before proceeding however, check that the tree has not simply lost its tag by comparing its position to that of other trees on the data sheet. Note newly tagged trees on the Visit Log.

Reference Cited

U.S. Department of Agriculture, Forest Service, 2007, Field instructions for the annual inventory of Washington, Oregon, and California Forest Inventory and Analysis Program: Pacific Northwest Research Station, U.S. Government Printing Office, 260 p.

This page intentionally left blank.

Crew _____

Mortality

Location: Corner, subplot	Tag No.	Species (6-9 letter code)	Tree Status (L, D, M, F)	Tree Type (Witness, Datatree, or Both)	Reference pt.	Azimuth (true) from ref. pt. to tree	Horiz. Dist. (m)	DBH (cm)	Diameter Check : 0-7	Height (m)	Ht. Method (L or C)	Compacted Crown Ratio	Crown Class (O,D,C,T)	Snag Decay Class	Damage: see damage table (Record most predominant type)	Location: 0=none, 1=roots, 2=bole, 3=branch, 4=foliage	Severity: % or category 1-4, see damage table.	Mistletoe Class: 0 - 6	Platform: live limb > 15 cm diam, ≥ 33° up, < 45° hrz, live crown diam, 1=1-5, 2=6-9, 3≥10	Moss Abundance: ave % of horiz. surf area on limb top, for lower 2/3 of live tree crown w/platform	Cavity Presence: 0=none 1<15cm diam, 2>15cm diam	Cause of Death: Disease, Fire, Animal, Weather, Insects, Vegetation, Unknown	Position: Standing, Broken, Uprooted, Other	Lean (°) - from vertical (0°)	
	XXXX	XXXXXX	X	X	XX	XXX	XX.Y	K.XX	X	K.XX	X	XX	X	X	XX	X	X	X	X	XX	X	X	X	XX	

Record data for all trees and snags ≥ 76.2 cm dbh; and ≥ 12.7 cm dbh in subplots 3, 9, 13, 14, 15, 16, 17, 21, 27. Height must be > 1.37 m, and lean must be < 45° from vertical.
 Definitions - Crown class: Open growth, Dominant emergent, Co-dominant, Intermediate, Over-Topped.

Figure 13.4. LTEM Forest Plot Tree Data.

Page ___ of ___

TREE COMMENTS
Park ___ Plot No. ___ MO ___ DAY ___ YEAR ___
Crew ___

Tree number	Comment

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 14:

Vegetation Quadrats: Percent Cover and Tree Sapling Measurements

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes procedures for estimating percent cover of terrestrial vegetation and measuring tree saplings within 1-ha permanent plots for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. The datasheet is shown in [figure 14.3](#) (at back of SOP).

I. Equipment Needed

Table 14.1. Equipment for estimating percentage of cover of vegetation and measuring tree saplings.

Equipment	
2 Quadrat frames (1 open and 1 gridded)	Plant lists
dbh tape	Datasheets
4 segments of tape each 5 meters in length	Clip board
Flagging	Plant identification books
Compass	Voucher envelopes for cryptogams
Pencils	Notebook and tape for vascular plant specimens
Sharpies	5 Cedar stakes (2 × 2 × 10 inches) - spares
Hammer (for pounding stakes)	

II. Estimating Vegetation in Quadrants

Percent cover of terrestrial non-vascular and vascular plants will be estimated to the nearest 1 percent for each species in 20 subplots per 1-ha permanent plot. The subplots are 10 × 10 m and are systematically distributed within the inner 50 × 0 m center section of the plot ([fig. 14.1](#)). The corner

and center subplots will not be sampled due to high potential for trampling. Within each subplot, the vegetation is sampled in nested quadrats of three sizes: 0.5 × 0.5 m, 1 × 1 m, and 5 × 5 m. Each type of vegetation present in the subplot will be listed on the datasheet and the cover or presence recorded in three different-sized quadrats as outlined in [table 14.2](#).

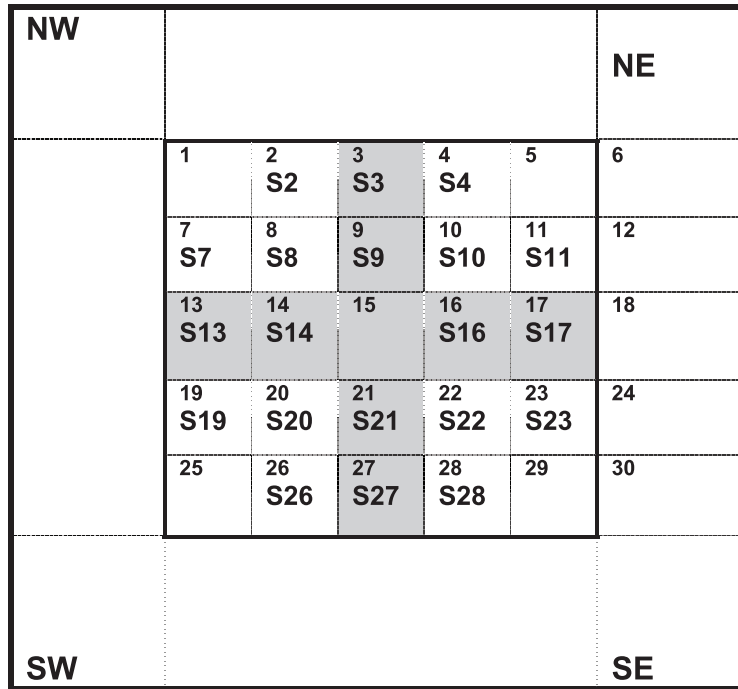


Figure 14.1. Map of 100 × 100 m plot.

Table 14.2. Vegetation type and measurement location.

[%, percent cover to the nearest 1 percent; P, present; NP, not present]

Type	Specifics	0.5 × 0.5 m	1 × 1 m	5 × 5 m
Non-vascular plants	Lichens and bryophytes; does not include litterfall or species on logs that do not contact the ground inside the quadrat	percent cover	P	No record
Herbs	Forbs, graminoids, and ferns (except large ferns listed with shrubs below)	No record	percent cover	P
Shrubs	Shrubs (not including low growing woody species); and large ferns (for example, POMU, PTAQ, ATFE)	No record	P or NP	percent cover
Seedlings	Trees < 2.5 cm dbh <i>and</i> ≤ 15 cm tall; rooted in quadrat	No record	count #	No record
Small trees	All trees < 2.5 dbh, any height; do not have to be rooted in quadrat	No record	percent cover	P
Saplings	2.5 cm to 12.6 cm dbh; fill box on page 2 of datasheet	No record	No record	dbh, ht, percent cover

Percent cover for this study is the proportion of ground covered by a vertically projected polygon as defined by lines drawn between the outer tips of live foliage on each plant (or foliage that was alive during the current growing season for senescing plants). Thus space between leaves on a single plant becomes part of the polygon and is included in the cover estimate. This best reflects the plant's above- and below-ground zone of dominance. It helps to identify the center of a plant (rather than focusing on just the leaves), and then draw the polygon around the outer leaves of that plant (fig. 14.2).

Base the percent cover estimate on growth that is present at the time of the plot visit. Include both living and dead material if it is from the current growing season. If herbs or shrubs have already dried out, dropped leaves, or senesced, estimate the cover of foliage that was alive during the current season. Do not include dead branches of shrubs and trees in the cover polygons. Plots from the same elevation band will be visited at approximately the same time each year.

Total cover for all species in a quadrat may exceed 100 percent and normally does except in depauperate areas, but one species cannot exceed 100 percent. If two plants of the same species are overlapping each other, this overlap section gets counted only once. Estimate to the nearest 1 percent. Round up from 0.5 percent – if coverage is greater than $\frac{1}{2}$ of 1 grid square but not equal to 1 entire square coverage equals 1 percent. Less than 0.5 percent is recorded as “trace.”

Estimating cover on grasses and ferns can be challenging. Note the position of the plants before you lay the quadrat down. The quadrat can flatten out some plants causing an over estimation of their cover. Remember to find the plant center and draw straight polygon lines from leaf tip to leaf tip, including the stem. If a sword fern is blocking your view of other plants, record coverage of the sword fern, gently move it out of the way, and replace it afterwards.

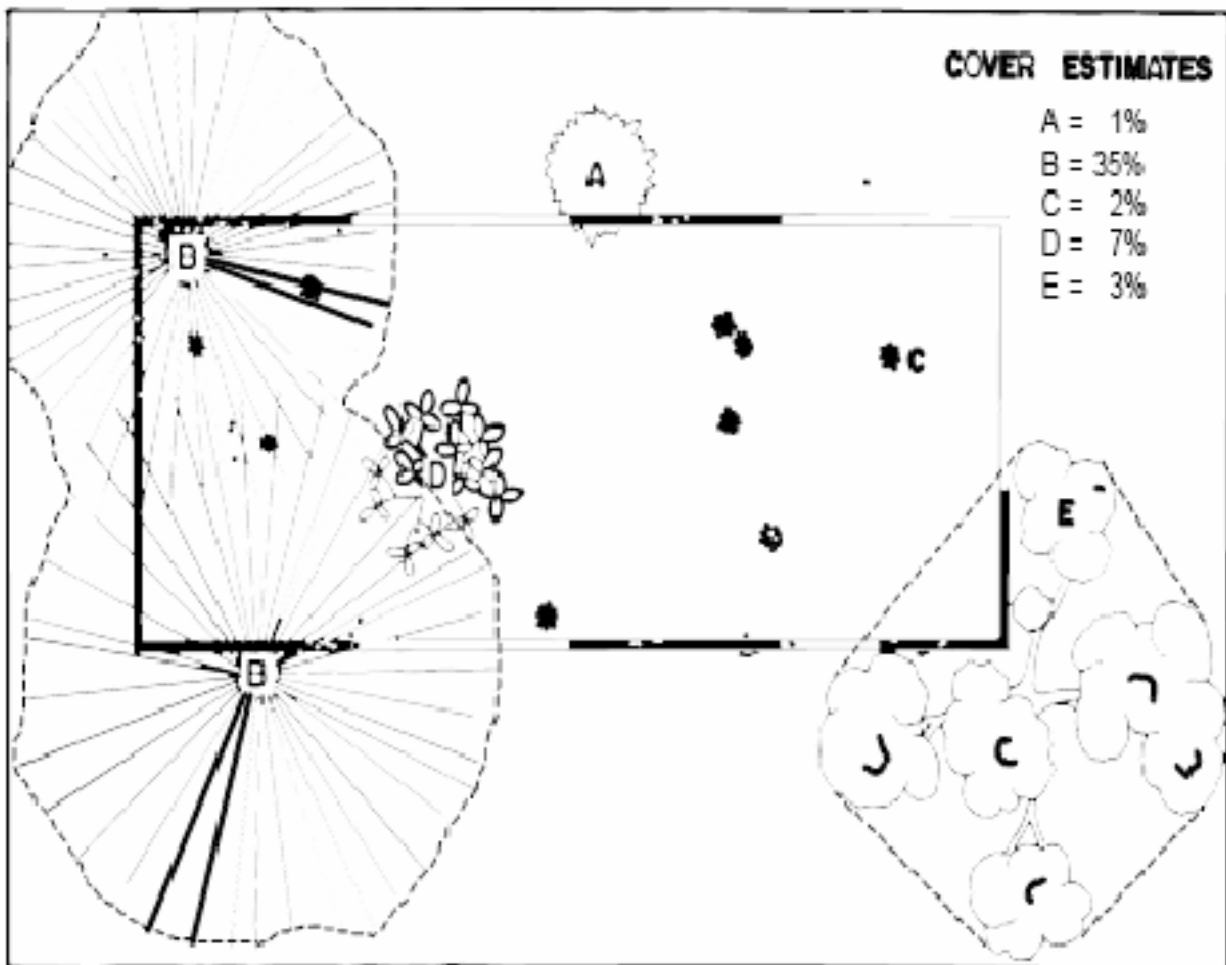


Figure 14.2. Illustration of cover method based on polygon outline of plants using a rectangular “Daubenmire plot”. Notice that plant E has no foliage over the plot but its outline does cover a portion of the plot. Polygon outlines and cover estimates added to drawing scanned from Daubenmire (1959, fig. 8-2).

Estimating percent cover in a manner that is repeatable from year to year is critical for this project. There are some pitfalls to be aware of, as well as techniques to help you so that you are doing the best possible job. Past studies have shown that estimates can vary by as much as 25 percent, with little evidence for one observer to be consistently high or low (Greig-Smith, 1983). With practice over several days of the 2-week training, we have found that observers can narrow the difference to within 5 percent of each other. One-m quadrats are gridded with string into 100 squares, each square equivalent to 1 percent of the quadrat. These squares can be visually filled with plant polygons and counted for a more accurate estimate of cover. For 0.5×0.5 m quadrats, each square is equal to 4 percent. For estimating in the 5×5 m subplots, a whole 1-m quadrat is equal to 4 percent. Also, become comfortable measuring a clump of plants or a plant's radius, and calculating the percentage area. Note that mental state can affect your estimates; observers that are tired, cold, hungry, or wet will likely have a less reliable estimate, so prepare accordingly and take a break if necessary. Some techniques to aid in cover estimation of the 5×5 m subplot are as follows:

Fill an Area:

- Divide plot into halves or quarters – at right angles or diagonally:
- Can the plants be pushed together to fill half of a plot? A quarter of a plot? More or less?
- Imagine filling a strip that is 50 cm wide for the length of the plot = 10 percent (etc.)
- Imagine filling a 1×1 m quad = 4 percent

Measure:

- Measure the diameter of a shrub (or average shrub), calculate the area, count shrubs and multiply.
Hint: Area of a circle = $3.14 \times \text{radius}^2$; radius = diameter/2
- Use known body lengths to measure the diameter or side of square thumb to pinky _____ hand to elbow _____ hand to shoulder _____ wingspan _____
- Use the field reference table with area and percent cover equivalents for different quadrat sizes.

Double Check:

- Double check your cover by estimating what area is *not* covered by a species
- Check your estimate two different ways to change your perspective

III. Setting up Quadrats

1 × 1 m Quadrat

Quadrat locations are permanently marked by placing cedar stakes in two of the frame corners. The stakes will be pounded into the ground and labeled during the first sampling visit with the quadrat number and corner (NW or SE) using a black permanent marker. On subsequent visits stakes will be relocated and occasionally need to be replaced. Note that the corners of each 10×10 also are marked with cedar stakes (inserted during plot set up), and these are labeled with the subplot number on a blue metal tag (except the four outer corners of the 50×50 m plot which are marked with rebar). The quadrats are offset by 1 m to the south and east of each 10×10 corner stake. Crews sampling vegetation in quadrats will work in teams of **two**.

1. Begin by placing red pin flags beside each subplot stake, taking care not to step to the SE of each stake. The flags will serve as a reminder to avoid stepping in the vegetation sampling quadrat area when moving about the plot.
2. Locate subplot #2 (subplot #1, 5, 15, 25, and 29 are not sampled) near the NW corner of the plot. The stake will be labeled either with permanent black marker or a metal tag.
3. Label one cedar stake Q2 NW and a second stake Q2 SE, unless the quadrat stakes are already in place. Label the stake on the top and sides.
4. Measure 1 m south and 1 m east and pound stake Q2 NW into the ground.
5. Lay down the quadrat frame with the NW corner at the stake, and use a compass to align the frame so that the edges are parallel with subplot edges. Take care to position the frame correctly; it is possible to get the direction confused. Whenever possible, use the quadrat frame with strings that partition the frame into 1 percent squares. When a shrub or tree makes it impossible to use a strung frame, use the open frame.
6. Pound in stake Q2 SE at the opposite corner of the quadrat. If you are using the strung quadrat frame, which is larger than 1×1 m to accommodate the strings, the stakes will be placed just inside the frame, whereas if you are using the open frame (exactly 1×1 m) you will place the stakes on the outside of the frame.
7. You are now ready to sample the vegetation in the 0.5×0.5 m and 1×1 m nested quadrat.
8. This will be followed by the set up of a larger 5×5 m quadrat for the completion of data collection.

Barriers and Alternative Marking Methods

Sample at the designated location regardless of the presence of a stream, large tree, rock, or log. A quadrat that cannot be safely sampled is left unsampled. Where a tree is blocking the use of a quadrat, use the open quadrat; pull it apart to accommodate the tree as needed.

Occasionally you will not be able to insert a stake due to the presence of a log, tree, rock, or rocky soil. A metal shiner or washer can be nailed to a log or tree to mark a quadrat corner, and this noted on the data form. As long as one corner is clearly marked, the quadrat can be correctly aligned N-S from that single corner during future sampling events. When a cedar stake cannot be inserted into rocky soil, rebar may be used instead and this noted on the Event Log. If it is not possible to mark either the NW or SE corner due to the presence of rock, mark the NE or SW corner, clearly labeling the stake and noting this on the Event Log. On the rare occasion that no quadrat corner can be marked, note this on the Event Log and simply measure to the correct location from the subplot stake.

5 × 5 m Subplot

Percent cover of shrubs, sapling species and size, and herbivory ([SOP 15: Herbivory](#)) will be measured in the 5 × 5 m subplots. A set of four pre-cut 5 m long tapes attached to aluminum stakes will be used to outline the subplot. The 5 × 5 m subplots may be set up before or after data has been collected in the 1 × 1 m quadrats.

1. Insert the end of two 5-m tapes into the NW subplot corner.
2. Use a compass to run one tape directly east and the other tape directly south.
3. Run a third tape south to east.
4. Run the fourth tape east to south, closing the subplot boundary in the SE corner.
5. Flag corners in densely vegetated plots.

IV. Data Collection

Refer to [figure 14.3](#) for Vegetation Quadrat Datasheet.

Park: The 4 letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

- single digit elevation stratum: 1, 3, or 6 (1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash;
- three digit plot number: the original firing-order number given to that location prior to reconnaissance

Date: Enter the date that the quadrat was sampled.

Crew: Enter the last names and first initials of crew members collecting vegetation data.

Subplot #: Enter the subplot number in which the quadrat lies.

Species Data: List all species in column one (a species table will be supplied after the first sampling visit, indicating species that were found in each quadrat).

0.5 × 0.5 m Quadrat

1. Begin by listing bryophyte and lichen species occurring on the ground, on logs, and on rocks within the 0.5 × 0.5 m northwest quarter of the 1 × 1 m quadrat. Record percent cover in the 0.5 × 0.5 m section. Do not record non-vascular plants that are clearly litterfall. Do not record non-vascular plants that are growing on logs suspended across the quadrat; the log must be in contact with the ground at some point inside the quadrat.
2. List and record as present (P) all vascular plants within the 0.5 × 0.5 m northwest quarter of the 1 × 1 m quadrat.

1 × 1 m Quadrat

3. List any new species of bryophytes and lichens that occur in the 1 × 1 m quadrat and record as present (P).
4. Record percent cover in the 1 × 1 for vascular plant species.
5. Shrubs (except low-growing woody species), and fern species that tend to be greater than 0.5 m tall (for example, *Polystichum munitum*, *Pteridium aquilinum*, *Athyrium filix-femina*) will be listed as present (P) if they occur in the 1 × 1 m quadrats, and percent cover will be estimated in a larger 5 × 5 m nested plot.
6. List and record percent cover of **all** tree species *less than 2.5 cm dbh* that occur in the 1 × 1 m quadrat.
7. Count the number of tree seedlings occurring in the 1 × 1 m quadrat if they are less than 2.5 cm dbh and *greater than 15 cm tall*.

5 × 5 m Quadrat

8. Record as present (P) any vascular species not found in the 1 × 1 m quadrat.
9. Record percent cover of shrubs and large fern species ([table 14.2](#)). **Note:** The same species should be consistently estimated in either the 1 × 1 or the 5 × 5. If in doubt about which frame size to use, do percent cover in both, and check with supervisor upon return from the field.
10. List species of saplings with dbh of 2.5 to 12.6 cm. Record dbh and height (see below).
11. Estimate herbivory ([SOP 15: Herbivory](#))
12. Take down flagging, pick up tapes and quadrat frame.
13. Take care not to step in quadrat area.

IV. Measuring Tree Saplings

Tree sapling species occurring in the 5 × 5 m subplot that have a dbh of 2.5 to 12.6 cm shall be listed in the box on the lower left side of the data sheet on page 2.

1. Record species.
2. Measure dbh with a dbh tape (always round down when measuring dbh – this will reduce the chances of an incorrect negative growth calculation).
3. Estimate height to the nearest 0.5 m. Dbh and height should be collected for trees that are rooted in the plot.
4. Estimate percent cover of all sapling species with a polygon that extends over the 5 × 5 m subplot whether or not the saplings are rooted in the plot.

VI. Collecting Voucher Specimens

Any plant species not easily identified should be collected as a voucher specimen. The species identity should be determined and/or verified at the office and the voucher preserved for future reference. If possible, collect a complete sample (roots, stems, leaves, and fruits). It also can be helpful to collect and preserve specimens lacking reproductive structures important for identification; you may come across the species later in the season when it is flowering and be able to compare it with the vegetative material collected earlier.

Collect the specimen from outside the 50 × 50 m inner plot, if possible, but preferably at least outside the 5 × 5 m quadrat, to preserve vegetation inside the permanent sampling plot. Record the collection number in the second column on the datasheet. Cryptogam specimens should be placed in cryptogam voucher envelopes ([fig. 14.4](#)). Label the specimen envelope or bag with the collection number, for example, 7-ABC-1 where the first number is the plot number, followed by the collector's initials, and the collector's consecutive collection number for the plot. Write a brief plant description and details about the growing substrate on the bag or envelope. See [SOP 21: Voucher Specimen Identification and Processing](#) regarding the identification and processing of voucher specimens.

References Cited

- Grieg-Smith, P., 1983, *Quantitative Plant Ecology*, 3rd Edition: Boston, Massachusetts, Blackwell Scientific.
- Daubenmire, R.F., 1959, A canopy-coverage method: *Northwest Science*, v. 33, p. 43-64.

Figure 14.3. Vegetation Quadrat Datasheet

LTEM FOREST PLOT – QUADRAT DATA

Park _____ Plot ____-____ Date: MO ____ DAY ____ YEAR ____ Crew _____ Subplot# _____

Instructions						Office use only: initials mm/dd/yy
1. Record all other plant species as specified, including saplings and herbivory on p 2. 2. Cover is estimated to the percent; less than 0.5% is recorded as Tr (trace). 3. Record below % area of tree boles, rocks, logs, stream, etc. if > 10% of 1x1m quadrat. Vouchers: only 1 sp. per envelope or bag						Entered by _____ date: _____ Verified by _____ date: _____ Updated by _____ date: _____ Updated by _____ date: _____
Example: 7-ABC-1 (plot #, initials, coll. #)	Coll. #	Cover NV (%) Presence Vascular (P, NP)	1. Presence NV (P, NP) 2. Cover herbs 3. Cover all small trees (< 2.5 cm dbh)	No. tree seedlings < 2.5 cm dbh and ≥ 15 cm tall (≥ 30 cm for hw)	Presence herbs Cover shrubs	NV=nonvascular, H=herb, S=shrub
Species	Coll. #	0.5x 0.5m	1x1 m	1x1 m	5x5 m	Plant Notes

0.5x0.5m notes	
1x1m notes	
5x5m notes	
10x10m notes	

Figure 14.4. Cryptogam Voucher Envelope

attn: Acker ONP NRM 600 E. Park Ave. Port Angeles, WA 98362, USA	
LTEM	
Forest Vegetation	
Cryptogams	

Instructions:

- flip paper over toward you
- turn up 1/3 of page and fold
- fold in each side 1.5 inches
- fold top flap down

You should now have an envelope/packet with the data sheet on the front cover.
Five sheets can be done at a time for more efficient folding.

Park: _____	Plot: _-_-_-	Quad: __	Collector + #: _____
Species: _____			Date: __/__/__
Location: _____		Notes: _____	
Substrate: _____			
MINERAL: soil, gravel, soil over rock, rock type: _____ rock crevice, wall/underhang			
FOREST FLOOR: humus/litter, litterfall, scat, owl pellet, on moss, Sphagnum			
CWD: corticate/decorticate, snag, stump, log (decay class 1,2,3,4,5)			
TREE or SHRUB: root, base, trunk, branch, twig, species: _____			
Water:	xeric, mesic, moist, wet		
Light:	Fsun/ Pshade/ Fshade		
Position:	valley wall, valley bottom, ridge, flat, cliff, ledge		
Habitat:	forest (conif/decid), shrubland, grassland, meadow, bog (mound/swale), aquatic, alpine tundra, marine, disturbed		

This page left intentionally blank

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 15:

Herbivory: Estimating Herbivory on Shrubs in 5 × 5 m Quadrats

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes procedures for a semi-quantitative measurement of herbivory within the inner 50 × 50 m plot area for each 1 ha permanent plot for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. We plan to estimate herbivory in all plots in each elevation band at Mount Rainier, North Cascades, and Olympic National Parks. The National Park Service has encouraged integration within and among monitoring programs, so that the interpretation of the whole monitoring program yields information more useful than that of individual parts (Jenkins and others, 2003). Ecological integration results in the most effective ecosystem monitoring strategy, collectively monitoring the integrity of the entire ecosystem. These herbivory measurements link ungulate herbivores (system drivers) with vegetation (system components). Changes in browsing can have a profound effect on forest structure and species composition (Leslie and Starkey, 1982; Woodward and others, 1994; Schreiner and others, 1996). Because herbivory is an important process in the forest ecosystem, we would like to be able to monitor trends in herbivory that may be linked with trends in vegetation composition and abundance. Monitoring also can be a valuable tool for identifying research needs. Furthermore, herbivory results will indicate herbivore presence or absence, and may have management implications. Elk are considered a high priority vital sign for wildlife in Mount Rainier and Olympic National Parks, and measuring herbivory links two vital signs programs. Elk herbivory has been measured in the past in the Olympic National Park (Schwartz and Mitchell, 1945; Newman, 1953; Jenkins, 1981; Jenkins and Starkey, 1984; Jenkins and Starkey, 1991; Happe, 1993).

I. Selected Plant Species

Plant Species

Plants selected for herbivory estimates ([table 15.1](#)) satisfied the following criteria:

1. relatively ubiquitous
2. palatable to ungulates
3. easy to estimate
4. historically used for herbivory estimates
5. at least one species likely to be present in each vegetation type per park

Table 15.1. Plants selected for estimates of herbivory.

FERNS	
<i>Athyrium filix-femina</i>	lady fern
<i>Blechnum spicant</i>	deer fern
<i>Polystichum munitum</i>	sword fern
SHRUBS	
<i>Amelanchier alnifolia</i>	serviceberry
<i>Rosa gymnocarpa</i>	baldhip rose
<i>Rubus spectabilis</i>	salmonberry
<i>Sorbus sitchensis</i>	Sitka mountain-ash
<i>Vaccinium</i> spp.	Huckleberry

Vaccinium Species

Shrubs in the genus *Vaccinium* are combined into one category. This eliminates the problem of differentiating very similar looking species that also are similar in herbivore use (Happe, 1993). Only the large *Vaccinium* species are included: *V. parvifolium*, *V. alaskaense*, *V. ovalifolium*, *V. ovatum*, and *V. membranaceum* ([table 15.2](#)). *Vaccinium* species with small growth form, including *V. deliciosum*, *V. scoparium*, and *V. myrtillus*, will not be assessed. This saves crews the effort of estimating herbivory on the dense *Vaccinium* species in subalpine plots (1,500–1,800 m). Despite the exclusion of *V. deliciosum* and *V. scoparium*, herbivory will be detected on the large shrubs. Low-growing seedlings (usually less than 15 cm tall), as is common with *V. parvifolium*, also are not included. This saves crews the time and effort of assessing herbivory on the numerous small individuals that usually escape browsing and are difficult to quickly locate.

Table 15.2. *Vaccinium* species.

<i>Vaccinium</i> species	
Included:	Not included:
◦ <i>V. parvifolium</i>	◦ <i>V. deliciosum</i>
◦ <i>V. alaskaense</i>	◦ <i>V. scoparium</i>
◦ <i>V. ovalifolium</i>	◦ <i>V. myrtillus</i>
◦ <i>V. ovatum</i>	◦ Seedlings
◦ <i>V. membranaceum</i>	

II. Detecting Browsing

Shrubs

Shrub browsing will be estimated on lead stems from the previous year. A shrub that has had lead branches browsed the previous year will show nipped stems where lead branches once existed and new shoots coming off lateral buds. New shoots typically are brighter green and more supple than shoots from past years. Browsing for several years previous also may affect the overall growth and form of the shrub. Some studies show that shrubs that are heavily browsed in the past have shown stunted growth (Happe, 1993; Keigley and Frisina, 1998); others show that shoots may be larger on plants that are browsed (Bilyeu and others, 2007). Moderate to high levels of herbivory have been observed to stimulate salmonberry, blue huckleberry, and swordfern production (Happe, 1993). Use [table 15.2](#) and [figure 15.3](#) to assess herbivore impact on shrubs.

Ferns

Browsing is evident by fronds stripped of their leaves, and leaves that are torn or removed in ungulate bite-sized amounts or larger. Leaf damage produced by insect herbivores is not included in browsing estimates. Whereas

sword fern is least palatable of the species selected, it is commonly eaten in early spring when the fiddleheads are present, evidenced as truncated fronds throughout the growing season. Furthermore, sword fern is a starvation food eaten during the winter (Jenkins and Starkey, 1991). The fertile fronds of deer fern are heavily browsed; in areas of abundant herbivore use, only a flattened rosette of non-fertile fronds will be present. Absence of fertile fronds has been consistently observed in herbivore-rich areas (P.J. Happe, OLYM, written commun., 2006); for this reason we will collect presence/absence of sexual reproduction on deer fern. Lady fern is commonly browsed, but also subject to trampling. Trampled leaves will often still be visible dangling from the frond or on the ground as compared with the completely removed leaf of a browsed plant.

Assessment of Herbivory within Herbivore Reach

Some shrubs grow to heights greater than can be reached by herbivores. Estimating percentage of the plant browsed would be difficult to do on very tall shrubs, and it would not be representative of the amount of browsing that is occurring on vegetation available to the herbivore (though it may better estimate stress to the shrub). For this reason, we limited the height of herbivory assessment to ≤ 2 m.

Table 15.3. Herbivory section of the Quadrat Datasheet.

Herbivory – 5 × 5 an assessment of herbivory within herbivore reach (approx. ht. < 2 m)						
Species	Number of individuals or stems*	Est?	Number of plants or stems* browsed	Form Class of browsed plants	% fronds browsed on browsed plant	Sexual Repro? (Y/N)
BLESPI						
POLMUN						
AMEALN						
ROSGYM						
RUBSPE						
SORSIT						
VACSP>30cm						
Sign: (scat, hair, tracks)						
*count <i>plants</i> for ferns; <i>stems</i> for shrubs			Est? = was number estimated? (Y/N)			
Form Class:						
0 = no past use						
1 = 1–25% removal of leader growth in past years;						
2 = 26–50% removal,						
3 = 51–75% removal;						
4 = >75% removal						
Sexual Repro? = flowers, fruits or fertile fronds present (Y/N)						

III. Data Collection

Herbivory data are collected for each of the selected species within the following 5×5 m subplots: 2, 4, 7, 9, 11, 14, 16, 19, 21, 23, 26, 28 ([fig. 15.1](#)). Thus, herbivory is sampled in every other 5×5 m subplot. Plants must be rooted in the subplot to be estimated for herbivory. Enter the required data in each data column, except where spaces are shaded ([table 15.3](#); [SOP 14: Vegetation Quadrats](#)).

Species

The 6-letter species code for each species requiring herbivory data is listed in the first column.

Estimate of Stem or Plant Number

The situation may infrequently occur when the number of stems or plants in the 5×5 m subplot is so large that it is not worth taking the time or effort to count them individually. If this number is greater than 20, you may estimate the number of stems or plants by assessing the space filled by X number of stems or plants, counting the number of equal-sized spaces that have stems or plants, and then multiplying that number by X. Record **Y** in the column labeled **Est?** whenever an estimate is taken (the second column). Record **N** in the column if the stems or plants were counted.

Number of Individuals or Stems

Ferns: Count the number of individual fern plants in the 5×5 m subplot. Record this number in the third column.

Shrubs: Count the number of shrub stems (present at ground level) for each indicated species in the 5×5 m subplot. Record this number in the third column.

Number of Plants or Stems Browsed

Ferns: Count the number of plants that show any sign of browsing in the 5×5 m subplot. Record this number in the fourth column.

Shrubs: Count the number of stems that show any sign of browsing in the 5×5 m subplot. Record this number in the fourth column.

Form Class of Browsed Plants

For shrubs only, record the average form class code for the browsed shrubs in the fifth column. See [table 15.4](#) for form class codes and descriptions, and [figure 15.2](#) for visual examples of each form class.

% fronds browsed on a browsed plant

This estimate indicates browsing pressure. Calculate only for ferns, and only on individuals that show browsing. Thus any ferns without browsing evidence will not be used in this calculation. For each browsed fern plant, estimate the percentage of fronds that show any level of browsing, and average across all browsed ferns for that species in the plot (this is an estimate: in essence it is a count of the number of fronds on a plant that show browsing, divided by the total number of fronds on that plant, and multiplied by 100 to get percent; do this for each plant, then record the average for that species in the 5×5). Estimate to nearest 10 percent, and record in column 6.

Sexual Reproduction

Indicate in column 7 whether or not there is any sign of sexual reproduction, such as flowers, fruits, or fertile fronds, on any of the plants within the 5×5 m subplot for each listed species. In past studies, lack of sexual reproduction has proven to be a reliable indicator of plant stress (P.J. Happe, OLYM, written commun., 2006). Whereas plant stress also can result in sexual reproduction as a “last gasp” effort, this is not commonly observed in the plant species selected for this monitoring program.

Sign

Record animal sign found within the 5×5 m subplot. This may include animal trails, prints, scat, hair, antler, or horn material, etc. Describe the sign, indicating the species to which it belongs, if possible.

Table 15.4. Form class codes and descriptions.

