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Forest Vegetation Monitoring Protocol for the North Coast and Cascades Network

Natural Resource Report NPS/NCCN/NRR—2010/242



ON THE COVER
Olympic National Park employee Patrick Loafman measuring a Douglas-fir tree at a long-term monitoring plot in the Elwha watershed, Olympic National Park.
Photograph courtesy of Olympic National Park.

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Abstract

Late-successional, coniferous forest is critical for ecosystem function and biological conservation in the Pacific Northwest. Such forests are well-represented in the North Coast and Cascades Network (NCCN) of the National Park Service. We expect that climate change and air pollution are the greatest threats to national parks in the Pacific Northwest. Throughout western North America, tree mortality in unmanipulated forests has begun to increase in recent decades. As part of Vital Signs Monitoring for the NCCN, we have begun to track trends in tree recruitment, growth, and mortality in forests representing the range of environments in network parks. We have established 35, 1-hectare plots in three parks (Mount Rainier, North Cascades, Olympic), at elevations from sea-level to 1800 m. We intend to establish additional plots at San Juan Island National Historical Park, Lewis & Clark National Historical Park, and North Cascades National Park. We will assess tree mortality annually, and record tree recruitment and growth every five years. Monitoring to understand changes in unmanipulated forests in national parks will help managers of harvested lands to practice sustainable management in the face of increasing environmental threats. Monitoring can also provide early warning of the types and severity of future changes in the parks themselves, so that management options can be developed and evaluated in time to be effective.

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Introduction

This protocol narrative outlines the rationale, sampling design and methods for monitoring forest vegetation in the North Coast and Cascades Network (NCCN) as part of the Vital Signs Monitoring Program of the National Park Service (NPS). The NPS defines “vital signs” as “a relatively small set of information-rich attributes that are used to track the overall condition or "health" of park natural resources and to provide early warning of situations that require intervention” (Fancy et al. 2009). Vital Signs Monitoring is being implemented throughout the National Park System; for this purpose, 270 park units have been organized by ecoregion into 32 networks (Fancy et al. 2009). As one of these networks, the NCCN is composed of eight NPS units including five with significant forest area: Lewis and Clark National Historical Park (LEWI), Mount Rainier National Park (MORA), North Cascades National Park Service Complex (NOCA), Olympic National Park (OLYM), and San Juan Island National Historical Park (SAJH). Since 1997, numerous monitoring workshops and meetings have been conducted in the NCCN to identify key park ecosystem components and core indicators within each ecosystem component, in addition to allocating limited funding to the development and implementation of monitoring protocols (Weber et al. 2009). As part of this process, forest vegetation was identified as one of the park ecosystem components for protocol development. The U.S. Geological Survey (USGS), through the Forest and Rangeland Ecosystem Science Center, has been integrally involved in development of Vital Signs Monitoring in NCCN (Weber et al. 2009), and was the lead agency for development of the original version of the forest monitoring protocol (Woodward et al. 2009).

The structure and content of this protocol adhere to the outline and recommendations adopted by the NPS in Oakley et al. (2003). Methodological details of the protocol are addressed in a set of standard operating procedures (SOPs) found at the end of the document, along with appendices containing additional supporting materials referred to in the narrative.

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 (Birkeland 1984, Jenny 1941). 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 et al. 2002). Consequently, knowledge of the status of forests in the North Coast and Cascades Network is fundamental to understanding the condition of Pacific Northwest ecosystems.

Diverse precipitation, temperature and soil properties across the Pacific Northwest result in a variety of forest types (Franklin and Dyrness 1988, Franklin et al. 1988, Henderson et al. 1989, 1992). Mountainous terrain creates steep elevation and precipitation gradients within and among the parks. These parks span an elevation gradient from sea level to over 4200 m; annual precipitation ranges from 50 cm to over 500 cm. The resulting forests range from coastal rainforests with massive trees draped with epiphytes and surrounded by dense understories; 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.

Table 1. Characteristic forest types in the five national parks of the NCCN included in forest monitoring. The dominant species within each elevation category is a consequence of the precipitation gradient in each park. Precipitation ranges at forested elevations for each park are indicated in parentheses.

Elevation Zone - Approximate	**Lewis and Clark NHP** (180 cm precipitation)	**Mount Rainier NP** (200 – 300 cm precipitation)	**North Cascades NP** (100 – 500 cm precipitation.)	**Olympic NP** (75 – 500 cm precipitation)	**San Juan Island NHP** (50 – 75 cm precipitation)
Low (0-300 m)	Sitka spruce	Western hemlock	Western hemlock	Sitka spruce	Douglas-fir
Mid (300-1000 m)	not present	Western hemlock	Western hemlock or ponderosa pine	Western hemlock or Douglas-fir	not present
Lower Montane (1000-1500 m)	not present	Pacific silver fir	Pacific silver fir or lodgepole pine	Pacific silver fir	not present
Upper Montane (> 1500 m)	not present	Mountain hemlock or subalpine fir	Mountain hemlock or subalpine fir	Mountain hemlock or subalpine fir	not present

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 (FEMAT 1993). Much of what is left is located at mid- and high elevations and in national parks and other protected areas such as 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 changes in unmanipulated forests in national parks will help federal managers of harvested lands to sustainably manage 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 having one-tenth of the plots 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). 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 can contribute to greater understanding and context for the other.

Several global and regional stressors (i.e., 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 (Weber et al. 2009). Changes in forest structure and composition will also alter the chemistry of water moving from terrestrial to aquatic systems (Edmonds et al. 1998, McClain et al. 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 (e.g., 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.

Forest monitoring is only one aspect of vegetation monitoring included in the NCCN monitoring program (Weber et al. 2009). Other protocols include using satellite-based imagery for landscape-scale monitoring 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. Forest monitoring and landscape-scale monitoring will reinforce one another. The landscape-scale monitoring will provide context for changes observed in the forest plots, while results from forest monitoring may suggest mechanisms for subtle changes observed through the landscape-scale monitoring. In addition, forest monitoring will aid in interpretation of landbird monitoring. Although plots are not co-located due to differing

sample designs, forest monitoring will provide insights into the dynamics of habitats which are essential for many breeding birds in the NCCN (Siegel et al. 2007).

The original goal of forest monitoring in the NCCN was to detect changes in the composition of forest understory vegetation in the face of climate change and other stressors with tree demography as an important, subsidiary goal (Woodward et al. 2009). However, in the time between development and full implementation of this approach, it became clear that it was too expensive to be sustainably funded. In the current, reduced monitoring protocol the focus is limited to tree demography (recruitment, growth, and mortality). We have been able to take advantage of the substantial effort expended since 2005 to generate a stratified random sample of potential locations for monitoring plots, screen locations in the office and in the field, and establish monitoring plots. The statistical validity (and power) of our sample design remains, although the emphasis has changed.

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 (Barnosky 1984, Davis 1981). 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 et al. 2000). Shifts in tree species distribution will be driven by global climate change at large spatial and temporal scales (Davis 1989, Stohlgren et al. 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. 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, van Mantgem et al. 2009), demonstrating the utility of long-term forest monitoring. Therefore we will establish permanent forest plots for monitoring forest demography, structure, and composition to detect biologically significant changes that are too subtle to monitor remotely and are not adequately collected by the FIA monitoring program at the scale of individual national parks.

Our general approach is to focus on coniferous forest zones that represent the range of climatic regimes and elevation in the NCCN (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 intermediate western hemlock zone, which is represented in all three large parks (Mount Rainier, North Cascades, and Olympic). Limited resources and the need for sample replication require that we further focus on particular vegetation 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 vegetation associations we have chosen in the context of

a more comprehensive list of known associations are shown in **Appendix E: Conifer Forest and Woodland Vegetation Associations of North Cascades, Olympic and Mount Rainier National Parks.**

C. Measurable Objectives

Our objectives are to monitor trend in the processes of tree recruitment, growth, and mortality, and forest structure and composition. 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 will also 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 that will not be funded as part of the monitoring program, but that we recognize will be important to study. Specifically we will monitor the following parameters:

Structure and Composition

- Trees – We will monitor dimensions, 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 – We will monitor changes in density and size as indicators of forest structure and carbon cycling.

Processes

- Tree recruitment – We will monitor saplings to track changes in establishment success and species composition as indicators of changing forest structure.
- Tree growth – We will monitor growth of tagged trees as an indicator of changing conditions for forests.
- Tree mortality – We will monitor numbers of deaths annually by species to detect changes in rate and cause (if possible) as indicators of changing forest structure and composition.

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

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

These parameters will be monitored in an array of permanent plots designed to intensively sample forest types selected to represent regional environmental extremes and a common forest type across the three large parks. Specifically, we will be limited 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 type common to all three parks (mid-elevation type in all three parks). We will also monitor forests at the two of the smaller parks in the network (Lewis and Clark National Historical Park and San Juan Island National Historical Park). Due to the smaller area and limited forest types at these two

parks, the forest types to be monitored will more broadly defined than at the large parks. Similar to the large parks, monitoring will be limited to mature and/or old-growth stands.

2. Sampling Design

A. Rationale

Basic Principles

We applied several basic principles or assumptions in developing our sample frame:

- 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 steep terrain and dangerous rivers.

We also sought replicates of communities defined by understory vegetation due to the need to detect change in community composition under the original primary objective of the protocol.

Evaluation of FIA Sample Frame

We evaluated the sample frame and methods for the FIA plots as to their usefulness to detect changes in understory species composition, tree basal area, and tree mortality (Woodward et al. 2009). FIA data are usually summarized by state with one number for each parameter (e.g., forested acres, harvested acres, acres by ownership), and they 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 (e.g., a positive change in a parameter in a drier portion 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. Unfortunately, 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 trend.

To test this assumption, we conducted a power analysis of data from two common communities using data from the first two years that the FIA program included national parks. We found that the communities labeled TSHE (i.e., western hemlock) and PSME (i.e., Douglas-fir) by FIA are the only ones with at least two plots in each year of data collection across all three large parks. Power analysis of these data showed at least 80% power at alpha equal 0.10 to detect a positive or negative 4% annual change over 20 years for tree basal area (Woodward et al. 2009). (Twenty years is the time required to revisit every plot according to the FIA sample frame.) Mortality estimates had at least 76% power after 30 years (the plots have to be visited at least three times to estimate a change in mortality). Although FIA data will have the power to detect trend in some forest types aggregated across the network, there is not enough community replication to meet the needs of parks in the NCCN. The network will make the best possible use of FIA data but sees the need for more intensive plot-level monitoring.

NCCN Sample Frame

In designing the sample frame for vegetation monitoring in NCCN, our goal is to develop a comprehensive spatial sample frame for the parks, recognizing that we can only monitor part of this frame initially. We want the sample to be interpretable based on vegetation types, yet

flexible enough to be useful in the face of expected future changes in community composition and/or elevation range (Gates 1993) as organisms respond independently to changing environment (Peters and Lovejoy 1992). Therefore, we will conduct double-sampling by initially stratifying our sample using elevation, and secondly by current vegetation. Finally, we are working in forests that have centuries-old trees, which have survived substantial environmental changes during their lives. 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). However, mortality of trees occurs throughout the life of any forest stand (Franklin et al. 1987, 2002). In earlier successional stages, tree mortality tends to result from competition with other trees rather than external factors (Franklin et al. 1987, 2002, Oliver and Larson 1990). Consequently we want to work in mature or older forests where the primary drivers of tree mortality are environmental factors external to the stand (Franklin et al. 1987, 2002).
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 Tesselation 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.

Our fixed strata in each park will be 300 m elevation bands, of which we can only afford to sample two in each of the large parks at present. We will sample one 300 m elevation band in the smaller parks. We will sample the chosen strata at random 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 set of vegetation communities to get a biologically interpretable sample. We are using sets of vegetation communities as proxies for climate within elevation strata, so as to increase the signal of vegetation change due to external drivers and decrease the potential for noise due to environmental differences within strata. The rationale for the sets of vegetation communities is different for the different strata. For the 0-300 m and 600-900 m strata, we have chosen sets of vegetation communities which characterize the middle of the moisture gradient within the stratum and are relatively widespread in the Pacific Northwest (Agee and Kertis 1986, Franklin et al. 1988, Henderson et al. 1989, Crawford et al. 2009). In the 1500-1800 m stratum, we have chosen a set of vegetation communities which characterize the dry end of the moisture gradient within high-elevation, cold forests (Franklin et al. 1988).

In addition to stand age and vegetation community, we will also 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 set of vegetation communities and other vegetation types. The second stage is evaluated by field reconnaissance. FIA 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 one example of a specific set of vegetation communities within one or two specific elevation bands within each park (detailed below). For example, our range of inference

in the western hemlock forest zone will be plant associations having Oregon grape or salal in the understory, between 600 m 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. (There are a few other criteria to be found in **SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots**).

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 chosen exemplify the extremes and the middle of the overall environmental gradient for forests in our network. In addition, the community in the middle of the gradient is present in all the large parks and common elsewhere allowing for comparison across parks and producing information that is relevant to the region as a whole.

1. Warm & wet – Sitka spruce from 0-300 m in Olympic National Park and Lewis and Clark National Historical Park. These forests are also important winter feeding grounds for Roosevelt Elk and are mentioned prominently in Olympic National Park's enabling legislation. For Olympic National Park we chose a vegetation association with an oxalis or sword-fern understory because it is common in inland Sitka spruce forests. At Lewis and Clark National Historical Park we will include a broader range of understory types than at Olympic National Park due to the small area in mature and old-growth forest.
2. Cold & dry – Subalpine fir from 1500-1800 m in North Cascades and Mount Rainier National Parks. High elevation ecosystems are expected to be sensitive to climate change (Giorgi et al. 1997, Mote et al. 2003) and we will have two examples for comparison.
3. Common among parks – Western hemlock with salal and/or Oregon grape understory from 600-900 m in Olympic, North Cascades and Mount Rainier National Parks. This elevation band appears to occur near the midpoint of the elevation distribution of western hemlock forests in these parks according to GIS analysis of vegetation maps. These vegetation 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.
4. We will also monitor mature and old-growth forest in the 0-300 m elevation range at San Juan Island National Historical Park. The target vegetation will be western hemlock with a broader range of understory types than at the larger parks due to the small area of forest at San Juan Island National Historical Park.

A complete list of coniferous plant communities occurring in the three large parks is shown in **Appendix E: Conifer Forest and Woodland Vegetation Associations of North Cascades, Olympic and Mount Rainier 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 associations developed by the Washington Natural Heritage Program for determining the vegetation type at each point (Crawford et al. 2009). 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 et al. 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. Fortunately, we cored plots that were questionable and know that our sample consists largely of plots older than 120 years.

In addition to selecting plot sites based on vegetation association 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 at the larger parks, and closer than 30 m at Lewis and Clark and San Juan Island, to minimize vandalism and the visual impacts to park visitors (see **SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots**). The closer allowable proximity to roads and trails at the smaller parks is due to the smaller area and less off-trail travel by visitors.

Stage 1 sample points within the chosen elevation bands and meeting the above criteria are identified using a variable density grid-based sampling method called Generalized Random Tessellation Stratified (GRTS, Stevens 1997) to select random points. 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 association scale, we need to visit each point and apply the classification key to stratify the stage 1 sample (stage 2 population) into mature or old-growth examples of a specific set of vegetation associations and other vegetation types. A 100% sample of the first stratum will be observed, but we will establish permanent plots only at points having the target vegetation. Permanent plots are added to the sample in the numerical order generated by GRTS.

We recognize that catastrophic disturbance (e.g., wildfire), may occur after a plot is established. Since catastrophic disturbance in permanent plots can represent informative "natural experiments," (e.g., Acker et al. 2003), we will continue to monitor such plots to the extent that it is safe and practical. As funding allows, we will identify and establish additional permanent plots so as to maintain an adequate sample of undisturbed forest in anticipation of some (unpredictable) amount of catastrophic disturbance.

In addition to identifying locations for permanent plots, this reconnaissance step also provides an estimate of the relative distribution of vegetation 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 (Figure 1).

The process of site selection is nearly complete for the three larger parks (Figures 2, 3, and 4) with only one more plot in the 1500-1800 m elevation band at North Cascades to be identified.

Site selection has not been carried out for Lewis and Clark and San Juan Island as of fall of 2009. Progess towards the planned sampling design is shown in Table 2.

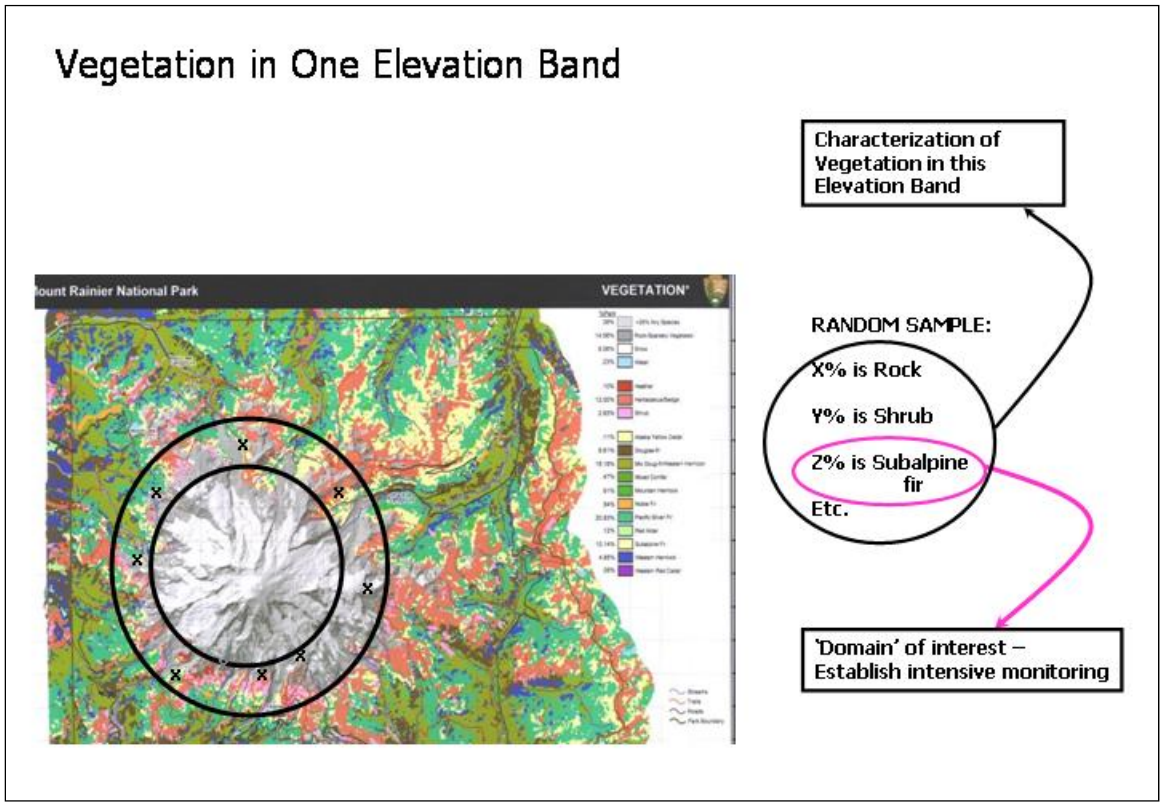


Figure 1. Example of selecting locations for permanent plots after visiting all points in the GRTS sample for a hypothetical 300 m elevation band. In addition to identifying sites for permanent plots, the process also provides a characterization of the elevation band that can be compared with results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

Table 2. Sample of permanent plots for forest monitoring in the NCCN as of fall 2009. The current goal for replication is six plots for each sampled combination of elevation stratum and park, though more will be established if possible.

Elevation stratum	Target vegetation type[1]	Lewis and Clark NHP	Mount Rainier NP	North Cascades NP	Olympic NP	San Juan Island NHP
0-300 m	Sitka spruce[2]	0	n/a	n/a	6	0
600-900 m	Western hemlock	n/a	6	6	6	n/a
1500-1800 m	Subalpine fir	n/a	6	5	n/a	n/a

[1]See **SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots** for target understory vegetation.
[2]Western hemlock at San Juan Island NHP.

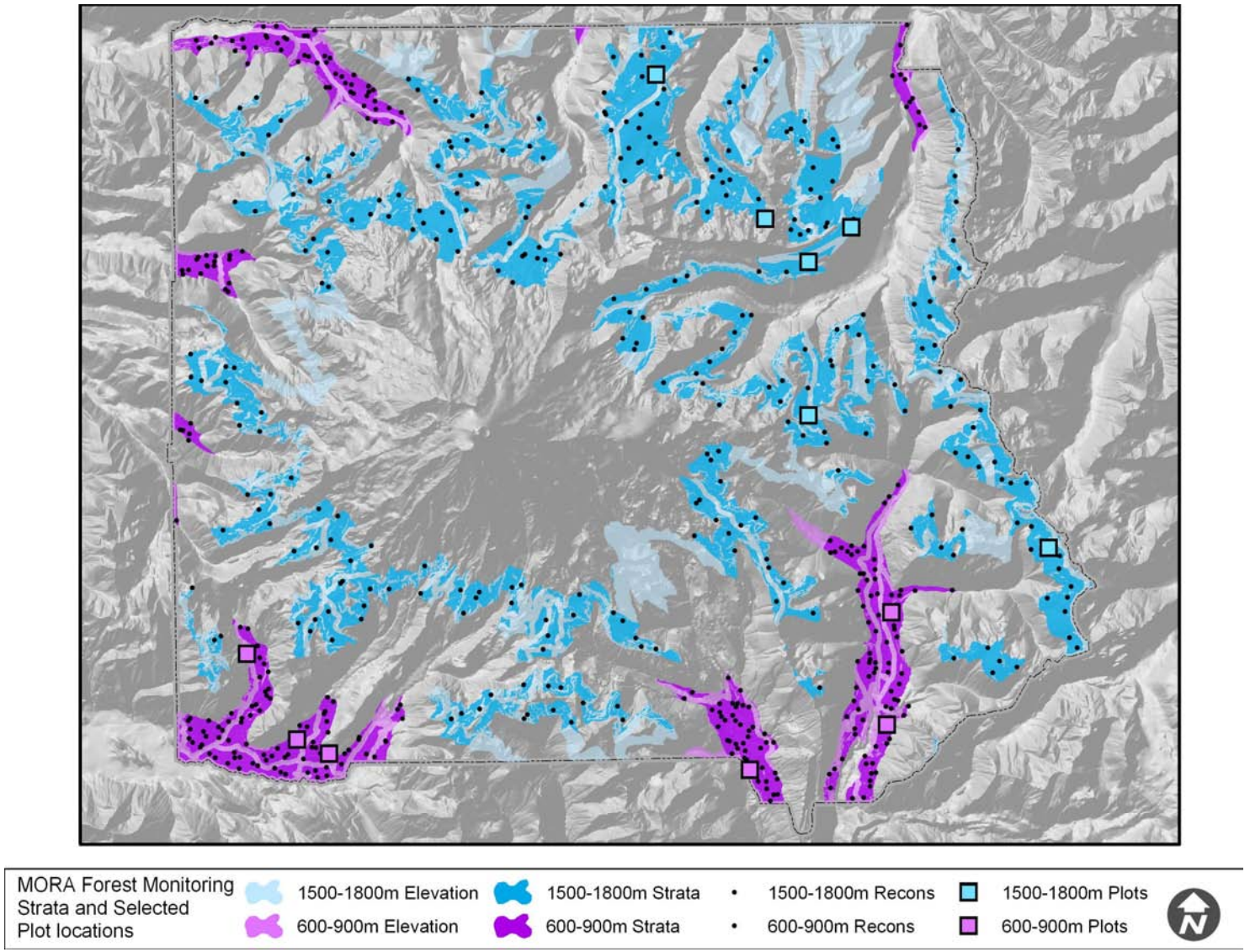


Figure 2. Locations of permanent plots in Mount Rainier National Park by elevation band. Lighter shading indicates the entire area within an elevation band; darker shading represents the area remaining after automated screening for excessive distance from roads or trails, excessively steep slopes, and water bodies.

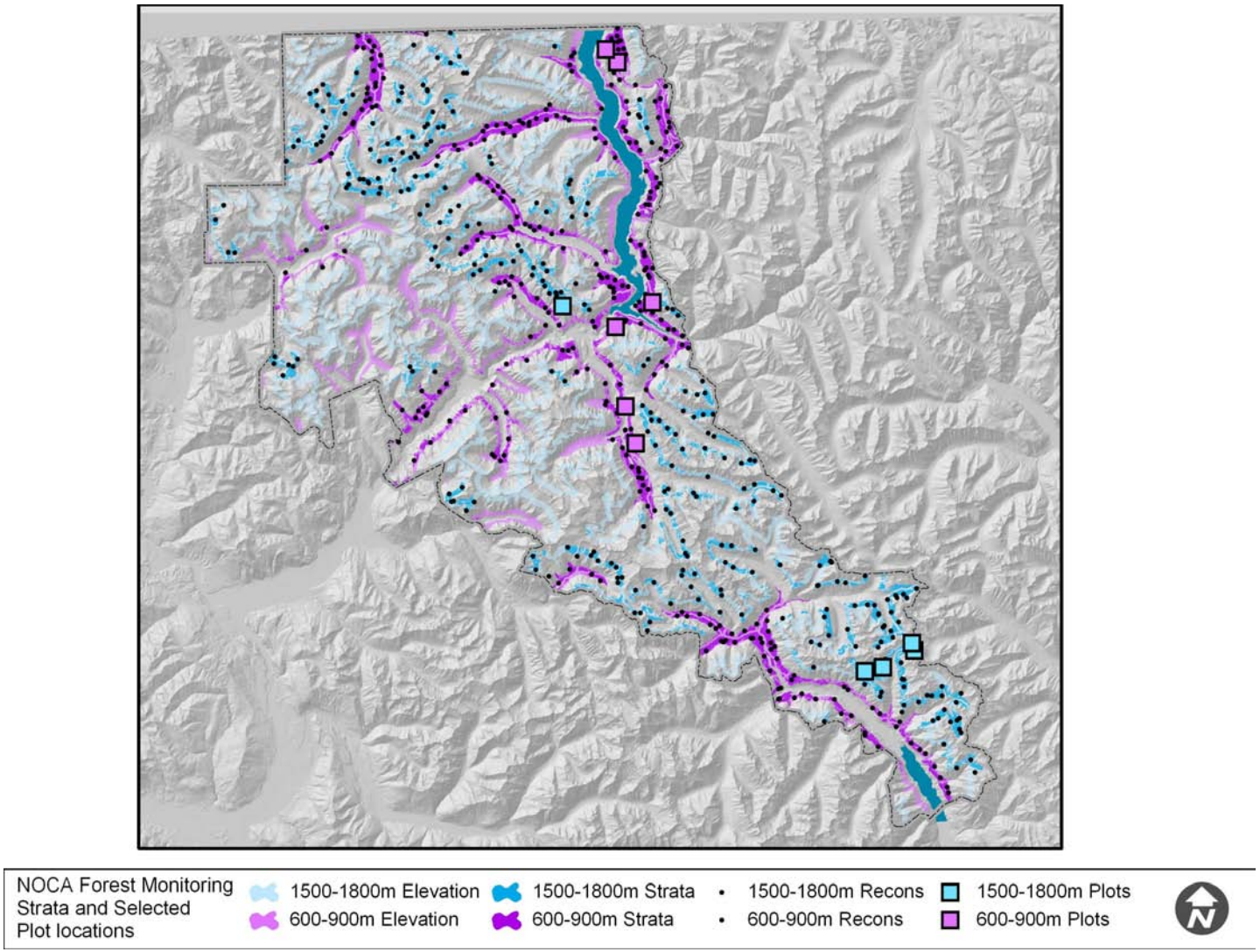


Figure 3. Locations of permanent plots in North Cascades National Park by elevation band identified to date. The complete sample will include six plots in each elevation band. Lighter shading indicates the entire area within an elevation band; darker shading represents the area remaining after automated screening for excessive distance from roads or trails, excessively steep slopes, and water bodies.

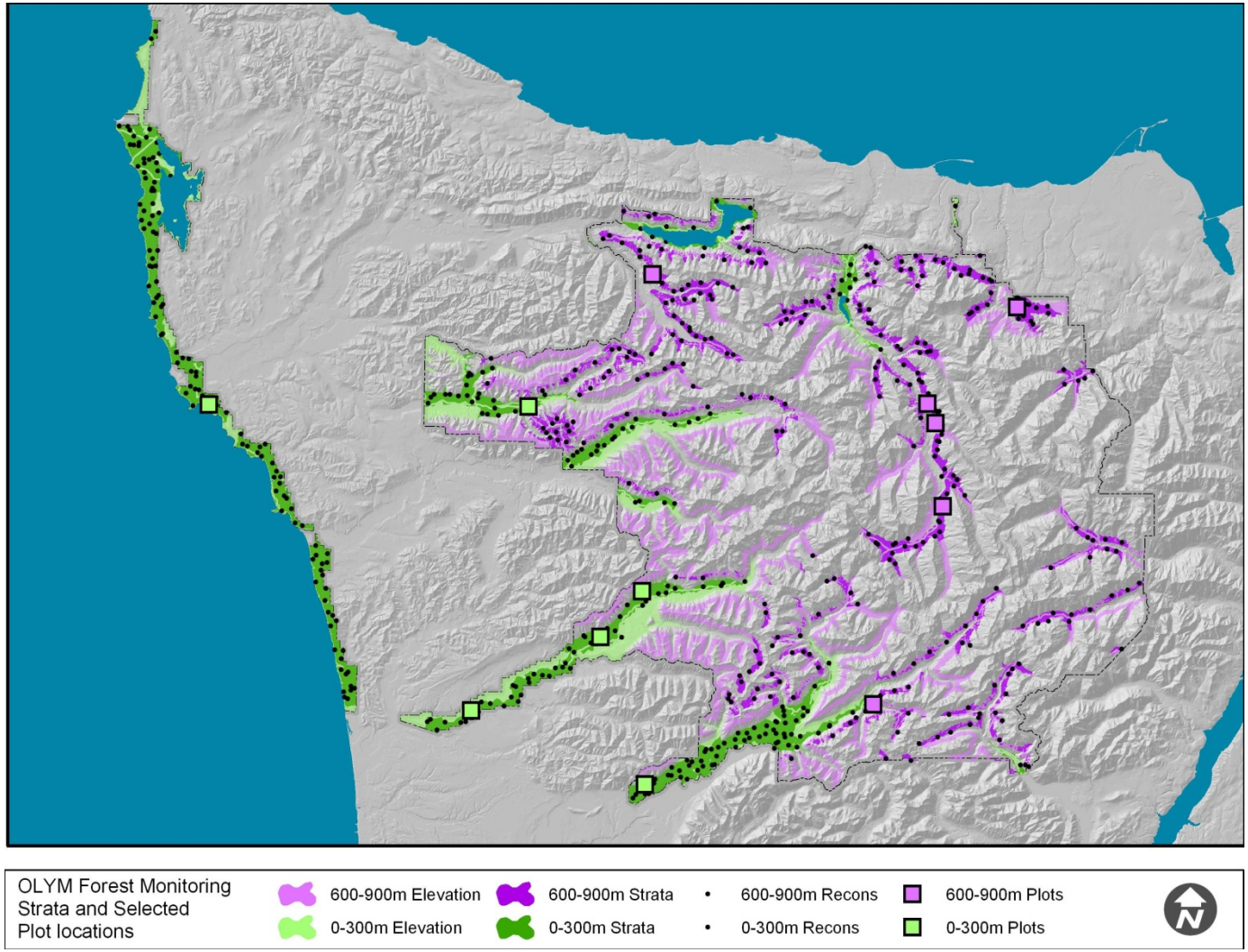


Figure 4. Locations of permanent plots in Olympic National Park by elevation band. Lighter shading indicates the entire area within an elevation band; darker shading represents the area remaining after automated screening for excessive distance from roads or trails, excessively steep slopes, and water bodies.

These intensive monitoring plots are part of a larger set of planned or potential forest monitoring in the NCCN (Table 2). Landscape change monitoring will provide context for changes observed in the permanent plots at the large parks by capturing disturbances and physiognomic changes in forests (i.e., changes between conifer and hardwood dominance). Data from FIA could be used to assess changes in canopy or understory composition in one or two forest types across the network, on a time scale of decades. The points that we assessed to be non-target vegetation types in target elevation strata could be revisited in several decades to detect gross changes in species composition (i.e., changes in vegetation association). All of these projects would complement our observations of tree demography and canopy composition and structure in the targeted combinations of park, elevation stratum, and forest type.

Table 2. Forest monitoring projects with data available to NCCN.

Project	Reference Frame	Frequency	Response Variables
NCCN Landscape Change Protocol (remote sensing)	• Entire park (all three large parks) • Compete sample	Annual	• Conifer/deciduous distribution • Disturbance regime • Treeline movement
FIA	• Entire park (all three large parks) • 5 x 5 km grid • One or two forest types across NCCN with adequate sample size	10 yr panel repeat	• Structure, composition of canopy, coarse understory description, few replicated communities
Reconnaissance (i.e., repeat observation of non-target vegetation types at points visited during preliminary screening for this protocol)	• 300 m elevation bands • GRTS sample	decades	• Vegetation classification
Permanent Plots (i.e., this protocol)	• Vegetation type w/in 300 m elevation band • GRTS sample	Tree mortality annually, 5 yr repeat for other measures	• Detailed demography, composition, and structure of saplings and canopy trees

This protocol is also linked to other NCCN monitoring protocols. Sitka spruce forests provide summer and winter habitat for elk which will also be monitored by the NCCN. By monitoring forest regeneration and structure, this protocol will provide context for interpretation of elk abundance and distribution. 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 et al. 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 set of vegetation associations.

We have chosen to record tree mortality annually for several reasons. Annual observations will better enable us to identify proximate causes of mortality (van Mantgem and Stephenson 2007), inasmuch as signs of relevant insects and pathogens may fade quickly and trees that die standing may soon fall or break. Annual observations also allow for correlation with specific weather events and short-term climate change (van Mantgem and Stephenson 2007). Finally, tree mortality is often an episodic process (Franklin et al. 1987). Longer measurement intervals lead to underestimates of the true rate of tree mortality (Sheil 1995, Sheil and May 1996), and underestimates of the temporal variability of tree mortality. We will measure trees and add trees that have grown large enough to measure every five years. This interval should be long enough to detect tree growth, and short enough to ensure that growth information is captured from most trees, that few new recruits die before being added to the monitored population, and that gross errors are detected and corrected promptly (Avery and Burkhart 1994, Sheil 1995).

The measurements at all plots will occur on the same schedule (Table 3). Thus, after five years we will have our first set of data points for tree recruitment and growth. After ten years we will be able to describe change in tree recruitment and growth, and after 15 years we will be able to describe trends. We will have our first set of data points for tree mortality after two years, with information on change and trends after three and four years, respectively.

Table 3. Monitoring variables and frequency of measurement.

Variable	Frequency	Population
Tree mortality	Annual	All tagged trees that were alive at last visit
Tree recruitment	Every five years	Stems attaining measurable size since last measurement
Tree growth	Every five years	All tagged trees that were alive at last measurement

The original sample design sought to detect trends in major understory species within each combination of park and elevation stratum. Based on a power analysis of data from a pilot study, we chose to establish 18 plots within each combination of park and elevation stratum (Woodward et al. 2009). As we shifted the emphasis to tree demography, we recognized the need to assess statistical power to detect changes in tree mortality to see if our sample sizes would still be adequate, and to determine whether or not we could reduce the cost of the protocol by reducing the number of plots. We chose mortality over recruitment and growth because it is likely to have more dramatic effects on forest structure in the short term, and because we will be able to report trends much sooner than for the other variables. We deduced that statistical power for tree mortality trends would be some function of both the number of plots and the number of stems per plot. We projected that we could afford to intensify our sub-sampling of saplings and small trees to roughly 200 stems per plot, while maintaining a total number of plots similar to the

number of plots analyzed by van Mantgem and Stephenson (2007). We asked what number of plots per stratum would be necessary to detect trends similar to those found by van Mantgem and Stephenson (3% annual increase in mortality rate over 20 years), with alpha <= 0.1 and power >= 80%. We used data from permanent plots in mature and old-growth forests in western Oregon and Washington to estimate the distribution of site mean mortalities and interannual errors (TerraStat 2008).

The power analysis indicated that 12 plots should be sufficient to detect a 3% annual increase in mortality over 20 years (TerraStat 2008). The analysis was conducted for three different habitat types: Sitka spruce, western hemlock, and Douglas-fir. The first two are most relevant to our sampling design. Estimated power for Sitka spruce was 99% with 12 plots, and 84% with six plots. Estimated power for western hemlock was 98% with 12 plots, and 74% with six plots. Our current design entails six plots for each combination of park and elevation stratum. Thus the predicted power is adequate for both Sitka spruce between 0 and 300 m (six plots at Lewis and Clark National Historic Park and Olympic National Park) and for western hemlock between 600 and 900 m (18 plots in the three large parks). The predicted power is slightly lower than we desired for the western hemlock plots in each large park alone. This is a necessary compromise to reduce costs. We were not able to obtain relevant, long-term data for subalpine fir forests in the Pacific Northwest so no estimate of statistical power is available. We propose to assess the power of our design for forests in the 1500-1800 m elevation stratum after we have accumulated 10 years of annual observations.

D. Plot Design

Our permanent plots are slope-corrected one-hectare squares with edges oriented along cardinal directions (Figure 5). This total area is consistent with FIA and other permanent monitoring plots in the Pacific Northwest (Acker et al. 1998). 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 et al. 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 et al. 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 et al. 1998). We centrally locate a 50-m intensive plot divided into 25 10-m subplots within the 1-ha macroplot (Figure 5; lengths represent one side of a square plot or subplot). The outer corners of the 50-m intensive plot are marked with rebar and the corners of the 10-m subplots are marked with wooden stakes. The wooden stakes help minimize the visual

impact of permanent markings in wilderness areas and can be replaced as they decay. At Lewis and Clark and San Juan Island, the 50 x 50 m area comprises the entire plot.

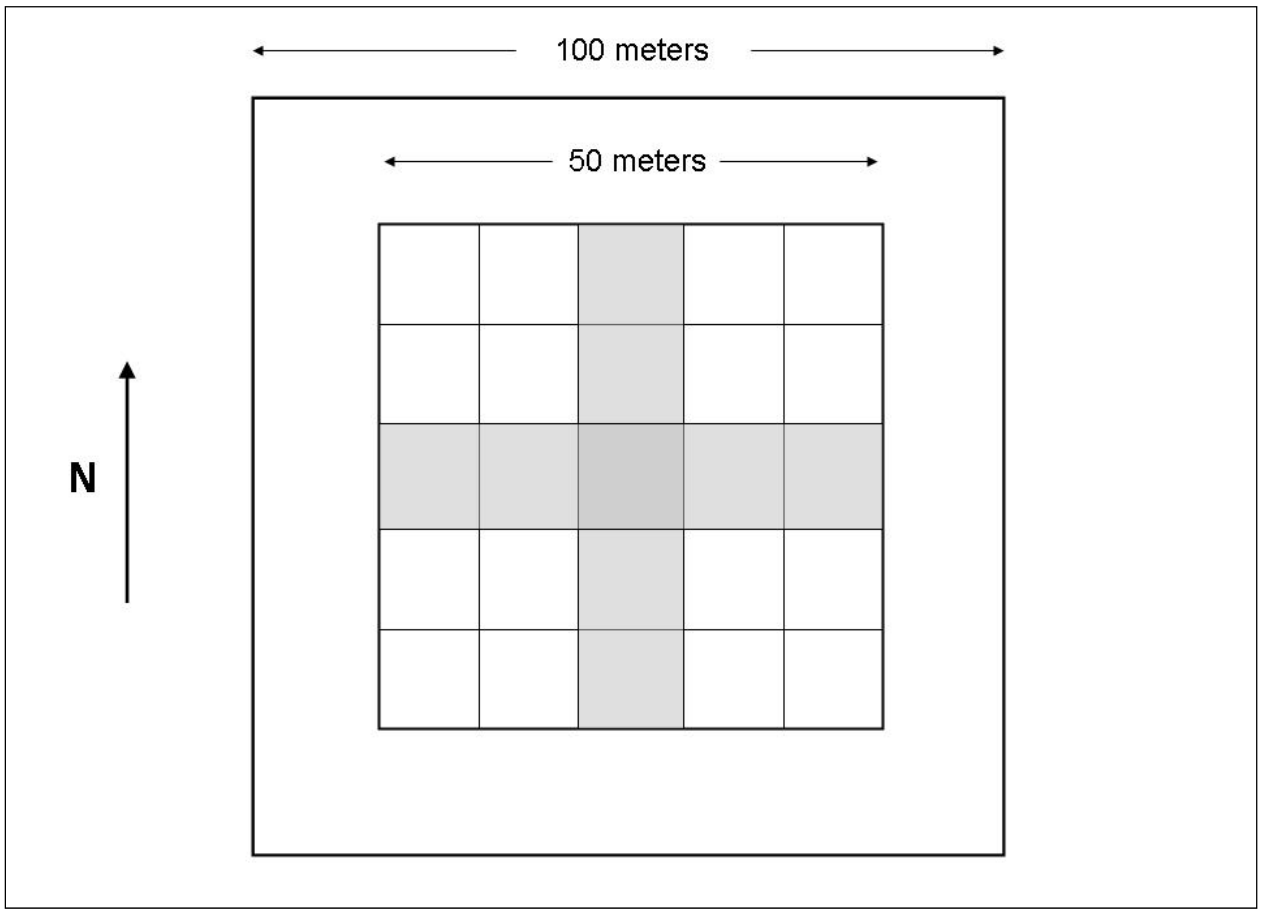


Figure 5. One-ha macroplot showing location of 50-m intensive plot divided into 10-m subplots. All plots are oriented along cardinal directions. The subplots within which saplings (2.5 to 12.6 cm dbh) are monitored are shaded. Small trees and snags (12.7 to 76.2 cm dbh) are measured within the entire 50-m intensive plot. Large trees and snags are measured within the entire macroplot. At Lewis and Clark and San Juan Island, the 50 x 50 m area comprises the entire plot.

3. Field Methods

A. Field Season Preparations and Equipment Setup

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, though it is 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 3: Hiring Guidelines and Procedures** and **SOP 2: Preparing for the Field Season**.)

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. We have not included precise locations for plots in this protocol document to avoid compromising the security of the plots. Precise locations and directions are maintained in the project database and are provided to field crews as necessary in the Navigation Report (see **SOP 2: Preparing for the Field Season**). Crew housing needs to be secured at each of the parks, and housing, campsites, and other logistic arrangements for the training session need to 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 logistic problems. This may be done in concert with staff planning logistics for other monitoring projects involving backcountry travel. (See **SOP 2: Preparing for the Field Season**.)

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 implementation for all three large 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 measurement interval (years 2013, 2018, etc.)

B. Sequence of Events During Field Season

Note: Refer to **Appendix B: Yearly Project Task List** 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 will also be encouraged to participate in parts of the seasonal training programs conducted by the large parks 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 one office day every 8 work days for data management and equipment maintenance. One crew each will be stationed at each of the large parks. The Mount Rainier crew will measure plots at Lewis and Clark; the work at San Juan Island will be performed by the North Cascades and Olympic crews. Plots will be grouped into geographic tours and will be visited beginning at low elevations and working up. The Project Lead (Olympic) or NPS Plant Ecologist (Mount Rainier and North Cascades) will be available at the beginning and end of each tour to hear feedback, answer questions, and address concerns (see Chapter 6).

C. Details of Taking Measurements, with Example Field Forms

In general, we adopted the methods of FIA whenever possible. In particular we used FIA size classes for tree categories (e.g., 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.

Trees will be monitored in areas commensurate with their size: saplings (2.5 to 12.6 cm dbh) in nine of the 10 x 10 m subplots; small trees (12.7 to 76.2 cm dbh) and snags in the 50 x 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 (see glossary). At Lewis and Clark and San Juan Island, the 50 x 50 m area comprises the entire plot.

We will take several descriptive measurements on small and large trees (i.e., species, height, diameter at breast height, canopy ratio, canopy class). We will also 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 of the measurements, categories, criteria, and methods will be according to FIA so that our measurements will be comparable to theirs. 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 10: Measuring and Mapping Live and Standing Dead Trees**.)

Complete tree measurements and tagging of any saplings or trees newly grown to the appropriate size will occur every five years. In the intervening years, all previously live trees will be checked, new mortality noted, and information on condition of newly-dead trees recorded.

D. End-of-Season Procedures

End of season procedures are described in **SOP 14: End of 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 deviations from established protocols. Finally, it should point out 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 Leads and Data Analysts.

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 are provided in the NCCN Data Management Plan (Boetsch et al. 2009), which describes the overall information management strategy for the network. The NCCN website (http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm) also contains guidance documents on various information management topics (e.g., 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 **Appendix B: Yearly Project Task List**. Readers may also refer to each respective chapter section for additional guidance and instructions.

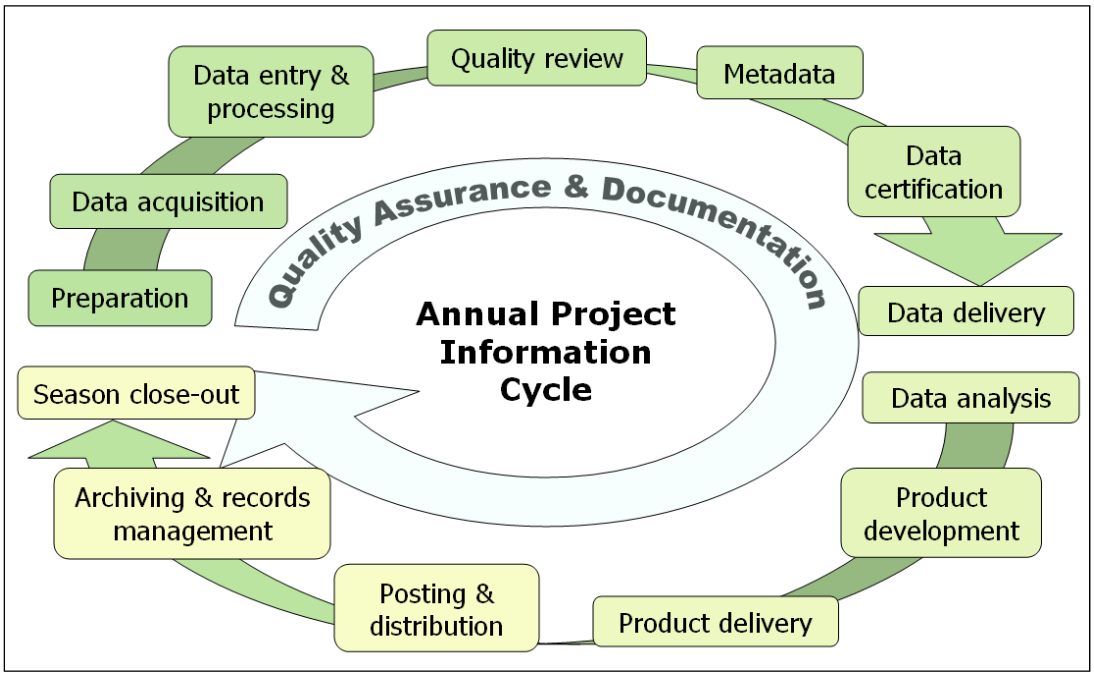


Figure 6. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out. Note that quality assurance and documentation are thematic and not limited to any particular stage.

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 & processing* – Data entry and database uploads, GPS data processing, etc.
- *Quality review* – Data are reviewed for structural integrity, completeness 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.
- *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 archiving.
- *Posting & distribution* – Distribute products as planned and/or post to NPS clearinghouses.
- *Archiving & 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, and develop work plans for the coming season.

B. Pre-season Preparations for Information Management

Project Workspace Setup

A section of the networked file server at each host park is reserved for this project, and access privileges are established so that project staff members have access to needed files within this workspace. Prior to each season, the Project 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. Workspace structure, naming conventions, and additional details are provided in **SOP 1: Project Workspace and 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 are provided in **SOP 6: GPS Use** and in NCCN GPS Guidelines (North Coast and Cascades Network—National Park Service 2007a).

Project Database Application

Prior to the field season, the Data Manager will update the project database application as needed to 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.

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. 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 storing data in a series of related tables composed of fields and records (i.e., the "back-end database"), and another that acts as a portal or user interface through which data may be entered, viewed, edited, error-checked, summarized and exported (i.e., the "front-end application"). By splitting the database into front-and back-end

components, multiple users may interact with the data simultaneously, and user interface updates can be implemented without service disruptions.

The back-end database schema (tables, fields and relationships) is documented in **Appendix C: Forest Vegetation Monitoring Protocol Database Documentation**. The back-end database is implemented in Microsoft SQL Server to take advantage of the automated backup and transaction logging capabilities of this enterprise database software.

The front-end is implemented in Microsoft Access. It contains the forms, queries, and formatted report objects for interacting with the data in the back-end. Its features and functionality are customized using Visual Basic for Applications (VBA) programming code. The application has separate forms for data entry that mirror the layout of hard-copy field forms used during data collection. There are also forms for browsing and editing data, for completing the annual quality review, and for summarizing and exporting data to other software (e.g., for analysis and graphics production).

D. Data Entry and Processing

During the field season, the project crew will be provided with a copy of the project database front-end, through which they enter, process, and quality-check data for the current season.

Technicians should enter data as soon as possible after each field trip in order to keep current with data entry tasks, and to identify any errors or problems as close to the time of data collection as possible. The front-end database application is found in the project workspace. For enhanced performance, it is recommended that users copy the front-end 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 database. Whenever updates to the front-end application are made available by the Data Manager, an updated front-end should be copied from the project workspace to the workstation hard drive.

The functional components of the front-end application are described in **SOP 13: Data Entry and Verification**. Each data entry form is patterned after the layout of the corresponding 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 to use only these pre-built forms as a way of ensuring maximum data quality.

Regular Data Backups

Automatic database backups are scheduled in the SQL Server database management system to help prevent data loss in case of user error, drive failure, or database file corruption. Full backups are scheduled on a weekly basis, with daily transactional backups to enable restore operations to a point in time within a moving eight-week window. Weekly backups and transaction files are retained for eight weeks to conserve drive space. Full monthly backups are retained for a longer period and are stored offsite as a protective measure.

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 Crew Lead should inspect the data being entered to check for completeness and perhaps identify avoidable errors. The Crew Lead may also periodically run the Quality Assurance Tools that are built into the front-end 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 15: Data Quality Review and Certification**).

Field Form Handling Procedures

As 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 should also 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 five-year basis, data sheets are to be scanned as PDF documents and archived (see the product delivery specifications in **SOP 16: Product Delivery, Posting and Distribution**). The PDF files may then serve as a convenient digital reference of the original if needed.

Image Handling Procedures

This section covers photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be filed and named in such a way that they will not be confused with project records.

Care should be taken to distinguish data photographs from incidental or opportunistic photographs taken by project staff. Data photographs are those taken for at least one of the following reasons:

- To document a particular feature or perspective for the purpose of site relocation
- To capture site characteristics and possibly to document gross structural changes over time
- To document a species detection that is also recorded in the data.

Data photographs are often linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photographs – e.g., of field

crew members at work, or photographs showing the morphology or phenology of certain plant species – may also be retained but are not necessarily linked with database records.

Refer to **SOP 12: Managing Photographic Images** for details on how to handle and manage image files.

