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Monitoring Vegetation Composition, Structure, and Function in the Parks of the Klamath Network

Natural Resource Report NPS/KLMN/NRR—2011/401

ON THE COVER
Douglas-fir (*Pseudotsuga menziesii*) at Oregon Caves National Monument.
Photograph by: Daniel Sarr

Monitoring Vegetation Composition, Structure, and Function in the Parks of the Klamath Network

Natural Resource Report NPS/KLMN/NRR—2011/401

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Revision History Log

Details on the procedure for protocol revisions are described in SOP #16: Revising the Protocol.

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

1.0 Background and Objective

1.1 Rationale for Monitoring Vegetation Composition and Structure

The development of the Klamath Network vital signs monitoring has emphasized the importance of documenting status and trends in the composition, structure, and function of ecosystems. Vegetation is a foundation for terrestrial ecosystem composition, structure, and function. Vegetation also ranked among the highest potential vital signs for monitoring in the Network's vital signs selection process. The reasons are simply that vegetation dominates biomass and energy pathways and defines the habitat for most other forms of life. Changes in vegetation composition, structure, and function will therefore have a profound effect on ecosystems. Monitoring vegetation change is thus imperative to detecting and understanding status and trends in park ecosystem vital signs, the overriding goal of NPS Inventory and Monitoring.

The vegetation of the Klamath parks contributes to the unique and renowned biodiversity of the region (for park descriptions of biodiversity and summaries of vegetative resources, see: http://science.nature.nps.gov/im/units/klmn/Monitoring/Documents/PhaseII/Appendix_A_Park_Profiles.pdf). The importance of the Klamath Region as a floristic center of diversity for western North America has been recognized in classic papers by Whittaker (1960, 1961) and Stebbins and Major (1965). This diversity is paralleled in other life forms, leading to the area being highlighted for its global biodiversity significance (DellaSala et al. 1999). The biological wealth of the region is generally attributed to the remarkable array of geologic parent materials and climates present (Wallace 1983) and the role the region played as a refugium during glacial maxima (Whittaker 1960, 1961). Disturbances such as fire have also been instrumental in producing spatial and temporal heterogeneity that promotes diversity (Taylor and Skinner 1998, Odion et al. 2004). Taylor and Skinner point out that, ―Few forested regions have experienced fires as frequently and with such high variability in fire severity as those in the Klamath Mountains."

Natural processes that have shaped vegetation inside and outside parks have been directly affected by a variety of land use activities, fire suppression/management, plus climate/atmospheric changes and many other anthropogenic factors (see conceptual models in section 1.4). Vegetation sampling can help document changes in species composition, structure, and function that occur as a result of these processes.

The vegetation monitoring will also complement monitoring of another driver of change: non-native species invasion. The Network has another vital sign specific to invasive species in areas predicted to be most susceptible to invasion: road, and trail corridors. However, there remains a need to sample parks more broadly for invasive species, and to determine trends in well established invasive species. In some park settings, invasives are causing significant impacts to vegetation composition, structure, and function. Therefore, the vegetation protocol is needed to support both invasive species and general vegetation monitoring goals.

Some aspects of vegetation change will be monitored by other protocols and thus do not need to be part of the vegetation protocol. For instance, the land cover protocol should provide extensive, but spatially less detailed information about vegetation structure. It will quantify the extent of vegetation formations and their patch size, configuration, and connectivity. It will also provide information about spatial patterns of disturbance. The whitebark pine protocol will monitor disturbances by diseases and insects in high elevation forests at plots that are co-located with vegetation plots. But the specific disease and insect sampling protocols are additions to the vegetation sampling under this protocol. The cave protocol will monitor the unique vegetation (non-vascular) at cave entrances, which are numerous at Lava Beds, but which will not be targeted with the probabilistic vegetation sampling design here. The intertidal protocol will monitor algae vegetation, which is abundant and diverse along the rocky coastline of Redwood National and State Parks. Finally, the aquatic protocols for streams and lakes will monitor aquatic macrophytes and periphyton (algae mixed with bacteria and other microorganisms). Also, many vegetation monitoring plots are co-located with landbird monitoring sites, which can help to identify habitat changes associated with trends in bird populations. Thus, the vegetation monitoring protocol plays a central role in the overall vital signs monitoring strategy of the Klamath Network.

1.2 Link to National Strategy

Many parks and networks are working on vegetation protocols collaboratively and individually. The objectives differ from network to network, but there are commonalities. In developing this protocol, we have adopted many field procedures used to monitor vegetation at Great Smoky Mountains National Park since 1978. The Smokies, like the Klamath Region, are a mountainous landscape of notable biodiversity, owing to their functioning as a glacial refugium. Biogeographically, the Klamath and Smokies are western and eastern North American counterparts (Whittaker 1961). Coincidentally, the existing Smokies vegetation protocol addresses many of the Klamath Network’s fundamental goals and perspectives for vegetation monitoring. We complemented the Smokies protocols with several additional monitoring procedures to meet the specific goals of the Klamath Network parks and to crosswalk with the other major vegetation monitoring programs on public land (the US Forest Service Forest Inventory and Analysis [FIA] monitoring and the NPS fire monitoring). Therefore, our vegetation protocol is consistent with a proven, national approach to vital signs monitoring in a biologically diverse region but is further refined to address the specific needs of the Klamath parks and to crosswalk with other monitoring.

1.3 Monitoring History

Several vegetation monitoring programs have been conducted in the parks of the Klamath Network in the past, ranging from broad, systematic monitoring of forest resources to fire-effects monitoring. The US Forest Service maintains FIA plots in the parks. The FIA program uses a systematic design to detect change in forest ecosystems and has been in place for decades. This work has been conducted by Forest Service field crews and has not involved park staff. Comprehensive reports for entire western states have recently been released for California and Oregon (Christensen et al. 2009a, 2009b). These present, “basic resource information such as forest area, land use change, ownership, volume, biomass, and carbon sequestration; structure and function topics such as biodiversity, older forests, dead wood, and riparian forests; disturbance topics such as insects and diseases, fire, invasive plants, and air pollution; and information about the forest products industry, including data on tree growth and mortality, removals for timber products, and nontimber forest products.” No park-specific information or analyses are part of these reports. The number of FIA plots that exist in the parks is modest (Table 1). In addition, only a portion of FIA plots have sampling that includes understory vegetation. These are sites sampled under the Forest Health and Monitoring Program that nest within the broader FIA framework. Thus, FIA monitoring will provide complementary, but much less detailed information at the scale of parks than this vegetation monitoring protocol.

Table 1. US Forest Service Inventory and Analysis plots in the park units of the Klamath Network.

Park Unit	Crater Lake	Lassen Volcanic	Lava Beds	Oregon Caves	Redwood	Whiskeytown
FIA Plots	28	13+	6-8	0	15-17	8-10

There are numerous plots in the Network parks that have been sampled as part of the NPS Fire Monitoring program in the parks. The methods are laid out in the NPS Fire Monitoring Handbook (FMH). These plots are sampled both before and after prescribed burns, wildfires (when unburned plots happen to burn in unplanned fires), and in vegetation treatments aimed at fire mitigation. This monitoring provides useful information about effects of prescribed fires, wildfires, and vegetation treatments, but there are important limitations. There are generally very few plots per burn or treatment unit and these are limited to select, homogeneous areas. There are typically no plots outside of burns or treatment units to serve as long-term controls and information on species diversity and species lists obtained from plots may be incomplete or unverified. Accordingly, the FMH monitoring will primarily complement the Network's monitoring by providing compatible information on parameters related to structure (including down wood and litter) and invasive species from the same sized plots in areas that are treated or that burn in wildfires. These areas are likely to be significantly undersampled by this protocol. The Klamath Network vegetation monitoring has the potential to complement FMH monitoring by sampling areas largely unaffected by prescribed fires or burned in wildfires, which can act as controls.

Although the monitoring we developed is not exactly the same as FMH or especially FIA monitoring, the existence of these two monitoring programs had an important influence on specific measures we chose. In order to complement and crosswalk our data to FIA and FMH monitoring, it was necessary for the Klamath Network vegetation monitoring to use, where possible, the same tree and fuel size classes and other categories (e.g., decay classes, terrain position classes, canopy height, etc.). In addition, the FIA and FMH monitoring protocols are described in detail and field tested, so we relied on the sampling manuals from the two programs to describe many general activities related to vegetation monitoring. A good example is our adoption of the FIA procedure for determining canopy base height. We present a table comparing FIA, FMH, and Klamath Network vegetation monitoring methods for easy, direct comparison (Appendix E).

There has also been a wide variety of park-specific vegetation sampling done in recent decades. Numerous agency and university researchers have worked on individual vegetation projects in all the parks using a variety of methods. Some of this work has been published, for example, the classic work of Robert Whittaker in the Siskiyous (Whittaker 1960), which sampled the Oregon Caves area (including the proposed monument expansion area) and the analysis of forest vegetation and environmental relationships in Lassen Volcanic by Albert Parker (1991). Relocating previous sampling locations or designing the Network's vegetation monitoring to complement past vegetation sampling by individual researchers does not appear possible. However, we will be able to compare our findings in meta-analyses.

1.4 Network Vegetation Monitoring Conceptual Modeling

The Network developed its monitoring plan with the use of conceptual models (Sarr et al. 2007, http://science.nature.nps.gov/im/units/klmn/Monitoring/MON_Phase_III.cfm) that provide the foundation for the Network's approach to monitoring the composition, structure, and function of ecosystems (Figure 1). Composition is the array of ecosystem components (genes, species, populations, special habitats, etc.). Structure refers to the spatial arrangement of physical components, such as canopy structure or corridors for species movement. Ecosystem function refers to the many processes that ecosystems require and provide through time, such as nutrient cycling, carbon cycling, hydrologic cycling, etc, which interact with disturbance processes, biological interactions (e.g., interspecific competition) and demographic and reproductive processes (Figure 1).

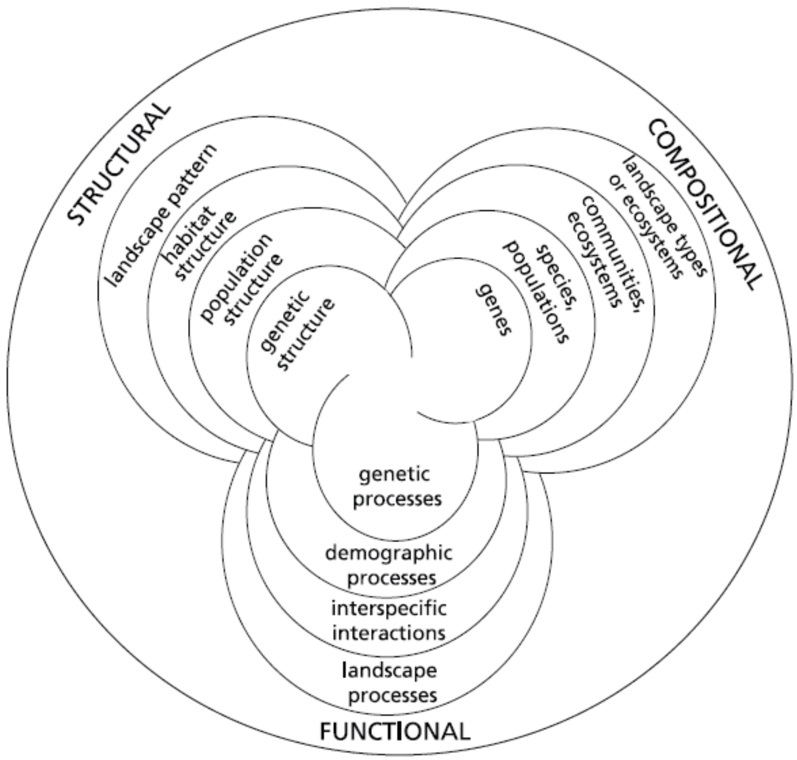

Figure 1. Conceptual model of the composition, structure, and function across levels of scale and biological organization (from Noss 1990).

Our holistic conceptual model (Figure 2) was developed through discussions with Network and park-based science staff and summarizes our view of the major influences on park ecosystems. These influences are abiotic, biotic, dynamic, and human environments that shape the composition, structure, and function of park ecosystems, with humans as a major influence in these ecosystems. A core concept of the Klamath Network monitoring program is that ecosystem composition, structure, and function can be used to assess the ecological integrity of park ecosystems as affected by humans (Figure 3). For terrestrial ecosystems, vegetation is a key determinant of these core ecosystem attributes at the landscape scale.

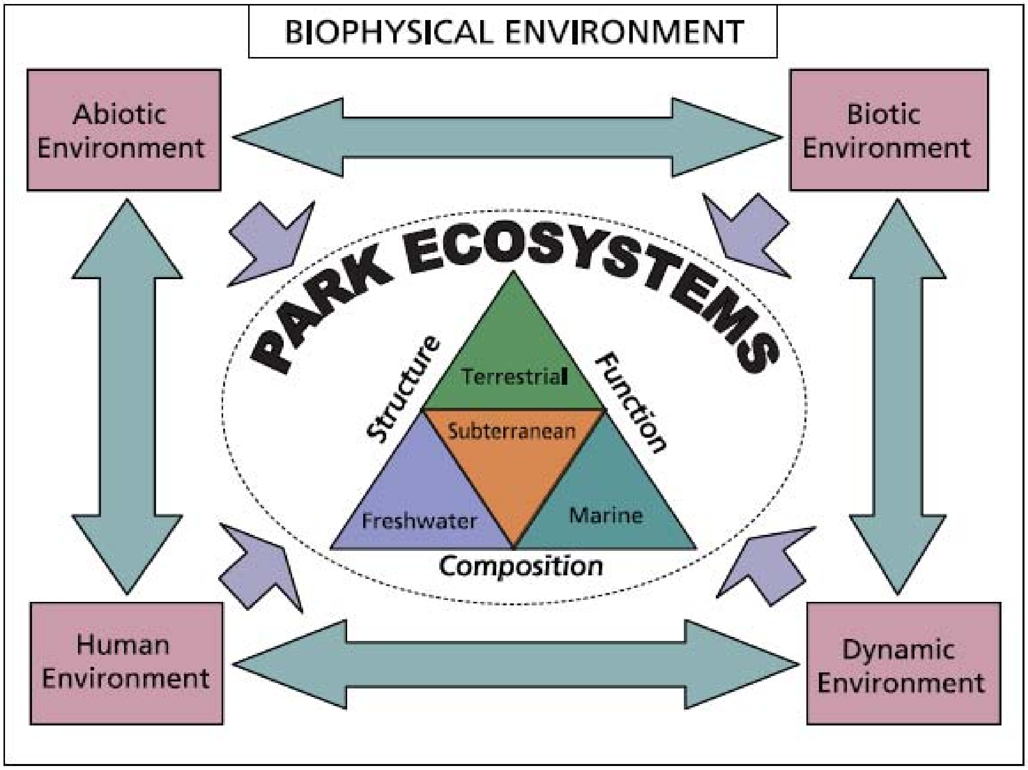

Figure 2. A holistic conceptual model of influences on Klamath park ecosystems.

A central goal of the long-term monitoring program is to detect changes that we suspect are caused by detrimental human actions. Potential sources of harm can come from near-field activities (e.g., campgrounds, local management actions, such as those related to fire, and point-source pollution) or from far-field effects (e.g., off-site pollution, climate change, and invasive species). Together, these stressors can affect the composition, structure, and function of park ecosystems, endangering their diversity and integrity (Figure 3).

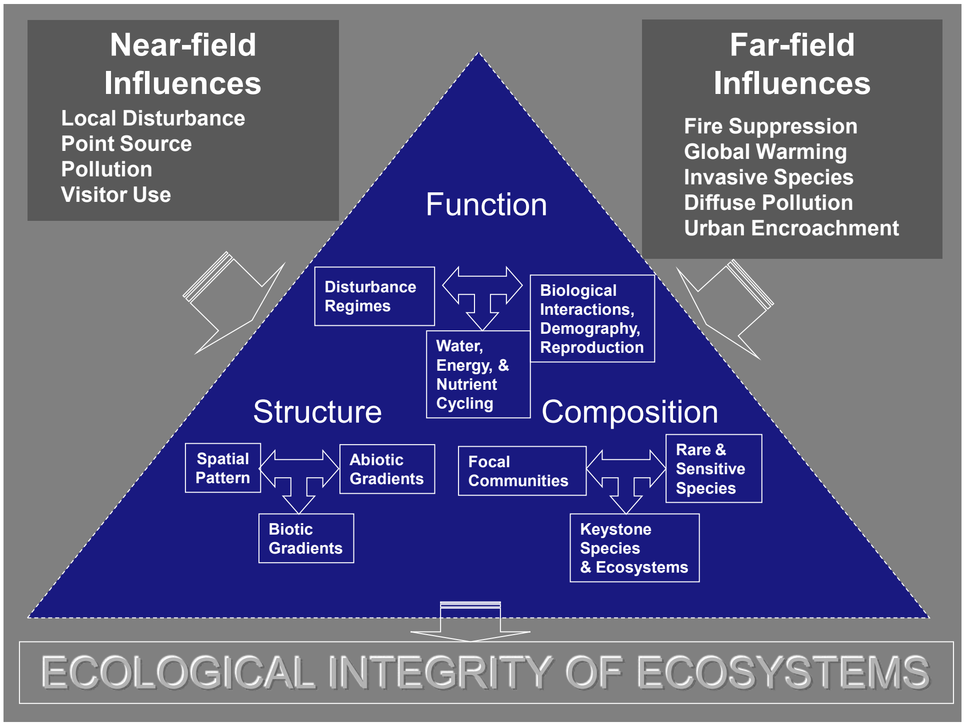

Figure 3. Human Influences on the structure, function, and composition of ecosystems.

Threats to terrestrial ecosystems range from local visitor use effects on individual species and ecosystems (e.g., trail development and stock use), to more widespread and diffuse effects, such as non-native plant and animal species introductions, and fire management or suppression treatments (Figure 4). These influences affect the structure of the habitat template, particularly the environmental gradients, disturbance regimes, and landscape patterns that create habitat for ecosystems, communities, and species of interest.

Approaches that monitor the status and trends in composition, structure, and function of ecosystems place greater emphasis on the types and degrees of relationships among different organisms in a community than more taxon-specific approaches. Traditional descriptive sampling of these relationships is often based on changes that occur along environmental gradients. Gradient relationships often emerge from multispecies sampling data, such as vegetation cover data for individual species. Multivariate approaches for analyzing these types of data may cause gradient relationships to emerge from the data at each time of sampling and allow determination of how these relationships change over time. Multivariate analysis of species composition data are therefore a key component of our data analysis (SOP #12: Reporting and Analysis of Data). How these gradient relationships among species change over time is likely to provide fundamental information about ecological integrity and can be a powerful way to initially detect change. For example, Manley et al. (2004) argue that a diversified, multispecies approach is the most comprehensive way to ensure that important trends are detected. In particular, we recognize conceptually that monitoring multiple species or attributes together may track changes in ecosystem composition, structure, and function better than taxonomic or functional groups (e.g., better than graminoids or hardwoods would detect change).

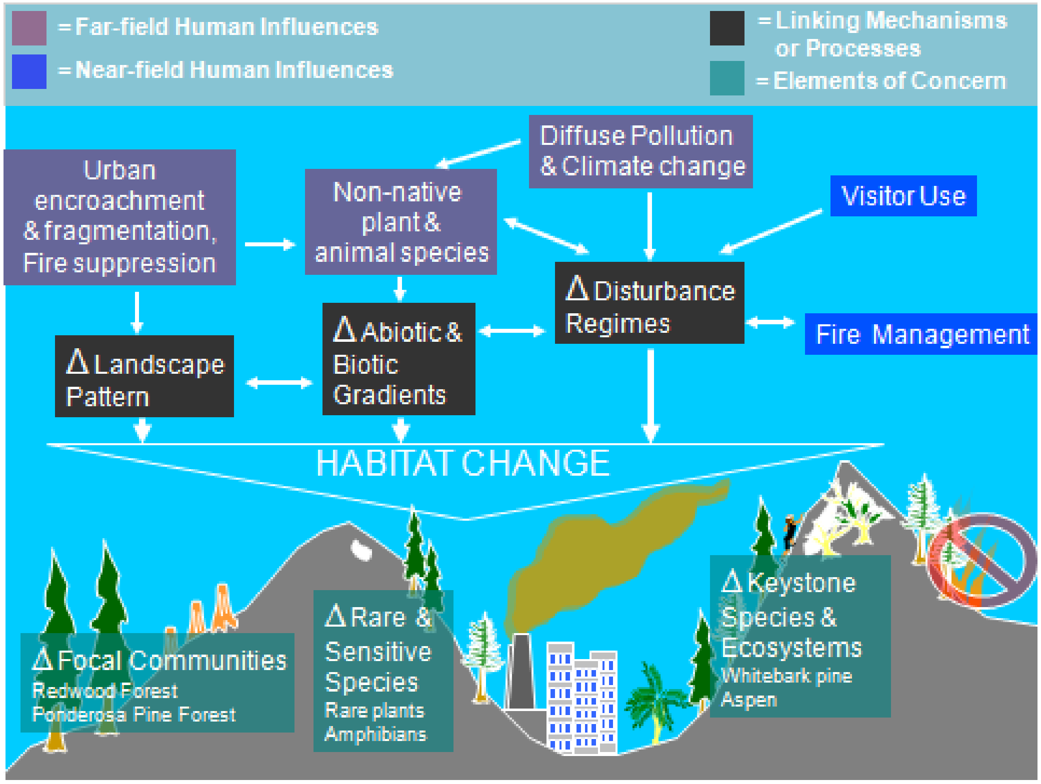

Figure 4. A conceptual model illustrating some key human influences on terrestrial ecosystems.

1.5 Vital Sign Objectives

The monitoring and sampling objectives for this protocol were largely determined at the two initial scoping meetings with Network plant ecologists and park vegetation and resource experts. Further refinement was done by the authors during the writing of this protocol based on additional study and assessment of other vital signs monitoring by the Klamath Network. Review of other networks' vegetation monitoring protocols, FIA and FMH approaches, and the results of the pilot study (Appendix A) also led to refinements of this protocol.

1.5.1 Monitoring Objectives

1. Describe the composition, structure, and function of vegetation communities in Klamath Network parks by installing and sampling a network of permanent plots established with a probabilistic sample design in safe, relatively accessible areas.
2. Quantify temporal and spatial change in these factors through the re-measurement of permanent plots.
3. Sample communities of special concern (alpine and riparian) at greater intensities to allow improved statistical sensitivity to ecological change and better identification of emerging threats.
4. Co-locate some vegetation plots with bird and stream sampling locations to provide more comprehensive status and trend data and evaluate interrelationships among biota.

2.0 Sampling Design and Rationale

The spatial sampling design was created to ensure that field data are statistically robust and could be collected by seasonal field crews safely and feasibly. The sampling focuses more intensively on special interest vegetation.

2.1 Special Interest Vegetation

Special interest vegetation types delineated under this protocol included riparian and wetland vegetation throughout the Network (except Lava Beds, where absent), and sensitive high elevation sites at Crater Lake, Lassen Volcanic, and the top of Shasta Bally, the highest peak in Whiskeytown. Additional special interest vegetation that will be monitored under different protocols, or by individual parks, is described in Table 2.

Table 2. Special interest vegetation in the Klamath Network that will be monitored under different protocols, by individual parks, or that may not be formally monitored.

Special interest vegetation	Protocol monitored under
Cave entrance community	Cave entrance community, I&M Protocol
Whitebark pine	Whitebark pine I&M Protocol (co-implemented)
Chaparral (Crater Lake)	Land cover I&M Protocol
Montane meadows	Land cover I&M Protocol
Coastal vegetation, bald hills	Will be monitored by Redwood
Puccinellia meadow and old growth at Whiskeytown, serpentine at Redwood	None (may get monitored by park)

2.2 Location of Plots

We used the Generalized Random Tessellation Stratified (GRTS) method (Stevens and Olsen 2003, 2004) for plot location within the three sample frames (matrix, riparian/wetland, and sensitive high elevation). GRTS produces a spatially balanced design if points are used in the order in which they are chosen by GRTS. This makes it easy to discard sampling locations if found unsuitable and have a ready set of additional points from which to draw a new sample. This is valuable because any plot found to be too steep, dangerous, or barren (e.g., talus) upon arrival in the field will be considered unsuitable and not be included in long-term monitoring. Plots will also be discarded if travel times prove to be excessive on the first visit.

2.3 Sampling Frames

2.3.1 All Vegetation

Due to budget constraints and safety considerations, it was necessary to limit sampling by accessibility. We therefore excluded areas more than 1 km from a road or trail. We chose to avoid steep slopes (>30^{o}) and areas too dangerous to sample for reasons other than slope (e.g., barren lava flows, talus, scree slopes). We also did not want to sample roadside or trailside environments, which are being sampled by the Invasive Species Early Detection Protocol (Odion et al. 2010). Areas that are excluded from our spatial sampling frame are listed in Table 3. By using road coverages and excluding areas within 100 m of a road, all paved and administrative areas were dropped from the sampling frames via GIS. Coverages of the lava flows at Lava Beds were acquired from the park. The inner caldera of Crater Lake was all eliminated due to its steepness and instability. Lakes were not eliminated, but no points landed within them. Some plot locations will be rejected after inspection in the field due to factors that could not be screened out by the GIS analyses.

Table 3. Areas that will not be sampled as part of the vegetation monitoring protocol.

Park Unit	Area excluded	Reason
All	Slopes greater than 30 degrees, locations less than 100 m from a road or trail, or farther than 1 km from a road or trail. Areas that meet the sampling criteria that are smaller than 2.5 ha	Too dangerous or inaccessible. Sampling plots on steep slopes causes significant soil and vegetation trampling disturbance.
Crater Lake National Park	Inner rim of caldera	Most of the area located within the caldera is highly unstable, surrounded by cliffs, or is part of Crater Lake itself, making access dangerous and/or difficult, or a time-consuming boat ride would be required.
Lassen Volcanic National Park	Talus slopes	Little or no vegetation, very slow travel time, dangerous.
Lava Beds National Monument	Callahan and Devil's Homestead flows, scree slopes on cinder cones; Riparian and high elevation areas	Little or no vegetation on lava flows. Safety concerns on lava flows which are composed of very sharp rock. Riparian and high elevation areas are lacking in the park.
Oregon Caves National Monument	High elevation areas	Limited to a very small area. Sample size would be too small.
Redwood National Park	High elevations	High elevation areas are lacking.

We used GIS to develop shapefiles of the acceptable sampling domains for matrix, riparian, and high elevation areas of all parks, with areas shown in Table 3 excluded. Then, all parcels that were acceptable based on these criteria that were 2.5 ha or less in size were also excluded. This systematically eliminated polygons whose dimensions made it difficult or impossible to encompass a plot. The sampling frames are shown in Figure 5. We used GRTS to create a list of sampling locations, including an oversample. Sampling locations are shown, in Figure 6 in relation to topography. The file names and their locations are found in Appendix D.

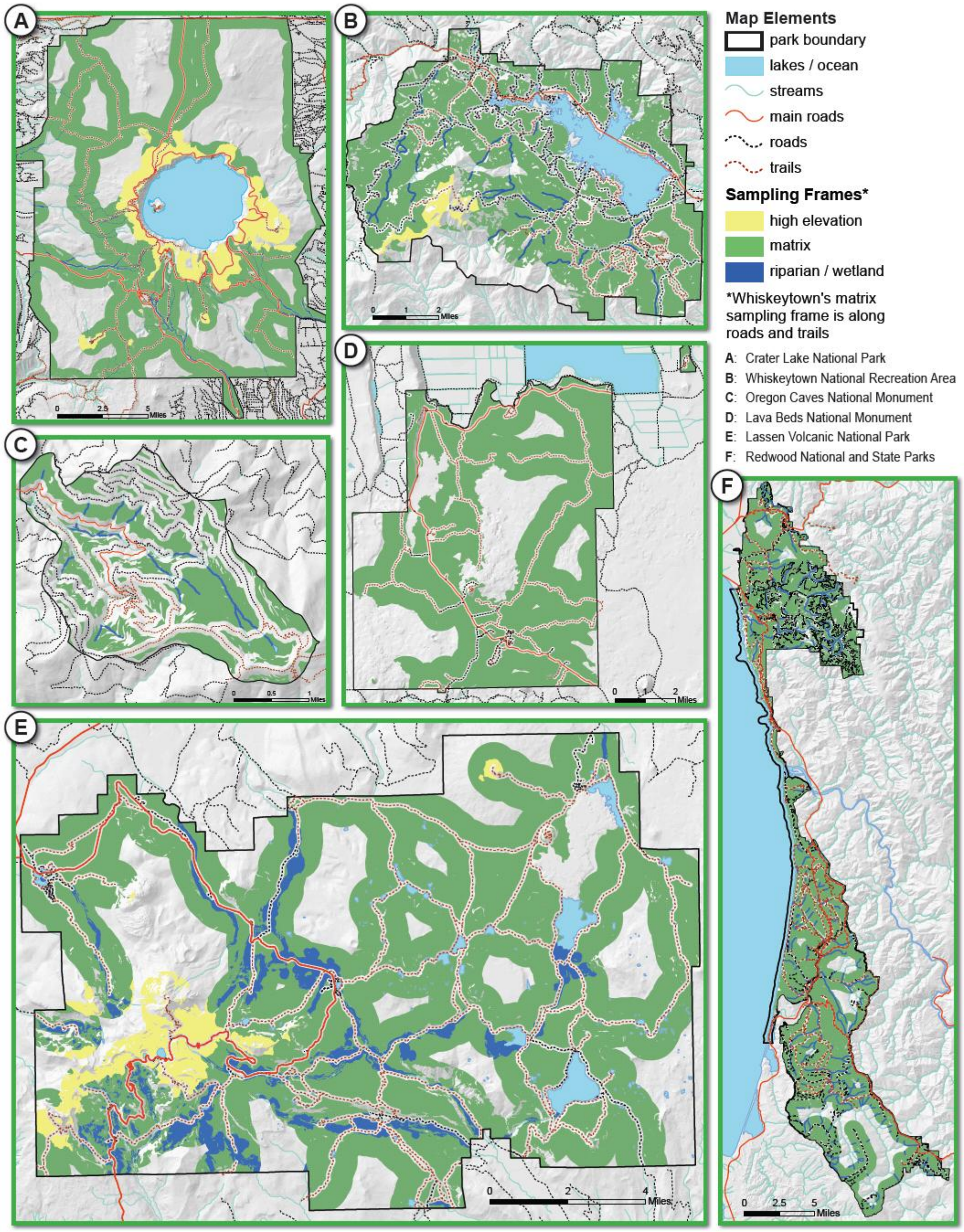

Figure 5. High elevation, matrix, and riparian/wetland sampling frames for all six parks. A = Crater Lake, B = Whiskeytown, C = Oregon Caves, D = Lava Beds, E = Lassen Volcanic, F = Redwood.

2.3.2 Comparison of Sampling Frames to Park-wide Environments

Table 4 compares the elevations sampled by the sampling frames with park-wide elevation parameters. Although their areas are smaller, the sampling frames at each park encompass most of the elevations that exist throughout the parks. Because rainfall variation within parks is largely a function of elevation, spatial variation in rainfall levels within each park should be captured by the sampling frames.

Table 4. Area (km2) and elevation (m) in each park as well as the composite of all sampling frames for each park.

			Elevation (m)				
		Area (km^2)	Minimum	Maximum	Range	Mean	SD
Crater Lake	Entire park	737.81	1222	2713	1491	1841	178
	Sampling frame	330.42	1328	2679	1351	1838	194
Lava Beds	Entire park	189.02	1228	1729	501	1361	110
	Sampling frame	111.36	1231	1684	453	1347	102
Lassen Volcanic	Entire park	433.8	1594	3186	1592	2092	204
	Sampling frame	256.52	1594	3149	1555	2076	189
Whiskeytown	Entire park	170.31	258	1894	1636	728	369
	Sampling frame	84.27	258	1885	1627	754	340
Oregon Caves	Entire park	18.22	805	2028	1223	1385	270
	Sampling frame	7.1	805	2028	1223	1417	272
Redwood	Entire park	572.18	0	981	981	290	201
	Sampling frame	330.55	1	981	980	313	194

The general topographic positions sampled by the plots are shown in Table 5. The software package Topographic Position Index (http://www.jennessent.com) was used to classify each park landscape into five topographic categories: valley, lower slope, middle slope, upper slope, and ridge. The software user specifies thresholds defining the topographic categories using histograms of the proportion of the landscape that falls into each category. We chose a default approach and applied it consistently to both the sampling frames and park landscapes as a whole for direct comparison. Maps illustrating the classified landscapes are shown in Figure 6. Detailed methods are available from Lorin Groshong, Klamath Network GIS specialist.

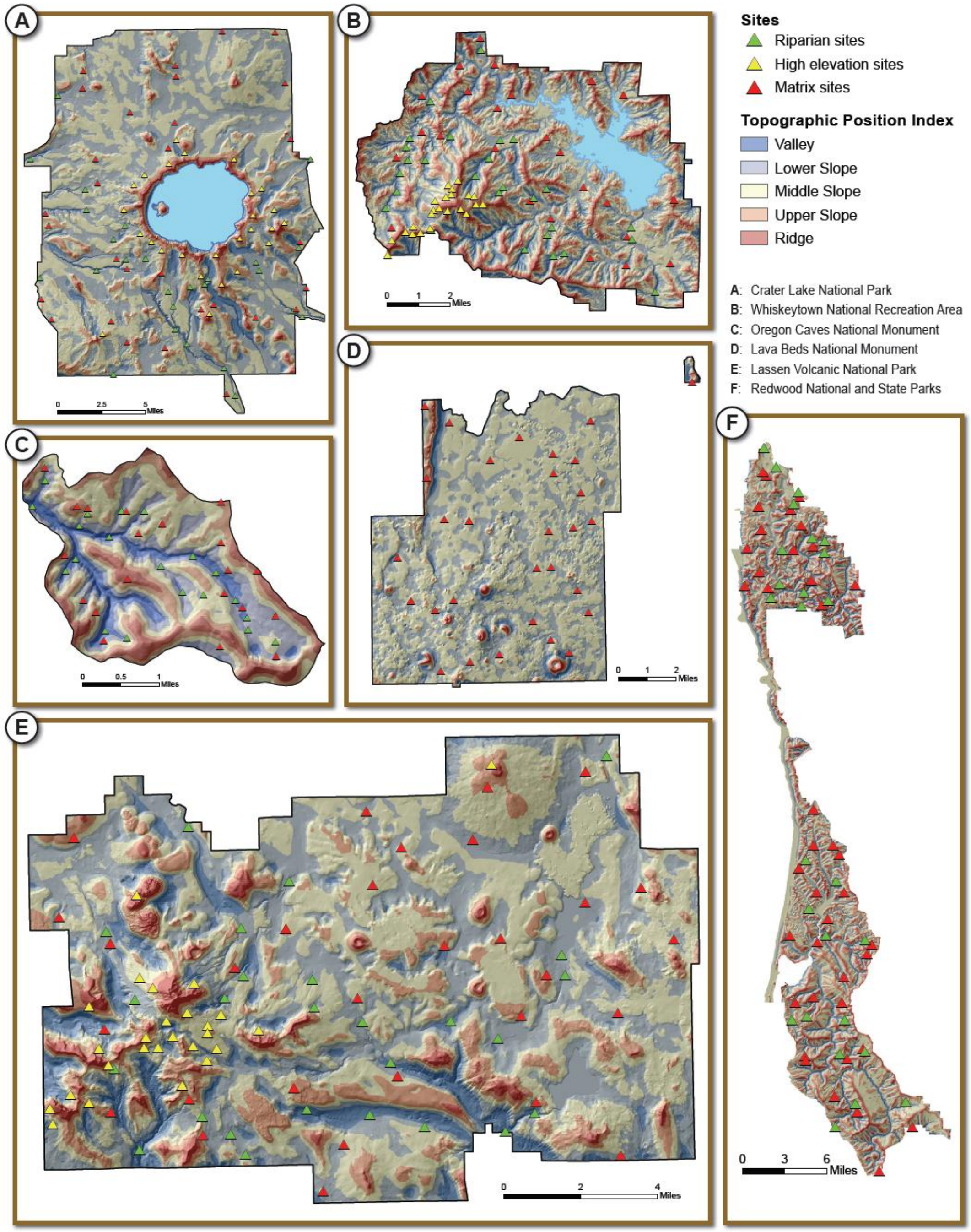

Figure 6. Sample locations for high elevation, matrix, and riparian/wetland sampling frames, shown in relation to topographic classes in the landscape (see text for methods).

As illustrated in Figure 6, at Crater Lake, Lassen Volcanic, and Whiskeytown there are more plots in valley locations and ridges, and generally fewer in mid-slope positions compared to the proportions of these categories park-wide. Similar patterns were found at Oregon Caves and Redwood, except that there were not more ridge plots in these parks. Lava Beds differed in having fewer plots in valley and ridge positions compared to the landscape as a whole. In general these differences, caused by the non-random location of roads and trails, are fairly minor in magnitude. The exception is Oregon Caves, where valleys are sampled in much greater proportion compared to their presence in the landscape. This is due to the location of 20 riparian plots within the small confines of this park. We considered 20 plots to be a minimal sample size for any one sampling frame, and thus placed 20 plots in the riparian zones at Oregon Caves even though they account for a small area.

Table 5. Topographic positions sampled by plots located in each park compared with the percentage of each park in a particular topographic position class.

Park	Topographic position	Sq. km	% Park area	# Plots	% of plots
Crater Lake	Valley	55.7	8	12	15
	Lower slope	305.4	41	32	39
	Middle slope	286.8	39	22	27
	Upper slope	72.3	10	10	12
	Ridge	17.5	2	6	7
Redwood	Valley	44.9	8	15	23
	Lower slope	113.9	20	13	20
	Middle slope	191.8	34	16	24
	Upper slope	154.2	27	14	21
	Ridge	67.3	12	8	12
Lava Beds	Valley	5.7	3	0	0
	Lower slope	70.6	37	9	30
	Middle slope	106.1	56	19	63
	Upper slope	5.1	3	2	7
	Ridge	1.6	1	0	0
Lassen	Valley	34.4	8	9	11
	Lower slope	152.4	35	28	34
	Middle slope	170.9	39	29	35
	Upper slope	62.1	14	13	16
	Ridge	14	3	3	4
Oregon Caves	Valley	2.1	11	12	30
	Lower slope	4.7	26	11	28
	Middle slope	5.6	31	10	25
	Upper slope	3.7	20	4	10
	Ridge	2.2	12	3	8
Whiskeytown	Valley	16.5	10	19	25
	Lower slope	45.7	27	15	20
	Middle slope	59.2	35	19	25
	Upper slope	33.9	20	13	17
	Ridge	15	9	9	12

2.3.3 Riparian and Wetland Vegetation

Separate riparian sampling frames were developed for Crater Lake, Whiskeytown, Redwood, and Oregon Caves. No riparian or wetland habitat exists at Lava Beds. Perennial stream coverages were derived from USGS National Hydrography Dataset (NHD) and confirmed by park resource staff. Perennial streams were buffered by 20 m to delineate the riparian sampling frames in each park. At Lassen Volcanic, wet meadow habitat is also extensive and co-located with riparian habitat. To include these wetlands, we created a combined riparian and wetland habitat sampling frame using the National Wetlands Inventory coverage to identify the extra riparian wetland habitat. Wetlands were chosen from this coverage after open water areas were first excluded.

Once suitable riparian and wetland habitat was delineated, we applied our selection criteria to exclude areas that were either within 100 m or more than a kilometer from a road or trail, and any areas where the slope exceeded 30 degrees. GRTS was used to locate plots within the suitable sampling areas. At Lassen Volcanic, plot location was done separately for riparian and wetland areas and wetland plots that fell within 500 m of riparian plots were excluded. The number of plots located in riparian habitats or a combination of riparian and wetland habitat (Lassen Volcanic only) was 30 percent of the total plots for a given park (except at Lava Beds, which had no riparian habitat). At Lassen Volcanic, plots were split evenly between riparian and wetland areas, which had similar total area in each sampling frame. Plot allocation is described in greater detail later in section 2.7 (Table 9). Riparian sampling frames for the parks are shown in Figure 6.

2.3.4 Sensitive High Elevation Vegetation

Sensitive high elevation habitat was not precisely defined in scoping meetings for the vegetation protocol, so we define it here. Subalpine and alpine habitat occurs in both Crater Lake and Lassen Volcanic, but the elevational boundaries of the zones are poorly defined on the skeletal volcanic soils of the parks. The lower elevational boundaries of subalpine habitats have been defined as 1818 m (6000 ft) in Crater Lake and about 2121 m (7000 ft) in Lassen Volcanic. The subalpine areas above these contours constitute ~35% and 53% of the two park areas, respectively. Alpine zones above about 2424 m (8000 ft) in Crater Lake 2727 m and (9000 ft) in Lassen Volcanic, comprise less than 5% of each park, respectively. Thus, including all subalpine area in the definition of sensitive high elevation habitat would create an extensive area for locating targeted samples, and they would not be more intensively sampled by locating 30 percent of plots within this area. Conversely, including just alpine areas would be too limited. To balance these considerations and focus the samples in the most sensitive areas, we chose to select just the upper subalpine areas, along with alpine areas, as sensitive high elevation vegetation. Elevation thresholds of 2057 m (6750 ft) and 2424 m (8000 ft) were used at Crater Lake and Lassen Volcanic. The area above these contours represents 10.8% and 6.6% of each park, respectively.

Sensitive high elevation habitat on Shasta Bally, the highest peak at Whiskeytown, was also identified as a priority, although it does not reach upper subalpine elevations. The area is distinctive and characterized by extremes in weather and unique vegetation. We considered sensitive high elevation habitat on Shasta Bally to be all area above 1524 m (5000 ft), where unusual, isolated vegetation of red fir forest and upper montane chaparral occur along with rare plants and granitic outcrops. This area constitutes 3.4% of the park. Climate change may be a threat to this mountain-top-limited vegetation.

As with the other sampling frames, areas within 100 m or more than a kilometer from a road or trail, and any areas where the slope exceeded 30 degrees, were excluded. Polygons smaller than 2.5 ha were also excluded since plots may not fit within them. Figure 6 shows sampling locations for sensitive high elevation sampling frames for the parks.

2.4 Plot Layout and Design

Our plot design is adapted from methodologies of the Carolina Vegetation Survey (Peet et al. 1998), which have been tested and are being used in Great Smoky Mountains National Park for vital signs monitoring (Jenkins 2006). According to Peet et al. (1998), this system is appropriate for diverse applications, incorporates multiple scales, yields data compatible with those from other common methods, and may be applied across a broad range of vegetation types. The Great Smoky Mountains National Park plot design is slightly reduced in intensity from the methods in Peet et al. (1998), making it more cost-effective and feasible. For application in the Klamath Network, we made additional changes to definitions of overstory tree diameter, snag classes, woody debris decay classes, and methods for sampling woody debris to aid in data compatibility with NPS Fire monitoring and FIA monitoring programs (Appendix E contains a comparison of these protocols). This will enable us to potentially do efficient meta-analyses with data from different programs. For example, we could analyze changes in the number of trees in forests that are less than or greater than 15 cm DBH because this is a common threshold. Had we chosen different tree size classes, such a meta-analysis would not be possible.

The standard unit of observation in the plot layout is a 10 x 10 m module (Figure 7). This modular design allows flexibility in sampling intensity, time commitment, and plot layout. A standard 2 x 5 arrangement of modules results in 20 x 50 m plot with a total area of 0.1 ha. This is consistent with the FMH standard plot size. In riparian zones, a linear series of modules is used to sample a comparable area but stay within the target habitat. Plots will be placed along contours perpendicular to the slope or lengthwise on ridges or along drainages (SOP #4: Site Set-up, Monumentation, and Description).

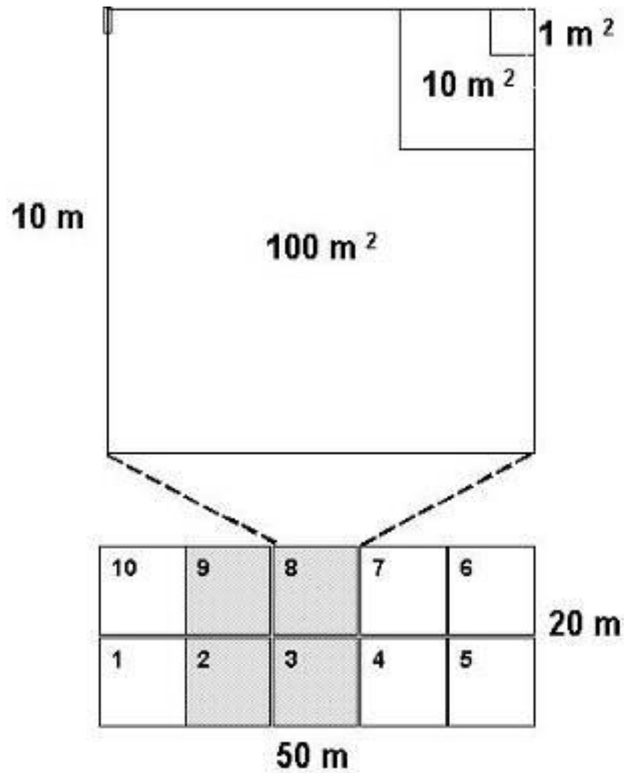

Figure 7. Layout of an intensive module (top) and a set of 10 modules as a 0.1 ha plot (bottom). Modules are numbered (1-10) and intensive modules (2, 3, 8, and 9) are shaded.

2.5 Parameters to be Monitored

A wide range of data is collected from each plot. On each forested plot, vegetation is assessed in four strata, from tree canopy to ground layers (SOP #6: Subplot Sampling [Species Cover, Tree Seedlings, and Saplings {<15 cm DBH}], SOP #7: Live and Dead Tree Sampling, and SOP #14: Collecting and Identifying Unknown Plants). Nested plots allow for the examination of relationships between area and species accumulation. Other components of vegetation to be examined include down wood, litter, and duff (SOP #8: Litter, Duff, and Downed Wood Sampling). The full list of parameters that will be measured under this protocol is provided in Table 6. The objective associated with each parameter is also listed in Table 4 along with the SOP describing the measurement methods for the parameters.

Table 6. Parameters that will be sampled under this protocol and the Compositional (C), Structural (S) and Functional (F) objective with which they are most associated. The SOP that describes how to sample each parameter, and a brief description of sampling specifics is also provided.

Parameter	Objective	SOP	Sampling
Environmental variables:	F	4	
Slope Aspect Elevation Microtopography Macrotopography Disturbance			1. Slope-measured at three locations. 2. Aspect-measured at three locations. 3. Elevation (from GPS) 4. Microtopography: Convex Concave Straight Undulating 5. Macrotopography: apex, hill, or ridge top. upper 1/3 of a hillslope. middle 1/3 of a hillslope. lower 1/3 of a hillslope. bottom of a hillslope adjoining a valley bottom, usually with a shallower slope than the adjacent hillslope. 6. Evidence of disturbance (from checklist).
Plant cover types Vascular plant species Rock, soil, fine and coarse wood and bryophyte (water/snow)	C	6	Ocular estimate recorded for all species in nested subplots within each of 4 intensive modules. Cover is estimated for individuals belonging to four height strata: S1 = (<0.75 m height), S2 = (0.75-2.5 m), S3 = 2.6-5 m), S4 = >5. Percent cover of rock (>15 cm diameter), bare soil, water, bryophytes, fine wood (snow/water) and litter, and coarse woody debris are also recorded for the 100 m^2 plot.
Species presence	C	6	Presence of additional species only found outside intensive modules recorded as occurring elsewhere in the 20 x 50 plot.
Photographs from photo points	S	5	Each 20 x 50 plot will be photographed 6 times, once from each end of the long axis (2) and once in each of the intensive plot (4). Photographs will be taken at eye level, approximately 5-5.5 feet from the ground.
Shrub height	S	6	The average height of shrub cover is measured for each intensive module. The height is the average for the 4 quadrants of each intensive module.
Tree seedlings <15cm tall	F	6	Density in the four 10 m^2 (3.16m x 3.16m) subplots located in the corner of the 4 intensive modules.
Trees seedlings from 15cm to 2.54 cm DBH	F	6	Density in the four 10 m^2 (3.16m x 3.16m) subplots located in the corner of the 4 intensive modules.

Table 6. Parameters that will be sampled under this protocol and the Compositional (C), Structural (S) and Functional (F) objective with which they are most associated. The SOP that describes how to sample each parameter, and a brief description of sampling specifics is also provided. (continued).