Form Class Code	Description – based on length and appearance of previous year’s wood
0	No past use – no visible sign of herbivory
1	1-25% removal of leader growth
2	26-50% removal of leader growth
3	51-75% removal of leader growth
4	> 75% removal of leader growth

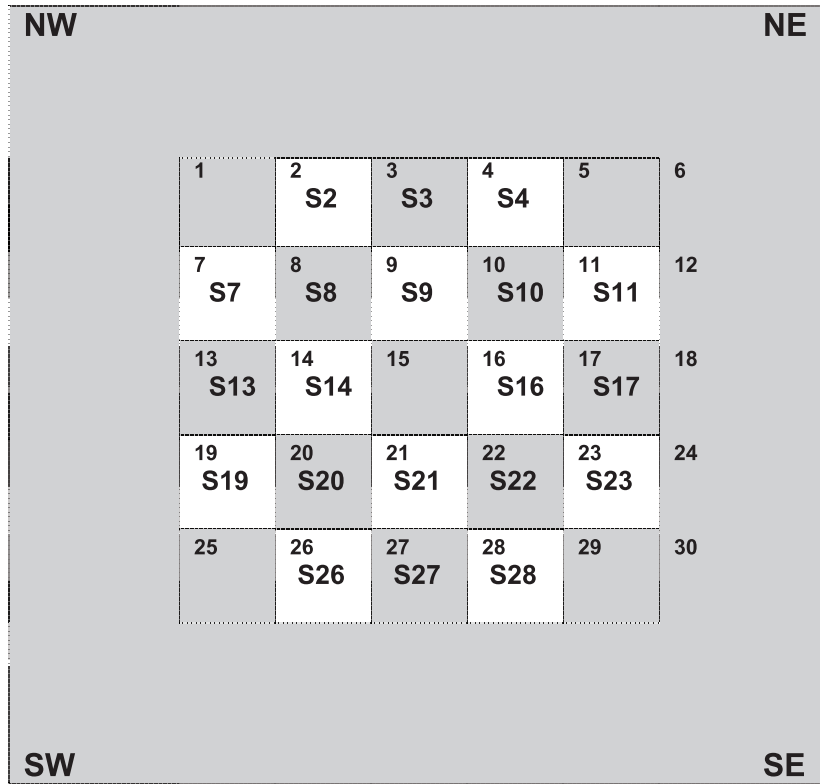


Figure 15.1. Herbivory sampling subplots in unshaded areas.

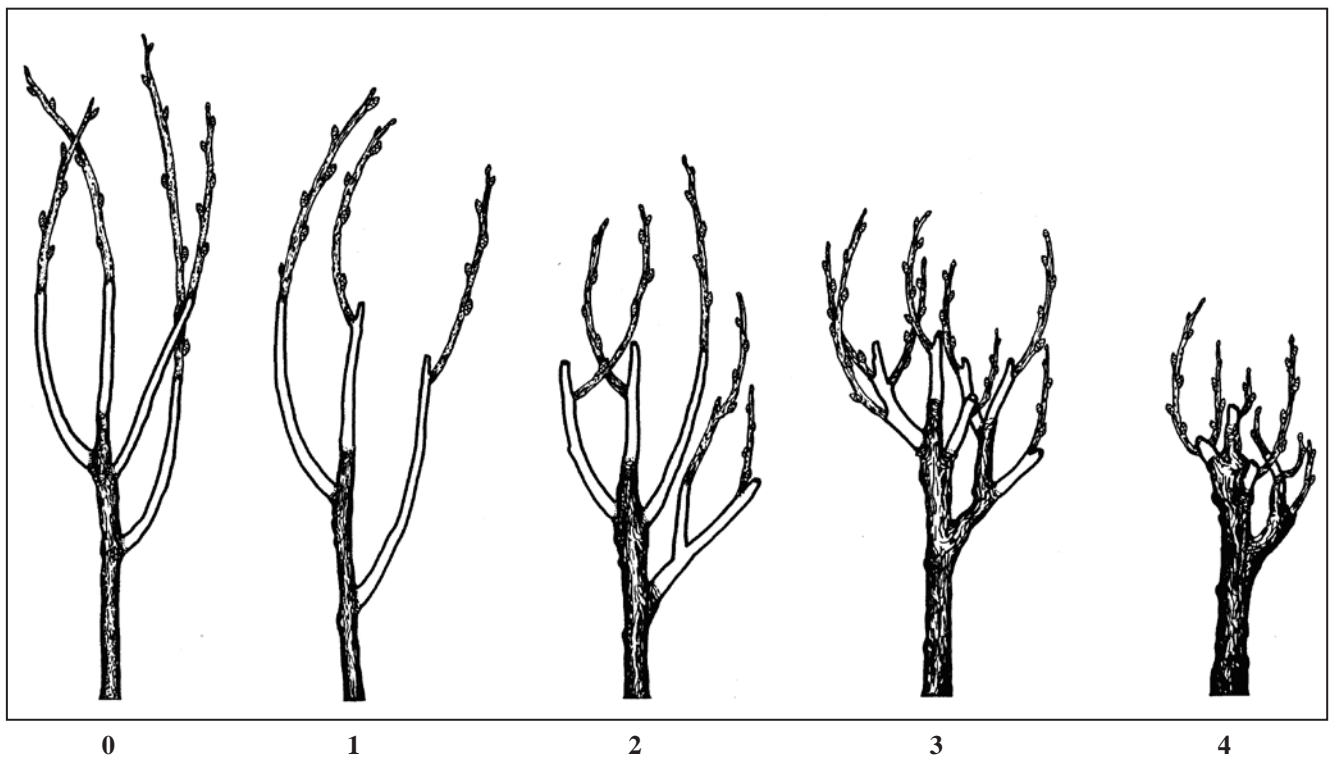


Figure 15.2. Form Class codes and visual examples.

IV. Summarizing Browsing Data

Browsing pressure on ferns and shrubs will be summarized using an index. The index ranges from 0 to 1.00 with higher numbers indicating heavier browsing. The index is calculated as:

$$\text{Browsing Index (ferns)} = \frac{\text{No. of plants browsed}}{\text{Total No. plants}} \times \% \text{ of fronds browsed plants.}$$

$$\text{Browsing Index (shrubs)} = \frac{\text{No. of stems browsed}}{\text{Total No. stems}} \times \text{Form Class Factor, where}$$

Form Class Factor:

FCF	Value
0	0
1	0.125
2	0.38
3	0.63
4	0.88

The index will be calculated by species and averaged over all subplots that have the species to give an estimate of browsing pressure on the plot. Averaging across only the subplots containing the species will avoid underestimating the browsing effect by incorporating zeros for plots without the species. One herbivory index will be calculated per species per plot.

Example:

Imagine a plot with 3 quadrats (out of 20) having sword fern.

- one quadrat has 3 plants averaging 50 percent browsed fronds
- second quadrat has 6 plants with 3 having 25 percent of their fronds showing browsing
- third quadrat has 1 unbrowsed plant

The index for sword fern would be:

$$[(3)(0.5)+(3)(0.25)+(1)(0)/10] = 0.225.$$

References Cited

Bilyeu, D.M., Cooper, D.J., and Hobbs, N.T., 2007, Assessing impacts of large herbivores on shrubs: Tests of scaling factors for utilization rates from shoot-level measurements: *Journal of Applied Ecology* 44, p. 168-175.

Happe, P.J., 1993, Ecological relationships between cervid herbivory and understory vegetation in old-growth Sitka spruce—western hemlock forests in Western Washington: PhD. Thesis, Oregon State University, Corvallis, Oreg., 147 p.

Jenkins, K., 1981, Status of elk populations and lowland habitats in western Olympic National Park: Oregon State University Cooperative Park Studies Unit, Corvallis, Oreg., Report 81-1.

Jenkins, K.J., and Starkey, E.E., 1984, Habitat use by Roosevelt elk in unmanaged forests in the Hoh valley: Washington: *Journal of Wildlife Management*, v. 48, p. 642-646.

Jenkins, K.J., and Starkey, E.E., 1991, Food habits of Roosevelt elk: *Rangelands*, v. 13, no. 6.

Jenkins, K., Woodward, A., and Schreiner, E., 2003, A framework for long-term ecological monitoring in Olympic National Park: prototype for the coniferous forest biome: USGS/BRD/ITR 2003-0006. 150 p.

Keigley, R.B., and Frisina, M.R., 1998, Browse evaluation by analysis of growth form, Volume I: Methods for evaluating condition and trend: *Montana Fish, Wildlife and Parks*. 153 p.

Leslie, D.M., and Starkey, E.E., 1982, Cervid-habitat interactions in Olympic National Park: Oregon State University Cooperative Park Studies Unit, Corvallis, Oreg., Report 82-2.

Newman, C., 1953, A preliminary report on the Roosevelt elk in Olympic National Park: Unpublished manuscript. Olympic National Park, Port Angeles, Wash.

Schreiner, E.G., Krueger, K.A., Happe, P.J., and Houston, D.B., 1996, Understory patch dynamics and ungulate herbivory in old-growth forests of Olympic National Park, Washington.

Schwartz, J.E., and Mitchell, G.E., 1945, The Roosevelt elk on the Olympic Peninsula, Washington: *Journal of Wildlife Management*, v. 9, p. 245-319.

Woodward, A., Schreiner, E.G., Houston, D.B., and Moorhead, B.B., 1994, Ungulate-forest relationships in Olympic National Park: retrospective enclosure studies: *Northwest Science*, v. 68, p. 97-110.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 16:

Down Woody Material: Measuring CWD, FWD, Duff, and Litter

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes the procedures for estimating down woody materials (DWM) in 1-ha permanent plots for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. The procedures are similar to methods used by the U.S. Department of Agriculture Forest Service (2007) Forest Inventory and Analysis Program, and are meant to allow for comparable results. The datasheet is shown in [figure 16.10](#) (at back of SOP).

Down woody components measured in this study will be limited to: coarse woody debris (CWD), fine woody debris (FWD), duff and litter. DWM is sampled using the line intersect sampling method (also called planar intersect method). In this method, transects are established, and individual pieces of CWD or FWD are tallied if the central axis of the piece is intersected by the plane of the transect. In addition, each piece must meet specified dimensions and other criteria before being selected for tally.

I. Definitions

CWD

In this inventory, CWD includes downed, dead tree and shrub boles, large limbs, and other woody pieces that are severed from their original source of growth and lying on the ground. CWD also includes dead trees (either self-supported by roots, severed from roots, or uprooted) leaning $>45^\circ$ from vertical. For multi-stemmed trees, only tally stems that are dead, detached, and on the ground; or dead and leaning $>45^\circ$ from vertical are included ([table 16.1](#)).

CWD does not include:

- Woody pieces < 7.5 cm in diameter at the point of intersection with the transect.
- Dead trees leaning 0 to 45° from vertical.
- Dead shrubs, self supported by their roots.
- Trees showing any sign of life.
- Stumps that are rooted in the ground (that is, not uprooted). Thus, using this method, stumps < 1.37 cm dbh are not recorded in the tree tally or the DWM survey.
- Dead foliage, bark or other non-woody pieces that are not an integral part of a bole or limb (bark attached to a portion of a piece is an integral part).
- Roots or main bole below the root collar.

Table 16.1. CWD requirements for tallying a piece that intersects the transect.

CWD Type	Lean	Diameter	Length
Decay Class 1-4	$> 45^\circ$ from vertical	≥ 7.5 cm	≥ 1 m long
Decay Class 5	$> 45^\circ$ from vertical	≥ 12.5 cm and ≥ 12.5 cm high	≥ 1 m long
Dead tree	$> 45^\circ$ from vertical	≥ 7.5 cm	≥ 1 m long

FWD

In this inventory, FWD includes downed, dead branches, twigs, and small tree or shrub boles that are not attached to a living or standing dead source. FWD can be connected to a larger branch, as long as this branch is on the ground and not connected to a standing dead or live tree. Only the woody branches, twigs and fragments that intersect the transect are counted. FWD can be connected to a down, dead tree bole or down, dead shrub. FWD can be twigs from shrubs and vines. FWD must be no higher than 6 ft above the ground to be counted. Further subdivisions of FWD are outlined in [table 16.2](#).

FWD does not include:

- Woody pieces >7.4 cm diameter at the point of intersection with the transect.
- Dead branches connected to a live tree or shrub; or to a standing dead tree or dead shrub.
- Dead foliage (that is, pine or fir needles, or leaf petioles).
- Bark fragments or other non-woody pieces that are not an integral part of a branch, twig, or small bole.
- Small pieces of decomposed wood (that is, chunks of cubical rot).

Table 16.2. Fine woody debris size class, and transect length and measurement location.

[Slope distance is described below]

Category of FWD	Size class	Diameter range (cm)	Transect (slope distance)	
			Length (m)	Location (m)
Small	1	0.3–0.6	2	5–7
Medium	2	>0.6–2.5	2	5–7
Large	3	>2.5–7.4	3	5–8

II. Locating and Establishing Line Transects

Transects begin at plot center and run to the edge of the square 100 × 100 m plot following the four cardinal directions: N, E, S, and W ([fig. 16.1](#)). The 50 × 50 m plot is subdivided into twenty-five 10 × 10 m subplots, and the central subplot (#15) is considered a “no sample zone” due to potential trampling damage. Pieces are not tallied until you have crossed out of the center subplot at 5 m from plot center (N, E, S, W). Thus, each transect will have 45 m of data associated with it. It is extremely important to lay out the transect in a straight line to avoid biasing the selection of pieces and to allow the re-measurement of transect lines and tally pieces for future change detection.

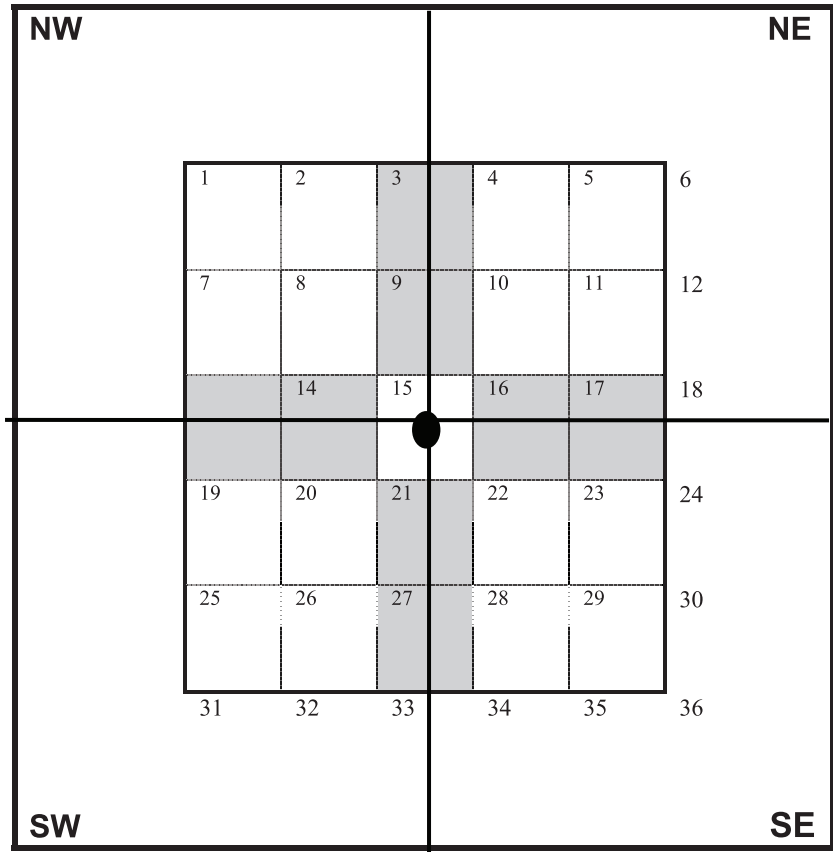


Figure 16.1. Line transect layout for sampling CWD and FWD.

CWD Transects

Four transects are established that originate at the subplot center and extend out to the edge of the 100 × 100 m plot.

Note: As the four transects extend beyond the 50 × 50 m inner plot, they will pass between two cedar stakes lying 10 m apart; it may be helpful to string a measuring tape between these stakes to check that the transect is running directly between them.

The total transect distance sampled is 180 m horizontal distance (the slope distance sampled will be greater in steep plots). By sampling in two perpendicular directions, we hope to avoid sampling bias on sloped land, where it is possible that CWD may be oriented in one direction. This configuration of transects should pick up CWD logs that are lying in different orientations to the slope.

FWD Transects

Fine woody debris (FWD) is sampled along the same transects as CWD (N, E, S, W), and can be tallied at the same time as CWD. The transects for FWD are shorter than for CWD, but will sufficiently sample FWD because it generally is present in higher densities. Transect begins at 5 m from the plot center and extends out either 2 or 3 m (along the CWD transects) depending on the FWD size class. FWD is tallied within 3 size classes. [Table 16.2](#) outlines the size class, respective transect length, and measurement location along the transect.

Note: FWD transects are slope distance not horizontal distance. The formulas used to estimate biomass from the data contain an adjustment for slope.

It is helpful to have a size gauge available until your eye is ‘trained’ to recognize the 3 size classes. Examples include a plastic or cardboard card with 3 notches cut for each size class, or a set of 3 dowels representing each size class.

III. Sampling Methods for Coarse Woody Debris

1. Coarse woody debris (CWD) is only sampled on sections of transects that cross safe travel conditions. Tally a piece if the central longitudinal axis intersects the transect ([fig. 16.2](#)).

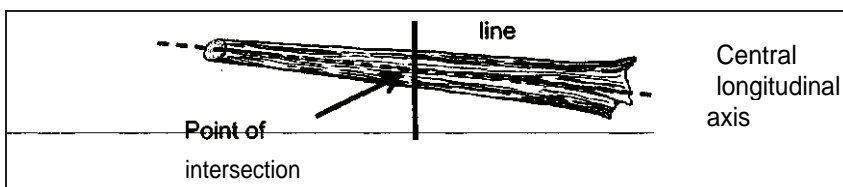


Figure 16.2. CWD tallied when central longitudinal axis intersects the transect.

2. Tally dead trees IF they are leaning > 45° from vertical. Do not tally live trees or standing dead trees and stumps that are still upright and leaning < 45° from vertical. Most CWD will be lying on the ground.
3. The minimum length of any tally piece is 1 m. When CWD pieces are close to 1 m, measure the length to the nearest 1 cm to determine if it is ≥ 1 m.
4. Decay class of the piece determines whether or not the piece is tallied.

For Decay Classes 1 to 4: tally a piece if it is ≥ 7.5 cm in diameter at the point of intersection with the transect. The piece must be ≥ 1 m in length and ≥ 7.5 cm or more in diameter along that length ([fig. 16.3](#)). If the intersect diameter is close to 7.5 cm, measure the diameter to the nearest 3 mm to determine if the piece qualifies.

For Decay Class 5: tally a piece if it is ≥ 12.5 cm in diameter at the point of intersection and ≥ 12.5 cm high from the ground. The piece must be ≥ 1 m in length and ≥ 12.5 cm or more in diameter along that length. The reason for treating Decay Class 5 pieces differently is that they are difficult to identify, especially when heavily decomposed. Only pieces that still have some shape and log form are tallied—humps of decomposed wood that are becoming part of the duff layer are not tallied. Do not record diameter at the small end and diameter at the large end for Decay Class 5.

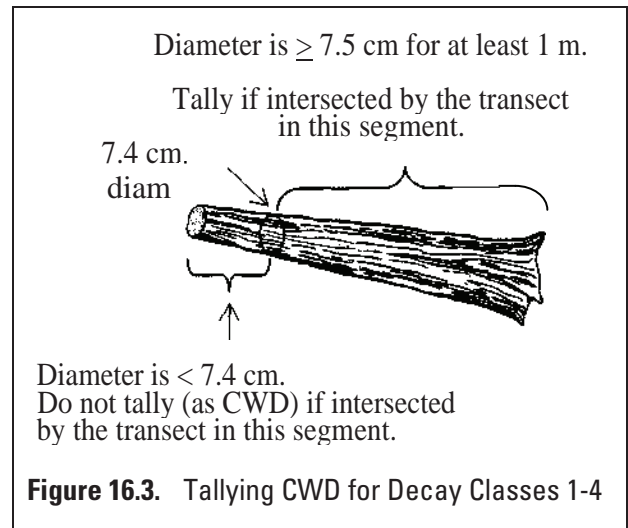


Figure 16.3. Tallying CWD for Decay Classes 1-4

5. Tally pieces created by natural causes or human activities (such as cutting) if it has not been piled. Pieces that are part of a windrow or log jumble at the bottom of a steep-sided ravine in which individual pieces are impractical to tally separately, shall be estimated and noted as an estimate.

6. Tally a piece only if the point of intersection occurs above the ground. If one end of a piece is buried in the soil, the piece ends at the point where it is no longer visible. Measure the diameter and length at this point.
7. If the central longitudinal axis of a piece is intersected by two transect lines, tally the piece each time it is intersected (uncommon situation: see [fig. 16.4](#)).
8. If a piece is fractured across its diameter or length, and would pull apart at the fracture if pulled from either end or sides, treat it as two separate pieces. If judged that it would not pull apart, tally as one piece. Tally only the piece intersected by the transect line.
9. Do not tally a piece if it intersects the transect on the root side of the root collar. Do not tally roots.
10. When the transect crosses a forked down tree bole or large branch connected to a down tree ([fig. 16.5](#)), tally each qualifying piece separately. To be tallied, each individual piece must meet the minimum diameter and length requirements.
11. In the case of forked trees, consider the “main bole” to be the piece with the largest diameter at the fork. Characteristics for this fork such as length and decay class should pertain to the entire main bole. For smaller forks, or branches connected to a main bole (even if the main bole is not a tally piece) characteristics pertain only to that portion of the piece up to the point where it attaches to the main bole (see [fig. 16.5](#)).

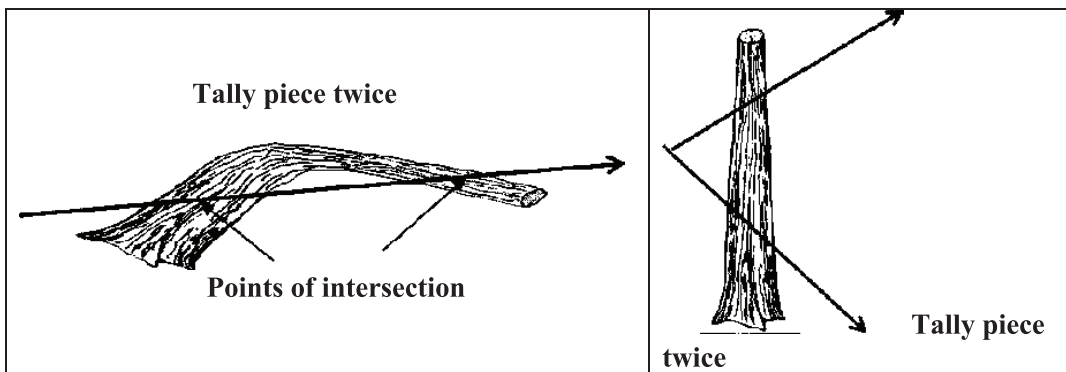


Figure 16.4. CWD tally rules: intersections.

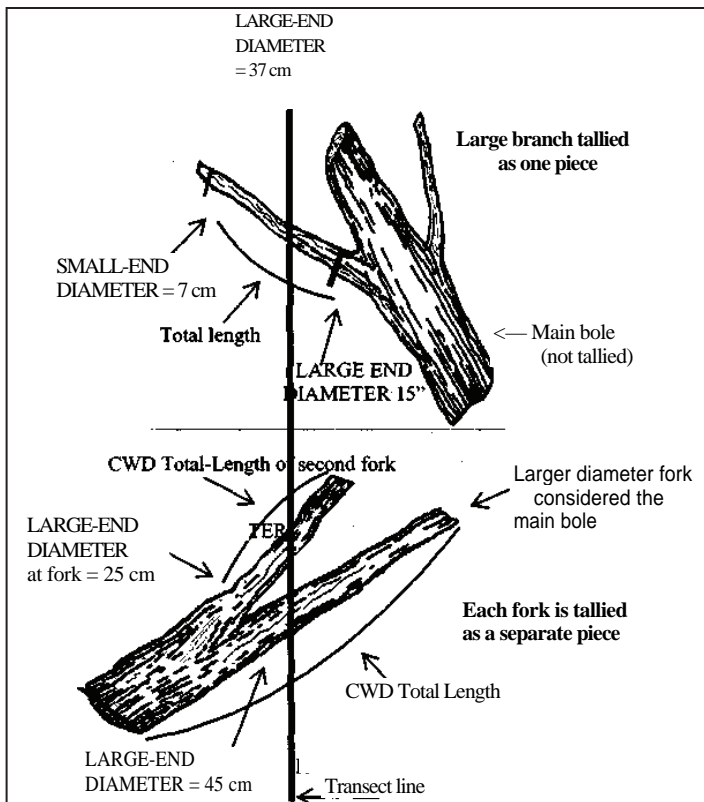


Figure 16.5. CWD tally rules for forked trees.

IV. Sampling Methods for Fine Woody Debris (FWD)

Fine Woody Debris (FWD) is only sampled in transect sections that cross safe travel conditions. Four transects run in the four cardinal directions. The length of FWD transects are measured in slope distance (no correction is applied to obtain a horizontal distance). The FWD transects begin at 5 m slope distance from plot center and extend for 2 or 3 m slope distance depending on FWD size. The FWD pieces that are intersected by the transect are counted and recorded on a datasheet in separate columns by size class.

FWD is sampled in three size classes (table 16.2). Two of the FWD size classes (0.3–0.6 cm and >0.6–2.5 cm) are counted on a 2 m transect, from 5 to 7 m from plot center. Pieces in the third size class (>2.5–7.4 cm) are counted on a 3 m transect, from 5 to 8 m from plot center. The two transects overlap.

Notes:

- Only count a piece of FWD if it intersects the transect.
- Only sample FWD that intersects the transect from the ground to a height of 2 m.
- Do not count conifer needles or non-woody parts of a tree or shrub.
- Do not count rotted pieces of a larger log.
- Individual diameters are not recorded for FWD.

Accurate counts of FWD can be conducted efficiently up to about 50 pieces for small and medium size classes, and up to 20 pieces for the large size class. After that, crews can begin estimating counts in a systematic fashion. Transects that fall on very dense FWD where counting is nearly impossible, can be subsampled and calculated. For example, an accurate count can be conducted on a 0.5-m section of the transect and then multiplied by 4 to provide an estimate for the 2-m transect, as long as the crew feels that the remaining transect has a similar density of FWD pieces. If a transect intersects an unusually large pile of material, crews should make their best estimate and describe the situation in the comment section.

If rocks, logs, or other obstructions are present along the transect, include any FWD that is present on top of these obstructions in the respective FWD counts. If the obstructions are so large (huge boulder) that the top surface cannot be seen, assume the count is zero in this area, and continue counting if there is transect line beyond the boulder.

V. Data Collection

Park: Enter the 4-letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

- **Single digit elevation stratum:** 1, 3, or 6
(1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash; and
- **Three digit plot number:** The original firing-order number given to that location prior to reconnaissance.

Date: Enter the date that the reconnaissance point was visited.

Crew: Enter the last names and first initials of all crew members that are part of this sampling event.

Transect: In the first column, record the heading of the transect on which the piece is sampled.

CWD Distance:

Record the slope distance (not horizontal distance) from the plot center to the point where the transect intersects the longitudinal center of the piece. If two or more pieces have the same slope distances, record the top piece first. Record in meters to the nearest centimeter. CWD slope distance is used to locate the piece for re-measurement in future inventories.

Species:

Record the 6-letter code indicating the species of the piece. Species identification may be uncertain for some species. The bark (either attached or sloughed and laying beside the piece), branching pattern (if the branches are still present), or heartwood smell (particularly if cedar, Douglas-fir, or western hemlock) may provide clues. You may be able to refer to previous tree data, see what tree species were tallied in past inventories. One way to distinguish hardwoods from conifers is by the type of decay present. Hardwoods usually have a white or grayish stringy rot, and conifers usually have a reddish-brown blocky rot. If it is not possible to identify the species, attempt to determine if it is a conifer or hardwood. Indicate if it is an unknown conifer (UNKCON) or an unknown hardwood (UNKHAR).

Diameters

The diameter is most commonly measured by holding a tape above the log, at a position perpendicular to the length. It is useful to carry a steel carpenter's retracting tape to measure diameters. Other methods include wrapping a tape around the bole if possible, holding a straight-edge ruler above the piece, or using calipers.

For pieces that are not round in cross section because of missing chunks of wood or “settling” due to decay, measure the diameter in two directions and take an average. Estimate the longest and shortest axis of the cross section (“A” and “B” in [fig. 16.6](#)), and enter the average in the diameter field. This technique applies to all three diameter measurements: transect, small-end, and large-end diameters.

If the transect intersects the log at the decayed or splintered end (that is, the portion where it is not considered part of the log because it is falling apart), record the diameter at this location as the intersect diameter, but record the large end and small end diameter according to established rules (that is, at the points where they best represent the log volume). If the splintered end appears to be two separate pieces (that is, a major split located just at the end) treat it as one log and take a diameter around the end (take two measurements if it is odd shaped—[fig. 16.4](#)). Length is measured between the large and small end diameters ([fig. 16.7](#)).

Transect Diameter:

Record the diameter at the point where the transect intersects the longitudinal center of the piece. The diameter is recorded to the nearest centimeter. If the diameter is close to 7.5 cm, measure the diameter to the nearest 2–3 mm to determine if the piece is actually ≥ 7.5 cm and a valid tally piece.

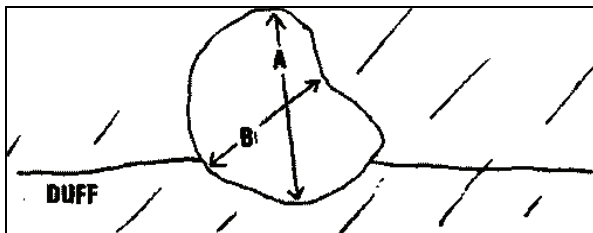


Figure 16.6. This log cross-section illustrates how to measure the diameter of a splintered log. Add diameter A and diameter B and divide by two: $(A+B)/2 =$ average diameter.

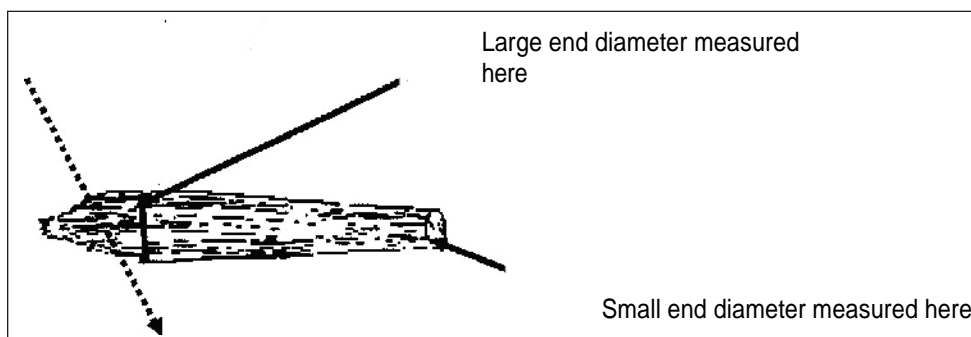


Figure 16.7. Measuring the diameter on a splintered log.

Small Diameter:

Record the diameter at the small end of the piece. The diameter is recorded to the nearest centimeter. The diameter at the small end occurs either at (1) the actual end of the piece, if the end has a diameter ≥ 7.5 cm, or (2) at the point where the piece tapers down to 7.5 cm in diameter. If the end is splintered or decomposing (sloughing off), measure the diameter at the point where it best represents the overall log volume.

Large Diameter:

Record the diameter at the large end of the piece. The diameter is recorded to the nearest centimeter. The large end will occur either at a broken or sawn end, at a fracture, or at the root collar. If the end is splintered or decomposing (sloughing off), measure the diameter at the point where it best represents the overall log volume ([fig. 16.7](#)). Use the same measuring procedures used for Diameter at Point of Intersection.

Total Length:

Record the total length of the piece that lies between the piece's recorded small and large end diameters ([fig. 16.8](#)). For Decay Class 5, small and large end diameters are not recorded for a log, therefore the length is measured between the two physical ends of the log. For curved logs, measure along the curve. The minimum log length is 1 m before it is a valid tally log. CWD total length is recorded to the nearest centimeter.

Decay Class:

Record a 1-digit code indicating the decay class of the piece. Code the decay class which predominates along the recorded CWD TOTAL LENGTH of the piece. Use [table 16.3](#) to determine CWD DECAY CLASS.

Note: CWD DECAY CLASS 5 pieces can be difficult to identify because they often blend into the duff and litter layers. They must still resemble a log, therefore, the first tally rule is that they must be > 12.5 cm in diameter, > 12.5 cm from the surface of the ground, and at least 1 m long. Decomposed logs that are slightly elevated ‘humps’ on the ground are not tallied.

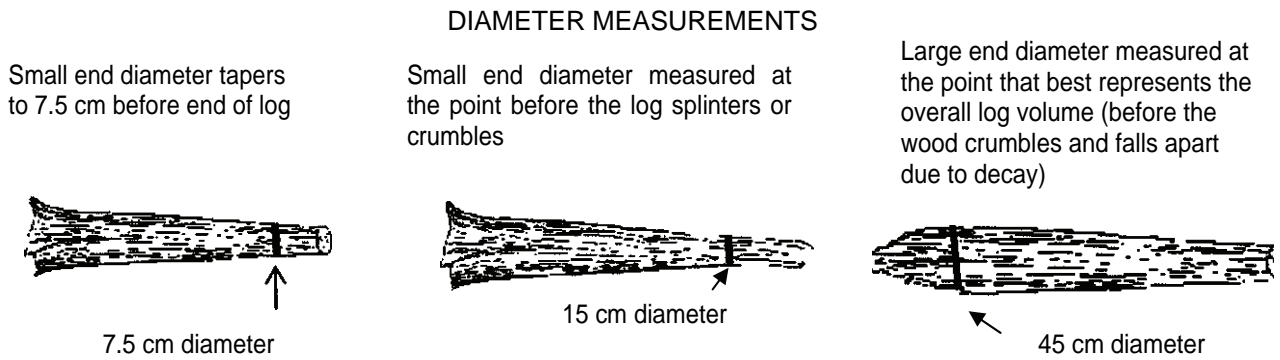


Figure 16.8. Measuring the length of a splintered log.

Table 16.3. Log decay class descriptions.