GPS Data Procedures

The following general procedures should be followed for GPS data (see **SOP 6: GPS Use** and **Appendix B: Yearly Project Task List**):

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: Project Workspace and 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 or update any project GIS data sets as needed.

The Crew Lead should periodically review the processed GPS data to make sure that any errors or inconsistencies are identified early.

E. Data Quality Review

After the data have been entered and processed, they need to be reviewed by the Project Lead for structural integrity, completeness and logical consistency. The front-end 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. Not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is documented and included in the metadata and certification report (see **Sections 4F, Metadata Procedures** and **4G**, **Data Certification and Delivery**, and **SOP 15: 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 reviewed and certified. Prior to certification, daily backups of the database provide a crude means of restoring data to the previous day's state. After certification, all edits to certified records are tracked in an edit log (refer to **Appendix C: 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 16: Product Delivery, Posting and Distribution**).

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 **Appendix B: Yearly Project Task List**), 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.

An up-to-date metadata record is 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 provided in NCCN Metadata Development Guidelines (North Coast and Cascades Network—National Park Service, 2007b). General procedures are 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 primary questions, many with additional sub-questions.
    b. The first year, a new copy of the NCCN Metadata Interview form (available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm) 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 (e.g., 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 the product delivery instructions in **SOP 16: Product Delivery, Posting and Distribution**.
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—National Park Service, 2007b).
4. The Data Manager will post the record and certified data to NRInfo, and maintain a local copy of the XML file for subsequent updates. NRInfo 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.

G. Data Certification and Delivery

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 (**Section 4E, Data Quality Review**); 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 the primary person responsible for completing an NCCN Project Data Certification Form, available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. This brief form should be submitted with the certified data according to the timeline in **Appendix B: Yearly Project Task List**. Refer to **SOP 15: Data Quality Review and Certification** and the delivery specifications in **SOP 16: Product Delivery, Posting and Distribution** for specific instructions.

H. Data Reduction and Analysis

Note: Refer to **Appendix B: Yearly Project Task List** for the specific analysis tasks and their timing.

Data Reduction

Data reduction will consist of calculation of counts (live trees, snags, tree mortality) and basal area by species, expressed on a per-hectare basis. This will require weighting quantities for saplings and small trees and snags in proportion to the fraction of the one-hectare macroplot within which they are measured.

Trend Detection

We will be able to report trends in tree mortality every year, starting in the fourth year of the project. Analysis of trends will follow the methods used by van Mantgem and Stephenson (2007), in which each plot is a unit of replication. We will be able to report changes in tree recruitment and growth after 10 years, and trends in these quantities after 15 years. Recruitment rates can be analyzed using the same approach as for tree mortality (van Mantgem and

Stephenson 2007). We will analyze trends in growth rates by adapting available methods (e.g., Jump et al. 2006, Feeley et al. 2007). We will also report on changes (after 5 years) and trends (after 10 years) in stem densities and basal area, using the methods of van Mantgem et al. (2009).

We will examine trends for combination of park and elevation stratum, for each elevation stratum as a whole, and for the entire set of plots. Where sample sizes are adequate, we will report trends by species and by tree size-class (saplings, small trees, large trees), as well as for the tree population as a whole.

I. Reporting and Product Development

Refer to **SOP 16: Product Delivery, Posting and Distribution** for the complete schedule for project reports and other deliverables and the people responsible for them.

Report Content

We will produce a detailed annual summary report and a cumulative five-year summary report after each iteration of tree measurements. Information for annual summary reports will be extracted from the NCCN Forest Monitoring Database, and graphed in the statistical program R by the Data Analyst. The finished report will be posted to NRInfo.

The annual report will:

- summarize tree mortality for park and elevation stratum, for each elevation stratum as a whole, and for the entire set of plots
- identify any particular plots or species with spikes of tree mortality.

The five-year report will:

- summarize and elucidate patterns and trends in the plot data; report on trends in tree mortality; trend for other variables will be reported in the second and subsequent five-year reports
- evaluate operational aspects of the monitoring program
- be published in NPS Technical Reports and peer-reviewed journals.

Since GRTS is a relatively new tool for sampling design, and since stratification by vegetation composition and age may complicate trend analysis, we will assess the effectiveness of our sample design in the ten-year report. It is not likely that we will be able to find independent datasets that are directly comparable, though comparisons to trends from FIA and/or the aerial surveys of USDA's Forest Health Monitoring Program (Johnson 2006) may be useful.

Detailed reporting guidelines and table structures are provided in **Appendix D: Template for Forest Monitoring Annual Report**.

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

Before preparing data in any format for sharing outside NPS – including presentations, reports, and publications – the Project Lead should refer to the guidance in the next section and in **SOP 17: 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. Identifying and Handling 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 consider whether or not the resulting information might put protected resources at risk. Information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

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 (available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm).

These guidelines apply to all NCCN staff, cooperators, contractors, and other partners who are likely to acquire or otherwise have access to information about protected NPS resources. The Project 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 likely to contain sensitive information from released data set copies.

Additional details for identifying, handling and protecting sensitive information are described in **SOP 17: Sensitive Information Procedures**.

K. Product Delivery, Posting and Distribution

Refer to **SOP 16: Product Delivery, Posting and Distribution** for the complete schedule for project deliverables and instructions for packaging and delivering them. Upon delivery products will be posted to NPS websites and clearinghouses (e.g., Reference, NPSpecies, NRInfo) 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 two years after it was originally collected. After the two-year period has elapsed, all certified, non-sensitive data will be posted to NRInfo. 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 delivery by the Project 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 be withheld from posting and distribution.

If requests for distribution of products containing sensitive information are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (i.e., the full data set that includes sensitive information) may be shared only after a confidentiality agreement has been established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to **Section 4J, Identifying and Handling Sensitive Information** for more information.

L. Archiving and Records Management

All project files should be reviewed, cleaned up and organized by the Project Lead on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director's Order 19 (available at:

http://data2.itc.nps.gov/npspolicy/DOrders.cfm), which provides a schedule indicating the amount of time that the various kinds of records should be retained.

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. Details for handling project files are described in **SOP 1: Project Workspace and Records Management**. In addition, files containing sensitive information must be stored in a manner that will enable quick identification. Refer to **Section 4J, Identifying and Handling Sensitive Information**.

M. 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, to the database structure or front-end application, or to any of the SOPs associated with the protocol.

5. Personnel Requirements and Training

A. Roles and Responsibilities

The roles associated with this protocol are Project Lead, Field Crew Lead, Technicians, Data Manager, Data Analyst, Park Plant Ecologist, GIS Specialist, Network Program Manager, and Park Curator. One person may take on several roles. Specific responsibilities associated with the roles are found in Table 4, and the information management task list associated with these roles and responsibilities are found in **Appendix B. Yearly Project Task List.**

Table 4. Roles and responsibilities for Forest Vegetation Monitoring in the NCCN.

Role	Responsibilities	Name / Position
Project Lead	• 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	Steve Acker, Supervisory Botanist, OLYM
Data Analyst	• Perform data summaries and analysis, assist interpretation and report preparation	
Park Plant Ecologists	• Facilitate logistics planning and coordination • Track individual park budget • Review reports, data and other project deliverables • Train and ensure safety of field crew • Insure compliance is up-to-date	Steve Acker, OLYM Mignonne Bivin, NOCA, and Lou Whiteaker, MORA
Field Crew Lead	• 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	• Collect, record, enter and verify data	Seasonal technicians, volunteers and interns
Data Manager	• 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	John Boetsch, Data Manager, OLYM*
GIS Specialist	• Consultant on spatial data collection, GPS use, and spatial analysis techniques • Facilitate spatial data development and map output	Roger Hoffman, GIS Specialist, OLYM*

Table 4. Roles and responsibilities for Forest Vegetation Monitoring in the NCCN (continued).

Role	Responsibilities	Name / Position
	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	
Network Program Manager	• Review annual reports for completeness and compliance with I&M standards and expectations	Mark Huff, NCCN Network Program Manager
Park Curator	• Receive and archive copies of annual reports, analysis reports, and other publications • Facilitate archiving of other project records (e.g., original field forms, etc.)	Park Curators and Collections Managers at OLYM, NOCA and MORA
USGS Liaison	• Consultant on technical issues related to project sampling design, statistical analyses, or other issues related to changes in protocol and SOPs	Andrea Woodward, Biologist, USGS-FRESC

*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 Leads each year should have experience with plant identification, preferably in the Pacific Northwest. Familiarity with one or more of the NCCN parks is also 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 must also be physically fit and prepared to spend extended periods of time in the backcountry. Substantial backpacking experience is desirable. (See **SOP 3: Hiring Guidelines and Procedures**.)

C. Training Procedures

Training will be accomplished during the first two weeks of the field season. The following general topics will be covered (See **SOP 4: Orientation and Training of Field Crews** for details):

- Safety – including vehicle safety, equipment safety, backcountry travel, packing for the backcountry, etc.
- Plant identification
- Tree diseases
- 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 measuring a plot, which may be one of the permanent plots.

6. Operational Requirements

A. Annual Workload and Field Schedule

A detailed schedule for project activities is found in **Appendix B: Yearly Project Task List**. In brief, hiring of field crews is conducted from December through March. The three crews of two 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 by March of each year, and the computer workspace and database set-up will be completed by May 1. Field crew training will occur during the last two 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 GPS training, downloading of GPS units during the field season, and generating occasional map output.

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 will also require transportation to plots or trailheads while on the job. Crew members will provide their own backpacking gear. Computer access for field crew members is necessary during the training session, and throughout the season for data entry. Equipment requirements for each task in the protocol are listed as appropriate in the SOPs.

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 $1000 to $2000.

Annual costs of fieldwork will be reduced by performing only mortality checks for four out of five years (Table 5). Costs for fieldwork (i.e., seasonal employees, travel, vehicles, supplies) will be approximately approximately 60% greater every fifth year, when tree measurements are taken. The network vegetation group is proposing that for the years with mortality checks, the balance of the field crew's season be devoted to monitoring high-elevation, non-forested vegetation. This would allow us to offer a sufficiently long season to attract high-quality employees, and result in an essentially constant annual effort for collection of vegetation monitoring data. It is important to note that the cost of personnel will escalate each year (not reflected in Table 5), which will eventually lead to funding needs outstripping the budget if it remains fixed.

Table 5. Forest monitoring protocol projected budget.

Project Stage / Budget Category	Personnel	Grade	Pay Periods	Cost for mortality check years	Cost for tree measurement years
Preparation	Project Lead	GS-12	3.4	12,940	12,940
	Park Plant Ecologists (2)	GS-12	2.3	14,191	14,191
	Data Manager	GS-11	0.5	1,540	1,540
	GIS Specialist	GS-9	0.5	1,459	1,459
Data Acquisition, Entry & Processing	Field Crew Lead (3)	GS-7	5, 8	28,982	46,371
	Technicians (3)	GS-5	5, 8	18,975	30,360
	Project Lead	GS-12	1.1	4,187	4,187
	Park Plant Ecologists (2)	GS-12	1.1	6,787	6,787
	Data Manager	GS-11	0.1	308	308
	GIS Specialist	GS-9	0.5	1,459	1,459
Quality Review	Project Lead	GS-12	0.25	952	952
	Data Manager	GS-11	0.6	1,848	1,848
	GIS Specialist	GS-9	0.5	1,459	1,459
Data Certification & Documentation	Project Lead	GS-12	1.3	4,948	4,948
	GIS Specialist	GS-9	0.3	875	875
	Data Manager	GS-11	0.4	1,232	1,232
Data Analysis	Project Lead/Analyst	GS-12	1.1	4,187	4,187
	Data Manager	GS-11	0.2	616	616
	GIS Specialist	GS-9	0.25	730	730
Reporting & Product Development	Project Lead/Analyst	GS-12	1.7	6,470	6,470
	Data Manager	GS-11	0.3	924	924
	Park Plant Ecologists (2)	GS-12	0.6	3,702	3,702
	NCCN Coordinator	GS-12	0.05	222	222
	GIS Specialist	GS-9	0.2	584	584
Archiving, Posting & Records Mgmt.	Project Lead	GS-12	0.1	381	381
	Data Manager	GS-11	0.3	924	924
Season Close-out	Project Lead	GS-12	0.3	1,142	1,142
	Park Plant Ecologists (2)	GS-12	0.2	1,234	1,234
	Data Manager	GS-11	0.2	616	616
	GIS Specialist	GS-9	0.05	146	146
	Field Crew Lead (3)	GS-7	1	5,796	5,796
Travel				3,600	5,760
Vehicles				3,750	6,000
Supplies				750	1500
Total				$137,916	$171,850

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Standard Operating Procedures



Sitka spruce forest, Quinault area, OLYM.

SOP 1: Project Workspace and Records Management

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Added sections for NCCN file workspace setup and workspace maintenance procedures.	New sections provide details on how to manage workspaces at the beginning and end of the season, and to map a drive letter to the network workspace.
May 2010	J. Boetsch	Replaced references to mapping drives with creating network shortcuts.	Mapped drives across parks creates a performance drain on the network and individual workstations.

Overview

This SOP describes how and where project files and records are managed by project staff. Workspace structure, naming conventions, and procedures for handling project files are included.

NCCN File Workspace

NCCN has a centralized file system and project workspaces available for use by field crews and project staff at: \\inpolymfs\parkwide\NCCN. This will help avoid the problem of NCCN projects having several versions of files on different servers around the network. These folders are set up so that park and network staff members at the network parks all have read privileges throughout the directory structure. Project leads and a few other individuals associated with each project have full privileges for their project folder so they can manage their own permissions. These workspaces are intended to be a more familiar and convenient way of storing information, as an adjunct to the NCCN SharePoint site. Project leads will decide what is to be stored locally in these project workspaces as opposed to on the team SharePoint site. Examples of files kept in these project workspaces include: working files for project field crews, GPS downloads, GIS map files, database files, and other project records.

The NCCN workspace is organized as follows under four main folders: Libraries, Projects, Temp, and Workspace. Project staff members will primarily be working in one or more of the project folders under Projects, and may wish to make desktop shortcuts to one or more of the project subfolders by right-clicking on the desired folder and selecting Send To > Desktop (create shortcut).

Project staff members should create a network shortcut to the project workspace by going to the Desktop in Windows Explorer and adding a new network place under My Network Places. Project staff located at OLYM will typically already have this path available to them via a mapped drive (e.g., the I:\ drive); however, they should still create this network shortcut where multiple parks are concerned for the sake of communications and consistency among parks. Performance is the main rationale for using network shortcuts instead of mapped drives at other parks.

Instructions for creating a network shortcut to the NCCN workspace:

1. Open an instance of Windows Explorer. One way is from the Start menu, go to: All Programs > Accessories > Windows Explorer. Another is to open My Documents, My Computer, or any other folder browser shortcut.
2. Navigate to the Desktop, and then to My Network Places.
3. Double-click the Add Network Place option to open the setup wizard.
4. Choose the option to specify the network location, then under network address, type in: \\inpolymfs\parkwide\NCCN
5. When prompted for a name for the network place, enter "NCCN" (or something similarly brief and meaningful).
6. This network place shortcut should now be available each time you log in to that particular computer, and can be accessed when navigating within most Windows software.

Project Workspace

A section of the NCCN workspace is reserved for this project. The recommended file structure within this workspace is shown in Figure 1.1.

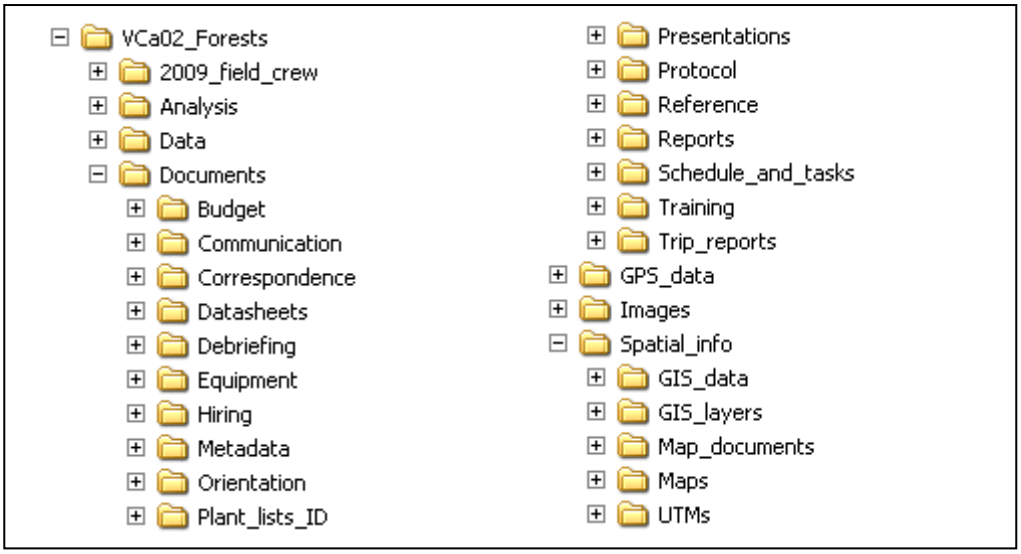


Figure 1.1. Recommended file structure for project workspace. Note: The workspace folder name includes 'VCa02', the NCCN project code.

Each major subfolder is described as follows:

- Analysis – Contains working files associated with data analysis.

- Data – Contains the front-end database application file for the season. The back-end database for the project is maintained in Microsoft SQL Server. Database exports and other intermediate summary information can be stored here as well; these files are most effectively managed within subfolders named by calendar year.

- Documents – Contains subfolders to categorize documents as needed for various stages of project implementation. Additional folders and subfolders may be created as needed to arrange information in a way that is useful to project staff.

- GPS data – Contains GPS data dictionaries, and raw and processed GPS data files. This folder contains subfolders to arrange files by year. Each of these subfolders also contains the project code to make it easier to select the correct project folder within the GPS processing software.

- Images – For storing images associated with the project. This folder has subfolders named by calendar year to make it easier to identify and move files to the project archives at the end of each season. Refer to **SOP 12: Managing Photographic Images** for more details.

- Spatial info – 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).

Seasonal Workspace
In addition to these permanent folders, a temporary seasonal workspace is established at the beginning of each field season (e.g., "2010_field_crew"). This temporary workspace provides a place for field crew members to create and modify files while limiting access privileges for the remainder of the project workspace. Subfolders are created for Images and GPS data to allow field crew members to process incoming files as needed. Temporary workspaces may also be established on other servers to provide local access to crews stationed at other parks. At the end of the season, files in these temporary workspaces are then filed in the appropriate permanent folder(s).

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 characters or fewer.
- Dates should be formatted as YYYYMMDD (this leads to better sorting than other date naming conventions).

File Naming Standards
Unless otherwise specified, 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.

Workspace Maintenance Procedures
Prior to each season, the Project Lead should:

1. Make sure that network accounts are established for each new staff member, or reactivated for returning staff members. By default, the IT staff puts new user accounts into a group that has read-only access to all files.
2. Create new folders named by year under the Images and GPS data sections.
3. Create the seasonal workspace, with subfolders for Images and GPS data.
4. Add user logins for the seasonal crew members to the seasonal workspace, with modify privileges. This can be done by right-clicking on the seasonal workspace folder, selecting Properties > Security, then adding users one at a time and checking the box in the Allow column for Modify privileges.
5. Provide the Data Manager with a list of user logins that need access to the database.

After each season, the Project Lead should:

1. Review the workspace organization and clean up any temporary files and subfolders that are no longer needed.

2. Move files from the seasonal workspace folders into the appropriate permanent folder(s), and archive or delete the seasonal workspace folders as desired. See **SOP 12: Managing Photographic Images** for specific instructions for images.
3. Compare older files against the retention schedule in NPS Director's Order 19 (available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm). Dispose of files that are beyond their retention schedule if they are no longer needed. As a long-term project, many files associated with this project are likely to be scheduled for permanent retention. This makes it all the more imperative to clean out unneeded files before they accumulate and make it harder to distinguish the truly useful and meaningful ones.
4. Convert older files to current standard formats as needed to maintain their usefulness.
5. Identify files that may contain sensitive information (as defined in **Section 4J, Identifying and Handling Sensitive Information**). Such files should be named and filed in a way that will allow quick and clear identification as sensitive by others.
6. Post final documents and files to the NCCN Digital Library for long-term storage. See **SOP 16: Product Delivery, Posting and Distribution**.
7. Send analog (non-digital) materials to the park collections for archiving.

SOP 2: Preparing for the Field Season

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Dec. 18, 2008	S. Acker	Revised estimates of time requirements; changed staffing to three crews of two at MORA, NOCA, and OLYM; removed references to SOPs that have been suspended indefinitely and mention of no-longer-needed supplies and equipment; added direction to take plot photographs on tree measurement years only.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Jul. 10, 2009	S. Acker	References to locations on the network drive were updated; one section was moved to the SOP for Orientation and Training; two SOPs (nos. 3 and 4) from the previous version that both dealt with assembling information for the field season were combined; the Navigation Report was substituted for a photocopy of the previous Event Log as the primary source of information on access to a plot and specific tasks to perform.	Streamlining of SOPs in the process of producing final version in response to NPS review.

Overview

This SOP provides instructions for preparations prior to the field season. This SOP encompasses season scheduling and travel planning, assessing and ordering equipment and supplies, and assembling packets of maps, directions, and data sheets for plot measurements. This work begins in late fall after certification of the previous year's data and continues through the start of the field season in May.

Scheduling and Coordinating with Personnel

1. Update the season schedule (located in the project workspace within the folder Documents\Schedule_and_tasks\), including a list of plots to be visited. The time required is dependent on whether or not it is a year in which trees are measured (one in five, years ending in 3 or 8). In other years, measurements are limited to checking for tree mortality and recording information on newly-dead trees. We plan to staff the project with three, two-person crews, one each at MORA, NOCA, and OLYM. We estimate that in measurement years, each crew will need nine pay periods, including training and data entry. Other years will require six pay periods for each crew, with the remaining portion of the field season devoted to monitoring high-elevation, non-forested vegetation. When planning field tours keep in mind the time required for the components of field tours listed below. Once plots have been visited, the logistics information recorded on the Event Log will help refine time estimates. 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:
        1. Full measurement years: 2 days
        2. Mortality check years: 1 day
    d. Crews may take up to twice as long to establish new plots, if any are needed.
    e. A full office day or more at the end of each tour is essential to the well-being of the crew and the acquisition of quality data. The crews need time to download photos, 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, WIC
4. Make 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. (e.g., 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. 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 in the project workspace within the folder Documents\Reference\Travel_Logistics\Packers. The packers may bring in project gear either while packing for trail maintenance crews, or at our convenience for a cost. For most situations, the packers would like our 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 the project may be asked to contribute funds to the pack stock operation.
10. Contact the aviation office at each park to inquire about helicopter flights in the parks. If helicopters are flying to locations near monitoring plots, supplies could be transported by helicopter and left at a designated site.
11. Speak with the WIC 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. Two crew members at MORA and NOCA (OLYM crew must secure own housing)
    b. Housing for one week of training at one of the parks
14. Reserve housing, ranger stations, and/or campsites for the season's field tours (see folder Documents\Reference\Travel_Logistics\Housing\ in the project workspace).
15. Reserve the following for the week of orientation and training:
    a. Conference room
    b. Power point projector
    c. Lap top computer

Ordering Supplies

At the end of each field season, project equipment and supplies should be inventoried by each Field Crew lead. The Project Lead and the field crews can then discuss what needs to be ordered for the next field season as part of the season close-out. During the off-season, the Project Lead should use this information, the list of gear supplied by NPS (Table 2.1), and the list of supplies for plot establishment below, to determine which items to order. 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 check list (Table 2.2), and consider what safety supplies may be needed in vehicles (Table 2.3). Contact information for companies and stores that have stocked equipment is located in the folder Documents\Reference\Travel_Logistics\Equipment_Lists\Purchasing in the project workspace. Label all new supplies with "NCCN 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 (i.e. hand lenses, compasses, tents, etc.)

Table 2.1. Field gear supplied by NPS.

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 2.2. 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

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 Lead. 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 them 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 NCCN and is kept at all times in the fire shed, the stone building beside fire management. Crews at MORA and NOCA need to ask their supervisors 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 eight-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 use and clean them properly.
8. Inspect and clean the bear-resistant food containers (BRFC) – one food container per person. The large, light-weight, composite bear canisters are 900 cubic inches (9" base x 14" length), and recommended for eight-day tours. Some crew members prefer the smaller hard plastic canisters.

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 – nine per new plot
   b. Cedar stakes – 32 per new plot
   c. Tree tags – 300 per new plot
   d. Temporary tree tags – for initial replacement of missing tags
   e. Aluminum nails – 300 per new plot
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. Additionally, inspect the field keys for condition and repair or replace as necessary.
3. 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.
4. Charge all batteries that will be used in the field, including batteries for the GPS unit, digital camera, laser range finder, and radios.

Preparation of Directions, Maps, and Data Sheets

For each plot being visited during the ensuing field season, print the following documents and place each set into a large envelope (approximately 11 x 12 inches; one per plot), labeled with the plot identification code (e.g., NOCA3-035) and a site name (e.g., Hozomeen). Remove the sticky adhesive on the envelope flap to prevent accidental sticking in the field. Refer to the season schedule to identify plots being sampled that year.

1. Navigation Report: This report contains information about the plot, including navigational directions, UTM coordinates, tasks that must be completed, and extra equipment or supplies needed. The report is produced from the database using a utility that is part of the front-end. It should be generated each year prior to the field season. It should be viewed before heading into the field, and brought along into the field. If you are setting up a new plot, obtain the corrected UTMs (differentially corrected after the reconnaissance visit), and write them on the Navigation Report. Prior to plot establishment and set up, compare corrected UTMs to target UTMs to determine if plot center should be moved, and by what distance and direction (azimuth).
2. Pre-printed Tree Data Sheet: The Tree Data Sheet is a report produced from the database using a utility that is part of the front-end. It is based on data from the previous year. For trees that were alive in the previous year, the Tree Status column is left empty. This form is used for both annual mortality assessments and the complete tree measurements conducted every five years (see **SOP 10: Measuring and Mapping Live and Standing Dead Trees** for details). The report should be generated prior to each field season. The report should be stored in a folder for pre-printed forms, within the crew folder in the project workspace.
3. Stem Map: Stem maps for each plot are produced by the GIS specialist each year. The stem maps indicate location, species, status (alive or dead), and size of each tagged stem. They are useful for navigating within the plot and ensuring that all trees are observed. A complete set of the stem maps should be stored in a folder for spatial information, within the crew folder in the project workspace.
4. Site Map: The site map is a diagram with environmental features hand-drawn by crews during previous visits to the plot (see **SOP 8: Establishing Permanent Monitoring Plots**). The original site map is stored in the plot file and is also scanned and stored

electronically. A copy of the most recent site map is taken on each visit to aid in navigation and to enable updates or corrections if needed.

5. Plot Layout: This diagram illustrates the plot layout including subplot numbers and intra-plot distances (see **SOP 8: Establishing Permanent Monitoring Plots**). It is a useful reference for navigating within the plot.
6. Blank Datasheets: Assemble complete sets of datasheets for each plot being sampled in the coming season per instructions in Table 2.1. The Reconnaissance Datasheet (**SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots**) is used only for initial reconnaissance, not for plot sampling. Photocopy all datasheets onto two-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 photos (on tree measurement years only).

Table 2.3. Quantities of blank data sheets needed to sample one permanent plot.

Quantity	Data Sheet	Details	SOP
1	Plot Layout	one-sided	**8**
1	Forest Plot Site Map (initial visit)	one-sided	**8**
1	Forest Plot Establishment Form (initial visit)	two-sided	**8**
1	Forest Plot Event Log	two-sided	**9**
8	Forest Plot Tree Data (initial visit)	two-sided	**10**
3	Forest Plot Tree Data (5-year measurement)	two-sided	**10**
2	Forest Plot Tree Comments (initial visit)	two-sided	**10**
1	Forest Plot Tree Comments (5-year measurement)	two-sided	**10**

GIS Maps and Orthoquads

Print topographic maps of the area on waterproof paper. Use a 1:24,000 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 orthophotos. Print enough copies of the 1:24,000 map for each crew person, and one copy of the other maps. Permanent plot maps may be laminated in plastic for field use in inclement weather. To make a new map:

- Go to the folder Spatial_info\MapDocuments in the project workspace and open the ArcMap project labeled with your parkcode (e.g., OLYM-field-maps). The project should contain all the shape files for making maps of plot locations.
- Set scale as prescribed
- Add a map title
- Add plot UTMs
- 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-pixilated.
- Maps made ahead of time are stored in the Spatial_Info\Maps folder of the project workspace.

- Maps that have been pre-made and laminated can be found in the plot paper files.

SOP 3: Hiring Guidelines and Procedures

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jul. 10, 2009	S. Acker	One section was moved to the SOP for Orientation and Training	Streamlining of SOPs in the process of producing final version in response to NPS review.

Overview

This Standard Operating Procedure describes hiring of the seasonal field crew for the North Coast and Cascades Network (NCCN) Monitoring of Forest Vegetation as part of the NPS Vital Signs Monitoring Program. Job announcements should be completed in December and posted in early January, so that lists of eligible candidates are received in early February. This will allow permanent staff to review applications and hire crews in February so that background check paperwork can be submitted by the end of the month. Adherence to this schedule will increase the probability of hiring high-quality crews, and completing the required paperwork before the field season begins in May.

Hiring the Field Crew

Once the lists of eligible candidates have been received, the Project Lead and Park Plant Ecologists will arrange a time to meet or speak on the phone, to review applications and plan interviews with potential hires and references. The folder Documents\Hiring in the project workspace contains questionnaires which can be used or adapted for interviewing prospective crew members and references. The Department of the Interior maintains a website with useful information on selecting employees, including many aspects of interviewing (http://www.doi.gov/hrm/pmanager/staffing.html).

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 Field Leads include the following:

- Proficiency at identifying 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.

Field Technician Qualities

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

- Proficiency at identifying vascular plants of the Pacific Northwest. Successful candidates should at least be able to identify common plant species, and demonstrate enthusiasm and ability to learn 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.
- Familiarity with one or more of the NCCN parks.
- Knowledge of (or preferably, certification in) wilderness first aid.

While 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.

SOP 4: Orientation and Training of Field Crews

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Dec. 18, 2008	S. Acker	Removed references to SOPs that have been suspended indefinitely; indicated that training will last one week instead of two; indicated that each crew will have two members instead of four.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Sept. 1, 2009	S. Acker	Combined SOPs for Orientation and Training. References to locations on the network drive and other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Oct. 3, 2009	S. Acker	Deleted description of methods of measuring tree height.	Redundancy with **SOP 10**: **Measuring and Mapping Live and Standing Dead Trees**.

Overview

This SOP contains instructions for orienting and training field crews. 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 safe and 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. Orientation begins prior to arrival of crew members at their duty locations. Most of the orientation and training will occur during the first week of the field season. The Project Lead is responsible for orientation and training of the field crews.

Training needs will be determined by the 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 measurement methods. Training may rotate between parks from year to year.

In addition to the orientation and training described here, each crew member may attend the general training session for seasonal employees at their park. These sessions usually cover park issues, current research, and safety. Crew members may attend a CPR/first aid course if it is offered at their park.

Information for Seasonal Employees

Soon after being hired, Field Technicians should be sent the following:

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 each park where they are likely to perform fieldwork, and information on local towns and amenities.
6. List of camping and hiking gear recommended and/or supplied by NCCN.

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. A copy of the NCCN Forest Vegetation protocol and a set of data sheets. Crews will **not** need copies of the appendices. A copy of the protocol, including all appendices, is available for reference in the folder \Documents\Protocol\Active_docs in the project workspace (read-only for crews).

Paperwork and Personnel Logistics

The Project Lead will ensure that the following items are addressed with employees in the first few days of the season.

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, and annual and sick leave.
3. Unemployment, and rehire status.

4. How time sheets should be handled, who will fill them out, and where they are turned in.
5. Travel per diem, travel forms, to whom and where travel forms are turned in.
6. 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.
7. Accident forms and procedures: Paperwork, timeframe, and procedure for notification.

Office Training

The Project Lead and/or park plant ecologist/botanist will give new crew members a tour of the office and relevant surrounding facilities. The office tour will include 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, e-mail, 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 e-mail account is working properly. They are further responsible for reading their NPS e-mail 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.

Crew Gear and Packing

The Project Lead will distribute items of individual gear provided by the project to crew members for the season. Crew members will check out the equipment as outlined below. A packing demonstration is highly recommended so that crew (especially new members) will be prepared for up to eight days in the backcountry in the extreme weather conditions which can occur in the Pacific Northwest even in summer.

Sign-Out and Sign-In Procedure

Individual Gear: includes compasses, hand lenses, packs, and rain gear. Each crewperson should record any individual gear taken on the "Individual equipment checkout form" (**I:\NCCN\ Projects\VCa02_Forests\Documents\Equipment \Gear_ individual _checkout**). This form must be filled out before crew members take project gear into the field. Crew members may use personal gear in place of equipment provided by NPS, but personal gear will not be replaced or repaired by NPS if it is lost, stolen, or broken. At the end of the field season, the crew and the supervisor will ensure that the equipment is returned, and that any damaged or lost items are noted for repair or replacement.

Group Gear: is distributed to the crews at the beginning of the field season. Crews will care for group gear, making sure that items are cleaned and dried at the end of each sampling tour. Specific equipment is maintained as follows:
water filters flushed with clean water
tents cleaned and dried
first aid kits restocked (& dried if necessary)
batteries recharged or replaced
stoves cleaned and tested for satisfactory burning

cook kits washed
fuel bottles filled and returned to an approved storage location
Information regarding broken or lost gear, or other problems, should be included in the reports prepared by each Crew Lead at the end of each tour, and brought to the attention of the crew's supervisor or the Project Lead.

Miscellaneous Equipment

Batteries: Batteries are required for the 1) camera, 2) GPS, and 3) laser range finder. Radios have integral, rechargeable batteries; 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. 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 Lead or supervisor before you get close to running out of disposable batteries.

Safety

During the training week, the Project Lead will facilitate a discussion of the "Job Safety Analysis" form to explore all aspects of working safely. This form is also referred to as a "Job Hazard Analysis." Versions of the form from previous years are located in the folder \Documents\Reference\Safety\Prevention in the project workspace. Each year the crew, the Project Lead, and the Plant Ecologists from other network parks will share their experiences about items included on the form, and revise text or add new items as necessary. Two areas of emphasis in the Job Safety Analysis are vehicle use and life and work in the woods.

Safe Use of Vehicles

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

1. Vehicle use
   - Key drawer or board: where keys (& 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: how to obtain reimbursement
   - How to schedule if using shared vehicle

2. Vehicle Safety
   - Safety checklist (Table 4.1)
   - Location and use of vehicle safety equipment (tire gauge, jumper cables, camera, etc)
   - Items to keep in vehicle (Table 4.2)
   - Emergency procedures
   - Procedure and equipment for changing a flat tire

Table 4.1. 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.

Table 4.2. Items to keep in the vehicle.

Washington atlas and gazetteer	Extra field gear that might come in handy: o 50 m tape o Pin flags o Spare camp stove o Extra data sheets o Binoculars
First aid kit	
Fire extinguisher	
Flashlight, warning markers or reflectors	
Car jack and lug nut wrench	
Jumper cables	
Spare tire	
Space blanket	
Camera (disposable, in case of accident)	
CA-1 Form	
Motor Vehicle Accident Report Form	

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. Safely pull off to the side of the road before using a cell phone.
   - **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, i.e. freeway to secondary highway to gravel and adjust speed accordingly.
- **Tail-gating.** Allow at least three 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 photos, 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 may also 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.

<u>Safety in the Woods</u>

- **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 may also 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 many not be the shortest. Routes across brushy, irregular terrain with rocks and down logs are 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.

Backcountry Basic First Aid

How to treat common backcountry injuries with first aid kit and available backcountry equipment:

- **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 tri 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 tri 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 4x4 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)): To treat, remember 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.

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 as promptly as possible (e.g., within 24 hours at OLYM).
- 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.

Radio Use

The Project Lead and/or park plant ecologist will go over radio protocol for the assigned park. The most recent radio information may be obtained from this website: (http://www.olym.nps.gov/Maintenance/Telecom/cheatsheets.htm). Crew members will be shown:

- How to use the type of radio assigned to them (with handout)
- How to maintain radios and batteries (if replaceable) with specifics about battery life on the shelf and in the backcountry
- How to contact dispatch
- Which repeater to use in each region of the park
- Appropriate topics and terminology for radio communication

- Who to contact if radio malfunctions

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 frontcountry camping. Crews are expected to read and follow posted NPS camping regulations and cooperate with NPS rangers.

Temporary Park Housing
Occasionally crews will be able to stay in temporary park housing or ranger stations during a tour. It is essential that the crews be considerate of the space and belongings of other employees and volunteers using these quarters. 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 one of the crews on the North Coast and Cascades Network forest monitoring project. Bring your own gear for cooking, eating, sleeping, and bathing 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 arrangement with your supervisor and/or the park staff.

Overview of Training

1. Presentations. Training will begin with a PowerPoint presentation given by the Project Lead, outlining the objectives of long-term ecological monitoring in NCCN, and the design of the forest monitoring project. The presentation will cover the history of the NPS I&M program, the formation of NCCN, and the study plan for forest monitoring, including the plot selection process and the crew's role for the current field season and beyond. The Project Lead should meet with the crews again after they have had some time in the field, to discuss the project and give the crews an opportunity to ask questions and share their experience with the fieldwork. A crew that understands the project they are working on will be more interested and collect better data.

   Additional PowerPoint presentations are available and may be used by the project coordinator to introduce:
   - Vascular 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 that crew members consistently prefer and benefit more from hands-on training than from indoor lectures.

2. Reading the Protocol. Each member of the vegetation sampling crew should read and become thoroughly familiar with the protocol at the start of the season. This may be accomplished in increments, facilitated by hands-on training. The Project Lead may choose to assign each person on the crew "lead" status for a subset of the SOPs (note that 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, but the Crew 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 are also expected to indicate where they may need additional training.

3. Training Plot. During the training, the Project Lead, and experienced crew will lead the crew in a mock reconnaissance, establishment, and sampling of a plot. 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 employees then guide the new crew members through the sampling techniques, first allowing new members to record data and then to take 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 crew members to become thoroughly familiar with the data sheets, the individual SOPs, and the order in which the procedures are carried out. If the crew is new it will also be necessary for the Project Lead or park ecologist to accompany the crew on their first tour.

4. Assessment. Throughout training, the Project Lead must assess the accuracy and precision of the measurements being taken by the crew, discuss discrepancies, and correct mistakes. Fieldwork 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.

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 training. New crew members are essentially in training for the 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, 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.

Compass and Orienteering

Crew members will receive hands-on training with the Silva Ranger, or similar compass. Crew members will be instructed in the following:

1. Safety. When 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, orthophotos, satellite availability chart (**SOP 5: Preparing for Fieldwork**), compass, altimeter, GPS, calculator, field notebook.
3. Maps. Use 7 ½ minute quads and orthophotos at the same scale (1:24,000). Maps and photos 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 latitude and longitude, 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.ngdc.noaa.gov/geomagmodels/Declination.jsp.

5. Azimuth**.** Keep compass level, and away from metal. Hold the compass at eye-level and 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 (e.g., a 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 in sync. 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 can also be estimated with pacing. To determine paces (a pace = two steps) lay out a 50-meter 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 (see Figure 8.3, Field Reference Sheet in **SOP 8**, **Establishing Permanent Monitoring Plots**).
9. Map distance. Use the scale below each map. Also some maps are gridded with a set distance (e.g., every 500 m). As a general reference, section lines when present are 1 mile apart, and UTM lines are 1 km apart.
10. Contouring. It is sometimes easier 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 as barometric pressure changes.
11. Triangulation. You can determine your position on a topographic map using a compass to triangulate between three points (note that 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, (e.g., 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 assumptions. Other indicators of location or direction include slope angle, aspect, and sun position. Orthophotos can also 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. Also rivers 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 notes while navigating. 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.

Equipment Training

The crew will receive hands-on training with the GPS, laser range finder, clinometer, digital camera, dbh tape, and increment borer as necessary. Training for measuring dbh can take place during the mock plot exercise.

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 UTMs 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 model of GPS unit, 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 6: GPS Use: Navigation, Data Collection, and Downloading**. Crew members will be given a copy of the GPS operating instructions for their model of GPS 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
   d. Interpret PDOP, and learn to adjust (if possible)
   e. Check battery power
   f. Make selections:

    1. Use arrow buttons to scroll and highlight your selection
    2. Press ENTER to select the highlighted option
    3. 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. Accuracy can be tested by measuring a tower or building of known height. The laser range finder can also be used to measure slope angle, and slope distance. See **SOP 10**: **Measuring and Mapping Live and Standing Dead Trees**, for instructions on measuring tree heights with either the laser range finder or the clinometer (see below).

3. Clinometer. The clinometer is a simple device for measuring slope. It can also be used, along with a tape or other distance-measuring device, to calculate tree heights or horizontal slope distance, but the laser range finder is much simpler to use. The clinometer and measuring tape 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 to read slope in degrees on the left, and in 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 are probably holding it upside down). When measuring slope hold the clinometer to your eye, focus one eye on the degree or %, and the other eye down or up slope to eye height of a second person. Make sure to record the units of measurement as either degrees or %.

4. Digital Camera. Refer to **SOP 9: Recording Plot Visit Details and Taking Digital Photos: Event Log** and **SOP 12: Managing Photographic Images**.

5. DBH Tape. Demonstrate the correct measurement of tree diameter at breast height per instructions in **SOP 10: Measuring and Mapping Live and Standing Dead Trees**.

6. Increment borer. Refer to **SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots**.

Data Sheets

Before beginning each sampling activity in the field, the Project Lead will go over the field datasheet. The Field Reference Sheet in **SOP 8: Establishing Permanent Monitoring Plots** contains all 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

Vegetation Training

1. Skilled and Enthusiastic Crew. Training the crew to recognize tree species and signs and symptoms of pest, pathogens, and other damaging agents in the field can be one of the most difficult aspects of this program, and also one of the most critical. Crews will also occasionally be called upon to identify vascular plants beyond trees, especially when reconnaissance is needed for replacement plots. We cannot rely solely upon training observers to meet the required standard of quality. The importance of hiring talented field botanists cannot be over-emphasized. 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 performing ecological fieldwork.

2. Plant Lists. Crew members will be given plant species lists with space for writing notes. Two types of lists will be provided 1) a list of vascular plant species previously recorded from surveys in each vegetation type: Sitka spruce, western hemlock, and subalpine fir forest; 2) an up-to-date list of plants that occur in each park.

3. Field Recognition. A minimum of a full day should be spent on tree, pest, and pathogen identification in the field. This may be coordinated with other training activities. Identification training will begin with local guided walks. If there is time, visit sites with the project vegetation types. Crew members are encouraged to keep notes on their species lists during the field instruction.

4. Categorizing: Beyond determining species identification, there are several requirements for vegetation categorization in this protocol. These include decay classes of snags, and tree damage. Separating into groups can at times be difficult. Address each category when going over individual field data collection methods.

5. PowerPoint Presentations. Between guided walks, PowerPoint presentations will be used to review trees and damaging agents seen, and to introduce species not occurring in the training area. This is a good time to go over species which are difficult to identify, allowing the crew to take notes on key differentiating characteristics.

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 Lead. The Crew Lead 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 4.1 shows how to organize a page in a field notebook. Develop a system so that information is always in a similar format, and is easy to find. Keeping dates, locations, tasks, and other repeat information in the same place will help you relocate that information later. The supervisors will rely on the Crew Lead's ability to quickly access information in these notes as questions arise regarding logistics or data that needs clarification. Your notes will also help the Crew Lead 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 e-mail) for supervisors and crew.

General location & task

MORA
PLOT: MORA3-033

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

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

7:00am - 6:30pm

Weather: overcast, cool in morning; downpour from 4pm 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 17 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 notebook (phone numbers etc. of sup. and crew)

Figure 4.1. Field notes example.

Crew Assignments

Each crew member will be solely responsible for a specific set of tasks. These will be assigned according to skill and interest. 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 Lead 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 two-person crew are outlined in Table 4.3. Rearrange as seems fit for each individual crew.

Table 4.3. 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
Additional tasks to divide between the Crew Lead and the other crew member	Wilderness permits, current backcountry info; Maintaining and tracking technical gear (GPS, radios, laser range finder); vehicle; Gear organization and distribution; Data sheets: packing, and tracking; Maps: packing and tracking; Digital camera and photography (see **SOP 9: Recording Plot Visit Details and Taking Digital Photos: Event Log**)	Maintenance of batteries and tech. gear; Downloading GPS data; Gear organization; Travel voucher forms; Data sheets: photocopying, tracking; Downloading and labeling photos (**SOP** 1**2: Managing Photographic Images**)

SOP 5: Preparing for Fieldwork

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Dec. 19, 2008	S. Acker	Removed 30x handlens from gear list; decreased number of wooden stakes from 72 to 32.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Sept. 1, 2009	S. Acker	References to locations on the network drive and other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Sept. 25, 2009	S. Acker	Updated number of rebar pieces in Table 5.2 (only need 5 for LEWI, SAJH)	Response to comment from NPS review.

Overview
This SOP describes preparations carried out prior to departure for fieldwork.

One Week in Advance
The following tasks are to be conducted approximately one 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 (example: http://www.olym.nps.gov/Reports/road_reports.htm), 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 Navigation Report for campsite suggestions. Park housing 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 park's Wilderness Information Center (WIC). Consider camping near the plot if 1) it is within park guidelines, 2) there is a water source, and 3) it will not damage the plot.
3. Verify Packers. Verify with the packers that gear has been transported to the site (see Documents\Reference\Travel_Logistics\ Packers\PACKERS.doc in the project workspace).
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.

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 E-mail. Read work related e-mail only, for messages from supervisor.
3. Check Weather. If it has not been done already, check on the weather so that you know what you are in for, 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 park's WIC (located in the Visitor Center at Olympic National Park and 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 as soon as you know your trip plans; they will be better able to accommodate your needs, especially in areas of high use. The WIC is also a good place to check on current back country conditions, recent trail or road washouts, common concerns for the area, weather forecasts, or camping options. Be sure to ask for information.
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. (in the folder \Documents\Reference\ Travel_Logistics\Forms in the project workspace).
6. Look Over Data Sheets. Data sheets are pre-printed on waterproof paper as outlined in **SOP 2: Preparing for the Field Season,** and stored in an envelope labeled with the plot name. Check that all required data sheets and reference documents are present.
7. Gather Navigation Reports, Maps and Orthoquads. These were pre-printed on waterproof paper before crew arrival (or laminated) as outlined in **SOP 2: Preparing for the Field Season**, and are stored in the plot folder.
8. Satellite Availability Charts. Satellite charts are available from the ONP home page. From http://www.olym.nps.gov/ click on the following:
   - Superintendents office
   - Link to GIS office home page
   - GIS/GPS Links
   - Current Satellite Availability Chart (plus 1 & 2 weeks in future)
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 5.1). Group and plot gear should be organized so that packing can be accomplished quickly that morning. See below 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: $\leq$ 1/3 of body weight).

11. Check the Navigation Report. Check the Navigation 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 UTMs indicate that the plot center needs to be adjusted.
12. 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.
13. Double Check the Equipment List. Make sure that you have everything on the equipment list by checking it twice.
14. 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 and UTM Zone: 10N (if borrowing a GPS)
    - Change in declination
    - Plant lists
    - Additional field references
    - Keys to pick up
    - Personnel to meet?

Packing Gear

Each person is in charge of maintaining, packing, and carrying their own personal gear as listed below. Some items on the list of personal gear will be available on loan from NPS. All other gear (group camping gear and required field equipment) needs to be set out to be distributed evenly among 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. It should be possible to complete tour preparation and packing quickly, so that the crew can leave the office approximately one hour after the meeting time.

Tips for packing gear

- Consider whether you will be packing for one or *possibly more* than one activity (e.g., plot reconnaissance *and* plot set-up; or plot set-up *and* measurement of established plots).
- 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 downpours or a sudden drop 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 consider all of the components of traveling and working safely, and that the abilities and needs of all crew members in taken into account.

Gear Lists

Print and post in the office a copy of the camping list (Table 5.1) and equipment for plot setup and sampling (Table 5.2) so that they can be checked when packing before a tour.

Table 5.1. Recommended gear for camping and hiking in PNW.

PERSONAL GEAR *supplied by NPS	
Large capacity backpack	Spare: socks, dry clothes
Compass*	Toothbrush, etc.
Map of route*	Iodine capsules (in case water filter breaks)
Whistle*	
Headlamp or flashlight (spare batteries)	*Optional:* your own tent, water filter, or stove if preferable to NPS supplied gear
Notebook, 3 pencils, 2 sharpies*	
Hand lens* (at least one 10x for each crew)	*Other ideas:* Bug repellant, bug net, chapstick, sunscreen, sunglasses, hat/visor, spare shoes/sandles, hiking poles*, gators, camp clothes, daypack or field vest, lightweight long-sleeved shirt or windbreaker, parachute cord for bear wire etc., towel, bandana, personal 1st aid kit w/ moleskin, ace bandage, etc., hot chocolate, cards, book, chocolate chip cookies.
Bear canister* (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!)	**GROUP GEAR** (supplied by NPS)
Sleeping mat	Scale (at office) for weighing back pack
Tent * (NPS supplies may be limited)	Water filter, (recommend 1 per two people)
Raingear * *always*.	Stove
Waterproof boots	Fuel (2 x 22oz for 2 people 8 days)
Hat and gloves	Lighter/matches
Long underwear	Cooking pot w/ handle
Fleece jacket	Tent w/ ground cloth
Quick dry clothes: nylon zip-off pants, polyester shirt	Trowel
	First aid kit

Table 5.2. Equipment for plot setup and sampling.

- Field vest or day pack
- Compass
- GPS w/ spare battery
- Radio w/ spare battery
- Laser Range Finder w/ spare batteries
- Range pole w/ 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 w/ slope equations
- 2 lb. metal hammer (or claw hammer)
- Flagging
- 32 Pin flags
- Rebar (five for LEWI, SAJH; nine for MORA, OLYM, NOCA)
- 32 cedar stakes
- Five metal 2-inch round shiners + five 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

SOP 6: GPS Use: Navigation, Data Collection and Downloading

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct. 6, 2009	Katherine Beirne	Removed operating instructions for specific GPS models.	To make this SOP valid irrespective to changes in availability of particular models of GPS units.
Oct. 6, 2009	S. Acker	References to other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.

Overview

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. We use the Universal Transverse Mercator (UTM) coordinate system, zone 10 north (10N), 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.

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

Methods of operation, data collection, data transfer, and data import and export for specific GPS models can be found in NCCN_GPS_Guidelines.pdf at http://www.nccn.nps.gov/im/dm/Guidance%20Documents/Forms/AllItems.aspx

General Practices for GPS Data Collection

Regardless of GPS receiver type, certain aspects of data collection apply.

- 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) should be 8 or less if possible.
- Length of time GPS data file is open
  Positional accuracy will be better the longer a GPS file is open and the more GPS positions are collected and averaged. Approximately three minutes of data collection is recommended, preferably with a four satellite minimum and a PDOP of 8 or less.
- Multipath error, or signal interference

While 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, or 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 display screen while a GPS is receiving satellite signals), and the 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 will become the best measure of a specific location. Coordinates are displayed in UTM zone 10N, North American Datum 1983 where the easting has six digits and the northing has seven digits.