Parameter	Objective	SOP	Sampling
Tree saplings <1.4 m tall and DBH < 2.54 cm	**F**	**6**	**Density in the 4 intensive 100 m^2 (10 m x 10 m) modules**
Tree saplings from 2.54 - 5 cm DBH	F	6	Density in the 4 intensive 100 m^2 (10 m x 10 m) modules.
Trees from 5-10cm DBH	F	6	Density in the 4 intensive 100 m^2 (10 m x 10 m) modules.
Trees from 10-15cm DBH	F	6	Density in the 4 intensive 100 m^2 (10 m x 10 m) modules.
Trees with DBH ≥ 15 cm	F	7	Measured or estimated in all modules: DBH to the nearest cm. Canopy position: dominant, codominant, intermediate, suppressed, open grown Canopy base height Tree condition: No dieback; 1-25% dieback; 26-50% dieback; 51-75%, = > 75 % dieback; broken top.
Live canopy cover	S	7	Average of 4 densiometer readings, one in each cardinal direction in each module.
Dead trees with DBH ≥ 15 cm	F	7	DBH to nearest 1 cm in all modules. Decay class Cause of death (checklist)
Down wood 0-.62 cm in diameter	S	8	Tallied on the following meter segments of a 50 m centerline transect: 0-1, 5--6, 10-11, 15-16, 20-21, 25-26, 30-31, 35-36, 40-41, 45-47 meters.
Down wood 0.63-2.54 cm in diameter	S	8	Tallied on the following meter segments of a 50 m centerline transect: 0-2, 5-7, 10-12, 15-17, 20-22, 25-27, 30-32, 35-37, 40-42, 45-47 meters.
Down wood 2.5-7.6 cm in diameter	S	8	Tallied on the following meter segments of a 50 m centerline transect: 0-2, 5-7, 10-12, 15-17, 20-22, 25-27, 30-32, 35-37, 40-42, 45-47 meters.
Down wood greater than 7.6 cm in diameter	S	8	Tallied along the entire 50 m transect, and their width (in cm) and length (in m) measured.
Litter and Duff	S	8	Take depth/thickness measurements for litter and duff at 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 m along the 50 m transect.

One important environmental parameter that strongly affects vegetation is soil. Soil analyses would have to be conducted by outside laboratories. Though desirable, the Network does not have adequate funding to add soil analyses without subtracting something else from the vital signs monitoring program. Therefore, the Network will explore the possibility of obtaining additional funding in an effort to pay for collection and analysis of soils from each plot in each park during the second round of sampling (years 4-6 of the monitoring). This would provide baseline soil information from which future samples could be compared.

2.6 Rationale for Selection of Response Design

The objectives of this protocol, available financial resources, and practical concerns were carefully considered when developing the spatial sampling design. We have incorporated many aspects of FMH and FIA. We are using the same plot size and most of the methods of FMH, but we cut out some of the time consuming aspects of this protocol, such as tree mapping, point intercept sampling. This was because FMH takes too long to sample one plot, often a whole day. We need to be able to sample plots and have sufficient travel time to and from plots in one day. We did not use the point intercept sampling because of how time consuming it is, and because it misses too many uncommon species. The main difference between our approach and FIA is the plot shape. Our module design allows much greater flexibility in linear habitats, such as riparian forests, than FIA circular plots. Other aspects of FIA are based on goals of the forest resource inventory, such as documenting tree volume and growth. We did not include these time-consuming forest mensuration methods. Nor did we wish to slope correct plots, which allows extrapolation of scale invariant parameters like stand volume across a unit area but is not appropriate for extrapolating nonlinear unit/area relationships, like floristic diversity across park landscapes.

A compositional goal of ours was to be able to document species richness at different scales, which is not possible with FMH or FIA. Our plot design is derived from the Whittaker plot, designed to explicitly evaluate species diversity. Our response design is also consistent with our multivariate data analysis approaches emphasizing relationships among all species, as described in SOP #12: Reporting and Analysis of Data.

The selected design offers a balance between statistical rigor and real-world applicability. For tracking changes in vegetation community composition, structure, and function through time, the plot and survey design offers several important advantages:

- *Plot design is appropriate for a variety of vegetation types and structures.*

The plot design may be readily modified to fit various vegetation types, topographic conditions, or study designs. The arrangement of 10 x 10 m modules can be modified to tailor the sampling design to a given area, as we have done for riparian sampling.

- *Plot design addresses community and species dynamics related to sampling scale.*

Since the protocol is based upon a modular design with nested subplots, the sample units may be added together to examine relationships at a variety of spatial scales. Since the modules are adjoining, analyses of scale-dependent relationships are possible. Many other plot designs contain more spatially distributed, but non-adjoining subplots. These other designs encompass a greater amount of spatial variability, which may be desirable for examining gross species richness. However, the distance between the plots is arbitrary and not related to the spatial variability unique to each of the vegetation communities sampled. Therefore, greater variability accounted for by these plots may be an artifact of the sampling design and not a product of natural variation within the plant community.

- *Compatibility with other active sampling designs and studies.*

The design has been used to sample over 3000 plots in North Carolina, Tennessee, South Carolina, and Georgia. A similar design is used to monitor vegetation in the Prairie Cluster parks. The design also overlaps with the FMH plot design. The plot design used by NatureServe in its classification of vegetation in the Southeast also uses a 20 x 50 m layout and records species cover by strata.

- *The sampling is not too time-consuming.*

The average sampling time during the pilot study (Appendix A), was 4-5 hours. Although some plots, particularly in species-rich riparian vegetation, can take longer, the average sampling rate should be 1-2 plots per day, which allows for adequate sample sizes Although the sampling frame includes plots that require hiking up to several kilometers on trails, it places nearly all plots in areas where travel to and from the site and sampling can be accomplished in a day. Although restricting the sampling frame by accessibility greatly increases the number of plots that can be sampled as part of the long-term monitoring program by decreasing travel times to plots, it does not create sampling frames that are unrepresentative of parks (Figures 5, 6).

2.6 Frequency and Timing of Sampling

The Network will have a 3 year, always revisit schedule in which two parks are paired together for sampling each year, as shown in Table 7. Careful consideration was given to pairing of parks in order to allow for a long field season by having one park that can be sampled early in the season and one late. We also strove to make the workload as even as possible among years by not combining large parks. In order to have a field season from May through September, the Network must combine field work in parks that are suited to sampling early and late in the field season. Fortunately, parks can be paired to accomplish this as follows: Lava Beds/Redwood, Whiskeytown/Lassen Volcanic, and Crater Lake/Oregon Caves. With six parks forming three pairs, and sampling every year, the Network can accommodate the 3 year revisit schedule for each park.

Table 7. Revisit design for the vegetation monitoring protocol.

	Sampling Year														
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Lava Beds & Redwood	x			x			x			x			x		
Lassen Volcanic & Whiskeytown		x			x			x			x			x	
Crater Lake & Oregon Caves			x			x			x			x			x

It is critical that plots be sampled during each revisit at the same general stage of vegetation phenology to the extent possible given unpredictability of climate. For example, low elevation vegetation at Whiskeytown contains many annual and ephemeral perennial species that may be present at maximum cover for a short period of time in spring. These species could be missed if sampling is undertaken too late. Therefore, sampling in each park will correspond to the peak time for floral diversity and ease of identification. The seasons in which sampling shall take place in different areas of the Network are shown in Figure 8.

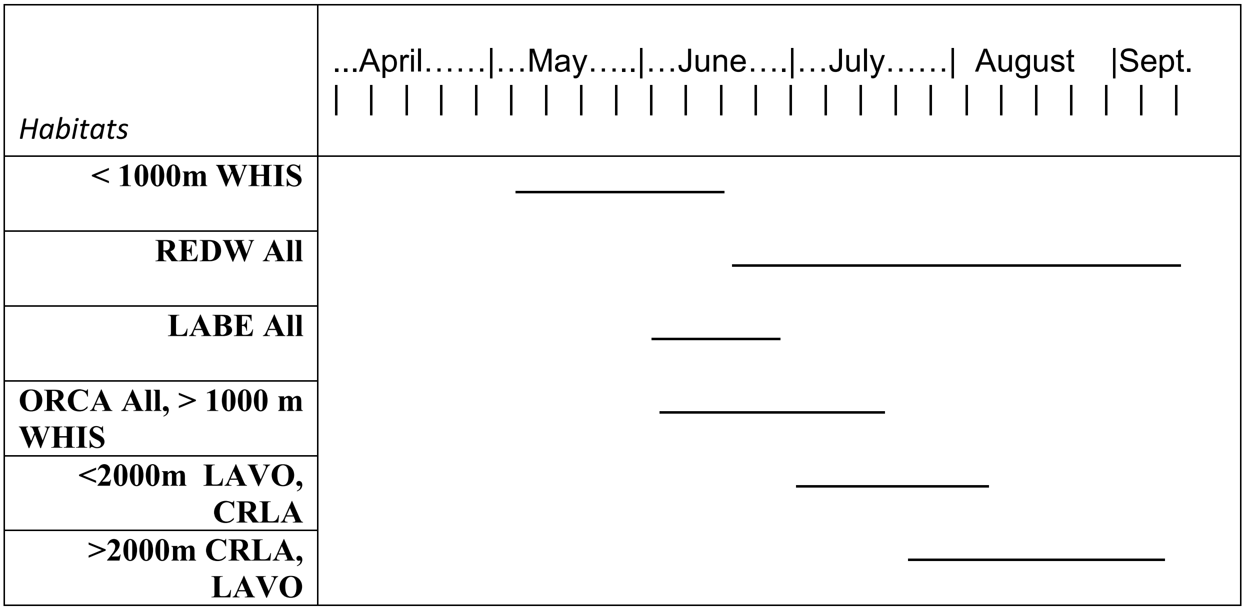

Figure 8. Bars denote seasonal windows for vegetation sampling in different elevation zones in different parks of the Klamath Network. WHIS = Whiskeytown, REDW = Redwood, LABE = Lava Beds, ORCA = Oregon Caves, LAVO = Lassen Volcanic, and CRLA = Crater Lake.

2.7 Sampling Effort in Parks

In evaluating the total Klamath I&M monitoring budget, it was determined that from $129,000 to $157,000 would be available for vegetation monitoring. The pilot study confirmed that, on average, five plots could be sampled per week by each two person crew. Thus, we are assuming that, given person days and staffing discussed below, we can average about 120 plots per year. The exact number each year will vary due to the pairing of parks (Table 7) and diversity of vegetation in the parks.

We allocated the number of plots to be sampled in each park based generally on the number of vegetation types present in each park (Table 8). This classification was presented and refined by experts from the parks at the vegetation protocol development meetings.

Table 8. Parameters used in defining sampling effort in each park. Park area and broadly defined vegetation types in the Klamath Network and their importance in each park. A= abundant, C = common, U = uncommon.

	Park Unit					
	Crater Lake	Lassen Volcanic	Lava Beds	Oregon Caves	Red-wood	Whiskey-town
Area (sq km)	738	430	188	18	550	176
Percent of Network area	35.4	20.6	9.0	0.9	26.4	8.4
Vegetation						
Coastal Environments						
Salt Marsh	-	-	-	-	U	-
Coastal strand, dune, scrub	-	-	-	-	C	-
Coastal Prairie	-	-	-	-	U	-
Coastal Sitka Spruce Forest	-	-	-	-	C	-
Low Elevation Environments						
Redwood Forest	-	-	-	-	A	-
Mixed Evergreen Forest	-	-	-	C	C	C
Oak/Pine Woodlands*	-	U	-	U	C	A
Serpentine vegetation	-	-	-	U	U	-
Annual Grassland	-	-	U	-	-	U
Perennial Grassland	-	-	U	-	C	?
Chaparral	-	-	-	U	U	A
Mid Elevation Environments						
Mixed Conifer Pine	A	A	-	U		C
Mixed Conifer Fir	A	A	-	A		C
Oak/Pine forest				U		C
Montane Chaparral	U	U	-	U	-	C
Upper Montane Environments						
Subalpine Forest	A	A	-	-U	-	U
Montane Meadows	C	C	-	U	-	U
Alpine	C	A	-	-	-	-
Great Basin Environments						
Sagebrush Steppe	U	-	A	-	-	-
Juniper Woodland/Savanna	-	-	A	-	-	-
Ponderosa Pine Woodland	C	U	C	-	-	**
Rosaceous Shrubland	-	-	C	-	-	-
Mesic and Hydric Environments						
Riparian Forests	C	C	-	C	C	C
Freshwater Marsh	-	C	-	-	U	U
Seeps and Springs	C	C	-	U	U	U
Alkali Meadows	-	?	-	-	-	U
Vegetation types (total)	10	11-12	6	12	13	15-16

*At low elevations usually dominated by Oregon White Oak (*Quercus garryana*) and at slightly higher to mid-elevations by California black oak (*Q. kelloggii*). Ponderosa pine (*Pinus ponderosa*) is common in both cases. Only Jeffrey pine (*P. Jeffreyi*) is at Redwood.
**Ponderosa pine, which is common at Whiskeytown, is captured there under Oak/Pine woodlands.

As summarized in Table 9, those parks with greater complexity (Redwood and Whiskeytown) were allocated 40 matrix plots per visit. Those with intermediate complexity (Crater Lake, Lassen Volcanic, and Lava Beds) were allocated 30 plots. Oregon Caves was allocated 20 matrix plots, to include the expansion area. The large parks with riparian and wetland habitats were allocated 26 plots per visit for this sampling frame, while Oregon Caves was allocated 20 plots. Twenty-six plots were also allocated for sensitive high elevation habitat in Crater Lake and Lassen Volcanic, while 20 plots were allocated for the much smaller area of high elevation habitat at Whiskeytown. Due to recent concern about the possible danger of sampling vegetation in Whiskeytown because of the presence of marijuana cultivators, the matrix sampling frame at Whiskeytown will be limited to 25 plots along roads and trails, co-located with landbird sampling.

Table 9. Allocation of sampling effort for each of the 12 vegetation target populations within the Klamath Network. The sample size for each park has been selected with regard to desired precision and the size and vegetation complexity of the park. Sampling in the matrix at Whiskeytown has been suspended due to safety concerns.

Environmental Stratum	Park	Sample Size, n
Riparian	Crater Lake	26
	Lassen Volcanic	26
	Oregon Caves	20
	Redwood	26
	Whiskeytown	26
Matrix	Crater Lake	30
	Lava Beds	30
	Lassen Volcanic	30
	Oregon Caves	20
	Redwood	40
	Whiskeytown	25*
High Elevation	Crater Lake	26
	Lassen	26
	Whiskeytown	20

*40 matrix plots may be sampled at Whiskeytown in the future if safety concerns due to marijuana cultivation diminish.

2.8 Statistical Power

It is difficult to assess the statistical power of the future monitoring data. One reason is that data from repeat sampling are not yet available. We will do power analyses once these data are available. A rigorous power analysis may not be possible until after two to three rounds of sampling in each park. Another reason that power cannot be assessed is that vegetation changes may be very slow and gradual, except where episodic disturbances like fire or insect outbreaks occur. Stochastic changes can only be accounted for in *a priori* power analyses if the frequency and magnitude of the change can be modeled.

Appendix B summarizes the preliminary univariate power analysis for the Klamath Network vegetation protocol. The power analysis is based on the pilot study data collected at Crater Lake and US Forest Service Forest Inventory and Analysis (FIA) data from the Oregon Cascades near Crater Lake. Pilot data are from one sample period and FIA data are from two periods that were 1 year apart. The parameters analyzed were total tree basal area and saplings measured or estimated for sampling plots. Plot sizes were similar between data sources and all data were converted to per ha values for this analysis. A standard linear model was used to estimate power based on these limited data and the Network's temporal sampling scheme. Based on this, the sampling design seems sufficient to detect a 50% change with 80 percent power over 15 years for basal area, but it may take twice that long to detect 50% change in saplings, which exhibit greater spatial and temporal variation. The two variables selected should be representative of two relative extremes in terms of variability in vegetation structural and functional data (i.e., we suspect we will be able to detect 50% change with 80 percent power over a time period ranging from 15-30 years for most variables.

Much of the information and insight about temporal change will be contained in multivariate analyses of vegetation composition data in relation to environmental parameters. These analyses can be used to efficiently explore the data and identify progressive changes. Identification of such change is based on assessing cumulative plot dissimilarity over time (SOP #12: Reporting and Analysis of Data). Compositional changes can provide compelling evidence that a meaningful ecological event has occurred, or an ecological threshold has been exceeded, before these changes would be detected using other methods (Clarke et al. 2008).

2.9 Co-location of Other Vital Signs

The sampling design is integrated with the Landbird Monitoring and stream sampling (water quality and aquatic community) protocols, which will likewise provide detailed status and trend information on a 3 year sampling frequency. The vegetation protocol established a plot in the center of a randomly located Landbird Monitoring Protocol systematic sampling route. Six to twelve adjacent bird count sampling points are placed 250 m apart, according to a set of rules. These rules ensure that a grid is set up as closely around the same GRTS sample used to locate vegetation plots as possible, using a systematic, random approach within constraints in the sampling frame already defined (Figure 6). Not all sampling frames will be monitored in each park under the landbird protocol (Table 10). The stream sampling protocol is currently being developed and will include a number of sites co-located with vegetation monitoring plots.

Table 10. Number of landbird survey routes in each park that will be co-located with an individual vegetation monitoring plot and the sampling frames in which these routes will be placed. The exact number of routes per sampling frame has yet to be determined.

Park	Total sampling routes	Matrix	Riparian	High Elevation
Crater Lake	35	x	-	x
Lava Beds	25	x	-	-
Lassen Volcanic	25	-	x	-
Oregon Caves	4	x	x	-
Redwood	30	x	-	-
Whiskeytown	30	x	-	x

3.0 Field Methods

3.1 Field Season Preparation and Equipment Set-up

Preparations for field work must begin several months before the season begins, in order for the field crews to be fully staffed. Details for the preseason preparation are included in SOP #1: Field Work Preparation. Details on observer training are provided in SOP #2: Observer Training. Roles and responsibilities are spelled out in detail below (5.1 Roles and Responsibilities). In general, it is the Field Crew Lead's responsibility to work with the Park Contacts to set up permits and to ensure availability of housing, keys, vehicles, radios, and computers when applicable. Sampling trips by Network crews will be scheduled and organized by the Field Crew Lead prior to the start of each field season. It is also the Field Crew Lead's responsibility to create a detailed work plan for each sampling trip prior to going into the field. In addition, the Field Crew Lead will ensure that the field crew is properly trained, has all the required gear, and has the most up-to-date field forms. SOP #1: Field Work Preparation, includes an equipment list, while SOP #6 lists supplies necessary for monumenting plots.

It is the Field Crew Lead's responsibility to make certain all databases (handheld and desktop applications) and field equipment (e.g., laser range finders, GPS units, etc.) are calibrated and properly set up prior to heading into the field (SOP #3: Setting up the Electronic Field Equipment). The Field Crew Lead will work closely with the Data Manager to get the equipment setup properly. The crew will be trained on the use of GPS units by the GIS Specialist. The Field Crew Lead will work with the field crew to make sure it is clear where everyone is going, what is expected to be completed, and timelines for when the work should be finished.

Prior to working in the field, each member of the field crew must review the entire protocol. The Field Crew Lead will provide training on safety, administrative procedures, and field methods for recording data following the Data Manager's specifications. All equipment and supplies shall be organized, prepared, and tested prior to the field season. All files needed for navigation will be loaded on to a GPS unit and on to a laptop, which will be taken to the park. SOP #3: Setting up the Electronic Field Equipment explains how to set up the current GPS units being used.

At least 1 month prior to when Network crews expect to visit the field sites, the Field Crew Lead will communicate with the Park Contacts at each park to assure that all logistical needs are addressed and on schedule. Each day, the Project Lead shall provide a briefing regarding any safety, plant identification, and park navigation issues of concern for the day. The Project Lead will also assign crew members to the search units for the day. Crew members will navigate to plots using the GPS unit, compass, and maps. Crews will be locating plots and revisited plots in the field following SOP #4: Site Set-up, Monumentation, and Description.

Prior to sampling in a park, the crew will spend a couple of days identifying plants throughout the park with the Project Lead. For new crew members who have not sampled a plot, all procedures will be demonstrated.

3.2 Collecting and Recording Data in the Field

Data are to be collected using GPS units (Trimble XT, Garmin V), a laser rangefinder, and handheld computers (tablet computer). Instructions for using the GPS and ArcPad software are provided in SOP #3: Setting up the Electronic Field Equipment. If there is a problem with the tablet computer that prevents its use, data will be recorded on standardized datasheets, which the crew will keep at their disposal. A description of how to enter the data is provided in SOP #10: Data Entry. Datasheets and electronic forms should be reviewed after each task is completed to make certain they are complete. At the end of a park-specific sampling trip, data forms and databases are submitted to the Crew Lead for review.

3.3 Post-field Season

After the field season, a number of activities need to occur to finalize the year's sampling efforts and help ensure smooth start-up for the next field season (SOP #15: Post Field Season). Equipment will be cleaned, inventoried, and stored. Any equipment that is found to be in need of repair or replacement will be identified and reported in writing to the Project Lead. A short report about the year's sampling shall be prepared by the field crew. If there are any special findings that are urgent for managers, such as a new invasive species, these will be described in a written briefing memo to be sent to parks by December 1st of the year of sampling (SOP #12: Reporting and Analysis of Data).

4.0 Data Management, Analysis, and Reporting

This section will focus on all aspects of managing, storing, analyzing, and reporting monitoring data according to the Network's Data Management Plan (Mohren 2007) and the reporting schedule in the Klamath Network Monitoring Plan (Sarr et al. 2007). Methodological details are located in these plans and the SOPs referenced herein. It is crucial to successful monitoring that project personnel understand all necessary data management methodologies. This includes knowing who is responsible for implementing the methods and the timelines they are expected to follow when conducting data management.

4.1 Data Management

Data management is a critical component of data collection and entry in the field (SOP #10: Data Entry), as well as data storage and archiving at the end of the field season (SOP #11: Data Transfer, Storage, and Archiving) and data analysis and reporting (SOP #12: Reporting and Analysis of Data). The data management cycle for the sampling year ends with a review of the yearly project activities. It is the responsibility of the Crew Lead to make sure all crew members are trained in proper data management protocols and procedures. It is also the responsibility of the Crew Lead to make sure all completed data have been transferred to the Data Manager. However, at least one of the crew members will be trained in data transfer to act as a backup. Data entry will be completed using electronic and paper formats for the initial years of the project. Unless stated otherwise, data entry will be uploaded from the tablet computer to the desktop database and backed up on a nightly basis. Data will be transferred from the field computer to the master database at the end of the field season after all quality control and quality assurance processes have been followed. It is the responsibility of the Crew Leader to make sure all electronic data collected during the field visit are transferred to the Data Manager, and that hardcopy datasheets are scanned and archived according to procedures detailed in SOP #10: Data Entry.

4.2 Metadata and Data Dictionary Procedures

Details on the process to develop, update, distribute, and archive metadata are provided in SOP #13: Metadata Guidelines. For GIS files and databases, metadata will be completed at the onset of implementing the protocol. Metadata will be created using Environmental Systems Research Institute (ESRI) tools, the NPS Metadata tools and Editor, and the NPS Database Metadata Extractor. Metadata will be to Federal Geographic Data Committee (FGDC) and NPS standards where applicable. It is the responsibility of the Crew Lead to complete the Metadata Interview forms at the end of each field season to document changes to the metadata. If changes have occurred, it is the Data Manager's responsibility to archive and update the metadata for each database by March 1st following the previous season's changes. The Klamath Network Data Manager will upload new metadata to Reference Applications when applicable.

The data dictionary will be finalized at the onset of implementing the protocol. It is the Crew Lead's responsibility to update the data dictionary, if needed, at the end of each field season. In addition, the Metadata Interview form; which will be submitted at the end of each field season, will be used by the Data Manager to indicate if changes have occurred to the metadata or data dictionary.

In addition to the databases and GIS layers, metadata should be completed for all images and reports as described in SOPs #13: Metadata Guidelines and SOP #5: Photographing Plots and Photograph Management.

4.3 Overview of Database Design

There are a variety of databases that have been developed by multiple agencies to store and manage vegetation data. The Klamath Network looked at several of these database but we were unable to find a database that could meet the majority of the needs of our project. Therefore, we have developed a database using the Natural Resource Database Template (NRDT) developed by the National Park Service. The NRDT:

- Provides both a data interchange standard and a standard MS Access database core that allows flexibility in application design.
- Serves as a starting point for application development that can be extended as necessary to accommodate any inventory or monitoring field sampling protocol.
- Standardizes location and observation data to facilitate the integration of datasets.
- Acts as a design platform for developing database applications in MS Access, allowing users to enter, edit, display, summarize, and generate reports for inventory or monitoring datasets.
- Integrates with other I&M data management systems and data standards including the NPS Data Store, Geographic Information System (GIS) tools and data, the NPS GIS Committee Data Layers Standard, and the NPS Metadata Profile.

The NRDT Front-end Application Builder (FAB) is a Microsoft Access file that is intended to be used by developers of NRDT applications to create a front-end (user-interface) to an NRDT v.3.2 back-end (database). The FAB comes with many built-in features, including:

- table linking utility
- data backup
- compaction
- lookup table management
- main menu
- standardized data entry forms for core NRDT v.3.2 tables
- standardized data "gateway" form for retrieving records
- standardized data summary reports
- standardized data exports (for statistical packages)

A project database will be provided to each crew at the beginning of the field season. Crews will use the project database (on a tablet computer) to enter data collected at each monitoring site. After validation and verification procedures have been followed, this database will be used to create summaries and conduct data analysis for annual reports. At the end of the year, the data from the project database will be uploaded to the master database for long-term storage and future analysis (SOP #9: Vegetation Database).

The master vegetation database will house all of the verified and validated data that are collected using this protocol. Members of the Klamath Network will have read-only access to this database and can use it to conduct multi-year data summaries and to develop Analysis and Synthesis reports or publications (SOP #9: Vegetation Database).

4.5 Data Entry, Verification, Validation, and Editing
Data entry will consist of nightly transferring data from field collection devices (currently tablet computers) to a desktop or laptop computer located in a stable environment. Forms have been created to be used in conjunction with the electronic collection devices that incorporate picklists; domain values; and automated, populated fields. In addition, for the initial years of data collection, hardcopy datasheets will be completed to help with verification process described below. Details on the data entry process are described in SOP #10: Data Entry.

Data verification is the process of ensuring the data entered into a database correspond with the data recorded on the hardcopy field forms and data loggers. After collecting for each separate task (i.e., when each datasheet is completed), before moving to the next task, the field crew will review all hardcopy and electronic datasheets to ensure they are complete and accurate. After the end of the sampling period in a park, the Crew Lead will review the data to make sure everything has been entered properly. In addition, the Crew Lead should examine the data after collection has occurred for 1 week, to ensure the field crew is following collection and data entry methods properly. At the end of the field season, a field crew member should cross-check the hardcopy field forms with the electronic data (SOP #10: Data Entry).

Data validation is the process of reviewing the finalized data to make sure the information presented is logical and accurate. Data validation requires a reviewer to have extensive knowledge of what the data mean and how they were collected. At the end of the season, the Crew Lead will compile data from all field surveys. This person should examine the data using general tools built into the database and their personal knowledge to ensure that the data are accurate.

Once all validation and verification methods have been implemented, the databases will be transferred to the Klamath Network Data Manager, who will upload them to the master database. While uploading the data into the database, the data will be subjected to an automated data quality process that will flag potential missing sites and invalid or improperly formatted data.

4.6 Data Certification
Data certification is a benchmark in the project information management process that indicates that: (1) the data are complete for the period of record; (2) they have undergone and passed the quality assurance checks; and (3) they are appropriately documented and in a condition for archiving, posting, and distributing. Certification does not necessarily mean that the data are completely free of errors or inconsistencies. Rather, it describes a formal and standardized process to track and minimize errors.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all data. The Crew Lead is primarily responsible for completing the Data Certification form, available on the KLMN web sites. This brief form is to be submitted with the certified data according to the timeline in SOP #10: Data Entry.

4.7 Product Distribution
It will be the Klamath Network Data Manager’s responsibility to utilize the season’s certified raw data along with the materials presented in the Annual report, Analysis and Synthesis report, data dictionary, and Metadata Interview form to populate or update the NPS I&M databases

including NPSpecies and Reference Applications. Details on distribution can be found in SOP #11: Data Transfer, Storage, and Archive. In general:

- All reports will be posted to Reference Applications and KLMN Internet and Intranet web pages.
- All reports will be sent to the Resource Chiefs of each park and to any park staff that are associated with the project.
- A short, one-page summary of the report will be sent to all park staff in the Network.
- One record will be created in Reference Applications for each Annual report, comprehensive report, and third year Analysis and Synthesis report and linked to the corresponding species in NPSpecies.
- Metadata for each database will be created and updated based on the Metadata Interview form and data dictionary provided by the Crew Lead each year. Metadata for the project database will be posted at the NPS Data Store.
- Photographs and metadata provided for photographs will be stored in the project folder located on the Klamath Network shared drive. The Data Manager moves copies of the images to the Network Image Library, where the images will be linked to the KLMN Photograph Database.
- After the holding period (4.7.1 Holding Period), all raw data, reports, GIS layers, scanned datasheets, and any other additional appropriate materials will be packaged together in a zipped file and posted to Reference Applications.

4.7.1 Holding Period
To permit sufficient time for the NPS to have the first priority to publish data, when data are distributed, it will be with the understanding that these data are not to be used for publication without permission obtained through the Network Contact. After each 3 year survey cycle, all certified, non-sensitive data will be posted to Reference Applications. Note that this hold only applies to raw data, and not to metadata, reports, or other products that are posted to NPS clearinghouses immediately after being received and processed.

4.7.2 Sensitive Information
Certain project information, for example, the specific locations of rare or threatened taxa, should not be shared outside NPS, except where a written confidentiality agreement is in place. Before preparing data in any format for sharing outside NPS, including presentations, reports, and publications, the Crew Lead should refer to the guidance in SOP #11: Data Transfer, Storage, and Archive. Certain information that may convey specific locations of sensitive resources or treatments may need to be screened or redacted from public versions of products prior to release (SOP #17: Sensitive Data). All official Freedom of Information Act (FOIA) requests will be handled according to NPS policy. The NPS Lead will work with the Data Manager and the FOIA representative(s) of the park(s) for which the request applies.

4.8 Reporting and Analysis of Data
The Klamath Network has developed a comprehensive strategy for reporting and analysis of data from this protocol over the next 15 years. There will be two elements of reporting: (1) An annual report focusing on status information, and (2) analysis and synthesis reports submitted every third year that will focus on status of various aspects of vegetation composition, structure, and function in the first four versions, and then trends in vegetation composition, structure, and

function in the fifth report. These reports will specifically address the vegetation protocol objectives described in section 1.5.1 above. SOP #12: Reporting and Analysis of Data provides details on report contents summarized briefly here.

4.8.1 Annual Reports

The annual reports focusing on status of the two parks sampled in a given field season will be due on March 1st of the year following that field season. Appendix A is an example of an annual report prepared from the pilot study data. As in this example, the annual report will include a summary of the sampling accomplished and how long it took. There will be sections describing the status of vegetation composition, structure, and function respectively in the two parks sampled the prior season. Descriptions will use summary statistics and user-friendly graphics. For example, data summaries will be illustrated on bubble maps or using histograms and tables reporting means and standard errors. SOP# 12: Data Reporting and Analysis describes how data will be presented in further detail. Any unusual or special significance findings (e.g., new species documented for a park) will also be highlighted in annual reports.

4.8.2 Analysis and Synthesis Reports

Analysis and Synthesis reports will be prepared and distributed by May 1st of the year following a complete round of monitoring six parks every 3 years. Therefore, the first report will be issued 4 years following project commencement. Subsequent reports will be issued every 3 years thereafter.

The first Analysis and Synthesis report will focus on status in vegetation composition. Once data have been collected from each park, we will need to verify that the composition data being collected are adequate for the monitoring objectives. Another goal of the first report will be to refine the specific ordination methods to be most illustrative of patterns of vegetation composition in the Network from which changes can be detected later. Summaries of community composition will be developed using ordination and classification techniques to illustrate interrelationships among sites and parks (McCune and Grace 2002). A better understanding of the natural variation in species assemblages across the gradients in park ecosystems will be valuable for distinguishing categorically different units and quantifying spatial variation. Along with these general community analyses, variation of species within local replicates or across gradients and parks will be used for distinguishing spatial from temporal variation in subsequent trend detection analyses undertaken in report five (Philippi et al. 1998).

The second, third, and fourth Analysis and Synthesis reports will focus on the status of vegetation structure and function. Key components of vegetation structure and function identified in the protocol objectives include potential fire behavior, wildlife resources, and stand dynamics. These three reports will describe status of these in relation to environmental variables as described in SOP #12: Reporting and Analysis of Data.

The fifth Analysis and Synthesis report will present the first trend analysis based on methods refined in earlier reports. In year 15, we expect to have a sufficient time series to begin the detection of vegetation trends. Determination of significant trends in vital signs will require considerably more time than status.

General tools for the determination of trend for all the vital signs will range in complexity from application of general linear models (Manly 2001) for the determination of univariate trend direction in early years, to development of hierarchical models and time series analyses of longer-term datasets (Box and Jenkins 1976, Manly 2001).

Much of the information and insight about temporal change will be contained in multivariate analyses. Although detecting trends in multivariate data is more challenging than for univariate parameters, multivariate analyses are particularly effective in environmental monitoring and can demonstrate trends not apparent in univariate analyses (Clarke et al. 2008). One of the most fundamental types of detectable change in multivariate or multispecies datasets is the increase in dissimilarity over time, or ―progressive change" (Philippi et al. 1998). Significance tests for progressive change can be determined with randomization or Mantel analyses (Philippi et al. 1998). Figure 9 illustrates an ordination diagram that shows a clear trend in progressive change in species composition over successive sampling intervals.

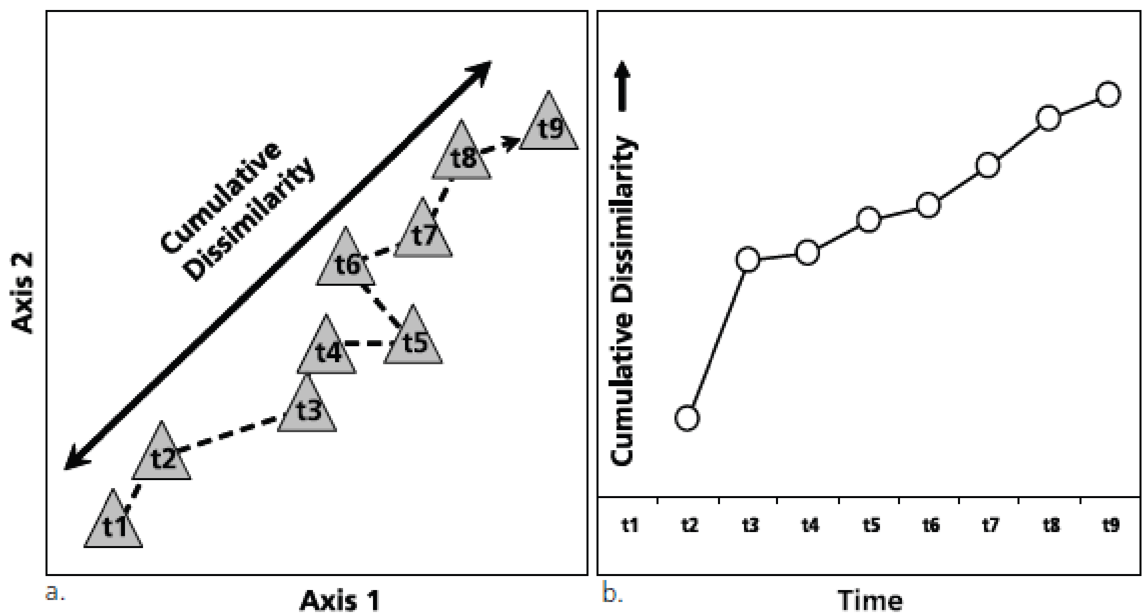

Figure 9. Cumulative change in species composition over nine sampling seasons. (A) An idealized two-dimensional ordination diagram illustrating the compositional position of a site at time one through nine where Euclidean distance between each year (i.e., time steps t1, t2...t9) is proportional to species dissimilarity. The solid two-headed arrow is an ordination that illustrates the cumulative dissimilarity (progressive compositional change) over the whole period. (B) A graph of cumulative dissimilarity between the first year sample and successive years (i.e., t1 to tn). Note that the change is positive and sustained, suggesting a clear trend of changing composition over time.

4.8.3 Report Format

Annual reports and third year Analysis and Synthesis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting. Annual reports and third year Analysis and Synthesis reports and other peer-reviewed technical reports will be formatted using the Natural Resource Data Series (NRDS) Report template. These templates and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Reports will be posted in Reference Applications, KLMN Internet and Intranet web sites, and SOU's Bioregional electronic archive collection. They will also be sent to the Technical Advisory Committee and to park staff with particular interest in the monitoring results. These reports will be used to update NPSpecies.

4.9 Data Storage and Archiving Procedures

File structure, version control, and regular backups are carefully controlled to preserve the integrity of Network datasets (KLMN Network Data Management Plan [Mohren 2007]). As described above, all data are transferred to the Network Data Manager, where they are placed on a Network server and are subject to regular archiving and backup processes as described in the Network's Data Management Plan.

During the field season, field forms will be submitted to the Crew Lead and stored in cabinets at the end of each sampling trip. At the end of the field season, these datasheets will be scanned into PDF documents and stored in the Vegetation Monitoring project folder located on the Klamath Network server.

Prior to the start of a new field season, all products from the prior field season should have been transferred to the Network Contact (SOP #11: Data Transfer, Storage, and Archive). The Network Contact will work with the Data Manager to make certain that products are stored in their proper location on the KLMN server and posted to the proper distribution locations.

5.0 Personnel Requirements and Training

5.1 Roles and Responsibilities

Roles and responsibilities under this protocol are summarized in Table 11. The Network Coordinator will serve as the Project Lead with attendant oversight responsibilities. The Project Lead is responsible for representing the Klamath Network in all issues related to this protocol. The Project Lead should be in constant communication with project and park staff to make certain the protocol is being properly implemented. It is the responsibility of the Project Lead to be familiar with all aspects of the protocol and provide assistance to the Network and parks when necessary.

The Project Lead will hire and supervise a GS-7 temporary botanist or plant ecologist as the Crew Lead. The Crew Lead will oversee data collection, data entry, data verification and validation, as well as data summary, analysis, and reporting. The Network Data Manager designs and maintains the database, provides data verification and validation, and oversees data security, archiving, and dissemination. The Data Manager, in collaboration with the Crew Lead, also modifies data entry forms and other database features to assure data quality and to automate report generation. The Network Data Manager is responsible for building adequate quality assurance quality control procedures into the database management system and for following appropriate data handling procedures.

Table 11. Roles and responsibilities for implementing the Klamath Network Vegetation Monitoring Protocol.

Role	Responsibilities	Position
Project Lead	Project oversight	Klamath Network Coordinator
	Administration and budget	
	Consultant on all phases of protocol review	
	Evaluates progress toward meeting objectives	
	Facilitate communications between NPS and parks	
	Research on invasion ecology	
	Interpretation of monitoring results	
	Report preparation	
	Protocol revision	
Data Manager	Oversees all data management activities	Klamath Network Data Manager
	Makes certain data are posted	
	Makes certain all products and deliverables are reviewed, submitted, stored, and archived	
	Maintain and update database application	
	Provide database and data management training as needed	
	Consultant on GPS/GIS use	
	Work with Project Lead to prepare and analyze data	
	Ensures metadata have been developed for appropriate project deliverables (e.g., databases, GIS/GPS documents, images, etc.)	
	Primary steward of Access database and GIS data and products	

Table 11. Roles and responsibilities for implementing the Klamath Network Vegetation Monitoring Protocol (continued).

Role	Responsibilities	Position
GIS Specialist (Data Manager and/or Project Lead in future)	Provide spatial data analysis that may be needed (e.g. GRTS)	Klamath Network GIS Specialist
	Develop metadata for spatial data products	
	Maintain GPS units	
	Help train crew members on GPS use	
	Prepare maps for field crews	
	Prepare maps and graphics for reports	
Crew Lead	Suggest changes to protocol	GS-7 Term Botanist
	Maintain research permits	
	Coordinate hiring of field crews	
	Coordinate scheduling, travel and accommodations	
	Acquire and maintain field equipment	
	Train field teams on vegetation sampling techniques, plant identification, and any other aspects of the protocol	
	Perform data summaries and analyses, and provide text for reports	
	Maintain and manage voucher specimens	
	Maintain and archive project records	
	Certify each season‘s data for quality and completeness	
	Creates metadata for products in GIS, GPS, image, and document format	
	Maintain research permits	
Field Crew	Collect, record, enter and verify data	Seasonal Network staff
	Provide recommendations to improve protocol operational efficiency	
Administrative contact	Arrange vehicles	Klamath Network Administrator
	Timesheets, purchasing, and reimbursements	
	Copy editing and report production	
	Equipment checkout	
Park Contact	Consultant on protocol implementation	Park botanist, plant ecologist, or Resource Chief
	Facilitate logistics planning and coordination	
	Help interpret management implications of results	
	Review reports, data and other project deliverables	

Each park within the Klamath Network has a designated Park Contact for this protocol. It is the responsibility of the Network Contact or Project Lead to contact the Park Contact when necessary. Park Contacts will help support the Vegetation Monitoring, when necessary, by participating in meetings, helping with logistical planning at their park, and providing assistance with other miscellaneous tasks to ensure that the crew can perform the work efficiently in their park.

The field work, seasonal data management, and data entry activity to be completed under this protocol will be conducted primarily by the field crew. They will work under the direct supervision of the Crew Lead. When and where feasible, the Network will explore means to supplement this core staffing with park-based employees or volunteers, or assistance from the

Project Lead or Network Contact during critical periods, but ultimately the scope and complexity of the field monitoring will be designed specifically for the capabilities of the assigned seasonal employees.

5.2 Qualifications and Training

Competent, observant, and detail-oriented observers are essential for collecting credible, high-quality vegetation data. The Crew Lead must have strong botanical, organizational, and leadership skills to ensure the crew is well outfitted, scheduled, adequately trained, and motivated do their best work. The crew members must take initiative to read and understand the protocol elements for which they will be responsible and ask for clarification from the Crew Lead when questions arise. All field crew members must possess sufficient botanical skill to accurately recognize many of the species encountered and to identify nearly all of the remainder with the help of species lists, photographs, keys, etc. Field crew members must also be competent with GPS navigation, compass use, estimating plant cover, and data collection. All crew members should be well organized, function well as team members, be comfortable in the field, and work methodically under difficult conditions. Field crew members need to be able to work in the field with another crew member for long periods of time. They must also be willing to work flexible schedules that may include long work days in inclement weather.

Training is essential for developing competent observers, both at the initiation of the field season and thereafter. At the start of the season, observers will review plant identification using interpretive materials developed by the Network, as well as herbarium specimens, keys, photographs and a field visit to each park immediately prior to sampling. The Project Lead will ensure that training is adequate and provide a refresher on invasive plant identification, GPS navigation, etc. at the start of the season (SOP#2: Observer Training). The Project Lead should work closely with the Data Manager to train field crews on all data collection devices and data management methods. As data are recorded or uploaded, additional training will ensure that data are recorded accurately, errors identified in a timely fashion, and all data are backed up in the most efficient and secure way in each park.

5.3 Safety

The field crew will be working in some remote areas; it is therefore essential that everyone be prepared for emergency situations. The Klamath Network has developed job hazard assessment documents specific to each park, to which crew members will strictly adhere while working at the parks (Appendix C). The safety appendix addresses known hazards (e.g., poison oak, rocky terrain, etc.), wildlife issues, communications, first aid, and an emergency response plan. Prior to going into the field, as part of observer training (SOP #2: Observer Training), the Crew Lead shall review safety procedures and job hazard analyses (Appendix C) with all field crew personnel.

6.0 Operational Requirements

6.1 Annual Workload and Implementation Schedule

The annual schedule for implementing the protocol is shown in Table 12.

Table 12. Annual schedule of major tasks and events for the Klamath Network vegetation monitoring protocol.

Month	Administration	Field	Data Management/Reporting
January	Annual report and work plan complete. Begin recruiting and hiring seasonal personnel	Hire seasonal staff and schedule field visits, reserve campgrounds, and vehicles.	Data analysis from previous year. Prepare Annual report and/or Analysis and Synthesis report(s) from previous season(s)
February	Administer and modify existing agreements, if necessary		Data analysis. Finish annual report. Prepare Analysis and Synthesis report
March	Final protocol modifications (if any)	Inventory field equipment and resupply where needed.	Prepare Analysis and Synthesis report
April		Prepare field and GPS/electronic equipment. Train field crew (Whiskeytown and Lassen Sampling Years)	Finish Analysis and Synthesis report
May		Train field crew (Lava Beds/Redwood and Oregon Caves/Crater Lake sampling periods.	
June		Field work	
July			
August	Prepare budget for new fiscal year		
September	Close out of fiscal year	Finish field work. Field season closeout.	Metadata production,
October	Network Annual Report and Workplan drafted.	Data verification, briefing report	Data certification, check in, and archival
November			Data analysis
December			

The monitoring workload will vary from year to year. During the years in which Whiskeytown and Lassen Volcanic are to be monitored, the greatest number of plots will be sampled (153), followed by the Crater Lake and Oregon Caves years (122), and then Redwood and Lava Beds (96). These numbers do not include 15 additional plots in the matrix at Whiskeytown that currently cannot be monitored due to safety concerns related to marijuana cultivation. In addition to year to year variation, budgeting is complicated by sampling of whitebark pine in Crater Lake and Lassen Volcanic. During years in which these parks are sampled, the whitebark pine protocol is expected to provide additional field crew members. It is anticipated that about half of the high elevation plots, or 13, can be sampled by these crews per year. Therefore, the plot total at Whiskeytown and Lassen Volcanic that will be monitored by vegetation crews is 119, while this number is 99 for Crater Lake and Lava Beds. The Analysis and Synthesis reports will be prepared by the Network Contact and Project Lead after sampling of the Redwood and Lava Beds, which will require the shortest field season.

Based on the pilot study, it is estimated that a two person crew can complete about five plots per week of sampling, or ten plots per pay period. Each crew will need an additional week before the field season for preparation, and a week after the field season for data entry and other post-season activities. The Crew Lead is a term employee who will spend at least 8 weeks in preparation for the season and in data validation and report preparation afterwards. The budgets for each year are detailed in Tables 13a-d.

The following assumptions are made in these budgets: The first field season assumes that that we will employ one GS-7 Crew Lead and three additional GS-5 field technicians. These will compose two field crews, which will each work 3.5 months total (except for the Crew Lead). Work during the sampling seasons that pair Redwood and Lava Beds (Table 13a and 13d) will be completed by two 2-person crews, consisting of one GS-7 crew leader and three GS-5 field technicians. The field work will be completed over a 3.5 month season, from June through mid-September. The next field season involving Whiskeytown and Lassen Volcanic is the most field work intensive. During this season, we will employ one GS-7 Crew Lead and three additional GS-5 field technicians as the long-season crews, which will work a total of 4.5 months. A second two person GS-5 field crew will work for 2.5 months on vegetation monitoring to supplement the plot total. It is expected that this crew will also conduct whitebark pine monitoring for approximately 5 weeks. The third field season in which Crater Lake and Oregon Caves will be sampled assumes that that we will employ one GS-7 Crew Lead and three additional GS-5 field technicians as the two long-season crews, which will work a total of 3.5 months. A second two person GS-5 field crew will work for 2 months on vegetation monitoring to supplement the plot total. It is expected that this crew will also conduct whitebark pine monitoring at Crater Lake for approximately 5 weeks. The fourth field season (Table 13d) will be the same as the first, but the first Analysis and Synthesis report will also be prepared. The budget accounts for this with increased time spent by the Network Coordinator (as Project Lead), and $5,000 for help with statistics and writing.

In addition, office staff and volunteers may assist with sampling during ―crunch" times when vegetation in multiple parks is ready for monitoring (typically late May, early June in Whiskeytown, Lava Beds, and Redwood, and late July, August in Lassen Volcanic and Crater Lake), or in the event of injuries or logistical challenges. Positions will be announced during the winter prior to a field season. Crews will be hired during early spring to enable training by mid-spring and sampling by late spring (SOP #1: Field Work Preparation).