[Developed for Douglas-fir]

Class	Bark	Structural integrity	Texture of rotten portions	Color of wood	Invading roots and vegetation	Branches and twigs
1	Intact	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Roots absent; no vegetation	If branches are present, fine twigs are still attached and have tight bark
2	Intact	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Roots absent; no surviving vegetation	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark
3	Sloughing	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish-brown or original color	Roots in sapwood only; conifer seedlings	Branch stubs will not pull out
4	Detached or absent	Heartwood rotten; piece does not support its own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can be pushed into heartwood	Reddish or light brown	Roots through-out; TSHE < 15 cm dbh, small shrubs, moss	Branch stubs pull out
5	Detached or absent	None, piece no longer maintains its shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Roots through-out; TSHE to 200 cm dbh, shrubs, some large, moss	Branch stubs and pitch pockets have usually rotted down

CWD DECAY CLASS: The chart above was developed primarily for Douglas-fir in the Pacific Northwest. At the present time, there are no other charts available to use to describe decay classes for other species or locations. Concentrate on the structural integrity and texture when estimating a decay class for CWD logs.

If a log is case hardened (hard, intact outer sapwood shell) but the heartwood is rotten, code this log as a CWD DECAY CLASS 2 with a HOLLOW PIECE. CWD DECAY CLASS 1 should be reserved for ‘freshly fallen’ logs that are completely intact (that is, recent windfalls, or harvest).

Hollow?

Record ‘Y’ (yes) if the piece is hollow, or ‘N’ (no) if the piece is not hollow (see [fig. 16.9](#)). A piece is considered hollow if a cavity extends at least 0.6 m along the central longitudinal axis of the piece, and the diameter of the entrance to the cavity is at least $\frac{1}{4}$ of the diameter of the piece where the entrance occurs. The entrance occurs at the point where wood is present completely around the circumference of the cavity. The length of the cavity begins at that point.

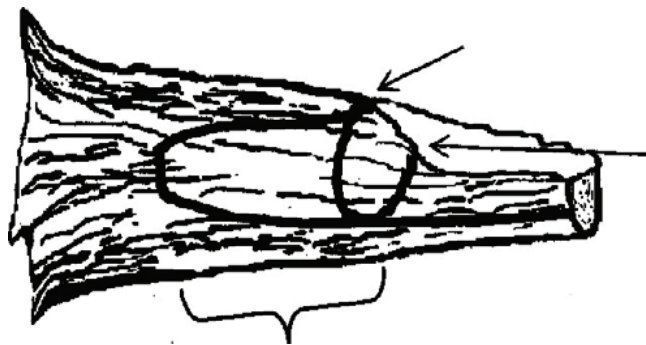
Fire Charred:

Record the approximate percentage of the log’s surface that has been charred by fire. Only examine the visible surface of the log. This data will be used by wildlife biologists to determine the impact fire has had on wildlife habitat. Wildlife tend to avoid charred logs because fire seals the wood making it slow to rot and hard to excavate.

FWD – Fine Woody Debris:

Tally the number of pieces within each size class along each transect. Write the total count per transect in the space beside the tally. If there is no tally on a transect, enter zero’s for the count. Count only what can be seen from a “bird’s-eye view”; do not dig under any litter or debris to count pieces not normally seen. If a transect intersects an unusually large pile of material, crews should make their best estimate and describe the situation in the comment section.

The entrance is the first point on the piece with wood all around the cavity



The diameter at the entrance of the cavity must be $> \frac{1}{4}$ of the total diameter of the log at that point

Length of cavity must be > 0.6 meters before it is classified as a hollow log.

Figure 16.9. Hollow log with cavity.

VI. Duff and Litter Depth Measurements

Definitions

1. **Litter** is the layer of freshly fallen leaves, needles, twigs, cones, detached bark chunks, dead moss, dead lichens, detached small chunks of rotted wood, dead grasses, dead herbaceous stems and flower parts (detached and not upright). Litter is the loose plant material found on the top surface of the forest floor. Little decomposition has begun in this layer, but the original material can still be recognized.

Litter is a flash fuel – think about it as the loose material that is exposed to the air, capable of igniting quickly and carrying a fire across the surface of the forest floor.

Litter does not include bark that is still attached to a down log, or rotten chunks of wood that are still inside a decaying log or log end (that is, if a decayed log end has a lot of rotten cubes or pieces laying on a log surface and exposed to air, they are considered part of the log and not litter – fire would burn differently if it hit a pile of rotten punky wood chips, cradled by the unrotted sapwood shell). If these rotten chunks have spilled out to the ground and are actually on the ground surface, then they would be included in the litter layer.

Litter does not include animal manure.

Litter is the material that can be seen on the surface of the forest floor; it does not include litter underneath a log or other obstruction.

2. **Duff** is the layer just beneath litter. It consists of decomposing leaves and other organic material. You should see NO recognizable plant parts; the duff layer is usually dark decomposed organic matter. When moss is present, the top of the duff layer is just beneath the green portion of the moss. The bottom of this layer is the point where mineral soil (A horizon) begins.

The duff layer is the organic material layer between the A-horizon (or uppermost soil mineral horizon) and the litter layer. The duff is a soil layer dominated by organic material derived from the decomposition of plant and animal litter (needles, leaves, twigs, etc.) and deposited on either an organic or a mineral surface. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (for example, individual plant parts) can no longer be identified.

Logs that have decayed beyond class 5 become part of the duff layer. A log that is barely discernible from the forest floor and decomposed enough that it can be easily penetrated with a trowel is considered duff.

Data Collection

Litter and duff depths will be measured at the 7 and 17 m locations along each of the four DWM transects (N, E, S, W) for a total of eight measurements each. Carefully expose a shallow profile of the forest floor by digging out an area at the sample point using a knife, hatchet, or other tool. Estimate the depth of each layer with a ruler to the nearest millimeter. If there is a large debris pile, log, rock, or other obstruction on the surface at the sample point, do not measure the litter or duff depth, regardless of what may lay on top of the obstruction (record DUFF and LITTER = N). As you dig the hole for this measurement, if you encounter a rock, root, or buried log – stop the depth measurement at this point. An average depth will be calculated in the office and stored with other information about the plot.

Note: As a general rule, duff depth should rarely exceed a few inches. The crew should be absolutely sure they are measuring deep duff depths, instead of mineral soil layers or parts of the litter layer. Duff can easily weigh more than six times that of litter. If unsure of the bottom of the duff layer, crews should feel the texture of the suspect material in their hand. Rub the soil between your fingers. Determine whether it crumbles (duff) or feels more like modeling clay (mineral).

We will not be measuring fuel bed depth or sampling residue piles in this monitoring program.

Reference Cited

U.S. Department of Agriculture, Forest Service, 2007, Field instructions for the annual inventory of Washington, Oregon, and California Forest Inventory and Analysis Program: Pacific Northwest Research Station, U.S. Government Printing Office, 260 p.

This page left intentionally blank

Figure 16.10 Down Woody Material, Duff & Litter Datasheet

LTEM FOREST PLOT – Down Woody Materials

Park _____ Plot No. ____-_____

<i>Office use only (use initials and mm/dd/yy)</i>	
Entered by _____	date: _____ Updated by _____ date: _____
Verified by _____	date: _____ Updated by _____ date: _____

Date: MO __ DAY __ YEAR __-____-____ Crew _____

version 9/23/2008

CWD - Coarse Woody Debris

Transects run 50 m horizontal distance from plot center to edge of plot, in four directions (N, E, S, W)

Begin measuring at 5 m where the transect crosses out of subplot 15. End measuring at the plot edge.

Transect Heading	CWD Transect Distance(m)	Species 6-letter code	Transect Diameter (cm)	Small Diameter (cm)	Large Diameter (cm)	Total Length (m)	Decay Class (1-5)	Hollow? (Y/N)	Fire Charred (%)

FWD - Fine Woody Debris

Transects run in 4 directions from plot center; tally small and med size materials from 5m to 7m, and large materials from 5m to 8m.

Transect heading	Small: (0.3-0.6 cm)	#	Medium: (>0.6-2.5 cm)	#	Large: (>2.5-7.4 cm)	#	Comment
N							
E							
S							
W							

- Equipment:
- Calipers
 - Metric tape
 - Size gauge for FWD (notched card)
 - Field reference sheet
 - Numbered tags and nails
 - Laser
 - Trowel

LTEM FOREST PLOT – Duff & Litter

<i>Office use only (use initials and mm/dd/yy)</i>			
Entered by _____	date: _____	Updated by _____	date: _____
Verified by _____	date: _____	Updated by _____	date: _____

Park _____ Plot No. ____-_____

Date: MO __ __ DAY __ __ YEAR __ __ __ __ Crew _____

version 9/23/2008

Take measurement twice along each transect at 7 m and at 17 m

Transect heading	Duff Depth (0.1 cm)	Litter Depth (0.1 cm)	Comments
N – 7 m			
N – 17 m			
E – 7 m			
E – 17 m			
S – 7 m			
S – 17 m			
W – 7 m			
W – 17 m			

CWM Decay Class

Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Absent	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark
3	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish-brown or original color	Sapwood only	Branch stubs will not pull out
4	Heartwood rotten; piece does not support its own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can be pushed into heartwood	Reddish or light brown	Through-out	Branch stubs pull out
5	None, piece no longer maintains its shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Through-out	Branch stubs and pitch pockets have usually rotted down

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 17: Lichen Survey: Timed Survey of Epiphytic Lichens

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes the instructions for conducting the timed survey of epiphytic lichens in 1-ha plots for NCCN’s Long-Term Ecological Monitoring of Forest Vegetation. The survey takes one crew member a total of 2 hours or less to complete. [Figure 17.1](#) shows the area where the lichen survey will occur (shaded area). The sampling area (henceforth the “lichen plot”) is 3,750 m² as compared with 3,782 m² sampled by the FHM method.

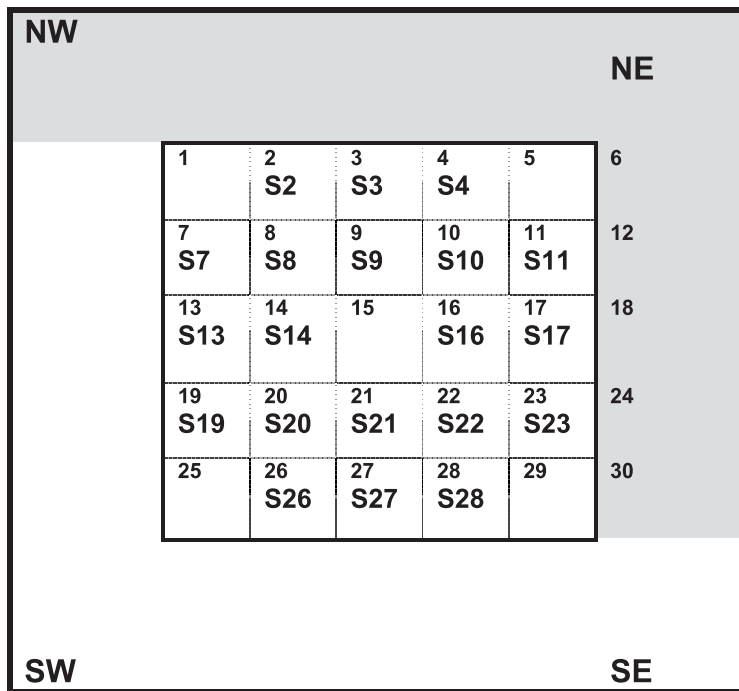


Figure 17.1. Lichens are surveyed in the grayed area.

I. Scope and Application

The purpose of the lichen survey is to use species and communities as biomonitors of change in air quality, climate change, and/or change in the structure of the forest community. Lichen communities are excellent indicators of air quality, particularly nitrogen compounds and long-term averages of sulfur dioxide concentrations (Hawksworth and Rose, 1976; Smith and others, 1993; van Dobben, 1993; van Dobben and others, 2001).

Lichen communities provide information relevant to several key assessment questions, including those concerning the contamination of natural resources, biodiversity, and sustainability of timber production. Lichens not only indicate the health of our forests, but there is a clearly established linkage to environmental stressors.

Regional gradient models have been developed, using the Forest Health Monitoring (FHM) survey method outlined in this SOP, that differentiate lichen community responses to air pollution and climate from other environmental variables (Geiser and Neitlich, 2007). Systematically sampled survey data were scored along air pollution and climate gradients and these can be used to assess conditions and monitor change across forested lands. Even conservative climate change scenarios imply a dramatic alteration of lichen diversity, frequency, and community composition by 2040 (Geiser and Neitlich, 2007).

II. Summary of Method

The objectives of this task are to determine the presence and abundance of macrolichen species on woody plants in each plot and to collect samples to be identified in the laboratory or mailed to lichen specialists.

Note: The crew member responsible for this task is not required to accurately assign species names to the lichens (that is done later by a specialist), but must be able to make distinctions among species.

The field method has two parts that are performed at the same time:

1. Collect a specimen of each epiphytic macrolichen species in the lichen plot, within the allotted time frame, for identification by a specialist.
2. Estimate the abundance (table 17.1) of each species and record on the specimen packet.

The crew person conducting the lichen survey must be certified by NWL, or must have completed a 2-day training for this method and passed the training test (finding 70 percent of the species located by the expert). A crew member not certified in lichens may assist by labeling lichen packets for the ‘lichen’ crew member as the latter collects. Crew members not certified in lichens should not collect specimens, nor should they help assign ABUNDANCE ratings for lichens.

Table 17.1. Abundance codes and descriptions.

Code	Abundance
1	Rare (< 3 individuals in area)
2	Uncommon (4–10 individuals in area)
3	Common (> 10 individuals in area but less than one-half of the boles and branches have that species present)
4	Abundant (more than one-half of boles and branches have the subject species present) Note: This code is not frequently assigned, but is valid. Make sure that more than one out of every two boles, branches, and twigs host this species.

III. Equipment and Supplies

Consumable Supplies

- **Specimen envelopes:** fold from 8.5” × 11” paper, averaging 30 per plot. Print the envelope from I:\NRM\Working\Vegetation\VCa02\Documents\Datashets\Permanent_Plots, or photocopy from figure 17.2.

- **Permanent ink pen** for recording data on packets.
Options:
 - med. pt. rolling ball pen with permanent ink
 - fine tip Sharpie
 - regular ballpoint pen (dry packets),
 - waterproof alcohol markers (dry or damp packets), and
 - very soft (#2 or softer) pencils (very damp packets) can be used.
- **Epiphytic lichens data form** (fig. 17.3) One per plot. Upon returning from the field, make a photocopy: keep the original with other plot data sheets and band the photocopy with lichen vouchers.
- **Mailing forms** (fig. 17.4).
- **Large rubber bands** to keep packets together.
- **Paper bags**
 - #1 or #2 size (30–50 bags) as backup “packets” on very wet days.
 - #3 or #4 size (1–4 bags per plot) for containing the specimen envelopes

Equipment and Apparatus

- **Backpack** or similar bag to keep lichen packets and equipment together.
- **Knife** with locking-blade or fixed-blade with sheath.
- **Hand lens** 10X – Hastings triplet optics preferred to avoid headaches. String the hand lens on a lanyard to avoid losing it.
- **Hand pruners** (optional) - useful for collecting small branch segments.
- **Timepiece**

LTEM FOREST VEGETATION MONITORING - LICHENS OF _____ (PARK)

Plot No:	Date:	Coll. No:
Scientific Name:	Substrate:	Abundance:
Collector:	Remarks:	<i>ID Notes:</i>

Figure 17.2. Lichen packet label. This label is printed and centered at the very bottom of an 8.5 × 11 inch sheet of paper. The sheet is triple-folded with the label on the outside flap; then the sides are folded in to make a packet with a flap.

<p>LICHEN PLOT DATA CARD This will be part of the permanent record for this plot. PLEASE COMPLETE IT FULLY!</p>	<p><i>Office use only (use initials and mm/dd/yy)</i></p> <p>Entered by _____ date: _____ Updated by _____ date: _____ Verified by _____ date: _____ Updated by _____ date: _____</p>
<p>Park: _____ Plot No. ____ - ____ Date: _____ Crew Member's Name: _____</p>	
<p>LICHENS COLLECTED Y N Time lichen sampling began: _____ Time lichen sampling ended: _____ % Cover (on lichen plot): Conifers _____ Hardwoods _____ Tall Shrubs _____ Dominant Tree/Shrub Species(w/% cover) _____ _____</p>	
<p>% gap _____ Recent(<5 yr)? Y N _____ w/ Tall Shrubs? Y N _____ Size class(es) of 3 largest trees (in dbh) <10 _____ 10-20 _____ 21-30 _____ 31-40 _____ >40 _____ Features important for high/low lichen diversity (if any) _____ _____</p>	
<p>Sampling issues/problems (weather, etc) _____ Other comments _____</p>	
<p>REMEMBER:</p> <ul style="list-style-type: none"> • Record the abundance code on each packet! • Remember to look for the common species. • Try to put only one species in each packet. 	

Figure 17.3. Lichen Plot Data Card.

- **Sources** for lichen identification:
 - McCune, B., 1992, Field Key to the Lichens of the Northwest Forests West of the Cascade Crest: Corvallis, Oregon State University, Department of Botany and Plant Pathology, 19 p.
 - McCune, B., and Geiser, L., 1997, Macrolichens of the Pacific Northwest: Corvallis, OR: Oregon State University Press, 386 p.
 - McCune B., and Peck, J., 1994, Lichen communities training document: Corvallis, Oregon State University, Department of Botany and Plant Pathology.
 - Vitt, D.H., Marsh, J.E., and Bovey, R.B., 1988, Mosses, Lichens and Ferns of Northwest North America: Lonepine Publishing, 296 p.
- Optional: 8-digit number stamp and date stamp plus ink pad for efficiently adding date to packets and Plot Data Card.

IV. Procedure

1. **Lichen plot.** The lichen plot is an L-shaped area within the NE outer section of the one-hectare plot (fig. 17.1). This sample area is 3,750 m².
2. **Time.** Sampling continues for a minimum of 45 minutes and a maximum of 2 hours or until 10 minutes elapse with no additional species recorded. At least 45 minutes must be spent searching the plot, even if very few lichens are present.
3. **Strategy.** Begin in the NW corner of the plot move through the lichen plot in a sinuous manner targeting the different woody shrubs and trees. The lichen surveyor should scan the whole area thoroughly, but intensely scrutinize selected areas to best represent the diversity on the plot (see item 4 for more details). Because of trampling concerns in these permanent plots, tread lightly and conservatively.

LICHEN SPECIMEN MAILING FORM
 Please enclose a copy of this form whenever these specimens are mailed. Keep a copy for your records.

FIELD CREW TO LICHEN SPECIALIST: Date
 Sent by: _____ To: _____
 Sender's comments: _____
 Received: _____
 Comments: _____

LICHEN SPECIALIST TO STORAGE: Date
 Sent by: To: _____
 Sender's comments: _____
 Received: _____
 Comments: _____

CONTENTS

State	County	Collector	Notes

Figure 17.4. Form used for mailing lichen community specimens, one form per box.

4. **Abundance rating.** Get a feeling for the abundance of each lichen as you go so that you can record the abundance score on each specimen packet. Make corrections to the abundance score on the packets as you gain a better sense for how much of each species is in the lichen plot. Possible species which you are not sure are different from those already collected should be collected as many times as needed with abundance rated separately for each sample.
5. **Specimen collection.** Collect fruticose and foliose macrolichens. Macrolichens include all species that are three-dimensional (fruticose) or flat and lobed (foliose). Even minute fruticose and lobate forms should be included. The exceptions are squamulose species and *Cladonia* squamules lacking fruiting bodies or upright stalks. Squamules are small rounded or lobed flakes or scales of lichen. Crustose lichens will not be sampled; these adhere tightly to the substrate and appear essentially 2-dimensional.
6. **Specimen size.** Collect a large (ideally palm-sized) sample of each possible species. Optimally a sample should have 20 lobes or branches and abundant morphological characters. For larger species, this means collect a sample about 8–10 cm in diameter if possible.
7. **One specimen packet.** Avoid multi-species packets. Each species should be placed in a separate packet with its own abundance rating. Multi-species packets typically result in missing abundance ratings. Genera such as the tufted lichens *Usnea* and *Bryoria* are frequently found on the branch with several species clustered together. Separate these prior to packeting specimens if possible.
8. **Where to collect.** Inspect the full range of epiphyte substrates and microhabitats.
 - a. Live or standing dead woody plants (trees, saplings, and shrubs > 0.5 m tall) within the lichen plot. **Do not** collect from the basal portions of trees, snags, saplings, and shrubs below 0.5 m.

- b. Recently fallen branches on which the canopy lichens still look healthy (usually down for no more than a few months). Branches and recently downed logs are legal substrates. Older down woody debris and any sawed or human-treated wood surfaces are not legal substrates.
 - c. Shaded and exposed branches.
 - d. Conifers and hardwoods.
 - e. Branches and small twigs on trees.
 - f. Shrubs and trees in different topographic positions (for example, a draw or ravine on an otherwise uniform slope, as long as it occurs within the lichen plot).
9. **Safety note:** Care should be used when removing lichens specimens with a knife or chisel. The knife must have a locking blade or fixed blade. Trees should not be climbed to procure specimens.
 10. **Data collection.** Record data on specimen envelopes and plot data cards as outlined in section V. *Data collection*.
 11. **Data check.** Be sure each packet has all required data and that the Plot Data Card is complete.
 12. **Packet bundle.** Place all specimen packets from a given plot with the Plot Data Card. Either bundle with two crossed rubber bands, or place into a single or several paper bags only if there are too many samples for rubber bands. For paper bags, record PLOT NO., COLLECTOR, CURRENT DATE, and “Bag#___of___” (total # of bags for that plot). Fold the top of each paper bag closed and secure with a rubber band (no staples, please).
 13. **Uncertainty.** The field crew may have uncertainties about the classification of an organism. The following rules for the field crew are designed to put the burden of the responsibility for classification on the specialist, not the field crew.
 - When in doubt, assume it is a lichen.
 - When the growth form is in doubt, assume it is a macrolichen.
 - When species distinctions are in doubt, assume that two different forms are different species.

The purpose of these rules is to encourage the field crew to make as many distinctions in the field as possible. The specialist can later adjust the data by excluding specimens that are not macrolichens and by combining forms that were considered separate by the field crew but are actually the same species.

14. **Post tour.** Dry packets as needed, and store them in a dry place. If specimens were damp or wet when collected, the individual packets should be spread out to dry as soon as possible. Update the project lead on the status of the packets. They will be examined by the project lead and/or mailed to the designated lichen specialist using package tracking ([Section VI. Sample Procurement](#)).

V. Data Collection

Written data are entered in two locations: (1) the lichen sample packet, and (2) the lichen Plot Data Card. All variables are listed and described in order of entry below.

Lichen Sample Packet

Primary data consist of the set of lichen samples collected from the plots and the data recorded on the lichen packets ([fig. 17.2](#)). Packets can be printed from **I:\NRM\Working\Vegetation\VCa02\Documents\Datasheets\Permanent_Plots\LICHEN_SAMPLE_PACKET**. Be sure to complete every entry except the gray-shaded *ID Notes*. The packets with specimens are sent to a lichen specialist for identification and then returned for electronic data entry into the VCa02 database. Written data on lichen packets link the sample to the proper plot and year during the sample identification process. Required fields on the Plot Data Card accompanying the samples help confirm sample location and provide habitat information about the plot that helps the lichen specialist who identifies the samples.

Park: The 4-letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ - _
The code is created by using:

- single digit elevation stratum: 1, 3, or 6
(1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash;
- three digit plot number: the original firing-order number given to that location prior to reconnaissance.

Date: Enter the date that the plot was surveyed and the lichen was collected.

Coll. No: Record the consecutive collection number in the “Coll. No.” box on all lichen packets only. Packets are numbered sequentially beginning with ‘1’ at each plot (thus it is essential that the plot number be filled in).

Scientific Name: Record the scientific name if it is known, but leave room for the lichen specialist to write in the final determination.

Substrate: Record details about where the lichen was growing (for example, location on tree or shrub, hardwood versus conifer, species). This may help with identification.

Abundance: Record relative abundance score on all lichen packets. Revise the abundance rating as collection proceeds. Make sure to check packets for missing abundance ratings before you leave the plot.

Collector: Record the last name and first initial of the crew member conducting the lichen survey, on both the packet and plot data card.

Remarks: Record comments or notes here (for example, specimen description, confusion, issues). There may be more than one species on a given branch sample. If there is any chance of ambiguity about which species in the packet corresponds with the abundance rating, write a descriptive clarifying phrase such as “the white one” or “the sorediate one.”

ID Notes: Leave this space blank for the specialist identifying the lichen.

Epiphytic Lichen Data Form

This data form ([fig. 17.3](#)) fulfills two functions: (1) to provide data regarding the epiphytic lichen survey that will be entered into the database for each plot, and (2) to provide information about the lichen survey that will accompany the lichen sample packets. Upon return from the field, photocopy the data form; keep the original form with other plot data sheets, and band the photocopy with the lichen samples. Duplicated sample location information on the lichen sample packets and data sheet are critical information used to correctly match lichen data from sample packets with data in the LTEM database. Fill out this data form also for a plot when you have searched and found no lichens.

Park: The 4-letter code for the park where the plot is located (MORA, NOCA, or OLYM).

Plot No: Enter a four digit plot code _ - _ _ _
The code is created by using:

- single digit elevation stratum: 1, 3, or 6 (1: 0–300 m; 3: 600–900 m; 6: 1,500–1,800 m), followed by a dash;
- three digit plot number: the original firing-order number given to that location prior to reconnaissance.

Date: Enter the date that the plot was surveyed and the lichen was collected.

Crew: The last name and first initial of crew member(s) that conducted the epiphytic lichen survey.

Time lichen sampling began: Record the time lichen sampling began as HHMM, where HH is hour and MM is minutes. Use military time (for example, 1:45 p.m. is 1345).

Time lichen sampling ended: Record the time lichen sampling ended as HHMM, where HH is hour and MM is minutes. Use military time (for example, 1:45 p.m. is 1345).

Lichens Collected: Y N

Circle **Y** if lichens were collected at the plot. Circle **N** if lichens were not collected and add the reason to the “Other Comments” field ([table 17.2](#)).

% Cover (on lichen plot): Conifers, Hardwoods, Tall shrubs

Record percent canopy cover of overstory (1) conifers, (2) hardwoods, and (3) tall shrubs. Total cover of conifers

plus hardwoods should not be > 100 percent. Total cover of conifers and hardwoods plus shrubs may be >100 percent. Tall shrubs are those > 1 m tall.

Dominant Tree/Shrub Species (w/% cover): Record full scientific names plus % cover for the most common trees and shrubs on the lichen plot. Only 1–3 tree species and 1–3 shrub species are needed here.

Important substrate species not in lichen plot: Record the scientific name of any trees or shrubs that were not found in the lichen plot, but that occur in the greater plot area, and that host a significantly different or more abundant lichen flora from that on tree species in the lichen plot.

% gap: Record gap in 5 percent classes.

To be a gap, there must be:

- Markedly different terrestrial vegetation than on forest floor
- Lack of trees on at least 3–5 percent of lichen plot (3 percent of a lichen plot is a circle with a 6-m radius).
- Canopy opening whose length or width is at least one tree length.

Note: Gaps are caused by disturbance, not just low density of tree establishment.

Recent (< 5 yr)? Y N

Record **Y** if the gap was created within the last 5 years (recently disturbed). Record **N** if the gap appears greater than 5 years. To determine gap age, consider looking at decay class and condition of epiphytes on downed trees, absence/presence/establishment of pioneering species on upturned rootwads, age of understory tree species, and/or past plot records.

Tall Shrubs? Y N

Record **Y** if the gap has > 40 percent cover of tall shrubs (that is, > 1 m tall). Broadleaf shrubs in gaps of conifer forest are often especially rich areas for lichen diversity. Record **N** if the gap has less than 40 percent cover.

Size class(es) of 3 largest tree (cm dbh): < 25 ___ 25-50 ___ 51-75 ___ 76-100 ___ >100 ___. Check the space to the right of the class that best describes the size of the three largest trees encountered on the lichen plot.

Features important for high or low lichen diversity (if any)

Record the important substrate species or conditions that had the most impact on the lichen plot diversity ([table 17.3](#)). If the diversity is normal, record “No significant features.”

Sampling issues/problems (weather, etc)

Record any major problems (up to 4) that negatively impacted the collection effort ([table 17.4](#)). Record on the Plot Data Card the reason on the “Sampling issues/problems” line.

VI. Sample Procurement

Sample Preservation and Storage

Specimens must be thoroughly air dried to avoid fungal decay. If specimens were damp or wet when collected, the individual packets should be spread out and dried as soon as possible. Extremely wet lichens can be blotted dry between towels, then returned to packets to continue air-drying. Dry in the sun, in an air conditioned room, or in any safe place that is as dry as possible. Lichens are dry enough to store when they have become slightly stiff and have lost their soft, wet appearance and feel. Herbarium dryers may be used, but do not use commercial food dryers, ovens, hair dryers, or other strong heat sources.

Store packets in a dry place until you mail them. Never store or ship lichen specimens damp, and never in plastic bags.

Sample Mailing

Always mail specimens using a mail or parcel service that includes parcel tracking. After the first week of sample collection, mail the specimens to the lichen specialist, if possible. The purpose of this is to allow immediate feedback to the field crews concerning specimen quality and quantity. Thereafter, mail the samples each week or every other week to the lichen specialist.

A possible source for lichen specialists: Susan Will-Wolf (608-262-2754 or swwolf@wisc.edu). Also contact Linda Geiser, USDA Forest Service, Corvallis, OR.

Before mailing the packets, check to see that all fields on packets are filled in. Make sure there is a properly filled in Plot Data Card with each set of samples. Also include a properly filled in Plot Data Card for each plot searched and found to have no lichens.

Bundles of packets should be packed closely, but without excessive crushing in sturdy cardboard boxes. Bundles of packets from several plots can be mailed in the same

Table 17.2. Lichen plot survey status codes.

Reasons for not collecting lichens
Plot searched, no lichens found
Not collected – no measurements taken, plot disturbance event
Not collected – no measurements taken – plot dangerous
Not collected – ran out of time
Not collected – rain/storm
Not collected – left plot for emergency
Not collected for other reason: list reason

box. Enclose in the box a Lichen Specimen Mailing Form (fig. 17.4) listing all plots, including plots with no lichens, for the box’s contents. Extra copies of the Mailing Form can be found in I:\NRM\Working\Vegetation\VCa02\Documents\Datashets\Permanent_Plots\12_Lichen_Mailing_Form.doc.

Information from plot data cards and associated lichen packets should be extracted from the database following data entry. The information should be sent to Linda Geiser, USDA Forest Service, Corvallis, OR, or the USDA Forest Service, Corvallis, OR, or the USDA Forest Service FIA program lead for calculation of air quality and climate indices.

Table 17.3. Features affecting lichen diversity.

No significant features
High Diversity type
Stand appears relatively old for its forest type
Old remnant trees in otherwise young stand
Riparian
Gap in forest
Moist areas on plot with open structure and high light
Abundance of tall shrubs hosting high lichen diversity
Hardwoods within conifer forest had high diversity and/or different species
Conifers within hardwood forest had high diversity and/or different species
Presence of exceptionally good lichen substrate species (differs by region)
Other
Low Diversity Type
Very young forest
Recently burned—lichens apparently removed by fire
Too dry for good lichen growth
Too exposed or open for good lichen growth
Some of plot nonforest
Most of trees on plot were poor lichen substrates (differs by region)
Most of the diversity was on a few trees or less
Other

Table 17.4. Codes for sampling issues or problems.

No significant issues
Too wet to see lichens well
Too dark to see lichen well
Sampling compromised by heat
Sampling compromised by other extreme weather (for example, hail, lightning, snow)
Very steep slope hindered thorough plot access
Access to some or all of plot blocked by natural obstacles (for example, lingering snowpack, high water, landslide, large blowdowns)
Other

References Cited

- Geiser, L.H., and Neitlich, P.N., 2007, Air pollution and climate gradients in western Oregon and Washington indicated by epiphytic macrolichens: *Environmental Pollution* 145, p. 203-218.
- Hawksworth, D.L., and Rose, F., 1976, *Lichens as pollution monitors*: London, Edward Arnold Ltd, 59 p.
- McCune, B., 1992, *Field Key to the Lichens of the Northwest Forests West of the Cascade Crest*: Corvallis, Oregon State University, Department of Botany and Plant Pathology, 19 p.
- McCune, B., and Geiser, L., 1997, *Macrolichens of the Pacific Northwest*: Corvallis, Oregon State University Press, 386 p.
- McCune B., and Peck, J., 1994, *Lichen communities training document*: Corvallis, Oregon State University, Department of Botany and Plant Pathology.
- Smith, C., Geiser, L., Gough, L., McCune, B., Ryan, B., and Showman, R., 1993, Species and communities, Chapter 4 *in* *Lichen as Bioindicators of Air Quality*: USDA Forest Service General Technical Report RM-224.
- van Dobben, H., 1993, *Vegetation as a monitor for deposition of nitrogen and acidity*, PhD Dissertation: Utrecht University, Netherlands, 214 p. (privately published)
- van Dobben, H.F., Wolterbeek, T., Wamelink, G.W.W., and ter Braak, C.J.F., 2001, Relationship between epiphytic lichens, trace elements and gaseous atmospheric pollutants: *Environmental Pollution* 112, p. 163-169.
- Vitt, D.H., Marsh, J.E., and Bovey, R.B., 1988, *Mosses, lichens and ferns of Northwest North America*: Lonepine Publishing, University of Washington Press, Edmonton, Alberta, 296 p.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 18:

Field Form Handling Procedures

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. If changes to data on the forms need to be made subsequent to data collection, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

- Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.
- All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes also should be dated and initialed.

- If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.
- Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. On a 5-year basis, data sheets are to be scanned as PDF documents and archived (see protocol narrative [Section 4K, Archival and Records Management](#) and [SOP 26: Product Delivery Specifications](#)). The PDF files may then serve as a convenient digital reference of the original if needed.

This page intentionally left blank.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 19: Procedures Following a Field Tour

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP outlines the procedures to be conducted following a field tour for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. These procedures are carried out directly upon return from the field. The responsibilities are described in detail below.

I. Crew Tasks

Crew members are to complete the following tasks at the end of each field tour. Office time will be limited and there will be much to do, so it is imperative that the crew plan ahead and work efficiently. Remember to be considerate of others sharing the same building. Work quietly and keep gear and paperwork organized.