Training

Training for specific GPS receiver use is covered in **SOP 4**: **Orientation and Training of Field Crews**.

Navigation

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 (e.g., in a canyon), low satellite coverage, or battery power loss. Always use a map, and compass (and altimeter if available), with GPS as an adjunct navigation method.

Navigating to a Location

Selected plot location coordinates are incorporated into the GPS background map if background maps are available in the GPS model. In the absence of a background map, hardcopies of target coordinates can be compared to GPS unit coordinate calculations shown on the GPS unit's coordinate display screen.

See instruction sheets or users' manuals for specific GPS models for navigation functions that give distance and bearing to selected target locations from a current location.

When using background map display screens to navigate, be aware of the display scale. Many GPS units zoom in to a minimum display scale of 10 meters.

The coordinates displayed on GPS unit display screens will often rapidly change or jump around. Use the coordinate averaging capability, if available, of GPS units to better calculate a current location.

Strategy for Locating Plot Center

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 and the target location.
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 displayed by the GPS unit, are continually changing. 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 a plot center.
7. Open a GPS file to record your current location as outlined in Data Collection: 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. Alternatively, use the GPS position averaging (if available in the GPS receiver) to average coordinates for approximately two to three minutes and compare the averaged coordinates to the target coordinates to determine how close the current location is to the target location and adjust your location if needed.
8. If the current UTM coordinates are within 10 meters of target UTM coordinates you may consider this the "plot center."
9. Record the GPS file name on the hardcopy datasheet.
10. Record coordinates from the GPS display screen as "field UTM coordinates" on the datasheet.
11. If you are more than 10 meters off, you may calculate the distance and direction to plot center, move to this location, and collect another GPS file (go to step (8)).

Data Collection

During reconnaissance and establishment of permanent monitoring plots, the field crew will need record GPS files that represent plot centers and other points of interest. GPS units have been pre-loaded with a project specific data dictionary named VCa02.xxx (where xxx is a manufacturer and software specific file extension) into which location specific data can be entered.
Files are later downloaded onto the computer, sent to the GIS specialist, differentially corrected, and entered into the project's database.

GPS File Naming Convention

Please name each file using the following format: GPS unit letter, two digit year, two digit month, and two digit day. For example, Z090708 for GPS unit Z on July 8, 2009.

Data Dictionary

Select the VCa02 data dictionary (the place at which you select this during opening a file varies by GPS model) to record a point location.

Select VCa02_NavPt if the point is being used to aid in navigation or you want to mark a location to help with future navigation. Enter a sequential navigation point number (unique per day), the park code, and an optional description. Record the NavPt number and a location description in your notebook.

Select VCa02_PlotCtr if the point location is the plot center. Enter the park code, the elevation stratum code, and a three digit plot number (please use leading zeroes, e.g. OLYM1-006). If, after collecting a GPS file, you decide to refine your location to better approximate the plot center target coordinates, please use the PlotCtr_Num to sequentially number your point locations. The highest PlotCtr_Num will be interpreted as the plot center location.

At the request of NPS botanists, an ExoticIncidental option has been added to the data dictionary. If you see high-priority, invasive, exotic plants, please collect a GPS file using the ExoticIncidental feature in the data dictionary and record as many of the listed attributes as possible. Check with the park's botanist for a list of high-priority, invasive, exotic plant species.

Other Data Collection Considerations

Once a file is open, do not move from your location (moving will alter the average position calculation). Try to collect at least three minutes worth of data, preferably with at least four satellites and a PDOP of 8 or less.

After collecting and closing a GPS file, go to the position display screen. On the hardcopy datasheet, record the UTM's displayed on the unit.

When a plot is being set up (permanently marked with rebar and stakes), you may need to adjust the plot center location from the previously marked location. This typically happens when the previously recorded and corrected UTM coordinates for the plot center are >10 meters from the target UTM coordinates.

1. Observe the **Navigation Report** (**SOP 2**: **Preparing for the Field Season**) that you have brought with you into the field.
2. 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
3. Open a file and log the new plot center location.

Offsets

If it is necessary to record an offset for a point location, please enter the offset into the GPS so that it can be calculated during GPS file processing**.**

If you are unable to get a reading close to the target location:

1. Move to the nearest location at which you can obtain satellite coverage **GPS position** (**a**)(Figure 6.1).
2. 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).
3. Open a GPS file and record the file name and your current location as described above.

4. Determine your distance from plot center by subtracting the GPS position coordinates from the Plot center target coordinates.
   a. 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).
   b. 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).
5. Move to Plot Center (**c**) with your compass and measuring tape. First move from **a to b**; then move from **b to c** (Figure 6.1). 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 correction table (in Figure 8.3) to calculate horizontal distance from slope distance.
6. 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.
7. 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.

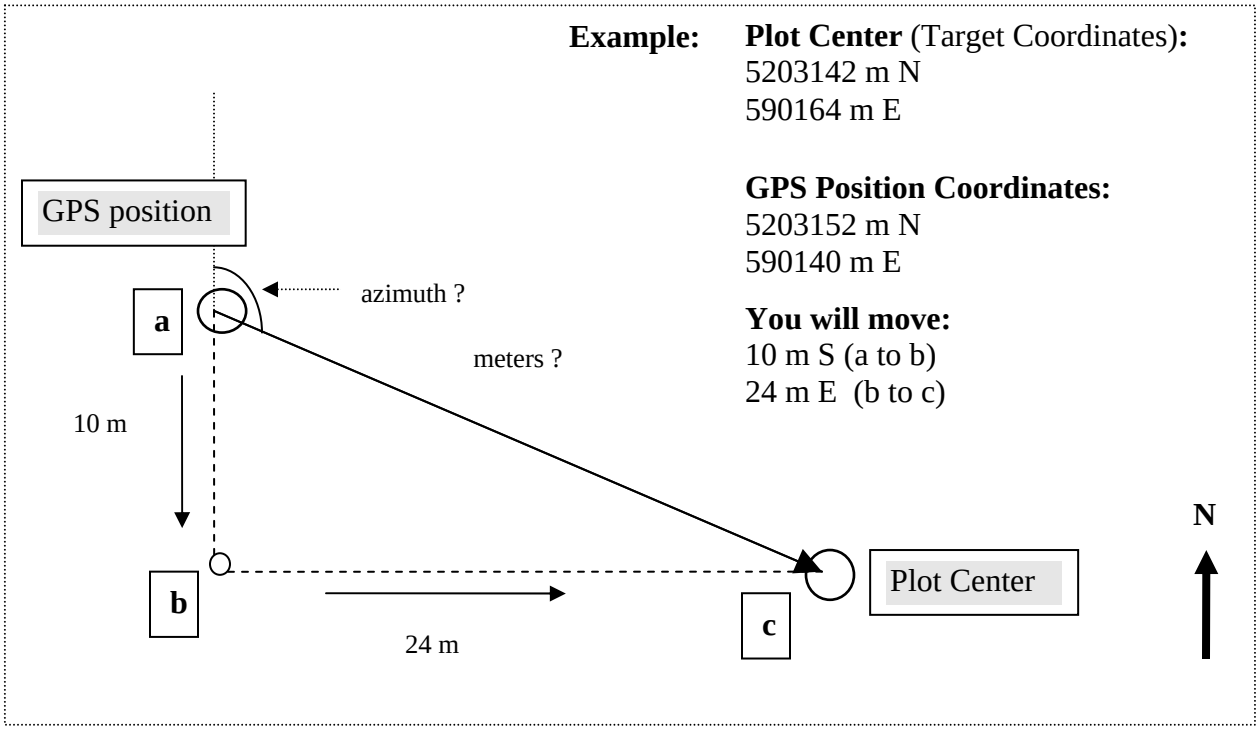


Figure 6.1. Measuring and recording offset.

Downloading and Processing GPS Files

Refer to instruction sheets or users' manuals for the GPS model for instructions on transferring files from GPS units to computers. Transferring GPS files requires a computer, a data-transfer cable, and GPS software installed on computers. GPS receivers typically come with manufacturer-specific software and data-transfer cables.

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_Files" or "Backup"). Communicate with GIS or data management staff to determine where and how GPS files should be stored.

GIS staff will be responsible for GPS file processing including differential corrections. GIS staff can export GPS data into GIS formats upon request throughout the field season. At the end of each field season, GIS staff will be responsible for entering GPS coordinate data into the project's database and conducting quality assurance and control procedures.

SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Sept. 23, 2009	S. Acker	References to other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Sept. 23, 2009	S. Acker	The citation for the vegetation classification for MORA, NOCA, and OLYM was updated, and the list of target vegetation associations was updated.	The final version of the vegetation classification was published after submission of the forest monitoring protocol.
Sept. 23, 2009	S. Acker	LEWI and SAJH were added to the list of parks monitored, and variations in protocol for those two parks were indicated.	Response to comment in the NPS review.
Oct. 20, 2009	S. Acker	Changed convention for naming of files containing photographs of plots.	To make file contents more obvious and facilitate sorting files chronologically.

Overview

This SOP describes screening criteria and field reconnaissance for selection of plots. Much of the reconnaissance for MORA, NOCA, and OLYM was carried out during the 2005 and 2006 field seasons. As of September, 2009, reconnaissance has yet to be completed for LEWI and SAJH. In addition, reconnaissance is needed to identify one more plot in the 1500 to 1800 m elevation stratum at NOCA. Additional reconnaissance at all parks will be performed as funding permits, so that there is a reserve of appropriate plot locations in case established plots experience catastrophic disturbance or become inaccessible. Equipment for conducting reconnaissance is listed in Table 7.1. The datasheet is located in Figure 7.1.

Equipment

Table 7.1. Equipment for conducting reconnaissance.

Pencils	Radio, spare battery
Field notebook	Digital camera, spare batteries
Flagging & permanent marker	Calculator
Meter tape	GPS satellite availability chart
Increment borer, paper straws, tape	List of UTMs
WD-40 & wax	Field Reference Sheet
GPS, spare batteries	Reconnaissance form
Compass	Ocular form
Clinometer	Key to Vegetation Associations
Altimeter	Plant Descriptions
Maps & Digital Orthoquads	Plant collection bags

Plot Selection Criteria

1. Point Distribution**:** Using the Generalized Random Tessellation Stratified (GRTS) program, points are randomly distributed within the parks by GIS staff using the following constraints:
   a. Within a designated 300 m elevation band (Table 7.2).

Table 7.2. Stratum, elevation, and target vegetation.

Stratum	Elevation	Target vegetation	Stratum	Elevation	Target vegetation
1	0-300m	Sitka spruce[1]	4	900-1200m	not used
2	300-600m	not used	5	1200-1500m	not used
3	600-900m	Western hemlock	6	1500-1800m	Subalpine fir

1—western hemlock at SAJH.

   b. $\leq$ 1.5 km from a maintained and/or established trail.
   c. No river barriers.
   d. 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 the plot, centered on the selected point.

Plots are 1 ha, 100x100m, at MORA, NOCA, and OLYM, and 0.25 ha, 50 x 50 m at LEWI and SAJH.

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 $\leq$ 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 $\leq$ 10% area with > 35° slope within the plot buffer ring.
- The plot edge is > 100 m from a road or trail for MORA, NOCA, and OLYM or > 30 m from a road or trail at LEWI or SAJH.
- The point is $\leq$ 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 % area.
- Tree cover is > 25% within the buffer ring.
- Inclusions are < 10% of the area within the buffer ring: examples are 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 x 50 m inner plot (i.e., the entire plot for LEWI and SAJH). 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% of the 50 x 50 m plot.
- Cover of trees must be > 25% within the 50 x 50 m plot. The 25% tree cover must consist of trees > 12.7 cm dbh.
- Inclusions of non-target vegetation types must not exceed 10% of the 50 x 50 m plot. An inclusion is defined as a discernable 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 yrs.
- 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 marked with flagging.

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 x 50 area. If inclusions are encountered or if per cent 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.

Forest Plot Reconnaissance Form

Identification and Location

*Park***:** Enter the four-letter code for the park where the plot is located (LEWI, MORA, NOCA, OLYM, or SAJH).

Plot No: Enter a four-digit plot code _ - _ _ _
The code is created by using:
- single digit elevation stratum: 1, 3, or 6
(**1**: 0-300m; **3**: 600-900 m; **6**: 1500-1800 m), followed by a dash;
- 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.

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). See **SOP 4**: **Orientation and Training of Field Crews**, for more information.

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

GPS file name: The file name created by the observer. See **SOP 6: GPS Use: Navigation, Data Collection, and Downloading** for the convention for naming GPS

files. It is critical that the file name be recorded in addition to the UTMs, because it is the reference used for entering the corrected UTMs later.

GPS model: 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.

Coord. source: Indicate if the coordinate data are from a GPS (default), or are estimated from a map.

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

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

GPS error: Record the horizontal error estimate from the GPS (in meters), if available.

Datum: The datum is the basis for a planar coordinate system and indicates which map projection and coordinates are being used. The North American Datum for 1983 (NAD83) is the standard for NCCN data acquisition. Some older topographic maps are still in NAD27, but we rarely use these to obtain UTM values. Recent map output (i.e., from ArcMap) 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 crew members or those temporarily filling in for others must be notified that we are using NAD83.

Zone: All of NCCN is in the zone 10N.

Elevation: The elevation at plot center, preferably measured in meters. If possible read the elevation from a topographic map or calibrated altimeter. The elevation can also 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: Indicate whether the elevation value is derived from a map, the GPS, an altimeter, or from a GIS theme.

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. Include distances in meters or 0.1 miles and use compass directions. For extremely complicated 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 (e.g., too steep, cliffs, major river or glacier crossing).

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

Plot at a sufficient distance from an official trail or road or park boundary? The trail must be established and maintained. For MORA, NOCA, and OLYM, this distance is evaluated using the potential margin of the 50x50 m inner plot. The edge of the potential inner plot must > 125 m, and the corner of the potential inner plot must be > 135 m, to assure that the all of the 1 ha plot is > 100 m from any trail. For LEWI and SAJH, the entire plot is 50x50 m, and the required distance from a trail or road is 30 m. 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 (MORA, NOCA, or OLYM) or entire plot (LEWI and SAJH) boundary.

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

Target vegetation association? Indicate if the vegetation is the type being targeted for that elevation band. Target vegetation associations for each elevation band are listed in Table 7.3. Note that for LEWI, the target is any vegetation association in the *Picea sitchensis*-(*Tsuga heterophylla*) Forest Alliance.

Table 7.3. Target vegetation associations for each of three elevation bands.

Elevation band	Vegetation association
1: 0-300m	PICSIT-TSUHET/POLMUN-OXAORE
	PICSIT-(ALNRUB)/RUBSPE/POLMUN
	PICSIT-TSUHET/POLMUN
3: 600-900m	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
6: 1200-1500m	ABILAS/VACDEL
	ABILAS-(ABIAMA)/VACMEM/VALSIT
	ABILAS/VALSIT
	ABILAS/VACMEM/LUPARC
	ABILAS-(PSEMEN)/VACMEM/CALRUB

Vegetation association (keyed in 50x50)*:* Write the vegetation type in the box. To key out the vegetation association for the 50x50 m inner plot (entire plot for LEWI and SAJH), use the key to vegetation associations found in Appendix A of Crawford et al., 2009.

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 50x50 m plot in inclusion(s): List the % area of the 50x50 m plot that contains the inclusion.

No. 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 "Taking and Preparing Increment Cores" 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 50x50 m area passes all evaluation criteria (a 'Y' answer in all boxes except *Non-target inclusions,* and $\geq$ 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 Lead upon 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 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 x 50): Describe the terrain, vegetation, and environmental features of the 50x50 m plot. Include tree, shrub and herbaceous species, size, and relative abundance.

Photos

Plot photographs allow us to view a plot if questions arise after the field visit. Photos 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 photos as indicated on the data sheet.

Image label (the first three are required)

Upslope: take one photo looking upslope from plot center
Downslope: take one photo looking downslope from plot center
Across plot: take one photo looking across the plot
Additional photos: Additional photos may be taken at the crew's discretion.

Photo number: Write in the photo number 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 **SOPs 9: Recording Plot Visit Details and Taking Digital Photos: Event Log and 12: Managing Photographic Images**). The image file name should consist of the following parts, separated by an underbar character:

1. The date on which the image was taken (formatted as YYYYMMDD)
2. The four-character park code (i.e., LEWI, MORA, NOCA, OLYM or SAJH)
3. Plot location code (elevation stratum and 3-digit plot number, separated by an underbar)
4. The photographic view code (UP for upslope, DW for downslope, AC for across plot)
5. Optional: a brief descriptive word or phrase
6. Optional: a sequential number if multiple images were captured
7. Optional: time (formatted as HHMM)

Example:

- 20090723_NOCA_6_209_UP.jpg
  [refers to NOCA plot #6-209 photo looking upslope from plot center, taken on July 23, 2009]

In most cases, a Classification Plot Survey Form and Ocular Form were completed at reconnaissance points, in collaboration with the Vegetation Mapping Project. Because this is not part of the forest vegetation monitoring project it will not be described here.

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 WD-40 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 4.5 feet 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 WD-40 and beeswax to the threads to reduce 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. 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 tree 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. Record in your notebook the height on the bole at which the core was taken.

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 (six-letter code), dbh, date, and corer's 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 WD-40 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.

Troubleshooting

- 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 borer 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 counter-clockwise in order to extract the borer from the tree.

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

NCCN FOREST PLOT RECONNAISSANCE FORM
IDENTIFICATION & LOCATION version 10/21/2009

Park: _ _ _ _ Plot No. _ -_ _ _ (*Stratum #, Firing order #*) Watershed: _____ Site name: _____

Date: M _ _ D _ _ Y _ _ _ _ Declination (E): ___°

Crew: _____ (*last name, first initial*)

GPS file name: _____ GPS model: _____ Coord. source: GPS Map

Field UTM **X** _ _ _ _ _ _ m E Field UTM **Y** _ _ _ _ _ _ _ m N GPS error: ____ Datum: NAD83 Zone: 10N

Elevation: _ _ _ _m Source: _Map _GPS _Altimeter _GIS theme

Directions to plot: _____

EVALUATION of 50 x 50 m plot

Plot safely accessible? *(unsafe=too steep, cliffs, major river or glacier crossing)*	**circle** Y	N	**Explanation:**		[*Reject and abandon if unsafe*]
Slope in plot < 35°? *(for at least 90% of plot)*	Y	N			[*Reject if >10% of plot has 35°*]
Plot at a sufficient distance from an official trail or road or park boundary *(MORA, NOCA, OLYM--Plot edge > 125m, and plot corner > 135m; LEWI, SAJH > 30 m)*	Y	N			[*Reject if distance insufficient*]
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? *(streams, cliffs, disturbance, wetlands, etc.)*	Y	N			
Proportion of 50x50 m plot in inclusion(s):	**%**				[*Reject if >10% of 50 x 50 m plot*]
No. of rings in core from dom/codom tree base *(do not core emergent or open-grown outliers* - Label core with park, forest type, plot number, species, date)	**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 label	Photo #	Brief description of view	Image file name (office)
Upslope			_ _ _ _ _UP.jpg
Downslope			_ _ _ _ _DW.jpg
Across plot			_ _ _ _ _AC.jpg
Additional photos			_ _ _ _ _.jpg

Image file name consists of: YYYYMMDD PARK_strata#_plot#_descrip.jpg

NCCN_Forest_Recon_Form.doc

Figure 7.1. Reconnaissance form.

Literature Cited

Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Natural Resource Technical Report NPS/NCCN/NRTR—2009/D-586. National Park Service, Fort Collins, Colorado.

SOP 8: Establishing Permanent Monitoring Plots

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Dec. 18, 2008	S. Acker	Reduced the number of cedar stakes to reflect that 1x1 m quadrats will not be established. Removed items from the Field Reference Sheet which pertained to understory vegetation and herbivory measurements.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Sept. 30, 2009	S. Acker	Combined SOPs for physically installing permanent plots and for recording physical and biotic characteristics of newly-established plots. References to other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Sept. 30, 2009	S. Acker	LEWI and SAJH were added to the list of parks monitored, and variations in protocol for those two parks were indicated.	Response to comment in the NPS review.

Overview

This SOP contains instructions for establishing permanent plots and recording their environmental characteristics. Plots are established once the corrected plot center is located and before the first iteration of sampling. Plots are squares of 0.25 ha (LEWI and SAJH), or 1.0 ha (MORA, NOCA, and OLYM), aligned with the cardinal directions (sides run directly N-S and E-W). Each plot will be marked with rebar at plot center and at outside corners. The entire plot for LEWI and SAJH, and the inner 0.25 ha for MORA, NOCA, and OLYM, is a 50 x 50 m area of subplots marked every 10 m with a cedar stake, except for the four outer corners which are marked with rebar. At MORA, NOCA, and OLYM, the four outer corners of the 1.0 ha are also marked with rebar. Refer to Figure 8.1 for plot layout. Equipment for establishing and marking permanent plots is listed in Table 8.1. The datasheet is located in Figure 8.2.

Note: If you arrive at a plot and find that it does not meet the criteria for a permanent plot as outlined in **SOP 7: Screening and Reconnaissance for Selection of Monitoring Plots**, contact your supervisor immediately. Do not proceed with the plot set up until the discrepancy is resolved.

Equipment

Table 8.1. Equipment for establishing and marking a permanent plot.

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 21.21m (recommended)	Clinometer
32 cedar stakes	Calculator
(Use 12" stakes for OLYM strata 1 plots; 10" for all others)	Flagging
Rebar (five for LEWI, SAJH; nine for MORA, NOCA, OLYM)	Slope equation table
Pin flags or tall garden stakes with flagging	Lot layout diagram
Five shiners, five nails (if stakes cannot be inserted)	Plot establishment form
36 blue metal numbered tags, 36 short nails	Plot maps

Plot Setup Procedure

This procedure can be accomplished with a two- to four-person crew in about five 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. If understory vegetation sampling is reinstated, quadrats would 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 50x50 m plot would 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 below. An error of 1% is acceptable (e.g. 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 $\leq$ 5 meters 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 aligned correctly.
3. Set Four 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 (ie. due to logs or trees), points may be marked with 2-inch 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.** 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% 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 the subplot corners around them (except the 50 x 50 m corner stakes).
7. True-up Hubs. Measure the distance between the hubs to check that there is no more than 1% error ($\leq$ 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 marked by rebar.
9. Set Corner Stakes. The corner rebar are set by aligning with four stakes, two on either side of the 50 x 50 m plot. For example, to put in corner #1 you would use stake numbers 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 (MORA, NOCA, and OLYM only). Locate the outer corners of the 1 ha plot from the outer corners of the 50 x 50 m plot. Carefully shoot an azimuth of 315° (NW) for a distance of 35.36 m. You may need to do this in two to four 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°).

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 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.

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 backcountry. In this situation horizontal distance can be calculated using slope distance (sd) and slope (s^o) as measured with a clinometer ($H = sd \cos s^o$), or by using % slope and the slope correction factor from the slope correction table in the Field Reference Sheet (Figure 8.3). For setting up relatively flat plots the crew may opt to use a measuring tape, keeping the tape level to measure H.

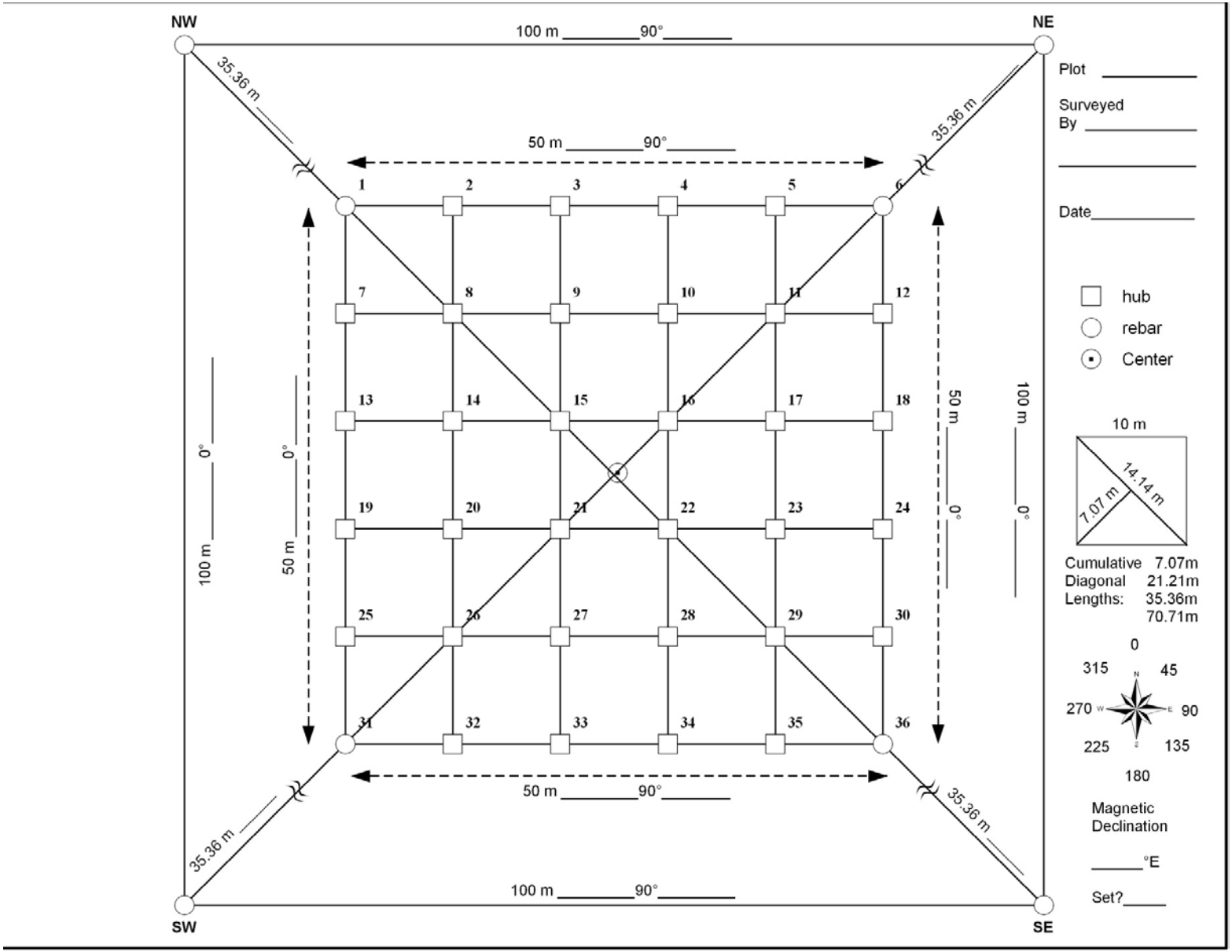


Figure 8.1. Plot layout diagram. For LEWI and SAJH omit outermost corners.

Plot Establishment Form

The plot establishment form is to be completed by the crew that sets up the plot. One techinician in each crew (usually the Crew Lead) will be responsible for ensuring that these data are completely recorded. Fields labeled "*office use only*" are to be completed in the office and not in the field. Fill out the form as follows:

Identification and Location

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

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

- single digit elevation stratum: 1, 3, or 6

(**1**: 0-300m; **3**: 600-900 m; **6**: 1500-1800 m), followed by a dash;

- 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.

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). See **SOP 4**: **Orientation and Training of Field Crews**, for more information.

Crew: The last names and first initials of crew members that participated in plot 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 UTMs, because it is the reference used for entering the corrected UTMs later.

GPS model: 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.

Coord. source: Indicate if the coordinate data are from a GPS (default), or are estimated from a map.

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

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

GPS error: Record the horizontal error estimate from the GPS (m), if available.

Datum: The datum is the basis for a planar coordinate system and indicates which map projection and coordinates are being used. The North American Datum for 1983 (NAD83) is the standard for NCCN data acquisition. Some older topographic maps are still in NAD27, but we rarely use these to obtain UTM values. Recent map output (i.e., from ArcMap) 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 crew members or those temporarily filling in for others must be notified that we are using NAD83.

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

Elevation: The elevation at plot center measured in meters. If possible read the elevation from a topographic map or calibrated altimeter. The elevation can also be read from the GPS, but this may be less accurate. Check the units for elevation from the source you are using (meters or feet); if in feet, change the units to feet on the data sheet.

Source: Indicate whether the elevation value is derived from a map, the GPS, an altimeter, or from a GIS theme.

Directions to plot: Starting from a road, trail head, or other mapped landmark, give detailed directions to aid an entirely new crew returning to the plot. 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 the next visit to the plot. This may include stakes, rebar, or tags that need to be replaced, the advisability of bug nets, etc.

Environmental Features (of 50 x 50)

All data recorded in this section pertains to the inner 50 x 50 m area 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 up slope and down slope) 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 8.3.

Parent material: Material from which the soil is derived. The descriptions below are also located in Figure 8.3.

- 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 x 50 m plot (see Figure 8.3).

Microtopographic position: Also called microposition; the landscape in the near vicinity of the 50 x 50 m plot. Refer to the Microposition diagram in Figure 8.3.

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 8.3.

Topographic moisture (TM): Used to describe and analyze the movement or redistribution of water by gravity through the soil and bedrock (Henderson et al. 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 is code "9" which 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. Record values to 0.1 units, but do not use halves (e.g. 4.5, 5.5). Refer to Topographic Moisture table in Figure 8.3.

Landform: The landform that best describes the 50 x 50 m plot. Options are listed in the Landform table in Figure 8.3.

Drainage: Choose the category (listed below) that most closely describes the drainage characterisitecs 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.

- Runoff: if it appears that water would run off quickly due to a relatively steep slope.
- Permeable: if it appears that water would drain quickly due to a permeable (rocky or sandy) substrate.
- Impeded: 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 above choices: This is not a required field. If you have trouble choosing from the options in the boxed fields, or feel there isn't a perfect fit, you may offer an explanation here.

Site Map

During plot set-up, make 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 (Figure 8.4). 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.

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

NCCN FOREST PLOT ESTABLISHMENT FORM

IDENTIFICATION & LOCATION version 10/21/2009

Park: __ __ __ __ Plot No. __-__ __ __ *(Stratum #, Firing order #)* Watershed: _____ Site name: _____

Date: M __ __ D __ __ Y __ __ __ __ Declination (E): ___°

Crew: _____ (*last name, first initial*)

GPS file name: _____ GPS model: _____ Coord. source: GPS Map

Field UTM X __ __ __ __ __ __ m E Field UTM Y __ __ __ __ __ __ __ m N GPS error: ____ Datum: NAD83 Zone: 10N
(check these on GPS unit)

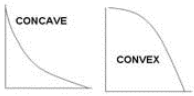
Elevation: __ __ __ __m Source: __Map __GPS __Altimeter __GIS theme

Directions to plot: _____

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 back	**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** __ Runoff – rapid drainage due to steep slope __ Permeable– rapid drainage due to coarse, permeable surface __ Impeded – low permeability __ Aquatic

Comments to clarify above choices: _____

Figure 8.2. Plot establishment form.

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

1=small twigs present, sound log, wood original color
2=starting to rot but bark resists being pulled off, twigs with peeling bark
3=sapwood spongy, bark falls off when disturbed, bole maintains its own shape
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)
5=heap with bark underneath, barely recognized as being a log

SNAG DECAY CLASS

1=pointed top, limbs present, bark left, wood hard
2=few limbs, no fine branches, sapwood sloughing, wood decayed
3=limb stubs only, broken top, sapwood sloughing, wood fibrous
4=few or no stubs, broken top, cubical, reddish wood
5=no stubs, broken top, <20% of bark left, wood mostly gone

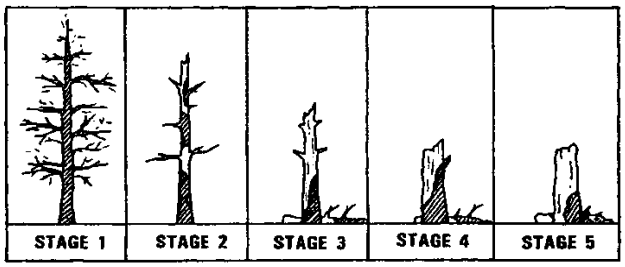


Figure 8.3. Field reference sheet (five pages).

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

LANDFORM (from J. Riedel, NOCA)

- High elevation landforms (primarily erosional in genesis)

H = Horn, summit ringed by cirques with no evidence of overriding by Cordilleran Ice Sheet

A = Arete, ridge with jagged form, not modified by CIS

C = Cirque, glacial landform with flat floor and amphitheater shape

O = Other, lower summit modified by CIS

R = Ridge top, lower elevation with rounded form, modified by CIS

P = Pass, low point between horns and aretes

LM= Little Ice age moraine. Ridge of till deposited by glacier movement from 700-100 yrs bp.

PG= Patterned ground.

PK= Parkland (MORA only) gentle terrain surrounded by steeper.

-Valley slope landforms (primarily erosional genesis)

VW = Valley Wall

RC = River Canyon- Vshaped valley incised in bedrock

BB = Bedrock Bench, 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 =Debris avalanche, large landslide includes rock and debris

MM-F = Rock Falls or Topple- accumulation of falling rock in single events. Usually void.

MM-DA = Rock and debris avalanches (large size, rapid)

MM-S = Slumps and Creeps- landslide of saturated ground material.

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 $>10^0$, 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 $< 5^o$

M = Glacial Moraines

PM = Pleistocene Moraine- ridge of till deposited by glacier

-Other landforms

U = Undifferentiated, usually glacial drift

Figure 8.3. Field reference sheet (five pages) (continued).

TOPOGRAPHIC MOISTURE

Convex

POSITION	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					

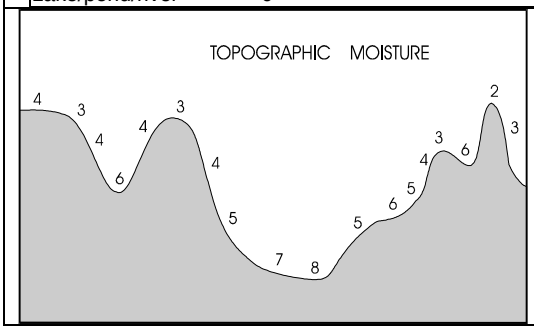
Straight

POSITION	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				

Concave

POSITION	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 halves** (e.g. 4.5, 5.5).

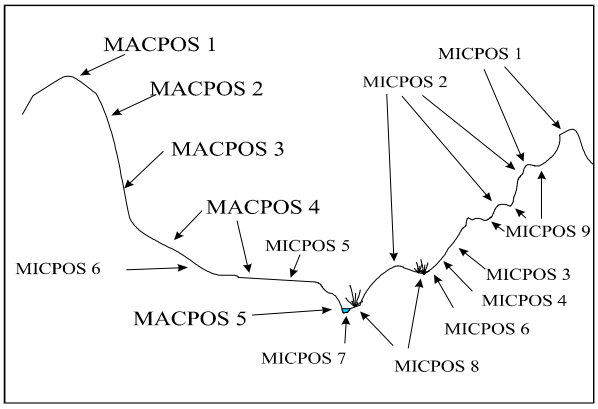


1 = extremely dry (rocky ridgetop)
2 = very dry
3 = dry, well-drained
4 = dry mesic
5 = mesic
6 = moist mesic
7 = moist, well-watered
8 = wet
9 = standing water

Figure 8.3. Field reference sheet (five pages) (continued).

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**



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

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

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

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

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

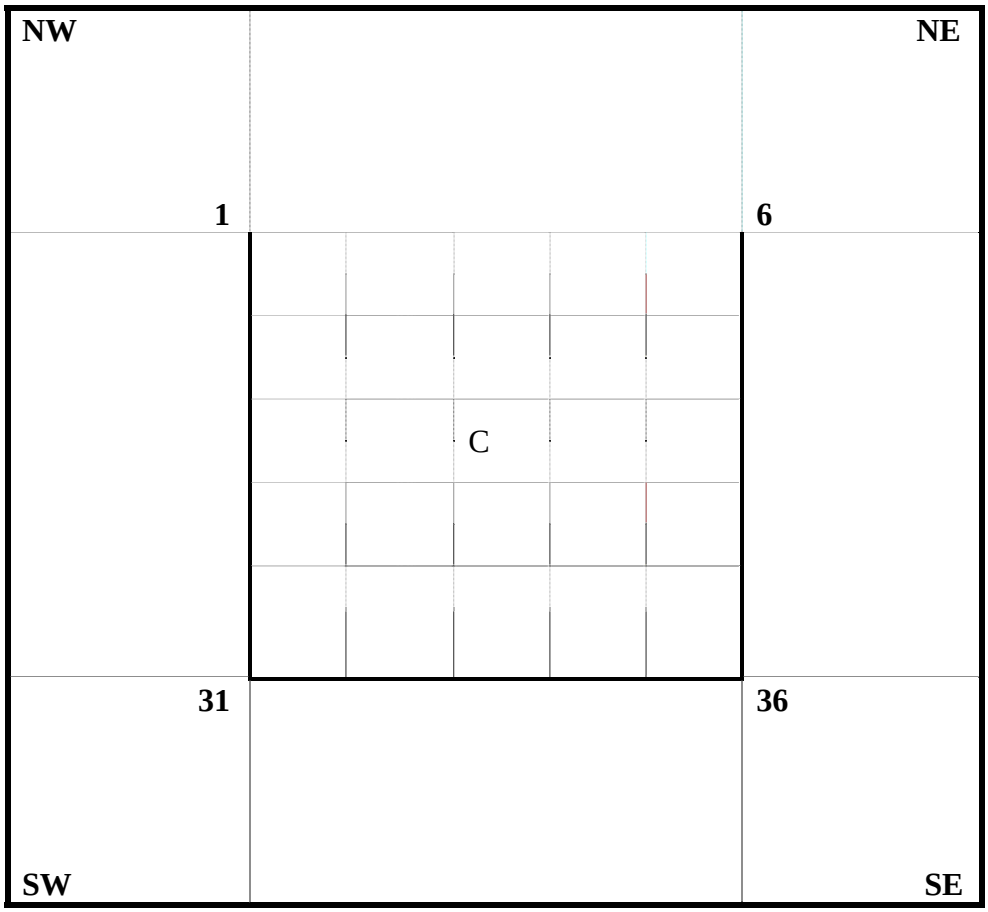
1 = convex 2 = straight 3 = concave 4 = undulating

Slope correction table (EF=expansion factor)

% 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		

Features will be marked on this map during plot set up. In the office the site map will be scanned and/or 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. Note that for LEWI and SAJH, the plot consists of the inner 50x50 m only.

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



Azimuths (^{o} true): C→1 = 315 ^{o} C→6 = 45 ^{o} C→31 = 225 ^{o} C→36 = 135 ^{o}

NOTES:

Figure 8.4. Site map form.

Literature Cited

Brewer, R. and M.T. McCann. 1982. Laboratory and field manual of ecology. Saunders College Pub., Philadelphia.

SOP 9: Recording Plot Visit Details and Taking Digital Photos: Event Log

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan. 6, 2009	S. Acker	Removed references to SOPs that have been suspended indefinitely.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Oct. 3, 2009	S. Acker	Variations in protocol for LEWI and SAJH were indicated.	Response to comment in the NPS review.
Oct. 3, 2009	S. Acker	References to other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Oct. 5, 2009	S. Acker and J. Boetsch	Updated Figure 9.1, Plot Event Log form.	Updated field form to reflect new naming conventions for photographs, and to include a default option for plot directions when no changes are needed.

Overview

This SOP provides directions for recording information on visits to permanent plots for data collection. Information recorded includes logistics, recent disturbances, status of measurement tasks, and photo-documentation. The data sheet for this purpose is referred to as the 'Event Log' (see Figures 9.1 and 9.2).

Completing the Event Log

Identification and Location

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

Plot No: Enter a four digit plot code _ - _ _ _

The code is created by using:

- single digit elevation stratum: 1, 3, or 6

(**1**: 0-300m; **3**: 600-900 m; **6**: 1500-1800 m), followed by a dash;

- 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.

End date: Enter the date sampling is completed.

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). See **SOP 4**: **Orientation and Training of Field Crew**, for more information.

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

Directions to plot: First determine if the directions in the Navigation Report are adequate. If so, check the box next to "No change (same as previous)" and leave the field blank. If no directions exist, or if the existing directions are not useful, check the box next to **"**Replace/New " and provide detailed directions as follows. Start from a road, known trail head, or other mapped landmark. Include distances in meters or 0.1 miles and use compass directions. Keep in mind that an entirely new crew may be returning to the plot. 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. If

the existing directions are useful, you may also choose to add to or revise them (check the appropriate box and write as needed).

Task list: Plot needs, special instructions, or adjustments to consider before plot revisit. These notes will be printed in the Navigation 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 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.

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

Collected: Indicate if the following data was completed (Y), not completed (N), or partially completed (Partial). This information becomes part of the Navigation Report that is printed and taken to the plot during each return visit.

Tree measurements? Indicate if tree diameters and associated data were collected (Y), not collected (N), or partially collected (Partial). These data are normally collected only every fifth year. Partial collection could occur in a measurement year if there was only time to do part of the plot, or in a non-measurement year if there were omissions or errors in the data from a measurement year.

Mortality data? Indicate whether all (Y), none (N), or part (Partial) of the mortality data was 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.

Improved GPS coordinates? Indicate if new GPS coordinates were collected for the plot center. If Yes, indicate the GPS file name in the space provided. Otherwise leave that space blank.

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

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.

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 tag number(s) 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 tag number(s) added.

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.

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 tops or limbs, cankers, brooms, conks, pitch, flagged branches, insect holes, insects, avalanche, and rock slides.

Water on plot: The hydrologic regime within the 50 x 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.
- Scattered standing water
- Saturated (water table): The soil is saturated, (i.e., the water table is at the surface).
- Other: description of water on the plot that does not fit any of the above selections.

Photo Documenting Permanent Plots

The crew photographer should take all photos as outlined in the Photos table on the data sheet. These photos are taken during tree measurement years only. However, photos of diseased vegetation, landscape disturbances, or wildlife evidence can clarify a description, and the crew is encouraged to photo-document these and 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 picture will capture changes that have occurred when other measurements do not capture the change.

One technician will be assigned the lead role for photo-documentation. Often other technicians will shoot some of the required photos, but the lead technician for this role is responsible for ensuring that all required photos are taken, and any good photo 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 12: Managing Photographic Images**).

Responsibilities of the Lead Technician

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

1. 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.
2. Make sure that the data sheet 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.
3. Check that the correct date and time are entered in the camera.
4. Ensure that a sufficient number of charged batteries and storage cards are brought into the field each day.
5. Ensure that the equipment is well-cared for, and that the camera is stored in dry conditions during inclement weather.
6. Be familiar with the methods, hardware and software required to download the images following a trip.
7. Ensure that the images get correctly downloaded, copied, renamed, sorted, and entered into the database at the end of each tour, as described below.
8. Be responsible for recharging the batteries such that they will be ready for use during subsequent field excursion.
9. Make recommendations at the end of the field season about lessons learned and improvements to this procedure.

Guidelines for Shooting and Recording Photos

1. *Before sampling*. Plot photos are taken before sampling the plot. It is essential that you take the plot photos before the measurements are made, so that images of the plot represent its most natural, undisturbed state.
2. *Consider time of day*. On sunny days, earlier or later in the day is best. Photos should not be taken into the glaring sun.
3. *Weather*. If it is raining, do not risk getting the camera wet to take photos. Take advantage of any break in the rain to get images of the site.
4. *Check view*. Before taking the photo, 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.
5. *Position*. Take photo from a standing position.
6. *Resolution*. Use a medium resolution format for photos. The typical file size of photos ranges between 400 KB – 1 MB. Rarely will you need to store images in the highest resolution format for routine photo-documentation. Most often, field excursions last for eight days, and you must not exceed the storage capacity for images. There should be storage capacity for the required photos for three plots, at 25 photos per plot, plus room for additional photos. See **SOP 12: Managing Photographic Images**, for more details.
7. *Identify the plot*. The first photo for each plot should frame a sign with plot information. Use a black sharpie pen to write in bold letters on blank paper: plot code, date, photo descriptor, and photographer's initials as in the example below. This will help to separate the photos between plots and help to prevent confusion.

MORA3-098
6/3/06
Center
J.T.

8. *Photo #*. Every photo that is taken must be recorded on the data sheet. The camera automatically assigns a number to each image. Record this number beside the photo code on the data sheet. If the photo is not represented by a code, write an abbreviated description of the view being photographed. Avoid deleting images in the field. If you delete a photo for any reason, record it as a deleted image next to the associated number, so that all numbers in the sequence are accounted for.
9. *Brief 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 photo if a mix-up occurs.
10. *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 datasheet for each photo. Fill in the park, strata, and plot # on the data sheet, at least for the first photo. This will help facilitate image naming back in the office.
11. *Images***.** Total number of required photos is 25. Views are described below.

Photo Views (see also Table 9.1)

1. First, take a low horizontal photo 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.

2. Standing at plot center and facing outward toward the designated corner, take two photos: 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.
3. Standing at each of the four inner plot corners (1, 6, 36, 31), facing plot center, take two photos as before (horizontal and vertical). This equals eight images per plot.
4. From these four inner plot corners take one photo (horizontal), facing away from the plot toward the outermost corner. This equals four images per plot.
5. Standing at each of the outermost plot corners (NW, NE, SE, SW) facing plot center, take one photo. This equals four images per plot. Note that these images are not taken at LEWI and SAJH.

Table 9.1. Position codes for data images routinely collected in monitoring plots.

Photo	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

Additional Photos

Record location, photo #, and a brief description for each additional photo. Although these are not required, take photos if they help describe or clarify plot characteristics, or work being conducted.

1. 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.
2. If possible, take two to four photos 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 upon what aspect gives the best overall picture of the area. Record aspect and position relative to the plot.
3. Take photos to illustrate interesting plant species, disease, or disturbance.
4. Occasionally photograph crew members and work in progress.
5. A GPS point can be recorded for photos 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.

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. Indicate in the Notes column if planned data collection (including photos) was not completed. Record the total number of days devoted to the plot (including travel to and from the plot as well as time at the plot). 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 notes to provide more detail on access if needed.

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

NCCN FOREST PLOT EVENT LOG FORM

IDENTIFICATION & LOCATION version 10/21/2009

Park: __ __ __ __ Plot No. __-__ __ __ *(Stratum #, Firing order #)* Watershed: _____ Site name: _____

Date: M __ __ D __ __ Y __ __ __ __ Declination (E): ___°

Crew: _____ *(last name, first initial)*

Directions to plot (check one): □ No change (same as previous) □ Replace/New □ Add □ Revise

_____

_____

_____

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

_____

_____

COMMENTS

Weather conditions:

Logistics problems:

Collected:	**Circle:**				**Circle:**		
Tree measurements?	**Y**	**N**	**Partial**	**Site map updated?**	**Y**	**N**	**New site map file name (*office*):**
Mortality data?	**Y**	**N**	**Partial**	**Stakes replaced?**	**Y**	**N**	**Replaced stakes:**
Improved GPS coords?	**Y**	**N**		**Tree tags replaced?**	**Y**	**N**	**Replaced tags:**
GPS file name (if yes):				**Tree tags added?**	**Y**	**N**	**New tag #s:**

Observed changes to plot:

Evidence of animals:

Significant events (e.g., sightings of rare/exotic species, accidents, tagged bears, etc.):

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 (H_2O table)
__Permanent stream/pond __Flood zone __Other _____
__Permanent swamp/bog __Scattered standing H_2O

Figure 9.1. Plot event log form, page 1.

PHOTOS (Tree measurement years only; NWC, NEC, SEC, and SWC not taken at LEWI and SAJH)

View code	Photo #	Brief description of view	Image file name (office) (Date_Park_Stratum_Plot_ViewCode.jpg) Example: 20100528_OLYM_1_001_C.jpg
C			_ _ _ _C.jpg
C1_H			_ _ _ _C1_H.jpg
C1_V			_ _ _ _C1_V.jpg
C6_H			_ _ _ _C6_H.jpg
C6_V			_ _ _ _C6_V.jpg
C36_H			_ _ _ _C36_H.jpg
C36_V			_ _ _ _C36_V.jpg
C31_H			_ _ _ _C31_H.jpg
C31_V			_ _ _ _C31_V.jpg
1C_H			_ _ _ _1C_H.jpg
1C_V			_ _ _ _1C_V.jpg
1NW			_ _ _ _1NW.jpg
6C_H			_ _ _ _6C_H.jpg
6C_V			_ _ _ _6C_V.jpg
6NE			_ _ _ _6NE.jpg
36C_H			_ _ _ _36C_H.jpg
36C_V			_ _ _ _36C_V.jpg
36SE			_ _ _ _36SE.jpg
31C_H			_ _ _ _31C_H.jpg
31C_V			_ _ _ _31C_V.jpg
31SW			_ _ _ _31SW.jpg
NWC			_ _ _ _NWC.jpg
NEC			_ _ _ _NEC.jpg
SEC			_ _ _ _SEC.jpg
SWC			_ _ _ _SWC.jpg

Optional photos (any year; plant spp., plant disease, animal sign, disturbance, working crew – include photo # & description)

Location	#	Brief description of view	Image file name (office)

Logistics Record - Fill out at end of each tour

Sampling event task	Time spent (hours)	# persons	Notes
Transportation office to trailhead			
Hike trailhead to campsite			
Hike campsite to plot			
Mortality data			
Tree measurements			
Taking plot photos			
Hike campsite to trailhead			
Transportation trailhead to office			
TOTAL DAYS on plot			

Special transportation needs: _____

Accommodation used (campsite, housing, ranger station): _____ Accommodation notes: _____

NCCN_Forest_Plot_Event_Log_Form.doc

Figure 9.2. Plot event log form, page 2.

SOP 10: Measuring and Mapping Live and Standing Dead Trees

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
May 27, 2008	S. Acker & S. McDonough	Added tagging of saplings in selected subplots; added tagging of small trees in 50x50, set minimum snag diameter to 12.7 cm dbh; set interval for dbh measurement and adding ingrowth to five years	Protocol trimmed to focus on tree recruitment, growth, and mortality, which required increased sample size for trees.
Sept. 1, 2009	S. Acker	Description of method of measuring tree height with a clinometer was rewritten.	Correction of minor errors and simplification of the process.
Oct. 3, 2009	S. Acker	Variations in protocol for LEWI and SAJH were indicated.	Response to comment in the NPS review.
Oct. 3, 2009	S. Acker	Distinctions between tree status values L (living), D (dead), and F (fallen) made explicit.	Confusion on the part of field crews, e.g., concerning trees that had fallen but were still living.
Oct. 3, 2009	S. Acker	Added emphasis on difficulties of measuring large trees on slopes, and suggested remedies.	Response to comment in the NPS review.
Oct. 3, 2009	S. Acker	References to other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.
Oct. 3, 2009	S. Acker	Added explicit criteria for assessing that a tree is alive.	Response to comment in the NPS review.
Oct. 3, 2009	S. Acker	Added directions for recording attributes of newly-dead trees which may contribute to assigning a cause of mortality.	Recommended by field crews implementing the protocol.
Oct. 19, 2009	S. Acker	Added tree status of 'S' for snags (standing dead trees previously recorded as dead).	Need to distinguish between tree mortality events and continued observations of snags.
Oct. 19, 2009	S. Acker	Added table showing which transitions between tree status values are allowed and which are not.	Reduction of potential for confusion on the part of field crews and future data users.
Oct. 23, 2009	S. Acker	Added directions to replace witness trees that die.	Need to make explicit that witness trees must be living.
Oct. 23, 2009	S. Acker	Added direct measurement by tape to list of methods of height measurement.	Need to make SOP consistent with full range of alternative methods of height measurement that are likely to be used.
Oct. 23,	S. Acker	Added directions to record	Need to accommodate in the SOP the

2009		information in Comments field if more than one type of damage or disease may have contributed to tree death.	likely circumstance of multiple possible causes of tree death.
Oct. 23, 2009	S. Acker	Added specific examples of causes of tree death that would be recorded under the categories of 'Weather' and 'Vegetation'.	Need to minimize ambiguity for field crews as to meaning of categories of causes of tree death.
Nov. 2, 2009	S. Acker	Deleted directions for estimating tree diameter at a previous measurement.	Need to remove reference to an aspect of FIA methods we are unlikely to employ.