6.2 Facility and Equipment Needs

Equipment and facility requirements for this protocol are modest. The crew will typically require housing or camping facilities in each park for several weeks every 3 years. The Crew Lead will contact the Park Contact the winter before field work begins so arrangements can be made (Table 12). The vegetation monitoring field work requires two high clearance 4WD vehicles, computers, GPS units, handheld computers, a laser rangefinder, a concave (standard) densiometer, taxonomic guides, tape measures, a plant press, hand lenses, identification material, and a digital camera. For safety purposes, crews will also carry radios and/or cell phones to communicate, if necessary, with park staff in the event of emergency. SOP #1: Field Work Preparations provides complete lists of all sampling and personal supplies that crews will need. During the off-season, equipment will be kept and maintained at the Klamath Network office on the lower Southern Oregon University campus office.

6.3 Startup Costs and Budget Considerations

Startup costs include the purchase of equipment and supplies as well as maintenance and or replacement of equipment shared among multiple projects (e.g., GPS units, cameras, vehicles).

All equipment that needs to be purchased will be acquired prior to the implementation of this protocol, tentatively scheduled for FY 2010. Additional monies are budgeted each year of data collection to cover equipment repair or replacement for this specific protocol.

This protocol will have an annual budget ranging from 129K to 157K per year (Table 13). Most of the budget will pay for field work, but a significant portion (approximately 26%) is designated to the Project Lead, Data Manager, and Crew Lead (2 months) for off-season data management, analysis, report writing, and other duties in support of field work. If in-season activities are included, data management and analysis activities will total between 35% and 40% of the budget each year. We expect that the annual budget will increase modestly due to inflation of general costs and cost of living increases for salaried staff. These increases will be addressed in part by scheduled cost of living increases for the KLMN monitoring budget based upon agency staff employed.

Table13a-d. Estimated startup costs and annual budgets for the first four field seasons of Klamath Network vegetation monitoring.

a. Year 1, Lava beds and Redwood (96 Plots)

	Item	Person-Months	Salary	Benefits	Total
Personnel	Network Program Manager	1.5	6416	2406	13,233.00
	Network Data Manager	2	5200	1950	14,300.00
	Field Crew Leader, GS-7	9.0	3,973.15		48,988.94
	Field Crew, GS-5	11.0	2,626.00		31,196.88
Other	Supplies				4,000.00
	Travel				10,000.00
	Vehicles				8,000.00
Subtotal (Fieldwork Only)					***53,196.88***
	Total				**129,718.82**

b. Year 2, Whiskeytown and Lassen (153 plots)

	Item	Person-Months	Salary		Total
Personnel	Network Program Manager	1.5	6416	2406	13,233.00
	Network Data Manager	2	5200	1950	14,300.00
	Field Crew Leader, GS-7	9.0	4,172.00		51,440.76
	Field Crew, GS-5	18.5	2,704.00		54,025.92
Other	Supplies				4,120.00
	Travel				10,600.00
	Vehicles				10,000.00
Subtotal (Fieldwork Only)					78,745.92
	Total				**157,719.68**

Table13a-d. Estimated startup costs and annual budgets for the first four field seasons of

Klamath Network vegetation monitoring (continued).

c. Year 3, Crater Lake and Oregon Caves (122 plots)

	Item	Person-Months	Salary		Total
Personnel	Network Program Manager	1.5	6416	2406	13,233.00
	Network Data Manager	2	5200	1950	14,300.00
	Field Crew Leader, GS-7	9.0	4,381.00		54,017.73
	Field Crew, GS-5	14.5	2,785.00		43,613.10
Other	Supplies				4,250.00
	Travel				10,630.00
	Vehicles				10,000.00
	Subtotal (Fieldwork Only)				***68,493.10***
	Total				**150,043.83**

d. Year 4, Lava beds and Redwood, second visit (96 Plots)

	Item	Person-Months	Salary	Benefits	Total
Personnel	Network Program Manager	3	6416	2406	26,466.00
	Network Data Manager	2	5200	1950	14,300.00
	Field Crew Leader, GS-7	9.0	3,973.15		48,988.94
	Field Crew, GS-5	11.0	2,626.00		31,196.88
Other	Supplies				4,000.00
	Travel				10,000.00
	Vehicles				8,000.00
	Subtotal (Fieldwork Only)				***53,196.88***
	Analysis and Synthesis Report Assistance				5,000.00
	Total				**142,951.82**

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Standard Operating Procedure (SOP) #1: Field Work Preparation

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedures that will be completed prior to the field season, including reviewing the budget; hiring and scheduling the field crew; preparing site description forms, data forms, and maps; developing GIS layers; and meeting park requirements.

Reviewing the Budget

It is the Network Coordinator's responsibility to provided adequate funding to conduct this protocol. Funding for this project should be clearly stated in the Annual Work Plan. The Crew Lead will meet with the Network Coordinator prior to each field season to review the budget for this project's work plan and ensure that it meets salary, equipment, mileage, and miscellaneous field expenses.

Hiring the Crew Lead

It is the Project Lead's responsibility to hire the Crew Lead. Recruitment for the Crew Lead should begin in late November or early December of the year preceding a field season. Hiring should be completed no later than January. Qualities to seek in potential Crew Leads include:

1. Proficiency at identifying vascular plants. Completed botany degree preferred.
2. Outdoor hiking and camping experience.
3. Moderate to high level of physical fitness.
4. Familiarity with one or more of the parks in the Klamath Network.
5. Familiarity with plant communities in the Klamath Region.
6. Leadership experience.
7. Strong organizational skills.
8. Knowledge of (or preferably, certification in) wilderness first aid.
9. Ability to work in the field with another crew member for long periods of time.

Once selected, the Crew Lead should review the protocol and discuss any questions with the Project Lead.

SOP #1. Field Work Preparation (continued).

Hiring the Field Crew

Recruitment of the field crew member(s) should begin by January of the year preceding field work. Hiring should be completed in March. As with hiring the Crew Lead, initiating the recruitment process early is critical for ensuring that well qualified candidates can be found. Although the field crew member(s) do not need to have the same level of experience nor all of the required skills as the Crew Lead, similar general qualities should be sought. While the first three of the above qualities should be considered mandatory, the others are desirable but not strictly required.

Soon after being hired, field crew members should be sent a copy of the Vegetation Monitoring Protocol.

Research Permits

The winter prior to field work, the Project Lead will submit any paperwork or other materials to ensure that research permits are up to date for the two parks to be visited that field season.

Preparing Data Forms, Databases, GIS Layers, and Maps

The Crew Lead, working with the GIS Specialist and Data Manager, will make certain that updated electronic forms, GIS layers, datasheets, and target plot sampling locations are prepared before the start of the field season. The Crew Lead will test the GPS units, tablet PC, and laser rangefinder to make sure they are set up and functioning properly prior to going into the field.

GIS Layers and Maps

The GIS Specialist should maintain the most up-to-date baseline GIS layers (Roads, Trails, Streams, Lakes, Park Boundary, Imagery, etc). Within 3 weeks of starting the first field season, the Crew Lead will work with the GIS Specialist to create a shapefile of the sites that will be surveyed as part of this monitoring protocol. We will be using an always revisit design so this task will only need to be completed once unless a new site is added to the sampling frame. A shapefile of the plot locations should be stored in the projects GIS folder and include the following attributes:

- Unique Site Name
- Park Code for each site
- Watershed in which the center of the site occurs
- Public Land Survey System Coordinates in which the center of site occurs
- Name of 7.5’ USGS map in which the center of site occurs
- Sampling frame stratum for the site (Matrix, Riparian, Alpine)

Hardcopy maps and aerial photographs covering all sites should also be prepared by the Crew Lead prior to going out in the field. The GIS Specialist has developed an ArcGIS .mxd that utilizes Mapbook to make map production easy and efficient. The individual creating the field maps will need to work with the GIS Specialist to learn how to utilize this tool.

Master and Project Database

Prior to starting the field season, it is the Crew Lead’s responsibility to work with the Data Manager to obtain and set-up the vegetation project databases (SOP #9: Vegetation Database).

At least 3 weeks prior to the start of the field season, the Crew Lead needs to provide the Data Manager with the following: (1) contact information for each person conducting field work (first and last name, position, mailing address, work number, email address) and (2) a GIS layer of the sites being visited that year. Once the project database is set-up, it should be stored on the tablet computer as described in SOP #3: Setting up the Electronic Field Equipment.

Data Forms

- Hardcopy data forms for the season's sampling (about 25 percent of the total) should be printed or copied using Rite-in-the-Rain paper.
- Field forms from the previous year's field work, stored in the project folder, should be used before printing new forms.
- Care should be taken to ensure that field forms from previous seasons represent the current data collection parameters before using them.

Preparing Equipment

Equipment will need to be checked before visiting the field to provide sufficient time for needed repairs or replacement. Electronic equipment (GPS units, cameras, tablet computers, and rangefinders) will need to have the settings checked prior to going into the field (SOP #3: Setting up the Electronic Equipment). With the exception of some basic camping gear, all equipment should be provided by the KLMN. It is important to remember that temperatures can range from 30 to 110 degrees Fahrenheit depending on the park where you are working. In addition, weather will be highly variable with a possibility of rain and snow. You should also be aware that some parks have unique conditions that could be hazardous to field crews if they are not adequately prepared (e.g., poison oak). The following equipment is needed to adequately implement this protocol:

Plot Equipment:

- Trimble GeoExplorer Pocket PC (or another unit of similar quality)
- Garmin 60CSx or 76CSx GPS unit (or another unit of similar quality)
- Tablet computer with the project database, protocol and supporting documentation, backup folder (for new data), species identification cards, and any other miscellaneous materials that might be needed (SOP #3: Setting up the Electronic Field Equipment, SOP #10: Data Entry)
- Laser rangefinder
- Camera
- Water resistant map of the park with plot locations
- Radios with park frequencies
- Pencils, sharpies
- Datasheets (25% on Rite-in-the-Rain paper)
- Aluminum closable clipboard
- Sighting compass
- Backpacks
- Metric tape measures (four 50 m)
- Loggers tape (metric)
- Diameter Tape (metric)

SOP #1. Field Work Preparation (continued).

- ~15 cm metric ruler, calipers (for smaller trees)
- Plot monumenting spikes (SOP #4: Site Locations, Set-up, Monumentation, and Description)
- Hatchet, or hammer
- Flagging (any bright color to be most easily seen)
- Pin flags
- Clinometer
- Tree tagging equipment(tags, stamps, nails)
- Extra batteries
- Field vest

Plant ID Gear

- Plant press, portable and repository (smaller newspaper works better [e.g., SOU campus paper])
- Plastic bags for collecting
- Dissecting scope and tools
- Hand trowel (plant collection)
- Hand lens
- Field guides (Jepson, Flora PNW, Zika's list for Crater Lake, Park ITIS species list, species lists from previously visited plots)

Miscellaneous/safety items:

- First aid kit
- Sun screen
- Insect repellant
- Hat
- Leather gloves
- Gaiters
- Light weight rain gear
- Flashlight, headlamp
- Matches
- Heavy boots (with extra laces)
- Long pants
- Long sleeve shirt

Standard camping gear (if housing is not available and for hard to access sites)

- Water filter, extra water in vehicle
- Stove, extra fuel
- Pots, pans, other eatery items
- Camprest or other ground padding
- Tent, ground tarp
- Rope and bag to hang food, or bear proof container (if not car camping)
- Cook tent (if insects are bad while car camping)
- Sleeping bag
- Food
- Cooler

- Toiletries (for back country use)

Equipment Log Book

It is expected that over the life of this project, equipment to measure parameters and monument locations will improve. It is important to recognize that upgrading equipment can have an effect on the data you are collecting and if not documented can lead a person to believe a trend or pattern is occurring. To ensure the Crew Lead knows when equipment has been changed, an equipment log book is used to track these events. It is the Crew Lead's responsibility to complete the log and submit it to the Data Manager following the timeline in SOP #11: Data Transfer, Storage, and Archive. If no equipment changes occur, the Crew Lead should enter their name, position, date, and in the equipment column add ―No Changes."

Equipment Log

Name	Position	Date	Equipment	Event
Example Joe	Data Manager	12/15/2006	DBH Tape	Upgraded from Biltmore Stick to DBH tape

Name – The full name of the person using the equipment (e.g., Sean Mohren)
Position – Position of the person using the equipment (e.g., Field Crew)
Date – Date the change or issues with the equipment occurred (e.g., 5/15/2007)
Equipment – Name of the equipment (include ID # if applicable)
Event – What occurred to the equipment (e.g., Battery died, Calibration, Lost)

Park Requirements

As early as possible after being hired (e.g., February or March*), the Crew Lead should communicate with the Park Contact to inform him/her of the survey schedule and to determine:

1. What housing or campground sites are available, as arranged with assistance from Network Contact.
2. Whether keys are needed to access survey sites.
3. Whether permits needed to conduct research in the parks are up-to-date. <u>(*NOTE*: research permits need to be submitted no later than January 1st. After the approval of the first year of vegetation monitoring protocol, we will pursue acquisition of multi-year permits)</u>.
4. Whether there are any safety procedures to follow; in particular, whether areas to be sampled need to be checked by law enforcement for safety concerns.
5. If special equipment is available such as freezers or storage units.
6. Pre-season conversations with the Park Contact should include whether access routes previously used are still useable (e.g., land ownership changes, landslides, etc.).

SOP #1. Field Work Preparation (continued).

Prepare For and Scheduling Training

The training sessions should be scheduled and materials should be prepared as detailed in SOP #2: Observer Training.

Scheduling Field Work

By sampling the Network's low elevation sites first, then the mid elevation sites, and finally the high elevation sites, crews can ensure that sampling coincides with the optimum time for observing plants in flower (Figure 1). It is the Crew Lead's responsibility to develop a tentative schedule for the entire season before the beginning of the season.

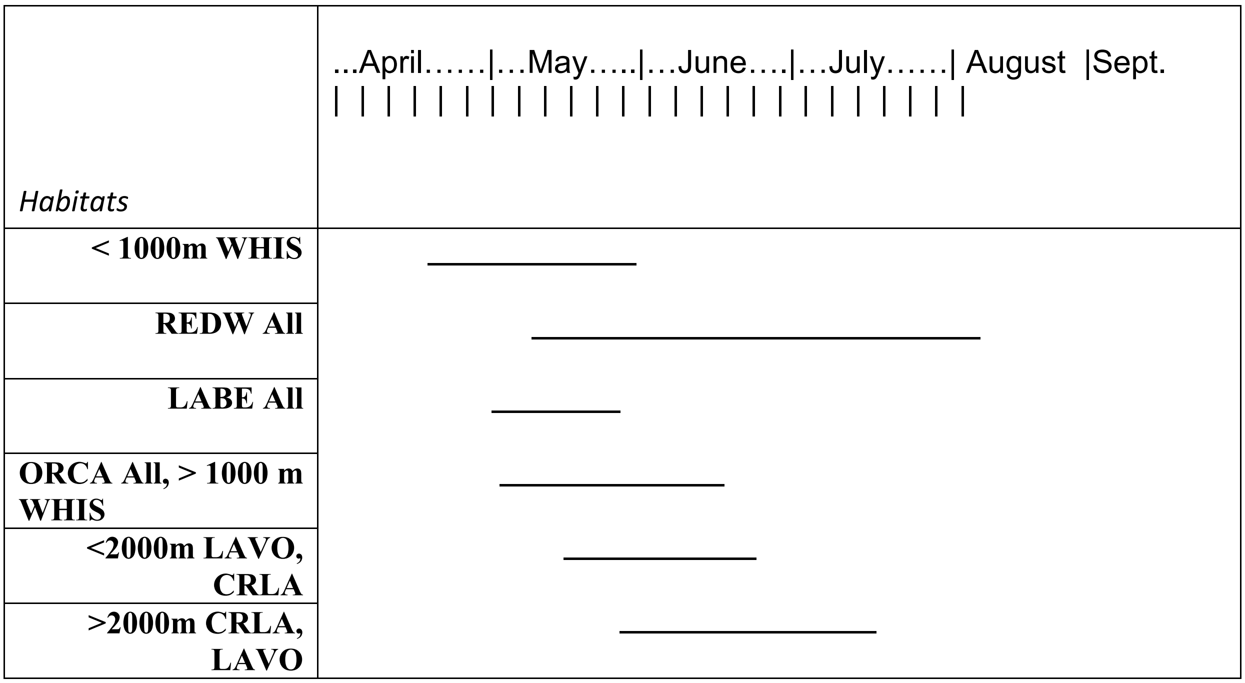

Figure 1. Timing for vegetation sampling in different elevation zones in different parks of the Klamath Network. WHIS = Whiskeytown, REDW = Redwood, LABE = Lava Beds, ORCA = Oregon Caves, LAVO = Lassen Volcanic, and CRLA = Crater Lake.

Training

Each crew member should have the appropriate level of training prior to beginning the field work for this protocol. It is the responsibility of the Project Lead (working with the Data Manager, GIS Specialist, and Crew Lead) to develop and implement all components of training associated with this protocol (SOP #2: Observer Training). A training log book should be maintained and submitted to the Data Manager following the timeline in Table 1 (SOP #2: Observer Training). The log book should record the trainer's name, trainee name, position, date, training, and name of equipment. A training log can be downloaded from the KLMN web site or obtained by contacting the Data Manager. For more information on log books, read the KLMN Logbook guidelines located on the KLMN web site.

Standard Operating Procedure (SOP) #2: Observer Training

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedures for training observers, including vegetation plot sampling, electronic equipment, databases, data management, site location and monumentation, first aid and safety, emergency procedures, administrative processes, and backcountry rules and ethics.

Survey Training

Two weeks before the start of field sampling, crews will be brought on for training. Prior to working in the field, each crew member will spend the first week working in the KLMN office reviewing the entire protocol and the Network's NPS administrative document. The latter part of this document describes safety issues, timesheets, travel status, checkout processes, equipment check-in check-out process, purchase process, vehicle use, computer use, and NPS required trainings. The first week of training will include a presentation of the specifics of the protocol by the Project Lead and Data Manager. The second week, the crew will go to the first park to be sampled that year and begin training on the items listed below. When transitioning to the second park of the field season, crews will spend 2-3 days studying the park's flora before beginning sampling.

Training Observers in Protocol Implementation

Observers will be trained in all aspects of protocol implementation following the vegetation monitoring SOPs (i.e., plot set-up and monumenting, cover estimation techniques, DBH measurements, down woody debris measurements, tree tagging, etc.). The Project Lead, Crew Lead, and all observers will set up and collect data from two to three plots as a group to gain proficiency, consistency, and accuracy in all protocol implementation steps.

Training Observers in Navigation

Observers are expected to be able to independently navigate in the field using a map and compass and/or a GPS unit. They will be provided instruction on the following:

a. Basic features of Garmin and Trimble GPS units. The GIS Specialist will provide this training.
b. Ensuring correct identification of site/plot.
c. Navigation to and from plots.
d. Understanding correspondence between map and GPS.
e. Use of map and compass to navigate to and from the site.

f. Use of compass in site set-up.

Training Observers in Plant Identification

Observers are expected to be familiar with plant taxonomy and terminology in order to become quickly familiar with plants encountered in the Network parks. With the Crew Lead, observers will review how to identify vascular plants using the outreach materials developed by the Network, and where appropriate, herbarium specimens, keys, and photographs. The Project Lead will develop a reference plant collection. Field botanists/crew members' training will include:

1. Review lists of common park species, and/or site vascular plant lists.
2. Review photographs, taxonomic keys, herbarium sheets, park NPSpecies species list, and other plant identification materials prepared by the Network.
3. Practice plant identification, making use of herbarium specimens where possible.
4. The Project Lead should work with the field crew members to specifically review how to identify common species in particular parks. This should include:
   a. Which species look similar.
   b. Which habitats common species are most likely to occur.
5. Prior to sampling in a park, the crew will spend a couple of days identifying plants throughout the park with the Project Lead and Crew Lead.

Training the Observer in Data Collection Techniques

Data are collected using hardcopy datasheets, tablet computers, GPS units, and digital cameras. The data collection workflow, data to be entered, and entry methods are described in SOP #10: Data Entry. Each member of the crew will attend a 2-day training on how to use the electronic equipment to collect and manage data. It is the responsibility of the Data Manager and Project Lead to develop the training materials and conduct the training prior to beginning field sampling. At the end of the training, each crew member will be tested to ensure that he/she understands how to collect and store data using the electronic equipment. If a crew member does not pass the test, the Data Manager will need to work closely with him/her until he/she learns the method. Each member of the field crew should be trained to utilize the following equipment and methods.

- How to use the laser rangefinder.
- How to use the Garmin and Trimble GPS units.
- How to care for and use the tablet computer for data entry.
- How to complete the data entry of a site using the hardcopy datasheets.
- How to use the GPS camera to photograph the sites.
- How to store and back up data collected electronically.

First Aid, Safety, and Emergency Procedures

The field crew will be working in some remote areas; it is therefore essential that everyone, to the extent possible, be prepared for emergency situations. The Klamath Network developed a safety protocol (Appendix C). All crew members will read this before going into the field and will strictly adhere to it while working at the parks. The safety protocol addresses known hazards (e.g., poison oak, rocky terrain, etc.), wildlife issues, communications, first aid, and an emergency response plan.

SOP #2. Observer Training (continued).

Backcountry Rules

The Project Lead should be familiar with the rules and regulations pertaining to working and camping in the backcountry of each park. If field sampling is expected to occur in the backcountry, it is the Project Lead's responsibility to make certain all crew members are aware of the rules and regulations. Check with each park to learn about their backcountry rules. Two examples:

Crater Lake NP--http://www.nps.gov/archive/crla/brochures/backcountry.htm
REDW NP-- http://www.nps.gov/redw/planyourvisit/backcountry.htm

Training Log Book

It is the responsibility of the Project Lead to complete the training log book for all members participating on this project. The training log book is used to document that each member of a project has completed sufficient training to implement this protocol. An example of the training log template is provided below and should be submitted to the Data Manager following the schedule in SOP #11: Data Transfer, Storage, and Archive.

Training Log

Trainer	Trainer Position	Trainee	Trainee Position	Date	Training	Equipment
Example Joe	Data Manager	Sean Mohren	Field Crew	12/15/2008	Photograph Data Entry	Ricoh Camera

Trainer – The person giving the training (e.g., Sean Mohren)
Trainer Position – Position of the person giving the training (e.g., Data Manager)
Trainee – The person receiving the training (e.g., Joe Smith)
Trainee Position – The position of the person receiving the training (e.g., Field Crew)
Date – Date or range of dates over which the training occurred
Training – The type of training
Equipment – If the trainee learned to use specific equipment (e.g., light meter, invasive database)

Standard Operating Procedure (SOP) #3: Setting up the Electronic Field Equipment

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the process for setting up the Global Position Systems (GPS), tablet computer, camera, and laser rangefinder to collect and store data for the Vegetation Monitoring Protocol. This SOP describes the process associated with using a Trimble GeoExplorer 2005 series Pocket PC, Garmin 60 and 76 series GPS unit, Ricoh Digital GPS camera, and the TruPulse 200 Laser Rangefinder. It is expected that this equipment will be updated throughout the life of the protocol and this SOP will need to be updated accordingly.

Review of the Data Collection Methods

As part of this protocol, the Klamath Network will use digital data collection as its primary means and collect data using hardcopy datasheets only when problems occur with digital data collection equipment. For more information on electronic data collection and the database for this project, see SOP #9: Vegetation Database and SOP #10: Data Entry.

Setting up the GPS Units

For the first visit to a site, field crews will use professional grade Trimble GPS units to find the center point of a site and to record the coordinates at the four corners of each plot. If not enough signals from satellites can be obtained using the Trimble GPS, recreational grade GPS units will be used to capture the location information during the first visit. After the first visit, a recreational grade Garmin GPS unit will be used to help field crews navigate to the general area of a site where they can search for monumenting stakes and tree tags. It is the GIS Specialist's responsibility to set up the GPS units prior to starting the field work. Field crews should not change the setting of the GPS units without prior authorization from the GIS Specialist or Data Manager.

Trimble GeoExplorer 2008 Series

The Pocket PC settings should be completed in the following manner.

1) On the Pocket PC, under the start menu, select [Settings]. At the bottom of the screen, select the [System] tab. Open [System Information]. Go to the following Trimble web site: http://www.trimble.com/geoxt_ts.asp?Nav=Collection-9554 and make certain the Pocket PC has the most up-to-date software.

SOP #3. Setting up the Electronic Field Equipment (continued).

2) Make certain the latest available version of ESRI ArcPad, Trimble GPSCorrect, and ActiveSync is loaded onto the Pocket PC.
3) Open ArcPad on the Pocket PC and tap the small drop-down arrow next to the GPS Tools button  and tap on [GPS Preferences].
    a. There are several tabs at the bottom of the screen. For the **GPS tab**, set the following:
        i. Protocol = Trimble GPScorrect
        ii. Port = Com3: TSIP Serial Port
        iii. BAUD = 9600
        iv. Make certain ―Automatically Active,” ―Show GPS Activity in System Tray,” and ―Automatically Pan View” are check marked
    b. On the **Capture tab**, set the following:
        i. ―Enable Averaging” should be check marked
        ii. Points = 30
        iii. Vertices = 5
        iv. Position Interval = 1
        v. Distance Interval = 5
    c. On the **Quality tab**, set the following:
        i. ―No Warnings” should be check marked
    d. On the **GPS Height tab**, set the following:
        i. Antenna Height = 3
        ii. Geoid Separation = 0
        iii. ―Use Map Units for Height Units” should be check marked
        iv. ―Use Height in Datum Transformation” should be check marked
    e. On the **Datum tab**, set the following:
        i. GPS Datum = D_WGS_1984
    f. On the **Alerts tab**, set the following:
        i. All the alerts should be turned off
    g. On the **Location tab**, set the following:
        i. Latitude, Longitude, and Altitude will automatically populate
        ii. ―Restore Location” should be check marked
        iii. DST Distance Alert = 10 and units should be = m
4) Tap the small drop-down arrow next to the GPS Tools button  and tap on [Trimble GPScorrect]
    a. Tap [Logging Settings] and make certain the settings are correct
        i. Log GPS to SSF = On
        ii. Log H-Star Data = No
        iii. Antenna Height = 3.000 m
    b. Tap [GPS Settings] and make certain the settings are correct
        i. DOP Type = PDOP
        ii. Max PDOP = 15
        iii. Min SNR = 39
        iv. Min Elevation = 15
        v. Velocity Filter = Auto

SOP #3. Setting up the Electronic Field Equipment (continued).

c. Tap [Real Time Settings] and make certain the settings are correct
    i. Choice 1 = Integrated SBAS
    ii. Choice 2 = Use Uncorrected GPS
    iii. Real-Time Age Limit = 4 min

5) Go to: G:\Monitoring\Vegetation_Monitoring\Vegetation_GIS\Template and load a copy of the blank shapefile called: Vegetation_Sites_XXXX onto the Trimble unit. Replace the XXXX with the year the survey work is going to be completed.

Setting up the Garmin 60/76 GPS Unit

The Garmin GPS unit is mainly used by the field crews to navigate to the site after it has been monumented. In the event that a GPS coordinate cannot be obtained using the Trimble unit, the Garmin unit may be used to obtain a GPS coordinate for the location (SOP #10: Data Entry). It is the responsibility of the Data Manager or GIS Specialist to prepare the GPS units for the field crews. The following steps should be used to prepare the GPS units.

1) Make certain you have the latest version of the program DNR Garmin. This program can be obtained from the following web site: http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html
2) Obtain the following layers from the GIS Specialist:
    a. Site locations to be visited that year.
    b. Park boundaries.
    c. All roads, trails, and waterways for the park.
3) Make certain the projection for all the layers is NAD83 Zone 10.
4) Use DNR Garmin and the following steps to load the GPS data onto the Garmin Units.
    a. Open DNR Garmin and go to [file→load from file] and under ―Files of type” select [ArcView Shapefile].
    b. Make sure the Garmin is plugged into the computer and is recognized by the DNR Garmin program.
    c. Click on the proper drop-down menu for either routes or waypoints and select upload.
    d. Repeat these steps for all GIS layers.
5) Use the program Topo Pro for ArcGIS to upload background imagery if needed.
6) Once you have the data loaded, go to the main menu in the Garmin Unit and select [Setup].
7) Use the default settings for this unit with the exception of the following changes:
    a. Under [setup→system] make certain WASS / EGNOS is ―Enabled.”
    b. Under [setup→map] make certain the proper maps are showing for the areas you will be surveying.
    c. Under [setup→time] change the format to [24 hour] and make certain the time zone is [US - Pacific].
    d. Under [setup→units] change the format to [hddd mm ss.s], Map datum should be NAD 83, Zone 10, Distance = Metric, Elevation = Meters (m/min), Temperature = Celsius.

SOP #3. Setting up the Electronic Field Equipment (continued).

Setting up the TruPulse Laser Rangefinder

The TruPulse Laser Rangefinder has three buttons: an up and down arrow on the left side of the unit and the ―fire" button on the top of the unit. Make certain the unit has new batteries and then follow these basic steps to set up the unit:

1) Hold the down arrow button down for 4 seconds while looking through the eye piece of the unit. You should see the words ―UnitS." Push the fire button and you should see a measurement type (Yards, Meters, Feet) under the UnitsS caption. Use the up and down arrows to set this to [Meters]. Hit the fire button once you have selected meters.
2) Look through the eyepiece and at the bottom of the screen you should see one of the following SD, VD, HD, INC, HT. Use the up and down arrow to set this to what you want. SD = Slope distance, a straight line to an object; VD=Vertical distance, how high or low an object is relative to you; HD = Horizontal distance (use when measuring distance to an object), an objects distance corrected for slope; INC = the angle to an object; HT=Height (used when measuring tree or snag heights), used to find the height of an object.
3) The two functions to be used during this protocol are 1) HD and 2) HT.

Setting up the Tablet Computer

Prior to heading into the field, the Data Manager should load the field project folder onto the desktop of each tablet computer. The field project folder should be renamed to include the vital sign, initials of each crew member that will be using the folder, and the current year separated by underscores (e.g., Vegetation_DO_SM_2008). This folder structure is located on the C drive of the tablet computer.

The core of this filing structure (levels one and two) mimics the file structure of all the KLMN project folders located on the server at the KLMN office and on the thumb drive that is used to store backups of this project data. The third and fourth level of the folder structure has some standardized folders which are described below but may also contain additional folders that are project specific. Field crew members and project managers can add information to these folders as necessary; however, folder names should not be changed unless you have checked with the Data Manager. Standard third level folders include the following:

Data Folder

- Database Template – This folder contains a blank project database that can be copied and used in the event something happens to the project database.
- Datasheet Template – This folder contains a copy of the datasheets.
- Project Database – This is the database that is used to store the project data while in the field.

Documents Folder

- Equipment Documentation – This folder contains documents pertaining to equipment used for this project. This can include user guiders, technical guides, etc.

- Log Books – This folder contains the four log books used in this project including the Training, Event, Datasheet, and Equipment logs. For more information on the mentioned log books see SOPs #2, 15, 10, 1, respectively.
- Protocol – Contains a copy of the protocol they are implementing.
- Identification – Provides identification guides that can be used by the field crew.

GIS Folder

- Shapefile Backups – This folder contains a backup copy of all shapefiles used on any Trimble to Garmin GPS units.

Images Folder

- Image Backup – Backup copies of images are placed in this folder to ensure they are not lost if damage occurs to the camera.
- Image Metadata Template – This is a template of the required metadata for each picture taken while working on a KLMN project. These data can also be entered directly into the database (SOP #10: Data Entry).

In addition to the tablet PC, a flash drive will be used to store backup copies of the database. A folder should be placed on the flash drive labeled similar to the project folder: ―Vegetation_SS_DO_YYYY_Backup” where SS and DO are the crew initials and YYYY is the year in which the field work occurred. After the crew completes a site, a backup of the database, GIS layers, and images is created and placed on the thumb drive following the process outlined in SOP #10: Data Entry.

Setting up the Ricoh Camera

The Ricoh camera gives the user the ability to create five picklists that can be used to automatically store metadata. To create the picklist, complete the following steps.

Setting up the Picklist

1) Make certain the camera is plugged into your computer and open the ―List Editor” using the Capilo Software.
2) On the ―Item 1” tab, under the ―Item Name” field, type ―Photographer.”
3) Under the same tab, in the ―Input” field, type the full name (first, last) of each person that could take a picture using this camera. Be certain the individuals who will take most of the pictures are listed first. If possible, select one crew member to take all of the site pictures and enter their name first in this list.
4) Click on the ―Item 2” tab and in the ―Input” field type ―Site Name.”
5) Enter the names of each site you plan on visiting in the field.
6) Click on the ―Item 3” tab and in the ―Item Name” field type ―Protocol.”
7) Enter the name of the protocol that is associated with these pictures in the ―input” field. Use one or more of the following names:
   a) Vegetation Protocol
   b) Cave Protocol
   c) Landbird Protocol

SOP #3. Setting up the Electronic Field Equipment (continued).

   d) Aquatics Protocol - Lakes
   e) Aquatic Protocol - Streams
   f) Intertidal Protocol
   g) Invasive Protocol
   h) Whitebark Pine Protocol
8) Click the save button and navigate to the folder on the camera entitled “GPSlog.” Save the file in this folder.
9) You have completed setting up the picklist for the camera.

Camera Settings
Make certain there are no pictures on the camera by pressing the first grey button as shown in Figure 1. If there are pictures on the camera, find out whose they are and be certain they are placed in the proper location. Now press the “Menu OK” button and make sure the following settings are correct.

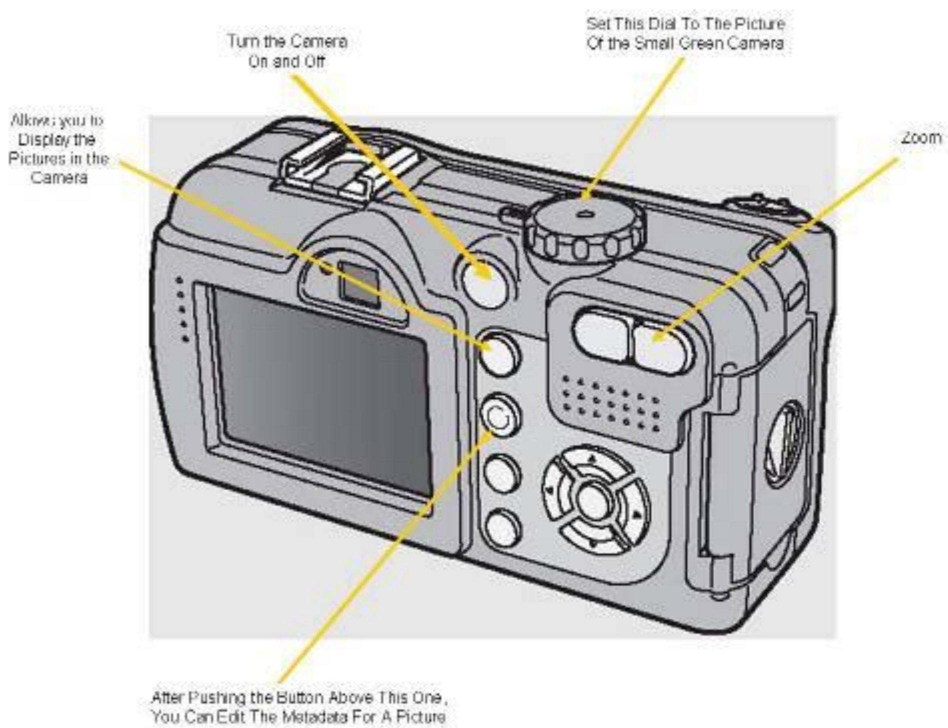

Figure 1. Image of the back of the Ricoh camera that will be used to take site pictures at the vegetation monitoring plots.

Setup Tab
1) Select the “Setup” tab and go to LCD Brightness. Make certain the screen is bright enough to see the picture in the view finder.
2) On ADJ BTN Set.1 make certain this is set to “AntiBlur.”
3) On ADJ BTN Set.2 make certain this is set to “Quality.”
4) On ADJ BTN Set.2 make certain this is set to “Quality.”
5) Check to make sure the Auto Power Off is set to “5 minutes.”

SOP #3. Setting up the Electronic Field Equipment (continued).

6) Set the Beep Sound to —Sutter.”
7) Turn the Col Setting to –Mute.”
8) For the LCD Confirm option, set it to –3 Seconds.”
9) Make certain Sequential No. is turned –On.”
10) Check to make sure you have the proper date and language set.
11) Set Step Zoom to –Off.”
12) Set SHTG STGS WARNG to –On.”
13) Se the USB Connection to –Mass Str.”
14) Set Cals Pic Quality to N3264.

SHTG STGS Tab
Check the following to make certain they are set correctly.
1) Pic Quality / Size = N3264
2) Antiblur = On
3) Focus = Multi AF
4) Photometry = Multi
5) Sharpness = Sharp
6) Cont. Mode = Off
7) Color Depth = Vivid
8) Time Exposure = off
9) Interval = All 0's (not set)
10) Image with sound = Off
11) Date Imprint = Off
12) Exposure Comp. = -0.3
13) Whie Balance = Auto
14) ISO Setting = Auto

EXP SET Tab
1) GPS Datum = WGS 84
2) GPS Display Mode = UTM
3) GPS Lock = Off
4) Pass Key = (Not Set)
5) Search Count = 4
6) BT Auto Conn = Off
7) BT Serial (not set)
8) Master / Slave = Slave
9) Auto Del = Off
10) Quick Send Mode = Off
11) Barcode Mode = Mode 1
12) Scan Time = 3 sec
13) GPS Track Time = 5 Sec.

Your camera should now be properly set and ready to go into the field. Make sure you have extra charged batteries and storage cards. You do not need to wait for the camera to acquire a GPS position before taking a picture.

Standard Operating Procedure (SOP) #4: Site Locations, Set-up, Monumentation, and Description

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP describes the set-up, monumentation, and collection of basic plot description data.

Supply Requirements

Monumenting a plot will require the following supplies and equipment:

- flagging tape
- 4 chaining pins
- Hammer/hatchet
- 9 Witness tree tags, 7 pre-stamped with site and module number (see below) and 2 with #1 & #2 (Standard round tree tags, brass or aluminum)
- Nails
- Compass
- Clinometer
- Aluminum stakes 12-15” (spikes), 7 if monumenting, 4 for site revisit
- Metal washers, same number as stakes
- Metal detector (only needed for site revisit)
- Three 50 m transect tapes
- 2 logger tapes
- 22 wire pin flags
- Trimble and Garmin GPS
- Tablet computer (for recording data)
- Site Information Card (for recording data, attached at the end of this SOP)
- Pencils
- Clipboard/tatum
- Specimen collecting bags

SOP #4. Site Locations, Set-up, Monumentation, and Description (continued).

Plot Establishment/Reestablishment

Establishment

All plots locations will be established using a Trimble unit (unless satellite reception is limited, then the Garmin unit should be used) and coordinates randomly selected from the sampling frame (SOP #10: Data Entry, see section on Site Navigation). Plots are not slope corrected. It is the discretion of the Crew Lead to decide when a plot location is unsafe or unsuitable due to excess travel, steep slopes, presence of water, etc., according to the following criteria:

1. Plot slope steeper than 30 degrees.
2. Travel time to plot exceeds 2.5 hours.
3. Plot has unstable scree, making it too unsafe to sample.
4. Plot is in a marijuana cultivation zone.
5. Plot is bare rock.
6. Plot is in water, with little or no emergent vegetation.
7. Wildlife issues (hornet nest).
8. Developed area (e.g., walk-in campground).

The Crew Lead has the authority to move the plot 100 m along a random azimuth away from the original location if deemed unsuitable for the above reasons (except travel time), or something unforeseen. If sites are rejected due to travel time, the crew leader will pick another location from the GRTS oversample. Plots should not be relocated to avoid poison oak. Once plot center is located, push an aluminum stake with a metal washer into the ground at the center point. This point will serve as point 3-8 for conventional plots (Figure 1), and point 4-5 for riparian plots (Figure 2). Attach an aluminum or brass tag to the stake, labeled with the stake number and plot number. Also, mark the stake with a wire flag and/or tie a piece of flagging above the center point if the area has thick vegetation. Record a new UTM coordinate for the center point, preferably with the Trimble, and record the UTM's and the PDOP (for Trimble) or Est Error (for Garmin) at this point.

SOP #4. Site Locations, Set-up, Monumentation, and Description (continued).

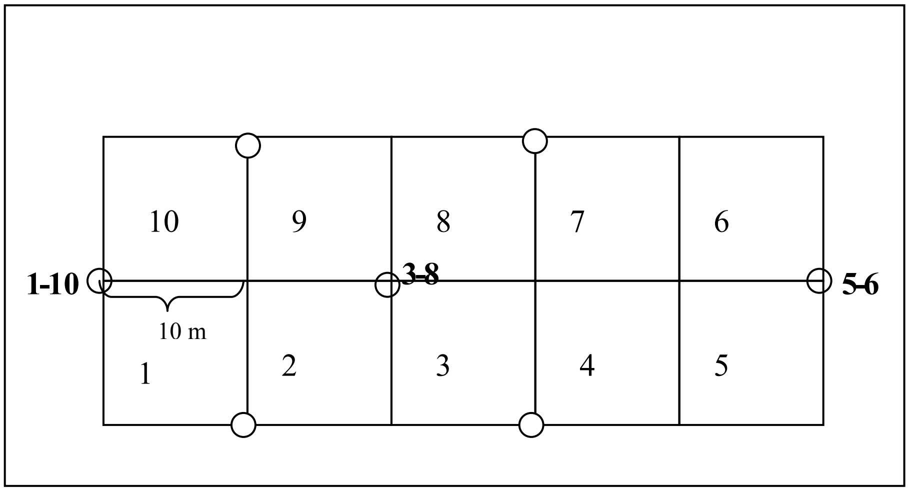

Figure 1. Normal 20 x 50 m plot layout. Circles indicate location of permanent stakes.

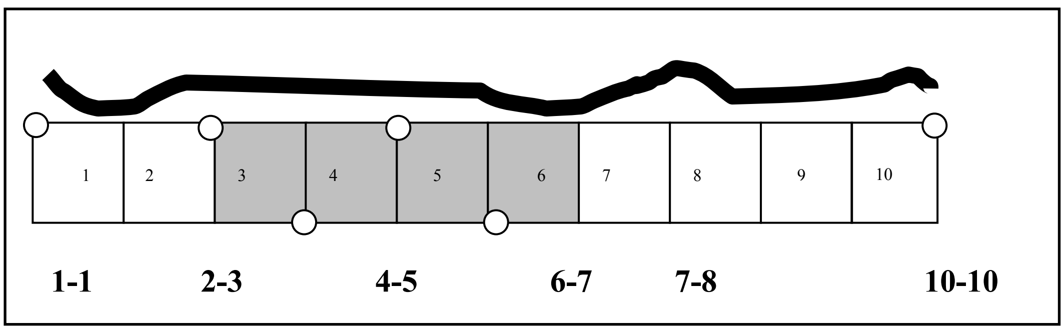

Figure 2. Plot layout for riparian areas (10 x 100 m). Circles indicate location of permanent stakes.

Selecting and Establishing Witness Trees

1. Witness trees are used to relocate the stake at the center of the intensive modules for each plot. Two witness trees are selected for each stake, 3-8 for non-riparian and 4-5 for riparian. If a suitable witness tree (see below) does not occur within 25 m of the stake, this step is eliminated, but must be noted. Only overstory trees that are likely to remain alive and standing between surveys should be selected. Trees should show no evidence of significant crown dieback or heart rot. Short-lived species should be avoided, if possible.
2. Once selected, witness trees should be tagged at the base with the tag FACING plot center. The tag should include the witness tree number (WT1 or WT2) stamped to the tag using the stamp set.
3. The distance from the witness tree to the stake is measured to the nearest 0.01 meter and recorded on the Plot Information datasheet.
4. The bearing FROM the witness tree TO the center stake should be determined and recorded on the Plot Information datasheet.

5. The DBH and species of each witness tree should be recorded on the Plot Information Datasheet.

Tree Tagging

All trees alive and dead ≥15 cm DBH will be tagged at breast height 1.4 m (4.5 ft), with the stamped number facing away from the trunk and towards plot center. Nail tags to trees leaving 1-2 inches of nail exposed, to account for diameter growth. Coppice stems that fork below DBH are tagged as two (+) stems, and recorded separately. Coppice stems that fork right at DBH should be tagged above the fork. Tag above any bulges or deformities that may occur at breast height on the tree. See Figure 1 for correct measurement methods.

Beginning in module one, trees should be tagged in sequential order starting with number one. Trees are tagged sequentially as they are measured (see overstory sampling below) making certain to record the tag number on the datasheet with the other tree measurements. Trees untagged in previous site visits, but have grown to ≥15 cm DBH, need to be tagged for the first time. New trees being tagged should start with the number following the last number used in the site on the previous visit (i.e., 100 trees have been tagged in the plot, new trees will be tagged starting with 101).

Plot Reference Information

If you are parking on the road shoulder, rather than a well known landmark or trailhead, record driving directions (including mileage) from the nearest landmark to where you parked the vehicle. Also record a GPS location of where you parked.

If needed, record waypoints on the return trip from the plot, using the easiest route. Make sure to record a waypoint where you encounter the road or trail on the return trip.

Measuring Plot Parameters

The following measurements are taken on the first plot visit:

Slope

The slope angle will be recorded at three locations for each plot, following the methods described below.

Record the angle of slope at each end of all plots and across the 3-8 stake of non-riparian plots (Figure 3) and from the 4-5 non-stream side corner to the 4-5 stream side corner for riparian plots (Figure 4) to the nearest 1 degree. Slope is determined by sighting the clinometer along a line parallel to the incline (or decline). To measure slope, Observer 1 should stand at the uphill edge of the plot and sight Observer 2, who stands at the downhill edge of the plot. When the observers cannot see each other, Observer 2 should move closer. Observers should sight each other at eye level. Read the slope directly from the degree scale of the clinometer. Slope measurements of the two observers should be compared for accuracy. With practice, slope measurements can be taken by only one observer.

SOP #4. Site Locations, Set-up, Monumentation, and Description (continued).

If slope changes across the plot but is predominately of one direction, record the predominant slope angle rather than the average. If the plot falls directly on or straddles a canyon bottom or narrow ridge top, code the average slope of the side hill(s). If the plot falls on a canyon bottom or on a narrow ridge top, but most of the area lies on one side hill, code the slope of the side hill where most of the area lies.

The shape of the slope at the plot scale should also be recorded using the following values in the drop down menu in the database and Plot Information Card.

- Convex
- Concave
- Straight
- Undulating

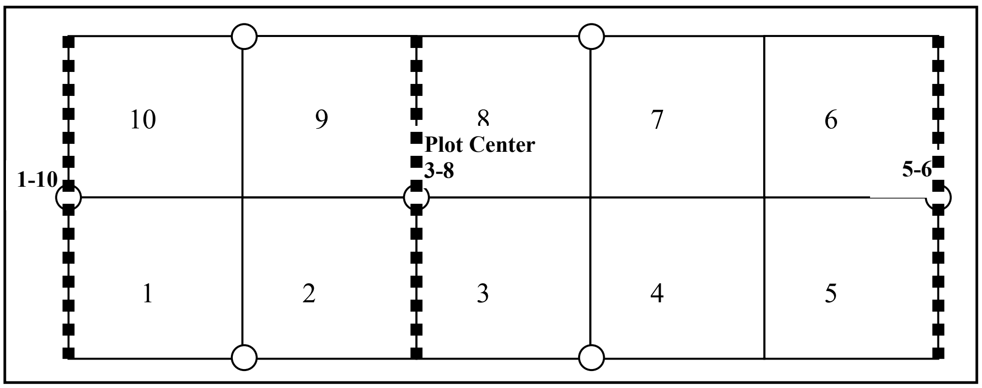

Figure 3. Location of slope and aspect readings shown in dashed lines.

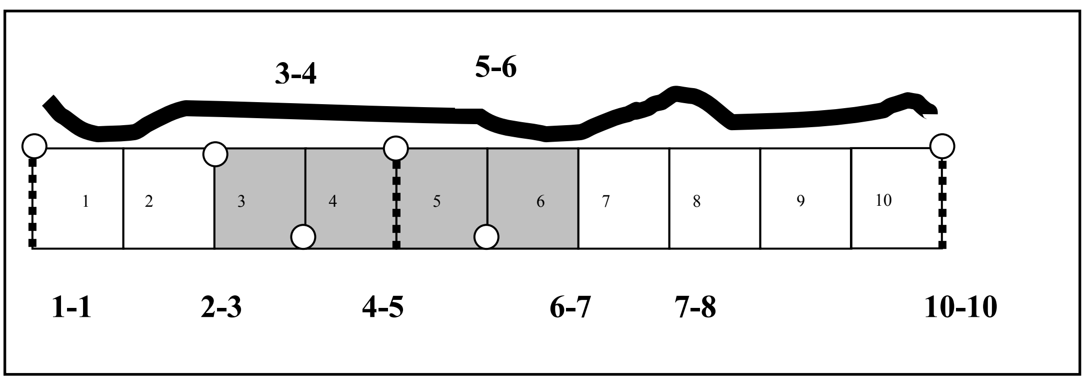

Figure 4. Location of slope and aspect readings shown in dashed line.