1. Return trip. During the return trip, outline who will be doing each task upon arrival at the office. Make sure that the logistics page on the event form is completely filled in. Discuss what important information needs to be relayed to the supervisor or project manager. You also can take this time to check and organize the data sheets one more time; this may prompt further thoughts for the supervisor.
2. Check in. Upon return, check in with the dispatch/communication center to let them know that you are back from the field. A radio call in at the trailhead may be sufficient. Check in is only necessary in parks where crews are in communication with dispatch and/or required to send a wilderness itinerary.
3. Meet with Supervisor. Check in with your supervisor: discuss how the tour went, any issues that came up, and how they can be addressed. If any additional training is needed, or any questions arise about procedures, let the supervisor know as soon as possible. Report the number of hours worked.
4. Check work email. Read messages from supervisor.
5. Travel voucher. Inform your supervisor of the number of days and nights spent in the field that tour. If you are required to fill out the travel voucher, forms (*In_Park_Travel_Form.doc*) can be found in: (*I:\NRM\Working\Vegetation\VCa02\Documents\Travel_Logistics\Forms*).
6. Photocopy. Photocopy or scan all data sheets. File originals in their respective folders for later data entry. Scanned copies are kept in *I:\NRM\Working\Vegetation\VCa02_Forest_Veg\YEAR_field_crew\Scanned_Field_Forms_YEAR*, until being moved out of the field crew folder. Photocopies can be kept in a second building (agreed upon by your supervisor), to protect the information from mishaps such as fire.
7. Batteries. Recharge used batteries and replace spare batteries as outlined in [SOP 6: Training Field Crews](#). Make sure that there will be two good sets ready for the field the following tour for the GPS, radio, camera, laser range finder, and any other battery-operated equipment.
8. Clean. Clean pots, bear canisters, and water filters.
9. Gear. Return gear to field box. Address any gear maintenance issues.
10. Fuel. Return fuel to the approved fuel storage area. Check with supervisor for the storage location at your park.

11. Vehicle. Clean out and gas the vehicle. Address any vehicle issues. Wash the vehicle if dirty, but not more than once per month.
12. Return keys. Always return vehicle keys to the key drawer or key board as specified by the supervisor.
13. Photographs. Download and name the images as outlined in [SOP 20: Photographic Image Processing and Management](#).
14. GPS. If plot UTM's were taken, download and send to the GIS support person.
15. Vascular plants. Seek help to identify any unknown plants. If there is time, use taxonomic keys to verify or identify the remaining unknown plants. Refrigerate plants that you plan to look at in the next few days. Press all other plants following directions in [SOP 21: Voucher Specimen Identification and Processing](#).
16. Non-vascular plants. Seek help to identify any unknown lichens or bryophytes. Process voucher specimens as outlined in [SOP 21: Voucher Specimen Identification and Processing](#). Leave envelopes out to dry, then store in dry cool place. If there is a refrigerator available, make sure that all liverwort specimens are stored there. Identify specimens in a timely manner, or mail to a specialist.
17. Data entry. Enter data into the Microsoft® Access database. *I:\NRM\Working\Vegetation\VCa02\Data\ForestVeg_2007_working.mdb*.
18. Preparations for next tour. If all tasks are complete, begin preparations for the next tour. Check that data sheets and maps are all present and ready to go. Waterproof your boots, etc.

Trip Report

During the office day, the crew lead should write a report summarizing tasks completed in the field and issues that need to be addressed immediately or in the future. The write up should take less than 1 hour. Trip reports are very helpful for trying to piece together what happened on a tour at some later time. This is the kind of information you should include:

1. dates and locations
2. crew members
3. what was done
4. what was not done
5. expected or unexpected problems
6. interesting observations

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 20: Photographic Image Processing and Management

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Overview

This SOP describes procedures for downloading, processing, and naming images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means—for example, downloaded from a website or those taken by a cooperating researcher—are not project records and should be handled separately.

Managing Data Photographs

Care should be taken to distinguish data photographs from incidental or opportunistic photographs taken by project staff. Data photographs are those requested on the Event Log data sheet to document the plot. These photographs are taken from specified locations for the following reasons:

- To document plot features
- To document perspective for the purpose of site relocation
- To capture plot vegetation characteristics
- To document gross structural changes over time.

Data photographs are linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photographs – for example, of field crew members at work, or photographs documenting a plant species or disease occurrence – also may be retained but are not necessarily linked with database records.

Effectively managing hundreds of photographic images requires a consistent method for downloading, naming, editing and documenting. The general process for managing data photographs proceeds as follows:

1. File Structure Setup – Set up the file organization for images prior to acquisition
2. Image Acquisition
3. Download and Process
 - Download the files from the camera
 - Rename the image files according to convention
 - Copy and store the original, unedited versions
 - Review and edit or delete the photographs
 - Move into appropriate folders for storage
4. Establish Database Links
5. Deliver Image Files for Final Storage

File Structure Setup

Prior to data collection for any given year, project staff will need to set up a new folder under the Images folder in the project workspace as follows.

[Year]		The appropriate year – 2007, 2008, etc.
[Park code]		Arrange files by park – MORA, NOCA, OLYM
	1_Originals	Unedited image file copies
	[Site_code]	Arranged in folders by plot for images taken at plots
	[Date]	Arranged by date, for images not taken at plots
	2_Processing	Temporary processing workspace
	3_Recon_Plots	Required data images for reconnaissance work
	[Site_code]	Arranged in folders by plot for images taken at plots
	[Date]	Arranged by date, for images not taken at plots
	4_Permanent_Plots	Required data images for permanent plots
	[Site_code]	Arranged in folders by plot for images taken at plots
	[Date]	Arranged by date, for images not taken at plots
	5_Miscellaneous	Non-data images taken by project staff
	[Site_code]	Arranged in folders by plot for images taken at plots
	[Date]	Arranged by date, for images not taken at plots
	6_Non-NPS	Images acquired from other sources

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. It also provides separate space for image processing and storage of originals.

Note: For additional information about the project workspace, refer to [SOP 1: Workspace Setup and Project Records Management](#).

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name
- Use the underbar (“_”) character to separate words in folder names
- Try to limit folder names to 20 or fewer characters
- Dates within folder names should be formatted as YYYYMMDD (for better sorting)
- Plot folder names are typically a 5-character string with the underbar character separating elevation stratum from the 3-digit plot number (for example, 3_140).

Note: Individual photograph names also will contain the 4 letter park code in front of the stratum number, but for folder naming this is not required as site folders are found within other folders named for each park.

Image Acquisition

For details on image acquisition, refer to [SOP 12: Event Log](#). Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same resolution initially. A recommended minimum raw resolution is 1,600 × 1,200 pixels (approximately 2 megapixels).

Downloading and Processing

1. Download the raw, unedited images from the camera into the ‘Originals’ folder.
2. Copy the images to the ‘Processing’ folder, then set the contents in the ‘Originals’ folder as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals are the image backup to be referred to in case of unintended file alterations (for example, file deletion, loss of resolution, or loss of image quality upon rotation of image).
3. In the ‘Processing’ folder, rename the images according to convention (refer to the image naming standards section). If image file names were noted on the field data forms, be sure to update these to reflect the new image file name prior to data entry. See [SOP 18: Field Form Handling Procedures](#).
4. Process the photographs in the ‘_Processing’ folder. At a minimum, the following processing steps should be performed on all image files:
 - Delete any poor quality photographs, repeats, or otherwise unnecessary photographs. Low quality photographs might be retained if the subject is highly unique, or the photograph is an irreplaceable data photograph.
 - Rotate the image to make the horizon level.
 - Photographs of people should have ‘red eye’ glare removed.
 - Non-data photographs may be cropped to remove edge areas that grossly distract from the subject.
5. When finished, move the image files that are to be retained and possibly linked in the database to the appropriate folder. Data images are moved to the Recon or Permanent Plots folder, and other images to the Miscellaneous folder. Photographs of interest to a greater audience should be copied to the park Digital Image Library. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.

Large groups of photographs acquired under sub-optimal exposure or lighting can be batch processed to enhance contrast or brightness. Batch processing also can be used to resize groups of photographs for use on the web. Batch processing may be done in ThumbsPlus, Extensis Portfolio or a similar image software package.

Image File Naming Standards

In all cases, image names should follow these guidelines:

1. No spaces or special characters in the file name
2. Use the underbar (“_”) character to separate file name components
3. Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
4. Park code and year should either be included in the file name or be obvious from the folder structure

The image file name should consist of the following parts:

1. The 4-character park code (MORA, NOCA, OLYM)
2. The elevation stratum, followed by an underbar
3. The three digit plot number (for example, 007), followed by an underbar
4. A brief descriptive code ([table 20.1](#)), word or phrase, followed by an underbar
5. Two digits representing year
6. Optional: a sequential number if multiple images were captured

Example:

- MORA3_007_C1_H_07.jpg — A MORA plot view taken from plot center to corner #1 in 2007

Renaming photographs may be most efficient as a three part event (you decide):

1. Insert the park code, stratum, and plot number at the beginning of the photograph name as a batch process.
2. Insert year at the end of the photograph as a batch process.
3. Manually add a descriptive component to each file name.

To rename files in batches use ThumbsPlus, Extensis Portfolio or a similar image software package. A somewhat less sophisticated alternative is to batch rename files in Windows Explorer, by first selecting the files to be renamed and then selecting File > Rename. The edits made to one file will be made to all others, although with the unpleasant side effect of often adding spaces and special characters (for example, parentheses), which will then need to be removed manually.

Table 20.1 Descriptive symbols.

Code	Description	Perspective
C	View of center rebar in surroundings	Horizontal - low
C1_H	From center looking NW toward rebar #1	Horizontal - low
C1_V		Vertical - mid
C6_H	From center looking NE toward rebar #6	Horizontal - low
C6_V		Vertical - mid
C36_H	From center looking SE toward rebar #36	Horizontal - low
C36_V		Vertical - mid
C31_H	From center looking SW toward rebar #31	Horizontal - low
C31_V		Vertical - mid
1C_H	From corner #1 looking SE toward plot center	Horizontal - low
1C_V		Vertical - mid
1NW	From corner #1 looking NW to outer corner	Horizontal - mid
6C_H	From corner #6 looking SW toward plot center	Horizontal - low
6C_V		Vertical - mid
6NE	From corner #6 looking NE to outer corner	Horizontal - mid
36C_H	From corner #36 looking NW toward plot center	Horizontal - low
36C_V		Vertical - mid
36SE	From corner #36 looking SE to outer corner	Horizontal - mid
31C_H	From corner #31 looking NE toward plot center	Horizontal - low
31C_V		Vertical - mid
31SW	From corner #31 looking SW to outer corner	Horizontal - mid
NWC	From NW corner looking toward plot center	Horizontal - mid
NEC	From NE corner looking toward plot center	Horizontal - mid
SEC	From SE corner looking toward plot center	Horizontal - mid
SWC	From SW corner looking toward plot center	Horizontal - mid

Establishing Database Links

During data entry and processing, the database application will provide the functionality required to establish a link between each database record and the appropriate image file(s). To establish the link, the database prompts the user to indicate the root project workspace directory path, the specific image folder within the project workspace, and the specific file name. This way, the entire workspace may be later moved to a different directory (that is, the NCCN Digital Library) and the links will still be valid after changing only the root path. Refer to [SOP 22: Data Entry and Verification](#) for additional details on establishing these links.

Note: It is important that the files keep the same name and relative organization once these database links have been established. Users should not rename or reorganize the directory structure for linked image files without first consulting with the Data Manager.

Final Storage

Note: Please refer to [SOP 26: Product Delivery Specifications](#).

At the end of the season, and once the year's data are certified, data images for the year may be delivered along with the working copy of the database to the Data Manager on a CD or DVD. To do this, simply copy the folder for the appropriate year(s) and all associated subfolders and images onto the disk. These files will be loaded into the project section of the NCCN Digital Library, and the database links to data images will be updated accordingly.

Prior to delivery, make sure that all processing folders are empty. Upon delivery, the delivered folders should be made read-only to prevent unintended changes.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 21: Voucher Specimen Identification and Processing

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP describes procedures for identifying and processing voucher specimens for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. These procedures must be followed in order to ensure that we get high-quality and repeatable results from the vegetation monitoring protocols for species composition and vegetation cover.

PROCEDURES:

1. **Storage.** Immediately upon return from the field, plant specimens that were collected during field work should be stored as follows:
 - a. Vascular plant species may be refrigerated if they are to be identified within the week. Plants should be pressed following identification.
 - b. Press vascular plant species between newspaper and blotter paper in plant presses and store in a warm, dry, well-ventilated, safe area so that they dry quickly and are not compromised due to mold. Make sure that the following information accompanies the specimen at all times:
 - **Collection number**
 - Collection date
 - Collector
 - Location
 - Plot number
 - Habitat and/or Substrate
 - Identification notes
 - c. Thoroughly dried specimens will be removed from the plant press and organized by genus into folders.
 - d. Liverwort specimens, stored in paper envelopes and boxes, are to be refrigerated until identification is complete.
 - e. All other non-vascular plant specimens shall be set out to dry in a warm, dry, well-ventilated, safe area so that they dry quickly and are not compromised due to mold. Thoroughly dried specimens will be placed into specimen boxes.
 - f. Field collection sheets and packets must be inspected to make sure proper identification attributes including collector, collection date, collection number, and site are on the specimen.
2. **Identification.** Identify plants soon after your return from the field if possible. Use the most recent accepted taxonomic keys for the project area, herbarium specimens, and park plant reference lists to aid in identification. Often, multiple keys will be helpful in determining the identity of a particular specimen. Verify that the species occurs within the respective park or region, and at the elevation, in the habitat, and on the substrate where the specimen was collected, by consulting (1) species lists, (2) the "Flora of the Olympic Peninsula" for OLYM vascular plants, and (3) plant descriptions. Discrepancies should be verified by a botanist as outlined below. Use the USDA website "Integrated Taxonomic Information System" (ITIS) at: <http://www.itis.gov/> to check that you have the current scientific name. Update these names on the datasheet by making a notation beside the name. **Never erase** an entry on the datasheet; simply put a single line through the entry so that the original data is still legible. The first cut at specimen ID is performed by the project biotechnicians. At the end of the field season, any remaining unidentified specimens should be carefully re-examined in the herbarium and identified.

3. Verification. Preliminary identifications will be verified by NPS or USGS botanists, or other specialists contracted by the program to perform this task. Botanists at the herbarium and the Project Lead may determine that certain specimens require inspection by an authority for a particular group. This inspection may be greatly facilitated by association with an accredited professional herbarium. In addition, this program may contract with specialists that have done identification work for the Forest Inventory and Analysis Program, especially for final determination of nonvascular plant specimens.
4. Annotation. After the final determinations of specimens are received, the original field data sheets will be annotated with the identities of the specimens. It is crucial that each reference to a particular specimen on these data sheets is annotated so that the correct species names are entered into the database. The Project Lead and data manager will maintain an updated master database with the accepted taxonomy for the project. This database will be archived each year in order to facilitate any changes in species nomenclature that may need to occur in the future. In general, this project will follow the accepted nomenclature of the Flora of North America and the USDA Plants database (ITIS).
5. Data entry. Once all final determinations have been received, specimen data are entered into the final collection database ([SOP 22: Data Entry and Verification](#)). The Project Lead will work with the curatorial staff to see that NPS accession and catalog numbers are assigned to the specimens. A label is printed for each vascular plant specimen and mounted onto archival herbarium paper. Non-vascular plant specimens are placed into acid-free archival specimen packets. Specimens are transferred to herbarium cabinets at NOCA or OLYM for storage. The curatorial staff will enter specimen data into ANCS+, the NPS cataloging database.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 22: Data Entry and Verification

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Overview Guidelines for Data Entry and Verification

This document describes the general procedures for entry and verification of field data in the working project database. For related guidance and a clarification of the distinction between the working database and the master database, refer to protocol [Section 4C, Overview of Database Design](#), and [Section 4D, Data Entry and Processing](#). The following are general guidelines to keep in mind.

1. Data entry should occur as soon after data collection as possible so that field crews keep current with data entry tasks, and catch any errors or problems as close to the time of data collection as possible.
2. The working database application will be found in the project workspace. For enhanced performance, it is recommended that users copy the front-end database onto their workstation hard drives and open it there. This front-end copy may be considered “disposable” because it does not contain any data, but rather acts as an interface with data residing in the back-end working database.
3. Each data entry form is patterned after the layout of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use the pre-built forms as a way of ensuring the maximum level of quality assurance.
4. As data are being entered, the person entering the data should visually review each data form to make sure that the data on screen match the field forms. This should be done for each record prior to moving to the next form for data entry.

5. At regular intervals and at the end of the field season the Field Lead should inspect the data that have been entered to check for completeness and perhaps catch avoidable errors. The Field Lead also may periodically run the Quality Assurance Tools that are built into the front-end working database application to check for logical inconsistencies and data outliers (this step is described in greater detail in [Section 4E, Data Quality Review](#) and also in [SOP 24: Data Quality Review and Certification](#)).

Database Instructions

Getting Started

The first action to be taken is to make sure the data entry workspace is set up properly on a networked drive. If you are unclear about where this should be, contact either the local Park Wildlife Biologist or Data Manager.

- Store the back-end database file on the server so that others can enter data into the same back end file. The back-end file has “_be_” as part of its name. Upon saving this back-end, the user may want to append the local park code to distinguish it from other back-end files associated with other crews (for example, ForestVeg_VCa02_be_2007_OLYM.mdb).
- The crew’s copy of the front-end database also may be stored in the same folder.
- If it doesn’t already exist, also create a folder in the same network folder named “backups” or “backup_copies” for storing daily backups of the back-end database file.

Prior to Using the Database:

- Open the front-end database. The first thing the front-end application will do is prompt you to update the links to the back-end database file. This update will only need to be done once for each new release of the front-end database.

Important Reminders for Daily Database Use

- A new copy of the front-end database will need to be copied to your workstation every day. Do not open and use the front-end database on the network as this ‘bloats’ the database file and makes it run more slowly.
- Backups should be made consistently at some point every day that data entry occurs. Normally, the front-end application will automatically prompt you to make a backup either upon initially opening or upon exiting the application. Backups also can be made on demand by clicking on the “Backup data” button on the main menu and storing the backup file in the “backups” folder.
- To save drive space and network resources, backup files should be compacted by right-clicking on the backup file in Windows Explorer and selecting the option: “Add to Zip file.” Old files may be deleted at the discretion of the Project Crew Lead.
- New versions of the front-end application may be released as needed through the course of the field season. If this happens, there should be no need to move or alter the back-end file. Instead, the front-end file may be deleted and replaced with the new version, which will be named in a manner reflecting the update (for example, ForestVeg_2007_v2.mdb).
- If the front-end database gets large or if performance slows, compact it periodically by selecting Tools > Database Utilities > Compact and Repair Database.

Database Components

The working front-end application has the following functional components, which are accessed from the main application switchboard form that opens automatically when the application starts:

- Enter / edit data – Opens a form to confirm default settings (for example, park, coordinate datum) prior to continuing to the project-specific data entry screens.
- Site task list – Keeps track of unfinished tasks associated with sample locations (for example, forgotten equipment, unfinished data collection) that one field crew can use to communicate with a future field crew.
- Lookup tables – Opens a tool for managing the lookup values for the project data set (for example, species list, list of project personnel, etc.).
- QA checks – Opens the data validation tool, which shows the results of pre-built queries that check for data integrity, missing data, and illogical values, and allows the user to fix these problems and document the fixes. See [SOP 24: Data Quality Review and Certification](#).
- View db window – Allows the user to view database objects (tables, queries, and forms).
- Back up data – Creates a date-stamped copy of the back-end database file.
- Connect data tables – Verifies the connection to the back-end working database file, and provides the option to redirect or update that connection.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 23: End of Field Season Debriefing and Close-Out

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP outlines the procedure for meeting to debrief the crew and close out the field season for NCCN's Long-Term Ecological Monitoring of Forest Vegetation. This is to occur during the last week of work for the seasonal bio-technicians.

I. Preparation

By the end of the field season, all data should be entered into the database and verified by the crew. Plant identifications should be as complete as possible and corrections made in the database. Any remaining unknown plants should be pressed, labeled, and stored. Lichens should be organized, bound, and appropriately stored or sent to the lichen specialist for identification and verification. The crew should be prepared for debriefing on the scheduled day during the last week of work (section II. Debriefing). Equipment should be inventoried and any borrowed equipment returned (section III. Equipment Assessment and Return). The crew lead should prepare a "Field Season Report" (section V. Field Season Reporting), noting any unfinished work, so that the park plant ecologist can arrange for its completion. All ice cream bars remaining in the freezer should be consumed or redistributed.

II. Debriefing

The objective of the debriefing is to understand and summarize how the field season went, what worked, and what can be improved for next year. Let the crew know ahead of time that there will be a meeting to discuss the accomplishments and challenges of the field season. The crew should review this SOP before beginning their last week of work, write down their thoughts and responses to the items in the debriefing agenda (below) for discussion at the debriefing, and add additional items that come to mind. The debriefing will be held on one of the last days of the field season before the crew departs. Meeting notes should be recorded for reference.

The subjects to be covered include the following:

Organization Issues

How did you feel about each of the following parts of the field season? What went well and where could improvements be made?

- Orientation (helpful, organized, logical, and applicable?) (review orientation agenda)
- Planning
- Scheduling
- Tours
- Communication (supervisors to crew lead, crew lead to crew, between crew members, between crews, within park, between parks, with park Plant Ecologist/Botanists)

Field Issues

How did you feel about each of the following:

- Field tours – Were you mentally and physically prepared for your season?
- Training – Was the training adequate for packing, hiking, GPS, map and compass, and safety? (sampling training addressed in next section)
- Transportation – were vehicles adequate, functional and safe?
- Field support – support for minimizing pack weight such as working with trail packers, etc.
- Field safety – Did you encounter any safety issues; what did you do to address them?
- Suggestions for avoiding injuries next year (Updates to the Job Hazard Analysis)
- Field equipment – Did you have the right equipment for backpacking and camping?

Plot Sampling

How did you feel about each of the following parts of plot sampling? What went well and where could improvements be made?

- Training – Was the training adequate for plot sampling (tools for each method)?
- Locating plots
- Plot set up
- Sampling
 - Event Log
 - Taking digital images
 - Trees
 - Percent Cover of Vegetation
 - Herbivory
 - Downed Woody Material
 - Canopy Cover
 - Cryptogams on Logs
 - Epiphytic Lichens
- Data forms
- Plant identification
- Handling voucher specimens

Technical Issues

- Field equipment – Did you have the right equipment to get the job done safely and efficiently? (for example, GPS, Lasers, cameras, altimeter, clipboards, paper, etc.)
- GPS / GIS support at each park
- Did the GPS guidelines work and how can they be improved?
- Radio use at each park

Office

- Office time
- Computers and network access
- Office supplies
- Database and data entry (with database support person)
- Status of data

Plans for Next Year

Go over the plans for next year. Let the crew know about rehire status for their current position, approximately when the job announcement will be on USAJOBS should they wish to apply, and what incentives may be available to them should they return.

Contact Information

Consider collecting crew contact information to be held by the supervisor. If any questions arise about the data, we may wish to contact the crew person that collected the data. Ideally data quality review and certification will have been conducted by the end of the field season, but with our short season, this may not be possible.

III. Equipment Assessment and Return

The Crew Lead is responsible for ensuring the inventory, return, and documentation of field equipment. By the last day, the crew will return all equipment that was borrowed for the field season. This should include field notebooks. Use the original check-out list to check-in the equipment. Note any equipment that was lost or damaged. Record what needs to be fixed or replaced and indicate if an improved model is desired. Organize and store the equipment so that it is contained and easily accessible for the next season. On the computer create a Crew_Equipment_Needs_List in **I:\...\VCa02\Documents\Equipment**, filed by year, so that it is easily accessible at ordering time the following year.

IV. Check Out

On the last day of work, the biotechnicians will go through the NPS termination procedure. This entails getting the termination document signed off by various authorities as equipment and park service keys are turned in.

V. Field Season Reporting

The Field Lead should prepare a brief report (generally not more than three pages) that includes the following:

- Clear enumeration of which plots were completed, and which were only partially completed during the season.
- Description of any logistic difficulties that arose, and explanation of how they were addressed.
- Clear documentation and explanation of any diversions from established protocols.
- Discussion of any interesting or potentially important observations about the parks' vegetation or animal communities that may have been noted during the field season (for example, apparent changes in composition from previous years, or notable changes in apparent abundance of exotic or rare species).
- Suggestions for improving the training session or field season logistics in the future.
- An inventory of field equipment, quantity and condition.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 24: Data Quality Review and Certification

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Overview

This SOP describes the procedures for validation and certification of data in the working project database. Refer also to protocol narrative [Section 4C, Overview of Database Design](#); [Section 4E, Quality Review](#); and [Section 4G, Data Certification and Delivery](#) for related guidance and a clarification of the distinction between the working database and the master database.

After the season's field data have been entered and processed, they need to be reviewed and certified by the Project Lead for quality, completeness and logical consistency. Data validation is the process of checking data for completeness, structural integrity, and logical consistency. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes.

Once the data have been through the validation process and metadata have been developed for them, they are to be certified by completing the NCCN Project Data Certification Form, available on the NCCN website. The completed form, certified data and updated metadata may then be delivered to the NPS Lead and the Data Manager according to the timeline in protocol narrative [Table 6: Yearly Project Task List](#).

Data Quality Review

The following table shows the automated validation checks that are performed on the data prior to certification. These queries are designed to return records that need to be fixed, so ideally—once all data checks have been run and any errors have been fixed—none of the queries will return records. However, not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report.

The queries are named and numbered hierarchically so that high-order data—for example from tables on the parent side of a parent-child relationship such as sample locations—should be fixed before low-order data (for example, individual species observations). The rationale for this is that one change in a high-order table affects many downstream records, and so proceeding in this fashion is the most efficient way to isolate and treat errors.

In addition to these automated checks, the person performing the quality review should remain vigilant for errors or omissions that may not be caught by the automated queries. Another task that cannot be automated is the process of making sure that all data for the current season are in fact entered into the database. This will often involve manual comparisons between field forms or other lists of the sites visited and the results of queries showing the sites for which data exist. The Data Manager also is available as needed to help construct new database queries or modify existing ones as needed.

Query_name	Returns records meeting the following criteria
qa_1a_Strata_missing_critical_info	Missing park code, project code, stratification date, stratum name, stratum definition
qa_1b_Strata_illogical_dates	Stratum record updated date prior to created date
qa_2a_Sites_missing_critical_info	Missing site code, park code, or stratum ID
qa_2b_Sites_park_inconsistencies	Park code inconsistent with strata table
qa_2c_Sites_duplicates_on_code_and_park	Duplicate records on site code and park code
qa_2d_Sites_missing_evaluation_codes	Established or rejected sites without evaluation codes
qa_2e_Sites_site_status_inconsistencies	Missing site status, 'retired' sites without discontinued dates, discontinued dates on status other than 'retired', or discontinued dates without establishment dates
qa_2f_Sites_illogical_dates	Discontinued date prior to establishment date, or updated date prior to created date
qa_2g_Sites_missing_panel_type	Active sites without a panel type
qa_2h_Sites_missing_site_name	Missing site name (no remedy required)
qa_3a_Locations_missing_critical_info	Missing site ID (except where loc_type = 'incidental'), location code, location type, or park code
qa_3b_Locations_park_inconsistencies	Park code inconsistent with sites table
qa_3c_Locations_duplicates_on_site_and_loc_code	Duplicate records on site ID and location code
qa_3d_Locations_duplicates_on_site_and_loc_name	Duplicate records on site ID and location name
qa_3e_Locations_duplicates_on_loc_name_and_park	Duplicate records on location name and park code
qa_3f_Locations_missing_sampling_events	Location type <> 'origin' and missing an event; or event is null and features, markers or images were entered
qa_3g_Locations_missing_establishment_dates	Locations with sampling events or field coordinates or discontinued dates, but without with location establishment dates
qa_3h_Locations_loc_status_inconsistencies	Missing location status; sampled locations with location status = 'rejected' or 'proposed'; locations with establishment dates or field coordinates and loc_status = 'proposed'; 'retired' locations without discontinued dates; discontinued dates on status other than 'retired'
qa_3i_Locations_unclassified_new_points	Newly sampled locations with an undetermined location type (location_type = 'new')
qa_3j_Locations_loc_type_and_loc_code_inconsistent	Locations where loc code = 'TO' and loc type <> 'origin' or vice versa, or where loc code = 'rare' and loc type <> 'incidental' or vice versa
qa_3k_Location_illogical_dates	Discontinued date prior to establishment date, or updated date prior to created date
qa_3l_Locations_without_coordinates	Locations without coordinates
qa_3m_Locations_without_field_coords	Locations that have sampling events but no field coordinates (no remedy required)
qa_3n_Locations_with_more_than_one_coord	Locations with more than one coordinate record - verify that these are intended
qa_3o_Locations_missing_travel_info	Sampled locations missing azimuth to point, travel notes, or reason for azimuth direction changes where direction changed = 'yes'
qa_3p_Locations_missing_env_values	Missing elevation, slope or aspect values
qa_3q_Locations_elev_source_inconsistencies	Sampled locations where elevation source = 'GIS theme'
qa_3r_Locations_missing_elev_metadata	Missing elevation units or elevation source where elevations are present
qa_3s_Locations_elev_unit_inconsistencies	Elevation units = 'm' but elevation source = 'GIS theme'; units = 'm' but elevation values greater than 4,419
qa_3t_Locations_without_markers	Locations that have sampling events but no markers
qa_3u_Locations_no_best_coord_assigned	For GIS specialist - locations without best coordinates
qa_4a_Coordinates_missing_critical_values	Records missing location ID or coordinate creation date
qa_4b_Coordinates_incomplete_field_UTMs	A portion of the field coordinate pair is missing, or the field datum is missing
qa_4c_Coordinates_missing_field_UTMs	Field UTMs are missing, but where there is either a coordinate collection date, a coordinate label, a field error, field offsets, field sources, GPS file or model type, or a source map scale filled in
qa_4d_Coordinates_missing_field_coord_date	Field coordinates without a coordinate collection date
qa_4e_Coordinates_inconsistent_field_source_info	Field coordinate source = 'map', however, there is a GPS file name, a field horizontal error, or GPS model filled in to suggest that the source is GPS
qa_4f_Coordinates_final_UTM_inconsistencies	Final UTM coordinates are incomplete; or they are present and the coordinate type or datum is missing; or coordinate type or an estimated error value is present and the coordinates are missing

Query_name	Returns records meeting the following criteria
qa_4g_Coordinates_public_UTM_inconsistencies	Public UTM coordinates are incomplete; or they are present and the public coordinate type is missing; or public coordinate type or public coordinate scale is present and the public coordinates are missing
qa_4h_Coordinates_illogical_dates	Coordinates with updated dates before creation dates
qa_4i_Coordinates_target_coord_inconsistencies	Target UTM coordinates are incomplete; or they are present and the target datum is missing
qa_4j_Coordinates_without_final_or_public_coords	For GIS specialist - records missing final UTMs and/or public coordinates
qa_5a_Sample_period_errors	Missing start or end dates; start date/time after end date/time; or updated dates prior to created dates
qa_6a_Events_missing_critical_info	Missing location ID, project code, or start date
qa_6b_Events_duplicates_on_location	Duplicate records on location ID - also shows how many records exist in related tables
qa_6c_Events_missing_start_times	Start times missing where location type is missing or <> 'origin'
qa_6d_Events_without_observers	Events without associated observers
qa_6e_Events_without_point_count_data	Events without associated point count data where location type <> 'incidental'
qa_6f_Events_without_habitat_data	Events without associated habitat data where location type <> 'incidental'
qa_6g_Events_missing_obs_records	Events at incidental sampling locations without associated rare bird or nesting observations
qa_6h_Events_inconsistent_coord_info	Events at locations where coordinates_updated = True but missing associated coordinate records, or having associated coordinates where coordinates_updated = False, or where coord_date is different from the date of the event
qa_6i_Events_inconsistent_feature_info	Events at locations where features_updated = True but missing associated feature records, or having associated features where features_updated = False
qa_6j_Events_inconsistent_marker_info	Events at locations where markers_updated = True but missing associated marker records, or having associated markers where markers_updated = False, or where marker_installed is different from the date of the event
qa_6k_Events_inconsistent_image_info	Events at locations where photos_taken = True but missing associated image records, or having associated images where photos_taken = False, or where image_date is different from the date of the event
qa_6l_Events_missing_conditions	Point count events with missing environmental conditions - noise level, wind_cond, precip_cond, cloud_cover, temperature
qa_6m_Events_illogical_dates	Events with start date/times occurring after end date/times; or records that have update or verified dates prior to the record creation date
qa_7a_Observers_missing_critical_info	Missing event ID or contact ID
qa_7b_Observers_missing_role	Observer role is missing (no remedy required)
qa_7c_Markers_missing_critical_info	Missing marker code, location ID, marker type, marker status, or marker updated values
qa_7d_Markers_missing_measurements	Missing marker height, substrate, or having only partial offset information (distance without azimuth or vice versa)
qa_7e_Markers_status_inconsistencies	Marker status = 'removed' but no removal date, or with a removal date and status <> 'removed'
qa_7f_Markers_illogical_dates	Marker updated or marker removed date before marker installed date
qa_7i_Features_missing_measurements	Missing distance or azimuth values
qa_7j_Features_missing_critical_info	Location ID, feature type, or feature status is missing
qa_8a_Habitat_missing_critical_info	Missing event ID or habitat number
qa_8b_Habitat_missing_values	Missing PMR code, canopy cover, or tree size class
qa_8c_Nesting_obs_missing_values	Missing event ID, taxon ID, or nest activity
qa_8d_Point_counts_missing_critical_info	Missing event ID, taxon ID, time interval, or group size
qa_8e_Point_counts_missing_values	Missing observation distance, seen first, ever sang, previously observed, or flyover
qa_8f_Rare_bird_obs_missing_critical_info	Missing event ID or taxon ID
qa_8g_Rare_bird_obs_missing_values	Missing observation distance, group size, or nest activity

Using Database Quality Review Tools

Open the working copy of the database application and click on the “QA Checks”. This will open the quality assurance review form. Upon opening, the quality assurance review form automatically runs the validation queries and stores the results in a table built into the front-end database (tbl_QA_Results). Each time the queries results are refreshed, or the quality assurance review form is re-opened, the number of records returned and the run times are rewritten so that the most recent result set is always available; any remedy

description and the user name for the person making the edits is retained between runs of the queries. These results form the basis of documentation in the certification report output as shown below.