Figures

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Figure 10.1. Map of 100 x 100 meter plot. ..... SOP 10.6

Figure 10.2. Schematic representation of decay classes of Douglas-fir snags. ..... SOP 10.18

Figure 10.3. Example of the Hawksworth six-class rating system. ..... SOP 10.24

Figure 10.4. Tree data form, page 1. ..... SOP 10.27

Figure 10.5. Tree data form, page 2. ..... SOP 10.28

Figure 10.6. Tree data form, page 3. ..... SOP 10.29

Tables

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Table 10.1. Equipment for measuring and mapping trees. ..... SOP 10.4

Table 10.2. Tally tree definitions. ..... SOP 10.5

Table 10.3. Tally trees: size, sampling activity, and location. ..... SOP 10.6

Table 10.4. Tree status transition matrix. ..... SOP 10.9

Table 10.5. Crown class definitions. ..... SOP 10.16

Table 10.6. Snag decay class codes and descriptions. ..... SOP 10.17

Table 10.7. Damage location codes. ..... SOP 10.18

Table 10.8. Class I damage agents. ..... SOP 10.19

Table 10.9. Class II damage agents. ..... SOP 10.21

Table 10.10. Mistletoe codes and descriptions. ..... SOP 10.24

Table 10.11. Cavity presence codes. ..... SOP 10.25

Overview

This SOP describes how and where to measure live and dead trees. 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. In summary:

- Tree location reference information is recorded once, during the initial tagging.
- Witness tree location and status are checked every visit.
- Tree mortality data are recorded every year after the initial visit.
- Every five years, tree diameters are measured, crown and bole attributes are recorded, and 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.

The tree data sheet is located in Figures 10.4, 10.5, and 10.6. Note: the terms "height" and "length" are used interchangeably to indicate distance along the trunk no matter its orientation to the ground (e.g., vertical, leaning). The equipment needed is listed in Table 10.1.

Equipment Needed

Table 10.1. Equipment for measuring and mapping trees.

Tagger (person 1)	**Data Recorder (person 2)**
Cloth dbh tape	Laser range finder
Tree Tags (300 per plot)	Compass (declinated)
Aluminum nails (300 per plot)	50 m tape – if no laser
Aluminum wire (50 per plot)	Clinometer – if no laser
Temporary tags	Tree Data Sheets, pre-printed and blank (rite-in-the-rain)
Claw hammer	Pencils
Reflector	Binoculars
Navigation Report*****	

* Check the Navigation Report (see **SOP 2**: **Preparing for the Field Season**) before going into the field to see if there are any special tasks or needs for the 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.

Definitions

An individual tree is categorized as a live tree, a snag, a sapling, or a seedling based on the criteria in Table 10.2. Note that for LEWI and SAJH, the entire plot is the 50 x 50 m area; for these parks, references to the portion of the plot outside of the 50 x 50 m area are not relevant. The standard measurement of tree size we use is diameter at breast height (dbh). Breast height is defined as 1.37 m measured on the uphill side of a tree bole.

Table 10.2. Tally tree definitions.

Type	Dbh (cm)
Live tree – dom/codominant *Measured throughout plot*	≥ 76.2
Live tree – smaller *Measured throughout 50x50*	12.7 to 76.1
Snag (standing dead) - large *Measured throughout plot*	≥ 76.2
Snag (standing dead) - smaller *Measured throughout 50x50*	12.7 to 76.1
Sapling *Measured in specified subplots*	2.5 to 12.6

Live Tree

Trees are alive if they have any living parts (leaves, buds, cambium) at or above the point of diameter measurement (1.37 m). 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 which has an unbroken actual length of at least 1.37 meters, and lean less than 45 degrees from vertical as measured from the base of the tree to 1.37 meters. Broken pieces on dead trees that are attached by more than 50% of their wood are included in tree measurements; partially attached pieces, separated from the main bole by more than 50 %, are not included. 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 degrees from vertical. They may be supported by other trees, branches, or their crown. Once tallied, dead trees at least 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.**

Witness Trees

Witness trees are a reference for the location of plot center and corner stakes and must be ≥ 12.7 cm dbh. Witness trees are recorded on the tree data sheet during plot setup. Witness trees are coded as 'W' in the 'Tree Type' column on the tree data sheet if they are used as witness trees only, or as 'B' if they also qualify as data collection trees. Only live trees are used as witness trees; if a witness tree dies, it must be replaced with a live tree.

Conducting the Tree Tally

Tree Selection

Trees or snags in the different size classes are treated in the manner and at the specified locations outlined in Table 10.3. 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 10.3. Tally trees: size, sampling activity, and location.

Tree/Snag Size	Activity	Location
dbh: ≥ 76.2 cm diameter **Length**: ≥ 1.37 m	tagged, mapped and measured: record data on data sheet	throughout 1 ha plot
dbh: 12.7 to 76.2 cm **Length**: ≥ 1.37 m	tagged, mapped and measured: record data on data sheet	Throughout 50x50
Saplings: 2.5-12.6 cm dbh **Length**: ≥ 1.37 m	tagged, mapped and measured: record data on data sheet	10 x 10 m subplots: 3, 9, 13, 14, 15, 16, 17, 21, and 27 only
Seedlings	No data collected until tree reaches 2.5cm dbh	

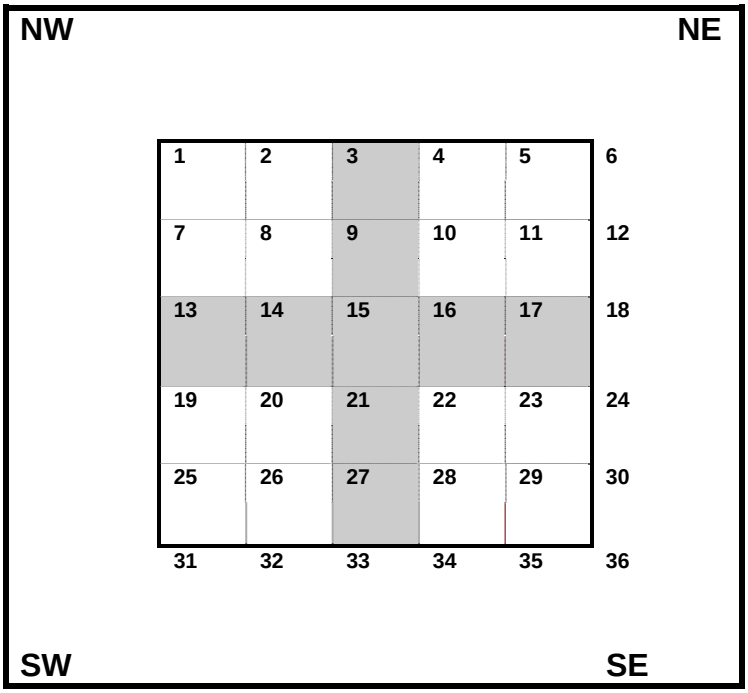


Figure 10.1. Map of 100 x 100 meter plot. (Note that inner 50x50 m area constitutes the entire plot at LEWI and SAJH.)

Strategy

Begin at one outer corner of the 100 x 100-m plot (usually the NW corner; see Figure 10.1) measuring all trees and snags ≥ 76.2 cm in dbh and ≥ 1.37 m in length. Work only on those trees outside of the 50x50 plot. After completing the outer ring then move into the 50x50 plot being aware of the subplots where the trees between 2.5 cm and 12.6 cm dbh are to be measured and mapped in addition to the trees ≥ 12.7 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 thru 36 or the NW, NE, SW, SE corner).

Person 1 (measurer) finds the tagged trees and directs Person 1 to a potential line of sight. Person 2 (finder) observes and records the canopy characteristics on the data sheet. Person 1 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 data sheet. It is possible also that the tree has simply grown large enough to be tallied (in-growth). A tree that is greater than 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 Event 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.

Data Collection

Form Header Information

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

Plot number: Enter a four digit plot code _ - _ _ _ . The code is created by using:

- single digit elevation stratum: 1, 3, or 6
  (**1**: 0-300m; **3**: 600-900 m; **6**: 1500-1800 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 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.

Tree Attributes for Identification and Mapping

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 (or wire for trees less than 5.0 cm dbh). To comply with wilderness directives, 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). Install the tag at breast height. Breast height can be pre-measured to a reference point on the surveyor (e.g. top vest button or grommet), so that the height can be determined quickly at each tree. The nail should be driven in only as far as necessary to firmly anchor it in the wood, angled downward. This will give the tree room to grow over the shaft of the nail, and keep the tag away from the bole so the tree will be less likely to grow over the tag. If the tree appears to be too small to use a nail to attach the tag (trees <5 cm dbh), attach the tag with a wire around a sturdy branch and the main stem, as close to breast height as possible. Record the height of the wire along the main stem in the comments. Then measure the diameter of the stem at ground level (referred to as "dba") and record this measurement in the comments also.

Each tree on a plot **must** have a unique tag number. So, do not use a tree number more than once on the same plot. Record the tree tag number on the tree data sheet.

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. Refer to the pre-printed tree data sheets to identify the tag numbers already in use on a plot. Temporary tags are made of soft aluminum allowing one to inscribe a number 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 composed of the first three letters of the genus and the specific epithet (e.g., PSEMEN for Douglas-fir).

Tree status: Indicate whether the tagged stem is:

L – Living, including trees that have fallen but are still alive. Trees with any green foliage are considered alive.
D – Dead. This status refers to newly-dead trees, i.e., dead trees which were recorded as alive at the last visit to the plot.
S – Snag. This status refers to dead trees which were previously recorded as dead.
F – Fallen. This status refers to a stem which was a snag at the last visit to the plot and is now on the ground. At this point it is no longer a part of the snag sample.
M – Missing. The tree was not relocated.

Note that missing, fallen, and dead trees can only be recorded when revisiting a previously measured plot. Any standing, dead trees tagged when a plot is established are recorded as status 'S'. The permitted transitions between values of tree status are indicated in Table 10.4.

Table 10.4. Tree status transition matrix. Table indicates that the transition combination is allowable.

Status from Previous Visit	Current Status				
	L	**D**	**S**	**F**	**M**
L	Yes	Yes	No	No	Yes
D	No	No	Yes	Yes	Yes
S	No	No	Yes	Yes	Yes
F	No	No	No	No	No
M	Yes	Yes	Yes	Yes	Yes
None (new tree)	Yes	No	Yes	No	No

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 data sheet. 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 during subsequent visits.

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. Also take care that you 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. If the tree is close enough to the reference point, the horizontal distance can also be measured using the side of a dbh tape that has a linear scale (be sure the tape is held level).

Tree Visit Attributes

Diameter (cm): Diameters are used in calculating basal area, growth, and average stand diameter. Diameters will be measured only once every five years.

Record the diameter at breast height (dbh). Since 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. If the tag is wired on instead of nailed (trees <5 cm dbh), measure 137 cm up the bole to measure dbh. Record dba in the comments for these small trees which have wired, rather than nailed, tags.

To measure dbh, keep the tape taut and level as you extend it around the tree. Record the measurement to the nearest 0.1 cm, always rounding down if the precise measurement is between two 0.1 cm marks on the tape. Measuring large trees on a steep slope is challenging. Usually it takes two people to insure that the dbh tape is at the correct height and is straight, level, and taut. A hiking pole or forked stick may be used to adjust the dbh 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.

Several situations that complicate measurement of diameter are described below.

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 degrees 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 (i.e., with separate tags and recorded on separate lines on the data sheet). 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, refer to the following instructions.
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 recorded. The same distance and azimuth are recorded for the distinct stems, and a comment is recorded to confirm that the duplicate mapping information is not in error. 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 from 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 meters 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 breast height: On trees with swellings, bumps, depressions, and branches at breast height, 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 breast height, continue to treat them as separate trees. Estimate the diameter of each, record a value of 1 for Diameter Check (see below), and explain the situation in a comment. To estimate the diameter of a connected tree, set a diameter nail at breast height on opposite sides of the tree (the distance between the nails is essentially 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 x 2) = 89.6 cm. record a value of 7 for Diameter Check (see below). Repeat for the other connected tree.

Missing wood or bark: Do not reconstruct the intact cross-section 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 breast height, 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 breast height.

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 5 m 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: This field is used to record any irregularities in diameter measurement positions (i.e. abnormal swellings, diseases, damage, new measurement positions, etc.) that may affect use of this tree in diameter growth/change analyses. If both values 1 and 2 apply (diameter is both estimated and moved), record value 2 and the new diameter.

Diameter Check values

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 value of Diameter Check.

If diameter at the current measurement is measured at a different location than at the previous measurement, record a value of 2 for Diameter Check, and remove the d-nail(s) from the previous visit.

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

If the nail is more than 30 cm away from where the diameter should be measured according to current protocols (e.g., if previous crew made a mistake), then move the tag if possible, measure the diameter at the correct location, and record a value of 2 for Diameter Check. If the old nail, marking a point of measurement not used at the current visit, cannot be removed, then pound it in flush with the tree.

Height (m): 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 grown
- Dominant
- Codominant
- Intermediate
- Overtopped

Record the length of the tree, to the nearest 0.3 meter from the ground level to the top of the tree.

This measurement will give a general idea of tree height for each category. Should the heights of all live 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 is also measured during the Mortality Assessment, for newly-dead trees with broken boles. If the height of a broken, newly-dead tree is < 1.37 meters, the height will be recorded, but the tree will not be part of the snag tally in future visits.

Height method: You may measure the tree height by one of three methods: measuring tape (T) (for very short stems), laser range finder (L), or clinometer (C). Method T simply consists of directly measuring the length of a stem the top of which is within reach. When using either the L or C methods, locate a position roughly one tree height away from the tree's base from which you can see both the base and the top of the tree. It is better to find a position close to the same contour as the tree, rather than going up or down hill. Find a location where the absolute values of the angles to both the bottom and the top of the tree are less than 50 degrees (otherwise measurement error is too great). If it is not possible to find a location

from which to view both the top and the bottom of the tree, find a location where the top and a point low on the bole can be seen.

1. **Laser range finder (L)**: Familiarize yourself with the instrument keys and laser range finder instructions (see **SOP 4**: **Orientation and Training of Field Crews**). Make sure that the pivot point is calibrated for your use.
   a. 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).
   b. 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.
   c. 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.)
   d. Press the fire button again for calculation of tree height.

2. **Clinometer (C)**: Measure and record the following quantities:
   a. Distance to the base of the tree along the slope (***b***);
   b. Angle to the base of the tree (A_1);
   c. Angle to the top of the tree (A_2);
   d. Distance along the bole from the lowest visible point to the ground (h_a)(if necessary, otherwise $h_a = 0$).

   Record all angles in degrees.

   Next, compute the following quantities:
   a. The horizontal distance to the base of the tree ($b_h = b * \cos A_1$);
   b. The height from eye-level to the base of the tree ($h_1 = b \sin A_1$);
   c. The height from eye-level to the top of the tree ($h_2 = b_h \tan A_2$).

   Calculate tree height with the following formula:

   $$ht = h_2 - h_1 + h_a.$$

   This formula works whether the angle to the base of the tree is positive or negative (i.e., whether you have to look up or down to see the base of the tree), because h_1 is negative when the angle is negative and positive when it is positive.

If the tree is leaning, you can convert the measured height to the true length of the tree using the equation: ***length = EF * ht***. ***EF*** is the expansion factor found in the slope correction table in **SOP 8**: **Establishing Permanent Monitoring Plots** (Figure 8.3, Field Reference Sheet).

1. Calculate tree height as described above, standing perpendicular to the plane in which the tree is leaning.
2. Standing at the base of the tree, sight up the bole with your clinometer, and measure the slope of the bole in degrees.
3. Subtract the slope of the bole from 90 degrees (this is lean angle, A_l).
4. Convert A_l to A_p, the percent slope of the bole, by the formula $A_p = 100 * \tan A_l$.
5. Use A_p to find ***EF*** in the slope correction table.

6. 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 (i.e. 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 (i.e., 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-meter spacing. Include epicormic 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 values 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 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. This data is 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.

Crown class codes and definitions are outlined in Table 10.5.

Table 10.5. 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 10.6. Figure 10.2 can also be used as a visual reference.

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 include in the tally.

Table 10.6. Snag decay class codes and descriptions.

Code	Limbs & Branches	Top	% 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

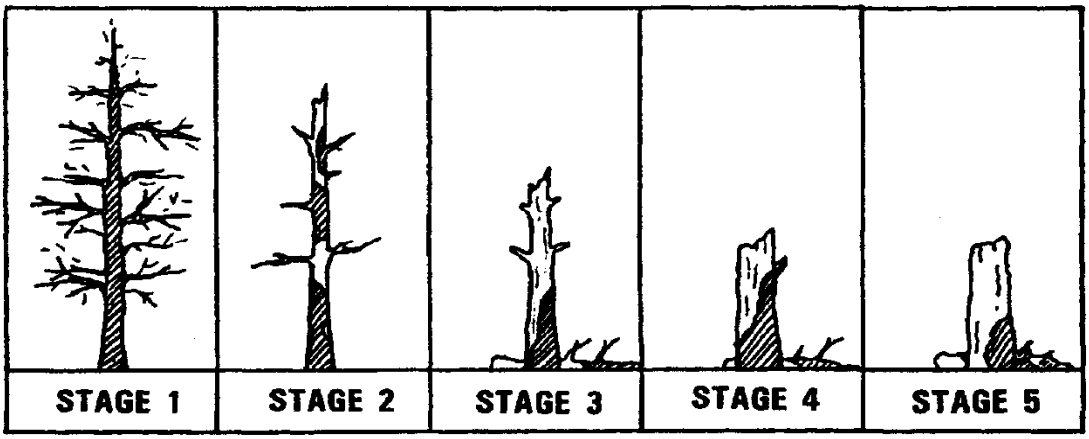


Figure 10.2. Schematic representation of decay classes of Douglas-fir snags. (From Forest Inventory and Analysis Program 2006).

Tree Damage and Disease

Tree damage is characterized using three attributes:

1. Damage agent
2. Damage location (on the tree)
3. Severity of damage

The crew observes the tree roots, bole, branches, and foliage and records the codes for specific damage agent, damage location, and severity. Record '0' to indicate that the lack of any significant damage on any visible part of the tree. When damage is found record damage location, agent, and severity codes.

Damage location: Record the predominant location on the tree of the damage agent (Table 10.7).

Table 10.7. 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 degrees in relation to the main stem.
3	Branch – All other woody material. Primary branch(s) occur at an angle ≥ 45 degrees in relation to the bole and are < 1/3 the diameter of the bole.
4	Foliage – All leaves, buds and shoots.

Damage severity: The severity code describes the extent or intensity of the damage. Possible severity codes are listed in the Severity column of Table 10.8 and 10.9.

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.; Table 10.8 and Table 10.9). 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 (e.g., root disease) then use the general code.

Table 10.8. Class I damage agents. Not in order of importance.

Category	Agent	Agent Code	Location	Severity
BARK BEETLES	General	**01**	**1**-Roots **2**-Bole	**1** – Successful current attack: foliage still green, boring dust, pitching **2** – Last year's successful attack: fading foliage (some green somewhere on crown), boring dust, pitching **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.
DEFOLIATORS	General	**10**	**4**-Foliage	Divide live crown into thirds. Rate each third separately based on the following classes: **0** – No detectable defoliation **1** – Up to 33% of foliage (old and new) affected **2** – 34 to 66 % of foliage affected **3** – 67 to 100% of foliage affected Obtain severity rating by adding ratings for each third. Record total (1-9).
	Budworm	**29**		
ROOT DISEASE	General/other	**60**	**1**-Roots	**1** – Tally tree is within 10 meters of a tree or stump that has a root disease to which the tally tree is susceptible. **2** – Tally tree with root disease
	Annosus	**61**		
	Armillaria	**62**		
	Black stain	**63**		

Table 10.8. Class I damage agents (continued).

Category	Agent	Agent Code	Location	Severity
	Laminated root rot	**65**		signs/symptoms such as characteristic decay, stain, ectotrophic mycelia, mycelial fans, conks, excessive resin flow at the root collar. **No visible crown deterioration.** **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.**
White Pine Blister Rust	White pine blister rust	**36**	2-Bole 3-Branches	Record % of affected location: **%** of bole circumference (combine multiple affected locations), or **%** of branches affected. Note if branch infections are: 1- more than 0.75 m from tree bole 2- 0.5 to 0.75 m from bole 3- within 15 cm of tree bole, or tree bole infected.
BALSAM WOOLY ADELGID (Hosts: true firs – i.e. silver fir, subalpine fir, and grand fir)	Balsam woolly adelgid	**24**	**2**-Bole **3**-Branches	Record % of affected area: **% of bole** circumference (combine multiple affected locations), OR **% of branches** (crown volume) affected.

Table 10.9. Class II damage agents.

Category	Agent	Agent Code	Location	Severity
OTHER INSECTS	General	**20**	**2**-Bole **3**-Branches **4**-Foliage	Record % of affected area: **% of bole** circumference, (combine multiple affected locations if they occur ≤ 1 vertical meter of each other on the bole), OR **% of branches** (crown volume) affected, OR **% of foliage** whose individual leaves or needles are damaged by more than 50%.
STEM BRANCH CANKERS	General	**40**	**2**-Bole **3**-Branches	Record % of affected area: **% of bole** circumference, (combine multiple affected locations if they occur < 1 vertical meter of each other on the bole), **OR** **% of branches** (crown volume) affected.
	Western gall rust	**41**		
STEM DECAYS	General (white rot)	**46**	**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.
	Red ring rot	**47**		
	Indian paint fungus	**48**		
	Velvet top fungus	**49**		
	Brown cubical rot (includes brown crumbly rot and brown trunk rot)	**52**		
FOLIAR PATHOGENS	General	**55**	**3**-Branches (brooming) **4**-Foliage	Record % of affected area: **% of branches** (crown volume) affected. **% of foliage** whose individual leaves or needles are damaged by > 50%.
ANIMAL AGENTS	General/unknown	**70**	**1**-Roots **2**-Bole **3**-Branches **4**-Foliage	Record % of affected area: **% of roots** affected, OR **% of bole** circumference, (combine multiple affected locations), OR **% of branches** (crown
	Mountain beaver	**71**		
	Deer or elk	**73**		
	Porcupines	**74**		
	Squirrels, mice, voles, rabbits, hares	**75**		

Table 10.9. Class II damage agents (continued).

Category	Agent	Agent Code	Location	Severity
	Beaver	**76**		volume) affected, OR **% of foliage** whose individual leaves or needles are damaged by > 50%.
	Bear	**77**		
	Human (not logging)	**78**		
WEATHER AGENTS	Windthrow or wind breakage	**81**	**2**-Bole **3**-Branches **4**-Foliage	Record % of affected area: **% of bole** circumference, (combine multiple affected locations if they occur ≤ 1 vertical meter of each other on the bole), OR **% of branches** (crown volume) affected, OR **% of foliage** whose individual leaves or needles are damaged by > 50%.
	Snow/ice bending or breakage	**82**		
	Lightning	**87**		
PHYSICAL INJURY	Fire: basal scars or scorch	**92**	**1**-Roots **2**-Bole **3**-Branches **4**-Foliage	Record % of affected area: **% of roots** affected, **OR** **% of bole** circumference, (combine multiple affected locations if they occur ≤ 1 vertical meter of each other on the bole), OR **% of branches** (crown volume) affected, OR **% of foliage** whose individual leaves or needles are damaged by > 50%.
PHYSICAL DEFECTS	Broken/missing top	**96**	**2**-Bole **3**-Branches	
	Dead top	**97**		
	Forks and Crooks (only if caused by old top out or dead top	**98**		
	Checks or bole cracks	**99**		
SPECIAL AGENTS	Suppression	**50**	**2**-Bole	
	Excessively deformed sapling	**51**		
UNKNOWN	Unknown	**90**	**1**-Roots **2**-Bole **3**-Branches **4**-Foliage	Record % of affected area: **% of roots** affected, *OR* **% of bole** circumference, (combine multiple affected locations if they occur ≤ 1

Table 10.9. Class II damage agents (continued).

Category	Agent	Agent Code	Location	Severity
				vertical meter of each other on the bole), *OR* **% of branches** (crown volume) affected, *OR* **% of foliage** whose individual leaves or needles are damaged by > 50%.

Note: 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 (% 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 (e.g. 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.
4. Broken: This damage type includes broken roots or 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, 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 10.10). 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 10.3).

Table 10.10. 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

Example: A conifer tree has no infection in top third of crown, light infection in the middle third, and has many brooms in the lower third.

Total score is: 0 + 1 + 2 = 3

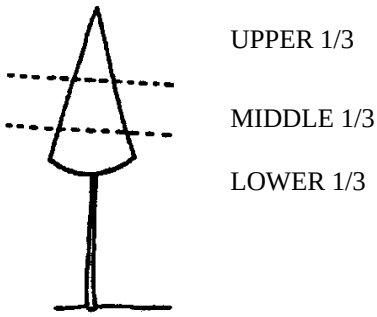


Figure 10.3. Example of the Hawksworth six-class rating system.

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 meters above the ground up to the top of a live crown of a tree, and not positioned at more than a 45 degree 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.

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. Record the number observed as grouped into one of four categories: **0**=0 limbs, **1**=1-5 limbs, **2**=6-9 limbs, **3**=≥10 limbs.

Moss abundance: For live 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 10.11). 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.

Table 10.11. 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

Mortality Assessment

Before revisiting a given plot (after the initial measurement) check that you have printouts of the tree data from the previous visit. These forms are generated from the database prior to each field season, and are stored in the project workspace in a sub-folder for pre-printed forms within the year's seasonal workspace. 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
- Height method
- Snag decay class
- Cause of death
- Position
- Lean (^{o})

Tree status: Trees that are still living will receive Tree Status of '**L**'. No further assessments are required for live trees during this visit. Record status for witness trees, even if they are witness-only trees (i.e., tree type **W**). No further data is recorded for **W** trees during a mortality assessment. However, if a **W** tree is discovered to be dead, record a comment stating that a new witness tree needs be identified at the next measurement event.

For trees with a tree status change to '**D**' (dead) record height, height method 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 and symptoms that indicate what may have directly caused or contributed to the death of the tree, if any such signs and symptoms are evident. Record this information using the procedures for **Tree Damage and Disease** described above. If there is more than one relevant type of damage or disease, record the most obvious using the damage codes on the data sheet and the remaining ones as a comment. Record the likely cause of death, choosing among: Insect damage (I), Disease (D), Fire (F), Animal (A), Weather (W), Vegetation (V), Unknown (U). Examples of weather as a cause of tree death include wind breakage (without evident heart rot) or crushing by snow or ice. Examples of vegetation as a cause of tree death include smothering by vines or shading by taller trees. Even if 'Unknown' is

recorded for cause of death, there may be signs and symptoms worth noting such as the ones in the section on **Unknown Damage Type** in the procedures for **Tree Damage and Disease**.

Position: Indicate whether the dead tree is standing upright (S), broken (B), uprooted (U), or crushed (C).

Lean (^{o}): If the dead tree is leaning, indicate the degree of lean from vertical. If the tree is leaning greater than 45° from vertical, the degrees will be recorded, but the tree will not be part of the snag population in future visits.

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 Plot Event Log.

NCCN FOREST – TREE DATA FORM version 11/2/2009 Park _ _ _ _ Plot No. _ - _ _ _ MO _ _ DAY _ _ YEAR _ _ _ _ Page _ of _

(WITNESS TREES record for: 1, 6, 31, 36, C, NW, NE, SE, SW) Crew _____ Mortality ☐

Location (corner, subplot number, or OP [outside plot])	**Tag No.**	**Species** (6-9 letter code)	**Tree status** (L, D, S, F, M)	**Tree type** (Witness, Data, or Both)	**Reference point**	**Azimuth (true)** from ref. pt. to tree	**Horiz. distance (m)**	**DBH (cm)**	**Diameter check** (0 – 7)	**Height (m)**	**Height method** (L, C, T)	**Compacted crown ratio**	**Crown class** (O, D, C, I, T)	**Snag decay class**	**Damage** – see damage table, record 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 (**0**=0, **1**=1-5, **2**=6-9, **3**>10)	**Moss abundance** – avg % 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, Animal, Insects, Weather, Fire, Vegetation, Unknown)	**Position** (Standing, Broken, Uprooted, Crushed)	**Lean (°)** – from vertical (0°)
xx	xxxx	xxxxxx	x	x	xx	xxx	xx.y	xx.y	x	xx.y	x	xx	x	x	x	x	xx	x	x	xx	x	x	x	xx
			L		**1**																			
			L		**6**																			
			L		**31**																			
			L		**36**																			
			L		**C**																			
			L		**NW**																			
			L		**NE**																			
			L		**SE**																			
			L		**SW**																			

Record data for ALL trees and snags ≥ 76.2 cm dbh; ≥ 12.7cm dbh in central 50x50; and ≥ 2.5 cm dbh (live only) 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, Co-dominant, Intermediate, Over-Topped.

NCCN_Forest_Tree_Data_Form.doc

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

Figure 10.4. Tree data form, page 1.

NCCN FOREST – TREE DATA FORM version 11/2/2009 Park _ _ _ _ Plot No. _-_ _ _ MO _ _ DAY _ _ YEAR _ _ _ _ Page _ of _

(WITNESS TREES record for: 1, 6, 31, 36, C, NW, NE, SE, SW) Crew ______________ Mortality ☐

Location (corner, subplot number, or OP [outside plot])	**Tag No.**	**Species** (6-9 letter code)	**Tree status** (L, D, S, F, M)	**Tree type** (Witness, Data, or Both)	**Reference point**	**Azimuth (true)** from ref. pt. to tree	**Horiz. distance (m)**	**DBH (cm)**	**Diameter check** (0 – 7)	**Height (m)**	**Height method** (L, C, T)	**Compacted crown ratio**	**Crown class** (O, D, C, I, T)	**Snag decay class**	**Damage** – see damage table, record 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 (0=0, **1**=1-5, **2**=6-9, **3**≥10)	**Moss abundance** – avg % 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** (**D**isease, **A**nimal, **I**nsects, **W**eather, **F**ire, **V**egetation, **U**nknown)	**Position** (**S**tanding, **B**roken, **U**prooted, **C**rushed)	**Lean (°)** – from vertical (0°)
xx	xxxx	xxxxxx	x	x	xx	xxx	xx.y	xx.y	x	xx.y	x	xx	x	x	x	x	xx	x	x	xx	x	x	x	xx

Record data for ALL trees and snags ≥ 76.2 cm dbh; ≥ 12.7cm dbh in central 50x50; and ≥ 2.5 cm dbh (live only) 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: O**pen growth, **D**ominant emergent, **C**o-dominant, **I**ntermediate, **O**ver-**T**opped.

NCCN Forest Tree Data Form.doc

Figure 10.5. Tree data form, page 2.

NCCN FOREST – TREE COMMENTS version 11/2/2009 Park _ _ _ _ Plot No. _ _-_ _ _ MO _ _ DAY _ _ YEAR _ _ _ _ Page _ _ of _ _
Crew _____

Tree number	Comment

NCCN_Forest_Tree_Data_Form.doc

Figure 10.6. Tree data form, page 3

Literature Cited

Forest Inventory and Analysis Program. 2006. Field instructions for the annual inventory of Washington, Oregon, and California. Pacific Northwest Research Station, USDA Forest Service.

SOP 11: Procedures Following a Field Tour

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan. 2, 2009	S. Acker	Removed references to SOPs that have been suspended indefinitely.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Oct. 3, 2009	S. Acker	References to locations on the network drive and other SOPs were updated.	Streamlining of SOPs in the process of producing final version in response to NPS review.

Overview

This SOP outlines the procedures to be conducted following a field tour. These procedures are carried out directly upon returning from the field. The responsibilities are described in detail below.

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. Also 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 determine who will be doing each task upon arrival at the office. Make sure that the logistics page on the Event Log is completed. Discuss what important information needs to be relayed to the supervisor or Project Lead. You can also take this time to check and organize the data sheets one more time; this may prompt further items to share with the supervisor or Project Lead.
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. Meet with your supervisor to 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 e-mail. Read messages from supervisor and Project Lead.
5. Travel voucher. Inform your supervisor of the number of days and nights spent in the field that tour. Complete any forms that are needed to document travel and initiate reimbursement.
6. Photocopy. Photocopy or scan all data sheets. File originals in their respective folders for later data entry. Scanned copies are kept in the project workspace in a sub-folder for scanned field forms within the crew folder for the year. 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, replace, and/or dispose of batteries as described in **SOP 4: Orientation and Training of Field Crews**. Make sure that there will be two good sets ready for the field the following tour for the GPS, 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.
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. Photos. Download and name the photo images as outlined in **SOP 12: Managing Photographic Images**.
14. GPS. If plot UTMs were taken, download and send to the GIS support person.

15. Data entry. Enter data into the MSAccess database. The front-end database application is found in a subfolder of the seasonal workspace. Refer to **SOP 13: Data Entry and Verification**.
16. Prepare 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. Writing the report should take less than one hour. Trip reports are very helpful for trying to piece together what happened on a tour at some time in the future. The report 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.

SOP 12: Managing Photographic Images

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Revised the image workspace subfolders, processing procedures, and the naming conventions for image files.	Simplified the workflow to allow bulk-renaming on downloading from the camera. New naming conventions allow for faster naming and more informative names.

Overview

This SOP describes procedures for downloading, processing and naming photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be stored separately and named in such a way that they can be readily identified as non-NPS images and not be mistaken for project records.

To effectively manage potentially hundreds of images requires a consistent method for downloading, naming, editing and documenting. The general process for managing project images is as follows:

1. Prepare image workspace – set up the file organization for images prior to acquisition.
2. Acquire images.
3. Download and process.
    a. Download the files from the camera
    b. Rename the image files according to convention
    c. Copy and store the original, unedited versions
    d. Review and edit or delete the photos
    e. Move into appropriate folders for storage
4. Deliver image files for final storage.

Data Photos Defined

Care should be taken to distinguish data photographs from incidental or opportunistic photographs taken by project staff. Data photographs are those taken for the following reasons:

- To document a particular feature or perspective for the purpose of site relocation
- To capture site characteristics and possibly to document gross structural changes over time
- To document a species detection that is also recorded in the data.

Data photographs are often linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photographs – e.g., of field crew members at work, or photographs showing the morphology or behavior of certain species – may also be retained but are not necessarily linked with database records.

Image Workspace Setup

Prior to each season, the Project Lead (or a designee) should create a new set of image folders under the new season year under the Images section of the project workspace and seasonal workspaces (refer to **SOP 1: Project Workspace and Records Management**). The workspace subfolders are as follows:

[Year]	The appropriate year – 2009, 2010, etc.
[Park code]	Arrange files by park – OLYM, MORA, etc.
1_Originals	Unedited versions of image files
[Download date]	Arranged by download date to preserve file names
2_Processing	Temporary processing workspace
[Site code]	Arranged by plot, for images taken at a plot
[Capture date]	Arranged by date, for images not taken at a plot
3_Data	Data images for required photos at plots
[Site code]	Arranged in subfolders by site
4_Miscellaneous	Non-data images taken by project staff
[Site code]	Arranged by plot, for images taken at a plot
[Capture date]	Arranged by date, for images not taken at a plot
5_Not_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. This structure also provides separate space for image processing and storage of originals. For additional information about the project workspace, refer to **SOP 1: Project Workspace and Records Management**.

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 characters or fewer.
- Date names should be formatted as YYYYMMDD.
- Plot folder names are typically a five-character string with the underbar character separating the elevation stratum from the three-digit plot number (e.g., 3_140). Note that individual photo names may also contain the four-letter park code in front of the stratum number.

Image Acquisition Standards

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 1600 x 1200 pixels (approximately 2 megapixels).

Higher resolutions may be available but are undesirable from the perspective of data storage and information content.

Download and Processing Procedures

1. Under the appropriate "Originals" subfolder, create a subfolder for the download date (e.g., 20090715). Other suffixes may be used to distinguish downloads when multiple sites or parks are downloaded on the same date.
2. Download the raw, unedited images from the camera into the new subfolder. Depending on the operating system used by the person downloading, it may be possible to greatly reduce the time and effort it takes to rename the images in subsequent steps.
   - Plug in the camera to the USB port and turn the camera on.
   - From the Start menu, select All Programs > Accessories > Scanner and Camera Wizard (or select this option if a dialog box appears upon plugging in the camera).
   - Follow screen prompts until reaching the 'Picture Name and Destination' screen. You will be able to select name prefix/suffix, image format, and photo destination.
     - For name prefix, use the naming conventions indicated later in this SOP.
     - For image file format, select the default (JPG).
     - For photo destination, browse to the appropriate "Originals" subfolder.
3. Copy the images to the “Processing” folder and set the contents under "Originals" as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals serve as backups in case of unintended file alterations (e.g., incorrect names applied, file deletion, loss of resolution, or loss of image metadata upon rotation).
4. Finish renaming the images in the "Processing" folder 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. Field form annotations should be done in a different color ink from the original notation, after first drawing a line through the original entry (for more information, refer to **Section 4D, Data Entry and Processing**).
   - Renaming may be most efficiently done as a batch using image processing software such as Microsoft Office Picture Manager, which allows a standard prefix or suffix to be added to the camera file name. After batch renaming, a descriptive component may be added manually to each file name.
5. Process the images in the "Processing" folder, using the edit features built into image software programs such as ThumbsPlus or Microsoft Office Picture Manager. At a minimum, the following processing steps should be performed on all image files:
   - Delete photographs of poor quality – e.g., out of focus, light levels, etc. Low quality photographs might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
   - Duplicates should also be deleted unless they provide unique information. Other non-data photographs should be evaluated against their potential long-term value.
   - Rotate images to make the horizon level.
   - Remove 'red eye' glare in photographs of people.
   - Crop non-data images to remove edge areas that grossly distract from the subject.

6. Optional processing steps may include enhancing contrast or brightness, or resizing images to make them small enough for use in documents or on the web. These steps are not recommended for data photos.
7. When finished processing the current download, move the image files that are to be retained to the appropriate folder – i.e., data images to the appropriate "Data" subfolder, other images under the appropriate "Miscellaneous" folder.
8. Photos of potential interest to a greater audience should be uploaded to the park Digital Image Library.
9. Delete files from the "Processing" folder between downloads to minimize the chance for accidental deletion or overwriting of needed files.

Image File Naming Standards

In all cases, image 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.
- Park code and year should either be included in the file name (preferred), or specified by parent folders in the directory structure.
- Dates should be formatted as YYYYMMDD (this leads to better sorting than other date naming conventions).

The image file name should consist of the following parts, separated by an underbar character:

1. The date on which the image was taken (formatted as YYYYMMDD)
2. The four-character park code (LEWI, MORA, NOCA, OLYM or SAJH)
3. Plot location code (elevation stratum and 3-digit plot number, separated by an underbar)
4. For data photos taken from defined points in the plot, the photographic view code (see Table 9.1 for a list of photographic view codes)
5. Optional: a brief descriptive word or phrase
6. Optional: a sequential number if multiple images were captured
7. Optional: time (formatted as HHMM)

Examples:

• 20100612_MORA_3_007_C1_H.jpg	MORA plot #3-007 photo taken from plot center to corner #1, taken on June 12, 2010
• 20090518_OLYM_ training_4.jpg	4th photo taken during training at OLYM on May 18, 2009

Post-season Cleanup Procedures

At the end of the season, field crew members stationed at parks should deliver images within their local seasonal workspace to the Project Lead 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. Prior to delivery, make sure that all processing folders are empty.

After each season, the Project Lead (or a designee) should:

1. Review the seasonal workspace folders to make sure that all images are properly named and filed and accounted for.
2. The "Processing" folder should be empty and may be deleted.
3. Files in the "Not_NPS" folder may be refiled as appropriate.
4. The contents of the "Originals" folder may be deleted once all desired files are accounted for. Originals of data images may be retained as desired, depending on the size of the files and storage limitations.
5. Copy the entire contents of the "Images" subfolder from the seasonal workspace to the main project workspace, and delete the images subfolders from the seasonal workspace.
6. Set the images in the project workspace to read-only to prevent unintended changes.

SOP 13: Data Entry and Verification

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Added screen captures and specific documentation for data entry forms.	The database application is now formalized enough to allow documentation.
Nov 2009	J. Boetsch	Revised text to include instructions for remote data entry.	Procedures for remote data entry were not in place prior to 2009.
May 2010	J. Boetsch	Replaced screen captures for the main startup menu, the main data entry form, and the database connections form.	To reflect recent changes to the application and form layouts.

Overview Guidelines for Data Entry and Verification

This SOP describes the general procedures for entry and verification of field data in the project database application. For related guidance, refer to **Section 4C, Overview of Database Design**, and **Section 4D, Data Entry and Processing**. The following are general guidelines:

1. Data should be entered as soon after data collection as possible so that field crews remain current with data entry tasks, and identify any errors or problems as close to the time of data collection as possible.
2. The front-end database application is a Microsoft Access file maintained in the project workspace (see **SOP 1: Project Workspace and Records Management**). 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 database. It contains the forms, queries, and formatted report objects for interacting with the data in the back-end.
3. The back-end database for this project is implemented in Microsoft SQL Server to take advantage of the automated backup and transaction logging capabilities of this enterprise database software.
4. 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.
5. 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 either be done for each record prior to moving to the next form for data entry, or preferably as a separate step after all of the data for a sampling trip has been entered. Important: It is a requirement that all events must be entered and verified at the end of the field season.
6. At regular intervals and at the end of the field season the Crew Lead should inspect the data that have been entered to check for completeness and perhaps identify avoidable errors. The Crew Lead may also periodically run the Quality Assurance Tools that are built into the front-end 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 15: Data Quality Review and Certification**).

Database Instructions

Getting Started

The first action to be taken is to make sure the project workspace is set up properly on a networked drive. Refer to **SOP 1: Project Workspace and Records Management** for instructions on how to set up and access the project workspace.

Important Reminders for Daily Database Use

- If accessing the database from a remote park (i.e., other than OLYM), do not open and use the front-end application outside the remote desktop environment as it will run very slowly and likely stall. Instead, refer to the following instructions on remote access before using the application.

- If accessing the database from OLYM, do not open and use the front-end application on the network as this makes it run more slowly. Instead, copy the front-end file from the project workspace to your local desktop and open it there. This copy can be replaced with new versions as they are released.
- New versions of the front-end application may be released as needed through the course of the field season. When this happens, you may see a notification about a new release when opening the current or older versions of the front-end. Copies of the outdated version of the front-end file should be deleted and replaced with the new version, which will be named in a manner reflecting the update (e.g., Forest_Veg_2010_v2.mdb).
- Upon opening the front-end application for the first time, there may be a need to reconnect the front-end to the back-end, depending on how the project workspace is mapped on your computer. This database connection update should only need to be done once for each new release of the front-end database.

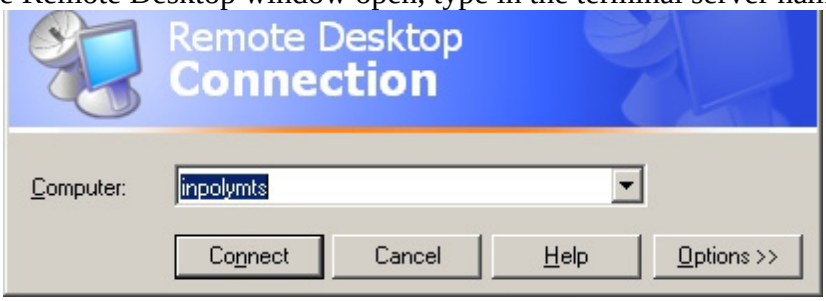
Remote Connections for Data Entry and Database Access

Most of our project databases are hosted on a server at OLYM. Due to bandwidth limitations, project database users accessing these databases from other parks (or from remote locations at OLYM) may encounter slow performance or application errors when accessing the database directly via a networked drive or a local front-end file. Therefore, to make data entry as smooth and efficient as possible, such users will typically need to use a remote desktop connection each time they need to access the database.

Remote desktop connections access what is called a "terminal server" at OLYM. In doing so, all of the processing is occurring on a server collocated with the database server, thus minimizing the negative effects of bandwidth on application performance. Through such a connection, the remote user is essentially sending mouse moves and keystrokes to the terminal server, and receiving screen updates in return. There may be some noticeable lag time in mouse moves and screen updates, but the performance is often much better than when accessing the data through other means.

Instructions for Using Remote Desktop

1. From the Start menu, go to: All Programs > Accessories > Communications > Remote Desktop Connection. You may wish to create a desktop shortcut by right clicking on the Remote Desktop Connection icon in the menu and selecting Send To > Desktop.
2. With the Remote Desktop window open, type in the terminal server name: "inpolymts".



3. Click on the Connect button.

4. Enter your NPS login and password. Note that the login must be preceded by "NPS\", for example: "NPS\gwashington".
5. The remote desktop session will open and you will see a blank desktop that represents what you would see if you were sitting at the computer at OLYM. The first time you use it you may need to map network drives you use frequently and create other useful shortcuts (e.g., to the project workspace), and you will need to use the Access 2007 first-time setup instructions (see the following section) so that the project database functions properly. These initial setup steps should only need to be done once, however.
6. You may switch back and forth between your remote session and your local session (i.e., on your local workstation) using the connection bar across the top of the remote desktop screen.
7. When using the project database, you may need to make a copy of the front-end application if someone else is already using the file (evidenced by a ".ldb" lock file with the same name and in the same folder as the front-end file). You may also want to create your own subfolder in the project workspace for your own front-end copy to avoid these conflicts with other users.
8. When you are finished with your remote session, log off by clicking on Start > Log Off.

The first time you use Remote Desktop, you may wish to select Options from the first Remote Desktop Connection screen to enter more specific information for your frequent remote desktop sessions (e.g., enter "inpolymts" for the computer, your NPS login, and "NPS" for the domain so you don't have to enter "NPS\" in front of your login each time). Do NOT enter your password or check the box to save your password, as this may present a security risk.

Special Instructions for Access 2007

If you are going to be using Access 2007, make sure the security settings will allow the database to function properly. This is necessary because Access 2007 may have been installed in a very restrictive security mode that disables the functionality built into the project database. Note: This setting change should only need to be performed once. However, if you move to a different workstation, these steps may need to be repeated to allow the database to perform properly. You will know the difference if none of the buttons or form functions on the main database switchboard form work properly, or if you get the following warning message across the top of the window:



To enable the database content to run properly on a consistent basis, do the following:

- Prior to using the front-end database, open Access 2007 from the Start menu.
- Go to Start > All Programs > Microsoft Office > Microsoft Office Access 2007.
- In the upper left corner, click on the Office Button.
- At the bottom of the menu page, click the Access Options button.
- Select the Trust Center category on the left panel.
- In the lower right, click the Trust Center Settings button.

- Select the Macro Settings category on the left panel.
- Select the option “Enable all macros”. Then hit OK, and exit Access.
- From this point forward the project database application should function properly on that computer.

User Roles and Privileges

The database application provides different levels of access privileges: read-only, data entry, power user, and administrator. These privileges are assigned based on user login by the Project Lead or a designee at the beginning of each field season. Most field crew users will be granted "data entry" rights, which allow one to enter and edit data for the current field season only. Certified data and lookup domains may only be edited by users with power user or administrator privileges. If a user name is not granted explicit rights to the database, the application will open in "read-only" mode.

Overview of Database Components

The front-end application has multiple functional components, which are accessed from the main application switchboard form that opens automatically when the application starts. Several buttons are found on the form to provide access to different components of the application, and are arranged in functional categories:

- Data Entry and Edits
    - Enter / edit data – Opens a form to confirm default settings (e.g., park, coordinate datum) prior to continuing to the project-specific data entry screens.
    - 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.

- Database Admin
    - Db connections – Manage and update the connections to the back-end database(s).
    - Set user roles – Manage the list of users who may view, enter and edit the database. Provides four levels of access: read-only, data entry, power user, and admin. This button is only enabled for power users and administrators.
    - View db objects – Allows the user to view and edit database objects (tables, queries and forms). This button is only enabled for power users and administrators.

- Management Tools
    - Data browser – Opens a tabbed form that provides comprehensive access to data arranged by sampling location. This form has headers for filtering by park, location code, location type and status.
    - Lookup tables – Opens a tool for managing the lookup values for the project data set (e.g., species list, list of project personnel).
    - Sampling schedule – Opens a form to view and edit the sampling schedule.
    - QA checks – Opens the data validation and quality review tool, which shows the results of pre-built queries that check for data integrity, missing data, and illogical

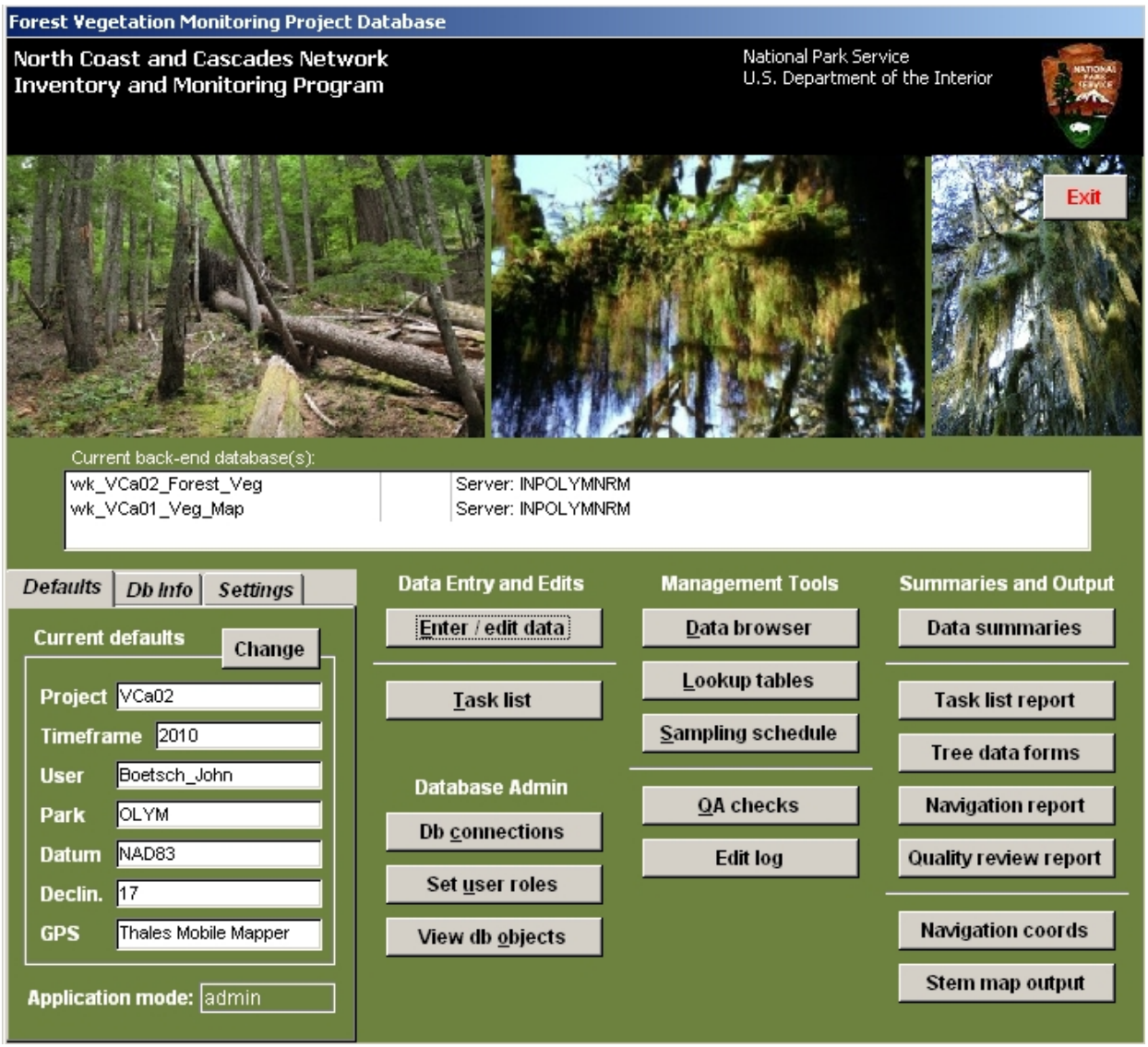
values, and allows the user to fix these problems and document the fixes. See **SOP 15: Data Quality Review and Certification**.
    - Edit log – Opens a form for documenting edits to certified data records.