Aspect

Record the aspect in the same locations the slope was recorded; record aspect to the nearest 1 degree. Aspect is determined for land surfaces with at least 5 percent slope in a generally uniform direction. Aspect is measured with a hand compass along the same direction used to determine slope.

If aspect changes across the plot, but the aspect is predominately of one direction, record the predominant direction rather than the average. If the plot falls on or straddles a canyon bottom or narrow ridge top, code the aspect of the ridgeline or canyon bottom. If the subplot falls on a canyon bottom or on a narrow ridge top, but most of the area lies on one side hill, record the aspect of the side hill.

Elevation
The elevation is measured at one location for each plot. Record elevation in meters using the Trimble unit at the 3-8 location for standard plots or the 4-5 location for riparian plots (Figures 3 and 4, respectively).

Macroposition
Record macroposition from the initial stake point (3-8 for standard plots [Figure 1], 4-5 for riparian plots [Figure 2]). Macroposition is the location of the plot as it relates to the surrounding landscape. Macroposition should be recorded as one of the following values.

- Top = apex, hill, or ridge top.
- Upper = upper $^1/_3$ of a hillslope.
- Middle = middle $^1/_3$ of a hillslope.
- Lower = lower $^1/_3$ of a hillslope.
- Bottom = bottom of a hillslope adjoining a valley bottom, usually with a shallower slope than the adjacent hillslope.

Plot Reestablishment

The first step in resampling a plot is to locate the center stake and/or witness trees. Use the Garmin GPS unit to navigate to the vicinity of the center stake. If the center stake is gone, or difficult to find, locate the witness trees and measure to the center point and use the metal detector at this point. If the metal detector cannot locate the center point, reestablish the center point with an accurate measurement from the witness tree. If either of the witness trees cannot be relocated, reestablish them, after determining a center point. If the center stake and witness trees are missing, try to locate the 1-10, 5-6, 2, 3, 8, or 9 stakes. If no stakes can be located, use the UTMs of the center point and the GPS to reestablish the center stake. Attach a tag with the stake number and plot number on the stake. Also replace any of the permanent stakes missing from the plot, following the plot setup procedures below.

Plot Set-up

Once a center point is located, complete the following steps to monument or set up the plot. To limit the impact on the vegetation at the site as much as possible, the crew should stay outside the plot during the set up or walk along module boundaries.

SOP #4. Site Locations, Set-up, Monumentation, and Description (continued).

1.On side slopes, the long axis of the plot will run parallel with the contour. At other sites, the long axis should run parallel to ridges, ravines, and streams (Figure 5). Use a sighting compass to determine the appropriate bearing for the centerline.

20 x 50 Plots

2a. Use a logger's tape and compass set at the azimuth of the slope contour to put in the 1-10 corner. From the 3-8 stake, go 10 m at the determined azimuth to the 2-9 module corner and place a pin flag, and then go another 10 m and place a 1-10 pin flag (and if monumenting, place a permanent stake with a tag labeled with the plot number and corner number, 1-10). Then turn around to do the other side using the back azimuth: from the 2-9 pin flag, stretch the tape over the 3-8 stake to establish the 4-7 corner, this leapfrog method will aid in keeping the centerline straight. Repeat this method, placing pin flags every 10 m until the 5-6 corner is established (if monumenting, place a permanent stake with a tag labeled with the plot number and corner number 5-6). Always pull the tape *parallel to the slope*; plots are not slope corrected. *Care should be taken to precisely place these stakes and pin flags. This task is best preformed by two people: one to sight the appropriate bearing and measure while the other moves and places the pin flag or permanent stake as directed.*

3a. From the 1-10, 3-8, and 5-6 points (this step is best done right after establishing these points), with one person on each side of the center line 20 m apart, pull the tape over the center line pin flags, perpendicular to the center line, and place pin flags. These flags mark the outer edge of the plot.

4a. Using a chain pin to anchor the tape, run a 50 m tape from each outer corner of modules 5 and 6 to the 1 and 10 module corners, making sure to pass over the outer (already marked) point of modules 3 and 8; these tapes should be parallel to the plot centerline.

5a. Walking along the outside of the plot, place pin flags between the 1-2, 3-4, and 4-5 modules, and along the other side the 6-7, 7-8, and 9-10 modules.

6a. Before placing permanent markers at the 1-2, 3-4, 7-8, and 9-10 outer corners, double checking the location of all stakes/pin flags, (module diagonals are 14.14 m), all pin flags should be accurate to <30 cm. After placing the stakes, place a tag labeled with the plot number and corner number on the stake.

10 x 100 m Plots (Riparian)

2b. Use a compass set at the azimuth of the stream's general directional path to determine the long axis of the plot. *Be careful to set the azimuth so that none of the modules are more than 50% standing water.* From the 4-5 center stake, go 10 m at the determined azimuth and place the 3-4 stream-side pin flag, then go another 10 m and place the 2-3 pin flag. Now have the person at the 4-5 stake advance to the 3-4 pin flag and have the other person advance 10 m from the 2-3. Next, pull the tape over the 2-3 pin flag and place the 1-2 pin flag. Repeat this leapfrog method and place the 1-1 pin flag (if monumenting, place a permanent stake with a tag labeled with the plot number and corner number 1-1). Starting at the 3-4 pin flag, repeat the leapfrog technique to establish the 5-6, 6-7, 7-8, 8-9, 9-10, and 10-10 points, placing pin flags at the module corners (if monumenting, place a permanent stake at the 10-10 point, with a tag labeled with the plot number and corner number 10-10). If these points are in the water, use the laser rangefinder to get an idea of where the corner should be, keeping in mind that no more than 50% of any module should be standing water. If more than 50% of the module is standing water, the center line needs to be moved. Always pull the tape *parallel to the slope*; plots are not slope corrected. *Care should be taken to precisely place these stakes. This task is best preformed by two people: one to sight the appropriate bearing and measure while the other moves and places the stake as directed.*

3b. From the 1-1, 3-4, 5-6, 8-9, and 10-10 streamside points, measure 10 m perpendicular to the center line away from the stream and place pin flags. If these points are in the water, use the laser rangefinder to get an idea of where the corner should be, keeping in mind that no more than 50% of any module should be standing water. If more than 50% of the module is standing water, the center line needs to be moved.

4b. Starting at the 1-1 non-streamside point, run a 50 m tape to the 5-6 point, and place pin flags at the 1-2, 2-3, and 4-5 streamside points. Pull the tape and repeat from the 5-6 point until all module corners are marked. If these points are in the water, use the laser rangefinder to get an idea of where the corner should be, keeping in mind that no more than 50% of any module should be standing water. If more than 50% of the module is standing water, the center line needs to be moved back away from the stream.

5b. Before placing permanent markers at the 2-3 streamside, 3-4 non-streamside, 5-6 non-streamside, double checking the location of all stakes/pin flags, (module diagonals are 14.14 m), all stakes/pin flags should be accurate to <30 cm. After placing the stakes, place a tag labeled with the plot number and corner number on the stake.

All Plots

5. After double checking the location of all stakes/pin flags, (module diagonals are 14.14 m), all pin flags should be accurate to <30 cm. Mark the four outermost corners of the plot with a GPS, using the Trimble GPS unit or Garmin if the Trimble cannot get adequate satellite signal coverage. This is only done during the monumenting step.

SOP #4. Site Locations, Set-up, Monumentation, and Description (continued).

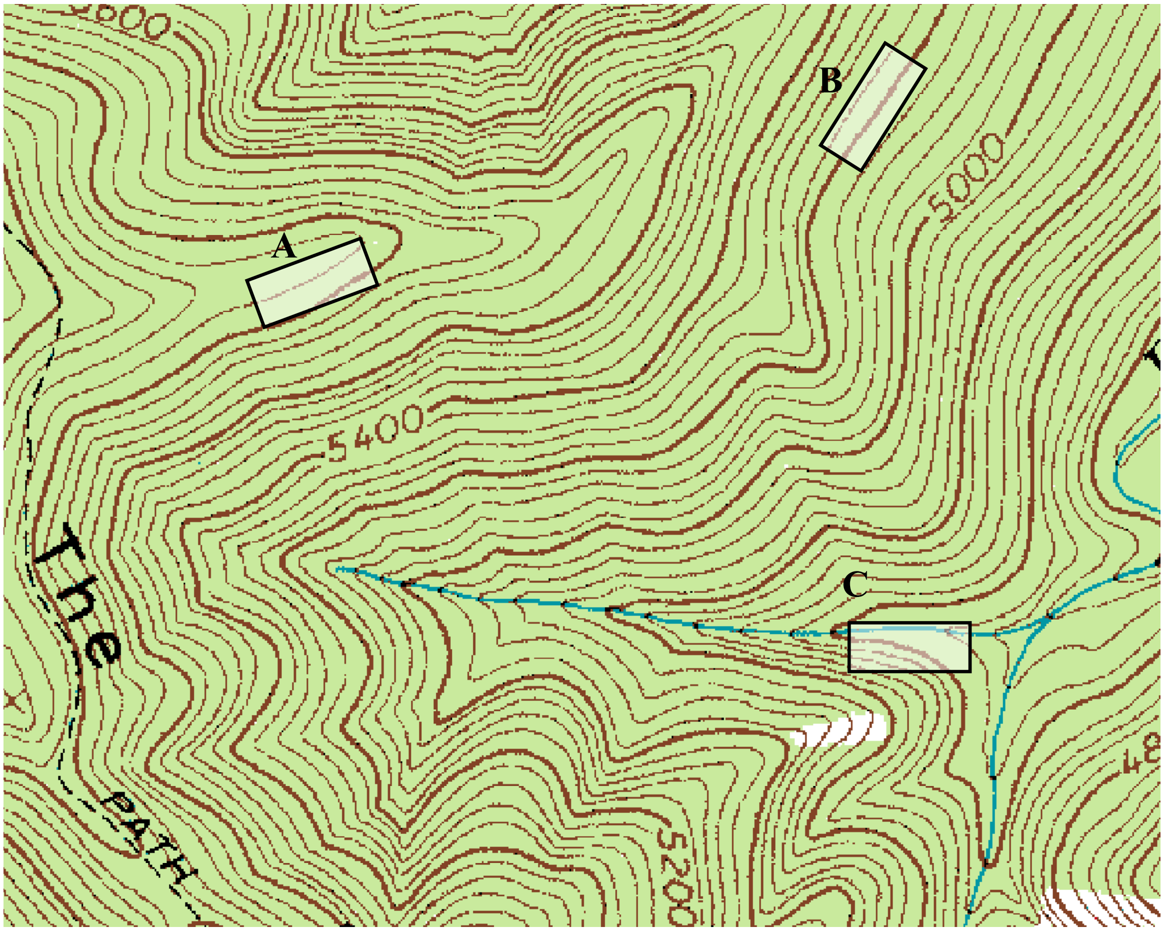

Figure 5. Proper orientation of plots on the landscape. The center line should run parallel to ridges (A), parallel to contours (B), and parallel to streams (C).

Disturbance

On each visit, disturbances within the plot should be recorded on the Plot Information Card and the disturbance tab on the electronic form. Disturbance should not be recorded if it occurs outside the plot but there is no evidence that it occurs in the plot. To record disturbance, place a checkmark in the appropriate box for each type of disturbance that occurs on the plot. If a disturbance type is not listed, check ―other" and describe the disturbance in the description field.

Non-Riparian Index Plot Information Card __#of__

Park and Site#			Date			Crew		

Site UTM Data

3-8 rebar	**N**		**Corner 1**	**N**	**Corner 10**	**N**
error	**E**		error	**E**	error	**E**
	Corner 5	**N**	**Corner 6**	**N**		
	error	**E**	error	**E**		

Witness Tree Info

Witness Tree#1 1-10	**Species**	**DBH**
Azimuth	**Distance**	
Witness Tree#2 1-10	**Species**	**DBH**
Azimuth	**Distance**	

Site Reference Data

Travel Time to Site from Parking	**Time to Complete Instalation (-travel)**	
Directions to parking (Include distance and directions from nearest landmark)	**UTM of Parking**	**N**
	error	**E**

Site Description

Slope @ 1-10		**Slope @ 3-8**		**Slope @ 5-6**	
Aspect @1-10		**Aspect @3-8**		**Aspect @ 5-6**	
Elev		**Slope Shape** (circle one)		**Center Line Azimuth**	
Macro Pos		Concave Convex	Straight Undulating		

Site Disturbance

Agriculture	Grazing/Browse	Logging	Fire	Animal	Insect	Wind	Other

Notes

Figure 6. Non-riparian datasheet for recording plot information.

Standard Operating Procedure (SOP) #5: Photographing Plots and Photo Management

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP provides the details on how to photograph plots and how to process photographic images collected by the Project Lead and field crew during the course of the Vegetation Monitoring Project. In addition, metadata (Table 1) for the photographs is described.

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

1. To document a particular feature or perspective for the purpose of site relocation.
2. To capture site habitat characteristics and to indicate gross structural changes over time.
3. To document species detection.
4. To document field crew activities during surveys and site set-up.

It is the responsibility of the Project Lead to ensure images are properly named and stored in their proper location along with the image metadata as described in this SOP.

Camera Set-up

The camera currently being used by the Network is the Ricoh Caplio 500SE (Figure 1). No matter what hardware is selected to take pictures of the site, it should have the capability to withstand harsh environments.

It is the responsibility of the Data Manager to work with the Project Lead to make certain the camera is properly set up before the field crew goes into the field. The camera settings should follow the instructions defined in SOP #3: Setting up the Electronic Field Equipment.

SOP #5: Photographing Plots and Photo Management (continued).

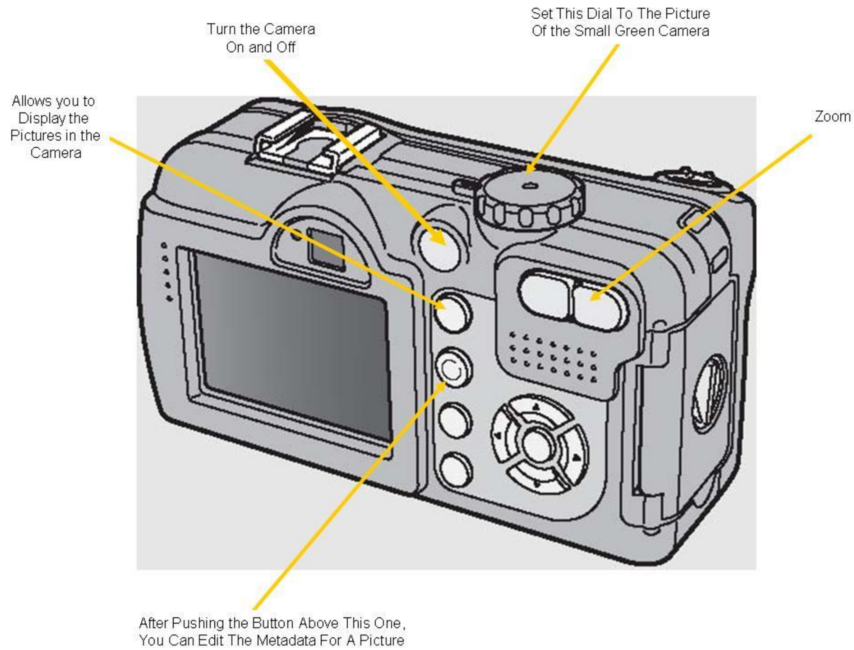

Figure 2. Back of the Ricoh Caplio 500SE Camera.

Photographing Plots

Each plot will be photographed at least six times (Figure 2): once from each end of the long axis (2) and once in each of the intensive plot (4). Photographs will be taken at eye level, approximately 5 feet from the ground. The photographer should review images in the LCD screen of the digital camera, to ensure an image of good quality has been recorded, before moving to the next image location. The corner locations shown in Figure 2 are the preferred locations. If necessary, due to vegetation directly in front of the camera blocking the view, the location can be moved to another corner. BE SURE TO RECORD THE ACTUAL CORNER FROM WHICH PHOTOS ARE TAKEN, if different from the protocol methodology described below. The following discussion assumes that no locations will have to be moved.

1a. For the non-riparian intensive plots 2, 3, 8, and 9, the center of the image should be the opposite corner of the module (Figure 2). For the end points, the center of the image should be oriented parallel to the long axis of the plot and directed towards plot center. *The order the photographs are taken in is important for data management and should be recorded as follows: 1-10, 5-6, 2 ,3, 8, and 9.* To expedite photographing, take 1-10 and 5-6 photos when the points are located during plot set-up.

1b. Four riparian intensive plots photographs are taken from the subplot corners facing diagonal across the plot (Figure 3). For the end points, the center of the image should be oriented parallel to the long axis of the plot and directed towards plot center. *The order the photographs are taken in is important for data management and should be recorded as follows: 1 long axis, 10 long axis, 3, 4, 5, and 6.* To expedite photographing take 1 long axis and 10 long axis photos when the points are located during plot set-up.

SOP #5: Photographing Plots and Photo Management (continued).

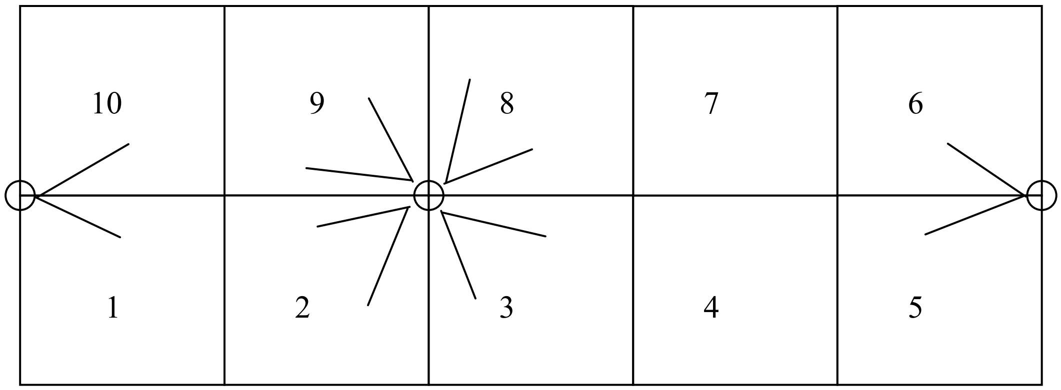

Figure 2. Location and orientation of plot photographs. The V's indicate the orientation and direction of the camera, with the open end facing the direction of the lens, when the image is taken.

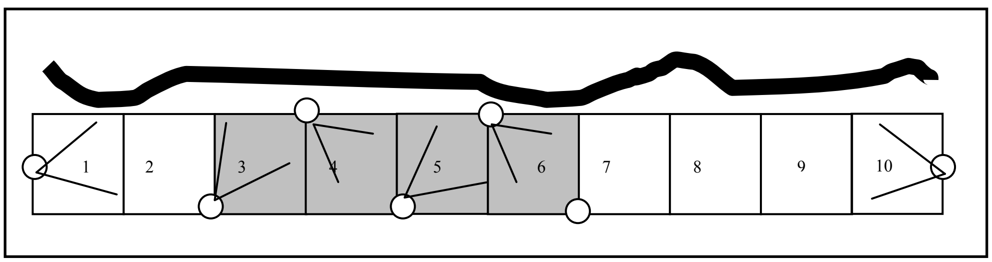

Figure 3. Location and orientation of riparian plot photographs. The V's indicate the orientation and direction of the camera, with the open end facing the direction of the lens, when the image is taken.

When taking a picture of a vegetation plot, complete the following steps:

1. Turn the camera on as soon as you get to the site so it can acquire the maximum number of satellites.
2. In a few instances, GPS coverage may not be possible. If the camera was turned on upon arriving at the site and you are ready to take photos but do not have satellite coverage, take the images anyway. If the camera was not turned on upon arriving at the site, or has powered down, try for at least 3 minutes to get proper coverage, then take photos regardless of satellite coverage.
3. Make sure the dial on top of the camera is set to the picture of the small green camera.
4. Press halfway down on the photograph button to make sure the picture is in focus.
5. Press all the way down to take the picture.
6. Push the first grey button so you can see the picture (Figure 1). If the quality is bad, repeat steps 1-6.
7. In the upper right corner of the display screen is the name of the photograph (format exp: 100-00295). Enter the name of the photograph into the database along with the photographer's name and photo date (SOP #10: Data Entry).
8. Push the first grey button.
9. If the picture is blurry or washed out (from the flash), delete the picture and retake until a good image is captured. For all good pictures, record the required information on the site photo metadata form (Figure 5).
10. Repeat steps 2-11 for each picture you take.

SOP #5: Photographing Plots and Photo Management (continued).

Incidental Photographs

When on the way to or from the site, if you see something you want to take a picture of, follow the steps above but record the required metadata on the ―Incidental” site photo metadata form (Figure 6).

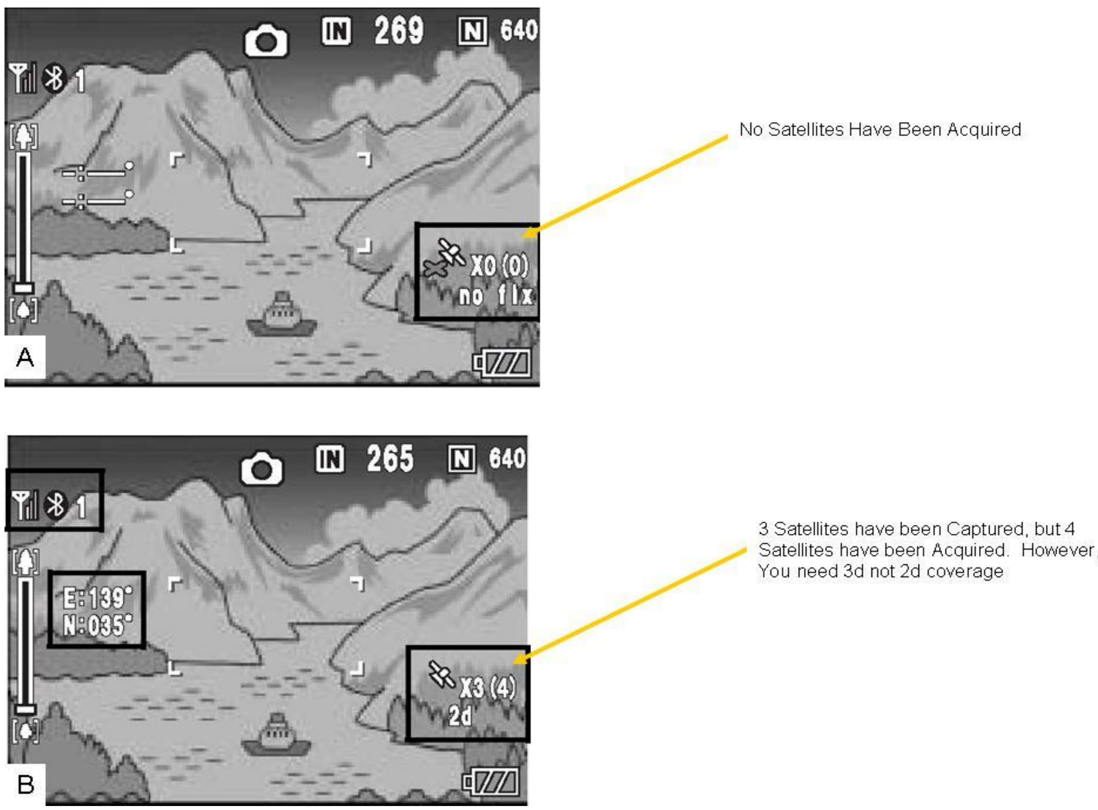

Figure 4. The display of the Ricoh camera showing (A) no satellite coverage and (B) 2d satellite coverage.

Download, Backup, and Processing Procedures

Any crew member who takes photographs while in the field should complete the following procedures for downloading and processing those photographs at the end of each day.

1. A folder entitled ―Images” should be located in the field project folder on the technician's tablet computer. Within this folder is a folder called ―Image Backup” (SOP#3: Setting up the Electronic Equipment).
2. At the end of the day, place a copy of the images you have taken THAT DAY into this folder. Keep in mind the original images should stay on the camera. This will ensure you have a copy of the images and at the end of the season the camera will have all the images that can be downloaded as a final copy.
3. Make certain you have completed a metadata record for each image. Images taken at the site should be entered into the database (SOP #10: Data Entry). Metadata for incidental images can be entered into the database or entered into the Excel metadata template.

SOP #5: Photographing Plots and Photo Management (continued).

Deliver Image Files for Final Storage

It is the Project Lead's responsibility to compile all images and transfer the images and metadata to the KLMN Data Manager (SOP #11: Data Transfer, Storage, and Archive). Prior to transferring the images, the Project Lead should remove all images that are of poor quality or personal images that are not needed by the Network, making certain to delete the metadata record for those images removed from the project folder.

At the end of the season, download the images from the cameras and place them in the appropriate folder. Images are stored in the Vegetation Monitoring_Image folder, a sub folder of the Vegetation Monitoring folder located on the Klamath Network server. On the shared server, go to: G:\Monitoring\Vegetation_Monitoring\Vegetation_Images\Seasonal_Data and place the images and metadata (that was not entered into the database) in a folder named with the appropriate year.

It is the responsibility of the Data Manager to place copies of the images in the KLMN Image Library. Metadata for the images will be loaded into the KLMN Image Database, which is linked to the photographs in the KLMN Image Library. Images and metadata will be backed up and archived following the methodologies outlined in the Klamath Network Data Management Plan.

Site Photo Metadata Card __#of__				
Park and Site#	**Date**		**Crew**	
Photo Name	Photographer	Description	UTM E	UTM N

Figure 5. Abbreviated Site photo metadata card.

Incidental Photo Metadata Card __#of__				
Park	**Date**		**Crew**	
Photo Name	Photographer	Description	UTM E	UTM N

Figure 6. Abbreviated Incidental photo metadata card.

Required fields: Park, Date, Crew, Photo name, Photographer, and a detailed description (names of people or organism in photo, general location (if no UTMs are recorded). The Project Lead is responsible for getting the data from this card into the appropriate metadata template.

Standard Operating Procedure (SOP) #6: Subplot Sampling (Species Cover, Tree Seedlings, and Saplings [<15 cm DBH])

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedure for establishing the nested subplots within the four intensive modules and for recording presence absence and cover percentage of species. Seedlings and small trees are measured at the 10 m^2 and 100 m^2 subplot, depending on the height and the diameter at breast height (DBH).

Subplot Setup

This procedure assumes plots have been set up following the process outlined in SOP #4: Site Locations, Set-up, Monumenting, and Description.

1. For consistency, 10 x 10 m intensive modules with subplots should be completed in a specific order: 2, 3, 8, and 9 (Figures 1 and 2). ***Be careful not to trample the subplots***. When traveling between intensive modules (or any module within the site), walk along the module boundaries, or off-site, when possible.
2. Using a Biltmore stick, layout the 1 m x 1 m subplot. Place a pin flag at the inside corner of the 1 m^2 subplot. Use a Biltmore stick to delineate one of the sides without a tape, and a meter stick or tape for the other.
3. To set up the 10 m^2 subplot, using meter tapes, measure 3.16 m in each direction, from the corner stake, forming a 90 degree angle. Mark with a pin flag. Extend each tape 90 degrees toward the plot center and mark the location where the two tapes intersect at 3.16 m; place a pin flag to establish the inner corner of the 10 m^2 subplot.
4. Use the diagonal measurement to make sure that subplots are square and improve the chances that sampling is done in the same place in subsequent revisits.
5. Repeat the above procedure for the other three intensive modules after recording species cover and tree density measurements.

SOP #6: Subplot Sampling (continued).

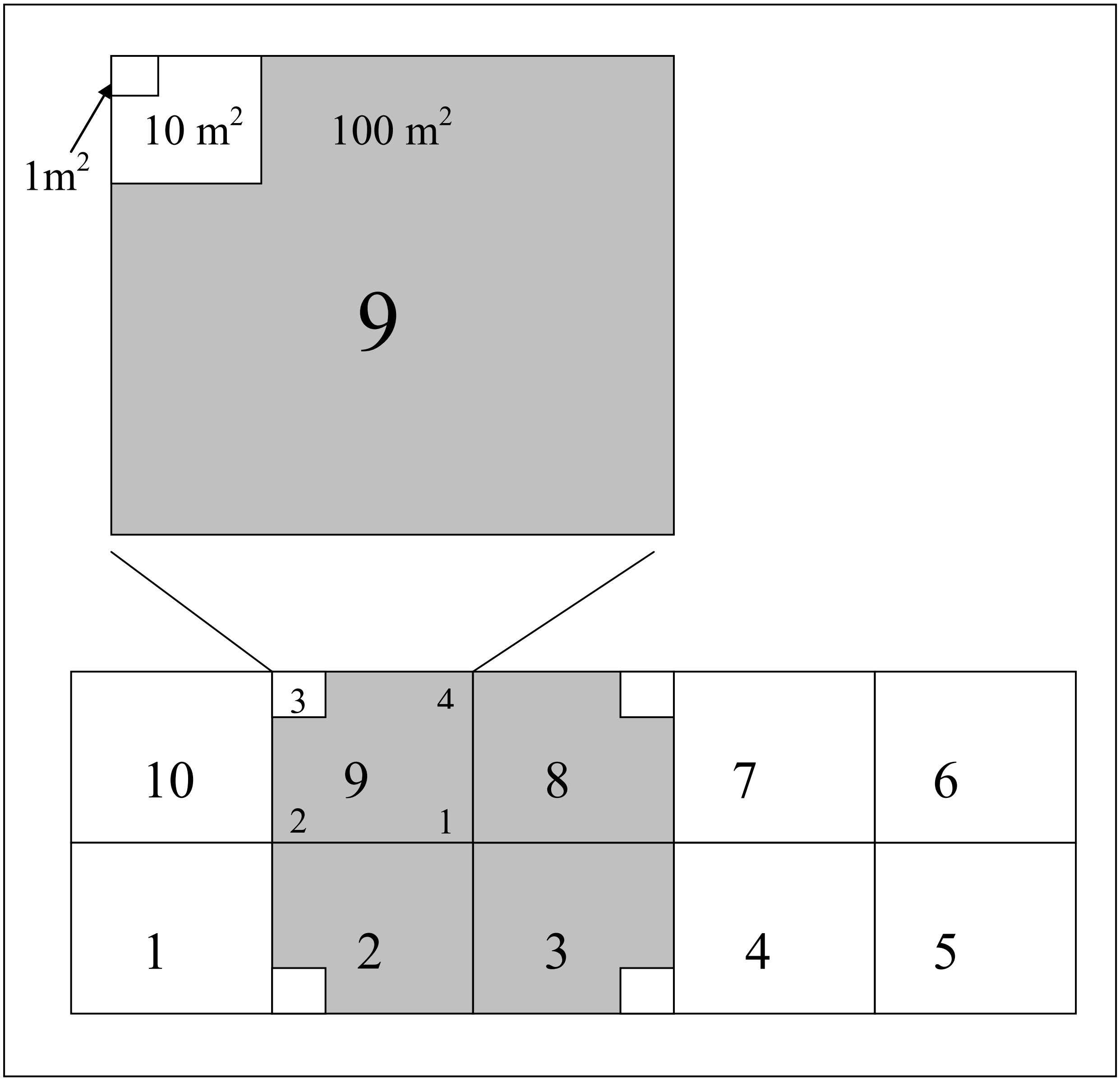

Figure 1. Arrangement of intensive modules and subplots. Location of nested subplots within the 0.1 ha long-term non-riparian vegetation monitoring plot. Nested plots, 1 m^2, 10 m^2, and the 100 m^2 modules (in gray) are sampled. Module corners are numbered as shown for module 9.

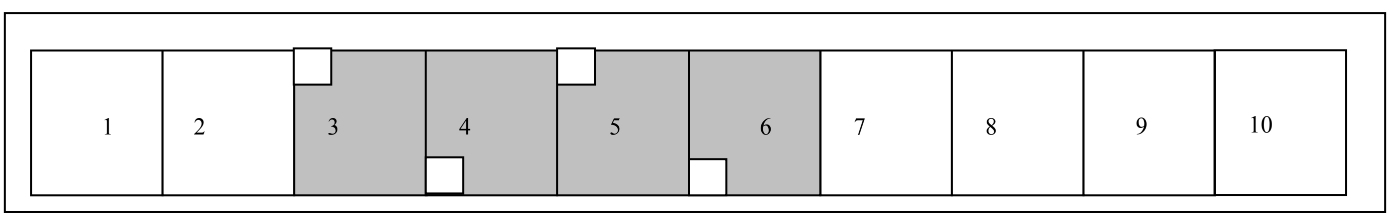

Figure 2. Location of riparian modules.

Species Cover

The nested subplot sampling inventories all vascular plant species on the main 0.1 ha plot to estimate their percent cover in four height strata. This sampling is mostly done in the four intensive modules (2, 3, 8, and 9 for non-riparian plots and 3, 4, 5, and 6 for riparian plots; see Figures 1 and 2, respectively). After sampling the four intensive modules, the entire 0.1 ha site is surveyed for species that did not occur in the module subplots.

1. Sample progressively from smallest to largest subplot. Species occurrence is recorded in three nested subplots: 1 m^2, 10 m^2, and the 100 m^2 module (Figure 1). On the subplot sampling card (Appendix 1) for nested plot sampling, the first occurrence of a species is noted in the column labeled subplot, by recording a 1, 10, or 100 according to the smallest size subplot in which the species in encountered.
2. Percent cover is estimated to be Trace, <1%, or to the nearest 1% if ≥1 for each species within the 100 m^2 intensive modules. Cover is estimated for individuals belonging to four height strata: S1 = (<0.75 m height), S2 = (0.75-2.5 m), S3 = (2.6-5 m), and S4 = (>5 m). The height strata of a species is determined by the maximum height of the individual(s) (e.g., *Abies concolor* [white fir] could belong to all four strata if seedlings (<0.75 m), saplings (0.75-2.5 m) poles (2.6-5 m) and mature trees (>5 m) were present in the 100 m^2 module). Species cover estimates are entered in the corresponding columns labeled S1, S2, S3, and S4 on the subplots datasheet. Individual plants rooted outside the plot but overhanging a module contribute to species cover (and are recorded as O in the column labeled subplot. Percent cover of rock (>1.5 cm diameter), bare soil (including rock <1.5 cm diameter), water, bryophytes, fine wood (0-7 cm) and litter, coarse woody debris, and shrub height (see below) are also recorded for the 100 m^2 plot.
3. After all four intensive plots have been sampled, subplot sampling ends when there are no more unrecorded species in the module, or in dense vegetation after 5-10 minutes has elapsed without the discovery of a new species.
4. Then, the other six modules are searched for species that did not occur in the intensive modules. Record these as **NEW** species across the entire 0.1ha plot and record the module numbers on the datasheet. To maximize efficiency, this step is best done by the person measuring the tree DBH during overstory sampling, or the person who measures overstory cover with the densiometer.

Training in Cover Estimates

Crew members will be trained in how to estimate foliar cover; measure tree DBHs; and sample down wood, litter, and duff in the field during the setup and measurement of two to three mock plots (SOP #1: Observer Training). Consistent cover estimates are important for modeling and for tracking changes in cover over time. However, obtaining consistent estimates among observers is notoriously difficult. The following guidelines will be followed to help improve consistency. Figures 3 and 4 are guides to help in the consistent estimation of plant cover.

1. Discuss cover estimation in a group setting, allowing for consideration of each other's estimates. With practice and discussion, foliar cover estimates by observers should begin to converge.
2. Practice estimating cover for different life forms, such as forbs, grasses, and shrubs.

SOP #6: Subplot Sampling (continued).

3. Throughout the sampling season, review foliar cover estimation. Periodically compare observer's cover estimates.
4. Ensure good communication among the crew about observer patterns of cover estimation.
5. As vegetation dies back, discuss estimation standards for estimating foliar cover of senescing vegetation.

There are numerous ways to estimate cover *of* a species on a plot. Begin by choosing one *of* the dominant species on the plot. Do this species very carefully using one or more *of* the following methods:

1. Quickly estimate whether the species covers more or less than half *of* the plot, then more or less than $^1/_4$ or $^3/_4$ of the plot:
   - if the species is greater than 75%, use methods 5, 6;
   - if the species is 25-75%, use methods 3, 4, 5, 6;
   - if the species is less than 25%, use methods 2, 3, 4.

2. Measure or estimate areas that are 1% and 10% *of* the plot. Ten percent *of* a 0.1 ha (1000 m^2) plot is 100 m^2, one 10 m x 10 m module; 1% *of* a 0.1 ha (1000 m^2) plot is 10 m^2 (3.16 m x 3.16 m). For species with low cover in the plot, it is often useful to try to mentally fill a 1% area (you have set up a 1 x1 m subplot for reference). If you fill the 1% area with plants and still have plants left over, fill another. This would give you 2%. Or if there are still some plants left over, fill another, and so on.

3. Measure the actual area covered by individual plants or clumps. This works well for large or clumpy plants such as vine maple, ocean spray, or trees. For example, given a large clump *of* vine maple, measure a typical radius *of* the clump and convert to area. If the <u>radius</u> was 3.5 m (3.5 x 3.5 x pi = 38.5 m^2), then that clump would be (38.5/100), 38.5% *of* the plot.

4. Measure or estimate the size *of* a typical individual *of* a species and then count the individuals *of* that species. This works well for small to medium-sized plants such as sword fern or bunchgrass. If the typical sword fern in a module was .6 m radius, or ~1%, and there were 24 plants, the cover for sword fern would be 24%.

5. Estimate the area <u>not</u> covered by a species. Use this method when a species has more than 75% cover. Use methods 2, 3, or 4, but apply them to areas not covered by a species. This often works well for dense species!

6. Divide the plot or module into quarters or halves if the species is very unevenly distributed or if the plot is large. If you divide a plot into quarters, estimate each quarter separately, then average the four quarters together. If most of the plants of one species fall in one of the quarters, mentally try to fill in the holes with plants from the other quarters.

7. Check your cover estimates by:
   - comparing each species to one that you are relatively certain about;
   - comparing estimates on the same species done by different methods; and
   - comparing to someone else's estimate.

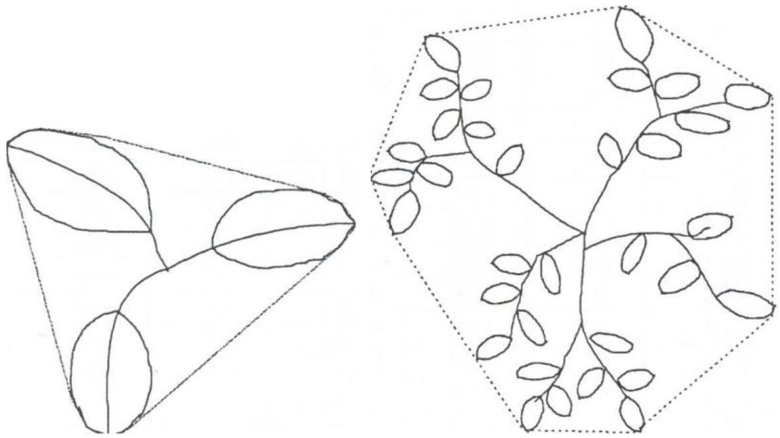

Figure 3. Plant cover is defined as the area of a polygon formed by connecting the outermost leaves and stems of a plant. In this drawing, the polygon is shown as the light dotted line connecting the outer parts of the plant.

It is the Project Lead's responsibility to test each member of the crew on their ability to measure foliar cover.

See SOP # 14: Collecting and Identifying Unknown Plants for information on dealing with unknown species.

SOP #6: Subplot Sampling (continued).

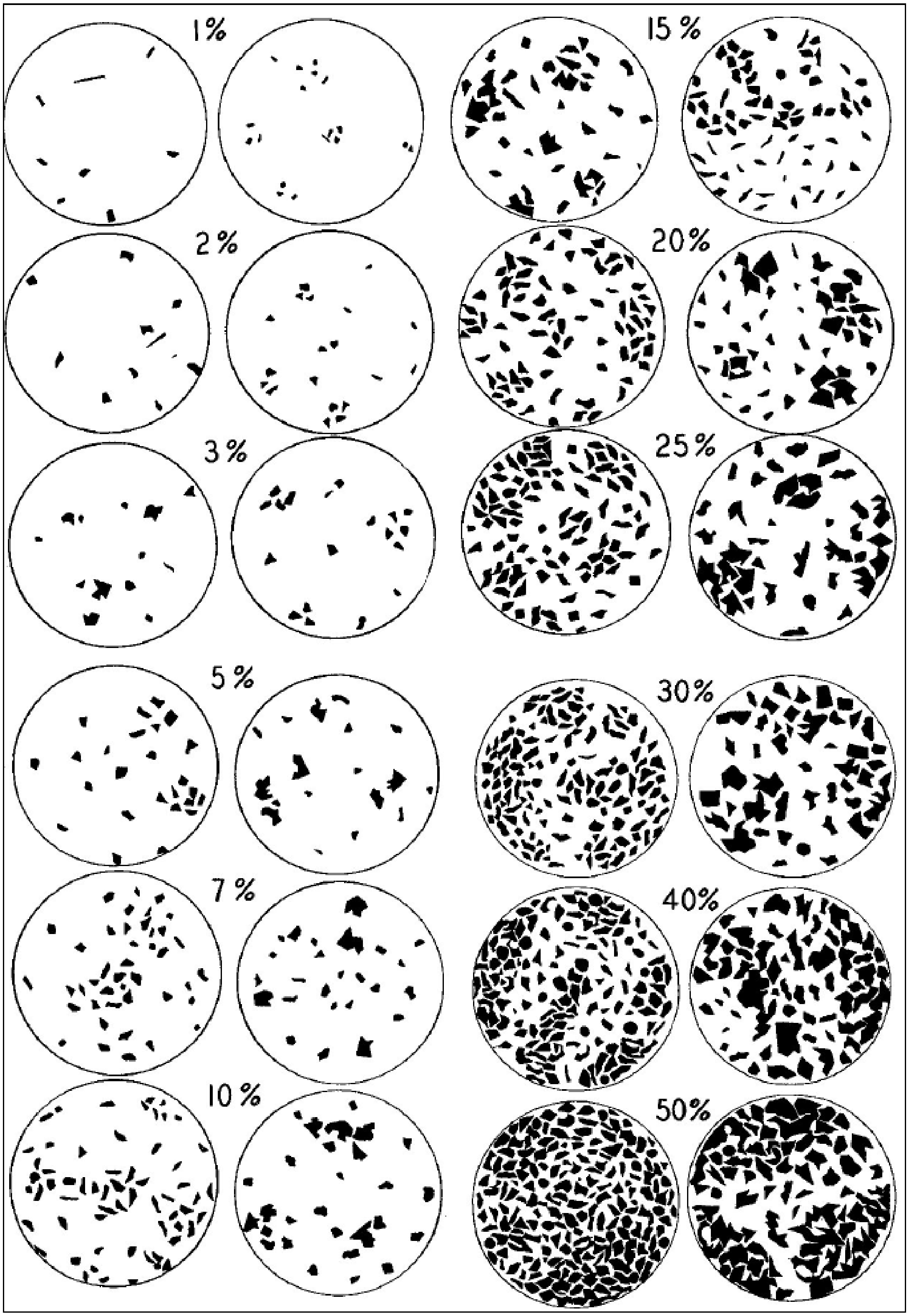

Figure 4. Reference scatterplots for cover estimates. From the 2006 Forest and Inventory Analysis Protocol.

SOP #6: Subplot Sampling (continued).

Shrub Height Measurement

The average height of shrub cover is measured in each quadrant for each intensive module.

1) Visually divide an intensive module into four quadrants.
2) Measure the average shrub height using a meter stick or tape. This measurement does not include trees. A species list for each park indicates which species are shrubs.
3) Record this measurement for each of the quadrants individually on the datasheet (Appendix 1).
4) Repeat for the other three intensive modules.

Trees <15 cm DBH

Appendix 2 shows the datasheet for recording tree seedlings according to the following methods:

1. Tree seedlings by species (refer to the park species list) ≤15 cm tall are counted in the four 10 m^2 (3.16 m x 3.16 m) subplots located in the corner of the four intensive modules, by live vs. dead. Whitebark pine seedlings, if encountered, are counted throughout the entire 0.1 ha plot area. Dead seedlings are included but the identification may have to be listed as unknown conifer or hardwood since they may be impossible to identify to species.
2. Tree saplings by species from >15 cm tall to <2.54 cm DBH are inventoried in the four 10 m^2 (3.16 m x 3.16 m) subplots, by live vs. dead. Whitebark pine saplings, if encountered, are counted throughout the entire 0.1 ha plot area. Dead saplings are included but the identification may have to be listed as unknown conifer or hardwood since they may be impossible to identify to species.
3. Tree saplings by species from ≥2.54 cm DBH to 5 cm DBH are inventoried in the four intensive 100 m^2 (10 m x 10 m) modules. The number of alive and dead individuals of each species is counted. Whitebark pine, if encountered, is also counted in the remaining modules to provide a total for the entire 0.1 ha plot area.
4. Trees by species from >5-10 cm DBH are inventoried in the four intensive 100 m^2 (10 m x 10 m) modules. The number of alive and dead individuals of each species is counted. Whitebark pine, if encountered, is also counted in the remaining modules to provide a total for the entire 0.1 ha plot area.
5. Trees by species from >10-<15 cm DBH are inventoried in the four intensive 100 m^2 (10 m x 10 m) modules. The number of alive and dead individuals of each species is counted. Whitebark pine, if encountered, is also counted in the remaining modules to provide a total for the entire 0.1 ha plot area.

Subplot Sampling Card ___#of___

Park, Plot#, Module#	**Date**		**Crew**			**Start Time** **End Time**
	module	Q1	Q2	Q3	Q4	Notes
Rock						
Bare soil						
Bryophytes						
Coarse wood						
Fine wood and litter						
Water						
Shrub height						
Species/Species code	Subplot	S1	S2	S3	S4	

Appendix 1. Subplot sampling card for recording percent cover by vegetation stratum.

Trees Count <15cm DBH Card __#of__											
Park and Plot#				**Date**			**Crew**			**Time Begin** **Time End**	
		<15cm tall $10m^2$ Subplot (seedling)		**15cm-2.54 cm dbh $10m^2$ Subplot** (sapling)		**2.54 cm dbh-5cm DBH $100m^2$ Subplot** (pole)		**>5cm-10cm DBH $100m^2$ Subplot** (pole)		**>10cm-15cm DBH $100m^2$ Subplot** (pole)	
Species Code	**Module**	**Count Alive**	**Count Dead**	**Count Alive**	**Count Dead**	**Count Alive**	**Count Dead**	**Count Alive**	**Count Dead**	**Count Alive**	**Count Dead**
PIAL	ALL										

Appendix 2. Datasheet for recording tree seedling data.

Standard Operating Procedure (SOP) #7: Live and Dead Tree Sampling

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP describes overstory sampling for live trees ≥15 cm DBH (diameter at breast height) or standing dead trees ≥15 cm DBH and 1.4 m or taller, and canopy cover in the 0.1 ha site. All measurements from this SOP are recorded in the Live and Dead Tree Sampling Database on the Tablet PC, and the sampling card shown at the end of the SOP (Figure 8).

Tree Tagging

All trees alive and dead ≥15 cm DBH will be tagged at breast height 1.4m (4.5 ft), with the stamped number facing away from the trunk and towards plot center (SOP #4: Site Locations, Set-up, Monumentation, and Description). Nail tags to trees, leaving 1-2 inches of nail exposed, to account for diameter growth. Trees that were likely numbered in the past (large size, much larger than 15 cm DBH) but are missing tags need to be retagged with the same number (if possible) using the previous datasheet and the surrounding trees to determine the tree number. In the notes section, record that the tree was retagged. If the plot occurs in an old-growth stand (defined as >4 trees >75 cm dbh within 40m of plot center) we will implement extend plot sampling. The extended plot (Figure 1) is not monumented but trees >75cm dbh are tagged. And all other overstory sampling procedures (listed below) are executed.