The first page of the quality review form has a results summary showing each query sorted by name, the number of records returned by the query, the most recent run time, and the description. There also is a button for refreshing the results, which may need to be done periodically as changes in one part of the data structure may change the number of records returned by other queries.

Quality Assurance Review Form

View Edit Close

Results Summary View and Fix Query Results Browse data tables

Note: Double click on a record to open that result set Refresh results View summary report

Query name	N records	Run time	Description
qa_1a_Strata_missing_critical_info	0	03/29/2006 16:57	Missing park code, project code, stratification date, stratum name, stratu
qa_1b_Strata_illogical_dates	0	03/29/2006 16:57	Stratum record updated date prior to created date
qa_2a_Sites_missing_critical_info	0	03/29/2006 16:57	Missing site code, park code, or stratum ID
qa_2b_Sites_park_inconsistencies	0	03/29/2006 16:57	Park code inconsistent with strata table
qa_2c_Sites_duplicates_on_code_and_park	0	03/29/2006 16:57	Duplicate records on site code and park code
qa_2d_Sites_missing_evaluation_codes	3	03/29/2006 16:57	Established or rejected sites without evaluation codes
qa_2e_Sites_site_status_inconsistencies	0	03/29/2006 16:57	Missing site status, 'retired' sites without discontinued dates, discontinue
qa_2f_Sites_illogical_dates	0	03/29/2006 16:57	Discontinued date prior to establishment date, or updated date prior to cr
qa_2g_Sites_missing_panel_type	109	03/29/2006 16:57	Active sites without a panel type
qa_2h_Sites_missing_site_name	661	03/29/2006 16:57	Missing site name (no remedy required)
qa_3a_Locations_missing_critical_info	0	03/29/2006 16:57	Missing site ID (except where loc_type = 'incidental'), location code, loca
qa_3b_Locations_park_inconsistencies	0	03/29/2006 16:57	Park code inconsistent with sites table
qa_3c_Locations_duplicates_on_site_and_loc_code	4	03/29/2006 16:57	Duplicate records on site ID and loc code
qa_3d_Locations_duplicates_on_site_and_loc_name	2	03/29/2006 16:57	Duplicate records on site ID and loc name
qa_3e_Locations_duplicates_on_loc_name_and_park	7	03/29/2006 16:57	Duplicate records on loc name and park code
qa_3f_Locations_missing_sampling_events	12	03/29/2006 16:57	Location type <> 'origin' and missing an event; or event is null and featur
qa_3g_Locations_missing_establishment_dates	19	03/29/2006 16:57	Locations with sampling events or field coordinates or discontinued date:
qa_3h_Locations_loc_status_inconsistencies	21	03/29/2006 16:57	Missing loc status; sampled locations with loc status = 'rejected' or 'prop
qa_3i_Locations_unclassified_new_points	543	03/29/2006 16:57	Newly sampled locations with an undetermined location type (location_ty
qa_3j_Locations_loc_type_and_loc_code_inconsistent	0	03/29/2006 16:57	Locations where loc code = 'TO' and loc type <> 'origin' or vice versa, or
qa_3k_Location_illogical_dates	0	03/29/2006 16:57	Discontinued date prior to establishment date, or updated date prior to cr
qa_3l_Locations_without_coordinates	6	03/29/2006 16:57	Locations without coordinates
qa_3m_Locations_without_field_coords	21	03/29/2006 16:57	Locations that have sampling events but no field coordinates (no remedy

Upon double-clicking a particular query name, the second page will open up to show the results from that query.

Data Validation and Quality Review Tool

Time frame of data being certified: 2008 View Edit Close

Results summary View and fix query results Browse data tables

* Double-click on the label to change sort order. Click on a query name to open. Query type: Done: False Refresh results View summary report

Query name*	Type*	Done*	N recs*	Last run time	Description
qa_a102_Overview_locs_with_multiple_events	warning		17	07/16/2008 15:43	Locations with more than one associated sampling event
qa_a113_Overview_sampling_visit_summary	information		6	07/16/2008 15:43	Number of locations visited at each park, grouped by location type
qa_a123_Overview_locations_visited	information		526	07/16/2008 15:43	Full list of locations visited at each park
qa_a133_Overview_monitoring_locations_visited	information		55	07/16/2008 15:43	List of monitoring locations visited at each park
qa_a203_Sampling_event_date_ranges	information		3	07/16/2008 15:43	Returns the earliest and latest sample dates in the data set
qa_a213_Quality_assurance_status	information		10	07/16/2008 15:43	Quality assurance status (i.e., unverified, verified, or updated) of
qa_a902_Unverified_events	warning		525	07/16/2008 15:43	List of unverified sampling events in the data set
qa_d133_Locations_duplicates_on_park_and_loc_nar	information		361	07/16/2008 15:43	Duplicate records on park code and loc name
qa_d142_Locations_missing_panel_info	warning		6	07/16/2008 15:43	Active sample locations without a panel type, or panel name whe
qa_d152_Locations_missing_establishment_dates	warning		19	07/16/2008 15:43	Sampled locations with loc type = 'monitoring' or non-blank discon
qa_d201_Locations_without_coordinates	critical		8	07/16/2008 15:43	Sampled locations without coordinate records
qa_d243_Locations_missing_sampling_events	information		1297	07/16/2008 15:43	Unsampled locations
qa_d312_Locations_missing_site_evaluation_info	warning		24	07/16/2008 15:43	Status = 'rejected' but missing evaluation code, or has evaluation
qa_d323_Locations_without_park_region	information		399	07/16/2008 15:43	Missing park region values
qa_f111_Events_duplicates_on_location	critical		40	07/16/2008 15:43	Duplicate event records on location ID
qa_f163_Events_missing_declination	information		1	07/16/2008 15:43	Sampling events with missing declination correction values

A switch in the upper-right corner allows the user to put the form in either view mode (default) or edit mode. Upon changing to edit mode, the form changes color to provide a visual reminder that edits are possible. At this point, the query results may be modified and the remedy details may be entered in the appropriate place. If certain records in a query result set are not to be fixed for whatever reason, this also is the place to document that. The user name is automatically filled in (if it was blank) once the user types in the remedy details.

Data Validation and Quality Review Tool

Time frame of data being certified: 2008 View Edit Close

Results summary | **View and fix query results** | **Browse data tables**

Query name: qa_a102_Overview_locs_with_multiple_events **Design view** QA by

Query description: Locations with more than one associated sampling event

Remedy details:

Query results **Requery results**

	Loc_code	N	Location_type
▶	MORA.3-012	3	monitoring
	MORA.3-023	3	monitoring
	MORA.6-063	2	monitoring
	NOCA.3-035	3	monitoring
	NOCA.3-044	3	monitoring
	NOCA.3-056	2	monitoring
	NOCA.3-080	2	monitoring
	OLYM.1-006	4	monitoring
	OLYM.1-031	2	monitoring
	OLYM.1-066	2	monitoring
	OLYM.1-098	2	reconnaissance
	OLYM.1-158	2	reconnaissance
	OLYM.3-010	2	monitoring
	OLYM.3-027	2	monitoring
	OLYM.3-057	2	monitoring
	OLYM.3-074	2	monitoring
	OLYM.3-080	2	monitoring

Data Validation and Quality Review Tool

Time frame of data being certified: 2008 View Edit Close

Results summary | **View and fix query results** | **Browse data tables**

Query name: qa_a102_Overview_locs_with_multiple_events **Design view** QA by Boetsch_John 07/17/2008

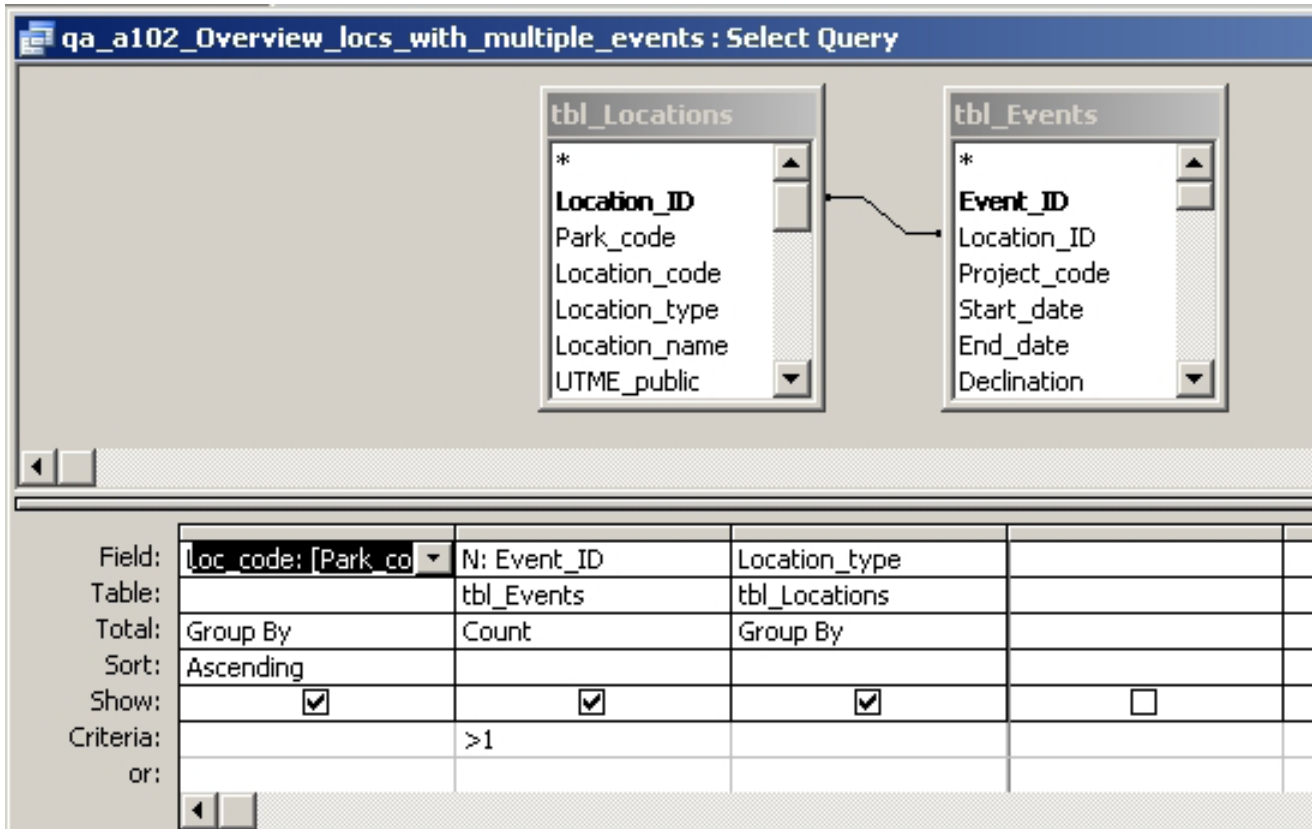
Query description: Locations with more than one associated sampling event

Remedy details: NOCA.3-012 was sampled a second time ...

Query results **Requery results**

	Loc_code	N	Location_type
▶	MORA.3-012	3	monitoring
	MORA.3-023	3	monitoring

Certain queries, due to their structural complexity, cannot be edited directly. Other queries may not contain all fields the user may want to see in order to make the best decision about whether and how to edit a given record. In such cases, the user may opt to view and/or edit data directly in the data tables. To facilitate this process, the “Browse Data Tables” page on the form can be used to open the table directly for viewing and editing as needed.



Important: As with all edits performed during the quality review, these types of direct edits in the data tables should be made with extreme care as the validation checks that are built into the front-end data entry forms are not present in the tables themselves. It is possible, therefore, to make edits to the tables that may result in a loss of data integrity and quality. While the automated queries are intended to check for these, it is not possible to check for every possible error combination.

Note: Whenever making quality review edits – whether through a query or directly in a table – the user should remember to update the Updated_date and Updated_by fields to the current date and the current user name.

Generating Output for the Certification Report

The first page of the quality review form has a button labeled “View summary report”. This button opens the formatted information for each query, the last run time, the number of records returned at last run time, a description and any remedy details that were typed in by the user. This report can be exported from the database and included as an attachment to the certification report by either hitting File > Export on the Microsoft® Access menu, or by right clicking on the report object and selecting Export. Select ‘Rich Text Format (*.rtf)’ to retain formatting to facilitate importing it into the certification report in Microsoft® Word.

<u>Quality Assurance and Data Validation Results</u>				Data season year/range	2008	Report run time	07/17/2008 11:52
Query name	Type	N Records	Query description	Remedy details	QA by		
1 qa_al02_Overview_locs_with_multiple_events	warning	18	Locations with more than one associated sampling event	NOCA.3-012 was sampled a second time ...	Boetsch_John		
2 qa_al13_Overview_sampling_visit_summary	information	6	Number of locations visited at each park, grouped by location type				
3 qa_al23_Overview_locations_visited	information	527	Full list of locations visited at each park				
4 qa_al33_Overview_monitoring_locations_visite	information	55	List of monitoring locations visited at each park				
5 qa_a203_Sampling_event_date_ranges	information	3	Returns the earliest and latest sample dates in the data set				
6 qa_a213_Quality_assurance_status	information	11	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data set				
7 qa_a#02_Unverified_events	warning	526	List of unverified sampling events in the data set				
8 qa_bl01_Strata_missing_critical_info	critical	0	Missing park code, project code, stratification date, stratum name, or stratum definition				
9 qa_bl11_Strata_duplicate_records	critical	0	Duplicate records on park code, project code, stratification date, and stratum name				
10 qa_bl21_Strata_illogical_dates	critical	0	Stratum record updated date prior to created date				
11 qa_dl01_Locations_missing_critical_info	critical	0	Missing park code, location code, location type, or firing order				
12 qa_dl11_Locations_park_inconsistencies	critical	0	Park code inconsistent with strata table - may be assigned to wrong stratum				
13 qa_dl21_Locations_duplicates_on_park_and_lo	critical	0	Duplicate records on park code and location code				
14 qa_dl33_Locations_duplicates_on_park_and_lo	information	360	Duplicate records on park code and loc name				
15 qa_dl42_Locations_missing_panel_info	warning	6	Active sample locations without a panel type, or panel name where panel type is 'annual'				
16 qa_dl52_Locations_missing_establishment_date	warning	19	Sampled locations with loc type = 'monitoring' or non-blank discontinued dates, but without establishment dates				

Completing Data Certification

Data certification is a benchmark in the project information management process that indicates that: (1) the data are complete for the period of record; (2) they have undergone and passed the quality assurance checks; and (3) they are appropriately documented and in a condition for archiving, posting, and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies that may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is primarily responsible for completing a NCCN Project Data Certification Form, available on the NCCN website. This brief form and the certified data should be submitted according to the timeline in [Table 6: Yearly Project Task List](#). Refer to [SOP 26: Product Delivery Specifications](#) for delivery instructions.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 25: Metadata Development

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all NCCN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized.

Updated metadata are a required deliverable that should accompany each season's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years then only need to be updated to reflect changes in contact information and taxonomic conventions, to include recent publications, to update data disposition and quality descriptions, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for creating, parsing and posting the metadata record are found in NCCN Metadata Development Guidelines (North Coast and Cascades Network, 2006). The general flow is as follows:

1. After the annual data quality review has been performed and the data are ready for certification, the Project Lead (or a designee) updates the Metadata Interview Form.
 - a. The Metadata Interview Form greatly facilitates metadata creation by structuring the required information into a logical arrangement of 15 main questions, many with additional sub-questions.
 - b. The first year, a new copy of the NCCN Metadata Interview Form should be downloaded. Otherwise the form from the previous year can be used as a starting point, in which case the Track Changes tool in Microsoft® Word should be activated in order to make edits obvious to the person who will be updating the XML record.
 - c. Complete the Metadata Interview Form and maintain it in the project workspace. Much of the interview form can be filled out by cutting and pasting material from other documents (for example, reports, protocol narrative sections, and SOPs).
 - d. The Data Manager can help answer questions about the Metadata Interview Form.
2. Deliver the completed interview form to the Data Manager according to [SOP 26: Product Delivery Specifications](#).
3. The Data Manager (or GIS Specialist for spatial data) will then extract the information from the interview form and use it to create and update an FGDC- and NPS-compliant metadata record in XML format. Specific guidance for creating the XML record is contained in NCCN Metadata Development Guidelines (North Coast and Cascades Network, 2006).
4. The Data Manager will post the record and the certified data to the NPS Data Store, and maintain a local copy of the XML file for subsequent updates. The NPS Data Store has help files to guide the upload process.
5. The Project Lead should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

Identifying Sensitive Information

Part of metadata development includes determining whether or not the data include any sensitive information, which is partly defined as the specific locations of rare, threatened, or endangered species. Prior to completing the Metadata Interview Form, the NPS Lead and Project Lead should work together to identify any sensitive information in the data after first consulting [SOP 27: Sensitive Information Procedures](#). Their findings may be documented and communicated to the Data Manager through the Metadata Interview Form.

Reference Cited

North Coast and Cascades Network, 2006, Metadata Development Guidelines: USDI National Park Service. Available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 26: Product Delivery Specifications

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP provides details on the process of submitting completed data sets, reports, and other project deliverables. Prior to submitting digital products, files should be named according to the naming conventions appropriate to each product type (see below for general naming conventions).

Overview

All digital file submissions that are sent by email should be accompanied by a product submission form, which briefly captures the following information about the products:

- Submission date
- Name of the person submitting the product(s)
- Name and file format of each product
- Indication of whether or not each product contains sensitive information (see [SOP 27: Sensitive Information Procedures](#) for more detail).

This form can be downloaded from the NCCN website or obtained from the Data Manager. People who submit digital files directly to the NCCN Digital Library will be prompted for the same information, and so a submission form is not required.

Upon notification and/or receipt of the completed products, the Data Manager or GIS Specialist will check them into the NCCN project tracking application.

Product Delivery Schedule and Specifications

Deliverable Product	Primary Responsibility	Target Date	Instructions
Field season report	Field Crew Lead	September 15 of the same year	Upload digital file in MS Word format to the NCCN Digital Library ¹ submissions folder.
Raw GPS data files	Field Crew Lead	September 15 of the same year	Zip and send all digital files to the GIS Specialist.
Processed GPS data files	GIS Specialist	September 15 of the same year	Zip and upload raw and processed files to the NCCN Digital Library ¹ .
Digital photographs	Project Lead	November 30 of the same year	Organize, name and maintain photographic images in the project workspace according to SOP 20: Photographic Image Processing and Management .
Certified working database	Project Lead	November 30 of the same year	Refer to the following section on delivering certified data and related materials.
Certified geospatial data	Project Lead with GIS Specialist		
Data certification report	Project Lead		
Metadata interview form	Project Lead		
Full metadata (parsed XML)	Data Manager and GIS Specialist	March 15 of the following year	Upload the parsed XML record to the NPS Data Store ² , and store in the NCCN Digital Library ¹ .
Annual I&M report	Project Lead	March 31 of the following year	Refer to the following section on reports and publications.
7-year analysis report	Data Analyst	Every 7 years by Sept. 1 of the following year	
Other publications	NPS Lead, Project Lead, Data Analyst	as completed	
Voucher specimens	Project Lead and Park Plant Ecologists	September 15 of the following year	Deliver to local park curatorial facilities. Park curator enters into ANCS+.
Field data forms	Project Lead	Every 8 years after initial data collection, by April 30 of the following year	Scan original, marked-up field forms as PDF files and upload these to the NCCN Digital Library ¹ submissions folder. Originals go to the Park Curator for archival.
Other records	Project Lead	review for retention every January	Organize and send analog files to Park Curator for archival. Digital files that are slated for permanent retention should be uploaded to the NCCN Digital Library. Retain or dispose of records following NPS Director's Order 19 ³ .

¹ The NCCN Digital Library is a hierarchical digital filing system stored on the NCCN file servers (Boetsch and others, 2005). Network users have read-only access to these files, except where information sensitivity may preclude general access.

² NPS Data Store is a clearinghouse for natural resource data and metadata (<http://science.nature.nps.gov/nrdata>). Only non-sensitive information is posted to NPS Data Store. Refer to [SOP 27: Sensitive Information Procedures](#) for details.

³ NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: <http://data2.itc.nps.gov/npspolicy/DOrders.cfm>.

Specific Instructions for Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates that: (1) the data are complete for the period of record; (2) they have undergone and passed the quality assurance checks; and (3) that they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. For more information refer to [SOP 24: Data Quality Review and Certification](#).

The following deliverables should be delivered as a package:

- *Certified working database* – Database in Microsoft® Access format containing data for the current season that has been through the quality assurance checks documented in [SOP 24: Data Quality Review and Certification](#).
- *Certified geospatial data* – GIS themes in ESRI coverage or shapefile format. Refer to NCCN GIS Development Guidelines (North Coast and Cascades Network, 2006) and NCCN GIS Product Specifications (North Coast and Cascades Network, 2005a) for more information.
- *Data certification report* – A brief questionnaire in Microsoft® Word that describes the certified data product(s) being submitted. A template form is available on the NCCN website at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm.
- *Metadata interview form* – The metadata interview form is a Microsoft® Word questionnaire that greatly facilitates metadata creation. It is available on the NCCN website at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. For more details, refer to [SOP 25: Metadata Development](#).

After the quality review is completed, the Project Lead should package the certification materials for delivery as follows:

1. Open the certified back-end database file and compact it (in Microsoft® Access, Tools > Database Utilities > Compact and Repair Database). This will make the file size much smaller. Back-end files are typically indicated with the letters “_be” in the name (for example, Forest_Vegetation_VCa02_be_2007.mdb).
2. Rename the certified back-end file with the project code (“VCa02”), the year or span of years for the data being certified, and the word “certified”. For example: VCa02_2007_certified.mdb.
3. Create a compressed file (using WinZip® or similar software) and add the back-end database file to that file.

Note: The front-end application does not contain project data and as such should not be included in the delivery file.
4. Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the naming conventions described elsewhere in this document.
5. Add any geospatial data files that aren’t already in the possession of the GIS Specialist. Geospatial data files should be developed and named according to NCCN GIS Naming Conventions (North Coast and Cascades Network, 2005b).
6. Upload the compressed file containing all certification materials to the new submissions folder of the NCCN Digital Library. If the Project Lead does not have intranet access to the NCCN Digital Library, then certification materials should be delivered as follows:
 - a. If the compressed file is under 5 mb in size, it may be delivered directly to the NPS Lead and Data Manager by email.
 - b. If the compressed file is larger than 5 mb, it should be copied to a CD or DVD and delivered in this manner. Under no circumstances should products containing sensitive information be posted to an FTP site or other unsecured web portal (refer to [SOP 27: Sensitive Information Procedures](#) for more information).
7. Notify the Data Manager and Project Lead by email that the certification materials have been uploaded or otherwise sent.

Upon receiving the certification materials, the Data Manager will:

 1. Review them for completeness and work with the Project Lead if there are any questions.
 2. Notify the GIS Specialist if any geospatial data are submitted. The GIS Specialist will then review the data, and update any project GIS data sets and metadata accordingly.
 3. Check in the delivered products using the NCCN project tracking application.
 4. Store the certified products together in the NCCN Digital Library.
 5. Upload the certified data to the master project database.
 6. Notify the Project Lead that the year’s data have been uploaded and processed successfully. The Project Lead may then proceed with data summarization, analysis and reporting.

7. Develop, parse and post the XML metadata record to the NPS Data Store.
8. After a holding period of 2 years, the Data Manager will upload the certified data to the NPS Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. See [SOP 28: Product Posting and Distribution](#).

Specific Instructions for Reports and Publications

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft® Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Report template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report template. Instructions for acquiring a series number and other information about NPS publication standards can be found at: <http://www.nature.nps.gov/publications/NRPM/index.cfm>. In general, the procedures for reports and publications are as follows:

1. The document should be formatted using the NPS Natural Resource Publications template. Formatting according to NPS standards is easiest when using the template from the very beginning, as opposed to reformatting an existing document.
2. The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the appropriate project work group. The Network Coordinator also will review all annual reports for completeness and compliance with I&M standards and expectations.
3. Upon completing the peer review, acquire a publication series number from the NPS Technical Information Center or the appropriate local or regional key official (currently the Regional I&M Coordinator).
4. Upload the file in PDF and Microsoft® Word formats to the NCCN Digital Library submissions folder.
5. Send a printout to each Park Curator.
6. The Data Manager or a designee will create a bibliographic record and upload the PDF document to NatureBib according to document sensitivity.

Naming Conventions

In all cases, file names should follow these guidelines:

- No spaces or special characters in the file name.
- Use the underbar (“_”) character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.
- As appropriate, include the project code (for example, “VCa02”), network code (“NCCN”) or park code, and year in the file name.

Examples:

- NCCN_VCa02_2007_Annual_report.pdf
- NCCN_VCa02_2007_Field_season_report.doc
- NCCN_VCa02_2007_Certification_report.doc

References Cited

- Boetsch, J.R., Christoe, B., and Holmes, R.E., 2005, Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program: USDI National Park Service, Port Angeles, WA, 88 p. Available at: <http://www1.nature.nps.gov/im/units/nccn/datamgmt.cfm>
- North Coast and Cascades Network – National Park Service, 2005a, GIS Product Specifications: USDI National Park Service. Available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm
- North Coast and Cascades Network – National Park Service, 2005b, GIS Naming Conventions: USDI National Park Service. Available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm
- North Coast and Cascades Network, 2006, GIS Development Guidelines: USDI National Park Service. Available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 27: Sensitive Information Procedures

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Overview

Although it is the general NPS policy to share information widely, the NPS also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to caves, archeological sites, tribal information, and rare plant and animal species. Therefore, information will be withheld when the NPS foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA). The National Parks Omnibus Management Act, Section 207, 16 U.S.C. 5937, is interpreted to prohibit the release of information regarding the “nature or specific location” of certain cultural and natural resources in the national park system. Additional details and information about the legal basis for this policy are in the NPS Management Policies (National Park Service 2006), and in Director’s Order #66.

These guidelines apply to all NCCN staff, cooperators, contractors, and other partners who are likely to obtain or have access to information about protected NPS resources. The NPS Lead has primary responsibility for ensuring adequate protection of sensitive information related to this project.

The following are highlights of our strategy for protecting this information:

- *Protected resources*, in the context of the NCCN Inventory and Monitoring Program, include species that have State- or Federally-listed status, and other species deemed rare or sensitive by local park taxa experts.

- *Sensitive information* is defined as information about protected resources that may reveal the “nature or specific location” of protected resources. Such information must not be shared outside the National Park Service, unless a signed confidentiality agreement is in place.
- In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it, and if information is provided to one requesting party without a confidentiality agreement, it must be provided to anyone else who requests it.
- To share information as broadly as legally possible, and to provide a consistent, tractable approach for handling sensitive information, the following shall apply if a project is likely to collect and store sensitive information:
 - Random coordinate offsets of up to 2 km for data collection locations, and
 - Removal of data fields from the released copy that are likely to contain sensitive information.

What Kinds of Information Can and Can Not Be Shared?

Do not share: Project staff and cooperators should not share any information outside NPS that reveals details about the “nature or specific location” of protected resources, unless a confidentiality agreement is in place. Specifically, the

following information should be omitted from shared copies of all data, presentations, reports, or other published forms of information.

- Exact coordinates—Instead, public coordinates are to be generated that include a random offset azimuth and distance. These offset coordinates can be shared freely.
- Other descriptive location data—Examples may include travel descriptions, location descriptions, or other fields that contain information that may reveal the specific location of the protected resource(s).
- Protected resource observations at disclosed locations—If specific location information has already been made publicly available, the occurrence of protected resources at that location cannot be shared outside NPS without a confidentiality agreement. For example, if the exact coordinates for a monitoring station location are posted to a website or put into a publication, then at a later point in time a spotted owl nest is observed at that monitoring station, that nest cannot be mentioned or referred to in any report, presentation, data set, or publication that will be shared outside NPS.

Do share: All other information about the protected resource(s) may be freely shared, so long as the information does not reveal details about the “nature or specific location” of the protected resource(s) that are not already readily available to the general public in some form (for example, other published material). Species tallies and other types of data presentations that do not disclose the precise locations of protected resources may be shared, unless by indicating the presence of the species the specific location also is revealed (i.e., in the case of a small park).

Details for Specific Products

Whenever products such as databases and reports are being generated, handled and stored, they should be created explicitly for one of the following purposes:

1. *Public or general-use* — Intended for general distribution, sharing with cooperators, or posting to public websites. They may be derived from products that contain sensitive information so long as the sensitive information is either removed or otherwise rendered in a manner consistent with other guidance in this document.
2. *Internal NPS use* — These are products that contain sensitive information and should be stored and distributed only in a manner that ensures their continued protection. These products should clearly indicate that they are solely for internal NPS use by containing the phrase: “Internal NPS Use Only – Not For Release.” These products can only be shared within NPS or in cases where a confidentiality agreement is in place. They do not need to be revised in a way that conceals the location of protected resources.

Data Sets

To create a copy of a data set that will be posted or shared outside NPS:

1. Make sure the public offset coordinates have been populated for each sample or observation location in `tbl_Locations`.
2. Remove `tbl_Coordinates` and `tbl_GPS_Info`.
3. Delete the following database objects to ensure consistent omission of fields that may contain specific, identifying information about locations of protected resources:
 - a. `tbl_Sites.Site_notes`
 - b. `tbl_Locations.Travel_notes`
 - c. `tbl_Locations.Elevation`, `Elev_units`, `Elev_source`
 - d. `tbl_Locations.Location_desc`
 - e. `tbl_Locations.Location_notes`

The local, master copy of the database contains the exact coordinates and all data fields. The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Maps and Other GIS Output

General use maps and other geographic representations of observation data that will be released or shared outside NPS should be rendered using offset coordinates, and should only be rendered at a scale that does not reveal their exact position (for example, 1:100,000 maximum scale).

If a large-scale, close-up map is to be created using exact coordinates (for example, for field crew navigation, etc.), the map should be clearly marked with the following phrase: “Internal NPS Use Only — Not For Release.”

The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Presentations and Reports

Public or general-use reports and presentations should adhere to the following guidelines:

1. Do not list exact coordinates or specific location information in any text, figure, table, or graphic in the report or presentation. If a list of coordinates is necessary, use only offset coordinates and clearly indicate that coordinates have been purposely offset to protect the resource(s) as required by law and NPS policy.
2. Use only general use maps as specified in the section on maps and other GIS output.

If a report is intended for internal use only, these restrictions do not apply. However, each page of the report should be clearly marked with the following phrase: “Internal NPS Use Only — Not For Release.”

Voucher Specimens

Specimens of protected taxa should only be collected as allowed by law. Labels for specimens should be clearly labeled as containing sensitive information by containing the following phrase: “Internal NPS Use Only — Not For Release.” These specimens should be stored separately from other specimens to prevent unintended access by visitors. As with any sensitive information, a confidentiality agreement should be in place prior to sending these specimens to another non-NPS cooperator or collection.

Procedures for Coordinate Offsets

1. Process GPS data, upload into the database, and finalize coordinate data records. Update tbl_Coordinates.Is_best as appropriate, especially where there is more than one set of coordinates per sample location.
2. Set the minimum and maximum offset distances (project-specific, typically up to 2 km).
3. Apply a random offset and random azimuth to each unique set of coordinates.
4. Coordinates may then be either rounded or truncated so the UTM values end in zeros to give a visual cue that the values are not actual coordinates.
5. Do not apply independent offsets to clustered or otherwise linked sample locations (for example, multiple sample points along a transect). Instead, either apply a single offset to the cluster so they all remain clustered after the offset is applied, or apply an offset to only one of the points in the cluster (for example, the transect origin) and store the result in the public coordinates for each point in that cluster.
6. These “public” coordinates are then the only ones to be shared outside NPS — including all published maps, reports, publications, presentations, and distribution copies of the data set — in the absence of a confidentiality agreement.

The following components can be used to create individual offsets rounded to the nearest 100 m in Microsoft® Excel:

- Angle = rand() * 359
- Distance = ((Max_offset – Min_offset) * rand() + Min_offset)
- Public_UTME = Round(UTME_final + (Distance * cos(radians(Angle – 90))), -2)
- Public_UTMN = Round(UTMN_final + (Distance * sin(radians(Angle + 90))), -2)

Sharing Sensitive Information

Note: Refer to [SOP 28: Product Posting and Distribution](#) for a more complete description of how to post and distribute products, and to keep a log of data requests.

No sensitive information (information about the specific nature or location of protected resources) may be posted to the NPS Data Store or another publicly accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Only products that are intended for public/general use may be posted to public websites and clearinghouses—these may not contain sensitive information.

Responding to Data Requests

If requests for distribution of products containing sensitive information are initiated by the NPS, by another Federal agency, or by another partner organization (for example, a research scientist at a university), the unedited product (the full data set that includes sensitive information) may only be shared after a confidentiality agreement is established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. All data requests will be tracked according to procedures in [SOP 28: Product Posting and Distribution](#).

Once a confidentiality agreement is in place, products containing sensitive information may be shared following these guidelines:

- Always clearly indicate in accompanying correspondence that the products contain sensitive information, and specify which products contain sensitive information.
- Indicate in all correspondence that products containing sensitive information should be stored and maintained separately from non-sensitive information, and protected from accidental release or re-distribution.
- Indicate that NPS retains all distribution rights; copies of the data should not be redistributed by anyone but NPS.
- Include the following standard disclaimer in a text file with all digital media upon distribution: “The following files contain protected information. This information was provided by the National Park Service under a confidentiality agreement. It is not to be published, handled, re-distributed, or used in a manner inconsistent with that agreement.” The text file also should specify the file(s) containing sensitive information.

- If the products are being sent on physical media (for example, CD or DVD), the media should be marked in such a way that clearly indicates that media contains sensitive information provided by the National Park Service.

Confidentiality Agreements

Confidentiality agreements may be created between NPS and another organization or individual to ensure that protected information is not inadvertently released. When contracts or other agreements with a non-federal partner do not include a specific provision to prevent the release of protected information, the written document must include the following standard Confidentiality Agreement:

Confidentiality Agreement — I agree to keep confidential any protected information that I may develop or otherwise acquire as part of my work with the National Park Service. I understand that with regard to protected information, I am an agent of the National Park Service and must not release that information. I also understand that by law I may not share protected information with anyone through any means except as specifically authorized by the National Park Service. I understand that protected information concerns the nature and specific location of endangered, threatened, rare, commercially valuable, mineral, paleontological, or cultural patrimony resources such as threatened or endangered species, rare features, archeological sites, museum collections, caves, fossil sites, gemstones, and sacred ceremonial sites. Lastly, I understand that protected information must not be inadvertently disclosed through any means including websites, maps, scientific articles, presentation, and speeches.