- Data Summaries
    - Data summaries – Opens a form for viewing and exporting summary queries for data exploration, analysis and reporting.

- Database Output
    - Task list report – Generates a report of tasks that need to be accomplished for a specified park or sample location (default is for all locations).
    - Tree data forms – Generates tree data forms for repeat visits to monitoring locations, with tree identification information already populated. Reports are for a specified park or sample location (default is for all locations).
    - Navigation report – Generates the field season Navigation Report used to relocate sample locations and brief the crew on tasks that need to be accomplished.
    - Quality review report – Generates the data quality review results for a selected year or all years.

- GIS Output
    - Navigation coords – Provides current, best navigation target coordinates for sample locations so these can be loaded into GPS units for navigation, or GIS for display and map production.
    - Stem map output – Generates formatted output used to create tree stem maps for monitoring plots.

Here is a view of the main startup menu / switchboard form.



The lower left portion of the main startup menu has tabs for user defaults, database version release information, and run-time settings.

- Defaults – Default values for the application. User name, park, datum, declination, and GPS model type can all be changed by the user. To change user defaults, click on the 'Change' button. This will open up a new window where the user can update the default values. This window also appears each time the user selects the path for data entry or review to ensure that the correct user and park are indicated.
- Db Info – Contains the release information, technical support contact information, and buttons for reporting a bug or issue.
- Settings – Contains checkboxes for run-time application settings:
    - Prompt for backup on startup – The user will be prompted to make a data backup when the application opens.
    - Prompt for backup on exit – The user will be prompted to make a data backup when the application closes. Default is on, which means that the user will be

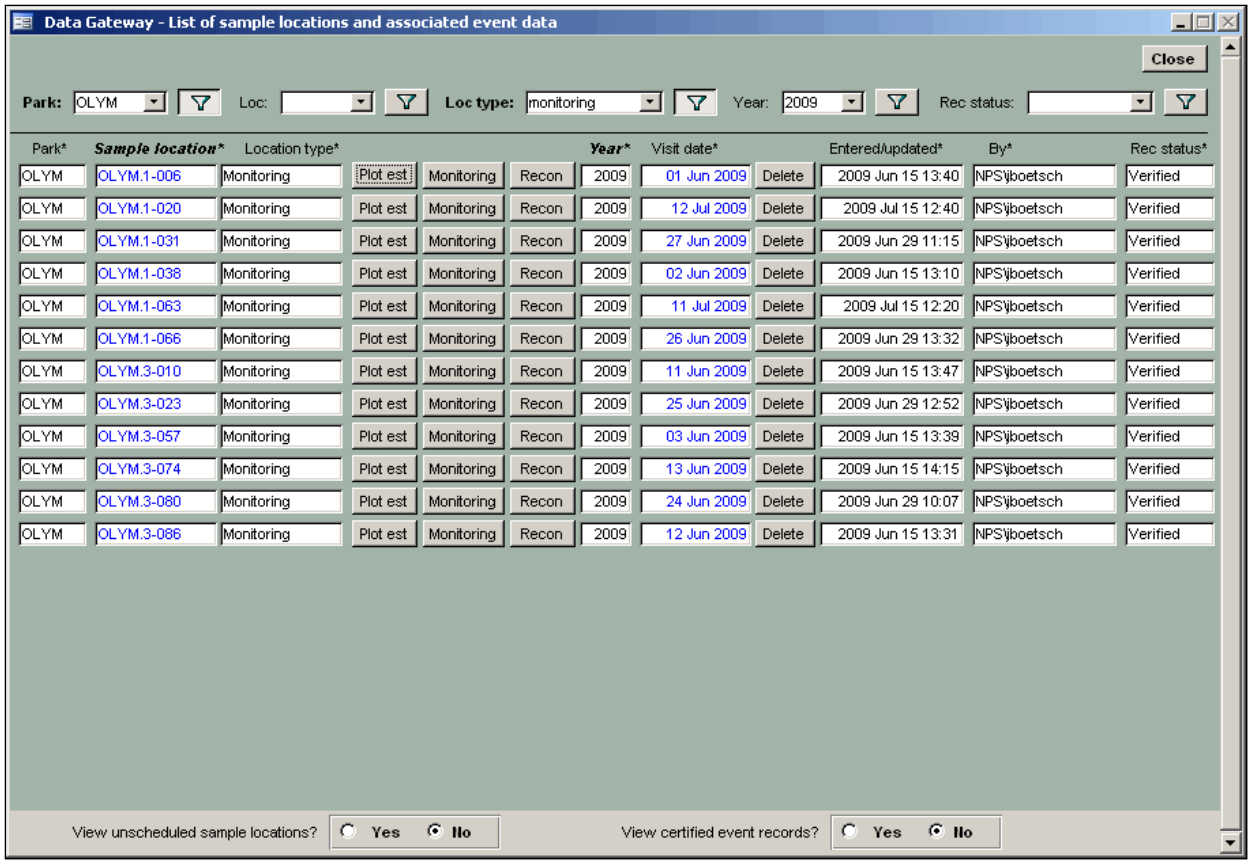
prompted each time the application closes if there is at least one Access back-end for which backups are specified.
- Compact back-end on exit – Compacts the back-end database when it the application closes. This helps to manage the size of the back-end, which improves performance over the network.
- Test all connections on startup – Ensures that each of the back-end tables is linked properly. Default is on, which means that the user will be prompted on startup if there is at least one Access back-end.

Entering and Verifying Event Data

When you select the "Enter / edit data" button, you will have a chance to change the default user name, park, datum, declination, and GPS model. Make sure this information is correct each time you enter data. Note: These defaults are properties of the front-end application, so different users reusing the same front-end file will need to change this information frequently. To avoid this, make copies of the front-end file for each user.

Data Gateway Form

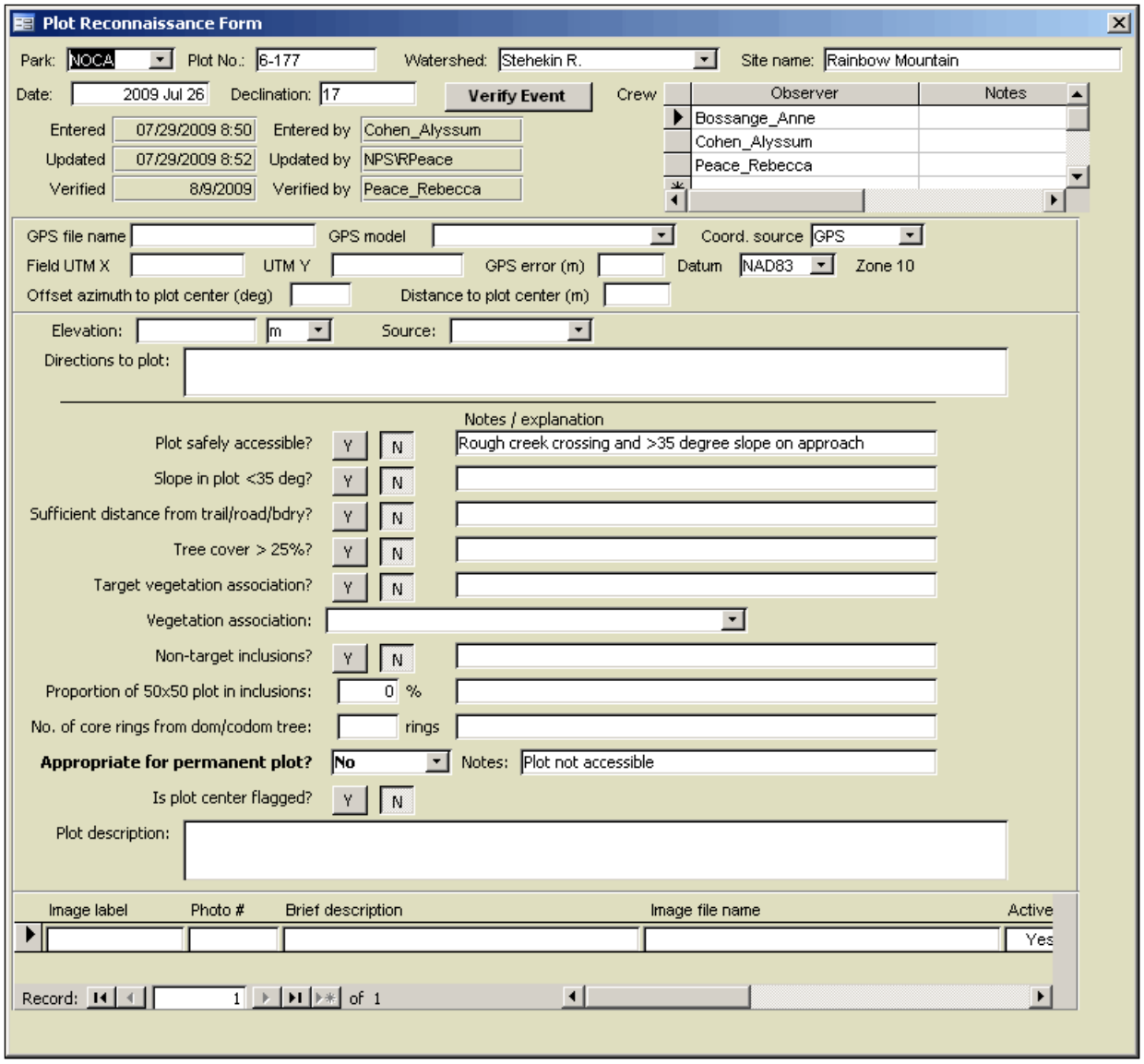
Next you will see the Data Gateway Form, which is where you will see a list of sample locations that are already present in the back-end database. This list is automatically filtered by the selected park (upper left corner), and to show only scheduled sample locations for the current sampling year. There is also the capability to filter by park, sample location, location type (reconnaissance vs. monitoring), sampling event year, and record status. Filters can be changed at any time, and records can be sorted by double-clicking on the field label above each column.



At the bottom of the form are radio buttons to allow the user to view unscheduled sampling locations if needed (e.g., an unscheduled site was visited after the sampling plan was made at the beginning of the season). Another set of radio buttons allows the user to view certified records from previous seasons (power users only).

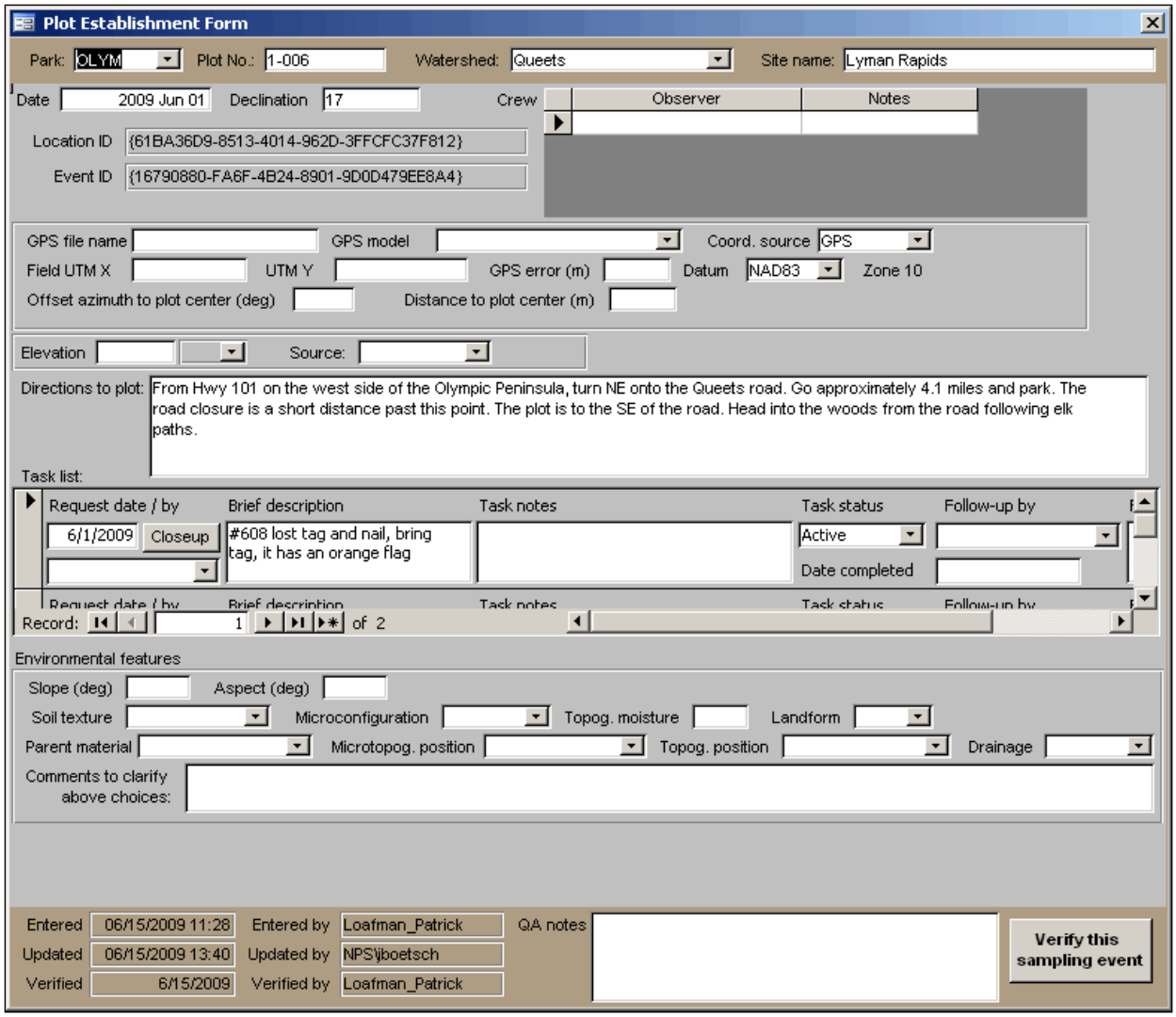
Plot Reconnaissance Form

Clicking on the "Recon" button associated with a given sample location will open the Plot Reconnaissance Form.



Plot Establishment Form

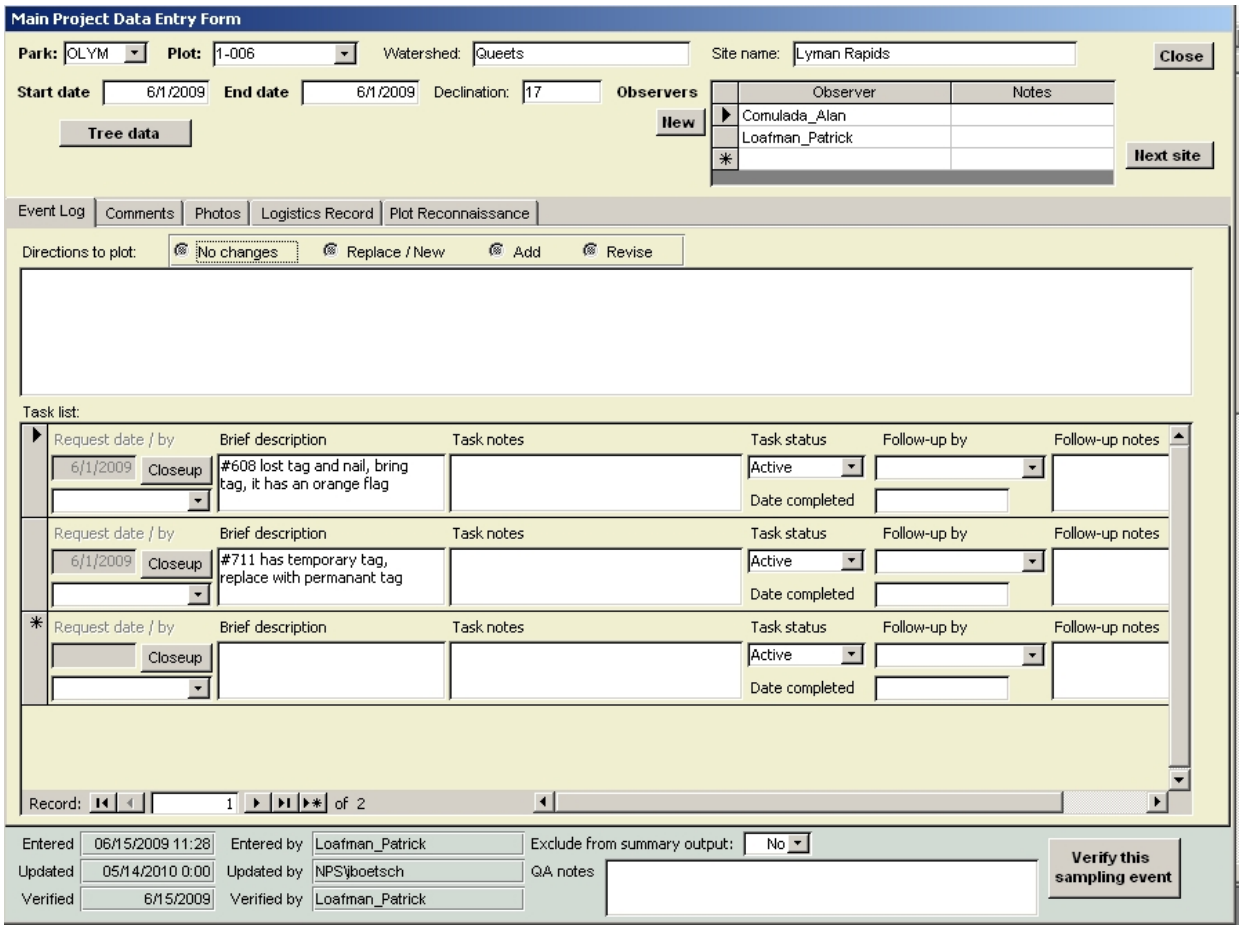
Clicking on the "Plot est" button associated with a given sample location will open the Plot Establishment Form. Note that this form may contain information collected in previous years at the same site – in particular, directions to plot and tasks may reappear for editing. It is important to be careful when editing this information to preserve the integrity of these records.



Data Entry Form

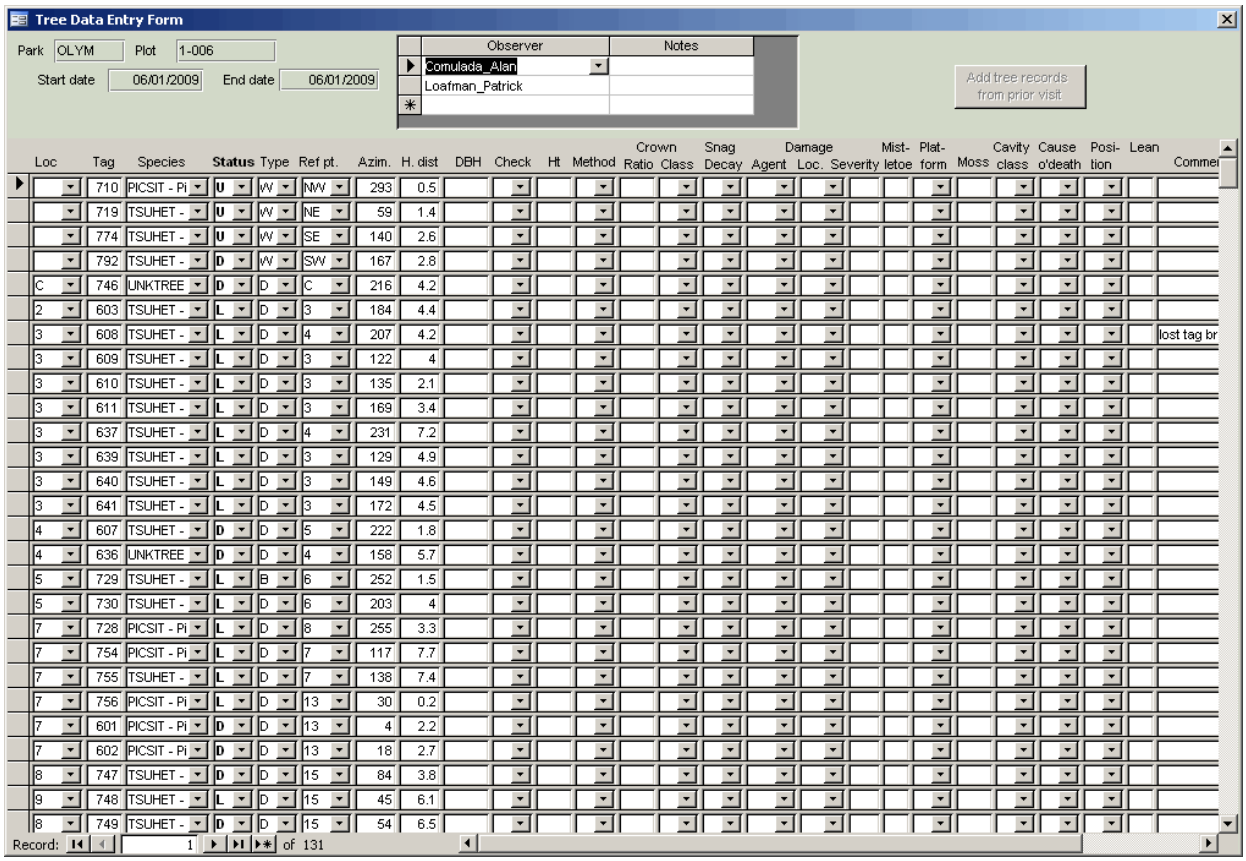
To access this form from the Data Gateway Form, either click on the "Monitoring" button associated with the desired record, or double-click on the appropriate "Sample location" cell, or on the "Visit date" cell. This form includes several tabs for various sections of the Event Log form. Note that the task list section will contain the full set of tasks for the sample location, not just those from the current sampling event. This allows the user to update task information from previous visits.

The sections for photos and plot logistics have buttons for auto-populating these sections with a pre-set list of photos and logistics tasks to reduce data entry keystrokes. There is also a button in the form header that opens the Tree Data Form associated with the sampling event.



Tree Data Form

This can be accessed from the Data Entry Form using the "Tree data" button in the header of that form. There is a button at the top of the Tree Data Form to auto-populate the form with active trees for the selected plot. Using this feature is particularly important to reduce the quantity of data to be entered and to ensure that data records from the current season are correctly related to records from past years. This button is disabled if tree records have already been entered or appended for a given sampling event.



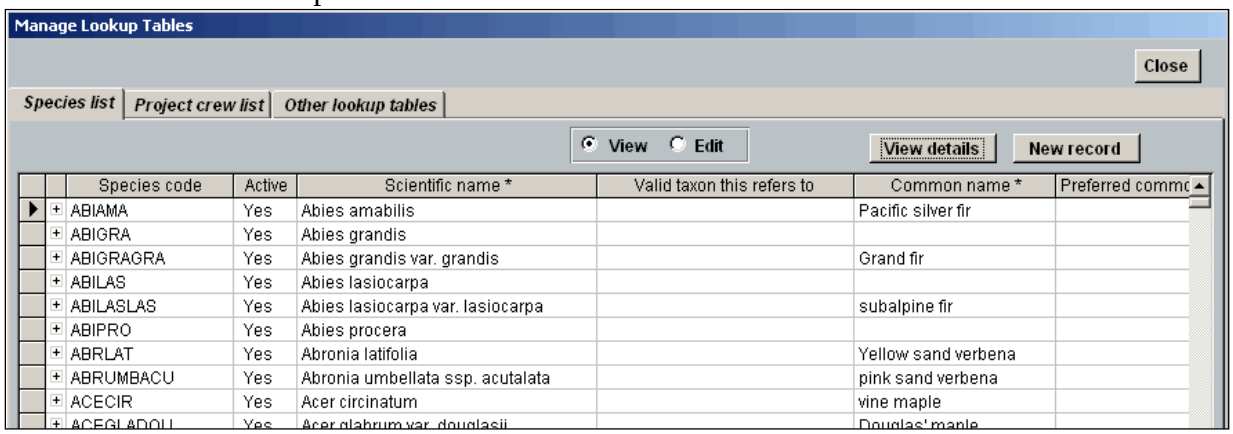
Verifying Data Records

Field crews must verify all sampling events throughout the field season. The recommended approach is for one crew member to do all of the data entry for one sample location, then have another crew member review and verify records for that location. The current record status for each sampling event is shown in the Data Gateway Form. To see all of the sampling events in the database, be sure to turn off the filters to show all of the sampling points and events. By double-clicking on the record status field in the Data Gateway Form, the appropriate data entry form will be opened for verification.

To complete the verification step: After all data for a given transect have been entered completely, the database entries should be compared against the original field forms. Each of the main data entry screens – Event Log, Reconnaissance and Plot Establishment – has a footer containing fields for storing quality assurance information about the event, and information on who created the sampling event record, who last updated it, etc. When all data for the sampling location has been verified, click on the button that says “Verify this sampling event” to indicate that the event record is complete and accurately reflects the field forms. Clicking this button instantly updates the record status in the Data Gateway for that sampling event. Remember that tree data will need to be verified before clicking the "Verify" button on the main Event Log form. Also, if more than one category of data was collected during a visit – for example, reconnaissance data and plot establishment information – both forms will need to be verified separately, even though the record status in the Data Gateway may indicate "Verified".

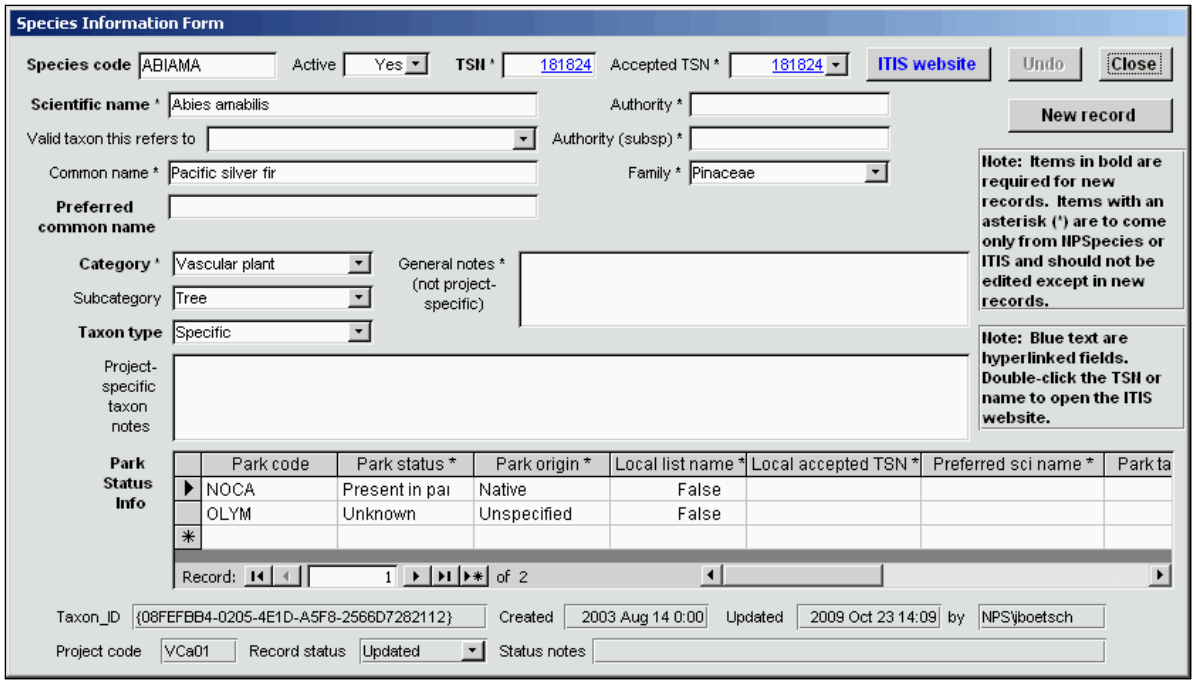
Manage Lookup Tables

From the main startup menu, click on 'Lookup tables' to open the Manage Lookup Tables Form. This form has three tabs – one for the project species list, another for the project crew list, and a third for viewing the contents of all other lookup tables. Minor edits may be made on the species list tab by putting the form into Edit mode. By selecting a record and clicking on "View details", or by double-clicking on any record selector (the gray box to the left of each record), the Species Information Form will open. To add a new record click on 'New record'.

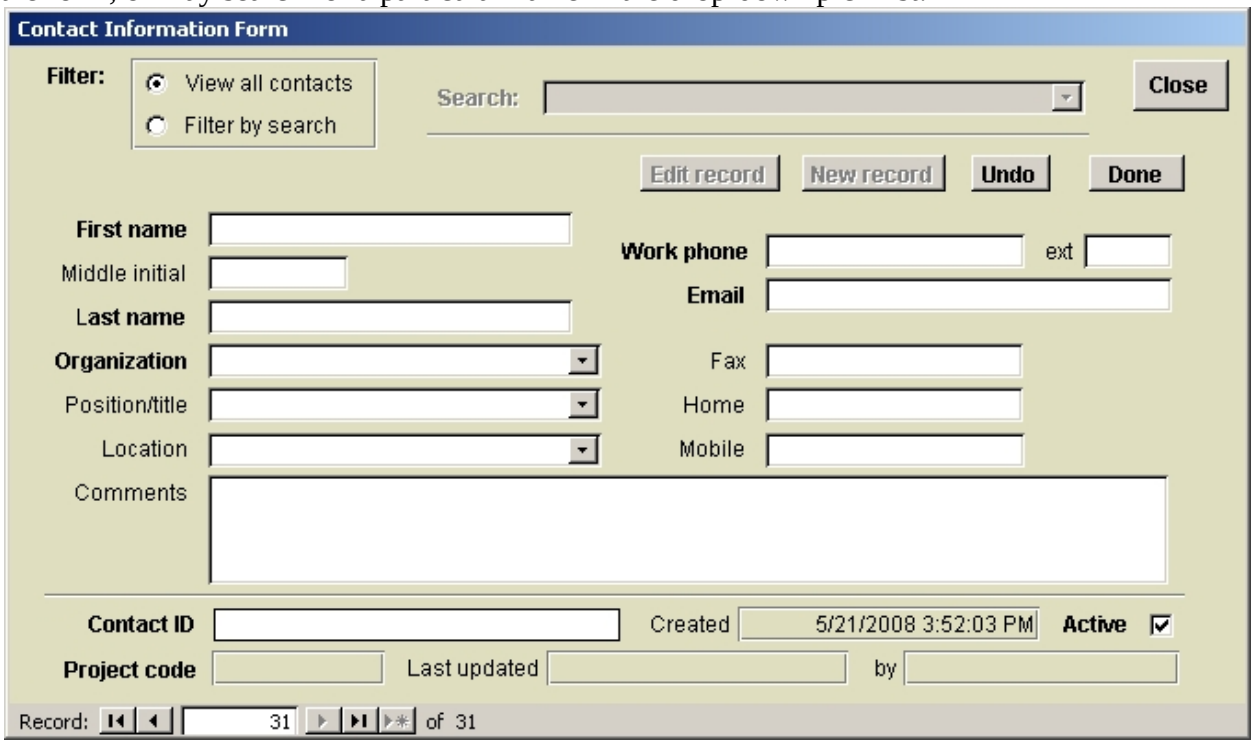


Species code	Active	Scientific name *	Valid taxon this refers to	Common name *	Preferred comm
ABIAMA	Yes	Abies amabilis		Pacific silver fir	
ABIGRA	Yes	Abies grandis			
ABIGRAGRA	Yes	Abies grandis var. grandis		Grand fir	
ABILAS	Yes	Abies lasiocarpa			
ABILASLAS	Yes	Abies lasiocarpa var. lasiocarpa		subalpine fir	
ABIPRO	Yes	Abies procera			
ABRLAT	Yes	Abronia latifolia		Yellow sand verbena	
ABRUMBACU	Yes	Abronia umbellata ssp. acutalata		pink sand verbena	
ACECIR	Yes	Acer circinatum		vine maple	
ACEGLADOU	Yes	Acer glabrum var. douglasii		Douglas' maple	

The Species Information Form can be used for adding or editing species records. Required fields are shown in bold, and items with an asterisk (*) next to the name are not to be edited except by the Data Manager (these come from either ITIS or the NPSpecies application). The Integrated Taxonomic Information System (ITIS) website may be accessed by clicking on the button labeled 'ITIS website', or by clicking on either the Taxonomic Serial Number (TSN) or scientific name if either of these fields is already populated. All new records – except for unknown taxa or temporary names – should have TSN entered if it exists on the ITIS website.



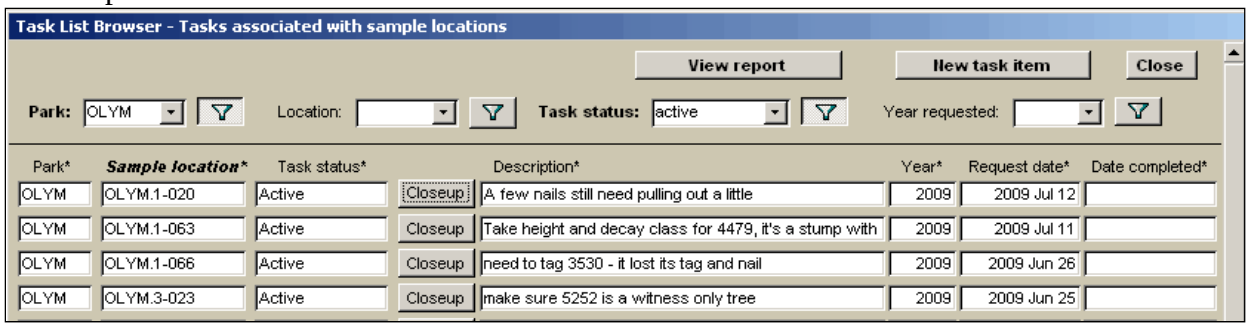
The second tab of the lookups module is a list of contacts for the project. By selecting a contact record and clicking on the "View / edit" button, or by double-clicking on a contact record, the Contact Information Form is opened in edit mode. Once edits are accepted with the "Done" button, the user may either page through the records using the record navigator at the bottom of the form, or may search for a particular name in the drop-down pick list.



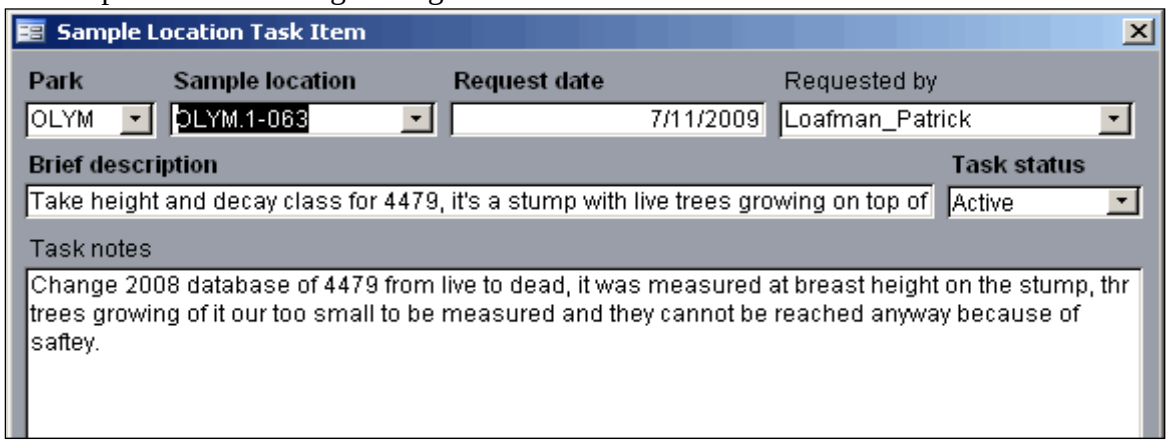
The third tab in the Manage Lookups Form has a dropdown pick list for selecting other lookup tables in the database. This can be useful when a user needs to learn more about the domain values and definitions for the project. These lookups may be edited only by power users and administrators.

Site Task List

The Task List Browser Form functions in much the same way as the Data Gateway Form, and can be sorted or filtered by park, location type, task status or request year. Click on the "Closeup" button to view or edit information for that record.

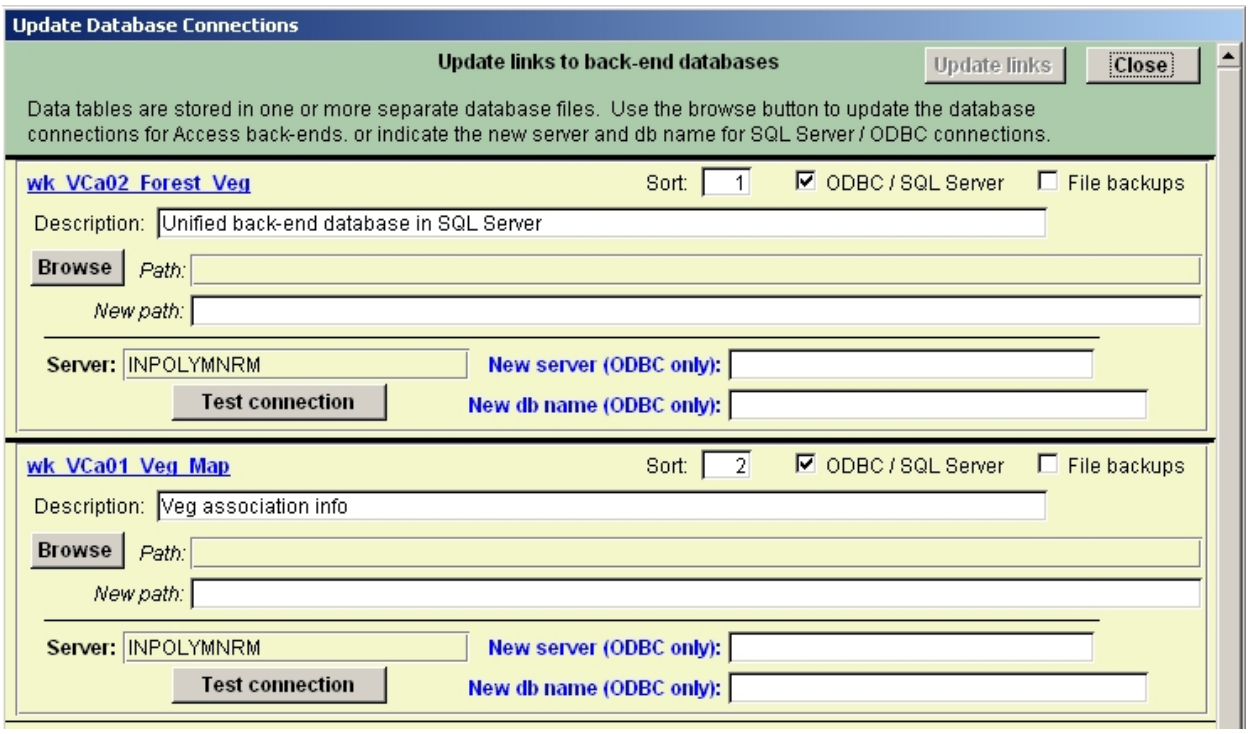


Close-up view for entering/editing location task items:



Update Database Connections

When first using the front-end application, the user may need to establish the connections to the back-end database(s). Database connections can be updated using the Update Database Connections form, available by clicking on the 'Db connections' button on the main switchboard menu. A separate record will be shown for each back-end database. For SQL Server databases, specify the server and database name. For Access back-ends, browse to the desired back-end file. To complete the connection updates, click on 'Update links'.


Update Database Connections
Update links to back-end databases
Update links
Close
Data tables are stored in one or more separate database files. Use the browse button to update the database connections for Access back-ends. or indicate the new server and db name for SQL Server / ODBC connections.
wk_VCa02_Forest_Veg
Sort: 1
ODBC / SQL Server
File backups
Description: Unified back-end database in SQL Server
Browse
Path:
New path:
Server: INPOLYMNRM
New server (ODBC only):
Test connection
New db name (ODBC only):
wk_VCa01_Veg_Map
Sort: 2
ODBC / SQL Server
File backups
Description: Veg association info
Browse
Path:
New path:
Server: INPOLYMNRM
New server (ODBC only):
Test connection
New db name (ODBC only):

SOP 14: End of Field Season Debriefing and Close-out

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan. 2, 2009	S. Acker	Removed references to SOPs that have been suspended indefinitely.	Change of protocol as of 2008 field season with indefinite suspension of understory measurements.
Oct. 3, 2009	S. Acker	A reference to a location on the network drive was updated. Minor edits were made to the text.	Streamlining of SOPs in the process of producing final version in response to NPS review.

Overview
This SOP outlines the procedure for meeting to debrief the crew and close out the field season. This is to occur during the last week of work for the seasonal bio-technicians.

Preparation
By the end of the field season all data should be entered into the database and verified by the crew. The crew should be prepared for debriefing on the scheduled day during the last week of work. Equipment should be inventoried and any borrowed equipment returned. The Crew Lead should prepare a "Field Season Report," noting any unfinished work, so that the park plant ecologist can arrange for its completion.

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. The Project Lead and the park plant ecologists should 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 below for discussion at the debriefing, and add additional items that come to mind. Meeting notes should be recorded for future 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 Leads, Crew Lead to crew, between crew members, between crews, within park, between parks, with park plant ecologists)

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 & compass, and safety? (training for data collection 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?

Data Collection
How did you feel about each of the following parts of data collection? What went well and where could improvements be made?

- Training – Was the training adequate for data collection?

- Locating plots
- Plot set-up
- Sampling
  - Event Log
  - Taking digital images
  - Trees
- Data forms
- Pest and pathogen identification

Technical Issues

- Field equipment - Did you have the right equipment to get the job done safely and efficiently? (e.g., GPS, Lasers, cameras, altimeter, clipboards, paper)
- GPS / GIS support at each park
- Did the GPS procedures 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 the 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 contact information from the crew. 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.

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. Create a list of needed items in the folder \Documents\Reference\Travel_Logistics\Equipment_Lists in the project workspace, indicating

the year in the file name, so that it is easily accessible when it is time to order equipment and supplies for the next field season.

Check Out

On the last day of work the biotechs will go through the NPS check-out procedure, unless they will be working on another project. Check-out entails getting the check-out form signed off by various authorities as equipment and keys are turned in.

Field Season Reporting

Each Crew 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 deviations from established procedures.
- Discussion of any interesting or potentially important observations about the parks' vegetation or wildlife that may have been noted during the field season (e.g., apparent changes in composition from previous years, or notable changes in apparent abundance of exotic or rare species).
- Suggestions for improving the training or field season logistics.
- An inventory of field equipment, quantity and condition.

SOP 15: Data Quality Review and Certification

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Nov 2009	J. Boetsch	Revised screen captures and documentation for the quality review tool.	Significant improvements in the functionality have been implemented, such as bulk updates, exports to Excel, and
Nov 2009	J. Boetsch	Included a description of potential sources of data problems in the overview. Included definitions of the three types of queries.	Text added to clarify the purpose and process of the quality review.
Nov 2009	J. Boetsch	Revised the list of validation queries in Table 15.1.	Changes to the underlying data model required an overhaul of the validation queries.
May 2010	J. Boetsch	Revised the list of validation queries in Table 15.1.	To make sure that recent changes and additions were reflected.

Overview

This SOP describes the procedures for validation and certification of data in the 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.

A critical part of project quality assurance is the year-end data quality review and certification. After the season's field data have been entered and processed, they need to be reviewed and certified by the Project Lead before they can be used for analysis and reporting. Data validation is the process of rigorously testing data for completeness, structural integrity, and logical consistency. Although the front-end data entry forms have built-in quality assurance measures – such as domain lookup pick lists, defined range limits for numeric data, and checks for missing values – not all errors can be caught during the data entry step. The following are a few of the general sources of data problems that might be identified during the validation:

1. The response design is ambiguous or insufficiently documented to prevent data gaps and logical inconsistencies.
2. There were logistics problems or a change of plans that prevented a complete sample (e.g., weather conditions, staffing changes).
3. Field crew members did not collect or properly record one or more data elements in the field.
4. Data were entered incorrectly or incompletely.
5. Database records were edited incorrectly or deleted after entry.
6. There is a design flaw in the front-end application that causes data errors during or after data entry.

Given the varied sources of data problems, there is a need for a thorough check of data quality on a regular basis as a means of ensuring continued data quality throughout the span of the project. The front-end database application includes a Quality Review Tool to facilitate the review process by showing the results of pre-built queries that check for data integrity, data outliers, missing values, and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed (e.g., missing response variable values), in which case documentation of the resulting errors and why records were not fixed is included in the metadata and certification report.

Once the data have been through the validation process and metadata have been developed for them, the Project Lead should certify the data by completing the NCCN Project Data Certification Form, available on the NCCN website.

Data Quality Review

Validation Queries

Table 15.1 shows the set of validation checks that are performed on the data set. Each line represents a pre-built database query that checks for potential problems in the data set, including data outliers, missing values, and illogical values. The set of queries is customized to match project requirements and the structure of the underlying data model. Each query is classified in one of three categories:

1. Critical – These queries check for structural integrity problems or gaps in critical information. This category might include queries that check for missing primary key values, mismatches between data values and lookup domain values, duplicate records, or illogical data combinations. Records returned by these queries fail to meet basic project requirements or structural requirements of the data model, and must be fixed so that they do not return any records before the data can be certified.

2. Warning – These queries represent problems that range in importance, but in any case have the potential to compromise data usability or representativeness if they are not addressed or at least made known to the end user. This category might include queries that check for missing response variables (e.g., dbh measurements) or values that are beyond a reasonable range; alternatively, it may include queries that require follow-up on data records that can only be done after the field season (e.g., changing status of a monitoring location from "Proposed" to "Active"). The person performing the quality review should make efforts to fix as many of these records as possible by reviewing hard-copy data forms or otherwise following up. However, it may frequently be the case that records in this category cannot be fixed because the reviewer does not have the information needed to fix the record. In such cases the reviewer should provide documentation about which records were not fixed and why using the space provided in the quality review tool (see below). If there are numerous records that cannot be fixed, a general description such as "80 records" or "all reconnaissance sites, 43 records", along with a statement of why these were not fixed, will suffice. Documentation will help future data users to know that reasonable efforts were made to address the problems.

3. Information – These queries provide information that can be used to evaluate the completeness and logical consistency of the data set – for example, the number of plots visited per park in a given season, the range of dates for sampling visits, or the number of trees recorded during a sampling event. This category may also include checks for missing values in less-vital or optional fields, where a large number of missing values may be anticipated on a regular basis (i.e., as an alternative to making these Warning queries that require follow-through and documentation).

The queries are named and numbered hierarchically so that high-order information – for example, from tables on the parent side of a parent-child relationship such as sample locations – is addressed before low-order information (e.g., individual species observation records). 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.

The set of queries may need to be augmented or changed as project requirements shift. The Data Manager is also available to revise queries or construct new database queries as needed. Throughout the quality review, the person performing the review should remain vigilant for problems that may not be caught by the validation queries. One task that cannot be automated is the process of making sure that all of the 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 against the results of queries showing the sites for which data exist.

Table 15.1. Database queries used to validate data during the annual data quality review. These queries allow project staff to test the data set for completeness, structural integrity, and logical consistency.