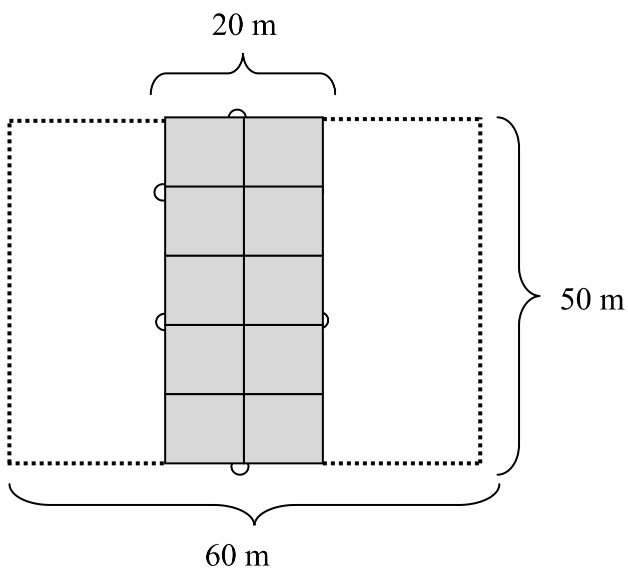

Figure 1. Diagram of extended sampling plot when in old growth stand. Dashed lines represent expansion of standard 20 x 50 m plot.

Overstory Sampling

All live trees ≥15 cm DBH are measured or assessed for 1. DBH, 2.Canopy position and crown condition, 3.Height of the largest tree in each module (10 total), and 4. Height to crown. Sampling will be done for each 100 m^2 module separately. This sampling is best done by a two-person team. One person will measure DBH and assist in identification of the tree species. The other will determine its condition (crown dieback), height to crown, canopy position, crown cover, and record all data. The following procedures will be used:

Diameter at Breast Height

Diameter is measured at 1.4 m (4.5 feet) above the ground surface. The FIA and FMH field manuals have detailed instructions for how to measure DBH under the wide variety of situations that arise in the field. Use the breast height tree tag as a height guide for measuring DBH; if the nail and tag are missing, try to determine the tree number and replace the tag (see tree tagging). When measuring DBH, always make sure that the diameter tape is at a right angle to the lean of the tree (Figure 2). The observer must stand on the uphill side of the tree. With the Biltmore stick (only to be used if the tree cannot be measured with a DBH tape), two measurements are required: one on the uphill and one sidehill; these measurements are averaged and then recorded.

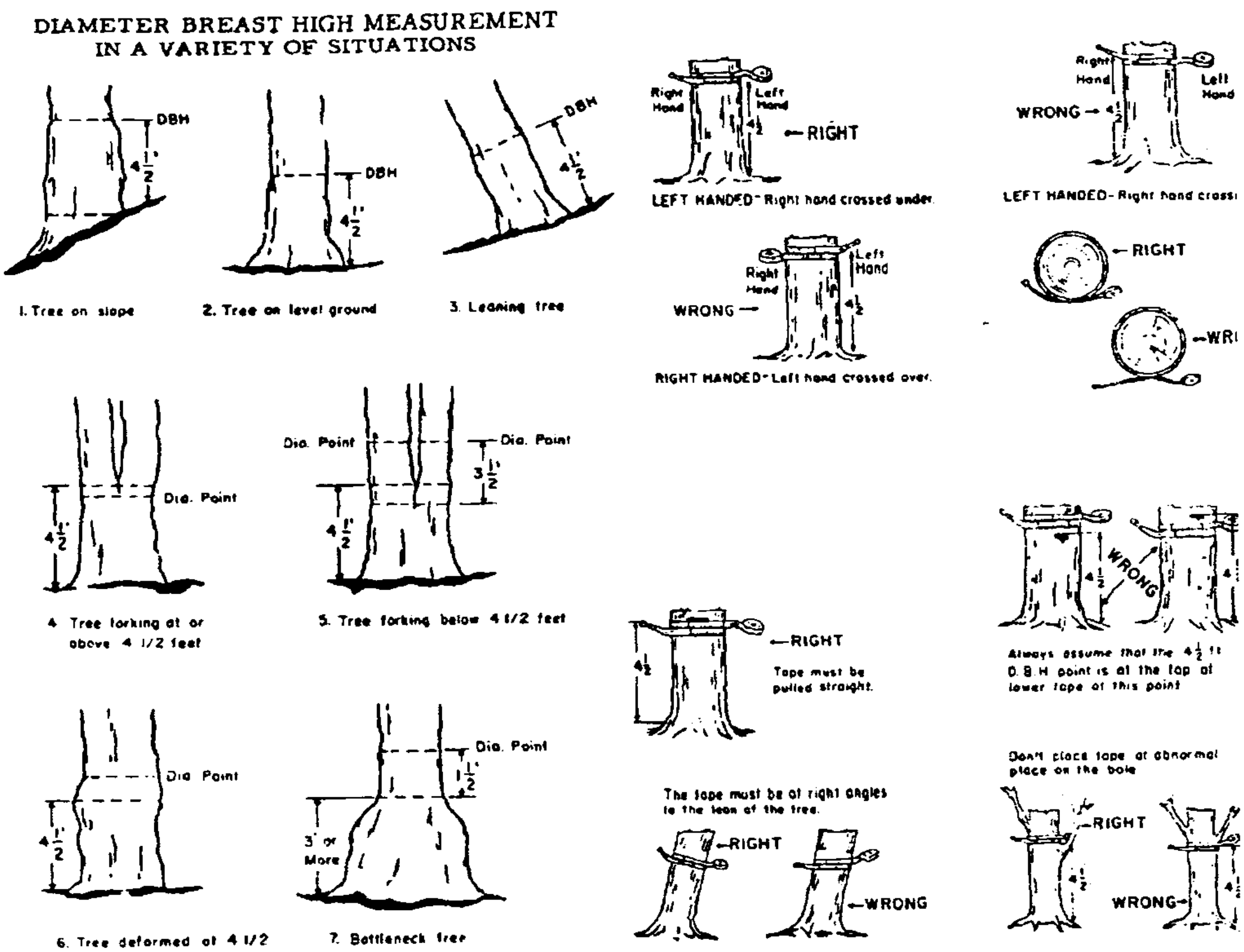

Figure 2. Correct placement of tape for DBH measurements. From the Great Smokey Mountains Vegetation protocol.

Canopy Position and Crown Condition

1. After visual inspection, each overstory tree is assigned to one of five canopy position classes: 1 = dominant, 2 = codominant, 3 = intermediate, 4 = suppressed, or 5 = open grown. Descriptions of each class are provided in Table 1 and Figure 3.
2. After visual inspection, trees are assigned to one of six crown condition classes based upon percent crown dieback: 1 = No dieback; 2 = 1-25% dieback; 3 = 26-50% dieback; 4 = 51-75% dieback; 5 = >75 % dieback; and 6 = broken top. If the tree has 100% dieback, follow procedures below for characterizing standing dead trees (snags). Dieback is defined as percent of branches in the crown that are either dead or missing.

Table 1. Canopy position class descriptions. Canopy class primarily describes the amount of sunlight received. These canopy classes are consistent with those used by the US Forest Service's Forest Inventory and Analysis monitoring.

Class	Description
1	*Dominant*—trees with crowns extending above the overall level of crown cover and receiving full sunlight from above and partly from the sides. Trees are larger than the average overstory tree in the stand and have well-developed crowns. NOTE: A dominant tree is one which generally stands well above all other trees in its vicinity. However, there may be a young, vigorous tree nearby, but not overtopped by a dominant tree. This smaller tree may be considerably shorter than the dominant, but still be receiving full light from above and partly from the sides. In its own immediate environment, it is dominant and should be recorded as such. Only understory trees immediately adjacent to the overstory tree will be assigned subordinate crown classes.
2	*Codominant*—trees with crowns forming the general overstory-level canopy and receiving full light from above, but comparatively little from the sides.
3	*Intermediate*—trees shorter than those of the two preceding classes, but with crowns either below or extending into the crown cover formed by dominant and codominant trees. Trees receive little light from above and none from the sides. Trees may be located in single tree gaps that have closed-in from lateral growth of surrounding trees.
4	*Suppressed*—overtopped trees with crowns entirely below the general level of crown cover that receive no light from either above or from the sides.
5	*Open Grown*—trees grown in the open. The distance from these trees to the nearest tallest tree is greater than the height of the nearest tallest tree.

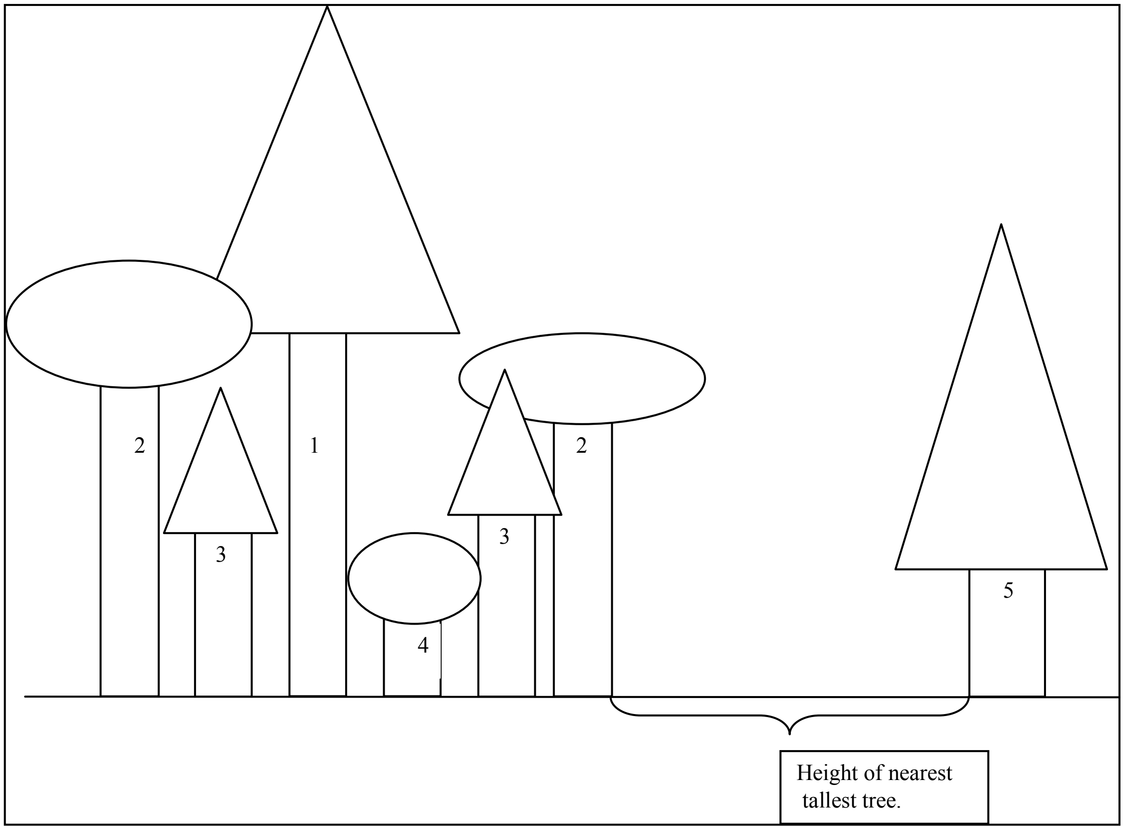

Figure 3. Diagram of the four canopy position classes (1 = dominant, 2 = codominant, 3 = intermediate, 4 = suppressed, and 5 = open grown). Depending upon stand history and developmental stage, all classes may not be present on a plot.

Tree Height (or Length)
Tree height will be recorded for the largest tree in each plot (10 total) and **all** whitebark pine and standing dead trees. A laser rangefinder will be used to measure height (SOP #3: Setting up the Electronic Equipment). Once on the HT setting, the first measure is HD the horizontal distance to the tree. Point the laser at the tree, making sure your view is unobstructed; push the fire button on the laser. The next measurement is INC 1: the angle to the base of the tree. Point the laser at the base of the tree and push the fire button. The next measurement is INC 2: the angle to the top of the tree. Point the laser at the top of the tree and push the fire button. All three of these measurements need to be taken from the same spot. Record the total height of the tree from the laser rangefinder, to the nearest 0.1 m. For trees growing on a slope, measure on the uphill side of the tree. Forked trees should be treated the same as unforked trees. For leaning trees, measure or estimate total normally-formed bole length (from the base to the tip of the tree). If the laser rangefinder is broken, a clinometer and tape can be used to measure tree height as described in Figure 4. However, this method is very time-consuming and should be recorded in the equipment log book.

Crown Base Height (Height to Compacted Crown)
Record the height to compacted crown for each live tree ≥15 cm DBH to the nearest 0.5 m or 10 percent. A laser rangefinder will be used to measure height. Compacted crown is the portion of

the tree supporting live foliage (or in the case of extreme *temporary* defoliation, should be supporting live foliage).

Compacted crown is foliage sufficiently dense enough to propagate fire. It is important to exclude isolated or sparse foliage below the compacted crown to avoid underestimating crown base height for fire behavior modeling. This modeling is based on live foliage. Therefore, an error term is introduced if twigs, dead branches, lichens, and other non-foliage are considered in the estimation of canopy base height. The base height of compacted crown is the lowest height of continuous foliage.

To determine height to compacted crown, mentally transfer lower live branches to fill in large holes in the upper portion of the tree until a full, even crown is visualized. *Try to picture the normal density of foliage that is not shade suppressed 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 m spacing. *Include epicormic branches once they are 3 cm in diameter.* Measure from the ground to the point you determine to be the bottom of the compacted crown. See above section (Tree Height) for use of the laser rangefinder and clinometers.

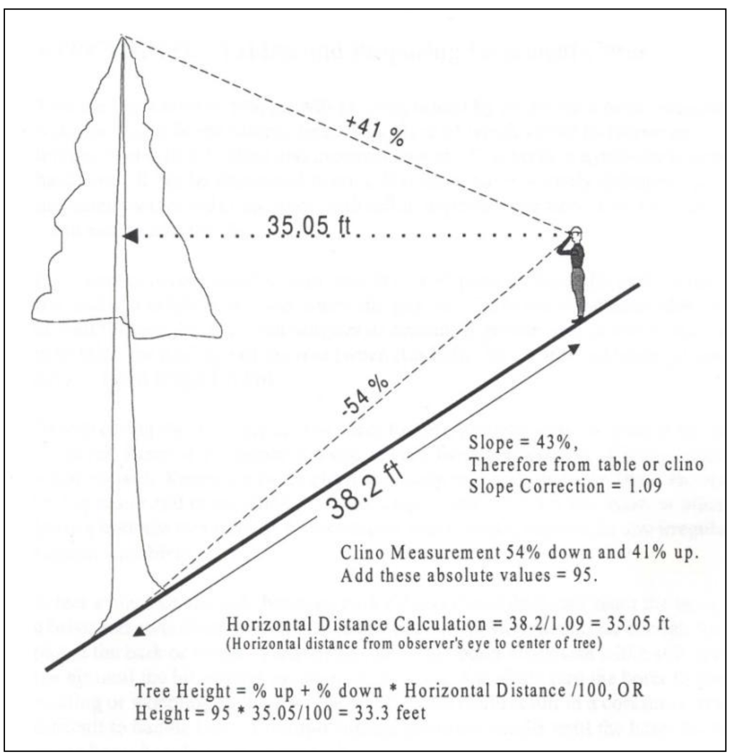

Figure 4. Finding tree height using a clinometer and tape measure.

Standing Dead Trees

1. Measure the DBH and height of all standing dead trees ≥15 cm DBH unless they have more than 45 degrees of lean from vertical, as measured from the base of the tree to 1.4 m

(4.5 feet). Trees supported by other trees or by their own branches that meet these requirements are considered standing. This includes broken tree tops stuck in the ground. Trees do not have to be self-supporting. See Figures 5, 6, and 7.
2. Record decay stage; see Table 2 and Figure 8.
3. Record cause of death Table 3.

Canopy Measurement

Densiometers are used at the center of each 100 m^2 plot to estimate the amount of canopy cover. The spherical densiometer consists of a concave mirror with twenty-four ¼ inch squares engraved on the surface. Standing over the plot center, four densitometer readings are taken facing the four cardinal directions (N, E, S, and W). The densiometer is held level 12 - 18” in front of body at breast height, so the operator’s head is not reflected back from the grid area. The 24 squares on the densiometer are divided into 96 dots, assuming equally spaced dots in each square of the grid. Readings are taken of the number of dots out of 96 that are covered by canopy (green leaves). If canopy openings are counted rather than canopy closure, subtract from 96 to obtain canopy coverage. The number of dots covered by canopy will be converted to percent canopy coverage (multiplied by 1.04) during the data summary process.

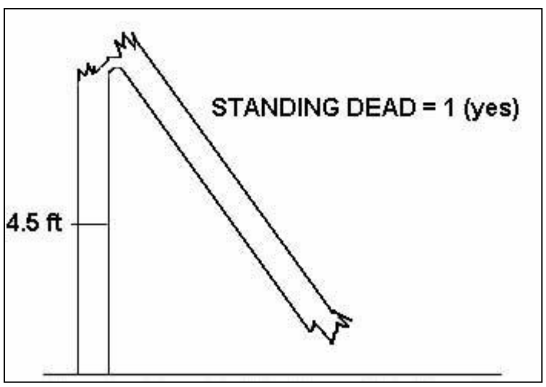

Figure 5. Example of a standing dead tree with an intact bole at 1.4 m (4.5 ft).

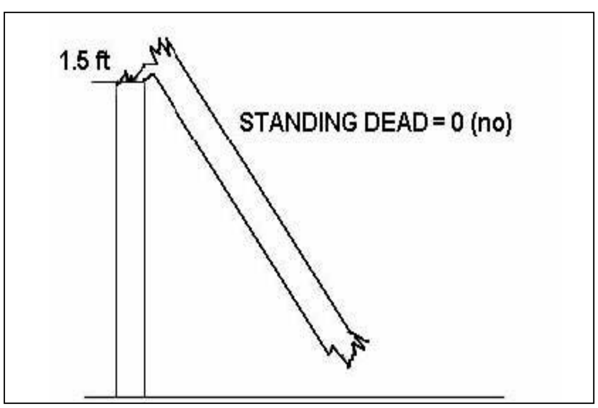

Figure 6. Example of a standing dead tree without an intact bole at 1.4 m (4.5 ft).

SOP #7: Live and Dead Tree Sampling (continued).

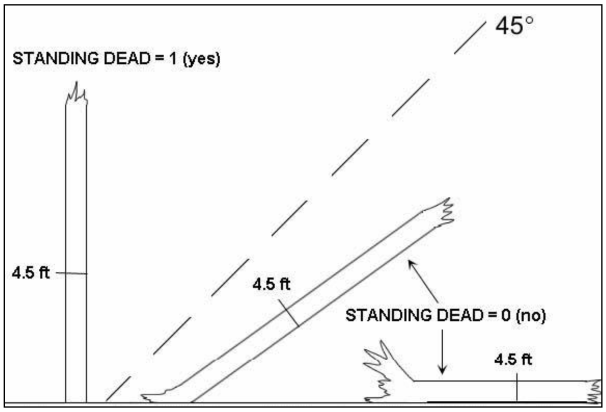

Figure 7. Determination of leaning standing dead trees. Leaning trees must be >45 degrees.

Table 2. Decay classification for standing dead trees. Characteristics are for Douglas-fir. Snags of other species may vary somewhat; use this table as a guide.

Stage	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 ~80%	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 ~60%	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 ~40%	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	Less than 40%	Gone	Gone	Sloughing, cubical, soft, dark brown, OR fibrous, very soft, dark reddish brown, encased in hardened shell

*The outermost, lighter colored wood of a tree bole.

SOP #7: Live and Dead Tree Sampling (continued).

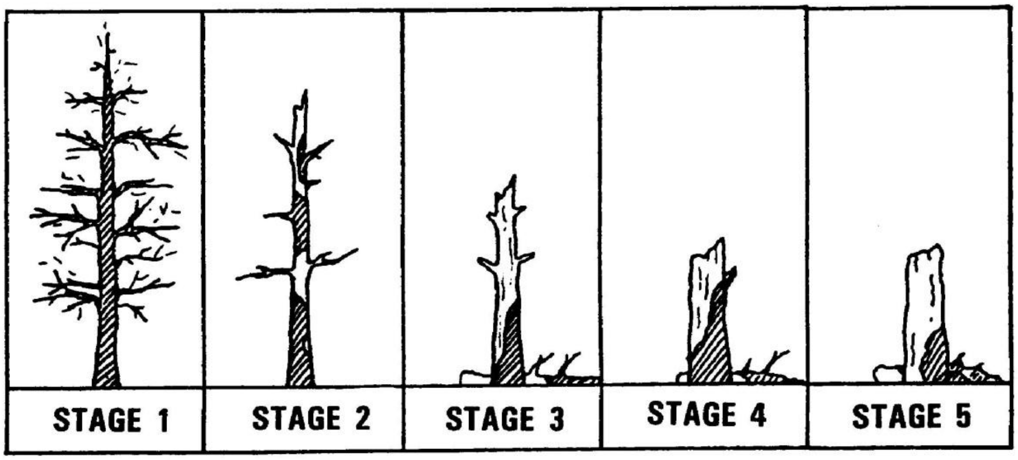

Figure 8. Decay stages for Douglas Fir. Others species may vary somewhat; use this as a guide.

Table 3. Causes of death for trees.

Cause of Death
Insect
Disease
Fire
Animal
Weather
Vegetation (suppression, competition, vines)
Unknown/not sure/other- includes death from human activity not related to silviculture or land clearing activity (accidental, random, etc.)

Overstory Sampling Card __#of__									
Park and Plot#				Date	Crew		Start Time / End Time		
Tree Species/ Code	Module	Tree #/Clump Letter	Crn Cond	Can Pos/ Decay	DBH Tape	Hght to Crown	Hght	Cause of Death	notes
Densiometer Cover - circle whichever is measured: open canopy									
Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6	Mod 7	Mod 8	Mod 9	Mod 10

Figure 9. Live and dead tree sampling datasheet.

Literature Cited

Cruz, M. G., M. E. Alexander, and R. H. Wakimoto. 2003. Assessing canopy fuel stratum characteristics in crown fire prone fuel types of western North America. International Journal of Wildland Fire **12**:39-50.

Standard Operating Procedure (SOP) #8: Litter, Duff, and Down Wood Sampling

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP describes the procedure for measuring dead and detached, down wood as well as duff and litter depths. Most of the information in this chapter is taken from the NPS Fire Monitoring Handbook (USDI 2003).

Dead and Detached Wood

To record the amount of dead and detached, down wood, complete the steps listed below:

1. Lay out a 50 m tape through the center of the plot as shown in Figure 1 for conventional plots and Figure 2 for riparian plots.

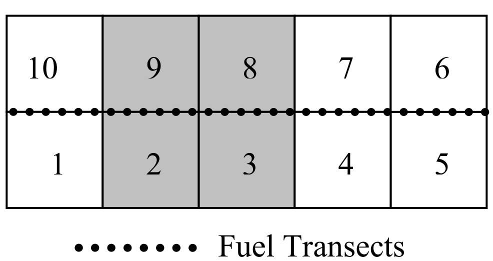

Figure 1. Placement of fuel transect in conventional plots.

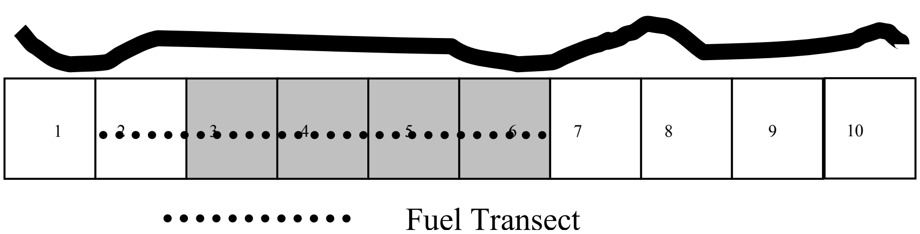

Figure 2. Placement of fuel transect in riparian plots.

SOP #8: Litter, Duff, and Down Wood Sampling (continued).

2. Record the slope, parallel to the transect, at each end of the 50 m transect on the data sheet for down wood, duff and litter (Figure 4), this allows for slope correction.

3. Tally each particle intersected along a 50 m tape, categorized by diameter size class 0-0.62 cm, 0.63-2.54 cm, 2.55-7.60, and >7.60 cm, using a ruler. Record the tally on the data sheet for down wood, duff, and litter (Figure 4).

4. Particles that are 0-0.62 and 0.63-2.54 cm are tallied on the following segments of the transect (measurements are in meters): 0-1, 5-6, 10-11, 15-16, 20-21, 25-26, 30-31, 35-36, 40-41, and 45-46. Particles that are 2.55-7.60 cm are tallied on the following segments of the transect: 0-2, 5-7, 10-12, 15-17, 20-22, 25-27, 30-32, 35-37, 40-42, and 45-47. Particles that are larger than 7.60 cm are tallied along the entire transect, and their width (in centimeters) and length (in meters) are measured. All logs (>15 cm diameter) are assigned to one of five decay stages (Table 1).

5. Measurement of all particles is taken perpendicular to the point where the tape crosses the central axis (Figure 3). Count intercepts along the transect plane up to 1.8 m from the ground.

6. When determining if you should include down wood in the sample, observe the following:
   - Do not count stems and branches attached to standing shrubs or trees.
   - Do not count twigs and branches when the intersection between the central axis of the particle and the sampling plane lies in the duff.
   - If the sampling plane intersects a curved piece more than once, tally each intersection.
   - Tally uprooted stumps and roots not encased in dirt. Do not tally undisturbed stumps.
   - For rotten logs that have fallen apart, visually construct a cylinder containing the rotten material and estimate its diameter. Measure through rotten logs whose central axis is in the duff layer.
   - Tally dead trees IF they are leaning >45 degrees from vertical and <1.4 m from the ground. Do not tally live trees or standing dead trees and stumps that are still upright and leaning <45 degrees from vertical.
   - If a transect intersects a large pile of material such as a wood rat's nest or a recently fallen tree (with many attached fine branches), crews should estimate a count but note the reason for the high count.
   - Broken logs should be measured their entire length and the spaces between sections subtracted. Do not tally cones, bark, needles, or leaves.

SOP #8: Litter, Duff, and Down Wood Sampling (continued).

Table 1. Decay classes for logs (>15 cm diameter) from the USFS FIA monitoring program.

Values:	Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
	1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
	2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand	Original color	Absent	If branches are present, many fine twigs are gone and remaining fine twigs have peeling bark
	3	Heartwood sound; piece supports its own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish-brown or original color	Sapwood only	Branch stubs will not pull out
	4	Heartwood rotten; piece does not support its own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can be pushed into heartwood	Reddish or light brown	Through-out	Branch stubs pull out
	5	None, piece no longer maintains its shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Through-out	Branch stubs and pitch pockets have usually rotted down

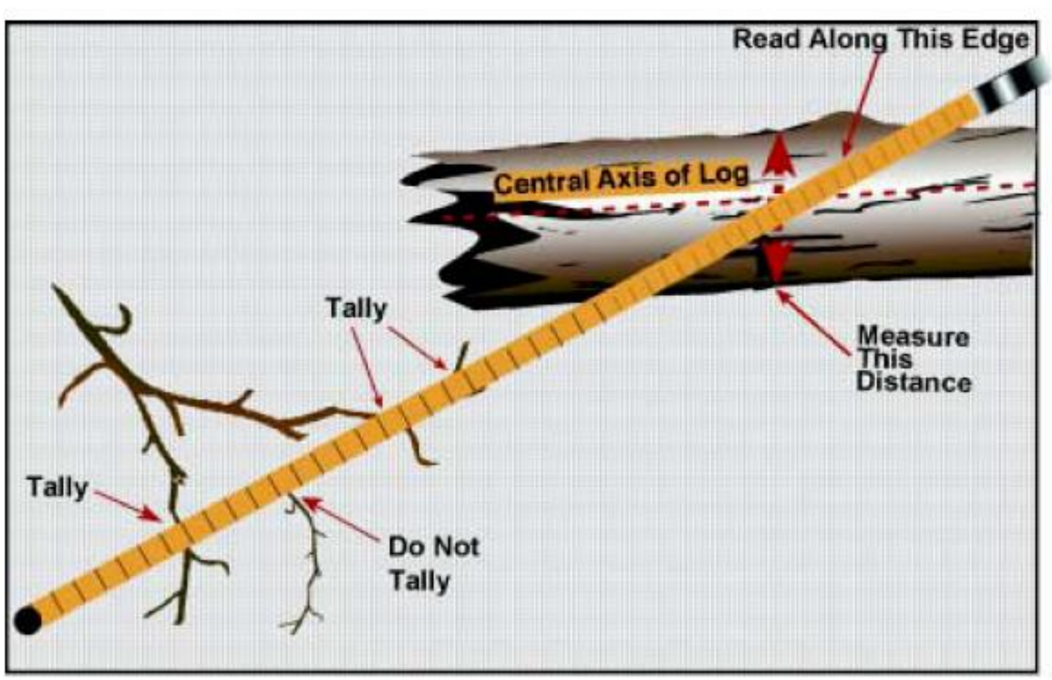

Figure 3. Tally rules for dead and down fuel. Count all intersections, even curved pieces. All intersections must include the central axis in order to be tallied (source: National Park Service Fire Monitoring Handbook [USDI 2003]).

SOP #8: Litter, Duff, and Down Wood Sampling (continued).

Litter and Duff Measurement

As part of this protocol, litter and duff will be sampled following the processes list below. Field crew members should be familiar with and abide by the definitions of litter and duff provided at the end of this section.

Procedure

a. Take depth measurements for litter and duff at 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 m along the transect. Take the measurement from anywhere within 1 m of the transect. Also, if a log or rock is along the transect at a sampling point, relocate the sample place to within 1 m of the obstruction.
b. Gently insert a trowel or knife into the ground until you hit mineral soil, then carefully pull it away exposing the litter/duff profile. Locate the boundary between the litter and duff layers. Vertically measure the litter and duff to the nearest millimeter.
c. Refill holes created by this monitoring technique.
d. Do not include twigs and larger stems in litter depth measurements.
e. Occasionally moss, a tree trunk, stump, log, or large rock will occur at a litter or duff depth data collection point. If a log is in the middle of the litter or duff measuring point, move the data collection point 0.5 m perpendicular to the sampling plane in a random direction.
f. If moss is present, measure the duff from the base of the green portion of the moss.
g. Record the measurement on the datasheet for down wood, duff, and litter (Figure 4).

Definitions

Litter—the layer of freshly fallen leaves, needles, twigs (<6 mm in diameter), cones, detached bark chunks, dead moss, dead lichens, detached small chunks of rotted wood, dead grasses, dead herbaceous stems, and flower parts (detached and not upright). Litter is the loose plant material found on the top surface of the forest floor. Litter does not include animal manure. Litter is defined as undecomposed or only partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.).

Duff—the layer just below litter. It consists of decomposing leaves and other organic material. You should see NO recognizable plant parts. The duff layer is usually dark decomposed organic matter. This layer is distinguished from the litter layer in that the original organic material has undergone sufficient decomposition that the source of this material (e.g., individual plant parts) can no longer be identified. The bottom of this layer is the point where mineral soil (A horizon) begins. If unsure of the bottom of the duff layer, crews should feel the texture of the suspect material in their hand. Rub the soil between your fingers. Does it crumble (duff) or feel more like modeling clay (mineral).

Literature Cited

USDI National Park Service. 2003. Fire Monitoring Handbook. Boise (ID): Fire Management Program Center, National Interagency Fire Center. 274p.

SOP #8: Litter, Duff, and Down Wood Sampling (continued).

Dead and Down Wood, Litter, and Duff Card

Park Plot #		Date		Crew				Start Time Stop Time			
0-.62cm		.63-2.54cm		2.55-7.6cm		>7.6cm					
Distance	Talley	Distance	Talley	Distance	Talley	Width cm	Length m	Decay	Width cm	Length m	Decay
0-1		0-1		0-2							
5-6		5-6		5-7							
10-11		10-11		10-12							
15-16		15-16		15-17							
20-21		20-21		20-22							
25-26		25-26		25-27							
30-31		30-31		30-32							
35-36		35-36		35-37							
40-41		40-41		40-42							
45-46		45-46		45-47							

Distance	Litter	Duff	Distance	Litter	Duff	Distance	Litter	Duff	Slope Measurments	
5			25			45				
10			30			50			Start	
15			35						Finish	
20			40							

Figure 4. Dead and down wood and litter sampling card.

Standard Operating Procedure (SOP) #9: Vegetation Database

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP provides the details on the design and set-up of the database that is to be used to enter data for the vegetation and whitebark pine vital signs monitoring effort including the relationship diagram and data dictionary. To learn how to use the database to enter data, see SOP#10: Data Entry.

Database Set-up

There are a variety of databases that have been developed to store and manage vegetation data. The Klamath Network looked at several of these databases, but we were unable to find a database that could meet the majority of the needs of our project. Therefore, we have developed a database using the Natural Resource Database Template (NRDT) developed by the National Park Service. The NRDT:

- Provides both a data interchange standard and a standard MS Access database core that allow flexibility in application design.
- Serves as a starting point for application development that can be extended as necessary to accommodate any inventory or monitoring field sampling protocol.
- Standardizes location and observation data to facilitate the integration of datasets.
- Acts as a design platform for developing database applications in MS Access allowing users to enter, edit, display, summarize, and generate reports for inventory or monitoring datasets.
- Integrates with other I&M data management systems and data standards including the NPS Data Store, Geographic Information System (GIS) tools and data, the NPS GIS Committee Data Layers Standard, and the NPS Metadata Profile.

The NRDT Front-end Application Builder (FAB) is a Microsoft Access file that is intended to be used by developers of NRDT applications to create a front-end (user-interface) to an NRDT v.3.2 back-end (database). The FAB comes with many built-in features, including:

- table linking utility
- data backup
- compaction

- lookup table management
- main menu
- standardized data entry forms for core NRDT v.3.2 tables
- standardized data "gateway" form for retrieving records

Master and Project Database

The Klamath Network plans on maintaining a Master Vegetation Database, which will house the verified and validated data that are collected using this protocol (Figure 1) and the whitebark pine vital sign monitoring effort. Members of the KLMN will have read-only access to this database and can use it to conduct data summaries and use the data to develop Analysis and Synthesis reports or publications. A project database will be provided to each crew at the beginning of the field season. Crews will use the project database (on a tablet computer) to enter data collected at each monitoring site. After validation and verification procedures have been followed, this database will be used to create summaries and conduct data analysis for annual reports. At the end of the year, the data from the project database will be uploaded to the master database for long-term storage and future analysis.

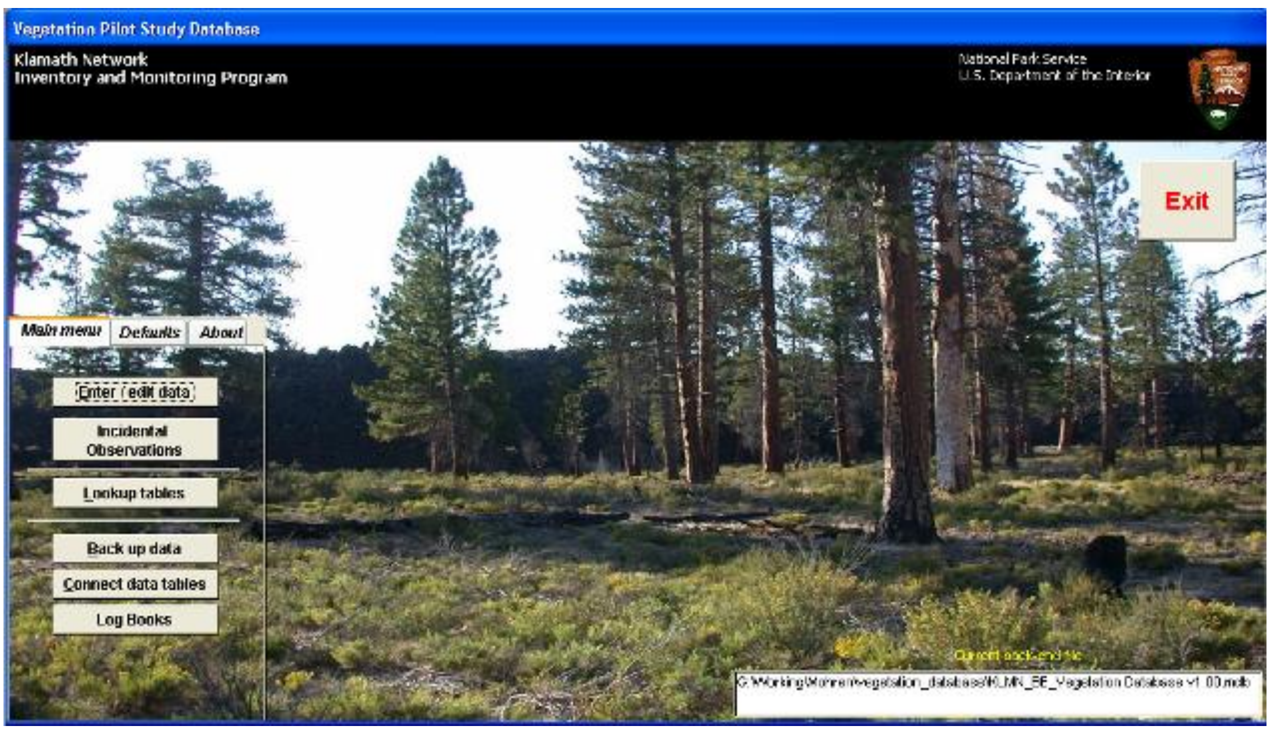

Figure 3. Main screen of the KLMN vegetation monitoring database.

Preparing the Databases for Field Work

Updating Contact Information: Prior to starting the field work, the Data Manager should obtain a COPY of the blank database template. This template should be located in the Vegetation Data subfolder of the Vegetation Monitoring folder. As discussed in SOP #1: Field Work Preparation, the Data Manager should obtain a list of contact information for each person involved in the vegetation monitoring effort. This data should be used to enter as much of the contact information into the project database as possible. To enter this information, the Data Manager should complete the following steps.

1. Open the back-end of the database and open the table called tlu_Contacts. Delete any of the contacts that are not on the list of project staff obtained from the Project Lead.
2. Once done, open the front-end of the database and click on the “Enter / Edit Data” command button.
3. On the “Set application default values” form, use the drop down box in the “User” field to make sure names for each person involved in this project are on the list. If a person needs to be added, click the “New User” command button.
4. Enter the following fields for each person involved in the monitoring effort this year.
    a. First Name
    b. Last Name
    c. Organization
    d. Position / Title
    e. Work Phone Number
    f. Email Address
    g. Address Type
    h. Address, City, State, and Zip
    I. Country
5. Once you have completed entering the data for each person, click the “Close” button.
6. Repeat step 3-4 until all project staff have been entered.

Updating Location Information: As part of this project, each time a field crew visits a park, they will survey the same sites. Implementing this design will allow the Data Manager the opportunity to preload all the sites into the database template. Provided below are the methods on how to preload the sites. In addition, these methods can be followed to add new sites to the database if needed. As discussed in SOP #1: Field Work Preparation, the Data Manager should obtain a GIS file of the sites that the Network plans on monitoring. These data should be used to enter as much of the site information into the project database as possible. To enter this information, the Data Manager should complete the following steps.

1. Click the “OK” button on the “Set application default values” form.
2. On the “Sample Data Gateway” form, click “Add a New Record.”
3. On the “Data Entry” form, next to the “Location” field, click the “Add New” command button.
4. Complete the following fields for each site in the GIS shapefile.
    a. Network Code
    b. Park Code
    c. Zone
    d. Site Type
    e. Location Name
    f. Watershed
    g. Township, Range, and Section
    h. USGS 7.5’ Quad Map Name
5. Once you have entered the information for each site, click the “Close” button.

SOP #9: Vegetation Database (continued).

6. Close all the forms until you are back at the main screen.

Updating Species Lists: The next thing that needs to be done is updating the species list for the parks that will be surveyed that year. To complete this task, the Data Manager should do the following:

1. Download the entire species list from NPSpecies for the park that will be surveyed.
2. In the project database, from the main menu, hit the F11 button. This should bring up the database view of the database.
3. Open the tlu_Species_List table and reorganize the downloaded species list (step 1 above) so it matches the file structure of this table.
4. Make a copy of the tlu_Species_List table and rename it tlu_Species_List_YYYY, where the year is the year the protocol was previously implemented.
5. Delete all the records in the tlu_Species_List table.
6. Copy the records from the species list you downloaded and reorganized and paste those records into the tlu_Species_List table.
7. Run the query called: qry_Species_Update.
8. Open the table: tlu_Species_List and populate any ―Lifeform” cells that do not have a value.
9. You now have an updated species list for the database and have saved the species list from the previous year.

Setting up the Tablet Computer: Once you have completed updating the database, do the following to get the database onto the tablet computer that the field crews will use to enter data.

1. In the Vegetation_Data subfolder of the Vegetation Monitoring folder, look for a folder called ―field crew support materials”.
2. Make certain this folder contains the following:
    a. The most up-to-date vegetation protocol.
    b. A blank project database with the corrections / updates listed above incorporated.
    c. Vegetation identification cards.
    d. A blank copy of all log books (equipment, training, datasheet, and events).
    e. Any supporting documentation that might help crews in the field.
    f. A blank data entry sheet.
3. Once these items have been updated, login to the tablet computer (using the Field Crew login) and place a copy of the folder on the C drive. Make a shortcut to the folder and place it on the desktop.
4. Rename the database by adding the crew member's initials to the end of the current naming convention.
5. Open the front-end of the database to make certain to link it to the back-end database.

Database Structure

Updating Database Structure: A Metadata Interview form and updated data dictionary are submitted at the end of the year which should indicate if any changes to the database are needed. In addition, it is always a good idea to check with the Project Lead prior to the start of the field season to see if there are additional changes needed. At this point, you should make any necessary changes to the structure of the database. Brief descriptions of the database elements are provide in the tables (Tables 1 and 2), data dictionary, and relational diagram (Figure 2) provided below.

Tables, Queries, Forms, Reports, Modules, and Macros: There are a variety of tables, queries, forms, modules, macros, and reports used in this database. Tables are located in the back-end database while the other object types are located in the front-end of the database. A brief description of the tables and forms in the databases are provided in tables 1 and 2 below.

Table 1. A brief description of the tables that are in the KLMN backend vegetation database.

Table Name	Description
tbl_Db_Meta	This table contains the database description and links to I&M metadata tools.
tbl_Db_Revision	This tables stores the revision history of the database
tbl_Densiometer	This table stores data related to cover
tbl_Distrubance	This table stores data related to disturbance at the site
tbl_Event_Details	This table holds the —Notes” field which links to the tbl_Events
tbl_Events	This table contains the general information about a visit to the site
tbl_Incidental	This table contains the records of incidental sighting by the field crew
tbl_Locations	This table stores the information about the location of the monitoring plots
tbl_Litter_Duff	This table stores the information related to the litter and duff measurements
tbl_Nested_Plot	This table stores the information related to species found in the nested plots
tbl_Nested_Plot_Substrate	This table stores the information related to substrate found in the nested plots
tbl_Overstory_Dead_Tree	This table stores the information related to snags
tbl_Overstory_WBP	This table stores information related to whitebark pine.
tbl_Seedling_Density	This table stores the information related to seedlings
tbl_Woody_Stem	This table stores the information related to woody debris in the smaller size class
tbl_Woody_Stem_Large	This table stores the information related to woody debris in the larger size class
tbl_Shrub	This table stores data related to shrubs on the site.
tbl_Sites	Stores data about the site.
tbl_Photographs	This table stores the data linked to the photographs for each plot
tlu_Contacts	This is a lookup table that contains information about individuals working on this project
tlu_Enumerations	This is a lookup table that contains the lookup values for all pick list with the exception of contact and species list information.
tlu_Species_List	This is a lookup table that contains information about the species that occur in each park
xref_Event_Contacts	This is a cross-reference table between events and contacts.

SOP #9: Vegetation Database (continued).

Table 2. A brief description of the forms that are in the KLMN backend vegetation database.

Form Name	Description
frm_Contacts	This form is used to enter the contact information for each person working on the protocol.
frm_Data_Entry	This form is used to enter data about the visit to a site
frm_Data_Gateway	This form is used to see and access all records in the database
frm_Event_Group	This form is used to enter comments about the visit
frm_Incidental	This form is used to enter data about incidental observations
frm_Locations	This form is used to enter data about the location of the monitoring plots
frm_Metadata_Display	This form is used to display the metadata of the database
frm_Metadata_Edit	This form is used to enter the database metadata
frm_Sites	This form is used to enter data about the site
frm_Switchboard	This form is the main screen of the database
fsub_Densiometer	This form is used to enter data about cover
fsub_Disturbance	This form is used to enter data about disturbances at the plot
fsub_Litter_Duff	This form is used to enter data about litter and duff
fsub_Nested_Plot	This form is used to enter data about species and cover at the nested plot
fsub_Nested_Plot_Substrate	This form is used to enter data about the substrate located at the nested plot
fsub_Overstory_Dead	This form is used to enter data about overstory species and nags
Fsub_Overstory_WPB	This form is used to enter data related to the whitebark pine monitoring
fsub_Photographs	This form is used to enter metadata for each photograph
fsub_Seedlings	This form is used to enter data about seedlings
fsub_Woody_Large	This form is used to enter data about large woody debris
fsub_Woody_Stem	This form is used to enter data about small woody debris

Relational Diagram: A relationship diagram presenting the relationship of the tables in the protocol database is provided below (Figure 1). As you can from this diagram, the core of the database center around the visits (tbl_events) to a site. Location and site specific data are linked to the visit using the unique identifiers labeled ―Event_ID” and ―Location_ID.”

SOP #9: Vegetation Database (continued).

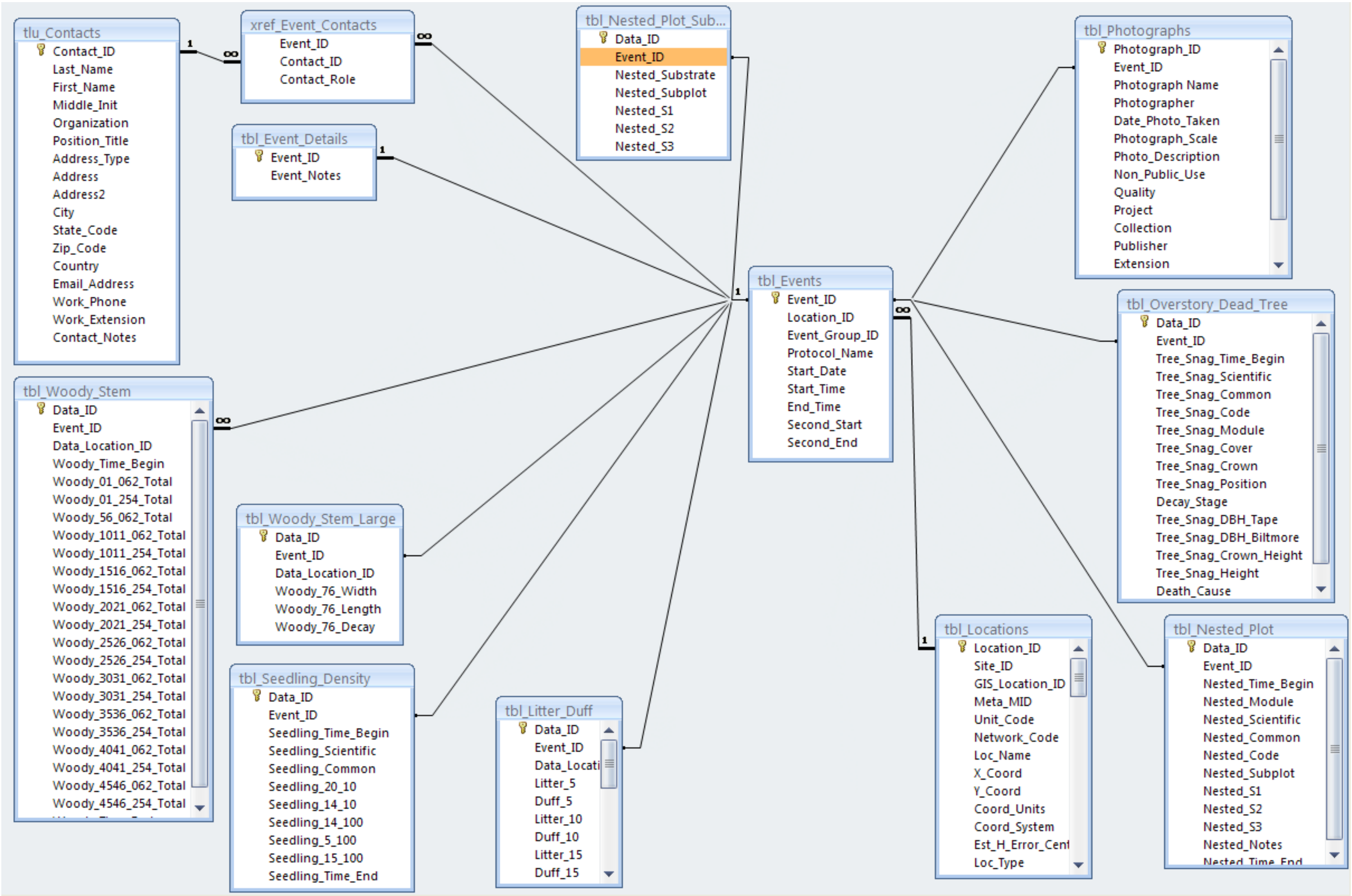

Figure 4. Relational diagram of the back-end database used to record vegetation monitoring data.