Note: Certain States, including the State of Washington, have Sunshine laws that do not have exemptions for sensitive information. NPS should not create confidentiality agreements or share sensitive information with these States without first seeking the advice of an NPS solicitor.

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The NPS Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Reference Cited

National Park Service, 2006, Management policies: Accessed February 6, 2007, <http://www.nps.gov/policy/MP2006.pdf>

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 28: Product Posting and Distribution

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

This SOP provides details on the process of posting and otherwise distributing finalized data, reports, and other project deliverables. For a complete list of project deliverables, refer to [SOP 26: Product Delivery Specifications](#).

Product Posting

Once digital products have been delivered and processed, the following steps will be taken by the Data Manager to make them generally available:

1. Full metadata records will be posted to the NPS Data Store, which is the NPS clearinghouse for natural resource data and metadata that is available to the public at: <http://science.nature.nps.gov/nrdata>. Refer to the website for upload instructions.
2. A record for reports and other publications will be created in NatureBib, which is the NPS bibliographic database (<http://www.nature.nps.gov/nrbib/index.htm>). The digital report file in PDF format will then be uploaded and linked to the NatureBib record. Refer to the NatureBib website for record creation and upload instructions.
3. Species observations will be extracted from the database and entered into NPSpecies, which is the NPS database and application for maintaining park-specific species lists and observation data (<http://science.nature.nps.gov/im/apps/npspp>).

These three applications serve as the primary mechanisms for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

Holding Period for Project Data

To protect professional authorship priority and to provide sufficient time to complete quality assurance measures, there is a 2-year holding period before posting or otherwise distributing finalized data. This means that certified data sets are first posted to publicly accessible websites (that is, the NPS Data Store) approximately 24 months after they are collected (for example, data collected in June 2006 becomes generally available through the NPS Data Store in June 2008). In certain circumstances, and at the discretion of the NPS Lead and Park Biologists, data may be shared before a full 2 years have elapsed.

Note: This hold only applies to raw data; all metadata, reports, or other products are to be posted to NPS clearinghouses in a timely manner as they are received and processed.

Responding to Data Requests

Occasionally, a park or project staff member may be contacted directly regarding a specific data request from another agency, organization, scientist, or from a member of the general public. The following points should be considered when responding to data requests:

- NPS is the originator and steward of the data, and the NPS Inventory and Monitoring Program should be acknowledged in any professional publication using the data.
- NPS retains distribution rights; copies of the data should not be redistributed by anyone but NPS.
- Data that project staff members and cooperators collect using public funds are public records and as such cannot be considered personal or professional intellectual property.
- No sensitive information (for example, information about the specific nature or location of protected resources) may be posted to the NPS Data Store or another publicly accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to the section in this document about sensitive information and also to [SOP 27: Sensitive Information Procedures](#).
- For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The NPS Lead will handle all data requests as follows:

1. Discuss the request with other Park Biologists as necessary to make those with a need to know aware of the request and, if necessary, to work together on a response.
2. Notify the Data Manager of the request if s/he is needed to facilitate fulfilling the request in some manner.
3. Respond to the request in an official email or memorandum.
4. In the response, refer the requestor to the NPS Data Store (<http://science.nature.nps.gov/nrdata>), so they may download the necessary data and/or metadata. If the request can not be fulfilled in that manner – either because the data products have not been posted yet, or because the requested data include sensitive information – work with the Data Manager to discuss options for fulfilling the request directly (for example, burning data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.

5. If the request is for a document, it is recommended that documents be converted to PDF format prior to distributing it.
6. If the request is for data that may reveal the location of protected resources, refer to the section in this document about sensitive information and also to [SOP 27: Sensitive Information Procedures](#).
7. After responding, provide the following information to the Data Manager, who will maintain a log of all requests in the NCCN Project Tracking database:
 - a. Name and affiliation of requestor
 - b. Request date
 - c. Nature of request
 - d. Responder
 - e. Response date
 - f. Nature of response
 - g. List of specific data sets and products sent (if any)

All official FOIA requests will be handled according to NPS policy. The NPS Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Special Procedures for Sensitive Information

Products that have been identified upon delivery by the Project Lead and/or NPS Lead as containing sensitive information will normally be revised into a form that does not disclose the locations of protected resources—most often by removing specific coordinates and only providing coordinates that include a random offset to indicate the general locality of the occurrence. If this kind of measure is not a sufficient safeguard given the nature of the product or the protected resource in question, the product(s) will withheld from posting and distribution.

If requests for distribution of the unedited version of products are initiated by the NPS, by another Federal agency, or by another partner organization (for example, a research scientist at a university), the unedited product (for example, the full data set that includes sensitive information) may only be shared after a confidentiality agreement is established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to [SOP 27: Sensitive Information Procedures](#) for more information.

Forest Vegetation Monitoring Protocol for National Parks in the North Coast and Cascades Network

Standard Operating Procedure (SOP) 29: Revising the Protocol

Revision History Log:

Revision Date	Author	Changes Made	Reason for Change

Overview

This SOP explains how to make and track changes to the NCCN Forest Vegetation Monitoring Protocol, including its accompanying SOPs. Project staff should refer to this SOP whenever edits are necessary, and should be familiar with the protocol versioning system in order to identify and use the most current versions of the protocol documents. Required revisions should be made in a timely manner to minimize disruptions to project planning and operations.

This protocol attempts to incorporate the best and most cost-effective methods for monitoring and information management. As new technologies, methods, and equipment become available, this protocol will be updated as appropriate, by balancing current best practices against the continuity of protocol information. All changes will be made in a timely manner with the appropriate level of review.

All edits require review for clarity and technical soundness. Small changes to existing documents – for example, formatting, simple clarification of existing content, small changes in the task schedule or project budget, or general updates to information management handling SOPs – may be reviewed in-house by project cooperators and NCCN staff. However, changes to data collection or analysis techniques, sampling design, or response design will trigger an outside review to be coordinated by the Pacific West Regional Office.

Procedures

1. Discuss proposed changes with other project staff prior to making modifications. It is important to consult with the Data Manager prior to making changes because certain types of changes may jeopardize data set integrity unless they are planned and executed with data set integrity in mind. Because certain changes also may require altering the database structure or functionality, advance notice of changes is important to minimize disruptions to project operations. Consensus should be reached on who will be making the changes and in what timeframe.
2. Make the agreed-upon changes in the current, primary version of the appropriate protocol document (that is, not the most recent versioned copy – see below).

Note: The protocol is split into separate documents for each appendix and SOP. A change in one document also may necessitate other changes elsewhere in the protocol. For example, a change in the narrative may require changes to several SOPs; similarly renumbering an SOP may mean changing document references in several other documents. The project task list and other appendixes also may need to be updated to reflect changes in timing or responsibilities for the various project tasks.

3. Document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes only in the document being edited (that is, if there is a change to an SOP, log those changes only in that document). Record the date of the changes (that is, the date on which all changes were finalized), author of the revision, describe the change and cite the paragraph(s) and page(s) where changes are made, and briefly indicate the reason for making the changes.
4. Circulate the changed document for internal review among project staff and cooperators.
5. Upon ratification and finalizing changes:
 - a. Ensure that the version date (last saved date field code in the document header) and file name (field code in the document footer) are updated properly throughout the document.
 - b. Make a copy of each changed file to the protocol archive folder (that is, a subfolder under the Protocol folder in the project workspace).
 - c. The copied files should be renamed by appending the revision date in YYYYMMDD format. In this manner, the revision date becomes the version number, and this copy becomes the 'versioned' copy to be archived and distributed.
 - d. The current, primary version of the document (that is, not the versioned document just copied and renamed) does not have a date stamp associated with it.
 - e. To avoid unplanned edits to the document, reset the document to read-only by right-clicking on the document in Windows Explorer and checking the appropriate box in the Properties popup.
 - f. Inform the Data Manager so the new version number(s) can be incorporated into the project metadata.
6. As appropriate, create PDF files of the versioned documents to post to the Internet and share with others. These PDF files should have the same name and be made from the versioned copy of the file.
7. Post the versioned copies of revised documents to the NCCN Digital Library and forward copies to all individuals who had been using a previous version of the affected document.

Example of Document Revision

1. SOP_2_Records_Mgmt.doc is revised on October 31, 2008, and circulated for review.
2. Changes are accepted by the group and changes are finalized on November 6, 2008.
3. The revised SOP is:
 - a. Copied into the Archive folder.
 - b. That versioned copy is renamed as SOP_2_Records_Mgmt_20081106.doc.
 - c. Both the current, primary version and the versioned copy are set to read-only.
 - d. A PDF of the document is created from the versioned copy and named SOP_2_Records_Mgmt_20081106.pdf.
 - e. Both the PDF and the versioned document are uploaded to the NCCN Digital Library.
 - f. The PDF is sent to any cooperators.

Appendix A. Cover Estimation Method Comparison

By Andrea Woodward, U.S. Geological Survey; Steve Acker, National Park Service Olympic National Park; and Karen Hutten, U.S. Geological Survey

Introduction

Cover of herbaceous vegetation is frequently estimated in 1 percent increments using gridded 1 m quadrats (Elzinga and others, 1998), while larger plots are often estimated in cover classes of 10 percent or more with cover reported as the mid-point of the class (Grieg-Smith 1983, Elzinga and others, 1998). We wanted to investigate whether cover of ferns and shrubs in 5 m quadrats could be effectively estimated in 1 percent increments. While estimating 1 percent increments may take longer than classes, the statistical analysis is more straightforward because 1 percent increments can be treated as a continuous variable. Also, 1 percent increments may be less sensitive to observer variation. For example, if the estimates of two observers varied by only a few percent, but the difference straddled a class boundary, the difference would seem larger when recorded in classes. This would be especially true of large classes compared with small. Finally, it should be easier to detect change with small increments rather than large ones. However, all of the potential advantages of small increments would be lost if observers cannot repeatably estimate cover to 1% in large un-gridded plots.

Methods

We marked 10 5-m plots in forest vegetation near the ranger station at Marblemount, North Cascades National Park. Four plots were used to train observers and six were used to compare observer variation. The species composition of the six test plots all included some amount of *Gaultheria shallon* (low growing shrub), *Vaccinium parvifolium* (tall shrub), and *Polystichum munitum* (large fern). The training plots included these species or species with similar growth forms. Prior to testing, all plots were gridded into 1-m quadrats and cover was estimated for each one separately, then combined to produce an estimate for the whole plot. We consider this to be the most accurate estimate of cover for each plot.

The observers were 12 seasonal employees hired to work on a vegetation project that did not include estimating cover in marked quadrats. While they had not been previously trained to estimate cover, they all had some experience measuring vegetation.

Training was conducted as a group, with each person making an independent estimate for each plant species, then reporting their estimate to the group. Cover was defined as a polygon connecting the outer tips of the leaves for each plant, and observers were not allowed to enter the plots. We repeated this for the four training plots. Differences among estimates and from the estimate based on 1-m quadrats were discussed so those with poor estimates could learn techniques from those with better estimates. This amount of training would be considered insufficient for a crew hired for estimating cover, but we were facing time constraints. This exercise can be seen as a worst case scenario for training.

Our experience indicates that teams of observers make less variable estimates than individual observers. Consequently, we had observers work in two-person teams to estimate cover in the six test plots and no more than one team worked on a plot at a time. Each team estimated cover for the three species in each plot twice, once in 1 percent increments and once in classes (0–1, 2–5, 6–15, 16–25, 26–35 ... 86–95, 96–100 percent cover). To minimize the effect of memory to influence the second estimate for each plot, we had each team repeat the plots on the day following the first estimate. We had each team follow a different schedule (table A1) to minimize confounding among day, team and type of estimate, while minimizing the number of times each team switched methods between consecutive plots.

Table A1. Schedule followed by crews for methods and plots on Days 1 and 2 of the exercise.

[C indicates class estimates; % indicates estimates to 1%]

	Day 1						Day 2					
	Plot						Plot					
Team	1	2	3	4	5	6	1	2	3	4	5	6
A	%	%	%	C	C	C	C	C	C	%	%	%
B	C	%	%	%	C	C	%	C	C	C	%	%
C	C	C	%	%	%	C	%	%	C	C	C	%
D	C	C	C	%	%	%	%	%	%	C	C	C
E	%	C	C	C	%	%	C	%	%	%	C	C
F	%	%	C	C	C	%	C	C	%	%	%	C

Analysis

We conducted four analyses:

- Comparison of team variance for 1 percent versus class estimates for each species and combining estimates across all three species using 2-tailed paired *t*-tests to see which method had the greatest variance, and therefore poorer ability to detect trend.
- Comparison of difference of observer estimates from estimates based on gridding the plots into 1-m quadrats in absolute amounts using 2-tailed paired *t*-tests. If we consider the 1 m estimates to be as close to ‘true’ as possible, this tests compares the ability of the methods to estimate the ‘true’ cover.
- Comparison of difference among observer estimates from 1-m quadrat estimates as a percent of the 1-m quadrat estimates using 2-tailed paired *t*-tests. This was done to correct for errors being larger for large cover values.
- Description of variance among observers at fourth training plot to determine the maximum variance allowable among trainees to set a training standard.

Analyses were conducted using Microsoft® Excel.

Results

We consider the estimates from 1 m quadrats to be the most accurate (table A2). The two other methods both over estimated cover for *G. shallon* and *V. parvifolium* and underestimated for *P. munitum*. For all species, estimates in classes averaged higher than estimates in 1 percent increments. Consequently, the 1 percent estimates were closer to the 1 m quadrat estimates than class estimates for *G. shallon* and *V. parvifolium* and farther for *P. munitum*.

The comparison of variance of estimates for each species using 1 percent versus class estimates (table A3) shows no significant differences.

The comparison of the difference of observer estimates from 1 m quadrat estimates among teams for 1 percent versus class estimates (table A4) shows a significant difference ($p < 0.05$) for *G. shallon*. Estimates to 1 percent were closer to the plot mean than class estimates except for *P. munitum*.

The comparison of the difference of estimates from plot mean as a percentage of plot means among teams (table A5) shows significant differences ($p < 0.05$) for *G. shallon* and *V. parvifolium*. Values are lower for 1 percent estimates compared with class estimates except for *P. munitum*.

Standard deviations among estimates by individuals for the last training plots are 3.5 (*P. munitum*), 2.0 (*V. parvifolium* or other tall shrubs), and 0.9 (*G. shallon* or *Mahonia nervosa*).

Table A2. Cover values estimated using three methods and averaged across observers by plots.

<i>Gaultheria shallon</i>							
Plot							
	1	2	3	4	5	6	Mean
1 m quadrat	28	13	39	13	6	10	18
1% estimates	34	15	43	14	6	18	22
Class estimates	36	14	47	14	9	24	24
<i>Polystichum munitum</i>							
Plot							
	1	2	3	4	5	6	Mean
1 m quadrat	47	19	38	80	60	73	53
1% estimates	37	17	24	69	56	62	44
Class estimates	36	19	26	76	56	64	46
<i>Vaccinium parvifolium</i>							
Plot							
	1	2	3	4	5	6	Mean
1 m quadrat	4	24	5	7	4	2	7
1% estimates	5	26	5	8	6	3	9
Class estimates	5	27	7	11	6	4	10

Table A3. Comparison of variance estimates by species.

Species	N	1%	Class	p (two-tailed)	Significance
<i>Gaultheria shallon</i>	6	5.2	5.3	0.900	Not significant
<i>Polystichum munitum</i>	6	7.5	6.5	0.162	Not significant
<i>Vaccinium parvifolium</i>	6	3.1	3.6	0.574	Not significant
All species combined	18	5.3	5.1	0.827	Not significant

Table A4. Comparison of the differences between observer estimates and estimates from 1 m quadrats.

Species	N	1%	Class	p (two-tailed)	Significance
<i>Gaultheria shallon</i>	36	5.5	7.5	0.038	Significant
<i>Polystichum munitum</i>	36	9.6	8.2	0.168	Not significant
<i>Vaccinium parvifolium</i>	36	2.7	3.4	0.147	Not significant
All species combined	108	5.9	6.4	0.371	Not significant

Table A5. Comparison of differences between observer estimates and estimates from 1 m quadrats as a percentage of 1 m quadrat estimates.

Species	N	1%	Class	p (two-tailed)	Significance
<i>Gaultheria shallon</i>	36	38	54	0.038	Significant
<i>Polystichum munitum</i>	36	21	17	0.079	Not significant
<i>Vaccinium parvifolium</i>	36	38	64	0.031	Significant
All species combined	108	33	45	0.009	Significant

Discussion

Even with a relatively untrained crew, estimates in 1 percent increments did not have larger standard deviations among teams of observers than class estimates. In addition, estimates in 1 percent increments were closer to the 1 m quadrat estimates for *G. shallon* and *V. parvifolium* and across all three species than class estimates when expressed as percent of the 1 m quadrat estimate ($p < 0.05$). For these reasons, and given the advantages of using 1 percent increments to detect change using standard statistical procedures, we see no reason to use class estimates.

We found estimation of cover for *P. munitum* to be challenging. This large fern is quite visible in the plots even for observers standing on the edges, and it is easy to estimate cover when the plants are intact. However, many plants were missing fronds and it was sometimes difficult to tell which fronds were part of each fern. While standing outside of the plot, it was easy to miss connecting parts of some ferns in a polygon for the whole plant. This explains why cover estimates from 1 m quadrats, where every plant was examined in detail, were higher than either other method. It was also not intuitive that these large, and sometimes fairly empty polygons were a good reflection of the cover or influence of the plant. Consequently, we are considering redefining how to imagine polygons around ferns.

We will use the standard deviations among observers at the fourth training plot as a standard for training. We believe that with thorough training, we can achieve much higher results.

References Cited

- Elzinga, C.L., Salzer, D.W., and Willoughby, J.W., 1998, Measuring and Monitoring Plant Populations: Washington, D.C., Government Printing Office, BLM/RS/ST-98/005+1730.
- Grieg-Smith, P., 1983, Quantitative Plant Ecology, 3rd Edition: Boston, Massachusetts, Blackwell Scientific.

This page intentionally left blank.

Appendix B. Forest Vegetation Monitoring Protocol Database Documentation

The database for this project consists of three types of tables: core tables describing the “who, where and when” of data collection, project-specific tables, and lookup tables that contain domain constraints for other tables. Although core tables are based on NCCN standards, they may contain fields, domains or descriptions that have been added or altered to meet project objectives.

The database includes the following standard tables:

tbl_Strata	Stratification classes used during design and analysis
tbl_Locations	Sample locations – places where data collection occurs
tbl_Coordinates	Coordinate data for sample locations
tbl_GPS_Info	GPS information associated with sample location coordinates
tbl_Events	Data collection event for a given location
tbl_Observers	Observers for each sampling event
tbl_QA_Results	Quality assurance query results for the working data set
tbl_Edit_Log	Edit log for changes made to data after certification
tbl_Task_List	Checklist of tasks to be completed at sampling locations
tbl_Images	Images associated with sample locations

The following are project-specific data tables:

tbl_Site_Evaluation	Documentation of site evaluation
tbl_Trees	Trees associated with sample locations
tbl_Quadrat_Data	Quadrat data for species occurrence and abundance
tbl_Disturbance	Disturbance observation records at the plot scale
tbl_Subplot_Visits	Notes associated with subplot visits
tbl_Herbivory	Herbivory observation data from 5 × 5m quadrats
tbl_Saplings	Height and diameter of saplings found in 5 × 5 m quadrats
tbl_Crypto_Transects	Transects for monitoring cryptogam occurrence
tbl_Crypto_Trans_Visit	Information about visits to cryptogam monitoring logs
tbl_Crypto_Data	Cryptogam presence along transects
tbl_Crypto_Obs	Incidental cryptogam observations
tbl_Tree_Visits	Tree observation data
tbl_Cores	List of all tree cores and bark widths taken
tbl_Core_Data	Growth data obtained from each tree core

The following are a few of the more prominent, standard lookup tables:

tlu_Project_Crew	List of personnel associated with a project
tlu_Project_Taxa	List of species associated with project observations
tlu_Park_Taxa	Park-specific attributes for taxa

Data Dictionary

Required fields are denoted with an asterisk (*).

tbl_Coordinates - Coordinate data for sample locations

<u>Index</u>	<u>Index columns</u>
Coord_updated	Coord_updated
pk_tbl_Coordinates (primary)	Coord_ID
Coord_label	Coord_label
Coord_type	Coord_type
Datum	Datum
Field_coord_source	Field_coord_source
GIS_loc_ID	GIS_loc_ID
Location_ID	Location_ID
udx_Coord_index (unique)	Location_ID, Event_ID
Event_ID	Event_ID

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Coord_ID	primary *	vchar (50)	Unique identifier for each coordinate record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
GIS_loc_ID	indexed	vchar (50)	GIS feature ID for each set of coordinates, to link with geospatial layers
Location_ID	unique (FK)*	vchar (50)	Sample location
Coord_label	indexed	vchar (25)	Name of the coordinate feature (e.g., plot center, NW corner)
Is_best		bit	Indicates whether this set of coordinates is the best available for this location
UTM_east		double	Final UTM easting (zone 10N, meters), including any offsets and corrections
UTM_north		double	Final UTM northing (zone 10N, meters), including any offsets and corrections
Coord_type	indexed	vchar (20)	Coordinate type stored in UTM_east and UTM_north: target, field, post-processed
Datum	indexed <i>Default: "NAD83"</i>	vchar (5)	Datum of UTM_east and UTM_north
Est_horiz_error		double	Estimated horizontal error (meters) of UTM_east and UTM_north
Field_UTME		double	UTM easting (zone 10N) as recorded in the field
Field_UTMN		double	UTM northing (zone 10N) as recorded in the field
Field_datum		vchar (5)	Datum of field coordinates
Field_horiz_error		double	Field coordinate horizontal error (m)
Field_offset_m		double	Distance (meters) from the field coordinates to the target
	<i>Constraint: Is Null Or >=0</i>		
Field_offset_azimuth		int	Azimuth (degrees, declination corrected) from the coordinates to the target
	<i>Constraint: Is Null Or (>=0 And <=360)</i>		
Field_coord_source	indexed	vchar (12)	Field coordinate data source
GPS_file_name		vchar (50)	GPS rover file used for data downloads
GPS_model		vchar (25)	Make and model of GPS unit used to collect field coordinates
Source_map_scale		vchar (16)	Approximate scale of the source map
Source_citation		vchar (250)	Name and date of the source map
Target_UTME		double	Target UTM easting (zone 10N)
Target_UTMN		double	Target UTM northing (zone 10N)
Target_datum		vchar (5)	Target coordinate datum
	<i>Default: "NAD83"</i>		
Coordinate_notes		memo	Notes about this set of coordinates

Coord_created_date		datetime	Time stamp for record creation
	<i>Default: Now()</i>		
Coord_updated	indexed	datetime	Date of the last update to this record
Coord_updated_by		vchar (50)	Person who made the most recent edits
Event_ID	unique (FK)	vchar (50)	Sampling event of coordinate data collection

tbl Cores - List of all tree cores and bark widths taken

<u>Index</u>		<u>Index columns</u>	
Event_ID (unique)		Core_ID	
PrimaryKey (primary)		Core_ID	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Core_ID	unique *	vchar (50)	Unique identifier for each core taken <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Tree_ID	(FK)*	vchar (50)	Unique identifier for each tree record
Core_date		datetime	Date on which the core was taken
Bark_width		int	***Width of the bark: ***Specify Measurement Protocol <i>Default: 0</i>
Core_notes		vchar (100)	Notes pertaining to the core

tbl Core Data - Growth data obtained from each tree core

<u>Index</u>		<u>Index columns</u>	
Core_ID		Core_ID	
PrimaryKey (primary)		Core_ID, Year	
Year		Year	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Core_ID	primary (FK)*	vchar (50)	Unique identifier for each core taken
Year	primary *	datetime	The year that the tree ring was layed down
Ring_width		int	The width of the tree ring <i>Default: 0</i>
Ring_notes		vchar (100)	Notes pertaining to the tree ring

tbl Crypto Data - Cryptogam presence along transects

<u>Index</u>		<u>Index columns</u>	
Collection_num		Collection_num	
Event_ID		Event_ID	
Intercept		Intercept	
PrimaryKey (primary)		Transect_ID, Event_ID, Intercept, Taxon_ID	
Taxon_ID		Taxon_ID	
Transect_ID		Transect_ID	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary (FK)*	vchar (50)	Sampling event
Transect_ID	primary (FK)*	vchar (50)	Cryptogam monitoring transect
Intercept	primary *	tinyint	Observation point along the transect, in centimeters from the transect origin
Taxon_ID	primary (FK)*	vchar (50)	Cryptogam taxon
Collection_num	indexed	vchar (20)	Voucher specimen collection number
Crypto_data_notes		memo	Comments about the cryptogam observation

tbl Crypto Obs - Incidental cryptogam observations

<u>Index</u>	<u>Index columns</u>
Collection_num	Collection_num
Crypto_tree_ID	Tree_ID
Event_ID	Event_ID
PrimaryKey (primary)	Tree_ID, Event_ID, Taxon_ID
Taxon_ID	Taxon_ID

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary (FK)*	vchar (50)	Sampling event
Tree_ID	primary (FK)*	vchar (50)	Tree selected for cryptogam monitoring
Taxon_ID	primary (FK)*	vchar (50)	Cryptogam taxon
Collection_num	indexed	vchar (20)	Voucher specimen collection number
Crypto_obs_notes		memo	Comments about the cryptogam observation

tbl Crypto Transects - Transects for monitoring cryptogam occurrence

<u>Index</u>	<u>Index columns</u>
PrimaryKey (primary)	Transect_ID
Tree_or_log	Tree_or_log
Tree_tag_code	Transect_code
Unique_idx (unique)	Tree_ID, Transect_code

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Transect_ID	primary *	vchar (50)	Unique identifier for each transect <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Tree_ID	unique (FK)*	vchar (50)	Tree selected for cryptogam monitoring
Transect_code	unique	vchar (10)	Cryptogam transect code
Tree_or_log	indexed	vchar (5)	Indicates whether this transect is associated with a tree or a log
Reading_azimuth		int	Azimuth (degrees, declination corrected) in which the transects is read <i>Constraint: Is Null Or (>=0 And <=360)</i>
Transect_is_active		bit	Indicates whether the transect is currently used for monitoring
Trans_install_date		datetime	Date the transect was first installed
Trans_removal_date		datetime	Date the transect was removed from use
Transect_notes		memo	Comments about the cryptogam transect

tbl Crypto Trans Visit - Information about visits to cryptogam monitoring logs

<u>Index</u>	<u>Index columns</u>
Cm_scale_on_nails	Cm_scale_on_nails
Event_ID	Event_ID
PrimaryKey (primary)	Event_ID, Transect_ID
Transect_ID	Transect_ID

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary (FK)*	vchar (50)	Sampling event
Transect_ID	primary (FK)*	vchar (50)	Cryptogam monitoring transect
Cm_scale_on_nails	indexed	bit	Indicates whether or not the cm scale of the ruler rested on the nails
Is_changed		bit	Indicates whether the subplot has experienced any obvious changes since the last visit
Transect_visit_notes		memo	Comments about the transect visit

tbl Disturbance - Disturbance observation records at the plot scale

<u>Index</u>	<u>Index columns</u>		
Disturb_type			Disturb_type
Event_ID			Event_ID
PrimaryKey (primary)			Disturb_ID
Unique_index (unique)			Event_ID, Disturb_type

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Disturb_ID	primary *	vchar (50)	Unique identifier for each disturbance record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Event_ID	unique (FK)*	vchar (50)	Sampling event identifier
Disturb_type	unique	vchar (20)	Disturbance type
Disturb_percent		tinyint	Extent of disturbance, in terms of percent of the plot area <i>Constraint: Is Null Or (>=0 And <=100)</i>
Disturb_notes		memo	Comments about the disturbance

tbl Edit Log - Edit log for changes made to data after certification

<u>Index</u>	<u>Index columns</u>		
pk_tbl_Edit_Log (primary)			Data_edit_ID
Edit_date			Edit_date
Edit_type			Edit_type
Table_affected			Table_affected
User_name			User_name
Project_code			Project_code

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Data_edit_ID	primary *	vchar (50)	Unique identifier for each data edit record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications
Edit_date	indexed *	datetime	Date on which the edits took place <i>Default: Date()</i>
Edit_type	indexed *	vchar (12)	Type of edits made: deletion, update, append, reformat, tbl design
Edit_reason		vchar (100)	Brief description of the reason for edits
User_name	indexed	vchar (50)	Name of the person making data edits
Table_affected	indexed	vchar (50)	Table affected by edits
Fields_affected		vchar (200)	Description of the fields affected
Records_affected		vchar (200)	Description of the records affected
Data_edit_notes		memo	Comments about the data edits

tbl Events - Data collection event for a given location

<u>Index</u>	<u>Index columns</u>
Certified_by	Certified_by
Certified_date	Certified_date
Entered_date	Entered_date
Location_ID	Location_ID
Period_ID	Period_ID
pk_tbl_Events (primary)	Event_ID
Project_code	Project_code
Sample_cycle	Sample_cycle
Start_date	Start_date
Updated_date	Updated_date
Verified_date	Verified_date
Visit_in_cycle	Visit_in_cycle

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary *	vchar (50)	Unique identifier for each sampling event <i>Default: =Format(Now(),"yyymmddhhnnss") & '-' & 1000000000*Rnd(Now())</i>
Location_ID	indexed (FK)*	vchar (50)	Sampling location for this event
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications <i>Default: "VCa02"</i>
Period_ID	indexed	vchar (50)	Sample period during which this event occurred
Start_date	indexed *	datetime	Start date of the sampling event
Start_time		datetime	Start time of the sampling event
End_date		datetime	End date of the sampling event (optional)
End_time		datetime	End time of the sampling event (optional)
Declination		vchar (25)	Declination correction factor for measurement of compass bearings
Sample_cycle	indexed	tinyint	Monitoring return cycle (e.g., 1, 2, 3, etc.)
Visit_in_cycle	indexed	tinyint	Visit number within cycle (e.g., 1 or 2)
Tree_data	(FK)	vchar (15)	Indicates whether tree data were not/partially/fully collected
Tags_replaced		bit	Indicates whether tree tags were replaced
Tags_added		bit	Indicates whether tree tags were added
Stakes_replaced		bit	Indicates whether stakes were replaced
Stake_notes		vchar (100)	Comments about stake replacement
Coords_updated		bit	Indicates whether coordinate data were updated
Environ_updated		bit	Indicates whether the site environmental description was updated
Weather_cond		vchar (255)	Comments about weather conditions
Observed_changes		vchar (255)	Notes about observed changes to the plot
Significant_events		vchar (255)	Significant events and observations (e.g., sightings of rare/exotic species, accidents, etc.)
Animal_evidence		vchar (255)	Comments about animal evidence
Event_notes		memo	Comments about the sampling event
Entered_by		vchar (50)	Person who entered the data for this event
Entered_date	indexed	datetime	Date on which data entry occurred <i>Default: Now()</i>
Updated_by		vchar (50)	Person who made the most recent updates
Updated_date	indexed	datetime	Date of the most recent edits
Verified_by		vchar (50)	Person who verified accurate data transcription
Verified_date	indexed	datetime	Date on which data were verified
Certified_by	indexed	vchar (50)	Person who certified data for accuracy and completeness
Certified_date	indexed	datetime	Date on which data were certified
QA_notes		memo	Quality assurance comments for the selected sampling event
Logistics_notes		memo	Comments about logistics difficulties

tbl_GPS_Info - GPS information associated with sample location coordinates

<u>Index</u>	<u>Index columns</u>
Coord_ID	Coord_ID
Corr_type	Corr_type
Datum	GPS_datum
Feat_name	Feat_name
Feat_type	Feat_type
GPS_date	GPS_date
Location_ID	Location_ID
pk_tbl_GPS_Info (primary)	GPS_ID
GPS_file	GPS_file

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
GPS_ID	primary *	vchar (50)	Unique identifier for the GPS record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Coord_ID	indexed (FK)	vchar (50)	Coordinate identifier
Location_ID	indexed	vchar (50)	Sample location, used for temporary links
Feat_type	indexed	vchar (20)	Feature type (point, line, or polygon) collected with GPS
Data_dict_name		vchar (50)	Data dictionary name used to collect feature
Feat_name	indexed	vchar (50)	Feature name in data dictionary
GPS_file	indexed	vchar (50)	GPS file name
GPS_date	indexed	datetime	Date GPS file was collected
GPS_time		datetime	Time GPS file was collected
AM_or_PM		vchar (2)	Ante-meridian or post-meridian (AM or PM) if a 12 hour clock was used
Corr_type	indexed	vchar (50)	GPS file correction type
GPS_UTME		double	UTM easting in GPS unit
GPS_UTMN		double	UTM northing in GPS unit
UTM_zone		vchar (5)	UTM projection system zone <i>Default: "10N"</i>
GPS_datum	indexed	vchar (5)	Datum of GPS coordinates
Elev_m		double	Elevation (meters) in GPS unit
Num_sat		int	Number of satellites tracked by GPS unit during data collection
GPS_duration		vchar (25)	Length of time GPS file was open
Filt_pos		int	Number of GPS positions exported from GPS file
PDOP		double	Position dilution of precision scale
HDOP		double	Horizontal dilution of precision scale
H_err_m		double	Horizontal error (meters)
V_err_m		double	Vertical error (meters)
Std_dev_m		double	Standard deviation (meters)
GPS_process_notes		vchar (255)	GPS file processing notes

tbl Herbivory - Herbivory observation data from 5x5m quadrats

<u>Index</u>	<u>Index columns</u>
Collection_num	Collection_num
Event_ID	Event_ID
Number_browsed	Number_browsed
PrimaryKey (primary)	Herbivory_ID
Subplot_num	Subplot_num
Taxon_ID	Taxon_ID
Unique_idx (unique)	Event_ID, Subplot_num, Taxon_ID