Query Name	Type	Description of Records Returned
qa_a102_Overview_locs_with_multiple_events	Warning	Locations with more than one associated sampling event in a sampling year
qa_a113_Overview_sampling_visit_summary	Information	Number of locations visited at each park, grouped by location type
qa_a123_Overview_locations_visited	Information	Full list of locations visited at each park
qa_a133_Overview_monitoring_locations_visited	Information	List of monitoring locations visited at each park
qa_a142_Scheduled_but_not_visited	Warning	Scheduled sample locations that were not visited in the year scheduled
qa_a152_Visited_but_not_scheduled	Warning	Locations visited in a calendar year on which they were not scheduled (after 2007)
qa_a203_Sampling_event_date_ranges	Information	Returns the earliest and latest sample dates in the data set
qa_a213_QA_status_by_year_summary	Information	Summary of number of event records by quality assurance status
qa_a222_Unverified_events	Warning	List of unverified sampling events in the data set
qa_a233_Quality_assurance_status	Information	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data set
qa_a242_Events_excluded_from_summaries	Warning	Uncertified event records that are flagged to be excluded from data summary output
qa_a253_Events_excluded_by_year	Information	Event records that are flagged to be excluded from data summary output among years
qa_b101_Strata_missing_critical_info_X	Critical	Missing park code, project code, stratification date, stratum name, or stratum definition
qa_b111_Strata_duplicate_records	Critical	Duplicate records on park code, project code, stratification date, and stratum name
qa_b121_Strata_illogical_dates_X	Critical	Stratum record updated date prior to created date
qa_d101_Locations_missing_critical_info	Critical	Missing park code, location code, location type, location status, stratum ID, or firing order
qa_d111_Locations_park_inconsistencies	Critical	Park code inconsistent with strata table - may be assigned to wrong stratum
qa_d121_Locations_duplicates_on_park_and_loc_code	Critical	Duplicate records on park code and location code
qa_d133_Locations_duplicates_on_park_and_loc_name	Information	Duplicate records on park code and loc name
qa_d142_Locations_missing_panel_info	Warning	Active sample locations without a panel type, or panel name where panel type is 'Annual'

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_d152_Locations_missing_establishment_dates	Warning	Sampled locations with loc type = 'Monitoring' (except where status ='Deferred') or non-blank discontinued dates, but without establishment dates
qa_d162_Locations_status_inconsistencies	Warning	Locs w/ establishment dates and status = 'Proposed'; 'Retired' locs w/o discont. dates; discont. dates w/ status other than 'Retired' or 'Rejected'; or sampled locations w/ status ='Proposed'
qa_d172_Locations_unclassified_new_points	Warning	New sample locations with an undetermined location status (='New')
qa_d202_Locations_without_coordinates	Warning	Sampled locations without any coordinate records - verify against data forms that field coordinates weren't recorded (post-QA processing will create coordinate records if a GPS file was collected)
qa_d243_Locations_missing_sampling_events	Information	Locations with status other than 'Rejected' or 'Proposed' that do not have sampling events
qa_d312_Locations_missing_site_evaluation_info	Warning	Status = 'Rejected' but missing evaluation code, or has evaluation notes but no code, or location established is not blank but missing evaluation code
qa_d322_Locations_missing_travel_info	Warning	Active sample locations with no travel navigation description
qa_d333_Locations_without_park_region	Information	Missing park region values
qa_d901_Location_illogical_dates_X	Critical	Discontinued date prior to established date, or updated date prior to created date
qa_f101_Events_missing_critical_info_X	Critical	Missing location ID, project code, or start date - delete if no Location_ID
qa_f111_Events_duplicates_on_location	Critical	Duplicate event records on location ID in a given season
qa_f121_Events_illogical_dates_X	Critical	Events with end dates prior to start date, or updated or verified dates prior to the record entry date
qa_f132_Events_without_observers	Warning	Events without associated observers
qa_f142_Events_missing_data	Warning	Events without tree data or recon data - successful sampling events should have one or the other, or both
qa_f163_Events_missing_declination_X	Information	Sampling events with missing declination correction values
qa_f202_Events_missing_QA_info_X	Warning	Event records without entered date/by entries, or incomplete updated date/by or verified date/by entries

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_f302_Plot_recon_loc_type_mismatch	Warning	Events where plot recon records are missing for loc type = 'Reconnaissance'
qa_f402_Events_missing_data_flags	Warning	Monitoring locations that are missing data flags for tree data or mortality data; or having these flags where loc type <> 'Monitoring'
qa_f422_Events_site_map_inconsistencies_X	Warning	Has_site_map = True but no map file name, or False but a file name entered
qa_f432_Events_tag_stake_inconsistencies_X	Warning	Tags replaced or added = True but no details entered, or False but details entered; or stakes replaced = True with no details, or False but details entered
qa_f442_Events_travel_notes_inconsistencies_X	Warning	Travel notes action is blank but travel notes were entered; or an action other than 'New' or 'None' is entered but no travel notes were entered; or action is 'Add' but there are no existing travel notes
qa_f452_Events_travel_notes_to_be_revised_X	Warning	Travel notes that need to be revised - revise the text to its desired final state and change the action to 'Replace'
qa_f463_Events_travel_notes_X	Information	Summary of travel notes and actions that will be taken after data are certified ('add' will append to the end of previous travel notes; 'none' will be ignored; all others will overwrite previous travel notes with current travel notes text)
qa_f502_Events_inconsistent_tree_data	Warning	Events where Has_tree_data or Has_tree_mortality = 'Yes' or 'Partial' but missing associated tree data records, or having such records and Has_tree_data and Has_tree_mortality are both either blank or = 'No'
qa_f513_Events_tree_data_summary	Information	Summary of tree data associated with sampling events, including number of previously unrecorded trees and the number of previously recorded trees missing from the current years data
qa_f522_Events_with_missing_new_coord_info	Warning	Events where Has_new_coordinates=False and GPS file name is not blank, or True and missing the GPS file name
qa_f533_Events_with_new_coordinates	Information	Events where Has_new_coordinates=True or GPS file name is not blank
qa_g101_Coordinates_missing_critical_values	Critical	Records missing event ID or coord creation date
qa_g122_Coordinates_missing_field_UTMs	Warning	Field UTMs and GPS file name is missing
qa_g131_Coordinates_incomplete_field_UTMs	Critical	A portion of the field coordinate pair is missing; or field datum or field coordinate source is missing; or the field UTMs have the wrong number of digits (6 for UTME, 7 for UTMN); or only a portion of offset distance or azimuth is filled in

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_g142_Coordinates_duplicates_on_field_UTMs	Warning	Locations sharing the same field UTMs in the same sample year (may indicate incorrect data entry)
qa_g191_Coordinates_inconsistent_field_source_info	Critical	Field coordinate source = 'Map', however there is a GPS file name, a field horizontal error, or GPS model (other than 'None') filled in to suggest that the source is GPS
qa_g202_Coordinates_incomplete_GPS_info_X	Warning	Field coordinate source = 'GPS' but missing GPS model or GPS file name
qa_g901_Coordinates_illogical_dates_X	Critical	Coordinates with updated dates before creation dates
qa_h101_Observers_missing_critical_info	Critical	Missing event ID, contact ID, or observer role - delete records with missing values
qa_i101_Project_crew_missing_critical_info	Critical	Missing contact ID, project code, last name, or first name
qa_i112_Project_crew_missing_info	Warning	Missing organization or position title
qa_j101_Project_taxa_missing_or_illogical_info_X	Critical	Missing taxon ID, project code, species code, scientific name, category, taxon type, or record status; or updated date prior to created date
qa_j111_Project_taxa_duplicate_sci_name	Critical	Duplicates on scientific name
qa_j121_Project_taxa_duplicate_species_code	Critical	Duplicates on species code
qa_j131_Project_taxa_duplicate_TSN	Critical	Duplicates on TSN
qa_j141_Project_taxa_inconsistent_reference_info	Critical	Taxon records that are not active and missing a reference to a current/active taxon; or active records with a reference to another taxon
qa_j152_Project_taxa_inconsistent_categories	Warning	Inconsistencies between taxon category and subcategory (e.g., non-vasculars with subcategory other than 'moss', 'liverwort' or 'hornwort'); or taxon category is not in the lookup table
qa_j163_Project_taxa_incomplete_categories_X	Information	Taxon records where subcategory is blank and taxon type <> 'Unknown'
qa_j173_Project_taxa_category_summary	Information	Summary of the number of taxa in each category and subcategory, by taxon type
qa_j202_Project_taxa_without_park_records	Warning	Taxon records (excluding temporary taxa, grouped taxa, and genus-level taxa) that do not have an associated park record
qa_j211_Park_taxa_missing_or_illogical_info_X	Critical	Missing taxon ID, park code, park status, park origin, or record status; or updated date prior to created date
qa_l101_Images_missing_critical_info	Critical	Missing image ID or event ID
qa_l113_Locations_wo_images	Information	Sampling locations with no images

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_l122_Images_missing_values_X	Warning	Image records missing both image label and image description, or frame number, or image filename
qa_n101_Task_list_missing_critical_info	Critical	Missing task description, request date, or status; or the completed date is before the request date; or the completed date is filled in but the status is not 'Complete'
qa_n113_Task_list_summary	Information	Summary of task list items
qa_p103_Plot_recon_summary	Information	Summary of plot reconnaissance information
qa_p112_Plot_recon_missing_info	Warning	Missing vegetation association or Is_appropriate
qa_p122_Plot_recon_veg_association_errors	Warning	Vegetation association is either not in the lookup table, or is not consistent with the current classification
qa_p132_Plot_recon_inconsistent_inclusion_info	Warning	Has_inclusions = True and Proportion_inclusions is blank or 0, or Has_inclusions = False and Proportion_inclusions is not blank
qa_p142_Plot_recon_elev_errors	Warning	Elevation value is missing; or elevation units or elevation source missing where an elevation was entered; or elevation source = 'GIS theme'; or elevations either below 0, above 4419 meters, or above 14500 feet
qa_p152_Plot_recon_specious_conclusions	Warning	Is appropriate = 'No' but meeting criteria for safe access, slope steepness, distance from trail, tree cover and target veg, and no non-target inclusions; or Is_appropriate = 'Yes' and any one of these is false or having non-target inclusions over 10%
qa_p162_Site_evaluation_missing_records	Warning	Sampled locations without site evaluation records
qa_p172_Site_evaluation_missing_info	Warning	Missing evaluation code where office eval='Fail'; field eval missing or 'None' with office eval='Pass'; missing evaluation code with field eval 'Pass' or 'Fail'; eval code of 'TS' with office or field eval='Fail', or <>'TS' or 'TD' with field eval='Pass'
qa_p181_Site_evaluation_codes_not_in_lookup	Critical	Locations with evaluation code values that are not found in the lookup table
qa_p203_Plot_desc_values_by_location	Information	Number of event records with associated values for descriptive variables (parent_material, soil_texture, microconfig, microtopog_position, topog_position, drainage, topog_moisture, or landform) - may want to follow up for those with zero records

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_p212_Plot_desc_elev_errors	Warning	Elevation source = 'GIS theme'; or elevations either below 0, above 4419 meters, or above 14500 feet; or elevation units or elevation source missing where an elevation was entered
qa_p222_Plot_desc_unmatched_lookups	Warning	Descriptor variables contain values that are not found in the lookup tables
qa_p233_Plot_desc_missing_desc_values	Information	Sampling events missing parent material, soil texture, microconfig, microtopog_position, topog_position, drainage, topog_moisture, or landform
qa_p243_Plot_desc_missing_values_X	Information	Missing elevation, slope, or aspect (note that these values also may be derived from GIS using coordinate data)
qa_p301_Plot_logistics_missing_critical_info	Critical	Missing plot_task or event_ID
qa_p312_Plot_logistics_no_records	Warning	Monitoring plots with missing logistics records, where the sampling event occurs after plot establishment and loc_status <> 'Deferred'
qa_p322_Plot_logistics_tasks_not_in_lookup	Warning	Plot sampling logistics records with tasks that are not found in the lookup table (one may wish to deactivate outdated lookup values rather than delete them)
qa_p332_Plot_logistics_missing_values	Warning	Plot sampling logistics records missing time_spent or N_people
qa_p342_Plot_logistics_values_above_threshold	Warning	Plot sampling logistics records with time_spent > 20 hours or > 3 days; or with > 6 people (note that some tasks/events may legitimately require values above these thresholds)
qa_p401_Trees_duplicate_tags	Critical	Tag numbers that are repeated at the same location
qa_p412_Trees_visited_more_than_once_per_year	Warning	Trees with more than one tree visit record in a calendar year (may lead to incorrect tree/species tallies)
qa_p421_Trees_with_no_visits	Critical	Trees that have no tree visit data records from prior years (all tree records should have at least one associated visit - visit data may have been accidentally deleted)
qa_p432_Trees_not_recorded_this_season	Warning	Active trees at plots visited this year that were not recorded during the current year - check for overlooked or misrecorded trees
qa_p441_Tree_data_entry_missing_critical_info_X	Critical	Missing tree tag num, taxon ID, tree type, or tree ID; or the taxon is not in the species lookup table
qa_p452_Tree_data_entry_visited_more_than_once_per_year	Warning	Trees with more than one tree data entry record in a calendar year (may lead to incorrect tree/species tallies)

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_p461_Tree_data_entry_duplicate_tree_tags	Critical	Duplicate tree tags for a given sampling event (possible duplicate records; if the duplicate numbers are actual and not a data entry error, suggest changing one to a large number and setting a task to replace the tag on next visit)
qa_p481_Tree_data_entry_new_recs_with_tag_conflicts	Critical	Newly-entered trees that match existing tag numbers at a given sampling location. If not the same tree, first change the tag # in the data entry form; otherwise use the auto-fix to link current year rec w/ existing tree ID (will also make it active).
qa_p491_Tree_data_entry_other_tag_conflicts	Critical	Current year recs matching existing tag numbers at a given loc, but w. a diff. tree ID than before. For valid tag # changes, first open the data browser and change the tag # for prior years; otherwise use the auto-fix to link current recs w/ existing ID.
qa_p502_Tree_data_entry_changed_tag_num_X	Warning	Trees matching records from prior years for which the tag number has changed; by default information from the current year will replace that for prior years during post-certification updates
qa_p513_Tree_tag_number_summary	Information	Tag number ranges by tree record status for all locations
qa_p522_Tree_data_entry_changed_location	Warning	Trees matching recs from prior years but associated with a different location (if prior year is correct, delete the record from the current year and add as needed to the correct location; otherwise post-cert updates will replace prior years info)
qa_p532_Tree_data_entry_changed_taxon_or_type_X	Warning	Trees matching records from prior years for which is_active, tree type or taxon ID has changed; by default information from the current year will replace that for prior years during post-certification updates
qa_p542_Tree_data_entry_changed_tree_loc_info_X	Warning	Trees matching records from prior years for which tree location, plot ref point, or offset values have changed; by default information from the current year will replace that for prior years during updates (except nulls will not replace prior values)
qa_p552_Tree_data_entry_missing_loc_info_X	Warning	Newly-entered trees missing tree location, plot reference point, or offset azimuth or distance values
qa_p601_Tree_data_entry_missing_status_X	Critical	Tree records for the current season with missing tree status (check data sheets to confirm), or status of 'U' for unknown; missing values should be filled in with 'U' (fix records runs a query to automatically fill blanks with 'U')

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_p613_Tree_data_entry_new_mortality_events	Information	New mortality events - where the prior status was <>'D' and current status is 'D'
qa_p621_Tree_data_entry_conflicting_mortality_events	Critical	New mortality events (status='D') for trees that already have a mortality event recorded during a previous visit (Mortality=True for a past event)
qa_p631_Tree_data_entry_undead_trees	Critical	Trees with status ='L' that have a mortality event recorded during a previous visit (Mortality=True for a past event)
qa_p641_Tree_visits_duplicate_mortality_events	Critical	Trees that have more than one past visit event flagged as a mortality event
qa_p651_Tree_visits_mortality_event_flag_not_set_X	Critical	Past tree visit records where tree status was 'D' but the mortality flag is False
qa_p661_Tree_visits_mortality_event_flag_error_X	Critical	Past tree visit records where tree status was <>'D' and the mortality flag is True
qa_p701_Tree_data_entry_tree_status_transition_errors	Critical	Tree status transition errors from the previous visit: current status='L' or 'D' (newly dead) and prior status was 'D', 'S' (snag) or 'F' (fallen); or current='S' or 'F' and prior='L' or 'F'; or current='M' and prior='F'; or 'D', 'F' or 'M' for new trees
qa_p712_Tree_data_entry_deactivated_trees_X	Warning	Trees visited this season where Is_active=False (deactivated trees will not appear in pre-printed forms or be automatically included in the auto-populate feature of the data entry screen; fallen snags will be deactivated during post-certification updates)
qa_p723_Tree_data_entry_fallen_trees_X	Information	Trees visited this season where status='F' (fallen snags); these records will automatically be deactivated during post-certification updates and will not appear in future pre-printed forms or data entry screens
qa_p731_Tree_data_entry_inconsistent_mortality_data_X	Critical	Trees where cause of death, position, or lean are filled in for anything but new mortalities (status <>'D')
qa_p742_Tree_data_entry_missing_mortality_data_X	Warning	Trees missing cause of death, position, or lean for new mortalities (status='D')
qa_p762_Tree_data_entry_inconsistent_damage_X	Warning	Trees for which damage agent was filled in where tree status is other than 'L' or 'D'; or mistletoe class was filled in for anything other than live trees or Tsuga, Abies or Pinus species
qa_p772_Tree_data_entry_incomplete_damage_info_X	Warning	Damage location or severity is missing where damage agent is filled in (except for agent 96,97,98 or 99); or damage agent is missing where severity or location are filled in; or damage loc other than 2 or 3 where agent=96,97,98 or 99

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_p782_Tree_data_entry_missing_damage_X	Warning	Trees missing damage agent for living or newly dead trees ('L' or 'D'); or missing mistletoe class for live Tsuga, Abies or Pinus species
qa_p793_Tree_data_entry_damaged_trees	Information	Summary of damaged trees
qa_p802_Tree_data_entry_inconsistent_wildlife_use_X	Warning	Trees with platforms or moss abundance filled in for anything but live ('L') trees; or where moss abundance was filled in where no platforms were recorded; or with cavity class filled in for anything but standing trees
qa_p812_Tree_data_entry_missing_wildlife_use_X	Warning	Trees missing platforms or moss abundance for live ('L') trees; or missing moss abundance where platforms were recorded; or missing cavity class for standing trees ('L', 'D', or 'S')
qa_p822_Tree_data_entry_inconsistent_other_X	Warning	Trees with dbh or height filled in on anything but live ('L') or standing dead trees ('D' or 'S'); or where crown ratio or crown class was filled in for anything but live trees; or where decay class was filled in for anything but standing dead trees
qa_p832_Tree_data_entry_missing_other_X	Warning	Trees missing crown ratio or crown class for live trees; or decay class missing for standing dead trees ('D' or 'S')
qa_p852_Tree_data_entry_missing_height_X	Warning	Missing height values where tree status = 'D' or 'S' (standing dead trees)
qa_p862_Tree_data_entry_height_method_inconsistent_X	Warning	Missing height method where height is not missing, or missing height value where height method is filled in
qa_p872_Tree_data_entry_missing_dbh_X	Warning	Missing dbh values where tree status is 'L', (live) 'D' (newly dead) or 'S' (snag)
qa_p882_Tree_data_entry_diameter_check_inconsistent_X	Warning	Missing diameter check value where dbh is not missing, or dbh value where diameter check is filled in
qa_p893_Tree_data_entry_dbh_measurement_irregularities	Information	Tree data from the current season with diameter check values <> 0, or for trees that had recorded a dbh irregularity in a previous visit
qa_p903_Tree_visits_dbh_measurement_irregularities	Information	Matrix showing dbh measurements from past years for trees that have ever had a diameter check value other than 0 (dbh shown with non-zero diameter check value in parentheses)
qa_p913_Tree_visits_dbh_data	Information	Matrix showing dbh measurements from past years for all trees, useful for looking for inconsistencies or illogical values (e.g., shrinking trees)
qa_p922_Tree_data_entry_dbh_comparison_excess_variability	Warning	Trees with dbh values for the current season representing over 2 percent change compared against maximum values from past years (possible measurement or data entry errors)

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_p923_Tree_data_entry_dbh_comparison	Information	Comparison of dbh values for the current season with maximum values from past years for all trees, useful for examining dbh data variability and looking for outliers
qa_p932_Tree_visits_dbh_data_excess_variability	Warning	Dbh data from past years with over 2 percent change per measurement (possible measurement or data entry errors)
qa_p933_Tree_visits_dbh_data_variability	Information	Dbh dispersion statistics from past years for all trees, useful for examining dbh data variability and looking for outliers
qa_p952_Tree_data_entry_dead_witness_trees	Warning	Active witness trees that are were recorded as standing dead, fallen or missing in the current year - consider adding a task list item to find a replacement witness tree
qa_p962_Tree_visits_dead_witness_trees	Warning	Active witness trees that are either standing dead or fallen - consider adding a task list item to find a replacement witness tree
qa_p971_Trees_active_but_fallen	Critical	Tree records from past years where Is_active = True and Tree_status='F' (fallen) or 'D' (dead) with Tree_position='U' (uprooted)
qa_p982_Tree_status_transition_matrix	Warning	Matrix showing tree status from past years for all trees, useful for looking for inconsistencies or illogical transitions
qa_x101_Locations_without_coordinates	Critical	Sampled locations without any coordinate records - all sampled locations must have at least one coordinate record (including previous sample years)
qa_x111_Locations_with_more_than_one_coord	Critical	Locations with more than one coordinate record per sampling date - only one is permitted per event, and this implies duplicate events
qa_x121_Coordinates_missing_final_UTMs	Critical	Coordinate records missing final UTMs, datum or coord_type
qa_x131_Coordinates_final_UTM_inconsistencies	Critical	Final UTM coordinates are incomplete; or they are present and the coordinate type or datum is missing; or coord type or an estimated error value is present and the final coordinates are missing
qa_x141_Coordinates_final_UTMs_not_in_NAD83	Critical	Coordinate records where final UTM coordinates are not in NAD83
qa_x152_Coordinates_duplicates_on_final_UTMs	Warning	Returns instances where more than one location shares the same final UTMs
qa_x161_Coordinates_missing_GIS_data	Critical	Coordinate records that need to have environmental data (elevation, slope, aspect) sampled from the GIS

Table 15.1. Database queries used to validate data during the annual data quality review (continued).

Query Name	Type	Description of Records Returned
qa_x171_Locations_no_best_coordinates	Critical	Locations where no best coordinates have been assigned - each location should have one and only one record identified as best
qa_x181_Locations_more_than_one_best_coord	Critical	Locations with more than one best set of coordinates - each location should have one and only one record identified as best
qa_x191_Locations_missing_public_UTMs	Critical	Locations missing public coordinates - all locations that have sampling events should have public coordinates and the public offset descriptor field populated
qa_x201_Coordinates_public_UTM_inconsistencies	Critical	Public UTM coordinates are incomplete or have the wrong number of digits; or they are present and the public offset is missing; or public offset is present and the public coordinates are missing
qa_x211_Locations_without_target_coords	Critical	Locations missing target coordinate records
qa_x221_Target_coord_errors	Critical	Target coordinates with incomplete UTMs, the wrong number of digits, missing datum, or illogical created/updated dates
qa_x231_Target_coords_not_in_NAD83	Critical	Target coordinate records that are not in NAD83

Using the Quality Review Tool

Open the front-end database application and hit the button labeled “QA checks” to open the quality review form. Upon opening, the quality review form automatically runs the validation queries and stores the results in a back-end database table (tbl_QA_Results). Each time the query results are refreshed, the number of records returned and the run times are updated so that the most recent result set is always available. Reviewer name and remedy descriptions are retained between query runs. Together, these results form the basis of documentation in the certification report output as shown below.

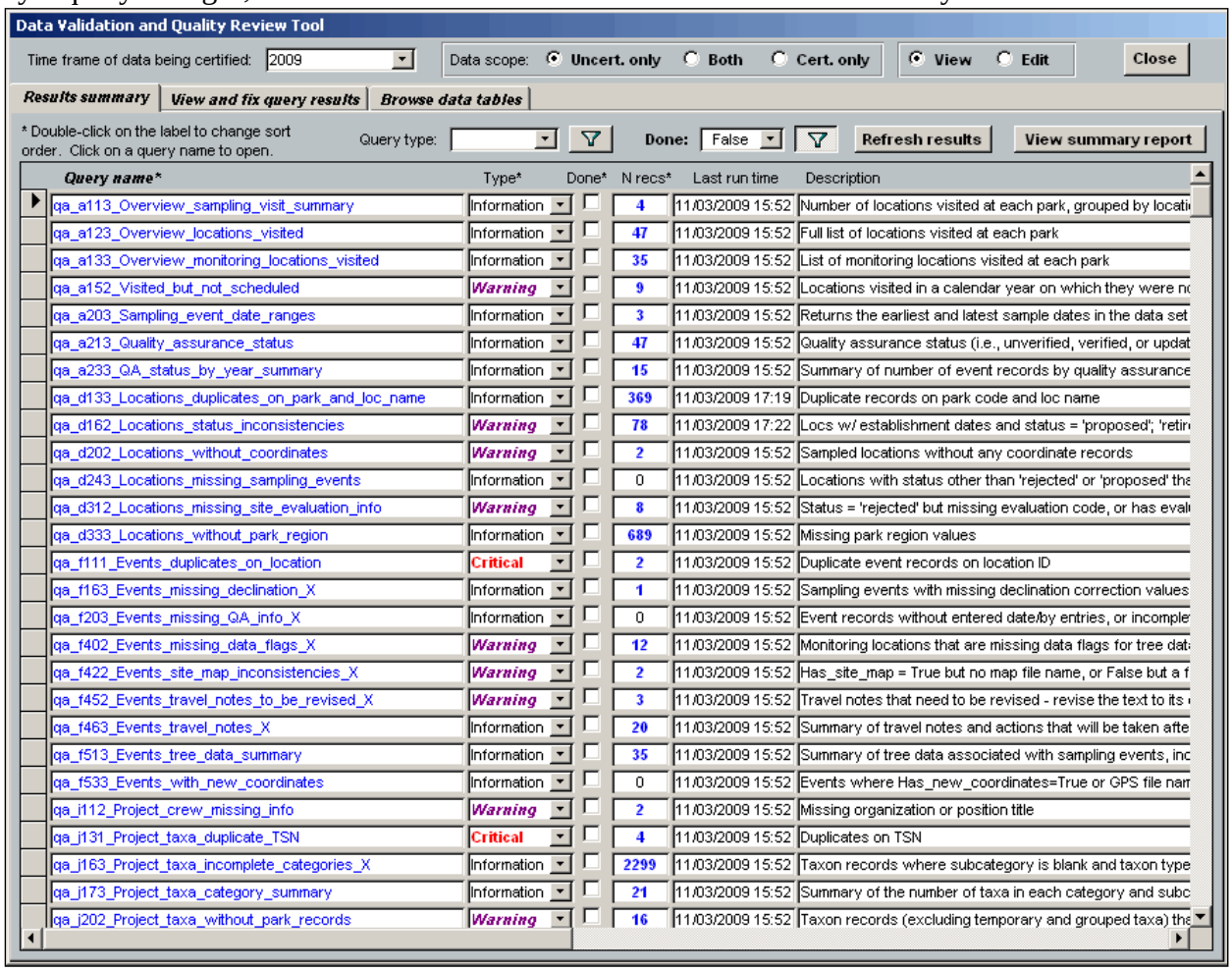
Across the very top of the form are indicators of the time frame (i.e., sample year) and scope of the data being validated. Data scope has three options:

- Uncertified data only (default) – Only uncertified events (i.e., those from the current sampling year) will be considered in validation queries. Note that by design, certain queries will evaluate for problems in records are associated with certified data anyway – for example, all location records are evaluated for duplicate location codes, even those associated only with certified sampling events.
- Both uncertified and certified data – All database records will be included, including certified event data from previous years.
- Certified data only – Only certified events from previous seasons will be considered in the validation queries.

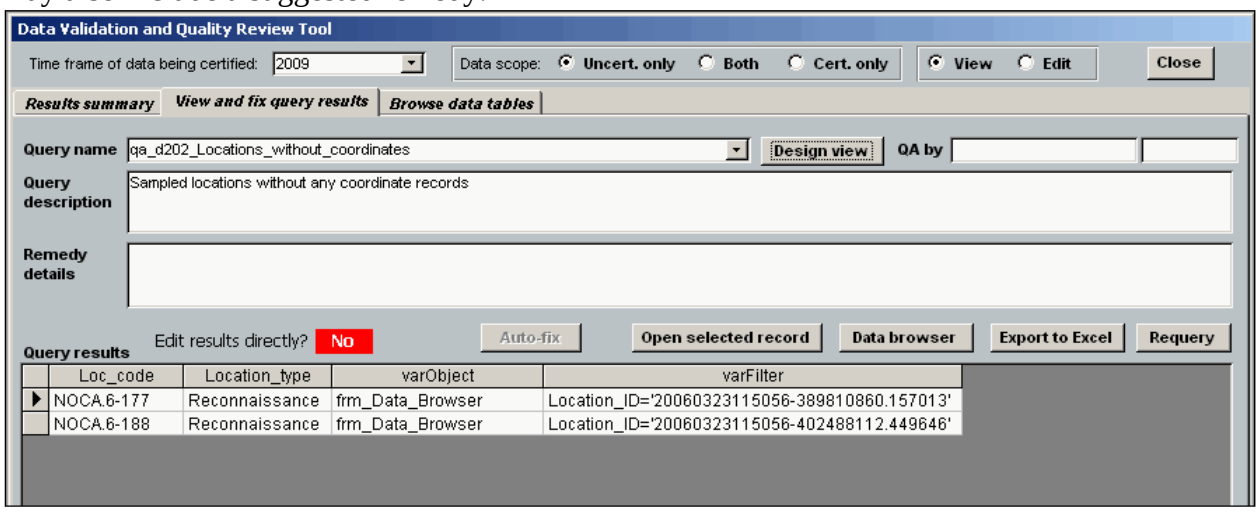
Changing the data scope will show only results for that scope – in other words, results and fixes associated with one scope will be retained even if the scope is changed and the results are refreshed.

The first tab of the quality review form contains a results summary showing each validation query, the type of query (i.e., Critical, Warning or Information), the number of records returned by the query, the most recent query run time, and the description. At the top of the page, there is a button for refreshing the full set of 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. Records default to sort by query name, but can be sorted by double-clicking on any of the column headings indicated with an asterisk.

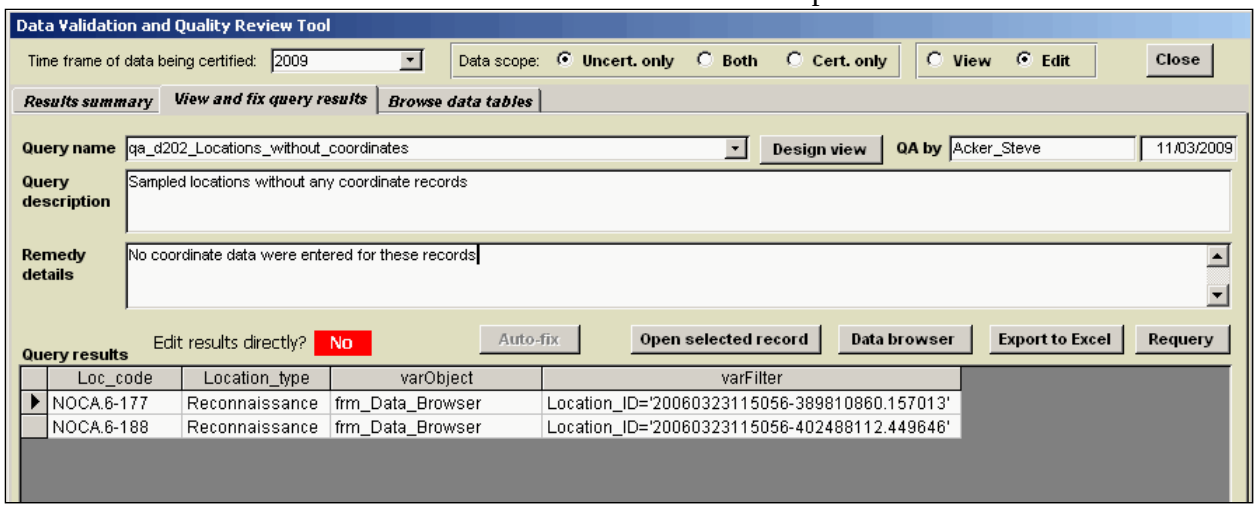
There is also a "Done" checkbox that the reviewer can use as an indicator that they are finished looking at that particular query. Critical and Warning queries that return zero records from the start are automatically set to "Done". The results records may be filtered by query type and/or by whether or not the query has been marked as "Done". Note that updating records in one query may change the number of records returned by another query; if the number of records returned by a query changes, the "Done" indicator will be switched off automatically.



Upon double-clicking a particular query name, the second page will open up to show the results from that query. The "Query description" field will indicate the kind of records returned, and may also include a suggested remedy.



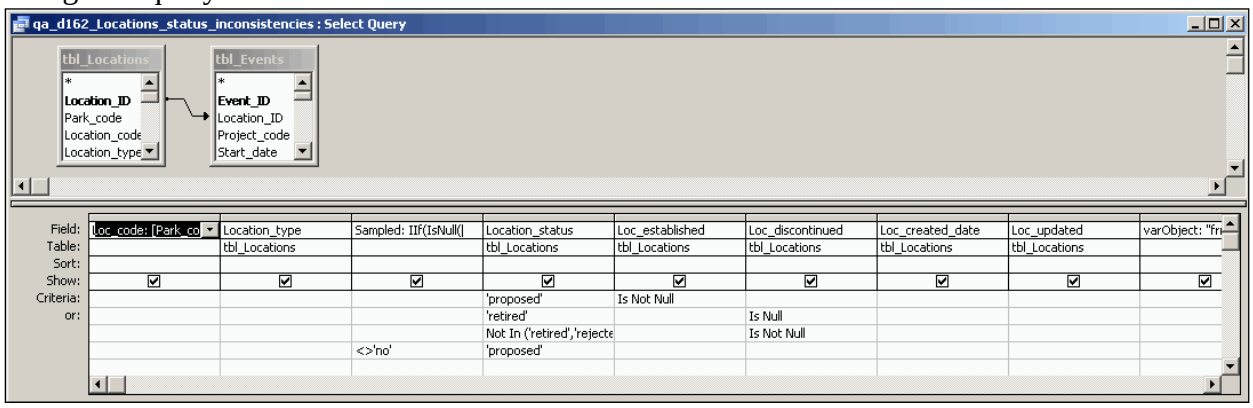
In the upper-right is a switch that allows the user to put the form in either view mode (default) or edit mode. Upon changing to edit mode, the form changes color to provide a visual reminder that edits are possible. At this point the query results may be modified and any documentation may be entered in the "Remedy details" section. If certain records in a query result set are not to be fixed for whatever reason, this is also the place to document that. Reviewer name is automatically filled in (if it was blank) once the user updates the documentation. If the reviewer does not have sufficient information to fix one or more records returned by a query, s/he should describe which records were not fixed and why. If there are numerous records that cannot be fixed, a general description such as "80 records" or "All reconnaissance sites, 43 records", along with a statement of why these were not fixed, will suffice. Documentation will help future data users to know that reasonable efforts were made to address the problems.



Some of the other functions of this second page of the Quality Review Tool:

- Edit results directly? – A flag to indicate whether the results for the selected query can be edited directly inside the query results subform. Queries that contain complex joins, subqueries, or grouping functions cannot be edited directly, and instead must be edited in the original data entry form.
- Auto-fix – A button that runs an action query for bulk updates if such a solution is appropriate and available (e.g., replacing all missing values with a code for "Unknown"). Not all validation queries contain references to a bulk update query.
- Open selected record – Opens the selected record returned by the query in the appropriate form. This is useful for quickly moving to the place where the fix can be made most efficiently, and taking advantage of existing quality assurance functionality.
- Data browser – Opens the Data Browser form, which provides comprehensive access to data arranged by sampling location.
- Export to Excel – Exports the validation query results to Excel. This can be helpful when there is a need to follow up on complex problems or to verify that all data have been entered.
- Requery – Reruns the validation query and updates the results set.

On this page is also a button labeled “Design view”, which will open the currently selected query in the design interface in Access. In this manner, the user can verify that the query is in fact filtering records appropriately. Note: Please contact the Data Manager before making any changes to query structure or names.



Finally, the third page of the Quality Review Tool is for viewing and editing data tables directly if needed. This page is only available for those with power user or administrator privileges to the database. 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 many of the quality assurance measures built into the 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.

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 outlined above; 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 the primary person responsible for completing an NCCN Project Data Certification Form, available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. This brief form should be submitted with the certified data according to the timeline in **Appendix B: Yearly Project Task List**. Refer to **SOP 16: Product Delivery, Posting and Distribution** for delivery instructions.

Generating Output for the Certification Report

The first page of the Quality Review Tool 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.

Quality Assurance and Data Validation Results

Data timeframe (season/year): 2009 **Scope:** Uncertifed events only **Report run time:** 11/03/2009 17:25

	Query name	Type	N Records	Query description	Remedy details	QA by
1	qa_a102_Overview_locs_with_multiple_events	Warning	0	Locations with more than one associated sampling event in a sampling year		
2	qa_a113_Overview_sampling_visit_summary	Information	4	Number of locations visited at each park, grouped by location type		
3	qa_a123_Overview_locations_visited	Information	47	Full list of locations visited at each park		
4	qa_a133_Overview_monitoring_locations_visite	Information	35	List of monitoring locations visited at each park		
5	qa_a142_Scheduled_but_not_visited	Warning	0	Scheduled sample locations that were not visited in the year scheduled		
6	qa_a152_Visited_but_not_scheduled	Warning	9	Locations visited in a calendar year on which they were not scheduled (after 2007)		
7	qa_a203_Sampling_event_date_ranges	Information	3	Returns the earliest and latest sample dates in the data set		
8	qa_a213_Quality_assurance_status	Information	47	Quality assurance status (i.e., unverified, verified, or updated) of all sampling events in the data set		
9	qa_a222_Unverified_events	Warning	0	List of unverified sampling events in the data set		
10	qa_a233_QA_status_by_year_summary	Information	15	Summary of number of event records by quality assurance status		
11	qa_b101_Strata_missing_critical_info_X	Critical	0	Missing park code, project code, stratification date, stratum name, or stratum definition		
12	qa_b111_Strata_duplicate_records	Critical	0	Duplicate records on park code, project code, stratification date, and stratum name		
13	qa_b121_Strata_illogical_dates_X	Critical	0	Stratum record updated date prior to created date		
14	qa_d101_Locations_missing_critical_info	Critical	0	Missing park code, location code, location type, location status, stratum ID, or firing order		

SOP 16: Product Delivery, Posting and Distribution

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Updated dates to be in alignment with the task list in Appendix B. Removed line for voucher specimens as these are not collected in normal operations.	Updating content in response to peer review and changes to response design.
May 2010	J. Boetsch	Replaced references and hyperlinks to NPS Data Store, NatureBib, and NPSpecies with updated information.	NRInfo (or Natural Resource Information Portal) is the current name for the combined information system.

Overview

This SOP provides a schedule, product specifications, and instructions for delivering completed data sets, reports and other project deliverables for long-term storage (Table 16.1). Details are also provided on posting products to websites and clearinghouses, and on responding to data requests.

Product Delivery Schedule and Specifications

Table 16.1. Schedule and instructions for project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Delivery Instructions
Field season report	Crew Lead	September 15 of the same year	Upload digital file in Microsoft Word format to the NCCN Digital Library.
Raw GPS data files	Crew Lead	September 15 of the same year	Zip and send all digital files to the GIS Specialist.
Processed GPS data files	GIS Specialist	October 15 of the same year	Zip and upload raw and processed files to the NCCN Digital Library.
Digital photographs	Project Lead	November 30 of the same year	Organize, name and maintain photographic images in the project workspace according to **SOP 12: Managing Photographic Images**.
Certified back-end database	Project Lead	November 30 of the same year; data are not posted to public sites until June of the second year	Refer to the section in this SOP 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 NRInfo [1] and the NCCN Digital Library.
Annual I&M report	Project Lead	Apr 30 of the following year	Refer to the section in this SOP on reports and publications.
5-year analysis report	Project Lead and Data Analyst	Every 5 years by September 1 of the following year	
Other publications	Project Lead and Data Analyst	as completed	
Field data forms	Project Lead	April 30 of the following year	Scan original, marked-up field forms as PDF files, zip and upload to the NCCN Digital Library. Hard copy originals go to the Park Curator for archiving 6 years after data collection.
Other records	Project Lead	review for retention every January	Retain or dispose of records following NPS Director's Order 19 [2]. Organize and send analog files to Park Curator for archiving. Digital files that are slated for permanent retention should be uploaded to the NCCN Digital Library.

[1] NRInfo is the agency's internet clearinghouse for natural resource data and metadata (http://nrinfo.nps.gov/home.mvc). Only non-sensitive information is posted to NRInfo. Refer to the section on sensitive information in **Section 4J, Identifying and Handling Sensitive Information** for more information.
[2] 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

NCCN Digital Library

The NCCN Digital Library is a hierarchical document management system maintained on the NCCN servers. NPS users have read-only access to these files, except where information sensitivity may preclude general access.

Contents of the NCCN Digital Library can be viewed from within the NPS firewall at: http://www.nccn.nps.gov/im/library/index.aspx. Documents may be uploaded by network users through the NCCN team site: http://www.nccn.nps.gov/im/library/documents1.aspx.

Upon uploading files to the Digital Library, the upload page will request the following information about the uploaded files to enable filing and searching:

- Document title
- Project code (e.g., "VCa02" for Forest Vegetation Monitoring)
- Park(s) to which the file(s) apply; multiple parks may be selected for each upload
- Document type (e.g., formal report, database, protocol, etc.)
- Document topic (e.g., Coastal/Marine Systems)
- Date of publication or last revision
- Author name(s)
- Sensitivity: Sensitive, NPS Only, or Public. Sensitive files will not be viewable without permission. For a definition of sensitive information, see **Section 4J, Identifying and Handling Sensitive Information**.
- Description - Document abstract, additional authors and credits, special use instructions, etc.

For project staff without access to the NPS intranet, files may be sent by email or CD/DVD to the NPS Lead or Data Manager for upload, along with the above information in a text file or accompanying email.

Park Collections

The collections at OLYM will serve as the park of record for the Forest Vegetation Monitoring Project. Voucher specimens, hardcopy field forms, and printouts of annual reports, technical reports, and other publications will be filed there. In addition, other hard copy project records should be reviewed and organized on an annual basis (or at the conclusion of a project), and sent to park collections for long-term storage.

The Project Lead should contact the Park Curator during the project planning if voucher specimens will be collected. All specimens must be labeled with NPS accession and catalog numbers, and with advance notice the Park Curator can help to provide these numbers ahead of time so they can be included in label printouts. Specimen label information will be entered by the Park Curator into the ANCS+ database. The Park Curator will help to decide which and how many specimens can be maintained at the park versus sent to another institution or collection. Collected materials remain NPS property even if they later reside in a non-NPS collection (e.g., university herbarium).

Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates that the data: 1) are complete for the period of record; 2) have undergone and passed the quality assurance checks; and 3) 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 15: Data Quality Review and Certification**.

The following deliverables should be delivered as a package:

- Certified back-end database – Database containing data for the current season that has been through the quality assurance checks documented in **SOP 15: Data Quality Review and Certification**. Delivery of this item is only applicable in cases where the back-end database is implemented in Microsoft Access and/or is deployed outside the NPS firewall during the quality review. In all other cases, the Data Manager will already have access to the certified data.
- Certified geospatial data – GIS themes in ESRI coverage or shapefile format. Refer to NCCN GIS Development Guidelines (NCCN 2007a) and NCCN GIS Product Specifications (NCCN 2007b) for more information.
- Data certification report – A brief questionnaire in Microsoft Word that describes the certified data product(s) being delivered. A template form is available on the NCCN website at: http://science.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://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. For more information, refer to **Section 4F, Metadata Procedures**.

After the quality review is completed, the Project Lead should package the certification materials for delivery as follows:

1. Create a compression file (using WinZip® or similar software, or by right-clicking in Windows Explorer). This file should be named in accordance with general file naming standards, and the name should include the project code ("VCa02") and the year or span of years for the data being certified. For example: VCa02_2009_certification_pkg.zip.
2. In cases where the back-end database is implemented in Microsoft Access and/or is deployed outside the NPS firewall during the quality review:
   a. Open the certified back-end database file and compact it (in Microsoft Access version 2003 and earlier, 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 (e.g., MIa01_Intertidal_MIa01_be.mdb).
   b. Add the back-end database file to the compression file.
   c. Note: The front-end application does not contain project data and as such should not be included in the delivery file.
3. Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the file naming standards described in **SOP 1: Project Workspace and Records Management**.
4. Add any geospatial data files that are not already in the possession of the GIS Specialist. Geospatial data files should be developed and named according to NCCN GIS Naming Conventions (NCCN 2007c).
5. Deliver the compressed file containing all certification materials to the Data Manager by placing it in the Data folder of the project workspace and notifying the Data Manager by email. If the Project Lead does not have network access, then certification materials should be delivered as follows:

a. If the compressed file is under 9.5 mb in size, it may be delivered directly to the Data Manager by email.
b. If the compressed file is larger than 9.5 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 **Section 4J, Identifying and Handling Sensitive Information**).

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. Check in the delivered products using the NCCN project tracking application.
3. Notify the GIS Specialist if any geospatial data are delivered. The GIS Specialist will then review the data, and update any project GIS data sets and metadata accordingly, and post those products to the NCCN Digital Library.
4. Work with the GIS Specialist to finalize coordinate data in the database, generate public coordinates (as applicable – see **Section 4J, Identifying and Handling Sensitive Information**), and update any GIS-derived data fields therein (e.g., elevation, slope, aspect).
5. Upload the certified products to the NCCN Digital Library.
6. Merge the certified data into the master project database, if applicable.
7. Notify the Project Lead that the year's data have been successfully reviewed and processed. The Project Lead may then proceed with data summarization, analysis and reporting.
8. Develop, parse and post the XML metadata record to NRInfo.
9. After a holding period of two years, the Data Manager will upload the certified data to NRInfo. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected data quality problems.

No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to NRInfo 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.

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. These templates and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

The procedures for annual reports, technical reports, and publications are as follows. (Note: This is optional for field season reports, which are intended to be internal communications only.)

1. The Project Lead or Data Analyst formats the document according to the NPS Natural Resource Publications standards.
   a. Formatting according to NPS standards is easiest when using the report template from the very beginning, as opposed to reformatting an existing document.
   b. When creating the file, use appropriate naming standards (described in this document), and add "DRAFT" to the file name.
   c. Open the document and add "DRAFT" to the header or document watermark as appropriate.
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 project work group. The Network Program Manager will also review all annual reports for completeness and compliance with I&M standards and expectations. Before sending the document for review, rename the document by adding a date stamp to the end of the file name using the YYYYMMDD format.
3. Upon completing the peer review, the Project Lead should acquire a publication series number from the appropriate regional or national key official. Instructions for acquiring a series number are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.
4. The Project Lead should finalize the document:
   a. Ensure that the publication/version date (last saved date field code in the document header, if used) and file name (field code in the document footer, if used) are updated properly throughout the document.
   b. Remove the word "DRAFT" from watermarks, document headers, and file name.
   c. Remove any previous date stamp from the file name.
   d. 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.
   e. Create a PDF version of the document and upload the PDF copy to the NCCN Digital Library at: http://www.nccn.nps.gov/im/library/documents1.aspx.
   f. Store both the Word document and PDF copy in the appropriate section of the project workspace (see **SOP 1: Project Workspace and Records Management**).
5. Notify the Park Curator and Data Manager that the report is available, and send a printout to the Park Curator to add to the host park collections.
6. The Data Manager (or a designee) will create a bibliographic record and upload the PDF copy to Reference according to document sensitivity.

File Naming Standards

Prior to delivering or uploading digital products, files should be named according to the naming conventions appropriate to each product type.

Reports and Publications

- 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.
- As appropriate, include the project code (e.g., "VCa02"), network code ("NCCN") or park code, and year in the file name.

Examples:

- NCCN_VCa02_2010_Annual_report.pdf
- NCCN_VCa02_2010_Field_season_report.doc
- NCCN_VCa02_2010_Certification_report.doc

Other Files

General naming standards as described in **SOP 1: Project Workspace and Records Management** apply to all deliverables. When delivering files to the Digital Library, file names should be modified as needed to include the project code (e.g., "VCa02"), network code ("NCCN") or park code, and year as appropriate (e.g., NCCN_VCa02_2010_cert_package.zip). Specific standards for images are described in **SOP 12: Managing Photographic Images** and in **SOP 18: Revising the Protocol** for protocol documents.

Product Posting

Once digital products have been delivered and processed, the Data Manager or a designee will post them to or otherwise update the following applications to make them generally available:

1. NRInfo is the agency's internet clearinghouse for natural resource data and metadata, also known as the Natural Resource Information Portal (http://nrinfo.nps.gov/home.mvc). Only non-sensitive information is posted to NRInfo. Refer to the section on sensitive information in **Section 4J, Identifying and Handling Sensitive Information** for more information. Full metadata records will be posted to NRInfo as they are created; data sets will be posted after a two-year hold to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems.

2. Reference is a module of NRInfo that contains NPS bibliographic data related to natural resources (http://nrinfo.nps.gov/home.mvc). This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record. For reports and other publications, a record will be created after first verifying that a record does not already exist. The digital report file in PDF format will then be uploaded and linked to the Reference record.

3. NPSpecies is a module of NRInfo used to maintain park-specific species lists and observation data (http://nrinfo.nps.gov/home.mvc). Species observations will be extracted from project data sets and uploaded into NPSpecies.

4. NCCN Web Site is maintained by NCCN staff as part of the NPS Inventory and Monitoring web site (http://science.nature.nps.gov/im/units/nccn) to describe our program, the vital signs selected for monitoring, and to highlight certain products and information derived from inventory and monitoring work at NCCN. The site has both internet and intranet components. Select products such as annual reports and technical reports will be posted to the web site.

These 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 two-year holding period before posting or otherwise distributing certified project data. This means that certified data sets are first posted to publicly-accessible websites (i.e., NRInfo) approximately 24 months after they are collected (e.g., data collected in June 2010 becomes generally available through NRInfo in June 2012). In certain circumstances, and at the discretion of the Project Lead, data may be shared before a full two years have elapsed.

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.

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:

- For all Inventory and Monitoring projects in NCCN, 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.
- The 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 (e.g., information about the specific nature or location of protected resources) may be posted to NRInfo 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 **Section 4J, Identifying and Handling Sensitive Information**.
- For quality assurance, only certified, finalized versions of data sets should be shared with others. In exceptional cases where a provisional data set needs to be shared with others prior to certification:
  - Any accompanying communications should clearly indicate that the data set is provisional and subject to change according to our quality review process.
  - File names and the media it is sent on should be clearly labeled as containing provisional data not for distribution.

The Project 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 if s/he is needed to facilitate fulfilling the request in some manner.
3. Respond to the request in an official email or memo.

4. In the response, refer the requestor to NRInfo (http://nrinfo.nps.gov/home.mvc), 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 (e.g., writing data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.
5. It is recommended that documents and presentation files be converted to PDF format prior to distribution. This is to maximize portability and to reduce the ability for others to alter and redistribute files.
6. If the request is for data that may reveal the location of protected resources, refer to the next section in this document about sensitive information and also to **Section 4J, Identifying and Handling Sensitive Information**.
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)

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The Project 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 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 products containing sensitive information are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (i.e., the full data set that includes sensitive information) may be shared only after a confidentiality agreement has been established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to **Section 4J, Identifying and Handling Sensitive Information** for more information.

Literature Cited

North Coast and Cascades Network – National Park Service. 2007a. GIS Development Guidelines. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

North Coast and Cascades Network – National Park Service. 2007b. GIS Product Specifications. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

North Coast and Cascades Network – National Park Service. 2007c. GIS Naming Conventions. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

SOP 17: Sensitive Information Procedures

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Corrected a mistake in the Excel offset equations on page 4.	Previous edition of the SOP omitted a radians function.
May 2010	J. Boetsch	Minor revision to list of database objects to clear before sharing data.	Amended and corrected out of date information.

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 (available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm).

These guidelines apply to all NCCN staff, cooperators, contractors, and other partners who are likely to acquire or otherwise have access to information about protected NPS resources. The Project 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 likely to contain sensitive information from released data set copies.

What Kinds of Information Can and Cannot 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 (e.g., 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 is also revealed (e.g., 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. Delete all data from the following database objects to ensure consistent omission of fields that may contain specific, identifying information about locations of protected resources:
   a. tbl_Coordinates – delete all records
   b. tbl_GPS_Info – delete all records
   c. tbl_Locations – Travel_notes, Location_desc, and Location_notes
   d. tbl_Target_Coords – Target_UTME and Target_UTMN

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 (e.g., 1:100,000 maximum scale).

If a large-scale, close-up map is to be created using exact coordinates (e.g., 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 (e.g., 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 (e.g., 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 16: Product Delivery, 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 (e.g., information about the specific nature or location of protected resources) may be posted to NRInfo 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 (e.g., a research scientist at a university), the unedited product (e.g., 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 16: Product Delivery, 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 should also specify the file(s) containing sensitive information.
- If the products are being sent on physical media (e.g., 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 Project Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Literature Cited

National Park Service. 2006. Management Policies. Retrieved May 5, 2010, from: http://www.nps.gov/policy/mp/policies.html.