SOP #9: Vegetation Database (continued).

Data Dictionary. The following tables provided the data dictionary for the database used as part of this monitoring effort.

tbl_Metadata	This table provides some general metadata about this database							
Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Db_Meta_ID	M	Text	50	NA	NA	NA	NA	Local primary key
Db_Desc	M	Memo		NA	NA	NA	NA	Description of the database purpose
Meta_MID	M	Text	255	NA	NA	NA	NA	Link to NPS Data Store
DSC_GUID	M	Text	50	NA	NA	NA	NA	Link to I&M Dataset Catalog desktop metadata tool
Meta_File_Name	M	Text	50	NA	NA	NA	NA	Name of the metadata file that describes this NRDT data file (must be in the same directory as this data file)

tbl_Db_Revision	This table contains information on the revision history of the database							
Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Revision_ID	M	Text	50	NA	NA	NA	NA	Database revision (version) number or code
Revision_Contact_ID	M	Text	50	NA	NA	NA	NA	Link to tlu_Contacts
Db_Meta_ID	M	Text	50	NA	NA	NA	NA	Link to tbl_DB_Meta
Revision_Date	M	Date	8	NA	NA	NA	NA	Database revision date
Revision_Reason	M	Memo	NA	NA	NA	NA	NA	Reason for the database revision
Revision_Desc	M	Memo	NA	NA	NA	NA	NA	Revision description

tbl_reports	This table contains information about canned reports that are utilized as part of the database reporting tool							
Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Report_Name	M	Text	100	NA	All reports in the front end of the database	NA	NA	Name of the report, analysis, or raw data
Report_Title	M	Text	100	NA		NA	NA	Title of the report, analysis, or raw data
Report_Seq	M	Long Integer	4	0		NA	NA	A sequence so you can sort the reports
Report_ID	M	Text	100	NA		NA	NA	A unique value for this record

tlu_Contacts	This table contains the contact information for individuals working on this project.							
Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Contact_ID	M	Text	50	NA		NA	NA	Contact identifier
Last_Name	M	Text	50	NA		NA	NA	Last name
First_Name	M	Text	50	NA		NA	NA	First name
Middle_Init	M	Text	4	NA		NA	NA	Middle initial

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Organization	M	Text	50	NA	NPS, SOU	NA	NA	Organization or employer
Position_Title	M	Text	50	NA		NA	NA	Title or position description
Address_Type	M	Text	50	NA	mailing, mailing and physical, physical	NA	NA	Address type
Address	M	Text	50	NA		NA	NA	Street address
Address2	MA	Text	50	NA		NA	NA	Address line 2, suite, apartment number
City	M	Text	50	NA		NA	NA	City or town
State_Code	M	Text	8	NA	CA, OR	NA	NA	State or province
Zip_Code	M	Text	50	NA		NA	NA	Zip code
Country	M	Text	50	NA	USA	NA	NA	Country
Email_Address	M	Text	50	NA		NA	NA	E-mail address
Work_Phone	M	Text	50	NA		NA	NA	Phone number
Work_Extension	M	Text	50	NA		NA	NA	Phone extension
Contact_Notes	MA	Memo	0	NA		NA	NA	Contact notes

xref_Event_Contact This table crosswalks the event table and the contacts table.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Event_ID	M	Text	50	NA		NA	NA	Link to tbl_Events
Contact_ID	M	Text	50	NA		NA	NA	Link to tlu_Contacts
Contact_Role	MA	Text	50	NA	Crew Leader, Crew Member, Data Manager, Data Recorder, Observer, Principle Investigator	NA	NA	The contact's role in the protocol

tlu_Enumerations This table contains picklist values for all fields except the species fields.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Enum_Code	M	Text	50	NA	NA	NA	NA	Code for lookup values
Enum_Description	MA	Memo	NA	NA	NA	NA	NA	Lookup value description
Enum_Group	M	Text	50	NA	NA	NA	NA	Category for lookup value
Sort_Order	M	Integer	4	0	NA	NA	NA	Order in which to sort lookup values

tlu_Species_List A lookup table that provides species names and ITIS numbers from NPSpecies

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Park	M	Text	255	NA	CRLA, LABE, LAVO, ORCA, REDW, WHIS	NA	NA	Park where the species was documented
Category	M	Text	255	NA	Amphibians, Birds, Fish, Mammals, Reptiles, Vascular Plants	NA	NA	Taxon group the species belongs too
Family	M	Text	255	NA	Families listed in ITIS	NA	NA	Family the species belongs too
Order	M	Text	255	NA	Orders listed in ITIS	NA	NA	Order the species belongs too
TSN	M	Text	50	NA		NA	NA	ITIS unique number for the species
Scientific_Name	M	Text	255	NA	Scientific Names listed in ITIS	NA	NA	Scientific name of the species
Lifeform	M	Text	255	NA	Tree, Shrub, SubShrub	NA	NA	Divides the species into Tree, Shrub, or SubShrub
Common_Name	M	Text	255	NA	Common Names listed in ITIS	NA	NA	Common names used for the species
Park-Status	M	Text	255	NA	Present in Park, Probably Present, Unconfirmed, Encroaching, Historic	NA	NA	The status of the species in the park
Abundance	M	Text	255	NA	Abundant, Common, Uncommon, Rare, Occasional, Unknown, NA	NA	NA	The abundance of the species in the park
Residency	M	Text	255	NA	Breeder, Resident, Migratory, Vagrant, Unknown, NA	NA	NA	The residency status of the species in the park
Nativity	M	Text	255	NA	Native, Non-Native, Unknown, NA	NA	NA	Divides the species by native or non-native
Cultivation	M	Text	255	NA	Cultivated, Persistent, Not Cultivated, Unknown	NA	NA	Cultivation status of the species
Weedy	M	Text	255	NA	Yes / No	NA	NA	Invasive species or not
Tree_Class	M	Text	50	NA	Conifer, Hardwood	NA	NA	Divides the trees into conifer or hardwood

tbl_Woody_Stem_Large This table contains the data related to large woody debris on the site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50	NA	NA	NA	NA	Field data table row identifier
Event_ID	M	Text	50	NA	NA	NA	NA	Link to tbl_Events
Woody_76_Width	MA	Long Integer	4	0	NA	7.6	150	Width of any woody debris along the transect that is >7.6cm
Woody_76_Length	MA	Long Integer	4	0	NA	0.01	50	Length of any woody debris along the transect that is >7.6cm
Woody_76_Decay	MA	Long Integer	4	0	1,2,3,4,5	1	5	Decay Class of any woody debris along the transect that is >7.6cm

SOP #9: Vegetation Database (continued).

tbl_Woody_Stem — This table contains the data related to small woody debris on the site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier (Data_ID)
Event_ID	M	Text	50					Link to tbl_Events (Event_ID)
Data_Location_ID	MA	Text	50					Optional link to tbl_Data_Locations (Data_Loc_ID)
Woody_01_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 0-1 meters
Woody_01_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 0-1 meters
Woody_02_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 0-1 meters
Woody_56_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 5-6 meters
Woody_56_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 5-6 meters
Woody_57_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 5-6 meters
Woody_1011_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 10-11 meters
Woody_1011_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 10-11 meters
Woody_1012_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 10-11 meters
Woody_1516_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 15-16 meters
Woody_1516_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 15-16 meters
Woody_1517_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 15-16 meters
Woody_2021_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 20-21 meters
Woody_2021_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 20-21 meters
Woody_2022_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 20-21 meters

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Woody_2526_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 25-26 meters
Woody_2526_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 25-26 meters
Woody_2527_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 25-26 meters
Woody_3031_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 30-311 meters
Woody_3031_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 30-311 meters
Woody_3032_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 30-311 meters
Woody_3536_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 35-36 meters
Woody_3536_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 35-36 meters
Woody_3537_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 35-36 meters
Woody_4041_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 40-41 meters
Woody_4041_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 40-41 meters
Woody_4042_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 40-41 meters
Woody_4546_062_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0-0.62cm size class at 45-46 meters
Woody_4546_254_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 0.63-2.54cm size class at 45-46 meters
Woody_4547_255_Total	M	Long Integer	4	0		0	100	Total number of down wood in the 2.55-7.6cm size class at 45-46 meters

SOP #9: Vegetation Database (continued).

tbl_Seedling_Denisty — This table contains information related to seedling density.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Seedling_Scientific	M	Text	50					Scientific name of the species
Seedling_Common	M	Text	50					Common name of the species
Seedling_15	M	Long Integer	4	0		0	100	Seedlings < 15 cm tall in the plot by species
Seedling_15_Dead	MA	Long Integer	1					Dead seedlings < 15 cm tall in the plots by species If
Seedling_15_254	M	Long Integer	4	0		0	50	Saplings 15 cm tall to 2.54 cm DBH in the plot by species
Seedling_15_254_Dead	MA	Long Integer	1					Dead saplings 15 cm tall to 2.54 cm DBH in the plot by species .
Seedling_254_5	M	Long Integer	4	0		0	50	Saplings 2.54 – 5 cm DBH in the plot by species the plot
Seedling_254_5_Dead	MA	Long Integer	1					Dead saplings 2.54 – 5 cm DBH in the plot by species
Seedling_5_10	M	Long Integer	4	0		0	50	Saplings 5-10 cm DBH in the plot by species
Seedling_5_10_Dead	MA	Long Integer	1					Dead saplings 5-10 cm DBH in the plot by speciesf
Seedling_10_15	M	Long Integer	4	0		0	50	Saplings 10-15 cm DBH in the plot by species
Seedling_10_15_Dead	MA	Long Integer	1					Dead splings 10-15 cm DBH in the plot by species
Seedling_Plot	M	Text	2			1	10	Plot where you collected the data

tbl_Photograph — This table contains the metadata for photographs taken while at a site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50	NA	NA	NA	NA	Unique identifier for the photograph
Event_ID	M	Text	50	NA	NA	NA	NA	Unique Identifier in tbl_Locations for the site
Photograph Name	M	Text	50	NA	NA	NA	NA	Name of the photograph
Photographer	M	Text	50	NA	tlu_Contacts	NA	NA	Individual who took the picture
Date_Photo_Taken	M	Date	8	NA	NA	NA	NA	Date the photograph was taken
Photo_Description	M	Memo	0	NA	NA	NA	NA	Description of the Photograph
Non_Public_Use	MA	Boolean	1	NA	Yes / No	NA	NA	If checked, the NPS does not have permission to use this picture in public displays

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Quality	MA	Boolean	1	NA	Yes / No	NA	NA	If checked, this is a great picture that can be used for coverpages, websites, etc.
Project	M	Text	40	NA	NA	NA	NA	If this picture is taken as part of a project, the project name is entered here
Collection	M	Text	4	NA	KLMN	NA	NA	NPS Require field. Which collection is photograph is part belongs too.
Publisher	M	Text	3	NA	NPS	NA	NA	NPS Required Field. The person or organization that is making this image available
Resource_Type	M	Text	5	NA	Image	NA	NA	NPS Required Field. The type of product.
Extension	M	Text	4	NA	NA	NA	NA	Type of picture taken
Historic	M	Boolean	1	NA	Yes / No	NA	NA	Pictures are considered historic if they were collected prior to 2007

tbl_Overstory_Dead_Tree — This table contains the information related to snags in the overstory.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Tree_Snag_Scientific	MA	Text	100		tlu_Species_List			Scientific name of the species
Tree_Snag_Common	MA	Text	100		tlu_Species_List			Common name of the species
Tree_Snag_Module	MA	Long Integer	4	0		1	10	Module where the species occurred
Tree_Tag	M	Long Integer	3	0		1		Tree tag number
Tag_Replace	M	Text	3		Yes,No			Was the tree tag replaced.
Tree_Snag_Crown	MA	Text	50		1 = No dieback, 2 = 1-25% dieback, 3 = 26-50% dieback, 4 = 51-75% dieback, 5 = > 75 % dieback, 6= broken top, 7 = dead			Crown condition based on percent dieback
Tree_Snag_PosDec	MA	Long Integer	4	0	1 = Dominant, 2 = Codominant, 3 = Intermediate, 4 = Suppressed, 5 = Open Grown			1-5 classification of the canopy position of a tree, "7" = Snag
Tree_Snag_DBH_Tape	MA	Long Integer	4	1		15	300	DBH of the tree or snag measure with a DBH tape

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Tree_Snag_DBH_Biltmore	MA	Long Integer	4	1		15	300	DBH of the tree or snag measure with a biltmore stick
Tree_Crown_Height	MA	Long Integer	4	1		0	50	Height to the crown of a tree
Tree_Snag_Height	MA	Long Integer	4	1		2	100	Total height of the snag or tree
Death_Cause	MA	Memo	0					Reason the snag is dead

tbl_Nested_Plot_Substrate — This table contains information about the substrate at each nested plot

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Nested_Substrate	M	Text	25		Bare Soil, Bryophytes, Coarse Wood, Fine Wood / Litter, Rock, Water			Type of substrate that was collected
Nested_Module	M	Long Integer	2	0		1	10	Module where the data was collected
Nested_S1	M	Long Integer	3	0		0	100	Cover of substrate

tbl_Location — This table contains general information about the plot include spatial and monumenting information.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Location_ID	M	Text	50					Location identifier
GIS_Location_ID	M	Text	50					Link to GIS feature, equivalent to NPS_Location_ID
Meta_MID	MA	Text	50					Link to NR-GIS Metadata Database
Unit_Code	M	Text	4		CRLA, LABE, LAVO, ORCA, REDW, WHIS			Park Code
Network_Code	M	Text	4		KLMN			Network Code
Loc_Name	M	Text	20					Name of the location
X_Coord	M	Double	6	0				X coordinate for the center of the plot
Y_Coord	M	Double	7	0				Y coordinate for the center of the plot
Coord_Units	M	Text	2		ft, m			Coordinate distance units
Coord_System	M	Text	3		Geo, UTM			Coordinate system
Est_H_Error_Center	M	Single	4	1				Estimated horizontal accuracy

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Loc_Unit_3	M	Text	5		+ / -, PDOP			Type of accuracy measurement taken at the 1st corner of the plot
X_Coord5	M	Double	6	0				X coordinate at Corner 10ns (for riparian) or Corner 6(for matrix or alpine)
Y_Coord5	M	Double	7	0				Y coordinate at Corner 10ns (for riparian) or Corner 6(for matrix or alpine)
Est_H_Error_4	M	Single	4	1				Estimated horizontal accuracy at Corner 10ns (for riparian) or Corner 6(for matrix or alpine)
Loc_Unit_4	M	Text	5		+ / -, PDOP			Type of accuracy measurement taken at the 1st corner of the plot
UTM_Zone	M	Long Integer	2	0	10	10	10	UTM Zone
Datum	M	Text	7		NAD83, WGS 84			Datum of mapping ellipsoid
Accuracy_Notes	M	Memo	0					Positional accuracy notes
Monument_Date	M	Date	8					Date the site was monumented (Index site only)
Macro_Position	M	Text	10		Macpos 1, Macpos 2, Macpos 3, Macpos 4, Macpos 5			Orientation of the plot as it compares to the slope
Loc_Slope_1	M	Long Integer	4	0		0	90	Slope of the vegetation plot at 1-10 (matrix, alpine) or 1 (riparian)
Loc_Slope_2	M	Long Integer	4	0		0	90	Slope of the vegetation plot at 3-8 (matrix, alpine) or 4-5 (riparian)
Loc_Slope_3	M	Long Integer	4	0		0	90	Slope of the vegetation plot at 5-9 (matrix, alpine) or 10 (riparian)
Loc_Aspect_1	M	Long Integer	4	0		1	360	Aspect of the vegetation plot at 1-10 (matrix, alpine) or 1 (riparian)
Loc_Aspect_2	M	Long Integer	4	0		1	360	Aspect of the vegetation plot at 3-8 (matrix, alpine) or 4-5 (riparian)
Loc_Aspect_3	M	Long Integer	4	0		1	360	Aspect of the vegetation plot at 5-9 (matrix, alpine) or 10 (riparian)
Loc_Elevation	M	Long Integer	4	0		0	3100	Elevation in meters of the vegetation plot
Loc_Slope_Shape	M	Text	20		Concave, Convex, Straight, Undulating			Shape of the slope at the plot
Travel_Directions	M	Memo	0					Detailed directions on how to get to the site

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Loc_Unit_Center	M	Text	5		+ / -, PDOP			Type of accuracy measurement taken at the center of the plot
Loc_Type	M	Text	10		Judgement, Index, Survey			Location type category
Loc_Site_Type	M	Text	10		Alpine, Matrix, Riparian			Location type category
Watershed	M	Text	100					The watershed where the sites is located
Subwatershed	M	Text	100					The subwatershed where the site is located
Township	M	Long Integer	2	0				Part of the PLSS where the site is located
Range	M	Long Integer	2	0				Part of the PLSS where the site is located
Section	M	Long Integer	2	0		1	36	Part of the PLSS where the site is located
USGS_Quad	M	Text	50					Part of the PLSS where the site is located
X_Coord2	M	Double	6	0				X coordinate (X_Coord2) at Corner 1s (for riparian) or Corner 1(for matrix or alpine)
Y_Coord2	M	Double	7	0				Y coordinate (Y_Coord2) at Corner 1s (for riparian) or Corner 1(for matrix or alpine)
Est_H_Error_1	M	Single	4	1				Estimated horizontal accuracy (Est_H_Error) at Corner 1s (for riparian) or Corner 1(for matrix or alpine)
Loc_Unit_1	M	Text	5		+ / -, PDOP			Type of accuracy measurement taken at the 1st corner of the plot
X_Coord3	M	Double	6	0				X coordinate at Corner 1ns (for riparian) or Corner 10(for matrix or alpine)
Y_Coord3	M	Double	7	0				Y coordinate at Corner 1ns (for riparian) or Corner 10(for matrix or alpine)
Est_H_Error_2	M	Single	4	1				Estimated horizontal accuracy at Corner 1ns (for riparian) or Corner 10(for matrix or alpine)
Loc_Unit_2	M	Text	5		+ / -, PDOP			Type of accuracy measurement taken at the 1st corner of the plot
X_Coord4	M	Double	6	0				X coordinate at Corner 10s (for riparian) or Corner 5(for matrix or alpine)
Y_Coord4	M	Double	7	0				Y coordinate at Corner 10s (for riparian) or Corner 5(for matrix or alpine)
Est_H_Error_3	M	Single	4	1				Estimated horizontal accuracy at Corner 10s (for riparian) or Corner 5(for matrix or alpine)

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Loc_Notes	M	Memo	0					General notes on the location (Loc_Notes)
Witness_1_1_10_Species	MA	Text	100		from tlu_Species_List			Species name of the witness tree used to monument the plot
Witness_1_1_10_DBH	MA	Long Integer	4	1				DBH of the witness tree used to monument the plot
Witness_1_1_10_Azimuth	MA	Long Integer	4	0		0	360	Azimuth of the witness tree used to monument the plot
Witness_1_1_10_Distance	MA	Long Integer	4	2				Distance of the witness tree used to monument the plot
Witness_2_1_10_Species	MA	Text	100		from tlu_Species_List			Species name of the witness tree used to monument the plot
Witness_2_1_10_DBH	MA	Long Integer	4	1				DBH of the witness tree used to monument the plot
Witness_2_1_10_Azimuth	MA	Long Integer	4	0		0	360	Azimuth of the witness tree used to monument the plot
Witness_2_1_10_Distance	MA	Long Integer	4	2				Distance of the witness tree used to monument the plot
Updated_Date	M	Text	50					Date of entry or last change (Upd_Date)
Site_Travel_Time	M	Date	8					Time to travel from the parking spot to the site.
Instalation_Time	M	Date	8					Time it takes to setup the site
Parking_Easting	M	Long Integer	6	0				UTM location of the spot to park so you can go to a site
Parking_Northing	M	Long Integer	7	0				UTM location of the spot to park so you can go to a site
Witness_Presence	M	Boolean	1		Yes / No			If not witness tree is available on the site, this is marked true
Center_Line	M	Text	10			0	360	Perpendicular and horizontal aspects of the centerline

SOP #9: Vegetation Database (continued).

tbl_Event — This table contains general information about the day of the visit to the site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Event_ID	M	Text	50					Event identifier
Location_ID	M	Text	50					Link to tbl_Locations
Event_Group_ID	M	Text	50					Link to tbl_Event_Group
Protocol_Name	M	Text	100		Vegetation Monitoring, Vegetation Pilot Study			The name of the protocol governing the event
Start_Date	M	Date	8					Starting date for the event
Start_Time	M	Date	8					Starting time for the event
End_Time	M	Date	8					Starting time for the event
Second_Start_Time	MA	Date	8					This is the start time for the second day
Second_End_Time	MA	Date	8					This is the end time for the second day
Second_Date	MA	Date	8					This is the last day the site was surveyed
Multiple_Days	MA	Boolean	1		True / False			If checked, the survey was done over multiple days

tbl_Litter_Duff — This table contains information related to the litter and duff collected at the site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Litter_5	M	Long Integer	4	0		0	100	This is the depth of the litter at 5 meters along the transect
Duff_5	M	Long Integer	4	0		0	100	This is the depth of the duff at 5 meters along the transect
Litter_10	M	Long Integer	4	0		0	100	This is the depth of the litter at 10 meters along the transect
Duff_10	M	Long Integer	4	0		0	100	This is the depth of the duff at 10 meters along the transect
Litter_15	M	Long Integer	4	0		0	100	This is the depth of the litter at 15 meters along the transect
Duff_15	M	Long Integer	4	0		0	100	This is the depth of the duff at 15 meters along the transect
Litter_20	M	Long Integer	4	0		0	100	This is the depth of the litter at 20 meters along the transect
Duff_20	M	Long Integer	4	0		0	100	This is the depth of the duff at 20 meters along the transect
Litter_25	M	Long Integer	4	0		0	100	This is the depth of the litter at 25 meters along the transect
Duff_25	M	Long Integer	4	0		0	100	This is the depth of the duff at 25 meters along the transect
Litter_30	M	Long Integer	4	0		0	100	This is the depth of the litter at 30 meters along the transect
Duff_30	M	Long Integer	4	0		0	100	This is the depth of the duff at 30 meters along the transect
Litter_35	M	Long Integer	4	0		0	100	This is the depth of the litter at 35 meters along the transect
Duff_35	M	Long Integer	4	0		0	100	This is the depth of the duff at 35 meters along the transect
Litter_40	M	Long Integer	4	0		0	100	This is the depth of the litter at 40 meters along the transect
Duff_40	M	Long Integer	4	0		0	100	This is the depth of the duff at 40 meters along the transect
Litter_45	M	Long Integer	4	0		0	100	This is the depth of the litter at 45 meters along the transect

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Duff_45	M	Long Integer	4	0		0	100	This is the depth of the duff at 45 meters along the transect
Litter_50	M	Long Integer	4	0		0	100	This is the depth of the litter at 50 meters along the transect
Duff_50	M	Long Integer	4	0		0	100	This is the depth of the duff at 50 meters along the transect

tbl_Event_Detail This table contains notes about the visit to a site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Event_ID	M	Text	50					Event ID
Event_Notes	MA	Memo						General notes about the visit to the site

tbl_Incidental This table contains data about incidental observations of plant and wildlife species.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Record_ID	M	Long Integer	4	0				Unique ID for this record
Species_Group	M	Text	20		Amphibians, Birds, Fish, Mammals, Reptiles, Vascular Plants			The general taxon group the species belongs too.
Scientific_Name	M	Text	100		from tlu_Species_List			Scientific name of the species based on ITIS lists
Common_Name	M	Text	255		from tlu_Species_List			Common name of the species based on ITIS lists
Observer	M	Text	100		from tlu_Contacts			First and last name of the individual who observed the incidental sighting
Date_Observed	M	Date	8					Date the sighting occurred
Habitat	O	Memo						General Habitat the species occured in or around
Description	M	Memo						General description of the sighting
Easting	MA	Long Integer	6	0				Easting Coordinate
Northing	MA	Long Integer	7	0				Northing Coordinate
Datum	MA	Text	10		NAD83, WGS84			Datum
Zone	MA	Text	10			10	10	Zone

SOP #9: Vegetation Database (continued).

tbl_Densiometer — This table contains data about the density of the canopy.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Event_ID	M	Text	50					Unique Id that links the densiometer records to the records in the events table
Data_ID	M	Text	50					Unique id for this record
Dens_Module	M	Long Integer	4	0		1	10	Module where the canopy cover was measure
Dens_Cover	M	Long Integer	10	0		0	100	Canopy cover measured using a densiometer

tbl_Disturbance — This table provides information about disturbances that are evident at the sites.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Dist_Agriculture	MA	Boolean	1		True / False			Evidence of agriculture activities in the plot
Grazing / Browse	MA	Boolean	1		True / False			Evidence of grazing activities in the plot
Logging	MA	Boolean	1		True / False			Evidence of logging activities in the plot
Fire	MA	Boolean	1		True / False			Evidence of fire activities in the plot
Natural	MA	Boolean	1		True / False			Evidence of natural (other then those currently listed) activities in the plot
Insect	MA	Boolean	1		True / False			Evidence of insect activities in the plot
Wind	MA	Boolean	1		True / False			Evidence of wind damage in the plot
Animal	MA	Boolean	1		True / False			Evidence of animals (other then those listed) activities in the plot
Other	MA	Boolean	1		True / False			Evidence of other activities in the plot
Describe_Other	MA	Memo	NA					Description of the other activities identified in the plot

tbl_Overstory_WBP — This table provides information about whitebark pine that occurs on the site.

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Data_ID	M	Text	50					Field data table row identifier
Event_ID	M	Text	50					Link to tbl_Events
Module	M	Long Integer	4	0		1	10	Module where the canopy cover was measure
Clump_Letter	M	Text	4					Clumps of stems in one general area
Alive/Dead	M	Text			Alive, Dead			State of the tree on the site
Crown_Top	M	Long Integer				0	999	Number or cankers on the crown top

SOP #9: Vegetation Database (continued).

Field Name	Required	Field Type	Field Size	Decimal	Enumerated Domain	Min Value	Max Value	Field Description
Crown_Mid	M	Long Integer	2			0	999	Number or cankers on the crown middle
Crown_Bot	M	Long Integer	2			0	999	Number or cankers on the crown bottom
Bole_Top	M	Long Integer	2			0	999	Number or cankers on the bole top
Bole_Mid	M	Long Integer	2			0	999	Number or cankers on the bole middle
Bole_Bot	M	Long Integer	2			0	999	Number or cankers on the bole bottom
Bole_Canker	M	Long Integer	2			0	999	Number or cankers on the bole
Branch_Canker	M	Long Integer	2			0	999	Number or cankers on the branch
Canker_Activity	M	Text	10		Active, Dead Tree, Inactive, N			Status of canker activity
MBP	M	Text	10		Active, Inactive			Determines presence of Mountain pine beetle
Bark Stripping	M	Text	10		Active, Inactive			Determines presence of bark stripping
Cones	M	Text	10		Active, Inactive			Determines presence of cones
Mistletoe	M	Text	10		Active, Inactive			Determines presence of mistletoe

Standard Operating Procedure (SOP) #10: Data Entry

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP provides the details of the workflow when at a site and how to collect data using a tablet computer and Access database (SOP #9: Vegetation Database). The database, loaded onto a tablet PC, will serve as the primary means of data collection for this protocol. All crews will also carry paper datasheets to use, should problems arise which prevent the tablet PC from being used to collect data.

Field Work Preparations

Prior to starting the field work, the Data Manager is responsible for setting up the tablet computers, Ricoh Camera, Trimble Pocket PC, and the Project Database as described in SOP #3: Setting up the Electronic Field Equipment, and SOP #9: Vegetation Database. The Project Lead should double check this equipment prior to going into the field to make certain it is set up and functioning properly. The Project Lead is responsible for working with the Data Manager in making certain the field crew has been properly trained on how to use the equipment as described in SOP #1: Field Work Preparation and SOP #2: Observer Training.

When preparing to go into the field, one member of each crew (preferable the Crew Lead) should check out the following equipment, which should already be set up by the Data Manager.

- 1 Tablet computer
- 1 Tablet computer power cord
- 1 Vehicle adapter for power cord
- 2 Eight gigabyte or greater flash drives
- 1 Clean cloth
- 1 Spare battery
- 3 Stylus
- 1 Ricoh camera
- 2 Spare batteries for Ricoh camera
- 1 Spare memory card for Ricoh camera
- 1 Trimble pocket PC
- 1 Garmin 60 or 76 GPS unit
- 1 Garmin vehicle adapter
- 1 inverter

- 1 set of rechargeable batteries and associated charger

It is the responsibility of the crew member who checks out the equipment to make certain that everything is charged and working properly. It is also the responsibility of the crew member checking out the equipment to make certain the equipment is treated properly while conducting field work. Before heading into the field, make certain the tablet computer, Ricoh camera, GPS, and Trimble PC are charged. This equipment should be plugged in at night when possible (*be careful to not leave equipment plugged into the vehicle overnight; this will more often than not kill the vehicle battery*). All electronic equipment has vehicle adapters and can be plugged in when driving to and from a site. In most cases, the tablet computer should be plugged in whenever using the vehicle, unless the unit has a full charge.

Linking the Database

The database used for this project relies on a back-end / front-end structure to store and maintain data. The back-end database contains the tables and associated data while the front-end database contains the forms and queries used in this database system. In most cases, the databases should be linked when you click on the shortcut icon located on the desktop. On the bottom right corner of the main page of the database, you should see the pathway to the back-end database. Make certain this is correct before entering data. This path should read:
C:\Documents and Settings\Field Crew\Desktop\Vegetation Monitoring\Database\KLMN_BE_Vegetation Database_v2.00.mdb

If the pathway is incorrect or you get a linking error when you open the database, follow the steps listed below.

1. From the main menu, click the “Connect data tables” command button.
2. Click the browse button and go to the back-end database following the pathway listed above.
3. Click “Open.”
4. Click “Update Links.”
5. You should now be linked to the proper database.

Field Forms

Hardcopy field forms should be carried to the site and used only when the vegetation database is not functioning properly. Crews should be sure to complete the forms in a similar manner as described below. At the bottom of the form, be sure to enter the number of pages for all datasheets collected at this site. For example, if 12 datasheets were populated at the site, the third datasheet would say 3 of 12 at the bottom of the sheet.

Data Entry

Once you have the site set up and are ready to collect data, turn on the tablet computer. Please note the tablet computer is set up to be energy efficient. Do not change the settings without checking with the Data Manager.

Log in as “Field Crew” and click on the shortcut icon called “Vegetation Database” located on the desktop. This should open the vegetation database shown in Figure 1. If you are collecting an incidental observation, click the “Incidental Observation” button and go the “Incidental Observation” section of this SOP. If you are collecting vegetation monitoring plot data, click the “Enter / Edit Data” button and go to the “Vegetation Data Collection” section of this SOP. If you are going to enter information into the training, equipment, datasheet, or special events log books, click the ―Log Book” button and go to the ―Log Book” section of this SOP.

Vegetation Data Collection

Once you have the plot set up, and the Ricoh Camera has a GPS reading of 3d or better (not mandatory), you are ready to start collecting data. Follow the steps below to complete the data collection portion of this protocol.

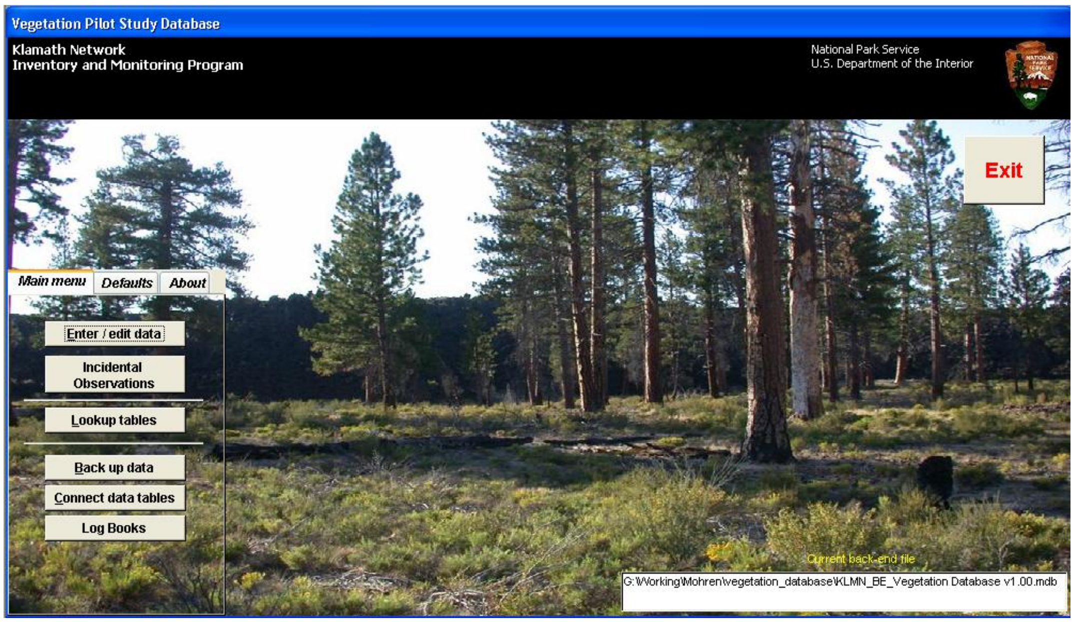

Figure 5. Main screen of the KLMN vegetation monitoring database.

1. Click on the ―Enter / edit data” button.
2. Using the drop down list in the ―User” field, select your name. If your name is not in the list, click the ―New User” button and populate all the information and hit ―Close.” Make certain the additional fields on the ―Set application default values” form match the list below.
   a. Network = The Park Where You Are Working
   b. Datum = NAD83
   c. UTM Zone = 10N
   d. Protocol = Vegetation
   e. Project = Vegetation Monitoring
3. Once these fields are properly populated, click ―OK.”
4. You may or may not see a list of all the records that have already been entered. Do not alter these records unless you are doing an edit. If you are entering data for a site that has not been visited that year, go to step 5. If you are entering data for a site you have already been to that year or if you are editing data from a previous visit, in the filter box enter the park which has the data you want to edit. Find the record you want to edit and double click on the ―Visit Date” field. Make any necessary edits if you are editing or go to step 5 if you are continuing data entry from a previous day.
5. At the top of the screen, click the ―Add a New Record” button.
6. Using the drop down list in the ―Location” field, select the name of your site.

SOP #10: Data Entry (continued).

7. Next to the “Location” field, click the “Edit” button.
8. Some of this record should already be completed; however, you will need to populate the following fields:
   a. X and Y coordinates for the four corners of the plot using the Trimble GPS if possible, or a Garmin 76CSx or 60CSx Garmin unit if you cannot get a reading using the Trimble unit. To complete this process do the following:
      (i) When you get to the site, make sure you have the Trimble unit turned on so it is acquiring satellites.
      (ii) Open ArcPad and then select “Browse for Project.” There should only be one project available entitled “Vegetation_Monitoring.”
      (iii) Make sure you can edit the shapefile “YYYY_Veg_Plots.”
      (iv) Walk to the first corner of the plot, make sure you have enough satellites, record the PDOP, and then create a new point. The Trimble unit is set up to average, so when you create a new point, it should show a count at the top of the screen. Wait until the count = 100% and then move on to the next point.
      (v) If you cannot get enough satellites move to a more open area, create a new point using the offset option. Use the rangefinder to record the distance between you and the corner of the plot. Use a compass to record the direction from you to the corner of the plot.
      (vi) If all else fails, use the Garmin unit to collect the location information. When collecting a point with the Garmin, make certain the unit is pointing straight up when collecting the point. Average a minimum of 30 readings. Rename the point using the site name followed by a 1, 2, 3, or 4.

   b. Average error of the Trimble (PDOP) or Garmin unit (+/-)
   c. Date (the current date automatically populates)
   d. Plot Slope
   e. Plot Aspect
   f. Plot Elevation
   g. Location Notes. Double tap in this field to open a blank page on which you can handwrite the notes on the location. Use complete sentences with mixed case. The computer will convert the handwriting to standard text. This process is only ~95% accurate and these records should be reviewed at the end of the day for accuracy.
   h. Travel Directions. Double tap in this field o open a blank page on which you can handwrite the directions to the site. Use complete sentences with mixed case. The computer will convert the handwriting to standard text. This process is only ~95% accurate and these records should be reviewed at the end of the day for accuracy.
9. Click the “Close” button.
10. The X/Y, Unit Code, and Protocol Name field will automatically populate.
11. The Start Date and Start Time will automatically populate when you open the record in step 5.
12. If you surveyed this site (this year) but had to return to the site because you did not finish sampling the plot, check the “Check this Box if the Survey took 2 Days” checkbox.
    a. Enter the “Second day Start Time” field (skip for now).
13. Using the picklist from the “Contacts,” enter the names of each crew member and assign them the appropriate “Role.”
    a. Role should follow the guidelines listed below

SOP #10: Data Entry (continued).

b. Crew Member → Crew Leader → Data Manager → Network Contact → Principal Investigator → Data Recorder

14. Add any visit notes that may be necessary.
15. Click on the photograph tab in the middle of the form.
16. Using the Ricoh Camera, have one crew member take pictures of the plot in the order described in SOP #5: Photographing Plots and Photo Management. Once they take a photograph, they should make sure it is a good picture and enter the following information into the database:
    a. Photo Name
    b. Photo Date (automatically populated with today's date)
    c. Name of Photographer (from a picklist)
    d. Photograph Extension (will automatically populate with .jpg)
    e. Photograph Description. Double tap in this field to open a blank page on which you can handwrite a description of the image. Use complete sentences with mixed case. The computer will convert the handwriting to standard text. This process is only ~95% accurate and these records should be reviewed at the end of the day for accuracy.
17. Click on the ―Nested Plot" tab and record the data following the methods outlined in SOP #6: Subplot Sampling (Species Cover, Tree Seedlings, and Saplings [<15 cm DBH]).
18. Click on the ―Seedling Density" tab and record the data following the methods outlined in SOP #6: Subplot Sampling (Species Cover, Tree Seedlings, and Saplings [<15 cm DBH]).
19. Click on the ―Woody Stem" tab and record the data following the methods outlined in SOP #6: Subplot Sampling (Species Cover, Tree Seedlings, and Saplings [<15 cm DBH]).
20. Click on the ―Tree and Snag" tab and record the data following the methods outlined in SOP #7: Live and Dead Tree Sampling field survey methods. When you are surveying trees and snags in modules 1, 4, 5, 6, 7, 10, be sure to search for any new plant species that were not found in step 19. If you find a new species, click on the ―Nested Plot" tab and record the data following the methods outlined in SOP #6: Subplot Sampling (Species Cover, Tree Seedlings, and Saplings [<15 cm DBH]).
    a. NOTE: If this site is part of the whitebark pine monitoring effort, complete the WBP Overstory section on this form. If this site is not part of the whitebark pine monitoring effort, you do not need to complete this section. However, you should still complete the ―All Overstory" and ―Densiometer" sections on this form.
21. Click on the ―Disturbance" tab and record the data following the methods outlined in SOP #4: Site Locations, Set-up, Monumenting, and Description.
22. IMPORTANT: Field crew members should do a complete review of all the information entered before leaving the site. When you are finished, click the ―Close Form" button.
23. Make certain the new record shows up in the list and if it does, click the ―Close" button.
24. If this is the last plot of the day, put the flash drive in the tablet computer and go to step 25. If not, just go to step 25 without putting the flash drive in computer.
25. Click the ―Exit" button. NOTE: Do not click the small X in the upper right corner of the screen to close this application. Clicking the ―Exit" button is a safer process to end this application.
26. You will get a message asking you if you want to make a backup copy of the data; click ―YES" if this is your last plot of the day and then complete step 27, or click ―NO" if you plan on working on another plot and go to step 28..

SOP #10: Data Entry (continued).

27. Navigate to the flash drive and go to the backup folder at: vegetation monitoring/vegetation data/database backup. Click ―Save.” Do not change the name of the database; the program will automatically add a date and time stamp to the name of the database.
28. You have now successfully entered a record for this plot and saved it as a backup (if it was your last plot of the day). Turn off the tablet computer and make certain you plug in the tablet computer whenever you are at the vehicle.
29. You should now be finished with all the vegetation sampling methods.

Returning from the Field

At the end of the day, once you return to the base camp, there are a few tasks that must be completed. The directions to the site and photograph descriptions need to be checked for accuracy and completeness. In addition, any incidental observation not recorded using the database need to be entered. Lastly, backup copies of the GPS files on the Trimble and Garmin unit and photographs on the camera need to be backed up.

To check the driving directions, follow these steps:

1. Plug the keyboard into the tablet computer and then turn on the tablet computer.
2. Open the database by tapping on the ―Vegetation Database” icon located on the desktop.
3. Click on the ―Enter / Edit Data” command button.
4. Select your name from the drop down list in the ―User” field and hit ―OK.”
5. From the list of sites, double click on the ―Visit Date” of the site you want to add or edit driving directions.
6. Next to the ―Location” field, click the ―Edit” button.
7. Enter/Edit the travel direction in the ―Travel Direction” field and then click the ―Close” button.
8. Click the ―Close Form” button.
9. If you need to enter driving directions for another site, repeat these steps starting with #5. If you are finished entering driving directions, click the ―Close” button.

To enter the descriptions of each photograph, follow these steps:

1. Plug the keyboard into the tablet computer and then turn on the tablet computer.
2. Open the database by clicking on the ―Vegetation Database” icon located on the desktop.
3. Click on the ―Enter / Edit Data” command button.
4. Select your name from the drop down list in the ―User” field and hit ―OK.”
5. From the list of sites, double click on the ―Visit Date” of the site you want to add or edit photographs.
6. Click the photographs tab.
7. Enter /edit the description for each photograph you have entered for this date.
8. Click ―Close Form.”
9. Repeat steps 5-10 for each record that needs photograph information populated.
10. Once complete, click ―Close.”

Incidental Observations

While this protocol is designed to monitor vegetation, park staff can provide valuable information about other species if they are provided documentation that the species was seen in the park. Each crew member should make every effort to thoroughly document rare or unknown species that they observe while working in the park. To document an observation, complete the observation form in the vegetation database on the tablet computer. Hardcopy datasheets are also provided; however, these should be entered into the database at the earliest possible convenience. An example of a hardcopy datasheet is provided at the end of this document. To enter an incidental sighting, follow the steps listed below.

1. On the main form of the database, click the ―Incidental Sighting” button.
2. Using the drop down list in the ―Taxon” field, select the proper taxon.
3. Using the drop down list in the ―Common Name” field, select the proper common name.
4. The scientific name should automatically populate along with the status, abundance, residency, nativity, cultivation, and weedy fields.
5. The date field will auto populate with today’s date, so be sure to change it if necessary.
6. Select the observers name using the drop down list.
7. Enter a description of the habitat. Include micro and macro habitat characteristics if necessary.
8. Add any ―General Notes” to describe the sighting.
9. Enter the Easting and Northing coordinates in NAD 83, Zone 10 projection.
10. Click the ―Close Form” button.

Backing up Images and GPS Data

At the end of each day, you should back up the data on the Trimble and Garmin GPS units and the images on the camera. Keep in mind that the Trimble and Garmin are only used to collect data the first time a plot is monumented. Complete these steps to create the backup.

Backing up the images: Plug the camera into the tablet computer; the tablet computer should recognize the camera. Now complete these steps:

1. Using the stylus, select all the pictures on the camera by dragging the stylus across the pictures, making sure not to lift the stylus off the screen.
2. Once all the images are selected, keep holding the stylus on the screen and a new menu should appear. Select ―Copy.”
3. In the vegetation folder on the C:/ drive of the tablet computer, browse to: vegetation monitoring/vegetation_images/backup. Then place the stylus to the screen until a menu appears.
4. Select “Paste” from the menu. You will be asked if you want to replace the pictures in the folder; say ―yes.”
5. You now have a copy of all the images on the folder.

Backing up the Trimble data: Plug the Trimble into the tablet computer; the tablet computer should recognize the GPS unit. Complete these steps to create the backup.

1. Browse to the folder that contains the shapefile of the sites. This should be at: vegetation_monitoring/vegetation_GIS/Vegetation_plots.shp.
2. Using the stylus, select all the files related to this shapefile by dragging the stylus across the pictures, making sure not to lift the stylus off the screen.
3. Once all the files are selected, keep holding the stylus on the screen and a new menu should appear. Select ―Copy.”
4. In the vegetation folder on the C:/ drive of the tablet computer, browse to: vegetation monitoring/vegetation_GIS/Trimble/backup. Then place the stylus to the screen until a menu appears.

SOP #10: Data Entry (continued).

5. Select “Paste” from the menu. You will be asked if you want to replace the files in the folder; say “yes.”
6. You now have a copy of the GIS layer.

Backing up the Garmin data: Plug the Garmin unit into the tablet computer; the tablet computer should recognize the GPS unit. Complete these steps to create the backup.

1. Open up the program DNR Garmin. Once you are connected, in the lower left of the DNRGarmin dialog box, click “Waypoint” then click “Download.”
2. Click OK once all points have been downloaded. Then click “File” and then “Save To.”
3. Browse to: vegetation monitoring/vegetation_GIS/Garmin/backup.
4. In the “Save as type” drop down, select ArcView Shapefile (projected). Name the file with the park name, “Garmin,” “VegPlots,” and date(yyyymmdd). For example: ORCA_Garmin_VegPlots_20110521.
5. You now have a copy of the GIS layer.

Data Validation and Verification

In order to ensure the data collected by the KLMN is as accurate as possible, multiple reviews of the data are completed by a variety of staff. Prior to leaving a site, a field crew member (preferable the one who did not enter the data) should review all the data on the data forms or in the database to make certain they are complete and accurate. Crew members should look for fields that should have been populated but were missed, data values that appear to be extreme, and values that were not included on the picklist for individual fields.

At the end of the field season, it is the responsibility of the Project Lead to review all data collected by the field crew. In addition to looking for errors similar to the ones described above, techniques such as outlier detection and automated data analysis should be done to look for additional errors. This task should be completed prior to releasing field crews from service.

After the data have gone through the validation and verification process and the data, along with a certified datasheet, have been submitted to the Data Manager, it is the Data Manager’s responsibility to conduct an additional review of the data to look for any potential errors missed by the field crew or Project Lead. Once complete and discrepancies addressed, the data are loaded into the master database.

Standard Operating Procedure (SOP) #11: Data Transfer, Storage, and Archive

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedures for transferring data and products to the Network Data Manager. In addition, data certification, storage, archiving, and a timeline for project deliverables are addressed.

Data Transfer

All project deliverables, including but not limited to raw data, processed data, Metadata Interview forms, updated data dictionaries, images with metadata, training logs, datasheets and log books, spatial files, and Certification forms will be transferred to the KLMN Data Manager following the timeline listed in Table 1. It is the responsibility of the Project Lead to ensure all products and associated documentation are delivered to the Data Manager following the timeline.

Certification Form

The Klamath Network will utilize a Certification form submitted by the Project Lead to ensure:

1. The data are complete for the period of time indicated on the form.
2. The data have undergone the quality assurance checks indicated in the Vegetation Monitoring Protocol.
3. Metadata for all data have been provided (when applicable).
4. Project timelines are being followed and all products from the field season have been submitted.
5. The correct level of sensitivity is associated with the deliverables.

A new Certification form should be submitted each time a product is submitted. If multiple products are submitted at the same time, only one Certification form is needed for those products. Certification forms can be obtained from the KLMN web site or by contacting the KLMN Data Manager. An example of the Certification form is included at the end of this SOP.

Field Forms

Hardcopy field forms will only be used when the database is not functioning properly. Hardcopy field forms will be provided to the Data Manager following the timeline in Table 1. It is the responsibility of the Data Manager to scan the datasheets into PDF documents within 1 month of

SOP #11: Data Transfer, Storage, and Archive (continued).

receiving the hardcopies. The Project Lead should organize the field forms in the order in which they will be scanned before they are transferred to the Data Manager. Datasheets should follow this order:

1. One PDF will be created for all datasheets for each site.
2. For each site, datasheets should be in the following order: Site Card, Photo Card, Subplot Card, <15 cm DBH Tree Card, Down Wood and Litter Card, and Overstory Card.