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Herbivory_ID	primary *	vchar (50)	Unique identifier for each record <i>Default:</i> =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())
Event_ID	unique (FK)*	vchar (50)	Sampling event identifier
Subplot_num	unique *	int	Subplot number <i>Default:</i> 0
Taxon_ID	unique (FK)*	vchar (50)	Taxon observed
Collection_num	indexed	vchar (20)	Voucher specimen collection number
Total_number		tinyint	Total number of individuals observed
Number_browsed	indexed	tinyint	Number of individuals browsed
Browse_class		tinyint	Browse form observed
Percent_browsed		tinyint	Percent of biomass browsed from quadrat <i>Constraint:</i> Is Null Or (>=0 And <=100)
Reprod_status		vchar (5)	Reproductive status
Herbivory_notes		memo	Comments about the observation

tbl Images - Images associated with sample locations

<u>Index</u>	<u>Index columns</u>
Image_quality	Image_quality
Image_type	Image_type
pk_tbl_Images (primary)	Image_ID
Image_label	Image_label
Event_ID	Event_ID

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Image_ID	primary *	vchar (50)	Unique identifier for each image record <i>Default:</i> =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())
Image_type	indexed	vchar (20)	Type of image <i>Default:</i> "ground photo"
Image_desc		vchar (255)	Brief description of the image bearing, perspective, etc.
Frame_number		vchar (10)	Frame number for photographic images
Image_date		datetime	Date on which the image was created, if different from the sampling event date
Image_source		vchar (50)	Name of the person or organization that created the image
Image_quality	indexed	tinyint	Quality of the image
Is_edited_version		bit	Indicates whether this version of the image is the edited (originals = False)
Object_format		vchar (20)	Format of the image
Orig_format		vchar (20)	Format of the original image
Image_edit_notes		vchar (200)	Comments about the editing or processing performed on the image
Image_is_active		bit	Indicates whether the image is still being used for navigation or interpretation <i>Default:</i> True
Image_root_path		vchar (100)	Drive space location of the main project folder or image library

Image_project_path		vchar (100)	Location of the image from the main project folder or image library
	<i>Default: "images\"</i>		
Image_filename		vchar (100)	Name of the image including extension (.jpg) but without the image path
Image_notes		memo	Comments about the image
Event_ID	indexed (FK)*	vchar (50)	Sampling event
Image_label	indexed	vchar (25)	Image caption or label

tbl Locations - Sample locations - places where data collection occurs

<u>Index</u>	<u>Index columns</u>
Firing_order	Firing_order
Loc_updated	Loc_updated
Location_code	Location_code
pk_tbl_Locations (primary)	Location_ID
Location_status	Location_status
Location_type	Location_type
Panel_name	Panel_name
Panel_type	Panel_type
Park_code	Park_code
Prov_association	Prov_association
Slope_class	Slope_class
Stratum_ID	Stratum_ID
Substratum	Substratum
Public_type	Public_type
Public_scale	Public_scale

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Location_ID	primary *	vchar (50)	Unique identifier for each sample location <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Location_code	indexed *	vchar (10)	Alphanumeric code for the sample location
Location_name		vchar (50)	Brief colloquial name of the sample location (optional)
Location_type	indexed *	vchar (20)	Indicates the type of sample location
Park_code	indexed *	vchar (4)	Park code
Region_of_park		vchar (50)	Region of the Park (used in site evaluation process)
Stratum_ID	indexed (FK)	vchar (50)	Stratum of the site
Slope_class	indexed	vchar (20)	Slope classification used for site selection
Substratum	indexed	vchar (20)	Additional criteria used for site selection
Panel_type	indexed	vchar (20)	Sampling panel for the site
Panel_name	indexed	vchar (10)	Name of the sampling panel, used to group data for analysis
Firing_order	indexed	int	Site selection and evaluation order
Prov_association	indexed	vchar (50)	** Provisional plant association name assigned by field crews during reconnaissance ** to be updated in winter 2007 upon completion of NCCN Veg Map Accuracy Assessment project
Elevation		double	Field elevation of the location <i>Constraint: Is Null Or (>=0 And <14500)</i>
Elev_units		vchar (2)	Units for field elevation data <i>Default: "m"</i>
Elev_source		vchar (20)	Source of elevation data
Slope_percent		int	Slope steepness, in percent <i>Constraint: Is Null Or >=0</i>
Aspect_deg		int	Dominant slope aspect, in degrees, corrected for declination <i>Constraint: Is Null Or (>=0 And <=360) Or -1</i>
Nonforested_percent		int	Percent of the plot that is a non-forested inclusion <i>Constraint: Is Null Or (>=0 And <=100)</i>
Burn_percent		int	Percent of the plot that shows evidence of fire

			<i>Constraint: Is Null Or (>=0 And <=100)</i>
Parent_rock		vchar (50)	Parent rock formation from which local sediments and rock are derived
Parent_rock_source		vchar (20)	Source of parent rock designation
Parent_material		vchar (20)	Generally unconsolidated material from which soil develops
Soil_memoure		vchar (20)	Determined in the field by hand, based on proportion of sand, silt, and clay
Microconfig		vchar (20)	Configuration of local terrain
Microtopog_position		vchar (20)	Position within the immediate landscape
Topog_position		vchar (20)	Position relative to large scale topographical features
Drainage		vchar (20)	Water drainage at the site
Hydrologic_type		vchar (20)	Site hydrology, expressed as whether water is observed on the plot
Topog_moisture		double	Topographic moisture index, predicted movement of water through the soil and bedrock as influenced by site topography
			<i>Constraint: Is Null Or (>0 And <=9)</i>
Landform		vchar (5)	Predominant landform at site
Environment_notes		memo	Comments on environmental description
Location_status	indexed	vchar (10)	Status of the sample location
			<i>Default: "proposed"</i>
Location_notes		memo	Other notes about the sample location
Loc_established		datetime	Date the sample location was established
Loc_discontinued		datetime	Date the sample location was discontinued
Loc_created_date		datetime	Time stamp for record creation
			<i>Default: Now()</i>
Loc_updated	indexed	datetime	Date of the last update to this record
Loc_updated_by		vchar (50)	Person who made the most recent edits
Site_ID		vchar (50)	Site membership of the sample location
UTME_public		double	UTM easting (zone 10N, meters). Note: in addition to any measurement error, these coordinates have been offset up to 2 km from their actual position.
UTMN_public		double	UTM northing (zone 10N, meters). Note: in addition to any measurement error, these coordinates have been offset up to 2 km from their actual position.
Public_type	indexed	vchar (50)	Type of processing performed to make coordinates publishable
Public_scale	indexed	vchar (50)	Estimated accuracy of public coordinates
Travel_notes		memo	Comments about navigation to the point - kept up to date as conditions change
Location_desc		memo	Environmental description of the sampling location

tbl Observers - Observers for each sampling event

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Contact_ID	primary (FK)*	vchar (50)	Observer identifier
Observer_role	primary *	vchar (25)	Role of the observer during data collection
Observer_notes		vchar (200)	Comments about the observer specific to this sampling event

tbl QA Results - Quality assurance query results for the working data set

<u>Index</u>		<u>Index columns</u>	
pk_tbl_QA_Results (primary)		Query_name, Time_frame	
Query_result		Query_result	
Query_type		Query_type	
Time_frame		Time_frame	
Query_name		Query_name	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Query_name	primary *	vchar (100)	Name of the quality assurance query
Query_result	indexed	vchar (50)	Query result as the number of records returned the last time the query was run
Query_run_time		datetime	Run time of the query results
Query_description		memo	Description of the query
Query_expression		memo	Evaluation expression built into the query
Remedy_desc		memo	Details about actions taken and/or not taken to resolve errors
QA_user		vchar (50)	Name of the person doing quality assurance
Time_frame	primary *	vchar (30)	Field season year or range of dates for the data being passed through quality assurance checks
Query_type	indexed	vchar (20)	Severity of data errors being trapped: 1=critical, 2=warning, 3=information
Remedy_date		datetime	When the remedy description was last edited

tbl Quadrat Data - Quadrat data for species occurrence and abundance

<u>Index</u>		<u>Index columns</u>	
Collection_num		Collection_num	
Event_ID		Event_ID	
Number_5x5m		Number_1x1m	
PrimaryKey (primary)		Quadrat_data_ID	
Subplot_num		Subplot_num	
Taxon_class		Taxon_class	
Taxon_ID		Taxon_ID	
UniqueTaxa (unique)		Event_ID, Subplot_num, Taxon_ID, Collection_num	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Quadrat_data_ID	primary *	vchar (50)	Unique identifier for each record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Event_ID	unique (FK)*	vchar (50)	Sampling event identifier
Subplot_num	unique	int	Subplot number <i>Default: 0</i>
Taxon_ID	unique (FK)*	vchar (50)	Taxon observed
Taxon_class	indexed	vchar (20)	Type of vegetation based on a broad classification category and vegetation size
Is_litterfall		bit	Type of quadrat data terrestrial or epiphytic (litterfall) <i>Default: No</i>
Collection_num	unique	vchar (20)	Voucher specimen collection number
Cover_05x05m		vchar (5)	Cover of the taxon in the 0.5 x 0.5m quadrat
Cover_1x1m		vchar (5)	Cover of the taxon in the 1 x 1m quadrat
Cover_5x5m		vchar (5)	Cover of the taxon in the 5 x 5m quadrat
Number_1x1m	indexed	tinyint	Tally of seedlings in the 1 x 1m quadrat <i>Constraint: Is Null Or <=1000</i>
Quadrat_data_notes		memo	Comments about the observation

tbl Saplings - Height and diameter of saplings found in 5x5m quadrats

<u>Index</u>		<u>Index columns</u>	
Collection_num		Collection_num	
Event_ID		Event_ID	
PrimaryKey (primary)		Sapling_ID	
Subplot_num		Subplot_num	
Taxon_ID		Taxon_ID	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Sapling_ID	primary *	vchar (50)	Unique identifier for each record <i>Default: 0</i>
Event_ID	indexed (FK)*	vchar (50)	Sampling event identifier
Subplot_num	indexed *	int	Subplot number <i>Default: 0</i>
Taxon_ID	indexed (FK)*	vchar (50)	Taxon observed
DBH_cm		double	Diameter at breast height, in centimeters <i>Constraint: Is Null Or >0 And <300</i>
Height_m		double	Sapling height, in meters <i>Constraint: Is Null Or >0 And <120</i>
Collection_num	indexed	vchar (20)	Voucher specimen collection number
Sapling_notes		memo	Comments about the observation

tbl Site Evaluation - Documentation of site evaluation

<u>Index</u>		<u>Index columns</u>	
Evaluation_code		Evaluation_code	
Recon_code		Location_ID	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Location_ID	indexed (FK)	vchar (50)	Alphanumeric code assigned to reconnaissance plots
Evaluation_code	indexed	vchar (2)	Site evaluation status code <i>Default: "NE"</i>
Evaluation_notes		vchar (100)	Brief comment about the site evaluation, rationale for not sampling, etc.
PMR_composition		vchar (50)	vegetation composition according to Pacific Meridian Resources
GIS_veg_layer		vchar (255)	PMR/PEG/Henderson/Agee/Franklin vegetation layer comments
Field_Evaluation		vchar (15)	Plot office evaluation: passed or failed criteria or evaluation not conducted
Office_Evaluation		vchar (15)	Plot office evaluation: passed or failed criteria or evaluation not conducted

tbl Strata - Stratification classes used during design and analysis

<u>Index</u>		<u>Index columns</u>	
pk_tbl_Strata (primary)		Stratum_ID	
Stratum_updated		Stratum_updated	
udx_tbl_Strata (unique)		Park_code, Project_code, Stratification_date, Stratum_name	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Stratum_ID	primary *	vchar (50)	Unique identifier for each stratum record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Park_code	unique *	vchar (4)	4-letter park code of the stratification
Project_code	unique *	vchar (10)	Project code, for linking information with other data sets and applications <i>Default: "VCa02"</i>

Stratification_date	unique *	datetime	Date on which the stratification occurred, used for grouping strata
Stratum_name	unique *	vchar (25)	Name of the stratification class (e.g., low, medium, high)
Stratum_definition		vchar (250)	Brief memo definition of the stratum (e.g., elevations below 1000 meters)
N_population		int	Total population in the stratum
Weight_factor		double	Weight factor to be used in analyses; inverse of inclusion probability
Stratum_notes		memo	Comments about the stratum
Stratum_created		datetime	Time stamp for record creation
		<i>Default: Now()</i>	
Stratum_updated	indexed	datetime	Date of the last update to this record
Stratum_updated_by		vchar (50)	Person who made the most recent edits

tbl Subplot Visits - Notes associated with subplot visits

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Subplot_num	primary *	vchar (5)	Subplot number
Notes_05x05m		vchar (250)	Comments about the 0.5 m quadrat
Notes_1x1m		vchar (250)	Comments about the 1 m quadrat
Notes_5x5m		vchar (250)	Comments about the 5 m quadrat
Subplot_notes		memo	Comments about the subplot as a whole
Is_changed		bit	Indicates whether the subplot has experienced any obvious changes since the last visit
Change_notes		vchar (250)	Brief description of the change noted, including any new offset information

tbl Task List - Checklist of tasks to be completed at sampling locations

<u>Index</u>	<u>Index columns</u>
pk_tbl_Task_List (primary)	Location_ID, Request_date, Task_desc
Date_completed	Date_completed

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Location_ID	primary (FK)*	vchar (50)	Sampling location
Request_date	primary *	datetime	Date of the task request
		<i>Default: Now()</i>	
Task_desc	primary *	vchar (100)	Brief description of the task
Date_completed	indexed	datetime	Date the task was completed
Task_notes		memo	Notes about the task
Requested_by		vchar (50)	Name of the person making the initial request
Task_status		vchar (50)	Status of the task
Followup_by		vchar (50)	Name of the person following up on or completing the task
Followup_notes		memo	Comments regarding what was done to follow-up on or complete this task

tbl Trees - Trees associated with sample locations

<u>Index</u>	<u>Index columns</u>
Collection_num	Collection_num
Location_ID	Location_ID
Old_tag_code	Old_tag_code
Plot_ref_point	Plot_ref_point
PrimaryKey (primary)	Tree_ID
Subplot_num	Subplot_num
Taxon_ID	Taxon_ID
Tree_tag_code	Tree_tag_num
Tree_tag_status	Is_active
Unique_idx	Location_ID, Tree_tag_num

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Tree_ID	primary *	vchar (50)	Unique identifier for each tree record <i>Default: =Format(Now(),"yyyymmddhhnss") & '-' & 1000000000*Rnd(Now())</i>
Location_ID	indexed (FK)*	vchar (50)	Sampling location
Tree_tag_num	indexed	int	Tree tag number
Taxon_ID	indexed (FK)*	vchar (50)	Taxon observed
Collection_num	indexed	vchar (20)	Voucher specimen collection number
Tree_type	(FK)	vchar (50)	Indicates that the tree is for measurement, is a witness tree, or both
Is_active	indexed	bit	Current status of the tree tag: active? <i>Default: Yes</i>
Subplot_num	indexed	vchar (5)	Subplot number <i>Default: 0</i>
Plot_ref_point	indexed	vchar (10)	Plot reference point used to locate the tree
Offset_dist_m		double	Offset distance in meters <i>Constraint: Is Null Or >=0</i>
Offset_azimuth		int	Azimuth (degrees, declination corrected) from the plot reference point to the tree <i>Constraint: Is Null Or (>=0 And <=360)</i>
Old_tag_code	indexed	vchar (12)	Previous tree tag field code
Tree_rec_notes		memo	Comments about the tree record

tbl Tree Visits - Tree observation data

<u>Index</u>	<u>Index columns</u>
PrimaryKey (primary)	Tree_ID, Event_ID
Tree_status	Tree_status

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Tree_ID	primary (FK)*	vchar (50)	Unique identifier for each tree record
DBH_cm		double	Diameter at breast height, in centimeters <i>Constraint: Is Null Or >0 And <300</i>
Height_m		double	Tree height, in meters <i>Constraint: Is Null Or >0 And <120</i>
Height_method		vchar (2)	Method used to determine tree height
Tree_status	indexed	vchar (2)	Status of the tree
Decay_class		vchar (2)	Decay class of standing dead trees and logs
Snag_disappearance		vchar (2)	Reason for disappearance from the data of a tree previously tallied as dead
Cause_of_death		vchar (2)	Apparent cause of death of snags
Crown_class		vchar (2)	Crown class of the tree (e.g., dominant)
Crown_ratio		int	Proportion of observed tree length that supports live foliage <i>Constraint: Is Null Or (>=0 And <=100)</i>

Mistletoe_class	vchar (2)	Extent of mistletoe damage to the canopy
Cavity_class	vchar (2)	Presence and size of cavities
Platform_present	bit	Indicates whether a platform was present in the canopy
Hardwood_clump	bit	Indicates whether this observation is part of a clump of hardwood stems
Is_damaged	bit	Indicates whether the tree is damaged
Damage_type	vchar (50)	Type of damage
Damage_severity	vchar (50)	Severity of damage
Tree_visit_notes	memo	Comments about the tree measurement record

tlu Browse Class - List of herbivory browse class codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Browse_class	primary *	tinyint	
Browse_class_desc		vchar (100)	

tlu Cause of Death - List of codes for apparent cause of tree mortality

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Cause_of_death	primary *	vchar (2)	
Cause_of_death_desc		vchar (100)	
Sort_order		tinyint	

tlu Cavity Class - List of tree cavity classes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Cavity_class	primary *	vchar (2)	
Cavity_class_desc		vchar (100)	
Sort_order		tinyint	

tlu Coord Label - List of project-specific coordinate labels (template)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Coord_label	primary *	vchar (25)	
Coord_label_desc		vchar (100)	
Sort_order		tinyint	

tlu Coord Source - List of coordinate data sources (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Coord_source	primary *	vchar (12)	
Coord_source_desc		vchar (100)	
Sort_order		tinyint	

tlu Coord Type - List of coordinate types (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Coord_type	primary *	vchar (20)	
Coord_type_desc		vchar (100)	
Sort_order		tinyint	

tlu Cover Class - List of cover class codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Cover_class	primary *	vchar (5)	
Cover_class_desc		vchar (100)	
Sort_order		tinyint	

tlu Crown Class - List of tree crown class codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Crown_class	primary *	vchar (2)	
Crown_class_desc		vchar (100)	
Sort_order		tinyint	

tlu Datum - List of coordinate datum codes (standard)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Datumprimary *	vchar (5)		
Datum_desc		vchar (50)	
Sort_order		tinyint	

tlu Disturb Type - List of disturbance type codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Disturb_type	primary *	vchar (20)	
Disturb_type_desc		vchar (100)	
Sort_order		tinyint	

tlu Edit Type - List of the types of post-certification edits made to data (standard)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Edit_type	primary *	vchar (12)	
Edit_type_desc		vchar (100)	
Sort_order		tinyint	

tlu Elevation Source - List of elevation data source codes (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Elev_source	primary *	vchar (20)	
Elev_source_desc		vchar (100)	
Sort_order		tinyint	

tlu Evaluation Status - List of evaluation codes for sample sites (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Eval_code	primary *	vchar (2)	
Eval_status	*	vchar (20)	
Eval_status_desc		vchar (100)	
Sort_order		tinyint	

tlu Field Evaluation - List of evaluation codes for sample sites (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Field_eval	primary *	vchar (15)	
Field_eval_description		vchar (100)	
Sort_order		tinyint	

tlu GPS Model - List of GPS devices used to collect coordinate data (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
GPS_model	primary *	vchar (25)	
Sort_order		tinyint	

tlu Height Method - List of methods for determining tree height

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Height_method	primary *	vchar (2)	
Height_method_desc		vchar (100)	
Sort_order		tinyint	

tlu Hydrology - List of hydrologic type codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Hydrologic_type	primary *	vchar (20)	
Hydrologic_type_desc		vchar (100)	
Sort_order		tinyint	

tlu Image Description - List of project image codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Image_code	primary *	vchar (20)	Code
Orientation		vchar (50)	Horizontal captures groundcover, Vertical captures trees, Broadview captures groundcover and trees
Image_desc_comments			vchar (255)
Sort_order	*	int	

tlu Image Format - List of image, map, and photographic formats (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Image_format	primary *	vchar (12)	
Image_format_desc		vchar (100)	
Sort_order		tinyint	

tlu Image Quality - List of quality ranks for images (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Quality_code	primary *	tinyint	
Image_quality	*	vchar (20)	
Image_quality_desc		vchar (100)	

tlu Image Type - List of image types (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Image_type	primary *	vchar (12)	
Image_type_desc		vchar (100)	
Sort_order		tinyint	

tlu Landform - List of landform codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Landform_code	primary *	vchar (5)	
Landform_desc		vchar (200)	
Category		vchar (50)	
Sort_order		tinyint	

tlu Linear Unit - List of measurement units for linear distances (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Units	primary *	vchar (2)	
Units_desc		vchar (25)	
Sort_order		tinyint	

tlu Location Type - List of location type codes (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Location_type	primary *	vchar (20)	
Loc_type_desc		vchar (200)	
Sort_order		tinyint	

tlu Log Decay Class - List of decay class codes for logs

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Decay_class	primary *	tinyint	Log decay class code
Integrity_memoure		vchar (150)	Structural integrity of the log and memoure of rotten portions
Wood_color		vchar (50)	Color of wood
Invading_roots		vchar (50)	Presence/extent of invading roots of other plants
Branch_condition		vchar (150)	Condition of branches and twigs

tlu Microconfig - List of site microconfiguration codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Microconfig_code	primary *	vchar (20)	
Microconfig_desc		vchar (100)	
Sort_order		tinyint	

tlu Micro Position - List of site microtopographic position codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Microtopog_position	primary *	vchar (20)	
Micro_position_desc		vchar (200)	
Sort_order		tinyint	

tlu Mistletoe Class - List of mistletoe damage classes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Mistletoe_class	primary *	vchar (2)	
Mistletoe_class_desc		vchar (100)	
Sort_order		tinyint	

tlu Observer Role - List of observer role assignments (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Observer_role	primary *	vchar (25)	
Role_desc		vchar (100)	
Sort_order		tinyint	

tlu Office Evaluation - List of evaluation codes for sample sites (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Office_eval	primary *	vchar (15)	
Office_eval_description		vchar (100)	
Sort_order		tinyint	

tlu Origin Code - List of origin codes for park taxa (standard)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Origin_code	primary *	vchar (16)	
Origin_desc		vchar (100)	
NPSpp_ID		int	
Sort_order		tinyint	

tlu Panel Type - List of sampling panel types (template)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Panel_type	primary *	vchar (20)	
Panel_type_desc		vchar (200)	
Sort_order		tinyint	

tlu Parent Material - List of parent material types

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Parent_material	primary *	vchar (20)	
Parent_material_desc		vchar (200)	
Sort_order		tinyint	

tlu Parent Rock Source - List of parent rock designation sources

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Parent_rock_source	primary *	vchar (20)	
Parent_rock_source_desc		vchar (100)	
Sort_order		tinyint	

tlu Parks - List of NCCN parks and park codes (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Park_code	primary *	vchar (4)	
Park_name		vchar (50)	

tlu Park Taxa - Park-specific attributes for taxa (template)

<u>Index</u>	<u>Index columns</u>
Origin	Park_origin
pk_tlu_Park_Taxa (primary)	Taxon_ID, Park_code
Record_status	Record_status
Taxon_status	Park_status

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Taxon_ID	primary (FK)*	vchar (50)	Taxon identifier
Park_code	primary *	vchar (4)	Park code
Park_status	indexed	vchar (16)	Status of the taxon in this park (from NPSpecies)
			<i>Default: "unknown"</i>
Park_origin	indexed	vchar (16)	Origin of the taxon in this park (from NPSpecies)
			<i>Default: "unspecified"</i>
Local_list		bit	Indicates that the taxon is the preferred one for use at the park (from NPSpecies)
Local_accepted_TSN		int	Taxonomic serial number of the local preferred taxon (from NPSpecies)
Preferred_sci_name		vchar (255)	Preferred scientific name of the taxon at the park (from NPSpecies)
Park_taxon_notes		memo	Comments about the taxon specific to this park
Record_status	indexed	vchar (16)	Indicates the status of the record in terms of synchrony with master databases
			<i>Default: "new record"</i>
Created_date		datetime	Time stamp for record creation
			<i>Default: Now()</i>
Updated_date		datetime	Date of the last update to this record
Updated_by		vchar (50)	Person who made the most recent edits

tlu Park Taxon Status - List of codes for park species occurrence (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Taxon_status_code	primary *	vchar (16)	
Taxon_status_desc		vchar (250)	
NPSpp_ID		int	
Sort_order		tinyint	

tlu Plot Ref Point - List of sample plot reference point codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Plot_ref_point	primary *	vchar (10)	
Plot_ref_point_desc		vchar (100)	
Sort_order		tinyint	

tlu Project Crew - List of personnel associated with a project (template)

<u>Index</u>		<u>Index columns</u>	
Contact_location		Contact_location	
Contact_updated		Contact_updated	
First_name		First_name	
Last_name		Last_name	
Organization		Organization	
pk_tlu_Project_Crew (primary)		Contact_ID	
Project_code		Project_code	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Contact_ID	primary *	vchar (50)	Unique identifier for the individual (Lastname_Firstname_MI)
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications
Last_name	indexed *	vchar (24)	Last name
First_name	indexed	vchar (20)	First name
Middle_init		vchar (4)	Middle initials
Organization	indexed	vchar (50)	Employer (e.g., NPS-MORA)
Position_title		vchar (50)	Position title held by the individual
Email		vchar (50)	Email address
Work_voice		vchar (25)	Work phone number
Mobile_voice		vchar (25)	Mobile phone number
Home_voice		vchar (25)	Home phone number
Fax		vchar (25)	Fax number
Contact_location	indexed	vchar (255)	Where the individual is located
Contact_notes		memo	Notes about the contact
Contact_created		datetime	Time stamp for record creation
		<i>Default: Now()</i>	
Contact_updated	indexed	datetime	Date of the last update to this record
Contact_updated_by		vchar (50)	Person who made the most recent edits
Contact_is_active		bit	Indicates that the contact record is currently available for data entry pick lists
		<i>Default: True</i>	
Work_ext		vchar (5)	Work extension number

tlu Project Taxa - List of species associated with project observations (template)

<u>Index</u>		<u>Index columns</u>	
Accepted_TSN		Accepted_TSN	
Category		Category	
pk_tlu_Project_Taxa (primary)		Taxon_ID	
Project_code		Project_code	
Record_status		Record_status	
Scientific_name (unique)		Scientific_name	
Species_code (unique)		Species_code	
Subcategory		Subcategory	
Taxon_type		Taxon_type	
TSN		TSN	

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Taxon_ID	primary *	vchar (50)	Unique identifier for each taxon
		<i>Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())</i>	
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications
		<i>Default: "VCa02"</i>	
Species_code	unique *	vchar (20)	Unique field code for each project taxon
Scientific_name	unique *	vchar (100)	Scientific name of the taxon (from ITIS/NPSpecies)

Common_name		vchar (100)	Common name for the taxon (from ITIS/NPSpecies)
Pref_com_name		vchar (100)	Preferred common name for this project
TSN	indexed	int	ITIS taxonomic serial number or a provisional number (from NPSpecies)
Accepted_TSN	indexed	int	ITIS taxonomic serial number of the accepted name for this taxon (from NPSpecies)
Category	indexed	vchar (20)	General category of the taxon (from NPSpecies)
		<i>Default: "unspecified"</i>	
Subcategory	indexed	vchar (20)	Subcategory specific to the needs of each taxonomic discipline (from NPSpecies)
Authority		vchar (60)	Taxonomic authority (from ITIS)
Authority_subsp		vchar (60)	Taxonomic authority for subspecific taxa (from ITIS)
Family		vchar (60)	Taxonomic family (from ITIS)
Taxon_type	indexed	vchar (12)	Indicates the taxonomic resolution and certainty represented by this record
		<i>Default: "specific"</i>	
Taxon_notes		memo	General notes about the taxon
Created_date		datetime	Time stamp for record creation
		<i>Default: Now()</i>	
Updated_date		datetime	Date of the last update to this record
Updated_by		vchar (50)	Person who made the most recent edits
Taxon_is_active		bit	Indicates that the record is currently available for data entry pick lists
		<i>Default: True</i>	
Record_status	indexed	vchar (16)	Indicates the status of the record in terms of synchrony with master databases
		<i>Default: "new record"</i>	
Rec_status_notes		vchar (255)	Notes about the disposition of the record
Project_taxon_notes		memo	Project-specific comments about the taxon

tlu Reprod Status - List of reproductive status codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Reprod_status	primary *	vchar (20)	
Reprod_status_desc		vchar (100)	
Sort_order		tinyint	

tlu Site Drainage - List of site drainage codes

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Site_drainage	primary *	vchar (20)	
Site_drainage_desc		vchar (100)	
Sort_order		tinyint	

tlu Site Status - List of status codes for sampling stations (standard)

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Site_status	primary *	vchar (10)	
Site_status_desc		vchar (200)	
Sort_order		tinyint	

tlu Snag Decay Class - List of decay class codes for standing dead trees

<i>Field name</i>	<i>Index/key*</i>	<i>Data type</i>	<i>Description</i>
Decay_class	primary *	vchar (2)	Decay class code
Limbs_desc		vchar (50)	Condition of tree limbs
Top_desc		vchar (50)	Condition of the tree top
Bark_remaining		vchar (50)	Brief description of how much bark remains
Sapwood_desc		vchar (50)	Brief description of how much sapwood remains
Sapwood_cond		vchar (100)	Condition of sapwood

Heartwood_cond vchar (200) Condition of heartwood

tlu Snag Disappearance - List of codes for why previously recorded snags do not appear in current event data

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Snag_disappearance_code	primary *	vchar (2)	
Snag_disappearance_desc		vchar (100)	
Sort_order		tinyint	

tlu Soil Memoure - List of soil memoure codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Soil_memoure	primary *	vchar (20)	
Soil_memoure_desc		vchar (200)	
Sort_order		tinyint	

tlu Source Scale - List of common map scales associated with maps and imagery (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Source_scale	primary *	vchar (16)	
Source_scale_desc		vchar (100)	
Sort_order		tinyint	

tlu Taxon Category - List of taxonomic categories (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Category	primary *	vchar (20)	
Category_desc		vchar (100)	
NPSpp_ID		int	
Sort_order		tinyint	

tlu Taxon Class - List of structural class codes for taxa

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Taxon_class	primary *	vchar (20)	
Taxon_class_desc		vchar (100)	
Sort_order		tinyint	

tlu Taxon Rec Status - List of status codes for taxon records (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Record_status_code	primary *	vchar (16)	
Record_status_desc		vchar (200)	
Sort_order		tinyint	

tlu Taxon Type - List of taxon resolution codes (standard)

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Taxon_type	primary *	vchar (12)	
Taxon_type_desc		vchar (200)	
Sort_order		tinyint	

tlu Topog Position - List of site topographic position codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Topog_position	primary *	vchar (20)	
Topog_position_desc		vchar (100)	
Sort_order		tinyint	

tlu Transect Code - List of cryptogam transect codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Transect_code	primary *	vchar (10)	
Transect_code_desc		vchar (100)	
Category		vchar (10)	

tlu Tree Data - List of codes indicating status of tree data

<u>Index</u>	<u>Index columns</u>
PrimaryKey (primary)	Tree_data
Sort_order (unique)	Sort_order
Tree_data (unique)	Tree_data

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Tree_data	primary *	vchar (15)	
Tree_data_desc		vchar (100)	
Sort_order	unique	tinyint	

tlu Tree Status - List of tree status codes

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Tree_status	primary *	vchar (2)	
Tree_status_desc		vchar (100)	
Sort_order		tinyint	

tlu Tree Tag Status - List of status codes for tree tags

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Tree_tag_status	primary *	vchar (20)	
Tree_tag_status_desc		vchar (100)	
Sort_order		tinyint	

tlu Tree Type - List of tree types

<u>Index</u>	<u>Index columns</u>
PrimaryKey (primary)	Tree_type
Tree_type_code	Tree_type_code

<u>Field name</u>	<u>Index/key*</u>	<u>Data type</u>	<u>Description</u>
Tree_type	primary *	vchar (20)	
Tree_type_code	indexed	vchar (3)	code used in reports to indicated tree type
Tree_type_description		vchar (255)	
Sort_order		int	

This page intentionally left blank.

Appendix C. Template for Forest Monitoring Annual Report

Authors/Contacts

Introduction/Background

Boilerplate for each report covering the following:

- Importance of vegetation monitoring
- Issues with monitoring vegetation (legitimate strata for statistical rigor, biological interpretation depends on sampling vegetation classes, access, safety, threat of trampling from frequent visits, etc.)
- Study design – spatial and temporal (how the issues were addressed)

Table 1. Temporal sampling frame. Each X represents 3 plots of each vegetation class sampled in each park.

Panel	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	X	X					X	X					X
2		X	X					X	X				
3			X	X					X	X			
4				X	X					X	X		
5					X	X					X	X	
6						X	X					X	X

- Trend detection, including schedule of trend estimates

Table 2. Schedule of reporting of interannual variation and long-term trends and the data for each.

Year of Report	Interannual Variation	Long-term Trend
2008	2007-2008 (Panel 1)	
2009	2008-2009 (Panel 2)	
2010	2009-2010 (Panel 3)	
2011	2010-2011 (Panel 4)	
2012	2011-2012 (Panel 5)	
2013	2012-2013 (Panel 6)	
2014	2013-2014 (Panel 1)	2007-2014 (Panel 1)
2015	2014-2015 (Panel 2)	2007-2015 (Panels 1-2)
2016	2015-2016 (Panel 3)	2007-2016 (Panel 1-3)
2017	2016-2017 (Panel 4)	2007-2017 (Panels 1-4)
2018	2017-2018 (Panel 5)	2007-2018 (Panels 1-5)
2019	2018-2019 (Panel 6)	2007-2019 (Panels 1-6)
Etc.		

- Summary of basic measurements
- Explain that annual reports will report data for plots having their second year of consecutive measurements in the current year (e.g., Panel 1 data will be reported in 2008, 2014, 2020, etc.; Panel 2 will be reported in years 2009, 2015, 2021, etc.). This way, the entire data set for the plot will be collected, including data collected both years (i.e., herbaceous cover, cryptogams, herbivory) and data collected only once (i.e., tree dimensions, tree cover, other tree characteristics).