SOP 18: Revising the Protocol

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Oct 2009	J. Boetsch	Significant changes to revision procedures. Added section and diagram on document life cycle.	Updated content to reflect current best practices.

Overview

This SOP describes 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 conventions 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 operations.

Peer Review

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 edits require review for clarity and technical soundness. Small changes to existing documents – e.g., formatting, simple clarification of existing content, minor changes to the task schedule or project budget, or general updates to information management SOPs – may be reviewed in-house by project and NCCN staff. However, changes to data collection or analysis techniques, sampling design, or response design are usually more significant in scope and impact and will typically trigger an outside review to be coordinated by the Pacific West Regional Office of the National Park Service.

Document Life Cycle

Protocol documents may be maintained as separate files for each component (e.g., narrative, SOPs, appendices in separate document files) or unified into a single document file. During its life cycle, each document file can be classified in one of six life cycle stages:

1. Draft documents – Documents that have been drafted or revised but have not been reviewed and approved yet.
2. Review documents – Draft documents that have been sent out for peer review or administrative review.
3. Active documents – The current, reviewed and accepted version of each protocol component in Microsoft Word format. These documents have been reviewed and approved at the appropriate level, and are currently implemented for active monitoring projects.
4. Inactive documents – Older versions of approved protocol components that are no longer in active implementation.
5. Archived documents – Comprehensive set of active protocol components plus older, inactive versions of approved protocol components in Microsoft Word format. These are stored as read-only and have a date stamp to identify their approval date. The history of the protocol versions through time should be entirely traceable from within the document archive.
6. Distribution copies – PDF versions of approved, date-stamped protocol components, used to post to websites or otherwise share outside NPS.

Protocol documents are stored in the project workspace in separate subfolders named for each life cycle stage, except for inactive documents which are filed together with date-stamped copies

of active documents in the archive folder. See **SOP 1: Project Workspace and Records Management** for additional details about the project workspace.

Document Versioning Conventions

Rather than using a sequential numeric versioning convention, we use date stamps to distinguish document versions because they are more intuitive and informative than version numbers. Date stamps are embedded within the document header, and also included in the document name.

Document Header

Within each document, the upper right section of the document header should show the date that the document was last saved. By using save date instead of current date, printouts and document previews will show the correct version number. The following is the field code to be used within the header to indicate the version number:

"{ SAVEDATE \@ "MMMM d, yyyy" * MERGEFORMAT }"

File Naming Conventions

All documents *except for active documents and draft documents* should include the last edit date as a suffix, using the YYYYMMDD format so that documents will sort by date rather than month or day (e.g., NCCN_Forest_Protocol_DRAFT_20090923.doc for the review draft on 9/23/2009).

Active documents and draft documents that have not been shared with others (as review documents) should not include the date because – unlike documents in other life cycle stages – they are not "point in time" document snapshots. By omitting the date stamp from these documents, they can more easily be distinguished from review drafts and archive or distribution copies. Draft documents should clearly contain the word "DRAFT" in the file name.

Note: General file and folder naming conventions are described in **SOP 1: Project Workspace and Records Management**; these should be followed when naming protocol document files.

Revision Procedures

Proposed changes to protocol components should be discussed among project staff prior to making modifications. It is especially 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 the continuity of the data set in mind. Because certain changes 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 agreed-upon changes and in what timeframe.

Note: 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 sections of the protocol. The project task list and other appendices also may need to be updated to reflect changes in timing or responsibilities for the various project tasks.

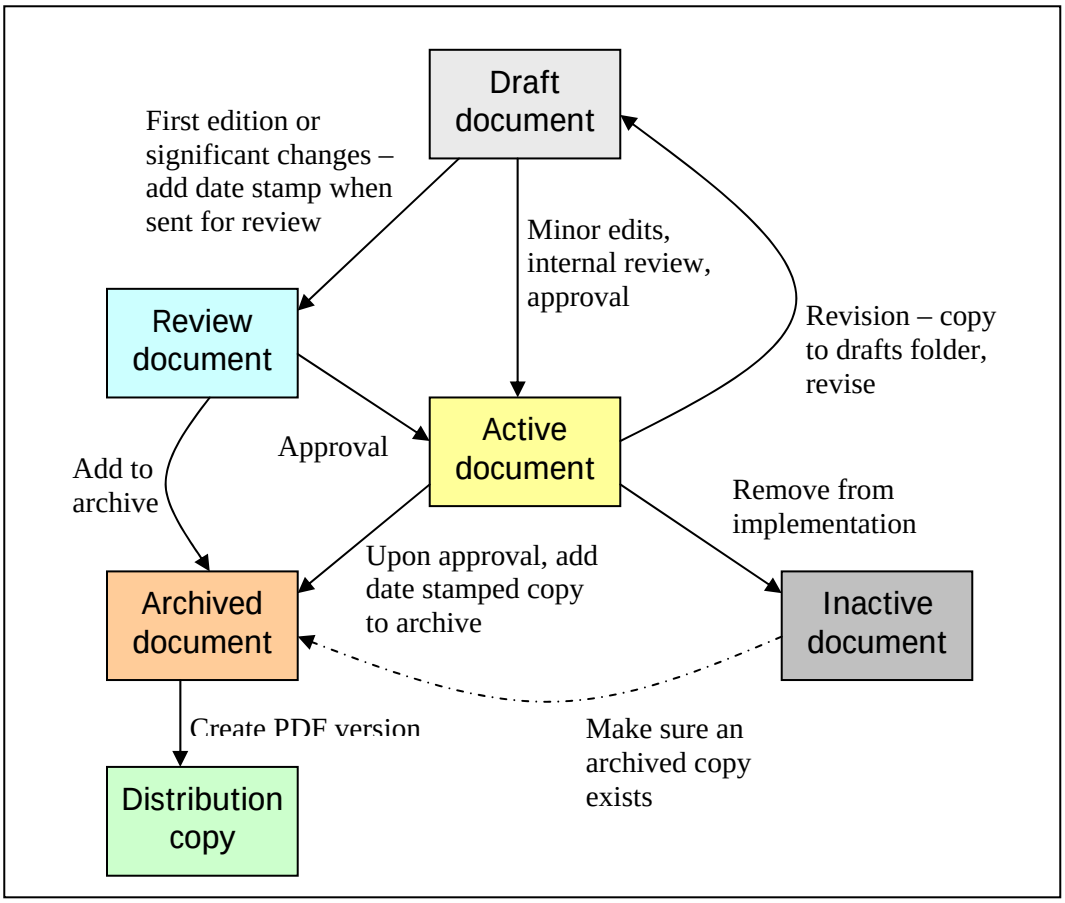


Figure 18.1. Process for creating and revising protocol documents. Boxes represent document life cycle stages, and connecting arrows indicate procedures.

The Project Lead is the primarily responsible for making edits and ensuring document review at the appropriate level. The process for creating and revising protocol documents is shown in Figure 18.1, and outlined below:

1. Create the draft document in Microsoft Word format. If modifying an existing document (usually an active document), copy the document to the draft document folder, remove any date stamp from the name. Add "DRAFT" to the file name. Open the document and add "DRAFT" to the header or document watermark as appropriate.

2. Track revision history. If modifying an existing document, document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes only for the section of the document being edited (i.e., if there is a change to an SOP, log those changes only in the revision history log for that SOP). Record the date of the changes (i.e., 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.

3. Document review. Circulate the changed document for internal review among project staff and cooperators. If the changes are significant enough to trigger peer review (as defined above), create a review document by adding a date stamp to the end of the file name using the YYYYMMDD format, copy the file to the archive folder, and submit the document for peer review according to current instructions.

4. Finalize and archive. Upon approval and final 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, if used) are updated properly throughout the document.
   b. Move the approved document to the active folder. Remove the word "DRAFT" from watermarks, document headers, and file name. Remove any previous date stamp. This is now an active, implemented document.
   c. 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.
   d. Create a copy of the file and add the revision date to the end of the file name using the YYYYMMDD format. Move this copy to the archive folder.
   e. Inform the Data Manager so the new version number can be incorporated into the project metadata.

5. Create distribution copies. As needed, create a PDF version of the archived document to post to the internet and share with others. These PDF versions should have the same date-stamped name as the archived Microsoft Word file. Post the distribution copy to the NCCN Digital Library (http://www.nccn.nps.gov/im/library/documents1.aspx) and forward copies to all individuals who had been using a previous version of the affected document.

6. Remove from implementation. If it is decided that a document needs to be removed from implementation – either because it is no longer necessary (e.g., an unneeded SOP), or because it has been superseded by a more recent version – this can be easily done by removing the document from the active document folder, after first checking that a copy of that version already exists in the archive folder.

Appendixes



Subalpine fir forest near South Pass, NOCA.

Appendix A. Administrative History

Recent history of the North Coast and Cascades Network (NCCN) monitoring program provides essential context for understanding our approach to forest monitoring. From the late 1990s until 2007, USGS and NCCN personnel devoted considerable time and energy to developing a robust protocol to detect changes in the composition of forest understory vegetation in the face of climate change and other stressors (Woodward et al. 2009). However, as costs escalated for NCCN and the monitoring budget remained constant, the network was forced to develop a new model for funding in 2007 which guarantees funding for a small number of protocols and funds others on a provisional basis. Also in 2007, the network held a meeting that combined an operational review of the monitoring program by a national scientific panel with the delivery of completed protocols from USGS to NCCN, marking the conclusion of the formal involvement of the USGS in network monitoring operations.

In April of 2008, the NCCN Board of Directors announced their decision concerning which monitoring protocols would receive secure funding, and which ones would be in the group with provisional funding. Forest monitoring was placed along with other vegetation monitoring in the group receiving provisional funding. In June of 2008, the national scientific panel reported its findings from the November, 2007 meeting. They stated that the forest monitoring protocol was too intensive and needed to be modified and reduced in scope.

In early 2008, the NCCN vegetation group agreed that limiting the focus to tree demography (recruitment, growth, and mortality) would yield critical information about forest dynamics and had the potential to be financially sustainable under the network's new model. A recent publication from the Sierra Nevada (van Mantgem and Stephenson 2007) had shown significant trends in tree mortality, with a sampling design in many ways similar to the set of plots NCCN planned to have established by the end of the 2008 field season. The sample design for forest monitoring in NCCN had been based on the goal of detecting changes in understory species, with tree demography as an important, subsidiary goal. Tree demography now became the essence of the protocol, with understory monitoring suspended indefinitely. Differences between the version of the protocol published by USGS (Woodward et al., 2009) and the version submitted to the NPS Administrative Review in January, 2009 are summarized in Table A.1. The revision log for the narrative for the protocol is contained in Table A.2.

If USGS and NCCN had begun with a focus on tree demography, we may have pursued a different sampling design. However, we were able to take advantage of the substantial effort expended between 2005 and 2007 to generate a stratified random sample of potential locations for monitoring plots, screen locations in the office and in the field, and establish monitoring plots. The statistical validity (and power) of the sample design remains, although the emphasis has changed.

It is important to note that we have evaluated statistical power for tree mortality for only two of the three sampling strata (TerraStat 2008). We were unable to assess power for the 1500-1800 m elevation stratum due to our inability to obtain relevant reference data on annual variability of tree mortality. We propose to assess the power of the design after we have accumulated 10 years of annual observations.

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol.

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
List of Authors		Revised order to reflect contributions to work on the document since completion of USGS version.
Narrative Introduction		Added. Includes brief descriptions of the Vital Signs Monitoring (VSM) program of NPS, development of VSM in the NCCN, and development of forest monitoring as part of VSM in the NCCN.
Narrative 1.A Background and History		Added text to make clearer the connections between forest monitoring and other protocols.
Narrative 1.C Measurable Objectives	The following monitoring parameters were deleted: vascular understory plants; non-vascular plants; epiphytic lichens; large woody debris; forest litter; herbivory. Tree growth was added as a monitoring parameter. Lewis and Clark National Historical Park (LEWI) and San Juan Island National Historical Park (SAJH) were added to the list of NCCN parks where the monitoring will occur.	Deleted the reference to canopy cover as a monitoring parameter.
Narrative 2. Sampling Design	Passages pertaining to the deleted monitoring parameters were deleted. The elevation strata and forest age-classes to be monitored at LEWI and SAJH, and tree species composition to be monitored at LEWI, were identified. Reference to a rotating-panel design with each plot measured for two successive years out of a six-year cycle was deleted. The new temporal design of measuring trees at all plots every five years, and assessing tree mortality annually, was described and explained.	Revised approach to plots which undergo catastrophic disturbance so that they will continue to be monitored if safe and practical. Indicated that plots in addition to the minimum sample size will be added, as a hedge against catastrophic disturbance, as resources allow. Expanded on the explanation for the use of vegetation type as a criterion for plot selection. Identified the target vegetation type for SAJH. Described modifications of protocols for LEWI and SAJH. Stated explicitly that monitoring plots are added in the order generated by GRTS. Added text

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
	The power analysis for assessing tree mortality using the revised temporal design was summarized.	and a table to make the target populations and degree of replication clearer. Added text to captions for Figures 2-4 to explain meaning of shading within elevation bands. Deleted the reference to the assumption that the number of plots for any combination of park and elevation stratum would be a multiple of three. Indicated that we plan to perform a power analysis for forests in the 1500-1800 m elevation stratum after we have accumulated 10 years of data.
Narrative 3. Field Methods	Passages pertaining to the deleted monitoring parameters were deleted. Staffing for fieldwork at LEWI and SAJH was added. The increase in sample intensity for saplings and small trees was described. The new temporal design of measuring trees and assessing recruitment at all plots every five years, and assessing tree mortality annually, was reiterated.	Indicated that the protocol document lacks precise directions to permanent plots to protect their security. Described modifications of protocols for LEWI and SAJH.
Narrative 4. Data Handling, Analysis and Reporting	Passages pertaining to the deleted monitoring parameters were deleted. Descriptions of data reduction and trend detection relevant to tree demography and stand basal area and volume were added. Descriptions of the annual and five-year reports were modified to pertain to tree mortality and the other relevant parameters.	Indicated that we plan to assess the effectiveness of our sampling design based on GRTS and including vegetation type as a criterion for plot selection, after we have accumulated 10 years of data.
Narrative 5. Personnel requirements and training	Passages pertaining to the deleted monitoring parameters were deleted.	
Narrative 6. Operational	Seasonal staffing was changed from two crews of three people to three	

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
Requirements	crews of two people. Description and discussion of the projected budget was modified to emphasize the lower cost in four out of five years, when fieldwork consists solely of assessing tree mortality. Emphasis on the difficulty of sustaining the degree of effort in the face of escalating costs and a fixed budget was reduced. The table containing potential reductions in monitoring effort to reduce costs over time was deleted.	
SOP 1: Workspace Setup and Project Records Management		Added sections for NCCN file workspace setup and workspace maintenance procedures.
SOP 2: Hiring Guidelines and Procedures		Changed order of SOPs (now no. 3); one section was moved to the SOP for Orientation and Training.
SOP 3: Preparation of Information Packets, Schedules, Equipment & Supplies	Revised estimates of time requirements; changed staffing to three crews of two at MORA, NOCA, and OLYM; removed mention of no-longer-needed supplies and equipment.	References to locations in the project workspace were updated; one section was moved to the SOP for Orientation and Training; two SOPs (nos. 3 and 4) from the previous version that both dealt with assembling information for the field season were combined; changed order of SOPs (combined SOP now no. 2).
SOP 4: Preparation of Reports, Datasheets, Maps and Orthophotos	Removed references to SOPs that have been suspended indefinitely; added direction to take plot photographs on tree measurement years only.	References to locations in the project workspace were updated; two SOPs (nos. 3 and 4) from the previous version that both dealt with assembling information for the field season were combined; the Navigation Report was substituted for a photocopy of the previous Event Log as the primary source of information on access to a plot and specific tasks to perform; changed

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
		order of SOPs (combined SOP now no. 2).
SOP 5: Orientation of Field Crew: Park Buildings, Field Preparation, and Safety		Combined SOPs for Orientation and Training; references to locations in the project workspace and other SOPs were updated.
SOP 6: Training Field Crews to Perform Vegetation Sampling	Removed references to SOPs that have been suspended indefinitely; indicated that training will last one week instead of two; indicated that each crew will have two members instead of four.	Combined SOPs for Orientation and Training; deleted description of methods of measuring tree height (redundant with SOP for tree measurements).
SOP 7: Preparing for a Field Tour	Removed 30x handlens from gear list; decreased number of wooden stakes from 72 to 32.	References to locations in the project workspace and other SOPs were updated; updated number of rebar pieces in Table 5.2 (only need 5 for LEWI, SAJH).
SOP 8: GPS Use: Navigation, Data Collection and Downloading		Removed operating instructions for specific GPS models; references to other SOPs were updated.
SOP 9: Reconnaissance Form: Evaluation and Reconnaissance for Plot Selection		References to other SOPs were updated; the citation for the vegetation classification for MORA, NOCA, and OLYM was updated, and the list of target plant associations was updated; LEWI and SAJH were added to the list of parks monitored, and variations in protocol for those two parks were indicated; convention for naming of files containing photographs of plots was changed to make file contents more obvious and facilitate sorting files chronologically.
SOP 10:	Reduced the number of cedar stakes to	Combined SOPs for physically

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
Establishing and Marking Permanent Monitoring Plots	reflect that 1x1 m quadrats will not be established.	installing permanent plots and for recording physical and biotic characteristics of newly-established plots; references to other SOPs were updated; LEWI and SAJH were added to the list of parks monitored, and variations in protocol for those two parks were indicated.
SOP 11: Establishment Form: Recording Physical and Biotic Characteristics	Removed items from the Field Reference Sheet which pertained to understory vegetation and herbivory measurements.	Combined SOPs for physically installing permanent plots and for recording physical and biotic characteristics of newly-established plots; references to other SOPs were updated; LEWI and SAJH were added to the list of parks monitored, and variations in protocol for those two parks were indicated.
SOP 12: Event Log: Recording Plot Visit Details and Taking Digital Photos	Removed references to SOPs that have been suspended indefinitely.	Variations in protocol for LEWI and SAJH were indicated; references to other SOPs were updated; updated Figure 9.1, Plot Event Log form, to reflect new naming conventions for photographs, and to include a default option for plot directions when no changes are needed.
SOP 13: Tree Data: Measuring and Mapping Live and Standing Dead Trees	Added tagging of saplings in selected subplots; added tagging of small trees in 50x50, set minimum snag diameter to 12.7 cm dbh; set interval for dbh measurement and adding ingrowth to five years.	Description of method of measuring tree height with a clinometer was rewritten; variations in protocol for LEWI and SAJH were indicated; distinctions between tree status values L (living), D (dead), S (snag) and F (fallen) made explicit; added table with permissible transitions between values of tree status; added emphasis on difficulties of measuring large trees on slopes, and suggested remedies; references to other SOPs were updated; added explicit criteria for assessing that a tree is alive; added directions for recording attributes of newly-dead trees which may contribute to assigning a cause

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
		of mortality; added directions to record information in Comments field if more than one type of damage or disease may have contributed to tree death; added specific examples of causes of tree death that would be recorded under the categories of 'Weather' and 'Vegetation'.
SOP 14: Vegetation Quadrats: Percent Cover and Tree Sapling Measurements	Deleted.	
SOP 15: Herbivory: Estimating Herbivory on Shrubs in 5 m Quadats	Deleted.	
SOP 16: Down Woody Material: Measuring CWD, FWD, Duff and Litter	Deleted.	
SOP 17: Lichen Survery: Timed Survey of Epiphytic Lichens	Deleted.	
SOP 19: Procedures Following a Field Tour	Removed references to SOPs that have been suspended indefinitely.	References to locations in the project workspace and other SOPs were updated.
SOP 20: Photographic Image Processing and		Revised the image workspace subfolders, processing procedures, and the naming conventions for image files.

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
Management		
SOP 21: Voucher Specimen Identification and Processing	Deleted.	
SOP 23: End of Field Season Debriefing and Close-out	Removed references to SOPs that have been suspended indefinitely.	A reference to a location in the project workspace was updated.
SOP 26: Product Delivery Specifications		Updated dates to be in alignment with the task list in Appendix B. Removed line for voucher specimens as these are not collected in normal operations.
SOP 29: Revising the Protocol		Updated content to reflect current best practices.
Appendix A: Cover Estimation Method Comparison	Deleted.	
Appendix B: Forest Vegetation Monitoring Protocol Database Documentation	Removed fields and tables that pertained to SOPs that have been suspended indefinitely.	
Appendix C: Template for Forest Monitoring Annual Report	Deleted descriptive information and planned analyses that were not longer relevant to indefinite suspension of measurement of understory vegetation and other parameters. Modified tables describing temporal sampling frame, schedule of reporting, and plot visit history to reflect changes in sampling design. Added summary of annual mortality by tree species for each plot.	Target population was added to standard information in the introduction; added text to explain the timing of reporting various quantities in Table D.2; removed labels for sampling strata that referred to vegetation types and replaced them with labels referring to elevation; added tables that illustrate we will report results for individual plots, each combination of park and stratum, and each stratum, in addition

Table A.1. Differences between the USGS, Jan. 2009 NCCN, and Nov. 2009 NCCN versions of the protocol (continued).

Item in USGS version	Changes for Jan. 2009 NCCN version	Additional changes for Nov. 2009 NCCN version
		to the entire set of plots.
Appendix D: Guidelines for Collecting Botanical Specimens	Deleted.	
Appendix E: Conifer Forest and Woodland Plant Associations of Mount Rainier, North Cascades, and Olympic National Parks	A more current version of the list was used, resulting in some minor changes in the nomenclature for a few of the target vegetation types. Two plant associations which were mistakenly omitted from the list of target types (*Pseudotsuga menziesii-Tsuga heterophylla*/*Mahonia nervosa* Forest *Pseudotsuga menziesii-Tsuga heterophylla*/*Mahonia nervosa-Polystichum munitum* Forest) were added to the list.	Extracted a new version of the list from the final, published version of the vegetation classification for MORA, NOCA, and OLYM; added text indicating that plant associations are identified in the field using the key and descriptions in the publication; corrected errors from previous versions of the protocol (two Sitka spruce and one subalpine fir target types were omitted in both previous versions and the Jan. 2009 version incorrectly labeled one subalpine fir type as one of the targets).

Table A.2. Revision log for the protocol narrative.

Revision Date	Author	Changes Made	Reason for Change
May 2010	S. Acker and J. Boetsch	Revised time estimates in Table 5 for Project Lead, Park Plant Ecologists, and Data Manager.	More experience with project indicated prior estimates were inaccurate.
May 2010	S. Acker and J. Boetsch	Combined or eliminated several project stages in Table 5.	Eliminated overlap between stages so that table captures workflow more succinctly.
May 2010	J. Boetsch	Updated data dictionary in Appendix C.	Needed to include a few minor changes made to date.
May 2010	J. Boetsch	Replaced references and hyperlinks to NPS Data Store, NatureBib, and NPSpecies with updated information.	NRInfo (or Natural Resource Information Portal) is the current name for the combined information system.

Literature Cited

Terrastat Consulting Group. 2008. Power analysis for detecting tree mortality in permanent vegetation plots. Unpublished report on file at Olympic National Park.

van Mantgem, P. J. and N. L. Stephenson. 2007. Apparent climatically induced increase of tree mortality rates in a temperate forest. Ecology Letters **10**:909-916.

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

Appendix B. Yearly Project Task List

This table identifies each task by project stage, indicates who is responsible, and establishes the timing for its execution. Protocol sections and SOPs are referenced as appropriate.

Project Stage	Task Description	Responsibility	Timing
Preparation (*Sections 3A, 3B and 4B*)	Initiate announcement for seasonal field crew positions	Project Lead	Dec
	Plan schedule and logistics, identify 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
	Inform GIS Specialist and Data Manager of specific needs for upcoming field season	Project Lead	By Mar 1
	Hire seasonal field crew positions	Project Lead and Park Plant Ecologists	By Mar 15
	Purchase equipment and supplies	Project Lead	By Apr 15
	Ensure that project workspace is ready for use (SOP 1)	Project Lead	By Apr 15
	Update and deploy database application for data entry	Data Manager	By May 1
	Update and load data dictionary, background maps, and target coordinates into GPS units. Make sure that GPS download software is loaded at each park.	GIS Specialist	By May 1
	Prepare and print field maps	GIS Specialist	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. Grant modify access to project workspace once crew user logins are known.	Project Lead	May
	Provide database/GPS training as needed	Data Manager and GIS Specialist	May
	Train field crew in tree measurements, pest and pathogen identification, use of equipment, field sampling protocols, safety, and backcountry travel	Project Lead	May
Data Acquisition (*Section 3C*)	Collect field data during field trips. Review data forms for completeness and accuracy after each field day.	Technicians	May-Sep

Appendix B. Yearly Project Task List (continued)

Project Stage	Task Description	Responsibility	Timing
	Review 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 & Processing (*Section 4C and 4D*)	Download GPS data and email files to GIS Specialist for correction (SOP 6)	Technicians	After each field trip
	Download and process digital images (SOP 12)	Technicians	After each field trip
	Enter data into the database (SOP 13)	Technicians	After each field trip
	Verify accurate transcription from field forms to database as data are entered (SOP 13)	Technicians	After each field trip
	Correct GPS data and send screen capture to Field Crew Lead and Project Lead for review	GIS Specialist	After each field trip
	Review GPS location data and database entries for completeness and accuracy	Field Crew Lead and/or Project Lead	Monthly
	Confirm that data entry is complete, and notify the Project Lead and Data Manager	Field Lead	By Sep 15
	Complete field season report, send to Project Lead, Park Plant Ecologists, Data Manager, and GIS Specialist	Field Crew Lead	By Sep 15
	Merge, correct, and export GPS data. Upload processed and verified coordinates to database	GIS Specialist	Sep-Oct
Quality Review (*Section 4E*)	Quality review and data validation using database tools (SOP 15)	Project Lead	Oct-Nov
	Determine best coordinates for subsequent mapping and field work	Project Lead and GIS Specialist	Oct-Nov
Metadata (*Section 4F and 4J*)	Identify any sensitive information contained in the data set (SOP 17)	Project Lead	By Nov 30
	Update project metadata interview form	Project Lead	By Nov 30
Data Certification & Delivery (*Section 4G*)	Certify the season's data and complete the certification report (SOP 15)	Project Lead	Nov
	Deliver certification report, certified data, and updated metadata to Data Manager (SOP 16)	Project Lead	By Nov 30
	Store certified data files in NCCN Digital Library [1]	Data Manager	Dec-Jan
	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]	Data Manager and GIS Specialist	By Mar 15

Appendix B. Yearly Project Task List (continued)

Project Stage	Task Description	Responsibility	Timing
Data Analysis (*Section 4H*)	Explore data in summary queries using database tools	Data Analyst	Feb-Mar
	Perform *ad hoc* queries as needed	Data Analyst and Data Manager	Feb-Mar
	Interpret results of automated and *ad hoc* queries	Data Analyst	Feb-Mar
Reporting & 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 (http://www.nature.nps.gov/publications/NRPM/index.cfm), create annual report	Data Analyst and Project Lead	Feb-Apr
	Screen all reports and data products for sensitive information (SOP 17)	Project Lead and Park Plant Ecologists	Feb-Apr
	Prepare draft report and distribute to Park Plant Ecologists for preliminary review	Project Lead	By Apr 15
Product Delivery (*Section 4K*)	Submit draft I&M report to Network Program Manager for review	Project Lead	By Apr 30
	Review report for formatting and completeness, notify Project Lead of approval or need for changes	Network Program Manager	May
	Upload completed report to NCCN Digital Library [1], notify Data Manager (SOP 16)	Project Lead	Upon approval
	Deliver other products according to the delivery schedule and instructions (SOP 16)	Project Lead	Upon completion
	Product check-in	Data Manager	Upon receipt
Posting & Distribution (*Section 4K*)	Submit metadata to NRInfo [2]	Data Manager	By Mar 15
	Create Reference [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 NRInfo [2]	Data Manager	Jun (after 2-year hold)
Archiving & Records Management (*Section 4L*)	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] (SOP 1)	Project Lead	Jan
	Move hard-copy data forms and voucher specimens to park collections	Project Lead	Jan
Season Close-out	Inventory equipment and supplies	Field Crew Lead	By Sep 15

Appendix B. Yearly Project Task List (continued)

Project Stage	Task Description	Responsibility	Timing
(*Section 3D and 4M*)	De-brief field crew concerning safety, logistics, and data concerns	Project Lead, Technicians	By Sep 15
	Meet to discuss the recent field season, and document any needed changes to field sampling protocols or the 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 document management system maintained on the NCCN servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2]NRInfo is the agency's internet clearinghouse for natural resource data and metadata (http://nrinfo.nps.gov/home.mvc). Only non-sensitive information is posted to NRInfo. Refer to the protocol section on sensitive information for details.
[3]Reference is a module of NRInfo that contains NPS bibliographic data related to natural resources. This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record.
[4]NPSpecies is a module of NRInfo used to maintain park-specific species lists and observation data (http://nrinfo.nps.gov/home.mvc).
[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.

Appendix C. 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_Schedule	Schedule for monitoring sites
tbl_Target_Coords	Target coordinates for sample locations selected within GIS
tbl_Analysis_Notes	Sample location-specific comments related to data analysis
tbl_Events	Data collection event for a given location
tbl_Coordinates	Coordinate data collected during sampling events
tbl_GPS_Info	GPS information associated with sampling event coordinates
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 sampling events

The following are project-specific data tables:

tbl_Plot_Desc	Plot description information
tbl_Plot_Logistics	Time and people required to complete plot sampling
tbl_Plot_Recon	Plot evaluation data from reconnaissance work
tbl_Site_Evaluation	Documentation of site evaluation
tbl_Subplot_Visits	Notes associated with subplot visits
tbl_Trees	Trees associated with sample locations
tbl_Tree_Data_Entry	Temporary table for tree visit data, to be appended to tbl_Trees and tbl_Tree_Visits at the end of the field season
tbl_Tree_Visits	Tree observation data

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

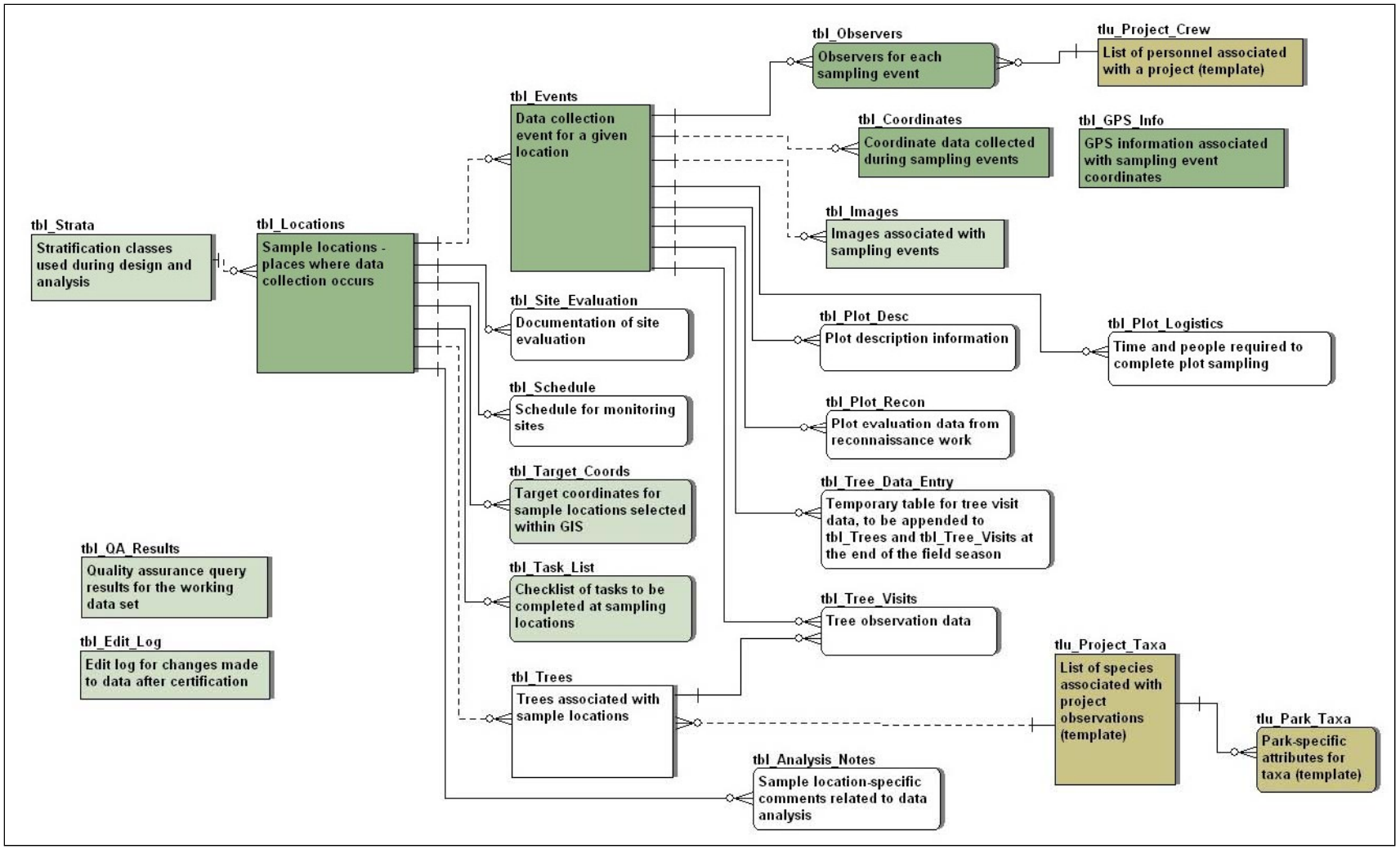


Figure C.1. Entity relationship diagram for the project database. Relationships between tables are represented by lines. Dark green tables represent core standard tables; light green represents extended standard tables; light brown are standard lookup tables. Project-specific tables are unshaded.

Data Dictionary

Required fields are denoted with an asterisk (*).
File name: Forest_Veg_VCa02.DM1
Model name: Master db - SQL
Platform: Microsoft SQL Server
Report date: 5/24/2010 1:39:36 PM

tbl_Analysis_Notes - Sample location-specific comments related to data analysis

Index	*Index columns*
Location_ID	Location_ID
pk_tbl_Analysis_Notes (primary)	Location_ID, Analysis_year

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	vchar (50)	Sampling location
Analysis_year	primary *	vchar (50)	Analysis year (e.g., 2010)
Analysis_notes		text	Comments about this sample location related to the specified analysis year

tbl_Coordinates - Coordinate data collected during sampling events

Index	*Index columns*
pk_tbl_Coordinates (primary)	Coord_ID
Coord_label	Coord_label
Coord_type	Coord_type
Datum	Datum
Field_coord_source	Field_coord_source
Event_ID (unknown)	Event_ID
Coord_updated	Coord_updated

Field name	*Index/key*	*Data type*	*Description*
Coord_ID	primary *	vchar (50)	Unique identifier for each coordinate record
	Default: newid()		
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
	Default: 0		
UTM_east		decimal (9,3)	Final UTM easting (zone 10N, meters), including any offsets and corrections
UTM_north		decimal (10,3)	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	vchar (5)	Datum of UTM_east and UTM_north
	Default: 'NAD83'		
Est_horiz_error		decimal (9,3)	Estimated horizontal error (meters) of UTM_east and UTM_north
Field_UTME		decimal (9,3)	UTM easting (zone 10N) as recorded in the field
Field_UTMN		decimal (10,3)	UTM northing (zone 10N) as recorded in the field
Field_datum		vchar (5)	Datum of field coordinates
Field_horiz_error		decimal (9,3)	Field coordinate horizontal error (m)
Field_offset_m		decimal (6,2)	Distance (meters) from the field coordinates to the target
	Constraint: ([Field_offset_m] is null or [Field_offset_m] >= 0)		

Field_offset_azimuth		smallint	Azimuth (degrees, declination corrected) from the coordinates to the target
	Constraint: ([Field_offset_azimuth] is null or [Field_offset_azimuth] >= 0 and [Field_offset_azimuth] <= 360)		
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_citation		vchar (250)	Name, date and scale of the source map
Coordinate_notes		text	Notes about this set of coordinates
Coord_created_date		datetime	Time stamp for record creation
	Default: getdate()		
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	(FK)*	vchar (50)	Sampling event of coordinate data collection
Elevation_m		unknown	Elevation in meters, derived from GIS using final UTMs
Slope_deg		unknown	Slope steepness in degrees, derived from GIS using final UTMs
Aspect_deg		unknown	Slope aspect in degrees, derived from GIS using final UTMs

tbl_Edit_Log - Edit log for changes made to data after certification

Index	*Index columns*
pk_tbl_Edit_Log (primary)	Data_edit_ID
Edit_type	Edit_type
Table_affected	Table_affected
User_name	User_name
Project_code	Project_code
Edit_date	Edit_date

Field name	*Index/key*	*Data type*	*Description*
Data_edit_ID	primary *	vchar (50)	Unique identifier for each data edit record
	Default: newid()		
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications
	Default: 'VCa02'		
Edit_date	indexed *	datetime	Date on which the edits took place
	Default: getdate()		
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		text	Comments about the data edits

tbl_Events - Data collection event for a given location

Index	*Index columns*
pk_tbl_Events (primary)	Event_ID
Certified_date	Certified_date
Entered_date	Entered_date
Location_ID	Location_ID
Start_date	Start_date
Updated_date	Updated_date
Verified_date	Verified_date
Has_tree_data	Has_tree_data

Has_tree_mortality	Has_tree_mortality
tbl_Locationstbl_Events	Location_ID
udx_tbl_Events (unknown)	Location_ID, Start_date

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary *	vchar (50)	Unique identifier for each sampling event
	Default: newid()		
Location_ID	indexed (FK)*	vchar (50)	Sampling location for this event
Project_code	*	vchar (10)	Project code, for linking information with other data sets and applications
	Default: 'VCa02'		
Start_date	indexed *	datetime	Start date of the sampling event
End_date		datetime	End date of the sampling event (optional)
Declination		vchar (25)	Declination correction factor for measurement of compass bearings
Has_site_map	*	bit	Indicates whether a site map was drawn
	Default: 0		
Were_tags_replaced	*	bit	Indicates whether any tree tags were replaced
	Default: 0		
Weather_cond		vchar (100)	Comments about weather conditions
Observed_changes		vchar (120)	Notes about observed changes to the plot
Significant_events		vchar (120)	Significant events and observations (e.g., sightings of rare/exotic species, accidents, etc.)
Animal_evidence		vchar (150)	Comments about animal evidence
Event_notes		text	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
	Default: getdate()		
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		vchar (50)	Person who certified data for accuracy and completeness
Certified_date	indexed	datetime	Date on which data were certified
QA_notes		text	Quality assurance comments for the selected sampling event
Is_excluded		bit	Flag to exclude the sampling event from data summary output
	Default: 0		
Travel_notes		text	Directions for relocating the sample location
Travel_notes_action		vchar (10)	Action to be taken to update the master copy of travel notes in tbl_Locations
Logistics_notes		vchar (255)	Comments about logistics for reaching and sampling this location
Has_tree_data	indexed	vchar (10)	Indicates whether tree diameters and associated data were partially or fully collected
Has_tree_mortality	indexed	vchar (10)	Indicates whether tree mortality data were partially or fully collected
Site_map_file		vchar (100)	File name and extension of the site map image
Replaced_tags		vchar (50)	Comments about the tags that were replaced
Were_tags_added	*	bit	Indicates whether any tree tags were added
	Default: 0		
New_tags		vchar (50)	Comments about the tags that were added
Were_stakes_replaced	*	bit	Indicates whether any stakes were replaced
	Default: 0		
Replaced_stakes		vchar (50)	Comments about the stakes that were replaced
Disturbance_indicators		vchar (120)	Comments about disturbance indicators since the last visit

Water_on_plot		vchar (20)	Standing or flowing water observed at the site
Transportation_notes		vchar (100)	Comments about special transportation needs
Accommodation_used		vchar (50)	Indicates the campsite, ranger station, or housing used
Accommodation_notes		vchar (100)	Comments about the overnight accommodations
Has_new_coordinates	*	bit	Indicates whether improved coordinates were collected
	Default: 0		
GPS_file_name		vchar (50)	GPS rover file used for data downloads

tbl_GPS_Info - GPS information associated with sampling event coordinates

Index	*Index columns*
pk_tbl_GPS_Info (primary)	GPS_ID
Corr_type	Corr_type
Datum	GPS_datum
Feat_name	Feat_name
Feat_type	Feat_type
GPS_date	GPS_date
Location_ID	Location_ID
GPS_file	GPS_file
Coord_ID	Coord_ID
tbl_Coordinatestbl_GPS_Info	Coord_ID

Field name	*Index/key*	*Data type*	*Description*
GPS_ID	primary *	vchar (50)	Unique identifier for the GPS record
	Default: newid()		
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
Corr_type	indexed	vchar (50)	GPS file correction type
GPS_UTME		decimal (9,3)	UTM easting in GPS unit
GPS_UTMN		decimal (10,3)	UTM northing in GPS unit
UTM_zone		vchar (5)	UTM projection system zone
	Default: '10N'		
GPS_datum	indexed	vchar (5)	Datum of GPS coordinates
Elev_m		decimal (9,3)	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		decimal (9,3)	Position dilution of precision scale
HDOP		decimal (9,3)	Horizontal dilution of precision scale
H_err_m		decimal (9,3)	Horizontal error (meters)
V_err_m		decimal (9,3)	Vertical error (meters)
Std_dev_m		decimal (9,3)	Standard deviation (meters)
GPS_process_notes		vchar (255)	GPS file processing notes
Coord_ID	indexed	vchar (50)	Coordinate identifier
Is_better	*	bit	Indicates that the field crew thought this coordinate record to be an improvement over the current Is_best coordinate
	Default: 0		
Flag	*	bit	Internal flag used to identify records while matching with tbl_Coordinates during post-season processing
	Default: 0		

tbl_Images - Images associated with sampling events

Index	*Index columns*
pk_tbl_Images (primary)	Image_ID
Image_type	Image_type
Image_label	Image_label
Event_ID	Event_ID
Image_quality	Image_quality
tbl_Eventstbl_Images	Event_ID
Sort_order	Sort_order

Field name	*Index/key*	*Data type*	*Description*
Image_ID	primary *	vchar (50)	Unique identifier for each image record
	Default: newid()		
Image_type	indexed	vchar (20)	Type of image
	Default: '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)
	Default: 0		
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
	Default: (1)		
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
	Default: 'images\'		
Image_filename		vchar (100)	Name of the image including extention (.jpg) but without the image path
Image_notes		text	Comments about the image
Event_ID	indexed (FK)*	vchar (50)	Sampling event
Image_label	indexed	vchar (25)	Image caption or label
Sort_order	indexed *	int	Used to show records in the order in which they were entered

tbl_Locations - Sample locations - places where data collection occurs

Index	*Index columns*
pk_tbl_Locations (primary)	Location_ID
Firing_order	Firing_order
Loc_updated	Loc_updated
Location_code	Location_code
Location_status	Location_status
Location_type	Location_type
Panel_name	Panel_name
Panel_type	Panel_type
Park_code	Park_code
Stratum_ID	Stratum_ID

Public_offset	Public_offset
udx_tbl_Locations (unique)	Park_code, Location_code
Park_region	Park_region
tbl_Stratatbl_Locations	Stratum_ID

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary *	vchar (50)	Unique identifier for each sample location
	Default: newid()		
Location_code	unique *	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	unique *	vchar (4)	Park code
Public_offset	indexed	vchar (50)	Type of processing performed to make coordinates publishable
Stratum_ID	indexed (FK)*	vchar (50)	Stratum of the site
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
Location_status	indexed *	vchar (10)	Status of the sample location
	Default: 'new'		
Location_notes		text	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
	Default: getdate()		
Loc_updated	indexed	datetime	Date of the last update to this record
Loc_updated_by		vchar (50)	Person who made the most recent edits
UTME_public		decimal (9,3)	UTM easting (zone 10N, meters). Note: in addition to any measurement error, these coordinates may have been offset up to 2 km from their actual position.
UTMN_public		decimal (10,3)	UTM northing (zone 10N, meters). Note: in addition to any measurement error, these coordinates may have been offset up to 2 km from their actual position.
Park_region	indexed	vchar (25)	Region of the park in which the site is located
Travel_notes		text	Directions for relocating the sample location
Location_desc		text	Environmental description of the sampling location

tbl_Observers - Observers for each sampling event

Index	*Index columns*
pk_tbl_Observers (primary)	Event_ID, Contact_ID, Observer_role
tbl_Eventstbl_Observers	Event_ID
tlu_Project_Crewtbl_Observers	Contact_ID
Observer_role	Observer_role

Field name	*Index/key*	*Data type*	*Description*
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_Plot_Desc - Plot description information

Index	*Index columns*
pk_tbl_Plot_Desc (primary)	Event_ID
tbl_Eventstbl_Plot_Desc (unique)	Event_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	vchar (50)	Sampling event
Field_elevation		decimal (8,3)	Elevation of the location
	Constraint: ([Field_elevation] is null or [Field_elevation] >= 0 and [Field_elevation] < 14500)		
Field_elev_units		vchar (2)	Units for elevation data
	Default: 'm'		
Elev_source		vchar (20)	Source of elevation data
Field_slope_deg		smallint	Slope steepness, in degrees
	Constraint: ([Field_slope_deg] is null or [Field_slope_deg] >= 0)		
Field_aspect_deg		smallint	Dominant slope aspect, in degrees, corrected for declination
	Constraint: ([Field_aspect_deg] is null or [Field_aspect_deg] >= 0 and [Field_aspect_deg] <= 360 or [Field_aspect_deg] = (-1))		
Parent_material		vchar (20)	Generally unconsolidated material from which soil develops
Soil_texture		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
Topog_moisture		decimal (5,2)	Topographic moisture index, predicted movement of water through the soil and bedrock as influenced by site topography
	Constraint: ([Topog_moisture] is null or [Topog_moisture] > 0 and [Topog_moisture] <= 9)		
Landform		vchar (5)	Predominant landform at site
Environment_notes		vchar (255)	Comments to clarify point description data

tbl_Plot_Logistics - Time and people required to complete plot sampling

Index	*Index columns*
pk_tbl_Plot_Logistics (primary)	Event_ID, Plot_task
Event_ID	Event_ID
tbl_Eventstbl_Plot_Logistics	Event_ID
Sort_order	Sort_order

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Plot_task	primary *	vchar (50)	Sampling event task
Time_spent		single	Time required to complete the task
	Constraint: ([Time_spent] is null or [Time_spent] >= 0 and [Time_spent] <= 100)		
N_people		single	Number of people needed to complete the task
	Constraint: ([N_people] is null or [N_people] >= 0 and [N_people] <= 20)		
Task_notes		vchar (100)	Comments about the task
Sort_order	indexed *	int	Used to show records in the order in which they were entered

tbl_Plot_Recon - Plot evaluation data from reconnaissance work

Index	*Index columns*
pk_tbl_Plot_Recon (primary)	Event_ID
Veg_association	Veg_association
tbl_Eventstbl_Plot_Recon (unique)	Event_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	vchar (50)	Sampling event
Field_elevation		decimal (8,3)	Elevation of the location
	Constraint: ([Field_elevation] is null or [Field_elevation] >= 0 and [Field_elevation] <		

			14500)
Field_elev_units	*	vchar (2)	Units for elevation data
	Default: 'm'		
Elev_source		vchar (10)	Means by which elevation data were acquired
Has_safe_access	*	bit	Whether or not safely accessible (unsafe=too steep, cliffs, major river or glacier crossing)
	Default: 0		
Access_notes		vchar (100)	Comments about safety of access
Meets_slope_criteria	*	bit	Whether or not at least 90% of the plot is under 35 degrees slope
	Default: 0		
Slope_notes		vchar (100)	Comments about slope steepness
Meets_distance_criteria		*	bit Whether or not the plot meets distance criteria from roads/trails/boundaries
	Default: 0		
Distance_notes		vchar (100)	Comments about distance from trails and roads
Meets_cover_criteria	*	bit	Whether or not the plot has at least 25 percent tree cover
	Default: 0		
Tree_cover_notes		vchar (100)	Comments about tree cover
Is_target_veg	*	bit	Whether or not the plot meets target vegetation criteria
	Default: 0		
Target_veg_notes		vchar (100)	Comments about the whether or not the plot meets vegetation criteria
Veg_association	indexed	int	Vegetation association name assigned by field crews for the 50 x 50 meter potential plot location
Has_inclusions	*	bit	Whether or not the plot contains any non-target inclusions such as streams, cliffs, disturbance, wetlands, etc.
	Default: 0		
Non_target_inclusions		vchar (150)	Description of any non-target inclusions such as streams, cliffs, disturbance, wetlands, etc.
Proportion_inclusions		tinyint	Proportion of the 50 x 50 meter plot that is in the mentioned inclusions
	Default: 0		
	Constraint: ([Proportion_inclusions] is null or [Proportion_inclusions] >= 0 and [Proportion_inclusions] <= 100)		
Inclusion_prop_notes		vchar (100)	Comments about the proportion of the plot in inclusions
N_tree_rings		vchar (10)	Number of rings in core from dominant/codominant tree base (no emergents or open-grown outliers)
Tree_ring_notes		vchar (100)	Comments about the tree ring count or the core
Is_appropriate		vchar (10)	Whether or not the site is appropriate for a permanent plot based on these criteria
	Default: 'Uncertain'		
Appropriate_notes		vchar (100)	Comments about the appropriateness of the site
Is_flagged	*	bit	Whether or not the plot center is flagged
	Default: 0		
Plot_description		text	Description of the 50 x 50 meter plot
Directions_to_plot		text	Directions for relocating the plot

tbl_QA_Results - Quality assurance query results for the working data set

Index	*Index columns*
pk_tbl_QA_Results (primary)	Query_name, Time_frame, Data_scope
Query_type	Query_type
Time_frame	Time_frame
Query_name	Query_name
Query_result	Query_result
Data_scope	Data_scope

Field name	*Index/key*	*Data type*	*Description*
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		text	Description of the query
Query_expression		text	Evaluation expression built into the query
Remedy_desc		text	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
Is_done	*	bit	Temporary flag to indicate that the user is done reviewing this query even if some records remain
	Default: 0		
Data_scope	primary *	tinyint	Scope of the data included in queries: 0=uncertified events only, 1=both certified and uncertified, 2=certified events only

tbl_Schedule - Schedule for monitoring sites

Index	*Index columns*
tbl_Schedule_Location_ID	Location_ID
tbl_Schedule_Calendar_year	Calendar_year
pk_tbl_Schedule (primary)	Calendar_year, Location_ID

Field name	*Index/key*	*Data type*	*Description*
Calendar_year	primary *	vchar (10)	Calendar year for scheduled sampling (not necessarily actually sampled)
Location_ID	primary (FK)*	vchar (50)	Sampling location
Schedule_notes		vchar (255)	Comments about this schedule item (especially for out-of-rotation sites)

tbl_Site_Evaluation - Documentation of site evaluation

Index	*Index columns*
pk_tbl_Site_Evaluation (primary)	Location_ID
Office_evaluation	Office_evaluation
Field_evaluation	Field_evaluation
Evaluation_code	Evaluation_code
tbl_Locationstbl_Site_Evaluation (unique)	Location_ID