The scanned document will be named with the park, site name, and the year the data were collected. For example, the scanned document associated with the site 004 of the 2009 vegetation plots at Crater Lake NP will be: CRLA_004_2009, where ―CRLA” is the four letter code for the park, ―004” is the site name, and ―2009” is the year the data were collected.

Databases

At the end of the field season, following the timeline in Table 1, the Project Lead should transfer a copy of each project database to the Data Manager. The databases should have gone through all validation and verification processes outlined in SOP #10: Data Entry and SOP #15 Post Field Season prior to the transfer. Once transferred, the Data Manager will subject the data to one more round of validation and verification checks. The Data Manager will work with the Project Lead to correct any errors. Once the data have been thoroughly checked, they will be uploaded into the Master Database stored on the KLMN server (SOP #9: Vegetation Database).

An updated data dictionary for the database should be submitted following the timeline in Table 1, if the data collected in this protocol have been altered (e.g., new or deleted parameters measured, additions to picklists, etc.).

Photos

Images and associated metadata will be transferred to the Data Manager in the format explained in SOP #5: Photographing Plots and Photo Management, following the timeline in Table 1.

GPS/GIS Files

As described above, the GIS Specialist is responsible for submitting a GIS layer of sites that are expected to be visited in a given field season to the Data Manager, 3 weeks prior to the beginning of the field work. These layers will be stored in the GIS folder of the vegetation project folder, as shown in Figure 1.

It is the responsibility of the field crew to collect GPS data points at each of the four corners of the plot the first time they are visited (SOP #4: Site Locations, Set-up, Monumentation, and Description). At the end of the field season, prior to releasing the field crew, it is the responsibility of the Project Lead to provide the GIS Specialist with a list of all sites that were surveyed along with the GPS files collected by the field crew. The GIS Specialist will create a polygon and point shapefile of the surveyed sites and upload it to the Master GIS file located in the GIS folder on the KLMN server.

SOP #11: Data Transfer, Storage, and Archive (continued).

Metadata

Following the timeline outlined in Table 1, the Project Lead should submit a Metadata Interview form for each GIS layer after the field season. If metadata have not been completed for this project, the form will need to be completed in full. If metadata have been completed, and no updates are needed, just complete question one on the form. The Data Manager should update the full metadata (Parsed XML) and post it to the proper locations.

Log Books

The field crew should maintain an equipment log to record any updates or changes to the equipment being used to measure the various parameters described in this protocol (SOP #1: Field Work Preparation); a event log that describes any unique events that occurred while implementing the protocol (SOP #15: Post Field Season); and a training log that documents the training each person receives as part of this protocol. It is the responsibility of the Project Lead to submit the logs to the Data Manager following the timeline in Table 1 and Mohren 2007b.

Reports

There is the potential for a variety of reports and publications to be developed utilizing data collected as part of this monitoring project, including Annual reports, Analysis and Synthesis reports, and scientific papers (SOP # 12: Reporting and Analysis of Data).

Annual reports will be the responsibility of the Project Lead and should be submitted in the NPS Technical Report Series format, unless utilizing another series format for publication. Final Annual reports should be submitted following the timeline in Table 1.

Analysis and Synthesis reports will be the responsibility of the Project Lead and should be submitted in the NPS Technical Report Series format, unless utilizing another series format for publication. Final reports should be submitted to the KLMN following the timeline listed in Table 1.

Data Storage

Project folders have been created for each monitoring protocol the KLMN plans to implement (Figure 1). Project folders contain five standard folders. These folders use a naming convention that includes the vital sign and one of the following: Documents, GIS, Data, Images, or Analysis. These five folders will contain all the data and information for a project as follows:

a) **Vegetation_Documents.** This folder contains the reports, budgets, work plans, emails, protocols, contracts, datasheets, and agreements associated with a specific project.
b) **Vegetation_GIS.** This folder contains shapefiles, coverages, layer files, geodatabases, GPS files, GIS/GPS associated metadata, and spatial imagery associated with a project.
c) **Vegetation_Data.** This folder contains the KLMN Vegetation database, database templates, raw data, scanned datasheets, etc.
d) **Vegetation_Images.** This folder contains any photographs related to the project and associated image metadata. In addition, copies of all photographs and metadata will be transferred into the KLMN Image database. Details on the KLMN Image database can be found in the KLMN Data Management Plan.

e) **Vegetation_Analysis.** This folder will contain derived-data and associated metadata created during analysis.

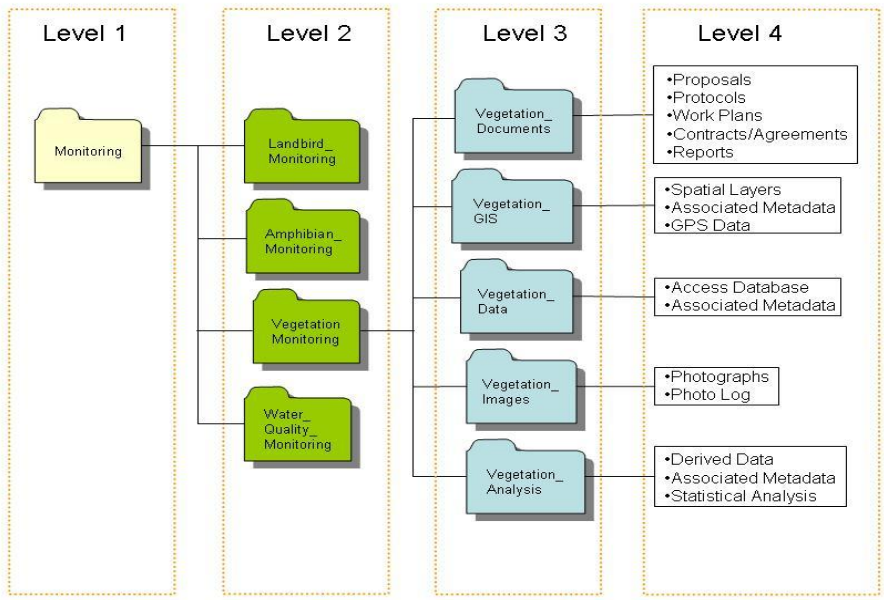

Figure 6. The file structure the KLMN will use to store all vegetation data and information.

Storage, Backup, and Archiving

The KLMN computer drives are subject to all backup and archiving processes described in the KLMN Data Management Plan. The KLMN relies on Southern Oregon University (SOU) for the backup and long-term storage requirements. Nightly backups are done by SOU to store information that has been edited. This is not a full backup but is intended to protect products that have been manipulated. This information is stored for a 1 week period before it is recycled. SOU begins a weekly full backup of their servers on every Friday and stores the files on tape drives. Backups are stored for 60 days before the tapes are reused. SOU will run quarterly backups on March 31st, June 30th, October 31st, and December 31st of each year. Files stored on a quarterly basis are maintained for 1 year before they are moved to a secure location in a building where the KLMN server is located (Mohren 2007a).

Despite the QA/QC measures in place, finding errors in datasets in the future is inevitable. The process for documenting the correction of such errors is detailed in SOP #10: Data Entry. In such instances, archived data will not be corrected; however, an updated product will be placed into the archive drive along with the digital error and entry logs.

Prior to the start of the new field season, deliverables associated with this project will be packaged into a zipped file and submitted to Reference Applications. The zipped file should include all final reports and resource briefs, raw data, scanned datasheets, and GIS files. In addition, final reports should be entered into Reference Applications and linked to NPSpecies as appropriate.

Table 1. Deliverable products, responsible individual, due data, and store location for all products developed while implementing the KLMN Vegetation Monitoring Protocol.

Deliverable Product	Primary Responsibility	Target Date	Instructions for KLMN
GIS Data	GIS Specialist	3 weeks prior to the start of the field season	Store in Vegetation_GIS[2]
Contact Information	Project Lead	2 weeks prior to the start of the field season	KLMN Vegetation Database Stored in the Vegetation_Data[2] Folder.
Metadata Interview Form	Project Lead	Prior to beginning the first field season and immediately after the field season	Store in Vegetation_Data[2], Use to create and revise full metadata.
Updated Data Dictionary	Project Lead	Prior to beginning the first field season and immediately after the field season	Store in Vegetation_Data[2], Use to create and revise full metadata.
Full Metadata (Parsed XML)	Data Manager	Prior to beginning the first field season and by March 1st of the following year	Store in Vegetation_Data[2], Upload the Parsed XML Record to Reference Applications [1]
Data Certification Report	Project Lead	Every time a product(s) is submitted	Store in Vegetation_Document[2]
Processed GPS Data Files	Project Lead	Prior to the field crew members being released from service or by Nov. 15th.	Store in Vegetation_GIS[2]
Training Log Book	Project Lead	Prior to the field crew members being released from service or by Nov. 15th.	Store in Vegetation_Document[2]
Digital Photographs and Metadata	Project Lead	Prior to the field crew members being released from service or by Nov. 15th.	Store in Vegetation_Image[2], Copies of Photographs in KLMN Image Library, Copies of Image Metadata into KLMN Image Database linked to Photographs
Equipment Log	Project Lead	Prior to the field crew members being released from service or by Nov. 15th.	Store in Vegetation_Document[2]
Event Log	Project Lead	Prior to the field crew members being released from service or by Nov. 15th.	Store in Vegetation_Document[2]
Field Data Forms	Project Lead	December 1st	Scan Original, Marked-up Field Forms as PDF Files and Store in Vegetation_Document[2]
Databases	Project Lead	January 1st	Store in Vegetation_Data[2], Send Copy to Parks
Voucher Specimens	Project Lead	December 1	Only specimens of new species to the park list will be kept for Vouchering. Species need to be mounted and mailed to parks to accession.
Annual Report	Project Lead	March 1st	Store in Vegetation_Document[2], Upload to NPS Reference Applications[1], Send Copy to Parks, Post on the KLMN Internet and Intranet Websites, Enter record into Reference Applications[1]
Analyses and Synthesis Report	Principal Investigator	Every 3 years on May 1st	
Other Publications	NPS Staff, Principal Investigator	as completed	
Packaged Data	Data Manager	March 1st	Reference Applications[1]

[1] Reference Applications is a clearinghouse for natural resource data and reports
[3] The KLMN Vegetation project folder contains five folders: Vegetation_Documents, Vegetation_Data, Vegetation_Analysis, Vegetation_GIS, and Vegetation_Image used to separate and store data and information collected as part of the vegetation monitoring.

SOP #11: Data Transfer, Storage, and Archive (continued).

Literature Cited

Mohren, S. R. 2007a. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, CO.

Mohren, S. R. 2007b. Log book guidelines, Klamath Inventory and Monitoring Network. National Park Service, Ashland, OR.

KLMN Certification Form

1) Certification date: ____

2) Certified by: ____
Title: ____
Affiliation: ____

3) Agreement code: ____________________
Project title: ____

4) Range of dates for certified data: ____

5) Description of data being certified: ____
____
____
____

6) List the parks covered in the certified data set, and provide any park-specific details about this certification.

Park	Details

7) This certification refers to data in accompanying files. Check all that apply and indicate file names (folder name for images) to the right:

_____ Hardcopy Datasheet(s): ____
_____ PDF Datasheet(s): ____
_____ Database(s): ____
_____ Spreadsheet(s): ____
_____ Spatial data theme(s): ____
_____ GPS file(s): ____
_____ Geodatabase file(s): ____
_____ Photograph(s): ____
_____ Data Logger(s) files: ____
_____ Other (specify): ____
_____ Certified data are already in the master version of a park, KLMN or NPS database.
Please indicate the database system(s): ______________________________

SOP #11: Data Transfer, Storage, and Archive (continued).

8) Is there any sensitive information in the certified data which may put resources at greater risk if released to the public (e.g., spotted owl nest sites, cave locations, rare plant locations)?

______ No ______ Yes Details:

____
____
____

9) Were all data processing and quality assurance measures outlined in the protocol followed?

Yes / No

If No, Explain ____
____
____

10) Who reviewed the products?
____

11) Results and summary of quality assurance reviews, including details on steps taken to rectify problems encountered during data processing and quality reviews.
____
____
____

Standard Operating Procedure (SOP) #12: Reporting and Analysis of Data

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP details the reporting and analysis components of the vegetation monitoring protocol. There are two main elements: (1) Annual reports and (2) third year Analysis and Synthesis reports. These reports will be authored by the Project Lead with assistance from the Data Manager and possibly interested university or USGS collaborators. The audience for the reports includes superintendents, resource managers, Klamath Network staff, service-wide program managers, external scientists, and partners. The reports are intended to address specific objectives of the vegetation monitoring protocol developed by the Klamath Network, as shown in Table 1, as well as the specific purposes of the reports, as discussed below.

Table 1. Overview of general reporting tools with purpose/objectives and reporting year.

Report	Year	Objective					
		Status and trends in vegetation composition	Status and trends in vegetation composition, structure, and function: Implications for fire.	Status and trends in vegetation structure, and function: Implications for wildlife	Status and trends in vegetation structure, and function: stand dynamics ddynamicsdddDddynamics.	Have the sensitivity to detect significant non-linear shifts in vegetation and a 50 percent gradual change in vegetation should they occur with approximately 80 percent power.	Provide data for modeling invasive species distributions.
Annual Report <u>Purposes</u> • Summarize annual data and monitoring activities • Describe current year's sampling (vegetation status) • Document changes in monitoring protocols • Increase communication between the parks and the I&M Program	All sampling years	X	X		X		X
Analysis and Synthesis Reports <u>Purposes</u> • Determine patterns/trends in vegetation • Discover new characteristics of resources and correlations among resources being monitored • Analyze data to determine amount of change that can be detected by the type and level of sampling • Recommend changes to management of resources	Every three years	↓	↓	↓	↓	↓	↓
Analysis and Synthesis Report 1: Vegetation Composition	2013	X					X
Analysis and Synthesis Report 2: Vegetation Composition, Structure and Function: Interactions with fire	2016				X		
Analysis and Synthesis Report 3: Vegetation Structure and Function: Wildlife Habitat	2019		X				
Analysis and Synthesis Report 4: Stand Dynamics	2022	X	X		X	X	
Analysis and Synthesis Report 5—Vegetation Status and Trends for all Parks	2025	X	X		X	X	

Approach to Data Analysis

Appendix A, which summarizes data from the pilot study, provides a starting point for the reporting the Network will provide on an annual basis. However, at this point, without a full year's sampling data from the protocol, the spatial and temporal variance structure and other aspects of the data that will be acquired in the future are impossible to know. Therefore, it is not possible to precisely prescribe all the specific data analyses that will be conducted. Moreover, some methods are evolving quickly, particularly multivariate analyses using species and environmental data. Accordingly, the Network will continue to work with statisticians to help standardize data analysis methods. In addition, the initial version of each report described below will establish standards and a template for later reports of the same kind. A key requirement for this protocol is that the Project Lead is a scientist possessing strong skills in analyzing multivariate vegetation data and knowledge of the literature on this topic.

Annual Reports

The purposes of annual reports are listed in Table 1. Each of these reports will focus on the status of the two parks sampled in the previous field season. Annual reports will be due to park managers and other interested parties and recipients on March 1st. Appendix A is an example annual report based on the pilot study data. It is intended to be used as a template for future reports. As illustrated in Appendix A, Annual reports will summarize the previous year's monitoring activities and data collected. However, unlike the sample report in Appendix A, actual Annual reports will discuss vegetation status and trends (pilot study data were too limited for this). After initial screening and quality control, data will be presented using summary statistics (range, mean, median, standard deviation) and user-friendly graphics (e.g., bubble maps, histograms, and tables) (Appendix A). The data will also be transformed where necessary and possible, to meet the normality assumptions for any parametric statistics employed to link vegetation and environment variables. Standard techniques for evaluating and transforming statistical distributions will be used (histograms, Q-Q plots) (Zar 1999, Legendre et al. 2002). For detecting effects of environmental factors (e.g., elevation, slope, aspect, and topographic position of plots) on vegetation parameters, correlation matrices between variables and vegetation parameters will be prepared as shown by example in Appendix A. Interactive effects among environmental variables and vegetation parameters may be explored using multiple regression approaches to identify the most parsimonious predictive model relating a combination of environmental variables and vegetation parameters. The Project Lead will determine specific analyses in consultation with statisticians, as needed. Any unusual or special significance findings (e.g., new species documented for a park) will also be highlighted in Annual reports. Invasive species distribution and abundance will be summarized, and the usefulness of the data for modeling invasives (protocol objective 6) will be discussed. However, any invasive species modeling analyses will be reported fully under the Klamath Network Invasive Species Protocol.

A section of the Annual report will be devoted to describing any changes to the specific instructions in the protocol that were suggested by the field crew and Project Lead as a result of implementing the protocol the previous season. If necessary, specific protocol revisions will be proposed for formal consideration. The first annual report will replace Appendix A as the template for future annual reports, and the data analyses described in the preceding paragraph will likely be updated.

Analysis and Synthesis Reports

Analysis and Synthesis reports will be prepared every 3 years after a complete sampling cycle of all panels of plots in the six parks of the Network. These reports will distributed by May 1st of each year shown in Table 1. The four purposes of Analysis and Synthesis reports as listed in

Table 1, from Sarr et al. (2007), are addressed in the series of reports described below. These reports will also highlight similarities and contrasts among the parks as well as explore emergent, network-wide patterns.

Analysis and Synthesis Report 1: Vegetation Composition
Once data have been collected from each park, Analysis and Synthesis Report 1 will describe vegetation status, focusing on vascular plant species composition and richness patterns in the Network. Structure and function data from annual reports will also be summarized at the Network level. The specific parameters to be analyzed, vegetation composition sub-objectives, and methods of data analysis are described in Table 2. The spatial variability of vegetation parameters (i.e., variance structure of the data) captured by the sample frame will be analyzed for its ability to describe vegetation status for each park. Vegetation and environmental data will be co-analyzed to best explain fundamental vegetation and environmental relationships in the parks.

In order to describe status in vegetation composition, an analysis that provides a synthetic understanding of the natural variation in species assemblages across the gradients in park ecosystems will be needed (Whittaker 1967). The vegetation composition and environmental data will be particularly well suited for analyses of species assemblages across gradients in park ecosystems. The presence/absence of species, and their cover, will be analyzed together with environmental data using ordination and classification techniques for community composition data, such as Non-Metric Multidimensional Scaling and constrained ordinations (Kruskal 1964, McCune and Grace 2002). These techniques will illustrate interrelationships among species assemblages at sites and parks and will be invaluable for distinguishing spatial from temporal variation in subsequent trend detection analyses (Philippi et al. 1998), discussed below under Analysis and Synthesis Report 5.

Table 2. Compositional parameters to be analyzed in Analysis and Synthesis Report 1 and the types of analyses and covariables to be examined.

Parameter	Vegetation Composition Sub-objective	Suggested Analyses and Software
Species cover and frequency	Describe vegetation composition and diversity in each park sample frame	Calculate species richness, species/area relationships, evenness, and heterogeneity (pairwise mean dissimilarity across all sites) for each sample frame using presence/absence data. Software: PC-Ord, PRIMER
Species cover or frequency	Describe vegetation distribution in relation to environment.	Nonmetric Multidimensional Scaling and constrained (Canonical Analysis of principle coordinates) ordinations (Sørensen distance measure) for each sampling frame and all samples in the park. Use cover data with 100 percent cover maxima for species whose cover in all strata sums to more than 100 percent. Software: PC-Ord, PRIMER
Species cover and frequency	Describe the most numerically abundant species across sites in each sampling frame.	Develop ranked dominance histograms to illustrate the 20 most important species in each sampling frame. Software: Microsoft Excel, PC-Ord
Species cover and frequency (invasive species)	Describe the most important invasive species in each sampling frame.	Develop ranked dominance histograms to illustrate invasive species present in each sampling frame. Software: Microsoft Excel, PC-Ord

Analysis and Synthesis Report 2: Vegetation Composition, Structure, and Function: Interactions with Fire

This report will summarize how vegetation composition, structure, and function affect fire, and, in turn, how they are affected by fire. The subsequent Analysis and Synthesis reports on this subject every 15 years will address how vegetation and fire interrelationships are changing.

Use of the vegetation data to address fire issues was specifically requested by the parks. Fire management, which directly influences vegetation structure and composition and surface soils, is perhaps the largest potential human influence on park vegetation. In order to strengthen the analysis and focus the questions, we will work with each park and use their NPS fire monitoring data to the extent possible (although they are neither probabilistic nor floristically comprehensive or correct in all cases). We will also use data from the land cover protocol and possibly data from FIA. Use of additional data and working with park staff will enable us to address management concerns to the best degree possible with existing data.

Table 3 describes the fuel parameters, specific sub-objectives for components of this report, and the suggested analyses and software. In order to understand how existing vegetation structure will affect potential fire behavior, we will use our structure data for inputs into fire behavior modeling. Our measure of crown base height will need to be converted to canopy base height as currently used in these models. We will also use the Natural Fuels Photo (http://www.fs.fed.us/pnw/fera/research/fuels/photo_series/) to make determinations of fuel quantities and stand conditions for inputting into fire behavior models. Current models for assessing questions about vegetation and fire behavior include NEXUS (Scott and Reinhardt 2001), Behave Plus (Andrews et al. 2005). Our measure of crown base height will need to be converted to canopy base height as used in these models. We may also use the newer Crown Fire Initiation Software (Alexander 2007, Alexander et al. 2006). There will likely be more options to chose from when the analysis is performed. We may also model fire spread using software such as Farsite (Finney 2004), using ignition locations suggested by historic patterns and management expertise. Modeling outputs will include parameters such as fire intensity, rate of spread, and windspeed needed to initiate crown fire. Modeling outputs will be compared to actual fire severity and spread data to help calibrate modeling.

Table 3. Parameters to be analyzed in Analysis and Synthesis Report 3: Structure and Function: interactions with fire.

Parameter	Vegetation Structure and Function Sub-objective	Suggested Analyses and Software
• 1 hr. fuel • 10 hr. fuel • 100 hr. fuel • 1000 hr. fuel • Litter and duff	Calculate and report quantities (metric tons/ha, tons/acre) by fuel time lag/particle size class and for litter and duff. Use to define fuel model for fire behavior modeling described below and to assess potential for soil heating during fire. Repeated measures ANOVA to analyze change over time.	Calculations using tree basal area information and species constants for specific density of wood and litter. See FMH manual (link at the bottom of the website) page 214-215) for equations. Software: Microsoft Excel, existing spreadsheets developed by the Network. SYSTAT for repeated measures ANOVA.
Shrub height in four 10 x 10 m plots.	Calculate average shrub height from four 10 x 10 m modules. Use along with canopy base height to define fuel strata gap, an input into fire behavior models. Repeated measures ANOVA to analyze change over time.	Use in fire behavior modeling. Software: as described below for modeling. SYSTAT for repeated measures ANOVA.
Fuel strata gap (Canopy base height – height of upper layer of surface vegetation).	Average canopy height based on all tree crowns in 0.1 ha plot (see Cruz et al. 2003). Use along with shrub height to define fuel strata gap, an input into fire behavior models. Repeated measures ANOVA to analyze change over time.	Use in fire behavior modeling. Suggested Software: as described below for modeling. SYSTAT for repeated measures ANOVA.
Canopy bulk density.	Use tree diameter and species to obtain canopy bulk density values based on published allometric relationships Input into fire behavior models. Repeated measures ANOVA to analyze change over time.	Use in fire behavior modeling. Software: as described below for modeling. SYSTAT for repeated measures ANOVA.
Modeled fire intensity and spread, or windspeed needed for crown fire initiation	Predict fire behavior as a function of vegetation. Changes from time 1 to time 2.	Fire behavior modeling with latest software (e.g. future versions of NEXUS (FLAMMAP), BEHAVE+, and Crown Fire Initiation Software.
Successional diversity and other vegetation conditions as affected by fire	Analyze fire history patterns and describe changes in vegetation associated with time since fire	Direct and indirect gradient analyses. Space for time substitution (chronosequence) to create time since fire gradient, along which to analyze many parameters using time series approaches. Software: PRIMER, PC-Ord, SYSTAT.

Additional analysis will focus on questions of how fire regimes are affecting vegetation. Spatial pattern analyses and chronosequence approaches will be employed for addressing these questions. The specific questions will be determined by working with park resource management staff.

Analysis and Synthesis Report 3: Vegetation Structure and Function: Wildlife Habitat

Our third Analysis and Synthesis report will focus on vegetation structure and functional attributes that most affect wildlife habitat. This was also an analysis specifically requested by park managers. However, since there are myriad wildlife that could be analyzed involving all the vegetation parameters measured under the protocol, we will work with park managers to analyze those parameters most important to particular wildlife in each park. We will also combine this report and analysis with Analysis and Synthesis Report 4 from the landbird protocol, which is scheduled the same year, to address bird-related wildlife parameters affected by vegetation in concert with bird data. We will additionally synthesize data from the land cover protocol, and combine this into a comprehensive the vegetation/wildlife/bird/habitat change Analysis and Synthesis report to meet co-occurring reporting requirements from all of these protocols. The result will be a synthetic document that addresses status and trends for wildlife habitat much more broadly than any individual protocol can. This document will be produced every 15 years, with analysis of trends becoming incorporated after the first report focusing on status.

The parameters to be measured, vegetation sub-objectives to address, and suggested analyses to examine are described in Table 4. Key wildlife parameters that will be reported from the vegetation protocol data will be canopy cover, snag and down wood amount, size and decay classes, and hardwood and shrub cover.

Table 4. Parameters to be analyzed in Analysis and Synthesis Report 3: Vegetation Structure and Function: Wildlife Habitat.

Parameter	Vegetation Structure and Function: Wildlife Sub-objective	Suggested Analyses and Software
Tree, shrub and herbaceous cover.	Describe characteristics and heterogeneity in cover types used for predicting bird and other wildlife habitat relations. Assess trend over time.	Calculate distribution, abundance, and diversity of major habitat types across each sample frame (physiognomic types). Repeated measures ANOVA for trend analyses. Software: Microsoft Access, Excel, SYSTAT
Tree basal area, abundance by size class	Describe characteristics and heterogeneity of different forest structure types used for predicting bird and other wildlife habitat relations. Assess trend over time.	Calculate distribution, abundance of forest structural types or successional stages (i.e., young, mature, and old growth) across each sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT
Tree height, height to canopy, canopy class	Describe characteristics and heterogeneity of tree canopy wildlife habitat features. Assess trend over time.	Calculate mean and variance in tree heights, canopy heights and canopy class in each plot and across each sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT
Coniferous and hardwood tree cover by vertical stratum, tree height	Describe characteristics and heterogeneity of tree functional types used for predicting wildlife habitat relations. Assess trend over time.	Graph hardwood and conifer cover by height stratum. Calculate mean and variance in tree height for each plot and across each sample frame. Repeated measures ANOVA for trend analyses. Software : Microsoft Excel, SYSTAT, SigmaPlot
Snag size, density, condition, and distribution	Describe abundance and characteristics of focal habitat elements: dead trees. Assess trend over time.	Calculate mean and variability in hardwood and conifer snag density, size, and decay class across each sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot
Dead and down wood volume, condition, and distribution	Describe abundance and characteristics of focal habitat elements: large diameter, down wood. Assess trend over time.	Calculate downed wood volume for hardwoods and conifers in each decay and diameter class across the sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot
Tree composition by canopy strata--large green trees	Describe abundance and characteristics of focal habitat elements: large trees. Assess trend over time.	Calculate density of large trees (e.g., >0.50 m). Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot
Tree composition by canopy strata--mast producing trees	Describe abundance and characteristics of focal habitat elements: mast producing trees. Assess trend over time.	Calculate density and plot locations of large (>0.50 cm) mast-producing (oak) trees across the sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot, ArcGIS

Table 4. Parameters to be analyzed in Analysis and Synthesis Report 3: Vegetation Structure and Function: Wildlife Habitat (continued).

Parameter	Vegetation Structure and Function: Wildlife Sub-objective	Suggested Analyses and Software
Browse plant height and cover	Describe abundance and characteristics of focal habitat elements: browse species. Assess trend over time.	Calculate means, variance, and plot locations of potential browse species (e.g. *Purshia*, *Salix, Populus*) in each sample frame. Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot, ArcGIS
Riparian shrub height and shrub cover, tree cover by stratum	Describe abundance and characteristics of focal habitat elements: Riparian trees and shrubs. Assess trend over time.	Calculate mean, variance, and plot locations of focal tree and shrubs species for riparian dependent wildlife (e.g., *Salix, Populus, Alnus*, etc.). Repeated measures ANOVA for trend analyses. Software: Microsoft Excel, SYSTAT, SigmaPlot, ArcGIS

Analysis and Synthesis Report 4: Vegetation Structure and Function: Stand Dynamics

The status of reproduction and mortality, canopy dieback, wood decay classes, and other aspects of vegetation dynamics measured by the protocol will be analyzed in Report 4. The parameters and sub-objectives and suggested analyses and software are summarized in Table 5. There will also be additional functional parameters to analyze that are derived from the data collected. These include biomass/carbon, ratio of live to dead tree basal area of trees, and tree age. Tree diameter and height relationship may be used as a proxy for age in demographic analyses.

Table 5. Structural parameters to be analyzed in Analysis and Synthesis Report 4: Structure and Function-Stand Dynamics.

Parameter	Vegetation Structure Objective	Suggested Analyses and Software
Tree seedling and Sapling Abundance	Describe stand recruitment processes over time.	Develop histograms illustrating densities of juvenile tree and mature trees by height or diameter class. Software: Microsoft Excel, SigmaPlot, SYSTAT
Snag density by decay class	Describe tree mortality and decay processes over time.	Calculate densities of snags in each decay class as a proxy for time since tree death. Software Platforms: Microsoft Excel, SYSTAT
Tree canopy condition	Describe factors affecting tree and canopy health and potential trends over time.	Calculate mean, variance, and spatial distribution of canopy mortality. Software: Microsoft Excel,SYSTAT, ArcGIS
Tree cover by height stratum	Describe patterns of canopy succession and dominance and potential trends over time.	Calculate the distributions of tree species by height stratum to canopy dominance in different strata. Software: Microsoft Excel, SigmaPlot, SYSTAT
Disturbance presence and type	Describe natural and anthropogenic disturbance processes and potential trends over time.	Calculate the types, abundance, and distribution of vegetation disturbances in each sampling frame. Use landcover data or analyses to supplement plot data. Suggested Software Platforms: Microsoft Excel, SigmaPlot, SYSTAT
Tree basal area	Describe tree dominance and stand biomass over time.	Calculate the mean, variance in stand biomass, plot spatial pattern. Software: Microsoft Excel, SigmaPlot, SYSTAT

SOP #12: Reporting and Analysis of Data (continued).

Analysis and Synthesis Report 5: Analysis of Vegetation Trends in the Network after 15 Years
The fifth Analysis and Synthesis report will present the first trend assessment. In year 15, we will have visited each park five times and we expect to have a sufficient time series to begin the detection of vegetation trends that are occurring at a relatively rapid pace. Determination of significant trends in vital signs will require considerably more time than status, depending on the degree of variance and magnitude of change in each vital sign.

Trends will be analyzed for vegetation composition and structural and functional parameters described in Tables 2-5. Table 6 describes the parameters, sub-objectives for analyses of vegetation trends, and suggested software and analyses.

Table 6. Trend analyses to be undertaken in Analysis and Synthesis Report 5.

Parameter	Trend Sub-objectives	Suggested Analyses and Software
Vegetation Composition		
Species presence and abundance (cumulative in 0.1 ha plot)	Detect ecologically significant changes in species composition if they occur	Permanova[1], rank correlation to determine significance of relationship between composition distance (Bray-Curtis distance measure) and time. Control chart analysis to determine abnormal levels or rates of change in composition. Software: ‗R,‘SYSTAT
Relative abundance (herbaceous and shrub cover, tree basal area) of 20 most dominant species in each sample frame as well as invasive species	Detect ecologically significant changes in relative abundance of dominant species if they occur	Parametric and nonparametric time series analysis of species relative abundance. Control chart analysis and rank clocks to determine rates of change in dominance. Software: ‗R,‘SYSTAT
Species richness and derived diversity metrics (evenness, Pielou‘s J, Fisher‘s α)	Detect ecologically significant changes in species richness if they occur	Parametric and nonparametric time series analysis of species diversity. Plot ―hot spots” of change in each sampling frame. Species area curves. Software: ‗R,‘SYSTAT, ArcGIS
Structure and Function: Fuels and Potential Fire		
Fuel beds (down wood, litter, duff)	Detect ecologically significant changes in ground fuels should they occur	Parametric and nonparametric time series analysis of quantities and depth per ha. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS
Live fuels (shrub height, canopy base height, canopy bulk density)	Detect ecologically significant changes in live fuels should they occur	Parametric and nonparametric time series analysis of changes in average canopy base height and density. Plot ―hot spots” of change in each sampling frame. Software Platforms: ‗R,‘SYSTAT, ArcGIS
Fire behavior modeling outputs (fire intensity, rate of spread, windspeed needed for crown fire)	Detect ecologically significant changes in potential fire behavior should they occur.	Parametric and nonparametric time series analysis of modeling outputs. Plot ―hot spots” of change in each sampling frame. Software Platforms: ‗R,‘SYSTAT, ArcGIS
Structure and Function: Wildlife		
Snag density	Detect ecologically significant changes in snag density should they occur.	Parametric and nonparametric time series analysis of snag density. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS

Table 6. Trend analyses to be undertaken in Analysis and Synthesis Report 5 (continued).

Parameter	Trend Sub-objectives	Suggested Analyses and Software
Down wood	Detect ecologically significant changes in down wood should they occur	Parametric and nonparametric time series analysis of down wood volume, size and decay classes. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS
Large green tree density	Detect ecologically significant changes in large green tree density should they occur	Parametric and nonparametric time series analysis of large snag density. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS
Structure and Function: Stand Dynamics		
Seedling and Sapling Density	Detect ecologically significant changes in recruitment should they occur.	Parametric and nonparametric time series analysis of tree recruitment. Identify high and low recruitment years by location. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS
Snag Density by Decay Class	Detect ecologically significant changes in snag density should they occur.	Parametric and nonparametric time series analysis of snag recruitment and decrease (fall rate). Identify high and low recruitment years by location. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS
Disturbances	Describe disturbance patterns, events	Because of the episodic nature of disturbance and the long-term nature of most disturbance regimes, it is unlikely that we will be able to detect trends or determine abnormality in this parameter over 15 years. However, general statistical summaries and descriptive mapping of disturbances should be prepared, as appropriate, to illustrate important dynamics over the time period. Software: Excel, SigmaPlot, SYSTAT, ArcGIS
Tree Basal Area	Detect ecologically significant changes in tree basal area should they occur.	Parametric and nonparametric time series analysis of tree recruitment. Identify high and low recruitment years by location. Plot ―hot spots” of change in each sampling frame. Software: ‗R,‘SYSTAT, ArcGIS

*Environmental variables: Elevation, slope, aspect, microtopography, macroposition, disturbance, derived GIS topographic or moisture variables or time since fire.
[1]Permutational Multivariate Analysis of Variance (non-parametric)

After the fifth Analysis and Synthesis report, we will begin the same reporting cycle again, unless it has been modified along the way.

Multivariate Analyses and Detection of Trend

Much of the information and insight about temporal change will be contained in multivariate analyses of vegetation composition data in relation to environmental parameters. These analyses can be used to efficiently explore the data and identify progressive changes (Figure 1). This is based on assessing cumulative plot dissimilarity over time, and in the context of outlier determination and control chart development (McBean and Rovers 1998, Anderson and Thompson 2004) (Figure 2). Compositional changes can provide compelling evidence that a meaningful ecological event has occurred, or an ecological threshold has been exceeded (Anderson and Thompson 2004). At a minimum, cumulative dissimilarity ordinations (Figures 1 and 2) will be developed for each sampling frame from each park (total = 14) for the first 15 years of the program.

Philippi et al. (1998) suggest tests for trend in matrices of similarity indices derived from multi-date species data: 1. Non-parametric multivariate analysis of variance can be used with a matrix of dissimilarities which can be partitioned into residual sums of squares to test for trend from the baseline condition (time 1, or another time period or reference). Significance is determined through a randomization test of date labels. 2. Mantel test of a locational dissimilarity matrix to the temporal time difference matrix. Randomization following the traditional Mantel test then tests for significance of association between time and species composition (Manly 1997).

Other tests for progressive trend in assemblage data exist, such as the canonical analysis of principal coordinates (CAP) as proposed by Anderson and Willis (2003) and Anderson and Robinson (2003), and the perMANOVA test. The CAP analysis can be implemented in the R software vegan package with the capscale() function, or in the PRIMER software (PERMANOVA for PRIMER). Also, perMANOVA could be used to test for differences amongst sampling periods, amongst sites, and the error term would be the site by sampling period interaction (Anderson 2001). This can be implemented in the vegan package as well with the adonis() function; this is another permutation approach so computational time is high and the number of iterations used may have to be adjusted.

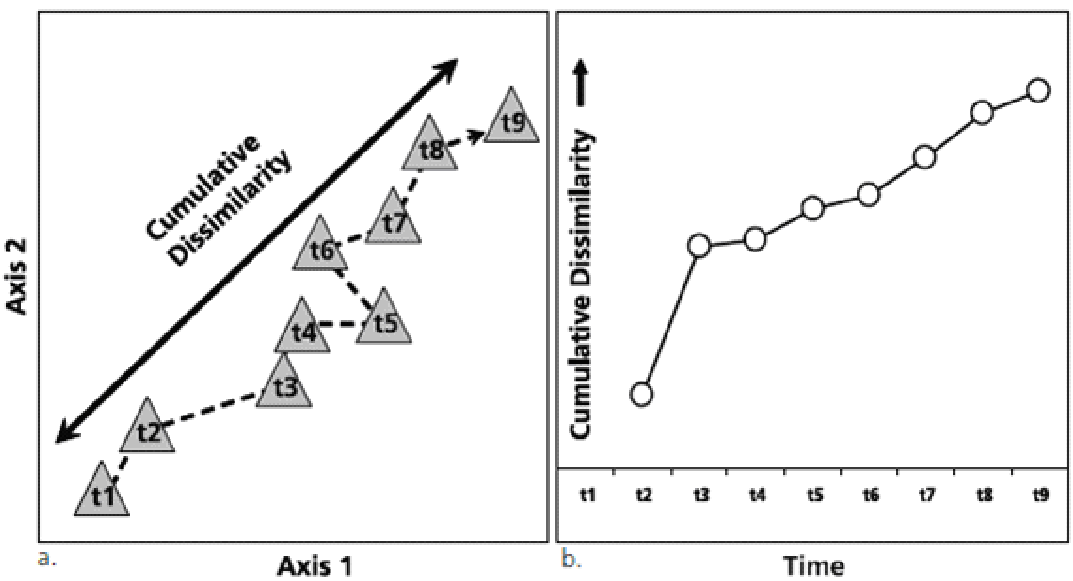

Figure 1. Cumulative change in species composition over nine sampling seasons. a.) An idealized two-dimensional ordination diagram illustrating the compositional position of a site at time one through nine, where Euclidean distance between each year (i.e., time steps t1, t2...t9) is proportional to species dissimilarity. The solid two-headed arrow is an ordination that illustrates the cumulative dissimilarity (progressive compositional change) over the whole period. b.) A graph of cumulative dissimilarity between the first year sample and successive years (i.e., t1 to tn). Note that the change is positive and sustained, suggesting a clear trend of changing composition over time.

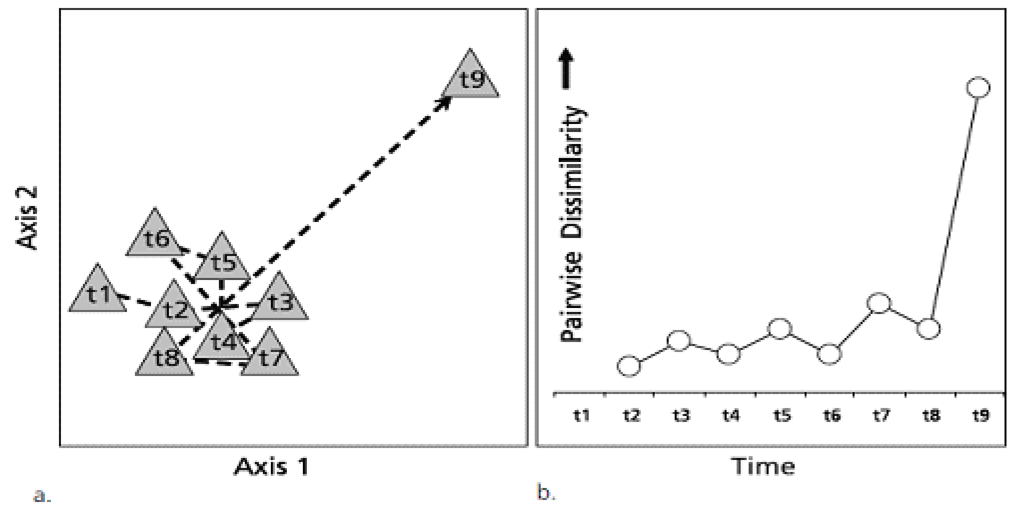

Figure 2 a and b. Year-to-year change in species composition over nine sampling seasons, with a major change at year nine. a.) An idealized two-dimensional ordination diagram illustrating the compositional position of a site at time one through nine where Euclidean distances between each pair of years (i.e., time steps t1, t2...t9) are proportional to pairwise species dissimilarity. The dashed arrow follows the year-to-year change in composition. b.) A graph of pairwise dissimilarity between each pair of successive time steps from years one to nine. Note that the composition is similar, but slightly variable in years one to eight, with a major change in year nine.

We provide an example that displays a strong progressive trend based on the data in Sarr and Hibbs (2007). These data were gathered across a strong environmental spatial gradient, but we make the assumption that such a gradient could occur across time under a scenario of accelerated climate change. We notice a strong pattern in both the visualization of the data through plots and ordinations as well as using the Mantel test for progressive trend. This multi-faceted approach to data analysis is beneficial because managers are more likely to understand graphical displays than simply a p-value when describing vegetation assemblages changing over time.

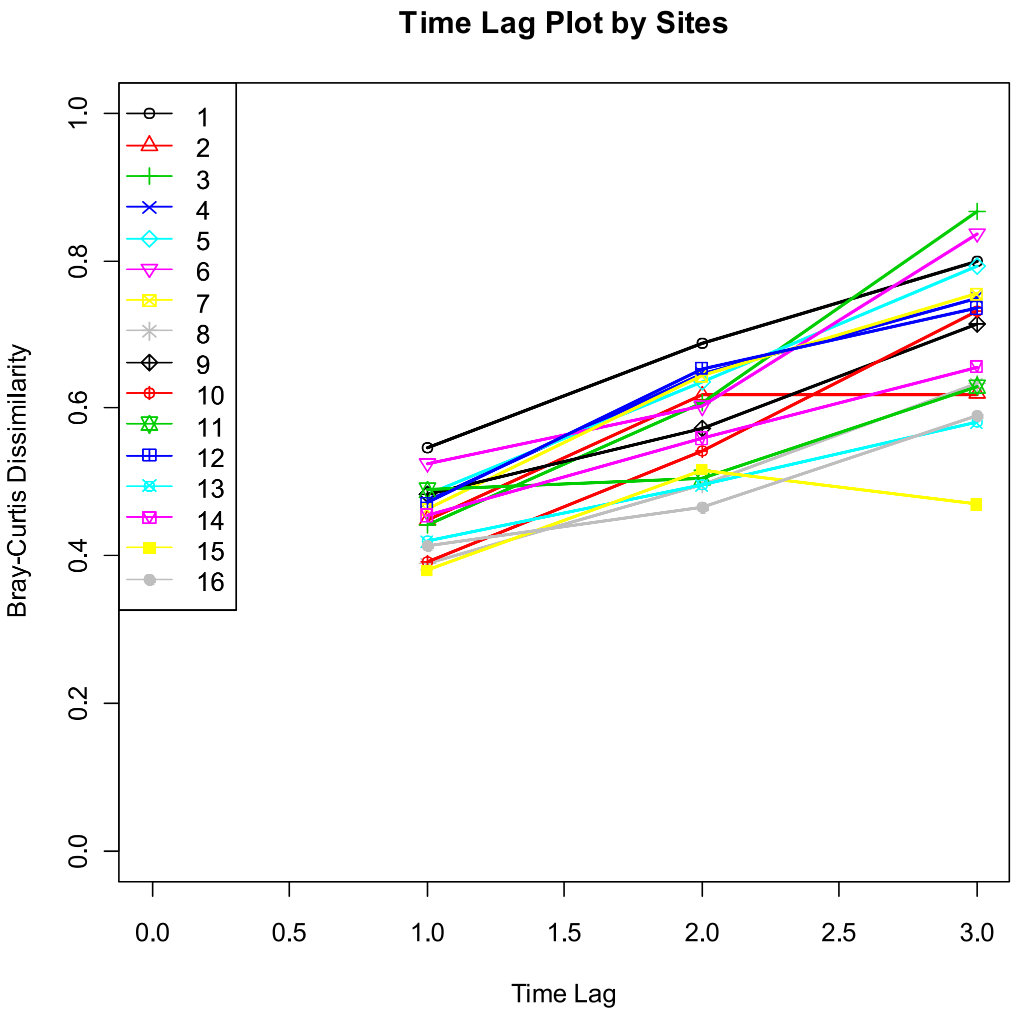

Figure 3. Time lag plot of the mean dissimilarity for each site. The mean is the average dissimilarity at each lag class for each site. This plot shows a strong progressive trend across the 16 sites through time.

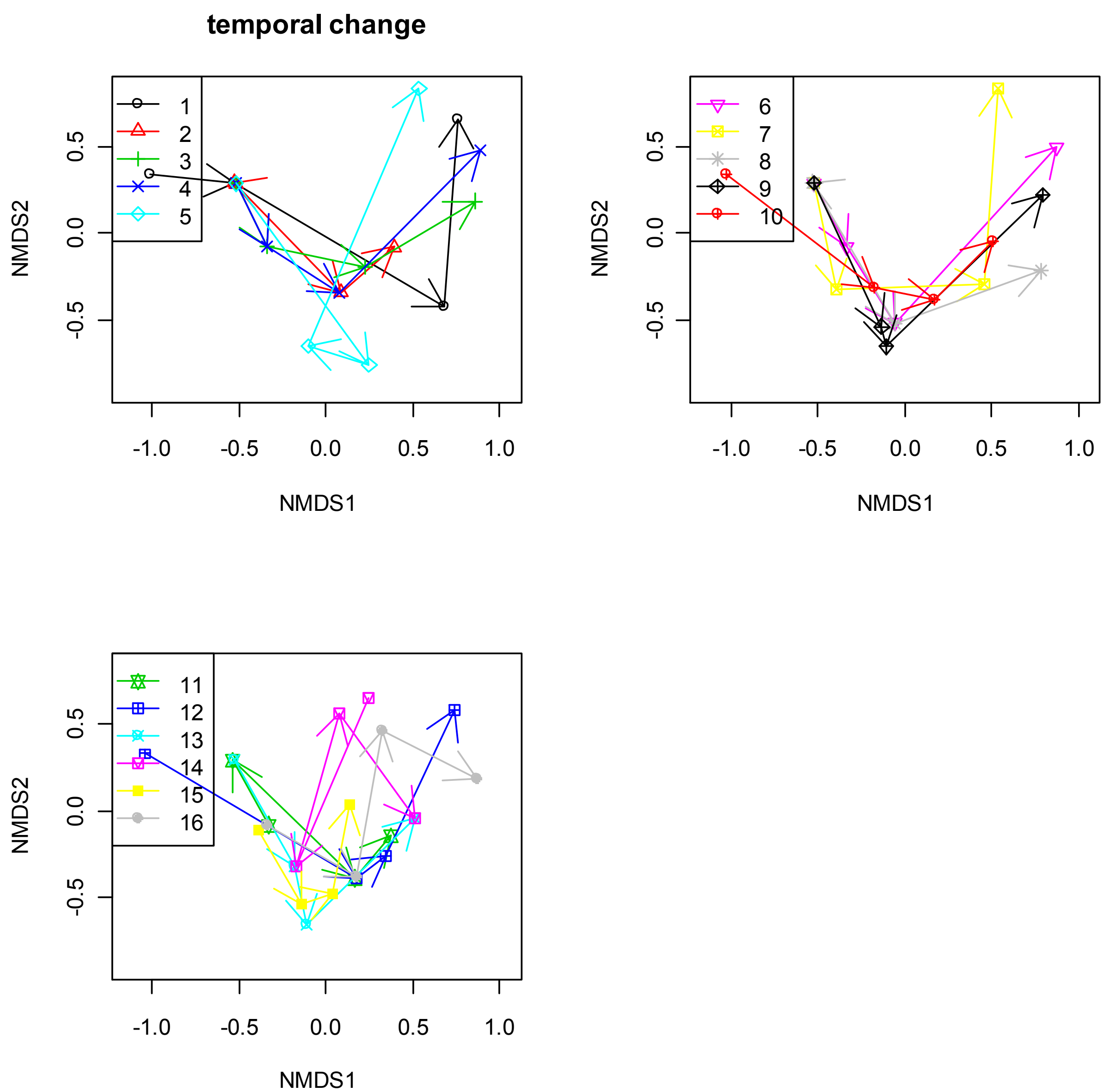

Figure 4. The bi-plot using the first and second axis of Nonmetric Multi-Dimensional Scaling (NMDS) ordination. The observations are colored according to the unique sites sampled over time. The arrows connect the site observations over time. There is a strong pattern with arrows tracking along NMDS1, consistent with theoretical display in Figure 1.