Plot Visit History

Table 3. History of plots visited (or missed) throughout study

PARK	VEG CLASS	PANEL	2007	2008	2009	2010	2011	2012	2013 etc.
MORA	WH	1	3	3					
		2		3	3				
		3			3	3			
		4				3	2		
		5					3	3	
		6						3	3
	SF	1	3	3					
		2		3	3				
		3			3	3			
		4				3	3		
		5					3	3	
		6						3	3
NOCA	WH	1	3	3					
		2		2	3				
		Etc							
OLYM	SS	1	3	3					
		2		3	3				
		Etc							

- Maps of the three parks showing points that were visited during the reporting year distinguished by stratum and panel. Input data include plot, panel, stratum, UTM's but only the maps will be made public.

Plot Structure

- Snapshot of stand structure using lollipop figures on 3-D illustration of plots. Tree dimensions will be measured in only one year of the consecutive visits (e.g., Panel 1: 2007 but not 2008; Panel 2: 2008 but not 2009, etc.)
- Or, at least histograms showing canopy classes and species versus number.
- Eventually will want to contrast these through time.
- Discussion of contrast of plots within panel and change over time.
- Data associated with individual trees will include tree species, height, canopy ratio, location, and mortality (appendix A)
- Data associated with plot include slope, aspect, litter depth, duff depth, climate and air pollution indices from epiphytic macrolichen data.

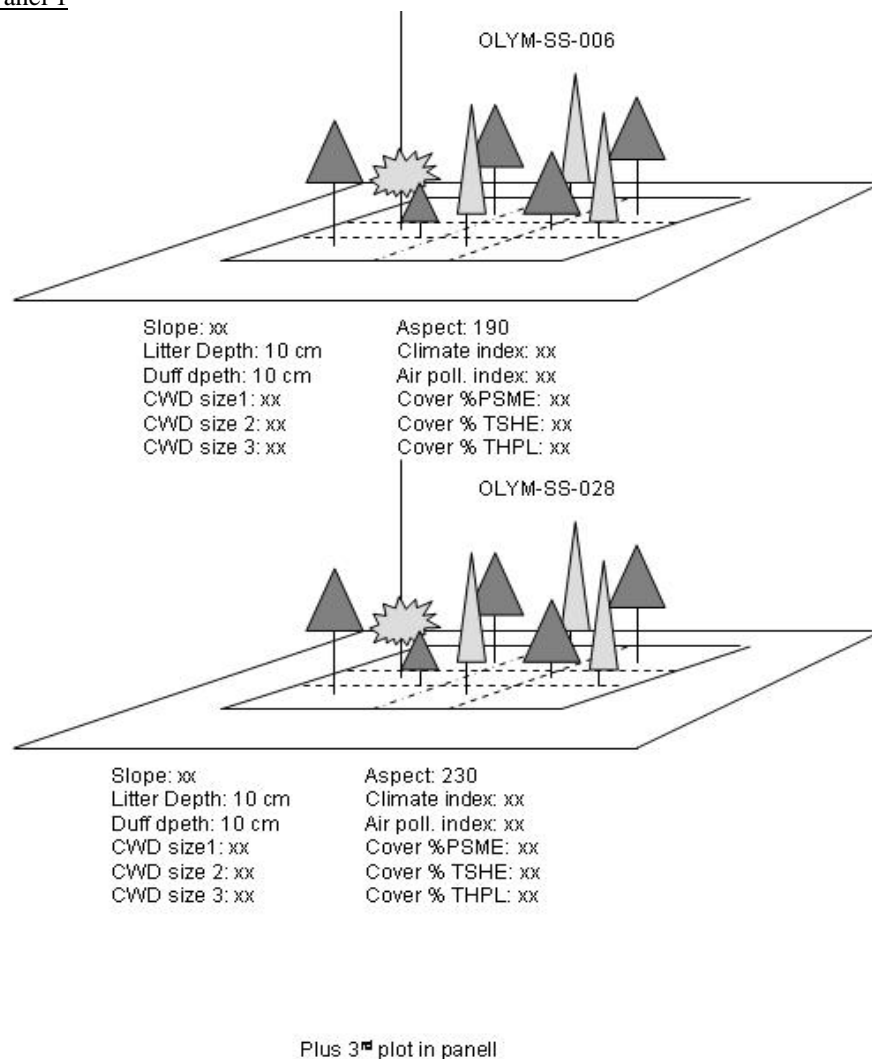
OLYM-SS, Panel 1

Figure 1. Graphs describing stand structure of plots in Panel 1 of the Sitka Spruce stratum for Olympic National Park.

MORA-WH - 3 graphs + Figure 2 caption

NOCA-WH - 3 graphs + Figure 3 caption

OLYM-WH - 3 graphs + Figure 4 caption

MORA-SF - 3 graphs + Figure 5 caption

NOCA-SF - 3 graphs + Figure 6 caption

- Discussion should cover interesting changes in all variables presented on these figures.

Understory Species Richness

1) Interannual Variation

Table 4. Summary of interannual changes in species lists since last visit to plot. (Example is for 2008). Total species includes those new to panel, missing from panel since last measurement, and present in both samples for plots sampled in both years. Bold font indicates exotic species; italic font indicates rare species.

PARK/VEG CLASS	PLOTS/ PANEL	NEW TO PANEL	MISSING FROM PANEL	TOTAL SPECIES
OLYM-SS	3	Species 1 Species 2 Species 3	None	75
MORA-WH	2	Etc.	<i>Species 4</i>	65
NOCA-WH	3			
OLYM-WH	3			
MORA-SF	3			
NOCA-SF	3			

- Discussion of changes in species lists including noting exotics, rares, species diversity, etc.
- Species lists by plot in appendix B.

2) Long-Term Changes

Table 5. Summary of long-term changes in species lists since last measurement cycle. Comparison is made between the list of species occurring in at least one year of the previous measurement cycle and species occurring in at least one year of the current cycle. Example is for 2014.

PARK/VEG CLASS	PLOTS/ PANEL	NEW TO PANEL	MISSING FROM PANEL	TOTAL SPECIES
OLYM-SS	3	Species 1 Species 2 Species 3	None	75
MORA-WH	3	Etc.		
NOCA-WH	3			
OLYM-WH	2			
MORA-SF	3			
NOCA-SF	3			

- Discussion of changes in species lists including noting exotics, rares, species diversity, etc.
- Species lists by plot in appendix B.

Understory Vegetation and Ground Cover

- Boiler plate about how inter-annual variation is not considered to be a significant trend and that it is not expected to be large or consistent across plots. These assumptions need to be substantiated by the data
- Interannual variation is all that can be reported until 2014 when panel one has been revisited for the second rotation. The power of the trend analysis will increase substantially as more panels are completed during the second rotation.

Vascular and non-vascular understory species on non-woody substrates

1) Interannual Variation

Figure 7. (not shown). Interannual variation in cover for species with at least 50% frequency in all plots in the Sitka Spruce stratum (OLYM only; figure should include on graph per species).

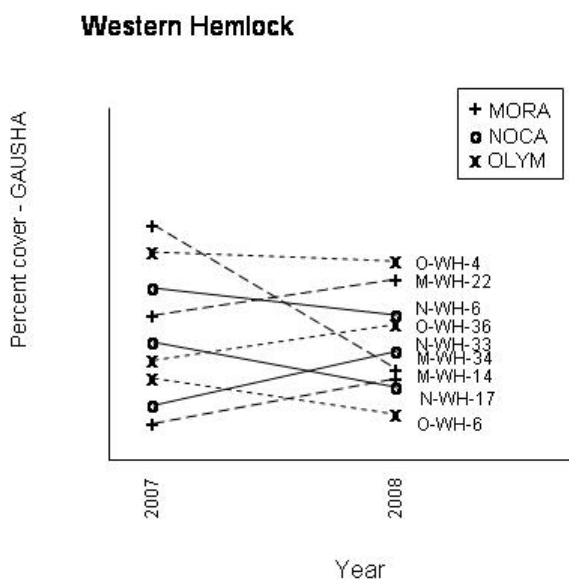


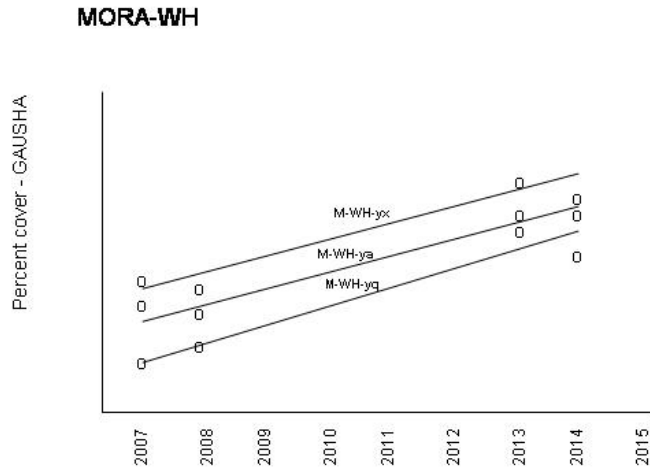
Figure 8. Interannual variation in cover for species with at least 50% frequency in all plots stratum Western Hemlock (MORA, NOCA, OLYM). Note: it may be better to do this by stratum within park. This is what the most complicated figure would look like; Sitka spruce will have data from only one park; Subalpine fir will have data from only two parks.

Figure 9 (not shown). Interannual variation in cover for species with at least 50% frequency in all plots in stratum Subalpine Fir (MORA, NOCA).

- Discussion of any unexpectedly large differences in interannual variation for species with $\geq 50\%$ frequency in all three plots per panel
- Relationships between plant cover and weather during growing season and previous year or so.
- Data in appendix C

2) Long-Term Trend

Figure 10 (not shown). Species showing statistically significant ($p < 0.10$) trend in Panel OLYM-SS (figure should include one graph per species).



(plus graphs of other species with statistically significant trends in Panel MORA-WH)

Figure 11. Species showing statistically significant ($p < 0.10$) trend in Panel MORA-WH.

Figure 12 (not shown). Species showing statistically significant ($p < 0.10$) trend in Panel NOCA-WH.

Figure 13 (not shown). Species showing statistically significant ($p < 0.10$) trend in Panel OLYM-WH.

Figure 14 (not shown). Species showing statistically significant ($p < 0.10$) trend in Panel MORA-SF.

Figure 15 (not shown). Species showing statistically significant ($p < 0.10$) trend in Panel NOCA-SF.

- Discussion of long-term trends including species with significant trends, autecology of those species, comparison among parks and veg types
- Consideration of weather patterns – it should be possible to relate changes in vegetation to GCC eventually; changes in weather with or without changes in veg are of interest (data needs from weather records: snow course indicating meltout, winter ppt., growing season ppt. by month, growing season temp. by month (May-Sept)).
- Any other explanations for changes?
- Graphs of significant or notable (may not be statistically significant yet) changes by species, and maybe by species across plots.
- Data in appendix C.

Epiphytic Lichens

- Report air pollution and climate gradient scores by plot (these will be calculated by the USDA Forest Service staff; see **SOP 17: Lichen Survey**; data in appendix D)
- Discuss trends in indices.

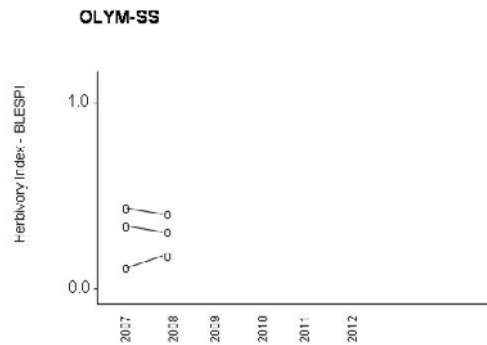
Herbivory

Ferns

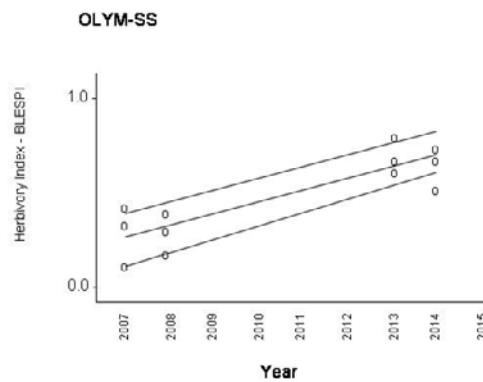
- Define herbivory index as (calculated by species):

$$\frac{\sum_{\text{subplots}} \text{no. plants browsed} \times \text{fraction of fronds browsed on browsed plants}}{\text{total no. of plants in plot}}$$

- Example: imagine a plot with 3 subplots having POLMUN; one subplot has 3 plants averaging 50% browsed fronds, second subplot has 6 plants with 3 having 25% browsed fronds, one subplot has 1 unbrowsed plant. The index would be:
 $[(3)(.5)+(3)(.25)+(1)(0)/10] = 0.225$
- There will be one herbivory index calculated per plot.
- Graph panels having notable herbivory.



Eventually, the graphs will look more like this:



- Discuss changes in herbivory
- Data in appendix E

Shrubs

- Define the herbivory index for each species as for ferns except substitute Form Class Factor for fraction of fronds browsed Form Class Factor = 0 (Form Class 1), 0.125 (Form Class 2), 0.38, 0.63 (Form Class 3), 0.88 (Form Class 4).
- Graph as above
- Discuss patterns and changes in herbivory.
- Data in appendix E

Wildlife Habitat

Table 6. Number of trees having wildlife habitat features per plot average across plots within vegetation class and park. Data by species are in appendix A.

Vegetation Class	Platforms (numbers/tree)			Cavities (opening size)		Mistletoe (canopy affected)	
	1-5	5-9	10 or more	<15 cm	>15 cm	< 50%	> 50%
OLYM-SS							
MORA-WH							
NOCA-WH							
OLYM-WH							
MORA-SF							
NOCA-SF							

- Discussion of wildlife habitat and change through time.

Summary/Conclusions

- Description of differences among plots and differences over time (when available) of species composition and stand structure of forest plots
- Compare across vegetation types and across parks within vegetation type

Appendix 1 Annual Report. Tree Characteristics
 • Introductory information

Panel MORA-WH

Plot	Species	Percent of Trees												Crown Ratio (average %)	DBH (average)	Height (average)	Cover (%)	Total No. Trees	
		Crown Class				Damage			Platforms		Cavities		Mistletoe						
		Open	Dominant	Co-dominant	Intermediate	Over-topped	Several categories	1 to 5	5 to 9	10 or more	< 15 cm	> 15 cm	< 50%						> 50%
M-WH-022	Tsuga heterophylla	0	0	50	25	25		0			4	0	7	0	0	50			45
	Pseudotsuga menziesii	0	100	0	0	0		0			0	5	0	0	0	30			20
	Abies amabilis	0	0	0	20	80		0			0	0	0	0	0	60			25
	Thuja plicata	0	0	0	0	10		0			0	0	0	0	0	50			5
M-WH-034	Tsuga heterophylla																		
	Pseudotsuga menziesii																		
M-WH-035	Tsuga heterophylla																		
	Pseudotsuga menziesii																		
	Abies amabilis																		
	Taxus brevifolia																		

Repeat for other panels

Appendix 2 Annual Report. Species lists by plots

Codes for origin: N(ative), R(are), E(xotic)

Codes under plots: P(resent) = present now and at the last measurement; N(ew) = present now but not in the past; D(isappeared) = not present now, but present before

Panel MORA-WH

Species	Origin	M-WH-022	M-WH-034	M-WH-035
<i>Cladonia fimbriata</i>	N	P	P	P
<i>Blechnum spicant</i>	N	P	P	P
<i>Dicranum fuscensens</i>	N	P	P	P
<i>Dicranum tauricum</i>	N		N	
<i>Eurhynchium oreganum</i>	N	P	P	P
<i>Gaultheria shallon</i>	N	P	P	P
<i>Mahonia nervosa</i>	N	P	P	P
<i>Pellia neesiana</i>	N	P	P	P
<i>Pyrola picta</i>	N			D
<i>Rhamnus purshiana</i>	N			P
<i>Rhytidiopsis robusta</i>	N	P	P	P
<i>Rubus spectabilis</i>	N	P	P	P
<i>Vaccinium parvifolium</i>	N	P	P	P

Panel MORA-SF

Etc.

Appendix 3 Annual Report. Summary of frequency, cover and range of cover for species suitable for trend analysis by panel and species (species with frequency greater than or equal to 50% in all three plots per panel).

Panel MORA-WH

Species	Type	M-WH-022			M-WH-034			M-WH-035			Panel Avg. (%)
		Freq %	Avg. Cover	Range	Freq (%)	Avg. Cover	Range	Freq (%)	Avg. Cover	Range	
<i>Cladonia fimbriata</i>	Non-V	70	1	0.5-1	60	2		50	1		1.3
<i>Dicranum fuscensens</i>	Non-V	80	2	0.5-3	50	2		50	3		2.3
<i>Eurhynchium oreganum</i>	Non-V	100	5	1-8	80	3		50	20		9.3
<i>Pellia neesiana</i>	Non-V	50	3	1-5	50	5		70	10		6.0
<i>Rhytidiopsis robusta</i>	Non-V	90	60	5-80	70	40		60	30		43.3
Etc.											
<i>Gaultheria shallon</i>	Herb/Shr										
<i>Goodyera oblongata</i>	Herb/Shr										
<i>Mahonia nervosa</i>	Herb/Shr										
Etc.											
<i>Blechnum spicant</i>	Shr/Fern										
<i>Rubus spectabilis</i>	Shr/Fern										
<i>Vaccinium parvifolium</i>	Shr/Fern										
Etc.											

Panel MORA-SF

Etc.

Appendix 4 Annual Report. Epiphytic Macrolichens

Species	M-WH-002	M-WH-031	M-WH-043
	Abund. Class	Abund. Class	Abund. Class
<i>Hypogymnia enteromorpha</i>	1	2	1
<i>Lobaria oregano</i>	3	3	4
<i>Paltismatia glauca</i>	4	3	4
<i>Xanthoria polycarpa</i>	2	1	1
etc			

Same for other strata

Appendix 5 Annual Report. Herbivory

- Introductory explanation

Ferns:

Panel MORA-WH

		Plants Browsed (%)	Fronds Browsed (%)	Sexual Reproduction (% quadratss)	Total No. of Plants
M-WH-022	<i>Athyrium filix-femina</i>				
	<i>Blechnum spicant</i>				
	<i>Polystichum munitum</i>				
M-WH-034	<i>Athyrium filix-femina</i>				
	<i>Blechnum spicant</i>				
	<i>Polystichum munitum</i>				
M-WH-035	<i>Athyrium filix-femina</i>				
	<i>Blechnum spicant</i>				
	<i>Polystichum munitum</i>				

- Panel MORA-SF
- Panel NOCA-WH
- Panel NOCA-SF
- Panel OLYM-SS
- Panel OLYM-SF

Shrubs:

Panel MORA-WH

Plot	Species	Stems Browsed (%)	Form Class (% of subplots)					Sexual Reprod. (% quadrats)	Total No. Stems
			Class 0	Class 1	Class 2	Class 3	Class 4		
M-WH-022	<i>Acer circinatum</i>								
	<i>Amelanchier alnifolia</i>								
	<i>Cornus stolonifera</i>								
	<i>Rubus spectabilis</i>								
	<i>Vaccinium sp.</i>								
M-WH-034	<i>Acer circinatum</i>								
	<i>Amelanchier alnifolia</i>								
	<i>Cornus stolonifera</i>								
	<i>Rubus spectabilis</i>								
	<i>Vaccinium sp.</i>								
M-WH-035	<i>Acer circinatum</i>								
	<i>Amelanchier alnifolia</i>								
	<i>Cornus stolonifera</i>								
	<i>Rubus spectabilis</i>								
	<i>Vaccinium sp.</i>								

- Panel MORA-SF
- Panel NOCA-WH
- Panel NOCA-SF
- Panel OLYM-SS
- Panel OLYM-SS

Appendix D. Guidelines for Collecting Botanical Specimens

Plant specimens will be collected by LTEM forest vegetation crew for the following reasons. The specimen is:

- Unknown and is collected for identification following vegetation sampling protocol
- Collected following lichen survey protocol
- Listed as undercollected for the park and will be added to the herbarium collections
- Rare, unusual, or new to the park (get authorization to collect)
- Exotic (collect and report to supervisor and Exotic Plant Management Team)

Consider plant conservation and use common sense when deciding whether or not to collect a plant specimen. There is increasing concern regarding the rapid disappearance of natural, pristine habitats and critically low population levels of many native plants, even within national parks. Remember that all plants, even common species, are afforded legal protection within Olympic National Park. When collecting is *necessary* and *authorized*, adhere to the following guidelines:

1. Practice minimum impact travel and camping techniques. Keep travel in sensitive habitats, such as wetlands or subalpine meadows, to a minimum. Wear soft-soled footwear when possible and safe, to minimize trampling impacts. Always use existing constructed trails or game trails when available. If no trail is discernible, travel along the margins of sensitive areas. Vary your travel route when revisiting an area multiple times to prevent establishing a trail. Follow all wilderness regulations when camping: use only designated sites, keep a clean camp, and pack out all trash.
2. Never collect rare species unless *specifically authorized* to do so.
3. Observe the 1-in-20 rule for collecting. Never collect more than one specimen out of 20 plants. This means *not collecting any individual plant until at least 20 more individuals of the same species have been located in the immediate vicinity*.
4. Be sensitive to and use common sense about where collecting takes place. Avoid collecting within sight of roads and trails, campsites, near developed areas, etc. Collect outside long-term sampling quadrats or plots when possible.
5. Make every field collection count by obtaining a complete, undamaged specimen, including the entire root system for forbs and graminoids. Collect samples of flowering and fruiting structures, including both male and female reproductive structures on dioecious plants. Record comprehensive field notes. Handle and transport the specimen carefully so that it will be in good condition for mounting and cataloging if it is to be retained in the collections.
6. Large-scale collecting is rarely justified. Be judicious in the quantity of material collected.
7. Specimens that are common and well represented in the herbarium can be disposed of once identification is determined and verified. Take care when disposing of exotic plants.
 - Be prepared to identify yourself and explain what you are doing to park staff and visitors. A professional demeanor will go a long way toward ensuring positive public contacts. Do not reveal location information regarding rare or sensitive species.
 - Use care when handling exotic plant material with fruit or seeds present to prevent their spread.
 - Material which is destined for the park herbarium should be carefully checked for insect pests and diseases.
 - The following label is used for vascular plant specimens that are retained in the herbarium. Taking thorough field notes will ensure that the label information will be complete.

NATIONAL PARK SERVICE		NPS FORM 10-512	
_____ National Park Herbarium			
Family:			
Scientific Name:			
Common Name:			
County:			
Locality:			
UTMs:			
Elevation:	Slope:	Aspect:	
Associated Species:			
Habitat:			
Collector:		Collection Date:	
Identified by:		Date:	
Accession Number:	-	Catalog Number:	

Appendix E. Conifer Forest and Woodland Plant Associations of Mount Rainier, Cascades, and Olympic National Parks

This list is from Washington State Department of Natural Resources, Washington Natural Heritage Program (work in progress). Plant associations sampled in this protocol are indicated in bold font.

Abies amabilis/Rhododendron albiflorum
 Abies amabilis/Menziesia ferruginea
 Abies amabilis-Tsuga mertensiana/Oplopanax horridus
 Abies amabilis-Tsuga mertensiana/Menziesia ferruginea
 Abies amabilis-Tsuga mertensiana/Streptopus lanceolatus
 Abies amabilis-Tsuga mertensiana/Vaccinium membranaceum/Rubus lasiococcus
 Abies amabilis-Tsuga heterophylla/Oplopanax horridus
 Abies amabilis-Tsuga heterophylla/Rubus pedatus-Tiarella trifoliata
 Abies amabilis-(Tsuga heterophylla)/Vaccinium membranaceum
 Abies amabilis-(Tsuga heterophylla)/Vaccinium membranaceum-Vaccinium alaskensis
 Abies amabilis-Pseudotsuga menziesii/Achlyls triphylla
 Abies amabilis-(Pseudotsuga menziesii)/Achlyls triphylla-Tiarella trifoliata
 Abies amabilis-(Pseudotsuga menziesii)/Vaccinium membranaceum/Achlyls triphylla
 Abies amabilis-(Pseudotsuga menziesii-Tsuga heterophylla)/Rhododendron macrophyllum
 Abies amabilis-(Pseudotsuga menziesii-Abies procera)/Vaccinium membranaceum/Xerophyllum
 tenax

 Abies grandis-Pseudotsuga menziesii/Acer circinatum
 Abies grandis/Bromus vulgaris

 Abies lasiocarpa/Luzula glabrata
 Abies lasiocarpa/Polemonium pulcherrimum-Pedicularis racemosa
 Abies lasiocarpa/Vaccinium deliciosum
Abies lasiocarpa/Valeriana sitchensis
Abies lasiocarpa/Valeriana sitchensis-Veratrum viride
 Abies lasiocarpa/Rubus lasiococcus
 Abies lasiocarpa/Vaccinium scoparium
 Abies lasiocarpa/Rhododendron albiflorum/Rubus lasiocarpa
 Abies lasiocarpa-Picea engelmannii/Phyllodoce empetriiformis
 Abies lasiocarpa-(Picea engelmannii)/Rhododendron albiflorum
Abies lasiocarpa-(Picea engelmannii)/Valeriana sitchensis
 Abies lasiocarpus-(Pinus contorta)/Juniperus communis-Lomatium martindalei
 Abies lasiocarpus-(Pinus contorta)/Lupinus arcticus
 Abies lasiocarpus-Pseudotsuga menziesii/ Calamagrostis rubescens
 Abies lasiocarpus-Pseudotsuga menziesii/Paxistima myrsinites/Calamagrostis rubescens
Abies lasiocarpus-(Pseudotsuga menziesii)/Vaccinium membranaceum
 Abies lasiocarpa-(Tsuga mertensiana)/Festuca viridula
 Abies lasiocarpa-(Tsuga mertensiana)/Eucephalus ledophyllus-Lupinus alpinus
 Abies lasiocarpa-Tsuga mertensiana/Vaccinium scoparium
Abies lasiocarpa-(Abies amabilis)/Vaccinium membranaceum/Valeriana sitchensis
Abies lasiocarpa-(Abies amabilis)/Vaccinium membranaceum/Lupinus alpinus
 Abies lasiocarpa/Depauperate

 Cupressus nootkatensis/Vaccinium deliciosum
 Cupressus nootkatensis/Vaccinium ovalifolium
 Cupressus nootkatensis/Valeriana sitchensis
 Cupressus nootkatensis/Oplopanax horridus

Larix lyallii/Vaccinium deliciosum
Larix lyallii/Cassiope mertensiana-Luetkea pectinata
Larix lyallii/Luzula glaberata

Picea engelmannii-(abies lasiocarpus)/Equisetum arvense
Picea engelmannii-(abies lasiocarpus)/Linnaea borealis

Picea sitchensis/Rubus spectabilis/Carex obnupta-Lysichiton americanus
Picea stichensis/Calamagrostis nutkaensis
Picea sitchensis/Vaccinium ovatum
Picea sitchensis/Gaultheria shallon
Picea sitchensis-(Alnus rubra)/Rubus spectabilis/Polystichum munitum
Picea sitchensis/Maiathemum dilatatum
Picea sitchensis/Scirpus microcarpus
Picea sitchensis-Tsuga heterophylla/Polystichum munitum-Oxalis oregano
Picea sitchensis-Tsuga heterophylla-(Alnus rubra)/Oplopanax horridus/Polystichum munitum
Picea sitchensis-Tsuga heterophylla/Polystichum munitum

Pinus albicaulus/Juniperus communis
Pinus albicaulus/Vaccinium scoparium/Luzula glaberata
Pinus albicaulus- (Tsuga mertensiana)/Luzula glaberata
Pinus albicaulus/Calamagrostis rubescens
Pinus albicaulus/Festuca viridula

Pinus contorta/Ledum groenlandicum/Sphagnum
Pinus contorta/gaultheria shallon/Gaultheris ovatum
Pinus contorta-(Pseudotsuga menziesii)/Gaultheria shallon

Pinus ponderosa/Pseudoroegneria spicata
Pinus ponderosa-Pseudotsuga menziesii/Purshia tridentata

Populus balsamifera-Picea sitchensis-(Acer macrophyllum)/Oxalis oregana

Pseudotsuga menziesii/Gaultheria shallon-Vaccinium parvifolium
Pseudotsuga menziesii/Holodiscus discolor-Rosa gymnocarpa/Festuca occidentalis
Pseudotsuga menziesii/Mahonia nervosa
Pseudotsuga menziesii/Paxistima myrsinites-Arctostaphylos uva-ursi
Pseudotsuga menziesii/Paxistima myrsinites/Calamagrostis rubescens
Pseudotsuga menziesii/Rhododendron macrophyllum
Pseudotsuga menziesii-Abies grandis/Acer circinatum/Polystichum munitum
Pseudotsuga menziesii-Abies grandis/Calamagrostis rubescens
Pseudotsuga menziesii-Abies grandis/Spirea betulifolia
Pseudotsuga menziesii-(Abies lasiocarpus)/Vaccinium scoparium/Calamagrostis rubescens
Pseudotsuga menziesii-Pinus contorta/Arctostaphylos uva-ursi/Racomitrium
Pseudotsuga menziesii-(Pinus contorta)/Arctostaphylos nevadensis
Pseudotsuga menziesii-(Pinus contorta)/Vaccinium mytilus
Pseudotsuga menziesii-Pinus ponderosa/Calamagrostis rubescens
Pseudotsuga menziesii-(Pinus ponderosa)/Symphoricarpus albus
Pseudotsuga menziesii-Tsuga heterophylla/Achyllys trifoliata
Pseudotsuga menziesii-Tsuga heterophylla/Rhododendron macrophyllum
Pseudotsuga menziesii-Tsuga heterophylla/Rhododendron macrophyllum/Polystichum munitum
Pseudotsuga menziesii-Tsuga heterophylla/Polystichum munitum
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon/Polystichum munitum
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Holodiscus discolor
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon/Xerophyllum tenax
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Mahonia nervosa
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Vaccinium Parvifolium
Pseudotsuga menziesii-Tsuga heterophylla/Mahonia nervosa
Pseudotsuga menziesii-Tsuga heterophylla/Mahonia nervosa-Polystichum munitum
Pseudotsuga menziesii-Tsuga heterophylla/Mahonia nervosa-Chimaphilla menziesii

Pseudotsuga menziesii-Tsuga heterophylla/Xerophyllum tenax
 Pseudotsuga menziesii-Tsuga heterophylla/Vaccinium alaskensis/Xerophyllum tenax
 Pseudotsuga menziesii-Tsuga heterophylla/(Acer circinatum)/Polystichum munitum
 Pseudotsuga menziesii-(Tsuga heterophylla)/Acer circinatum-Paxistima myrsinites
 Pseudotsuga menziesii-(Tsuga heterophylla)/Acer circinatum-Corcor/
 Polystichum munitum
 Pseudotsuga menziesii-Tsuga heterophylla/Depauperate

Thuja plicata-Tsuga heterophylla/Lysichiton americana/Spagnum

Thuja plicata-Tsuga heterophylla/Gaultheria shallon-Vaccinium ovatum

Tsuga heterophylla/Gaultheria shallon/Polystichum munitum-Blechnum spicant

Tsuga heterophylla/Polystichum munitum-Oxalis oregana

Tsuga heterophylla/Polystichum munitum-Blechnum spicant

Tsuga heterophylla-Thuja plicata/Gaultheria shallon/Lysichiton americanus

Tsuga heterophylla-Thuja plicata-(Abies amabilis)/Gaultheria shallon/Blechnum spicant

Tsuga heterophylla-(Thuja plicata)/Ledum groelandicum/Sphagnum

Tsuga heterophylla-(Thuja plicata-alnus rubra)/Lysichiton americana-Athyrum felix-femina

Tsuga heterophylla-Abies amabilis/Vaccinium alaskensis/Lysichiton Americana

Tsuga heterophylla-Abies amabilis/Vaccinium alaskensis/Tiarella trifoliata

Tsuga heterophylla-Abies amabilis/Oxalis oregano-Blechnum spicant

Tsuga heterophylla-Abies amabilis/Blechnum spicant-Tiarella trifoliata-Polystichum munitum

Tsuga heterophylla-Abies amabilis/Vaccinium alaskensis/Rubus pedatus

Tsuga heterophylla-Abies amabilis-(Thuja plicata)/Vaccinium alaskensis/Blechnum spicant

Tsuga heterophylla-(Abies amabilis)/Gaultheria shallon/Blechnum spicant

Tsuga heterophylla-Abies amabilis-Pseudotsuga menziesii/Gaultheria shallon

Tsuga heterophylla-Abies amabilis-(Pseudotsuga menziesii)/Vaccinium alaskensis

Tsuga heterophylla-Abies amabilis-(Pseudotsuga menziesii)/Mahonia nervosa

Tsuga heterophylla-Pseudotsuga menziesii/Vaccinium alaskensis/Oxalis oregana

Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskensis/Polystichum munitum

Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskensis-Mahonia nervosa-(Gaultheria shallon)

Tsuga heterophylla-(Pseudotsuga menziesii)/Tiarella trifoliata-Gymnocarpium dryopteris

Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskensis/Cornus unalaskensis

Tsuga heterophylla-(Pseudotsuga menziesii-Thuja plicata)/Oplopanax horridum/Polystichum munitum

Tsuga heterophylla-(Pseudotsuga menziesii-Thuja plicata)/Polystichum munitum-Athyrum felix-femina

Tsuga mertensiana/Caltha leptosepala

Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum

Tsuga mertensiana-Abies amabilis-(Cupressus nootkatensis)/Elliota pyroliflorus-Vaccinium membranaceum

Tsuga mertensiana-Abies amabilis/Rhodendron albiflorum

Tsuga mertensiana-(Abies amabilis-Abies lasiocarpa)/Luzula glabrata

Tsuga mertensiana-Abies amabilis/Vaccinium alaskaensis/Maianthemum dilatatum

Tsuga mertensiana-Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax

Tsuga mertensiana-Abies amabilis/Vaccinium membranaceum/Valeriana sitchensis

Tsuga mertensiana-Abies lasiocarpa/Vaccinium deliciosum-Phyllodoce empetriformis

Tsuga mertensiana-Abies lasiocarpa/Carex spectabilis

This page intentionally left blank.

Publishing support provided by the U.S. Geological Survey
Publishing Network, Tacoma Publishing Service Center

For more information concerning the research in this report, contact the
Director, Forest and Rangeland Ecosystem Science Center,
U.S. Geological Survey, 777 NW 9th Street
Corvallis, Oregon 97330
<http://fresc.usgs.gov>