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	vchar (50)	Alphanumeric code assigned to reconnaissance plots
Evaluation_code	indexed	vchar (2)	Site evaluation status code
	Default: 'NE'		
Evaluation_notes		vchar (100)	Brief comment about the site evaluation, rationale for not sampling, etc.
PMR_composition		vchar (50)	Vegetation composition acording to Pacific Meridian Resources
GIS_veg_layer		vchar (255)	PMR/PEG/Henderson/Agee/Franklin vegetation layer comments
Field_evaluation	indexed	vchar (15)	Plot office evaluation: passed or failed criteria or evaluation not conducted
Office_evaluation	indexed	vchar (15)	Plot office evaluation: passed or failed criteria or evaluation

not conducted

tbl_Strata - Stratification classes used during design and analysis

Index	*Index columns*
pk_tbl_Strata (primary)	Stratum_ID
udx_tbl_Strata (unique)	Park_code, Project_code, Stratification_date, Stratum_name
Stratum_updated	Stratum_updated

Field name	*Index/key*	*Data type*	*Description*
Stratum_ID	primary *	vchar (50)	Unique identifier for each stratum record
	Default: newid()		
Park_code	unique *	vchar (4)	Four-letter park code of the stratification
Project_code	unique *	vchar (10)	Project code, for linking information with other data sets and applications
	Default: 'VCa02'		
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 text definition of the stratum (e.g., elevations below 1000 meters)
N_population		int	Total population in the stratum
Weight_factor		decimal (19,7)	Weight factor to be used in analyses; inverse of inclusion probability
Stratum_notes		text	Comments about the stratum
Stratum_created		datetime	Time stamp for record creation
	Default: getdate()		
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_Target_Coords - Target coordinates for sample locations selected within GIS

Index	*Index columns*
pk_tbl_Target_Coords (primary)	Location_ID
Target_updated	Target_updated
tbl_Locationstbl_Target_Coords (unique)	Location_ID

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	vchar (50)	Sample location
Target_UTME		decimal (9,3)	Target UTM easting (zone 10N)
Target_UTMN		decimal (10,3)	Target UTM northing (zone 10N)
Target_datum		vchar (5)	Target coordinate datum
	Default: 'NAD83'		
Target_notes		text	Notes about the target coordinates
Target_created_date		datetime	Time stamp for record creation
	Default: getdate()		
Target_updated	indexed	datetime	Date of the last update to this record
Target_updated_by		vchar (50)	Person who made the most recent edits

tbl_Task_List - Checklist of tasks to be completed at sampling locations

Index	*Index columns*
pk_tbl_Task_List (primary)	Location_ID, Request_date, Task_desc
Date_completed	Date_completed
Task_status	Task_status
tbl_Locationstbl_Task_List	Location_ID

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	vchar (50)	Sampling location

Request_date	primary *	datetime	Date of the task request
	Default: getdate()		
Task_desc	primary *	vchar (100)	Brief description of the task
Date_completed	indexed	datetime	Date the task was completed
Task_notes		text	Notes about the task
Requested_by		vchar (50)	Name of the person making the initial request
Task_status	indexed *	vchar (50)	Status of the task
	Default: 'active'		
Followup_by		vchar (50)	Name of the person following up on or completing the task
Followup_notes		text	Comments regarding what was done to follow-up on or complete this task

tbl_Trees - Trees associated with sample locations

Index	*Index columns*
pk_tbl_Trees (primary)	Tree_ID
Plot_ref_point	Plot_ref_point
Taxon_ID	Taxon_ID
Tree_tag_num	Tree_tag_num
udx_tbl_Trees (unknown)	Location_ID, Tree_tag_num
Tree_type	Tree_type
Tree_loc	Tree_loc
Location_ID	Location_ID
tbl_Locationstbl_Trees	Location_ID
tlu_Project_Taxatbl_Trees	Taxon_ID

Field name	*Index/key*	*Data type*	*Description*
Tree_ID	primary *	vchar (50)	Unique identifier for each tree record
	Default: newid()		
Location_ID	indexed (FK)*	vchar (50)	Sampling location
Tree_tag_num	indexed *	smallint	Tree tag number
Taxon_ID	indexed (FK)*	vchar (50)	Taxon observed
Is_active	*	bit	Indicates whether the tree record is active for data collection and field form output
	Default: (1)		
Plot_ref_point	indexed	vchar (5)	Plot reference point used to map and relocate the tree
Offset_dist_m		decimal (5,2)	Offset distance in meters
	Constraint: ([Offset_dist_m] is null or [Offset_dist_m] >= 0 and [Offset_dist_m] < 200)		
Offset_azimuth		smallint	Azimuth (degrees, declination corrected) from the plot reference point to the tree
	Constraint: ([Offset_azimuth] is null or [Offset_azimuth] >= 0 and [Offset_azimuth] <= 360)		
Tree_rec_notes		text	Comments about the tree record
Tree_type	indexed *	vchar (2)	Indicates that the tree is for measurement, is a witness tree, or both
Tree_loc	indexed	vchar (5)	Location of the tree relative to the plot - corner, subplot or outside plot

tbl_Tree_Data_Entry - Temporary table for tree visit data, to be appended to tbl_Trees and tbl_Tree_Visits at the end of the field season

Index	*Index columns*
idx_Tree_type	Tree_type
idx_Tree_tag_num	Tree_tag_num
idx_Event_ID	Event_ID
idx_Plot_ref_point	Plot_ref_point
idx_Tree_loc	Tree_loc
idx_Taxon_ID	Taxon_ID

pk_tbl_Tree_Data_Entry (primary) Tree_ID, Event_ID
udx_tbl_Tree_Data_Entry (unknown) Event_ID, Tree_tag_num

Field name	*Index/key*	*Data type*	*Description*
Tree_ID	primary *	vchar (50)	Unique identifier for each tree record
	Default: newid()		
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Tree_tag_num	indexed *	smallint	Tree tag number
Is_active	*	bit	Indicates whether the tree record is active for data collection and field form output
	Default: 1		
Taxon_ID	indexed *	vchar (50)	Taxon observed
Collection_num		vchar (20)	Voucher specimen collection number
Tree_type	indexed *	vchar (2)	Indicates that the tree is for measurement, is a witness tree, or both
Tree_loc	indexed	vchar (5)	Location of the tree relative to the plot - corner, subplot or outside plot
Plot_ref_point	indexed	vchar (5)	Plot reference point used to map and relocate the tree
Offset_azimuth		smallint	Azimuth (degrees, declination corrected) from the plot reference point to the tree
	Constraint: ([Offset_azimuth] is null or [Offset_azimuth] >= 0 and [Offset_azimuth] <= 360)		
Offset_dist_m		decimal (5,2)	Offset distance in meters
	Constraint: ([Offset_dist_m] is null or [Offset_dist_m] >= 0 and [Offset_dist_m] < 200)		
Tree_status		vchar (2)	Status of the tree
DBH_cm		decimal (5,2)	Diameter at breast height in centimeters
	Constraint: ([DBH_cm] is null or [DBH_cm] > 0 and [DBH_cm] < 500)		
Diameter_check		tinyint	Code to identify any irregularities in diameter measurement positions that may affect use of this tree in diameter growth/change analyses
Height_m		decimal (5,2)	Tree height in meters
	Constraint: ([Height_m] is null or [Height_m] > 0 and [Height_m] < 120)		
Height_method		vchar (2)	Method used to determine tree height
Crown_ratio		tinyint	Compacted crown ratio, proportion of observed tree length that supports live foliage
	Constraint: ([Crown_ratio] is null or [Crown_ratio] >= 0 and [Crown_ratio] <= 100)		
Crown_class		vchar (2)	Crown class of the tree
Decay_class		tinyint	Decay class of standing dead trees and logs
Damage_agent		vchar (2)	Agent of damage
Damage_loc		tinyint	Location of damage
Damage_severity		tinyint	Severity of damage
	Constraint: ([Damage_severity] is null or [Damage_severity] >= 0 and [Damage_severity] <= 100)		
Mistletoe_class		tinyint	Extent of mistletoe presence in the canopy, using the Hawksworth six-class rating system
	Constraint: ([Mistletoe_class] is null or [Mistletoe_class] >= 0 and [Mistletoe_class] <= 6)		
Platforms		tinyint	Number of platforms observed in the canopy
Moss_abundance		tinyint	Avg percent cover of horizontal surface on limb top for lower 2/3 of live tree crown (note: trees with platforms only)
	Constraint: ([Moss_abundance] is null or [Moss_abundance] >= 0 and [Moss_abundance] <= 100)		
Cavity_class		vchar (2)	Presence and size of cavities
Cause_of_death		vchar (2)	Apparent cause of tree death (dead trees only)
Tree_position		vchar (2)	Observed position of the tree (dead trees only)

Lean_deg		tinyint	Angle in degrees at which the dead tree is leaning from vertical (vertical = 0)
	Constraint: ([Lean_deg] is null or [Lean_deg] >= 0 and [Lean_deg] <= 90)		
Tree_visit_notes		vchar (250)	Comments about the tree measurement record
Sort_order	*	int	Used to show records in the order in which they were entered

tbl_Tree_Visits - Tree observation data

Index	*Index columns*
pk_tbl_Tree_Visits (primary)	Tree_ID, Event_ID
Tree_ID	Tree_ID
Event_ID	Event_ID
Tree_status	Tree_status
tbl_Eventstbl_Tree_Visits	Event_ID
tbl_Treestbl_Tree_Visits	Tree_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	vchar (50)	Sampling event identifier
Tree_ID	primary (FK)*	vchar (50)	Unique identifier for each tree record
DBH_cm		decimal (5,2)	Diameter at breast height, in centimeters
	Constraint: ([DBH_cm] is null or [DBH_cm] > 0 and [DBH_cm] < 500)		
Height_m		decimal (5,2)	Tree height in meters
	Constraint: ([Height_m] is null or [Height_m] > 0 and [Height_m] < 120)		
Height_method		vchar (2)	Method used to determine tree height
Tree_status	indexed *	vchar (2)	Status of the tree
Decay_class		tinyint	Decay class of standing dead trees and logs
Cause_of_death		vchar (2)	Apparent cause of tree death (dead trees only)
Crown_class		vchar (2)	Crown class of the tree
Crown_ratio		tinyint	Compacted crown ratio, proportion of observed tree length that supports live foliage
	Constraint: ([Crown_ratio] is null or [Crown_ratio] >= 0 and [Crown_ratio] <= 100)		
Mistletoe_class		tinyint	Extent of mistletoe presence in the canopy, using the Hawksworth six-class rating system
	Constraint: ([Mistletoe_class] is null or [Mistletoe_class] >= 0 and [Mistletoe_class] <= 6)		
Cavity_class		vchar (2)	Presence and size of cavities
Damage_severity		tinyint	Severity of damage
	Constraint: ([Damage_severity] is null or [Damage_severity] >= 0 and [Damage_severity] <= 100)		
Tree_visit_notes		vchar (250)	Comments about the tree measurement record
Diameter_check		tinyint	Code to identify any irregularities in diameter measurement positions that may affect use of this tree in diameter growth/change analyses
Damage_agent		vchar (2)	Agent of damage
Damage_loc		tinyint	Location of damage
Platforms		tinyint	Number of platforms observed in the canopy
Moss_abundance		tinyint	Avg percent cover of horizontal surface on limb top for lower 2/3 of live tree crown (note: trees with platforms only)
	Constraint: ([Moss_abundance] is null or [Moss_abundance] >= 0 and [Moss_abundance] <= 100)		
Tree_position		vchar (2)	Observed position of the tree (dead trees only)
Lean_deg		tinyint	Angle in degrees at which the dead tree is leaning from vertical (vertical = 0)
	Constraint: ([Lean_deg] is null or [Lean_deg] >= 0 and [Lean_deg] <= 90)		
Collection_num		vchar (20)	Voucher specimen collection number

Mortality	* *Default*: 0	bit	Flag to indicate a mortality event
Mortality_notes		vchar (100)	Comments about the mortality event

tlu_Cause_of_Death - List of codes for apparent cause of tree mortality

Field name	*Index/key*	*Data type*	*Description*
Cause_of_death	primary *	vchar (2)	
Cause_of_death_desc		vchar (100)	
Sort_order		tinyint	

tlu_Cavity_Class - List of tree cavity classes

Field name	*Index/key*	*Data type*	*Description*
Cavity_class	primary *	vchar (2)	
Cavity_class_desc		vchar (100)	
Sort_order		tinyint	

tlu_Coord_Source - List of coordinate data sources (standard)

Field name	*Index/key*	*Data type*	*Description*
Coord_source	primary *	vchar (12)	
Coord_source_desc		vchar (100)	
Sort_order		tinyint	

tlu_Coord_Type - List of coordinate types (standard)

Field name	*Index/key*	*Data type*	*Description*
Coord_type	primary *	vchar (20)	
Coord_type_desc		vchar (100)	
Sort_order		tinyint	

tlu_Crown_Class - List of tree crown class codes

Field name	*Index/key*	*Data type*	*Description*
Crown_class	primary *	vchar (2)	
Crown_class_desc		vchar (100)	
Sort_order		tinyint	

tlu_Current_Association - Cross-reference table of current interpretations of provisional veg associations

Index	*Index columns*
Current_association	Current_association
Veg_association	Veg_association
pk_tlu_Current_Association (primary)	Veg_association, Current_association

Field name	*Index/key*	*Data type*	*Description*
Veg_association	primary (FK)*	int	Vegetation association ID
Current_association	primary *	int	Current interpretation of the association

tlu_Damage_Agent - List of tree damage agent codes

Field name	*Index/key*	*Data type*	*Description*
Damage_agent_code	primary *	vchar (2)	
Damage_agent_desc		vchar (100)	
Agent_category		vchar (50)	
Agent_class		vchar (20)	
Sort_order		tinyint	

tlu_Damage_Loc - List of tree damage location codes

Field name	*Index/key*	*Data type*	*Description*
Damage_loc_code	primary *	tinyint	
Damage_loc_desc		vchar (100)	

Sort_order		tinyint

tlu_Datum - List of coordinate datum codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Datum	primary *	vchar (5)	
Datum_desc		vchar (50)	
Sort_order		tinyint	

tlu_Diameter_Check - List of tree diameter measurement method codes to identify any irregularities in diameter measurement positions

Field name	*Index/key*	*Data type*	*Description*
Diam_check_code	primary *	tinyint	
Check_desc		vchar (100)	
Sort_order		tinyint	

tlu_Drainage - List of site drainage codes

Field name	*Index/key*	*Data type*	*Description*
Drainage_code	primary *	vchar (20)	
Drainage_desc		vchar (100)	
Sort_order		tinyint	

tlu_Edit_Type - List of the types of post-certification edits made to data (standard)

Field name	*Index/key*	*Data type*	*Description*
Edit_type	primary *	vchar (12)	
Edit_type_desc		vchar (100)	
Sort_order		tinyint	

tlu_Elevation_Source - List of elevation data source codes (template)

Field name	*Index/key*	*Data type*	*Description*
Elev_source	primary *	vchar (20)	
Elev_source_desc		vchar (100)	
Sort_order		tinyint	

tlu_Elevation_Unit - List of elevation measurement units (standard)

Field name	*Index/key*	*Data type*	*Description*
Elev_unit	primary *	vchar (2)	
Units_desc		vchar (25)	
Sort_order		tinyint	

tlu_Evaluation_Code - List of field and office evaluation codes used in site screening

Field name	*Index/key*	*Data type*	*Description*
Eval_code	primary *	vchar (15)	
Eval_code_desc		vchar (100)	
Sort_order		tinyint	

tlu_Evaluation_Status - List of evaluation codes for sample sites (template)

Field name	*Index/key*	*Data type*	*Description*
Eval_code	primary *	vchar (2)	
Eval_status	*	vchar (20)	
Eval_status_desc		vchar (100)	
Sort_order		tinyint	

tlu_GPS_Model - List of GPS devices used to collect coordinate data (template)

Field name	*Index/key*	*Data type*	*Description*
GPS_model	primary *	vchar (25)	
Sort_order		tinyint	

tlu_Height_Method - List of methods for determining tree height

Field name	*Index/key*	*Data type*	*Description*
Height_method	primary *	vchar (2)	
Height_method_desc		vchar (100)	
Sort_order		tinyint	

tlu_Hydrology_Code - List of lookup values for observed site hydrology

Field name	*Index/key*	*Data type*	*Description*
Hydrology_code	primary *	vchar (20)	
Hydrology_desc		vchar (100)	
Sort_order		tinyint	

tlu_Image_Code - List of project image codes

Field name	*Index/key*	*Data type*	*Description*
Image_code	primary *	vchar (20)	
Image_code_desc		vchar (100)	
Orientation		vchar (50)	
Sort_order		tinyint	
Is_active	*	bit	Indicates whether the record is active for data entry
	Default: 1		

tlu_Image_Format - List of image, map, and photographic formats (template)

Field name	*Index/key*	*Data type*	*Description*
Image_format	primary *	vchar (12)	
Image_format_desc		vchar (100)	
Sort_order		tinyint	

tlu_Image_Quality - List of quality ranks for images (template)

Field name	*Index/key*	*Data type*	*Description*
Quality_code	primary *	tinyint	
Image_quality	*	vchar (20)	
Image_quality_desc		vchar (100)	

tlu_Image_Type - List of image types (template)

Field name	*Index/key*	*Data type*	*Description*
Image_type	primary *	vchar (12)	
Image_type_desc		vchar (100)	
Sort_order		tinyint	

tlu_Landform - List of landform codes

Field name	*Index/key*	*Data type*	*Description*
Landform_code	primary *	vchar (5)	
Landform_desc		vchar (200)	
Category		vchar (50)	
Sort_order		tinyint	

tlu_Location_Type - List of location type codes (template)

Field name	*Index/key*	*Data type*	*Description*
Location_type	primary *	vchar (20)	
Loc_type_desc		vchar (200)	
Sort_order		tinyint	

tlu_Microconfig - List of site microconfiguration codes

Field name	*Index/key*	*Data type*	*Description*
Microconfig_code	primary *	vchar (20)	

Microconfig_desc	vchar (100)
Sort_order	tinyint

tlu_Micro_Position - List of site microtopographic position codes

Field name	*Index/key*	*Data type*	*Description*
Microtopog_position	primary *	vchar (20)	
Micro_position_desc		vchar (200)	
Sort_order		tinyint	

tlu_Observer_Role - List of observer role assignments (template)

Field name	*Index/key*	*Data type*	*Description*
Observer_role	primary *	vchar (25)	
Role_desc		vchar (100)	
Sort_order		tinyint	

tlu_Origin_Code - List of origin codes for park taxa (standard)

Field name	*Index/key*	*Data type*	*Description*
Origin_code	primary *	vchar (16)	
Origin_desc		vchar (100)	
NPSpp_ID		smallint	
Sort_order		tinyint	

tlu_Panel_Type - List of sampling panel types (template)

Field name	*Index/key*	*Data type*	*Description*
Panel_type	primary *	vchar (20)	
Panel_type_desc		vchar (200)	
Sort_order		tinyint	

tlu_Parent_Material - List of parent material types

Field name	*Index/key*	*Data type*	*Description*
Parent_material	primary *	vchar (20)	
Parent_material_desc		vchar (200)	
Sort_order		tinyint	

tlu_Parks - List of NCCN parks and park codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Park_code	primary *	vchar (4)	
Park_name		vchar (50)	

tlu_Park_Taxa - Park-specific attributes for taxa (template)

Index	*Index columns*
pk_tlu_Park_Taxa (primary)	Taxon_ID, Park_code
Record_status	Record_status
Park_status	Park_status
Park_origin	Park_origin
tlu_Project_Taxatlu_Park_Taxa	Taxon_ID

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary (FK)*	vchar (50)	Taxon identifier
Park_code	primary *	vchar (4)	Park code
Park_status	indexed *Default*: 'unknown'	vchar (16)	Status of the taxon in this park (from NPSpecies)
Park_origin	indexed *Default*: 'unspecified'	vchar (16)	Origin of the taxon in this park (from NPSpecies)
Local_list	*	bit	Indicates that the taxon is the preferred one for use at the park (from NPSpecies)

	Default: 0		
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		text	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
	Default: 'new record'		
Created_date		datetime	Time stamp for record creation
	Default: getdate()		
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)

Field name	*Index/key*	*Data type*	*Description*
Taxon_status_code	primary *	vchar (16)	
Taxon_status_desc		vchar (250)	
NPSpp_ID		smallint	
Sort_order		tinyint	

tlu_Platform_Code - List of tree platform codes

Field name	*Index/key*	*Data type*	*Description*
Platform_code	primary *	tinyint	
Platform_desc		vchar (100)	
Sort_order		tinyint	

tlu_Plot_Ref_Point - List of sample plot reference point codes

Field name	*Index/key*	*Data type*	*Description*
Plot_ref_point	primary *	vchar (5)	
Plot_ref_point_desc		vchar (100)	
Sort_order		tinyint	
Tree_map_alias		tinyint	Alternate value used for automated stem map output

tlu_Plot_Tasks - List of logistics and sampling tasks for tracking time spent

Field name	*Index/key*	*Data type*	*Description*
Task_code	primary *	vchar (50)	
Task_desc		vchar (100)	
Sort_order		tinyint	
Task_units		vchar (10)	
Is_active	*	bit	Indicates whether the record is active for data entry
	Default: 1		

tlu_Project_Crew - List of personnel associated with a project (template)

Index	*Index columns*
pk_tlu_Project_Crew (primary)	Contact_ID
Contact_updated	Contact_updated
First_name	First_name
Last_name	Last_name
Organization	Organization
Project_code	Project_code
Contact_location	Contact_location

Field name	*Index/key*	*Data type*	*Description*
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
	Default: 'VCa02'		
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		text	Notes about the contact
Contact_created		datetime	Time stamp for record creation
	Default: getdate()		
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
	Default: (1)		
Work_ext		vchar (5)	Work extension number

tlu_Project_Taxa - List of species associated with project observations (template)
Constraints: CK_tlu_Project_Taxa: (abs([Taxon_is_active]) = 1 and isnull([Refers_to],'') = '' or [Taxon_is_active] = 0 and isnull([Refers_to],'') <> '')

Index	*Index columns*
pk_tlu_Project_Taxa (primary)	Taxon_ID
Accepted_TSN	Accepted_TSN
Category	Category
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

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary *	vchar (50)	Unique identifier for each taxon
	Default: newid()		
Project_code	indexed *	vchar (10)	Project code, for linking information with other data sets and applications
	Default: 'VCa02'		
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)
	Default: 'unspecified'		
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
	Default: 'specific'		
Taxon_notes		text	General notes about the taxon
Created_date		datetime	Time stamp for record creation
	Default: getdate()		
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
	Default: (1)		
Record_status	indexed	vchar (16)	Indicates the status of the record in terms of synchrony with master databases
	Default: 'new record'		
Rec_status_notes		vchar (255)	Notes about the disposition of the record
Project_taxon_notes		text	Project-specific comments about the taxon
Refers_to		vchar (50)	Valid taxon the record should refer to for analysis and summaries

tlu_Site_Status - List of status codes for sampling stations (standard)

Field name	*Index/key*	*Data type*	*Description*
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

Field name	*Index/key*	*Data type*	*Description*
Decay_class	primary *	tinyint	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 (200)	Condition of sapwood
Heartwood_cond		vchar (200)	Condition of heartwood

tlu_Soil_Texture - List of soil texture codes

Field name	*Index/key*	*Data type*	*Description*
Soil_texture	primary *	vchar (20)	
Soil_texture_desc		vchar (200)	
Sort_order		tinyint	

tlu_Taxon_Category - List of taxonomic categories (standard)

Field name	*Index/key*	*Data type*	*Description*
Category	primary *	vchar (20)	
Category_desc		vchar (100)	
NPSpp_ID		smallint	
Sort_order		tinyint	

tlu_Taxon_Rec_Status - List of status codes for taxon records (standard)

Field name	*Index/key*	*Data type*	*Description*
Record_status_code	primary *	vchar (16)	
Record_status_desc		vchar (200)	

Sort_order		tinyint

tlu_Taxon_Type - List of taxon resolution codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Taxon_type	primary *	vchar (12)	
Taxon_type_desc		vchar (200)	
Sort_order		tinyint	

tlu_Topog_Position - List of site topographic position codes

Field name	*Index/key*	*Data type*	*Description*
Topog_position	primary *	vchar (20)	
Topog_position_desc		vchar (100)	
Sort_order		tinyint	

tlu_Tree_Position - List of tree position codes

Field name	*Index/key*	*Data type*	*Description*
Position_code	primary *	vchar (2)	
Position_desc		vchar (100)	
Sort_order		tinyint	

tlu_Tree_Status - List of tree status codes

Field name	*Index/key*	*Data type*	*Description*
Tree_status	primary *	vchar (2)	
Tree_status_desc		vchar (100)	
Sort_order		tinyint	

tlu_Tree_Type - List of tree types

Field name	*Index/key*	*Data type*	*Description*
Tree_type	primary *	vchar (2)	
Tree_type_description		vchar (255)	
Sort_order		tinyint	

tlu_Veg_Association - List of provisional vegetation associations of North Cascades, Olympic and Mt. Rainier National Parks

Index	*Index columns*
pk_tlu_Veg_Association (primary)	Association_ID
Association_type	Association_type
Association_code (unique)	Association_code

Field name	*Index/key*	*Data type*	*Description*
Association_ID	primary *	int	Unique identifier for each association
Association_code	unique *	vchar (100)	Code for associations based on shortened version of name
Association_name		vchar (255)	Name of the association based on dominants and diagnostic species
Association_type	indexed	vchar (50)	Alliance level categories for associations
Association_notes		text	Description of association
Name_change_notes		vchar (255)	Comments about name change from 2005 to 2006 field season
Sort_order		smallint	Record display sort order

tsys_App_Releases - Application table - Application release history

Index	*Index columns*
udx_tsys_App_Releases (unique)	Release_date, Database_title, Version_number
pk_tsys_App_Releases (primary)	Release_ID

Field name	*Index/key*	*Data type*	*Description*

Release_ID	primary *	vchar (50)	Unique identifier for the release
	Default: convert(varchar,getdate(),112) + convert(varchar,getdate(),8)		
Release_date	unique	datetime	Date of the release
Database_title	unique	vchar (100)	Title of the database
Version_number	unique	vchar (20)	Version control number
File_name		vchar (50)	Filename, used to identify older versions of the database
Release_by		vchar (50)	Person who issued the release
Release_notes		text	Release notes, which may include a summary of revisions
Is_supported	*	tinyint	Indicates the support level of this release: 0=user must use a newer version; 1=supported but newer available; 2=full suport, current version
	Default: 2		

tsys_Bug_Reports - Application table - Application bugs and development history

Index	*Index columns*
Fix_date	Fix_date
Release_ID	Release_ID
Report_date	Report_date
pk_tsys_Bug_Reports (primary)	Bug_ID

Field name	*Index/key*	*Data type*	*Description*
Bug_ID	primary *	vchar (50)	Unique identifier for each bug record
	Default: newid()		
Release_ID	indexed (FK)*	vchar (50)	Database release version of the report
Report_date	indexed *	datetime	Date the bug was reported
	Default: getdate()		
Found_by		vchar (50)	Person who found the bug
Reported_by		vchar (50)	Person who filled out this bug report
Report_details		text	Nature of the bug report
Fix_date	indexed	datetime	Date the bug was fixed
Fixed_by		vchar (50)	Person who fixed the bug
Fix_details		text	Notes on fix

tsys_Logins - Application table - Log of user access to the database through the front-end

Field name	*Index/key*	*Data type*	*Description*
Time_stamp	primary *	datetime	
	Default: getdate()		
User_name	primary *	vchar (50)	
Action_taken		vchar (50)	

tsys_User_Roles - Application table - Determines user access privileges through the front-end

Field name	*Index/key*	*Data type*	*Description*
User_name	primary *	vchar (50)	Network login
User_role	*	vchar (50)	Database application role, used to determine the access level

Appendix D. Template for Forest Monitoring Annual Report

Figures

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Figure D.1. Graphic depiction of stand structure for a plot in the 0–300 m elevation stratum at Olympic National Park. D.4

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Table D.5. Mortality rates by species by plot for the annual report. D.6

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Table D.7. Mortality rates by species by elevation stratum for the annual report. D.7

Table D.8. Mortality rates by species for the entire set of plots for the annual report. D.7

Table D.9. Number of trees having wildlife habitat features per plot average across plots within vegetation class and park. D.8

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, etc.)
- Study design – spatial and temporal aspects; target population for each combination of park and stratum
- Numbering system for elevation strata (i.e., 1 = 0-300m, 3 = 600-900m, 6 = 1500-1800m)

Table D.1. Temporal sampling frame.

Measurement type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Plot establishment	X	X	X													
Tree recruitment						X					X					X
Tree growth						X					X					X
Tree mortality		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- Detection of change and trend, based on initiation of monitoring in 2008. Values reported for all plots, all combinations of park and elevation stratum, all elevation strata, and for the entire set of plots (see Tables D.5 to D.8)

Table D.2. Schedule of reporting of initial values, change, and long-term trends.

Year of Report	Tree recruitment	Tree growth	Tree mortality
2009			Initial value
2010			Change
2011			Trend
2012			Trend
2013	Initial value	Initial value	Trend
2014			Trend
2015			Trend
2016			Trend
2017			Trend
2018	Change	Change	Trend
2019			Trend
2020			Trend
2021			Trend
2022			Trend
2023	Trend	Trend	Trend
Etc.			

- Summary of basic measurements

Plot Visit History

Table D.3. History of plots visited (or missed) throughout study. Note that the number of plots at LEWI and SAJH has yet to be determined, and may be different for those two parks.

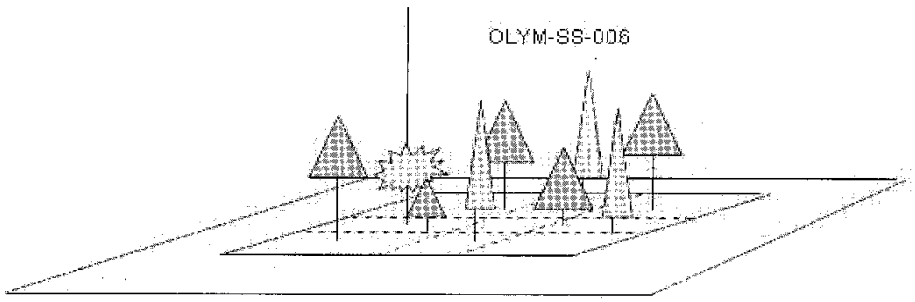
PARK	Elevation stratum	2008	2009	2010	2011	2012	2013 etc.
LEWI	**1**		X	X	X	X	X
MORA	**3**	6	6	6	6	6	6
	6	6	6	6	6	6	6
NOCA	**3**	6	6	6	6	6	6
	6	5	5	6	6	6	6
OLYM	**1**	6	6	6	6	6	6
	3	6	6	6	6	6	6
SAJH	**1**		Y	Y	Y	Y	Y

- Maps of the five parks showing points that were visited during the reporting year distinguished by stratum and panel. Input data include plot, panel, stratum, UTMs but only the maps will be made public.

Tree and site data

- Snapshot of stand structure using lollipop figures on 3-D illustration of plots. Tree dimensions will not be measured in mortality-check-only years.
- Or, at least histograms showing canopy classes and species versus number.

- Data associated with plot include slope, aspect, landform, topographic position, soil texture, climate from nearest weather station, and trees per hectare (tph) and basal area for three most abundant tree species.
- Discussion of contrast of plots between vegetation classes and change over time.
- Data associated with individual trees will include tree species, height, canopy ratio, location, and mortality (Table D.4).
- Include summary of tree mortality by species for each plot (Table D.5).



Slope: xx	Aspect: xx
Landform: xx	Topographic position: xx
Soil texture: xx	
Annual precipitation: xx	Mean annual temperature: xx
tph PICSIT: xx	bsl area PICSIT: xx
tph THUPLI: xx	bsl area THUPLI: xx
tph TSUHET: xx	bsl area TSUHET: xx

Figure D.1. Graphic depiction of stand structure for a plot in the 0–300 m elevation stratum at Olympica National Park. The annual report would contain similar information for all plots in the network.

- Discussion should cover interesting changes in all variables presented on these figures.

Table D.4. Tree characteristics by plot for the annual report.

Stratum MORA-3 (partial list of plots; report in table will include all plots, all strata; values for illustration only).

		Percent of Tress																	
		Crown Class					Damage	Platforms			Cavities		Mistletoe						
Plot	Species	Open	Dominant	Co-dominant	Intermediate	Over-topped	Several categores	1 to 5	5 to 9	10 or more	< 15 cm	> 15 cm	< 50%	> 50%	Mortality (%)	Crown Ratio (average %)	DBH (average)	Height (averge)	Total No. Trees
MORA_3-012	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	1	30			20
	Abies amabilis	0	0	0	20	80		0			0	0	0	0	0	60			25
	Thuja plicata	0	0	0	0	100		0			0	0	0	0	0	50			5
MORA_3-015	Tsuga heterophylla																		
	Pseudotsuga menziesii																		
MORA_3-023	Tsuga heterophylla																		
	Pseudotsuga menziesii																		
	Abies amabilis																		
	Taxus brevifolia																		

Table D.5. Mortality rates by species by plot for the annual report. Information will be included for each plot; values are for illustration only.

Park/stratum	MORA-3			
Plot	MORA_3-012			
Start year	2008			
End year	2009			
Species	Number of stems in starting population	Total dead	Percent dead	Annual mortality rate*
Abies amabilis	25	0	0.0	0.0
Pseudotsuga menziesii	20	1	5.0	5.0
Tsuga heterophylla	45	0	0.0	0.0
Other species	5	0	0.0	0.0
Total	95	1	1.1	1.1

*Annual mortality rate is only different from percent dead if the interval between observations is more than one year (e.g., due to access difficulties). If so, mortality rate is calculated using the negative exponential formula (Sheil et al. 1995).

Table D.6. Mortality rates by species for combinations of park and elevation stratum for the annual report. Information will be included for all combinations of park and elevation stratum; values are for illustration only.

Park/stratum	OLYM-1			
Start year	2008			
End year	2009			
Species	Number of stems in starting population	Total dead	Percent dead	Annual mortality rate
Picea sitchensis	352	0	0.0	0.0
Thuja plicata	63	0	0.0	0.0
Tsuga heterophylla	954	5	0.5	0.5
Other species	81	0	0.0	0.0
Total	1451	5	0.3	0.3

Table D.7. Mortality rates by species by elevation stratum for the annual report. Information will be included for all elevation strata; values are for illustration only.

Stratum	3			
Start year	2008			
End year	2009			
Species	Number of stems in starting population	Total dead	Percent dead	Annual mortality rate
Pseudotsuga menziesii	6162	5	0.1	0.1
Thuja plicata	1782	0	0.0	0.0
Tsuga heterophylla	7881	20	0.3	0.3
Other species	1767	5	0.3	0.3
Total	17592	30	0.2	0.2

Table D.8. Mortality rates by species for the entire set of plots for the annual report. Values are for illustration only.

Start year	2008			
End year	2009			
Species	Number of stems in starting population	Total dead	Percent dead	Annual mortality rate*
Abies lasiocarpa	7679	10	0.1	0.1
Pseudotsuga menziesii	6198	8	0.1	0.1
Tsuga heterophylla	8835	30	0.3	0.3
Other species	8231	10	0.1	0.1
Total	31132	30	0.2	0.2

Wildlife Habitat

Table D.9. Number of trees having wildlife habitat features per plot average across plots within vegetation class and park.

Park/stratum	Platforms (numbers/tree)			Cavities (opening size)		Mistletoe (canopy affected)	
	1-5	5-9	10 or more	<15 cm	>15 cm	< 50%	> 50%
LEWI-1							
OLYM-1							
SAJH-1							
MORA-3							
NOCA-3							
OLYM-3							
MORA-6							
NOCA-6							

- 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

Literature Cited

Sheil, D., D. F. R. P. Burslem, and D. Alder. 1995. The interpretation and misinterpretation of mortality rate measures. Journal of Ecology **83**:331-333.

Appendix E. Conifer Forest and Woodland Vegetation Associations of North Cascades, Olympic and Mount Rainier National Parks

This list is from the recently-published vegetation classification for North Cascades, Olympic and Mount Rainier National Parks (Crawford et al., 2009). Vegetation associations sampled in this protocol are indicated in bold font. Vegetation associations are identified in the field by use of the key and descriptions in Crawford et al. (2009).

Abies amabilis-(Pseudotsuga menziesii)/Achlys triphylla-Tiarella trifoliata var. unifoliata Forest
Abies amabilis-(Pseudotsuga menziesii)/Vaccinium membranaceum/Achlys triphylla Forest
Abies amabilis-(Pseudotsuga menziesii-Abies procera)/Vaccinium membranaceum/Xerophyllum tenax Forest
Abies amabilis-(Pseudotsuga menziesii-Tsuga heterophylla)/Rhododendron macrophyllum Forest
Abies amabilis-(Tsuga heterophylla)/Vaccinium membranaceum Forest
Abies amabilis-(Tsuga heterophylla)/Vaccinium membranaceum-Vaccinium alaskaense Forest
Abies amabilis/Menziesia ferruginea Forest
Abies amabilis/Rhododendron albiflorum Forest
Abies amabilis/Rubus spectabilis-Vaccinium alaskaense Forest
Abies amabilis/Vaccinium membranaceum /Rubus lasiococcus Forest
Abies amabilis-Pseudotsuga menziesii/Achlys triphylla Forest
Abies amabilis-Tsuga heterophylla/Depauperate undergrowth Forest
Abies amabilis-Tsuga heterophylla/Oplopanax horridus Forest
Abies amabilis-Tsuga heterophylla/Rubus pedatus-Tiarella trifoliata var. unifoliata Forest
Abies amabilis-Tsuga mertensiana/Menziesia ferruginea Forest
Abies amabilis-Tsuga mertensiana/Oplopanax horridus Forest
Abies amabilis-Tsuga mertensiana/Streptopus lanceolatus var. curvipes Forest
Abies amabilis-Tsuga mertensiana/Vaccinium membranaceum/Rubus lasiococcus Forest

Abies grandis/Bromus vulgaris-Polystichum munitum Forest

Abies lasiocarpa Krummholz Shrubland
Abies lasiocarpa-(Abies amabilis)/Menziesia ferruginea Forest
Abies lasiocarpa-(Abies amabilis)/Vaccinium membranaceum/Valeriana sitchensis Forest
Abies lasiocarpa-(Abies amabilis)/Vaccinium membranaceum/Xerophyllum tenax Forest
Abies lasiocarpa-(Picea engelmannii)/Rhododendron albiflorum Forest
Abies lasiocarpa-(Pinus contorta)/Juniperus communis-Lomatium martindalei Woodland
Abies lasiocarpa-(Pinus contorta)/Lupinus (arcticus, latifolius) Woodland
Abies lasiocarpa-(Pseudotsuga menziesii)/Vaccinium membranaceum/Calamagrostis rubescens Forest
Abies lasiocarpa-(Tsuga mertensiana)/Eucephalus ledophyllus-Lupinus (arcticus, latifolius) Woodland
Abies lasiocarpa-(Tsuga mertensiana)/Festuca viridula Woodland
Abies lasiocarpa/Erythronium montanum Forest
Abies lasiocarpa/Polemonium pulcherrimum-Pedicularis racemosa Woodland
Abies lasiocarpa/Rhododendron albiflorum/Rubus lasiococcus Forest
Abies lasiocarpa/Rubus spectabilis Forest
Abies lasiocarpa/Vaccinium deliciosum Woodland

Abies lasiocarpa/Vaccinium membranaceum/Lupinus (arcticus ssp. subalpinus,latifolius) Woodland
Abies lasiocarpa/Vaccinium ovalifolium (alaskaense)/Lupinus (arcticus, latifolius) Woodland
Abies lasiocarpa/Vaccinium scoparium/Valeriana sitchensis Woodland
Abies lasiocarpa/Valeriana sitchensis Forest
Abies lasiocarpa/Veratrum viride Woodland
Abies lasiocarpa-Cupressus nootkatensis/Mahonia nervosa/Valeriana sitchensis Forest
Abies lasiocarpa-Picea engelmannii/Linnaea borealis Woodland
Abies lasiocarpa-Picea engelmannii/Phyllodoce empetriformis Woodland
Abies lasiocarpa-Picea engelmannii/Vaccinium scoparium Woodland
Abies lasiocarpa-Pseudotsuga menziesii/Calamagrostis rubescens Woodland
Abies lasiocarpa-Pseudotsuga menziesii/Mahonia nervosa Forest
Abies lasiocarpa-Tsuga mertensiana/Vaccinium scoparium Woodland

Cupressus nootkatensis/Oplopanax horridus-(Alnus viridis ssp. sinuata) Woodland
Cupressus nootkatensis/Ribes lacustre Forest
Cupressus nootkatensis/Streptopus lanceolatus var. curvipes Forest
Cupressus nootkatensis/Vaccinium deliciosum Woodland
Cupressus nootkatensis/Valeriana sitchensis Forest
Cupressus nootkatensis-Pseudotsuga menziesii/Acer circinatum Forest

Larix lyallii/Cassiope mertensiana-Luetkea pectinata Woodland
Larix lyallii/Vaccinium deliciosum Woodland
Larix lyallii/Vaccinium scoparium/Luzula glabrata var. hitchcockii Woodland

Picea engelmannii/Equisetum arvense Forest

Picea sitchensis-(Alnus rubra)/Rubus spectabilis/Polystichum munitum Forest
Picea sitchensis/Calamagrostis nutkaensis Woodland
Picea sitchensis/Gaultheria shallon Forest
Picea sitchensis/Maianthemum dilatatum Forest
Picea sitchensis/Rubus spectabilis/Carex obnupta-Lysichiton americanus Forest
Picea sitchensis/Scirpus microcarpus Woodland
Picea sitchensis/Vaccinium ovatum Forest
Picea sitchensis-Tsuga heterophylla-(Alnus rubra)/Oplopanax horridus/Polystichum munitum Forest
Picea sitchensis-Tsuga heterophylla/Polystichum munitum Forest
Picea sitchensis-Tsuga heterophylla/Polystichum munitum-Oxalis oregana Forest

Pinus albicaulis Krummholz Shrubland
Pinus albicaulis-(Abies lasiocarpa)/Vaccinium scoparium-Luzula glabrata var. hitchcockii Woodland
Pinus albicaulis-(Tsuga mertensiana)/Luzula glabrata var. hitchcockii Woodland
Pinus albicaulis/Calamagrostis rubescens Woodland
Pinus albicaulis/Festuca viridula Woodland
Pinus albicaulis/Juniperus communis Woodland

Pinus contorta var. contorta/Ledum groenlandicum/Sphagnum spp. Woodland
Pinus contorta var. contorta-Pseudotsuga menziesii/Gaultheria shallon Forest
Pinus contorta/Paxistima myrsinites/Calamagrostis rubescens Forest
Pinus contorta/Vaccinium membranaceum Woodland

Pinus ponderosa/Pseudoroegneria spicata Woodland

Pinus ponderosa-Pseudotsuga menziesii/Purshia tridentata Woodland

Pseudotsuga menziesii-(Abies grandis)/Acer circinatum/Paxistima myrsinites Forest
Pseudotsuga menziesii-(Abies grandis)/Acer circinatum/Polystichum munitum Forest
Pseudotsuga menziesii-(Alnus rubra-Tsuga heterophylla)/Rubus spectabilis Forest
Pseudotsuga menziesii-(Pinus contorta)/Arctostaphylos uva-ursi/Racomitrium canescens Woodland
Pseudotsuga menziesii-(Pinus contorta)/Vaccinium myrtillus Woodland
Pseudotsuga menziesii-(Pinus ponderosa)/Symphoricarpos albus Forest
Pseudotsuga menziesii-(Thuja plicata-Abies grandis)/Vaccinium membranaceum Forest
Pseudotsuga menziesii-(Tsuga heterophylla)/Acer circinatum-Paxistima myrsinites Forest
Pseudotsuga menziesii/Acer circinatum/Mahonia nervosa Forest
Pseudotsuga menziesii/Achlys triphylla Forest
Pseudotsuga menziesii/Gaultheria shallon-Holodiscus discolor Forest
Pseudotsuga menziesii/Gaultheria shallon-Mahonia nervosa/Polystichum munitum Forest
Pseudotsuga menziesii/Gaultheria shallon-Vaccinium parvifolium Forest
Pseudotsuga menziesii/Holodiscus discolor/Calamagrostis rubescens Forest
Pseudotsuga menziesii/Holodiscus discolor-Rosa gymnocarpa/Festuca occidentalis Forest
Pseudotsuga menziesii/Mahonia nervosa/Achlys triphylla Forest
Pseudotsuga menziesii/Mahonia nervosa/Calamagrostis rubescens Forest
Pseudotsuga menziesii/Paxistima myrsinites-Spiraea betulifolia Woodland
Pseudotsuga menziesii/Vaccinium caespitosum Forest
Pseudotsuga menziesii/Vaccinium membranaceum Forest
Pseudotsuga menziesii-Abies grandis/Calamagrostis rubescens Woodland
Pseudotsuga menziesii-Abies grandis/Mahonia nervosa-Gaultheria shallon/Polystichum munitum Forest
Pseudotsuga menziesii-Abies grandis/Spiraea betulifolia Forest
Pseudotsuga menziesii-Pinus contorta/Arctostaphylos nevadensis Woodland
Pseudotsuga menziesii-Pinus ponderosa/Arctostaphylos nevadensis Woodland
Pseudotsuga menziesii-Pinus ponderosa/Calamagrostis rubescens Forest
Pseudotsuga menziesii-Pinus ponderosa-Populus balsamifera/Acer circinatum Forest
Pseudotsuga menziesii-Tsuga heterophylla/(Acer circinatum)/Polystichum munitum Forest
Pseudotsuga menziesii-Tsuga heterophylla/Achlys triphylla Forest
Pseudotsuga menziesii-Tsuga heterophylla/Depauperate undergrowth Forest
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon/Polystichum munitum Forest
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon/Xerophyllum tenax Forest
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Holodiscus discolor Forest
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Mahonia nervosa Forest
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon-Vaccinium parvifolium Forest
Pseudotsuga menziesii-Tsuga heterophylla/Mahonia nervosa Forest
Pseudotsuga menziesii-Tsuga heterophylla/Mahonia nervosa-Polystichum munitum Forest
Pseudotsuga menziesii-Tsuga heterophylla/Paxistima myrsinites/Linnaea borealis Forest
Pseudotsuga menziesii-Tsuga heterophylla/Polystichum munitum-Oxalis oregana Forest
Pseudotsuga menziesii-Tsuga heterophylla/Rhododendron macrophyllum Forest
Pseudotsuga menziesii-Tsuga heterophylla/Rhododendron macrophyllum/Polystichum munitum Forest
Pseudotsuga menziesii-Tsuga heterophylla/Vaccinium alaskaense/Xerophyllum tenax Forest

Thuja plicata-Tsuga heterophylla/Lysichiton americanus/Sphagnum spp. Woodland
Thuja plicata-Tsuga heterophylla/Vaccinium ovatum Forest

Tsuga heterophylla-(Abies amabilis)/Gaultheria shallon/Blechnum spicant Forest
Tsuga heterophylla-(Pseudotsuga menziesii)/Tiarella trifoliata-Gymnocarpium dryopteris Forest
Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskaense/Cornus unalaschkensis Forest

Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskaense/Polystichum munitum Forest
Tsuga heterophylla-(Pseudotsuga menziesii)/Vaccinium alaskaense-Mahonia nervosa-(Gaultheria shallon) Forest
Tsuga heterophylla-(Pseudotsuga menziesii-Thuja plicata)/Polystichum munitum-Athyrium filix-femina Forest
Tsuga heterophylla-(Thuja plicata)/Ledum groenlandicum/Sphagnum spp. Woodland
Tsuga heterophylla-(Thuja plicata-Alnus rubra)/Lysichiton americanus-Athyrium filix-femina Forest
Tsuga heterophylla/Gaultheria shallon/Polystichum munitum-Blechnum spicant Forest
Tsuga heterophylla/Polystichum munitum-Blechnum spicant Forest
Tsuga heterophylla/Polystichum munitum-Oxalis oregana Forest
Tsuga heterophylla/Vaccinium alaskaense/Oxalis oregana Forest
Tsuga heterophylla-Abies amabilis-(Pseudotsuga menziesii)/Vaccinium alaskaense Forest
Tsuga heterophylla-Abies amabilis-(Thuja plicata)/Vaccinium alaskaense/Blechnum spicant Forest
Tsuga heterophylla-Abies amabilis/Blechnum spicant-Tiarella trifoliata-Polystichum munitum Forest
Tsuga heterophylla-Abies amabilis/Oxalis oregana-Blechnum spicant Forest
Tsuga heterophylla-Abies amabilis/Vaccinium alaskaense/Lysichiton americanus Forest
Tsuga heterophylla-Abies amabilis/Vaccinium alaskaense/Rubus pedatus Forest
Tsuga heterophylla-Abies amabilis/Vaccinium alaskaense/Tiarella trifoliata var. unifoliata Forest
Tsuga heterophylla-Abies amabilis-Pseudotsuga menziesii/Gaultheria shallon Forest
Tsuga heterophylla-Abies amabilis-Pseudotsuga menziesii/Mahonia nervosa Forest
Tsuga heterophylla-Pseudotsuga menziesii-(Thuja plicata)/Oplopanax horridus/Polystichum munitum Forest
Tsuga heterophylla-Pseudotsuga menziesii/Mahonia nervosa-Chimaphila menziesii Forest
Tsuga heterophylla-Pseudotsuga menziesii/Vaccinium alaskaense/Oxalis oregana Forest
Tsuga heterophylla-Thuja plicata-(Abies amabilis)/Gaultheria shallon/Blechnum spicant Forest
Tsuga heterophylla-Thuja plicata/Gaultheria shallon/Lysichiton americanus Forest
Tsuga heterophylla-Thuja plicata/Taxus brevifolia Forest

Tsuga mertensiana-(Abies amabilis-Abies lasiocarpa)/Luzula glabrata var. hitchcockii Woodland
Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum Woodland
Tsuga mertensiana-Abies amabilis-(Cupressus nootkatensis)/Elliottia pyroliflorus-Vaccinium membranaceum Woodland
Tsuga mertensiana-Abies amabilis/Caltha leptosepala Woodland
Tsuga mertensiana-Abies amabilis/Depauperate undergrowth Forest
Tsuga mertensiana-Abies amabilis/Rhododendron albiflorum Forest
Tsuga mertensiana-Abies amabilis/Vaccinium alaskaense/Maianthemum dilatatum Forest
Tsuga mertensiana-Abies amabilis/Vaccinium alaskaense/Rubus pedatus Forest
Tsuga mertensiana-Abies amabilis/Vaccinium membranaceum/Valeriana sitchensis Woodland
Tsuga mertensiana-Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax Forest
Tsuga mertensiana-Abies lasiocarpa/Alnus viridis ssp. sinuata Woodland
Tsuga mertensiana-Abies lasiocarpa/Vaccinium deliciosum-Phyllodoce empetriformis Woodland

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Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Natural Resource Technical Report NPS/NCCN/NRTR—2009/D-586. National Park Service, Fort Collins, Colorado.

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