The easiest test to implement for progressive trend is the Mantel test (see McCune and Grace 2002, Chapter 27). We provide an example here that requires some understanding of multivariate statistics and the R software.

In the Mantel test for progressive trend, two distance matrices need to be created, one for the response and one for the explanatory variable (time). The response variable is the vector of dissimilarity values, or the upper triangle (i.e., nonzero values) of the dissimilarity (resemblance) matrix http://www.statistics.com/resources/glossary/d/dissimmatr.php calculated from the raw site by species matrix. Calculation of the dissimilarity matrix using R is specified at http://cc.oulu.fi/~jarioksa/softhelp/vegan/html/vegdist.html. The explanatory variable for progressive trend is time. For the vegetation protocol, this will be sample periods spaced 3 years apart (1, 4, 7 years and so on). The Mantel test for progressive trend is just the correlation between the response and explanatory variable. Figure 5 displays the example data used to calculate the spearman correlation between Bray-Curtis dissimilarity and the time lag. The Mantel test is implemented within the R package vegan, http://cc.oulu.fi/~jarioksa/softhelp/vegan/html/mantel.html. The observed data produce a Spearman correlation statistic of 0.60. To assess the significance of this value, a permutation distribution is found by randomly assigning a dissimilarity value to one of the time lags within a site; e.g., time lag 1 might now become time lag 3. For each permutation of the dissimilarity values, the Spearman correlation is calculated again. To calculate the p-value, the number of values equal to or more extreme than the observed 0.599 are counted and divided by the total number of permutations. The permutations are constrained within a site because we have fixed sites for sampling. In vegan using the Mantel function, the strata argument should equal the variable containing the site unique identifier. One should also be aware that as implemented in vegan, the p-value is assuming the one-sided test for a positive correlation. The implementation in vegan is based on that described in Legendre and Legendre (1998). The Mantel test can be done in PRIMER using the RELATE function.

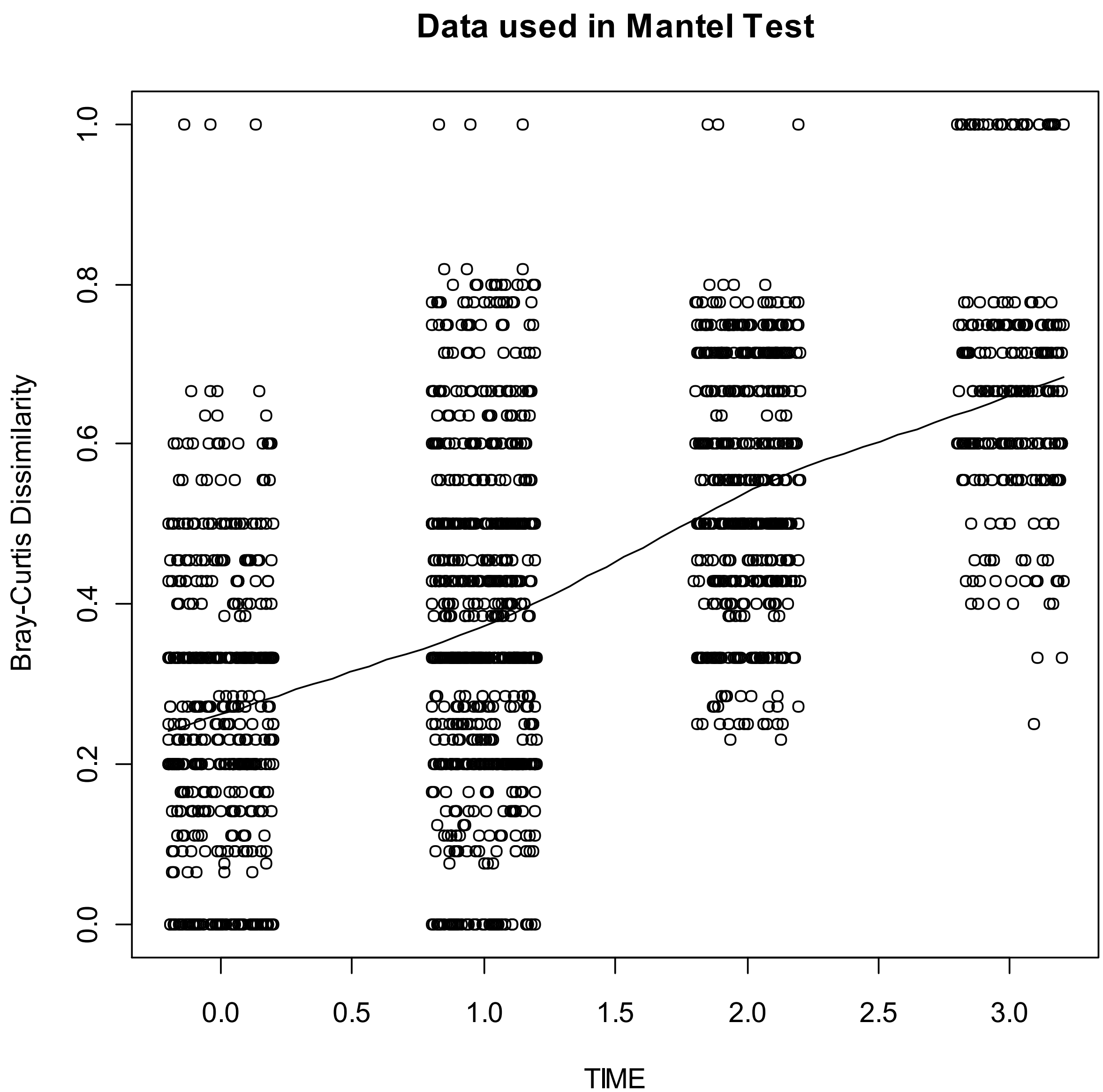

Figure 5. Data used in the Mantel test with a smoother added to aid in visualizing a trend in the dissimilarity values over time. In the Mantel test, permutations are constrained within a site. There is a strong trend which corresponds to the large Mantel statistic values of 0.599.

Based on the Mantel test for progressive trend, there is strong evidence of progressive trend in the woody species assemblage dissimilarities (constrained permutation p-value < 0.001) in the Sarr and Hibbs (2007) data. The estimated magnitude of the Mantel statistic is large (0.60). Others have investigated the connection between the Mantel statistic and the Pearson correlation coefficient (Dutilleul et al. 2000, Goslee 2010). One should be aware that a significant p-value can occur for a very low Mantel statistic, although this is not the case for these data.

SOP #12: Reporting and Analysis of Data (continued).

Multivariate outputs will suggest many specific analysis possibilities for the large number of univariate parameters beyond those outlined in Table 6. Targeted analyses and statistical methods will be chosen based upon outstanding research or management questions in each park.

General tools for the determination of trend in univariate parameters will range in complexity from application of general linear models (Manly 2001), to time series analyses of longer-term datasets for univariate parameters (Box and Jenkins 1976, Manly 2001), analyses of covariance (ANCOVA), and non-parametric procedures. Regression-based analyses for trend detection (e.g., F-test of slope) should account for the year, interaction, and residual sources of variation.

For the sample panel with 3 year revisits, a regression model (linear model) can be used to analyze change over time in univariate parameters such as shrub height, seedling density, or basal area that are continuous variables. The basic model for trend is: $\log(Y_{ij}) = \beta_{0j} + \beta_{1j}Yr_i$ where Y_{ij} is the observed characteristic of interest (e.g., shrub height) for site j in year i. This model assumes site-specific trends over time. This model is a ―rich” model in terms of modeling the fixed sites over time, separate lines for each site j ($\beta_{oj} + \beta_{1j}$). However, the linear assumption of trend through time should be evaluated based on data. Also, this model can be compared to reduced models of parallel lines ($\beta_{1j} = \beta_1$ for all j), or a common line ($\beta_{oj} = \beta_0$ for all j and $\beta_{1j} = \beta_1$ for all j). On the back-transformed scale, the trend is in terms of a multiplicative change in the medians over time [$\exp(\beta_1)$]; this is typically appropriate for biological data that display exponential growth and increasing variability with an increase in mean. This model assumes that the residuals have constant variance, are independent, and follow a normal distribution. These assumptions should be verified through standard visual displays, residual plots, and qqplots. For variables that do not meet these assumptions, Generalized Linear Models (GLMs) could be used which allow for alternative error distributions appropriate for counts, proportions, or ordered categories (e.g., Agresti 2002). The SYSTAT software has a flexible dialog box for hypothesis testing with GLMs. This includes an option for post-hoc analyses for repeated measures.

New techniques are also emerging that allow complex dynamics of species dominance shifts to be more clearly demonstrated, for example, rank abundance clocks (Collins et al. 2008). Rank abundance analyses may be undertaken to complement ordination analyses for each sampling frame. As new methods evolve, this SOP will need to be revised accordingly.

Assessing Change

The National Park Service goal of maintaining unimpaired conditions has traditionally been interpreted to mean that conditions remain stable and unaffected by humans. Unfortunately, there are no benchmarks that provide an unambiguous measure of when conditions are becoming ―unimpaired” (Cole et al. 2008). All ecosystems are dynamic, characterized by natural disturbance regimes (Pickett and White 1985, Wu and Loucks 1995, Poff et al. 1997) and long-term fluctuations in climate and biogeography (see Whitlock and Bartlein 1997, Mohr et al. 2000, Weisberg and Swanson 2003, and Whitlock et al. 2008 for analyses from the Klamath Region). Relatively infrequent, extreme events are important parts of the disturbance regime in most natural ecosystems (Benda and Dunne 1997, Moritz 1997). Disturbance-mediated variation is important for vegetation diversity (Odion and Sarr 2007), yet the dynamics are often highly nonlinear and vary with scale (Sarr et al. 2005), making them difficult to place into the context of ―unimpaired."

With paleoecological, fire history, and archaeological studies, we are only now coming to an understanding of some of these natural dynamics in park landscapes. Our limited understanding is compounded by the fact that parks are not, as once assumed, insulated from human impacts like climate change and altered fire regimes. There have also been human-caused declines and extirpations in keystone species such as top terrestrial predators, including wolves and grizzly bears. Ecosystem engineers such as beavers may be much less common today. These cumulative human impacts may have considerably altered our ability to assess baseline vegetation conditions. We will need to develop a quantitative understanding of what is acceptable variation in ecosystems for which there are no historical analogs. This may be one of the most challenging analysis problems the National Park Service faces (Cole et al. 2008).

We will explore indices of biological or ecological integrity (IBIs, IEIs; Karr and Chu 1999) to help differentiate acceptable from unacceptable change. These indices are based on the approach of using reference sites unimpacted by particular human stressors against which potentially affected areas are compared. Reference sites can be plots that happen to fall into unimpacted areas. There are no perfect reference sites, but there are sites that may be lacking particular human impacts such as invasive species, predator removal, fire suppression, and stream flow alteration. Although indices of biological integrity have been most successfully applied in aquatic ecosystems, where disturbance or pollution effects have been well studied (Karr 1991), they more recently have been developed and applied in riparian and wetland environments (Innis et al. 2000) for terrestrial invertebrates (Kimberling et al. 2001) and for bird communities (O'Connell et al. 2000). The indices may rely on a variety of taxa, and we expect to evaluate biotic integrity using data not only from the vegetation protocol, but also from the landbird (which has co-located monitoring sites), invasive species, land cover, water quality, whitebark pine, and cave protocols (the cave protocol will be monitoring vegetation and wildlife at cave entrances). We expect that indices of biotic integrity may prove valuable in interpreting the acceptability of vegetation change and identifying where management intervention can mitigate unacceptable change.

Report Format

Annual reports and third year Analysis and Synthesis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting. Annual reports and third year Analysis and Synthesis reports will be formatted using the Natural Resource Technical Report template (http://www.nature.nps.gov/publications/NRPM/NRTR.dot). These templates and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

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Standard Operating Procedure (SOP) #13: Metadata Guidelines

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedures for completing metadata for products developed using this protocol. This includes, but is not limited to databases, documents, and GPS and GIS data. Details on metadata for photographs can be found in SOP #5: Photographing Plots and Photo Management. This SOP is based on metadata recommendations developed by the Klamath Network (KLMN) (Mohren 2007), the Natural Resource GIS Program (NR-GIS Data Store 2005a-i), and the NPS North Coast Cascades Network (NCCN 2006a, NCCN 2006b, NCCN 2006c). Acronyms used in this SOP are defined at the end.

Documentation is a critical step towards ensuring that products collected as part of this monitoring effort are usable for their intended purposes now and in the future. This involves the development of metadata, defined as structured information about the content, quality, condition, and other characteristics of a product. In addition to spatial information, metadata include information about data format, collection and analysis methods, time of collection, originator, access/use constraints, and distribution. Metadata provide the means to catalog products, within Intranet and Internet systems, making them available to a broad range of potential users. While most frequently developed for geospatial data, metadata describing non-geospatial datasets are also important (NCCN 2006a).

Timelines

It is the responsibility of the Project Lead to submit metadata or metadata products (e.g., Metadata Interview form, data dictionary) to the Klamath Network Data Manager, in the proper format, when he or she submits the product with which the metadata are associated. SOP #11: Data Transfer, Storage, and Archive provide the details on the products to be delivered to the Data Manager, the due dates for those products, and the persons responsible for those products.

Responsibilities and Standards

Metadata are among the most important pieces of documentation to help guarantee the long-term usability of data. The degree of documentation will vary depending on the product, but a few standards will always hold true.

1. Metadata for spatial data collected through I&M funded projects will meet FGDC, NBII, and NPS standards.
2. Project Leads will be expected to submit a data dictionary (for tabular and spatial data) and Metadata Interview form (for spatial data) prior to the start of the first field season.
3. Project Leads will be expected to review and revise all data dictionaries and Metadata Interview forms at the end of each field season and report changes following the timeline listed in SOP #11: Data Transfer, Storage, and Archive.
4. It is the responsibility of the Data Manager to develop the official metadata based on the data dictionary and Metadata Interview form provided by the Project Lead.
5. It is the Data Manager's responsibility to parse and transfer metadata to the NPS Data Store, if applicable.
6. The Data Manager will work with the Project Lead and park staff to determine the sensitivity level of any data.

Reports

Three main types of reports are expected to be developed during this monitoring effort, including Annual reports, Analysis and Synthesis reports, and scientific publications (SOP #12: Reporting and Analysis of Data). It is the responsibility of the individual creating the reports to ensure that the following guidelines are met:

1. First and last name of all authors are included on the reports.
2. Affiliations of the authors are included on the report.
3. Version numbers are used on all drafts of the report.
4. The date the report was completed is included on the report.
5. The date representing the information presented in the report is included in the report.
6. Series number is included in the report when applicable.
7. The NatureBib accession number has been added to the subject field in the properties of the document in the format: NatureBib #123456. This will be created by the Network Data Manager.

Spatial Data, Databases, and Spreadsheets

The GIS Specialist is responsible for creating and maintaining the official metadata for all GIS and GPS products and the Data Manager is responsible for creating the metadata for the relational databases and spreadsheets. It is the responsibility of the Project Lead to provide Metadata Interview forms and data dictionaries to the Data Manager prior to implementing the field work as described in SOP #11: Data Transfer, Storage, and Archive. The Data Manager will use the Metadata Interview form, data dictionary, and protocol to develop complete metadata for each product. Each year that field work occurs, the Project Lead must submit a data dictionary (if changes to the product have occurred) and Metadata Interview form following the timeline in SOP #11: Data Transfer, Storage, and Archive.

Steps for Metadata Creation

Step 1: Metadata Interview Form and Information Gathering (Figure 1)

A. The Project Lead should obtain and complete the KLMN Metadata Interview form at project onset to facilitate compiling the information required to create compliant metadata.
   1. The KLMN Metadata Interview form is posted on the KLMN Internet and Intranet web pages. In addition, the form can be obtained by contacting the Network Data Manager and is located on the KLMN server at: G:\Data_Management\Standard Operating Procedures\Klamath_Network_SOP_and_Guidelines\Metadata\Documents.
   2. Best attempts should be made to populate the Metadata Interview form as completely as possible prior to starting field work. However, it is recognized that changes to the form will occur throughout the project.

B. A data dictionary must be created to provide information to help the Data Manager create or update the official metadata and in some cases, the project database. A template data dictionary can be obtained from the Data Manager and is also located on the KLMN server at: G:\Data_Management\Standard Operating Procedures\Klamath_Network_SOP_and_Guidelines\Data Dictionary

C. If a taxa list other than a current ITIS certified taxa list was used, the Project Lead will need to provide the list that was used at the end of each field season. Taxa lists should include:
   1. Taxon group (plant).
   2. Scientific name.
   3. Common name.
   4. Any special code that defines a species.

D. The Project Lead should send a copy of any additional information that might be valuable for the development of metadata.

Step2: Sensitivity Review: Sensitive Data (Species Locations, Site Locations, Etc.) May Not Be Subject for Release to the Public

A. The current version of NPS Data Store does not screen for sensitive information. Therefore, any data with a sensitive status will not be posted on the Data Store.

B. The Network Data Manager will be responsible for posting data as sensitive. Status of the data will be based on comments provided by the Project Lead under the ―Sensitivity" question in the Metadata Interview and Certification forms. In addition, the Klamath Network will consult with park staff if the sensitivity status of any data is questionable.

Step 3: Additional Requirements

A. Along with the required metadata, the Klamath Network requires the following information be included in the metadata document.
   1. The name and agreement code for the project. These can be entered in the Related Key element in the Program Information section (NPS Section 0) on the NPS Profile.

2. References to all products (GIS, GPS, Databases, Reports) generated by the projects. These references can be entered in the repeatable Cross Reference element of the Identification Information section.
3. Standard language for NPS liability should be inserted into the Distribution Liability metadata element of the Distribution Information (FGDC Section 6).
    i. This can be found at: http://www.nps.gov/gis/liability.htm.

Step 4: Biological Data Profile

If a dataset includes biological information, the Biological Data Profile provides a set of extended metadata elements to document the species observed, taxonomic information, methods, and analytical tools.

A. The most direct, and KLMN preferred, means to populate the Biological Data Profile metadata elements are outlined in Biological Profile (National Biological Information Infrastructure - NBII) Metadata Guide (NR-GIS Data Store 2005a).
    i. This approach primarily utilizes the NPS Metadata Tools and Editor and may also require the entity and attribute harvesting capability of NPS Database Metadata Extractor for Access datasets.

B. The two documents at the following links describe alternative approaches to completing the Biological Data profile for a metadata record. Note that the first requires the use of additional metadata creation software (Spatial Metadata Management System, or SMMS):
    i. Metadata Tools Used in the Creation of the FGDC Biological Data Profile (Callahan and Devine 2004).
    ii. National Biological Information Infrastructure (NBII) Metadata Steps (McGuire 2004).

Step 5: Metadata Review

The Data Manager should review metadata for quality control (QC) prior to posting to NPS Data Store. A useful QC Checklist is available for download on the NPS Intermountain Region GIS website at: http://imgis.nps.gov/tips_templates.html.

Step 6: Metadata Parsing and Exporting to XML Format

The NPS Data Store requires that metadata records be parsed into FGDC-structured metadata and then exported to XML format.

A. If using ArcCatalog, these steps can both be done directly with the NPS Metadata Tools and Editor. See Parsing Metadata with the NPS Metadata Tools and Editor (NR-GIS Data Store 2005i) for more information.

B. If using other applications, export the metadata first to ASCII text format and then parse with Metadata Parser (MP). MP can simultaneously output an XML format metadata file as well.
    i. MP must be customized to handle NPS, Biological Data, or ESRI Profile metadata elements. For specifics, refer to:
        a. The README.txt file included in the zipped NPS Metadata Profile configuration files, available from the NPS Data Store web site at: http://science.nature.nps.gov/nrdata/docs/metahelp/metahelp.cfm.

b. Parsing Metadata with the NPS Metadata Tools and Editor (NR-GIS Data Store 2005i).

Step 7: Metadata Posting

Post the metadata to the NPS Data Store.

A. Authorized NPS staff may request upload and edit access to the NPS Data Store through the NPS Natural Resource Universal Web Login (UWL), available at: https://science1.nature.nps.gov/nrdata/. This is also the portal for uploading data.

B. More information about metadata upload format requirements is available at: http://science.nature.nps.gov/nrdata/docs/metahelp/metainfo.cfm and in Metadata and Data Uploading Guidance (NR-GIS Data Store 2005g).

Step 8: Editing/Updating Metadata Already Posted to NPS Data Store

As of Version 1, the NPS Data Store application allows online editing of NPS Theme Category and ISO Theme Keyword information and the deletion of single metadata records and/or datasets only (see help documentation at: http://science.nature.nps.gov/nrdata/docs/metahelp/edithelp.cfm).

A. For metadata records simply needing edits to NPS Theme Category or ISO Theme Keyword elements, refer to Editing Category Information (NR-GIS Data Store 2005f).

B. If a metadata record posted to the NPS Data Store contains errors or requires edits to other elements, it will need to be deleted from the NPS Data Store, edited, and then reposted. Refer to Deleting Single Records (NR-GIS Data Store 2005e).

   i. The user should first download the metadata record (save in XML format) to the local system, then edit as needed in a text editor or metadata software program.

   ii. The edited metadata record can then be resubmitted to the NPS Data Store.

   iii. If the dataset documented by the metadata record requires no edits, it will not need to be reposted. Simply ascertain that the metadata file still specifies the correct pathway to the dataset on the NR-GIS Data Server before resubmitting the metadata file.

SOP #13: Metadata Guidelines (continued).

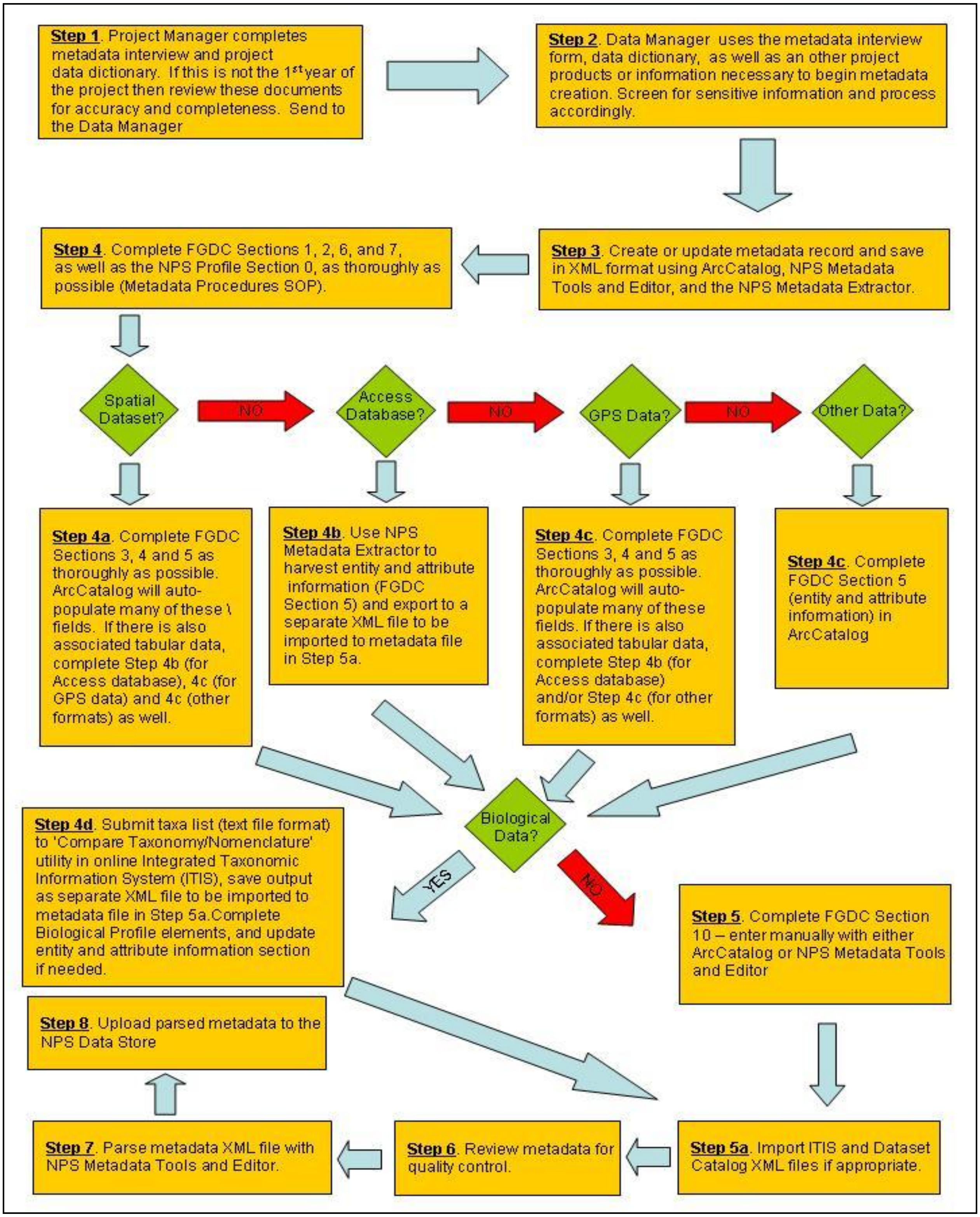

Figure 7. The general workflow for metadata creation for spatial and tabular data.

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Electronic Metadata Interview

[**Note: Please make your responses directly within this word document in "Red" type**.]

1. Have you already prepared metadata for this dataset?
   a. If yes, please send a copy of the document or reference to where it can be found and skip to item **18**.

2. What is the title of the dataset?

3. Who is the originator(s)/owner of the dataset? (Include address and telephone number)?
   a. If someone else should answer question about the data, please list the name, address, and telephone number.

   b. Are there other organizations or individuals who should get credit for support, funding, or data collection and analysis?

4. Does the dataset contain any sensitive information that should not be released to the public? NPS?
   a. Explain why the data should not be released to the public.

   b. Explain why the data should not be released to non-park NPS staff.

5. Is the dataset published or part of a larger publication?
   a. If so, what is the reference?

6. Include a brief (no more that a few sentences) description of the dataset.

7. Why were the data collected in the first place?

8. What is the time period represented by the dataset?

9. Were the data developed primarily through:
   a. Field visits?
   b. Remote instrumentation (e.g., temperature recorders, etc.)?
   c. Existing data sources?

10. What is the status of the data you are documenting? – *complete, in progress, planned*
    a. Will the dataset be updated? If so, how frequently?

11. Where were the data collected? Include description and coordinates, if known.

12. List some keywords to help search for this dataset.
    a. Thematic, Place, Temporal, Strata, Taxonomy

    b. If a controlled vocabulary was used, what is the reference?

13. List any related datasets that could be documented for cross-reference.

14. The FGDC Biological Profile includes the means to document tabular datasets, taxonomy, field methods, and the use of analytical tools or models.
    a. Was your dataset developed using a model or other analytical tool?

        i. If so, what is the reference?

        ii. If the model or tool is available, include a contact and/or URL.

    b. Does the dataset contain biological information? If no, skip to item **15**.
        i. What species or communities were examined?

        ii. Did you use a taxonomic authority or field guide for identification? If so, what is the reference?

        iii. Briefly summarize your field methods (cut and paste from other documents!).

        iv. If you used existing protocols or methods, list the references.

        v. If you use a different taxonomic hierarchy than what is available in ITIS, then you need to supply the taxonomic hierarchy for all species within the dataset.

15. Is your dataset archived in a databank or data catalog? If yes, please include a reference to the documentation and skip to item 16. If No:
    a. What measures did you take to make certain that your dataset was as nearly correct as possible?

    b. Were there any things that you excluded from your data collection (e.g., stems less than a certain diameter or streams without surface flow)?

    c. What is the form of your dataset? - *spreadsheet, ASCII file, GIS layer, database, other.*

    d. What is the filename for your dataset?

i. For each file or table, list the fields in the dataset and for each field list:

- The definition of the field.

- If the data are coded (Enumerated Domain), list the codes and the definitions.

  - If the codes come from a published code set (Codeset Domain), list the reference.

  - If the data are measured (Range Domain), list the units and the minimum and maximum allowable values (“no limit” is acceptable).

ii. Otherwise, the domain is unrepresentable. Include a brief description of what is in the field.

16. Is this a GIS dataset? If no, skip to item 17.
    a. Include a path to where the data can be accessed over the network or send a copy of the ArcInfo export file, an ArcView shapefile, or an ArcCatalog exported metadata file (txt or xml).
       i. Include projection parameters, if necessary.

    b. List any source datasets you used. For each source, list:
       i. Source name, originator, and publication date.

       ii. Source time period and scale.

       iii. Source presentation form and media type.

       iv. Contribution of source to your analysis.

    c. List the processing steps you used to create your dataset, including the approximate date of processing.

17. Is the dataset available for distribution? If no, go to 18.
    a. Are there legal restrictions on who may use the data?

    b. Do you have any advice for potential users of the dataset?

c. What are your distribution instructions?

18. You are done. Send this completed document with the relevant responses to this interview to your metadata coordinator (Sean Mohren, Klamath Network Data Manager Sean_Mohren@nps.gov, 541-552-8576).

SOP #13: Metadata Guidelines (continued).

Example Data Dictionary

Dataset: ASXXYY
File Type: mdb
Relationship: Area Search Header (one) to Area Search Data (many)
Table: Area Search Header

Field Name	Field	Required (Y/N)	Type	Length	Decimal	Definition	Enumerated Domain	Range Domain
RecNum	1	Y	Numeric	Integer	0	Auto Number based on order of entry; Key Field		Integer starting at 1, no limit
Project	2	Y	Character	20		Project or Region Code		
Site	3	Y	Character	20		Site name (often 4-letter code)	Each 4-letter code represents itself	
Point	4	Y	Character	2		Point (Search area)	Typically designated A or B	
Month	5	Y	Character	2		Month		01 to 12
Day	6	Y	Character	2		Day		01 to 31
Year	7	Y	Character	4		Year		
PrimObs	8	Y	Character	4		Primary observer's initials		
SecObs	9	N	Character	20		Secondary observer's initials, if multiple observers, initials separated by ―,‖		
Temp	10	Y	Character	3		Temperature		Degrees Celsius, range=-10 to 40
CldCvr	11	Y	Character	3		Cloud Cover		Percentage, range=0 to 100%

Definitions and Acronyms

ArcCatalog Module in ESRI’s ArcGIS software within which metadata for spatial datasets (coverages, shapefiles) can be created.

Biological Data Profile Set of definitions for the documentation of biological data through the creation of extended elements to the FGDC Content Standard for Digital Geospatial Metadata (CSDGM).

CSDGM Content Standard for Digital Geospatial Metadata. The FGDC-promulgated metadata standard established to provide a common set of terminology and definitions for documenting digital geospatial data.

Dataset Catalog NPS Inventory and Monitoring Program tool for metadata creation, ideal for abbreviated dataset documentation but not for fully FGDC-compliant metadata creation.

ESRI® Environmental Systems Research Institute. A GIS software company.

FGDC Federal Geographic Data Committee. The interagency committee that promotes the coordinated development, use, sharing, and dissemination of geographic data.

GIS Geographic Information System. A computer system for capturing, manipulating, analyzing, and displaying data related to positions on the Earth's surface.

ISO International Organization for Standardization. A network of national standards institutes of 150 countries, responsible for the ―ISO 19115” international metadata standard.

Metadata Data about the content, quality, condition, and other characteristics of a dataset, documented in a standardized format.

MP Metadata Parser. A command-line program developed by the USGS to locate syntax errors in metadata files, verify FGDC-compliance, and convert between file formats.

NBII National Biological Information Infrastructure. Collaborative program instrumental in developing the Biological Data Profile of the FGDC’s CSDGM.

SOP #13: Metadata Guidelines (continued).

NPS Profile	The NPS Natural Resource and GIS Metadata Profile extends the FGDC CSDGM to incorporate NPS-specific elements such as park and project details. The NPS Profile includes the Biological Data Profile and the ESRI Profile.
NPS Data Store	The NPS Natural Resource, GIS, and I&M Programs' web-based system (incorporating a database, data server, and secure web interface) to integrate data dissemination and metadata maintenance for Natural Resource, GIS, and other program data sets, digital documents, and digital photos.
SGML	Standard Generalized Markup Language. An ISO standard flexible markup language (predecessor to XML) used in many applications, including electronic publishing on the Web.
XML	Extensible Markup Language. A simple and flexible text format (a profile, or subset, of SGML) that facilitates large-scale electronic publishing and exchange of data on the Web.

Standard Operating Procedure (SOP) #14: Collecting and Identifying Unknown Plants

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

Collection and Identification of Unknown Plants

To improve the quality of vegetation profile data, a formal procedure is followed to identify as many of the unknown plant species that are tallied as possible. While on the plot, the crew should not spend an inordinate amount of time trying to identify an unknown plant. If the plant can be keyed out quickly using a plant guide and species list, identification should be attempted. If the crew is confident the plot can be completed in 1 day, they can spend more time trying to identify unknown plants while on the plot. In most cases, it will be more effective to collect unknown plants for later identification. After the initial visit to a site, a plant lists for each site will be provided to the crew. This list will be on the tablet computer and can be useful in identifying unknown plants.

If the plant cannot be identified to family or genus, it qualifies for tally as a generic life form record (shrub, forb, fern, grass, or graminoid) on the datasheet and in the database. Record the plant accordingly (e.g., *Carex* sp1; if more than one unknown *Carex* is collected, then name the second unknown *Carex* sp2 and so on. If the species cannot be identified to family or genus, then use the generic life form name [e.g., forb1, etc.].). The numbering process should be restarted at each site.

When making a collection, gather as much of the complete plant as possible. Make sure to collect roots, flowers, and seed-heads. Collect the plant off-plot if possible. Never collect a plant from a local population of <20 individuals. If the population is <20 individuals, collect several photograph vouchers rather than a vegetative specimen. Place the sample in a plastic bag and label the specimen with the same name as recorded on the datasheet, plot number, and module. If you have a hunch what family or genus it belongs to and time permits, look in a field guide to see what characters are important to identify members of that group; record any observations related to those important features.

Once back at the camp or the office, try to identify the collected specimens the same day that the plot was visited. Use whatever plant guides are available. Other field crew members who might be familiar with the species and/or are good at plant identification should be consulted. Twenty minutes is the recommended maximum amount of time that should be spent on one plant. If the specimen cannot be identified, contact the Crew Leader. If the same plant is collected several times and identification attempts are unsuccessful, the Crew Leader should consult park personnel to see if they are familiar with the species.

If no attempt can be made to key out a plant the same day it is collected, or if it cannot be identified, the specimen should be placed in a plant press (one is in each vehicle), and labeled with the same name as recorded on the datasheet, plot number, and module. Do not leave the specimen in a plastic bag for more than a day; specimens left bagged may mildew and mold. If a plant is successfully identified, the vegetation profile data for that plot should be updated accordingly (see updating the datasheet/database below). When a datasheet is updated to a proper species name, the person that updates the datasheet shall initial and date their change.

Voucher Specimens

Voucher specimens will be needed for new species collected at a park. Also (at the request of some park personnel), these species will need to be sent to an expert for an official determination before being added to the park's species list. Voucher specimens can be left in the plant press until ready to be mounted or sent to an expert. Preservation of specimens will be enhanced if you freeze them for a few days before mounting them. After the voucher is properly mounted and labeled, it will be sent to parks that have herbaria to house vouchers or another park's herbarium, or will be kept in a network herbarium case, depending on the preferences of the affected parks.

Mounting specimens is a simple yet time-consuming task, requiring considerable space. You will need:

- Space (several large tables, such as in SOU Science Room 214, if available)
- Mounting paper
- Mounting tape (preferred over gluing the specimens)
- Specimens
- Glue
- Properly filled out labels (Table 1)

Table 1. Example of a properly filled out label.

Date: 7/18/06	**Collector:** Sean B. Smith	**Collection#:**
Binomial: *Amaranthus albus*	**Authority:** L.	
Family: Amaranthaceae	**Common Name:** Tumbleweed	
Distinctive Features: Infl clusters axillary		
Habitat: Waste areas/ roadsides		
Location Description: LABE North Park W of Captain Jacks Stronghold		
Numeric Location/UTMs: T46N R4E sec15/ 4631300N 624300E		
Slope: 0	**Aspect:** 0	**Elev.:** 4050ft
Comments:		
Determined by: Sean B. Smith		

SOP #14: Collecting and Identifying Unknown Plants (continued).

Mount the label in the lower right corner of the mounting sheet. Carefully brush or clean soil from roots. Lay the dried specimen out on the mounting paper to visualize how to fit it onto the sheet; do not cover the label. Make sure that both sides of leaves and flowers and fruits are visible. Two herbarium sheets may be needed for larger specimens. Arrange the specimen and then cut several strips of mounting tape to appropriate sizes and arrange then, before wetting. Once all pieces of tape have been arranged, begin wetting the gummed side and gluing the specimen down. Often, weights are needed to hold the specimen flush with the mounting paper. Allow the mounted specimens to dry overnight before stacking them. Additional instructions and details for dealing with plant parts like cones are available in the document Preparing Herbarium Specimens of Vascular Plants, U.S. Department of Agriculture Information Bulletin 248, kept with at the Network office and available online (http://www.brit.org/fileadmin/Herbarium/pdfs/PreparingHerbspecimens_AIB348.pdf), or from the University of Melbourne, Department of Botany: http://www.docstoc.com/docs/29309814/Make-your-own-Herbarium-Specimens.

Species collections that are new to the park's plant list will need to be sent to the park and accessioned into the park herbarium if there is one. After the voucher is properly mounted and labeled it will be sent to parks that have herbaria or to another park's herbarium, or will be kept in a Network herbarium case, depending on the preferences of the affected parks.

Updating the Datasheet and Database

Datasheet

Once a plant has been identified, the datasheet and database records will need to be updated. On the datasheet, find the record for that species (e.g., Unknown 1, *Carex* Unknown 1, etc.). Place a single red line through the name and write the actual name of the species on the datasheet using a red pencil or pen.

Database

To correct the record in the database, first open the database. The database is located on the tablet computer if you are still in the field or on the Klamath Network server in the vegetation project folder (vegetation monitoring/vegetation data/seasonal data/yyyy) if you have returned from the field. Click the –enter/edit” command button. On the next form, make sure your name is selected and click –OK.” Find the record that matches the site and date where the unknown species was collected and double click on the date. Click on the species tab and find the unknown species. Change the name from –unknown” to the correct name. Close out of the database. If the species is identified after the data has been verified and validated, you will need to submit changes to the Data Manager so the master database can be updated as well.

Standard Operating Procedure (SOP) #15: Post Field Season

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains procedures that will be completed after the field season, which include handling equipment, completing data management tasks, communicating with NPS personnel, and reporting. Field crew members will assist the Project Lead in completing post season field tasks.

Inventory, Clean, and Store Field Equipment

1. All equipment should be checked-in following the Klamath Network property guidelines maintained by the Program Assistant. Electronic equipment (GPS units, rangefinders, laptop computers, tablet computers, etc.) should be checked-in with the Data Manager.
2. Record broken or missing equipment on the Network's equipment inventory sheet. Label the equipment with sufficient information so that someone else will understand the specific problem.
3. Report missing or faulty equipment and/or equipment needing repairs to the Project Lead, so that equipment can be repaired or replaced before the following field season. It is the Project Lead's responsibility to account for all equipment and have it repaired or replaced at the end of the field season. Keep in mind other projects may be relying on the availability of this equipment, so it should be repaired or replaced as soon as the problem is identified.
4. All equipment should be cleaned, in working order, and stored in the proper storage location. Equipment should be prepared for winter storage, which will include removing batteries, emptying fluids, and winterizing when applicable. Project data should be removed before turning in the equipment.

Vehicles

Vehicles should be full of fuel and the inside and outside thoroughly cleaned. Mileage reports and vehicle maintenance forms should be submitted to the Program Assistant. Any damage, needed repairs, or required maintenance should be reported at the time the vehicle is checked-in to the Network. Before signing off on the vehicle, one of the core Network staff should inspect the vehicle.

Interviews

Prior to ending the field technician's seasonal employment, the Project Lead (or Network Contact if Project Lead is not available) should meet with the seasonal employees to discuss the field season. The following should be discussed:

SOP #15: Post Field Season (continued).

- Determine how the field season went overall.
- Review what was accomplished and what did not get completed.
- Discuss options to improve upon any aspect of the protocol.
- Determine whether the field crew has any concerns that should be addressed prior to the next field season.
- Discuss field equipment (e.g., repairs needed, software updates, additional equipment, etc.).
- Review the training schedule and see if there are any areas for improvement or if there is additional training the field crew needs.
- Review of crew safety practices/procedures.

This information should be summarized and included in the briefing report. In addition to the field crews, the Project Lead should contact the Park Contact to accomplish the following:

- Discuss the field season and determine if the park staff had any concerns or areas for improvement.
- Ensure that all park keys have been returned.
- If park housing was used, make certain it was left in proper order.
- Examine ways to improve Project Lead, Park Contact, and field crew relationships (e.g., improved communication, periodic meeting, etc.).

It is the Network Contact's responsibility to follow the check-out procedures developed by Redwood National Park when ending the employment of seasonal employees. At the end of the field season, 2 weeks prior to the end of the seasonal employee's employment, the Project Lead should inform the Network Contact about an end date for each employee. The Network Contact should then work with Redwood National Park staff to complete the final paperwork.

Raw Data and Deliverables
There are a variety of deliverables associated with this project that should be stored in their proper location by the end of the field season. See SOP #11: Data Transfer, Storage, and Archive for a list of deliverables, where they should be stored, and who is responsible completing this task.

Finalize Data Collection
1. Before field crews are released from active duty, make sure that all unknown plants are identified and the identification entered into the database.
2. Make sure that any remaining plant vouchers have been processed before the crew departs.
3. Make sure that all other outstanding missing data issues are resolved before the crew retires for the season.
4. Be certain any data not previously entered into the database had been entered.
5. Check to ensure training, event, and equipment log books are complete.
6. Do a quick follow up with the Data Manager to ensure he/she has everything he/she needs prior to crews being released.

SOP #15: Post Field Season (continued).

Back in the Office

Once the field crew returns, have them turn in the tablet computer and their backup flash drives immediately. This should be kept in a secure location until the data have been downloaded to the Klamath Network server. Once you have all the field crew’s data, complete the following steps.

1. Place a copy of the final database (the one on the tablet PC) in the following location: G:\Monitoring\Vegetation_ Monitoring\Vegetation_Data\Seasonal_Data\Park\2010. Where ―park” is the 4 letter code for the park where the work was completed and the year is the year the field work was conducted. Add the Crew Lead’s initials to the database if data using two crews at the same park was collected.
2. Place a copy of the final images (the one on the camera) in the following location: G:\Monitoring\Vegetation_ Monitoring\Vegetation_Images\Seasonal_Data\Park\2010. Where ―park” is the 4 letter code for the park where the work was completed and the year is the year the field work was conducted.
3. Place a copy of the unprocessed GIS layers (the one on the Garmin and Trimble units) in the following location: G:\Monitoring\Vegetation_Monitoring\ Vegetation_GIS\Seasonal_ Data\Park\2010. Where ―park” is the 4 letter code for the park where the work was completed and the year is the year the field work was conducted. Work with the GIS Specialist to post-process the GIS layers and place the final layers in this location and in the monitoring GIS geodatabase.
4. The Project Lead should implement the verification and validation processes associated with this project and then submit the finalized certification form to the Data Manager.
5. The Data Manager should run the built-in QA/QC process to make sure the data are accurate. Then, inform the Project Lead that you are loading the data into the Master Database. If there are still problems with the data, work with the Project Lead to resolve any issues and then repeat steps 3-6.
6. You are finished. You should now have this year’s validated and verified data loaded into the master database. You should also have the annual data stored in the proper location.

Event Log Book

Consistency in implementing this protocol is crucial to ensure the integrity of a long-term dataset that can be used to develop reports. It is important that project staff understand all situations that have occurred throughout the life of this project that may have an effect on the consistency of the data collection methods. In an effort to track these situations, it is the Project Lead’s responsibility to complete the event log and submit it to the Data Manager following the timeline in SOP #11: Data Transfer, Storage, and Archive. Some examples of events that have already been observed during the implementation of other KLMN protocols include: 1) A park not being surveyed because of a change in the study design, 2) Several sites being dropped because of the decommission of a trail, 3) A change in the categories used to classify vegetation types, and 4) dropping of a site because it was not safe access. One event log book can be used throughout the life of this project. If no significant events occur, the Project Lead should enter their name, position, date, and in the event column, add ―No Events.”

SOP #15: Post Field Season (continued).

Event Log

Name	Position	Date	Event	Reason
Example Joe	Crew Leader	12/15/2006	Stopped measuring tree DBH	Requested by the Project Manager

Name – The full name of the person reporting the event (e.g., Sean Mohren).
Position – Position of the person reporting the event (e.g., Field Crew).
Date – Data the event occurred (e.g., 5/15/2007).
Event – Explain what is the event (Canopy method change, new employee).
Reason – Explain why the event occurred (e.g., Old method was found inferior).

Standard Operating Procedure (SOP) #16: Revising the Protocol

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

Introduction

This document explains how to make and track changes to the Klamath Network's Vegetation Monitoring Protocol, including its accompanying SOPs. While this monitoring protocol has been developed using current standardized methodology, all long-term monitoring programs need to be flexible to adapt to changes. As new technologies, methods, and equipment become available, this protocol will be updated as appropriate. As described in Table 9 of the protocol narrative on roles and responsibilities, the revision of the protocol will be the responsibility of the Network Coordinator, who will consider input from the other team members, particularly the Project Lead, as well as statisticians. All changes will be made in a timely manner with the appropriate level of review.

All edits require review for clarity and technical soundness. Small changes to existing documents (e.g., formatting, simple clarification of existing content, small changes in the task schedule or project budget, or general updates to information management handling SOPs) may be reviewed in-house by project cooperators and KLMN staff. However, major changes to data collection, analysis techniques, sampling design, or response design will trigger an outside review. The Project Lead should coordinate with the KLMN Contact to determine if outside review is needed.

Revision Procedures

The following procedures will ensure that both minor and major revisions to this document will align with the monitoring plan.

1. The Network Coordinator will discuss proposed changes with other project staff prior to making modifications. It is imperative to consult with the Data Manager prior to making changes because certain types of changes may jeopardize dataset integrity unless they are planned and executed to avoid this. Also, because certain changes may require altering the database structure or functionality, advance notice of changes is important to minimize disruptions to project operations.
2. Make the agreed-upon changes in the appropriate protocol document. Note that the protocol is split into separate documents for each appendix and SOP. Also note that a change in one

document may necessitate other changes elsewhere in the protocol. For example, a change in the narrative may require changes to several SOPs; similarly, renumbering an SOP may mean changing document references in several other documents.

3. Document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes only in the document being edited (i.e., if there is a change to an SOP, log those changes only in that document). Record the date of the changes (i.e., the date on which all changes were finalized), author of the revision, the change and the paragraph(s) and page(s) where changes are made, and briefly the reason for making the changes, and the new version number. Version numbers increase incrementally by hundredths (e.g., version 1.01, 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0). Record the previous version number, date of revision, and author of revision; identify paragraphs and pages where changes are made, rationale for revisions, and the new version number.
4. Circulate the changed document for internal review among project staff and cooperators. Minor changes and clarifications will be reviewed in-house. When significant changes in methodology are suggested, revisions will first undergo internal review by the project staff. Additional external review including, but not limited to, National Park Service staff with appropriate expertise, will be required.
5. Upon ratification and finalizing changes:
   a. Ensure that the version date (last saved date field code in the document header) and file name (field code in the document footer) are updated properly throughout the document.
   b. Make a copy of each changed file to the protocol archive folder (i.e., a subfolder under the Protocol folder in the project workspace).
   c. The copied files should be renamed by appending the revision date in YYYYMMDD format. In this manner, the revision date becomes the version number and this copy becomes the ―versioned" copy to be archived and distributed.
   d. The current, primary version of the document (i.e., not the versioned document just copied and renamed) does not have a date stamp associated with it.
   e. To avoid unplanned edits to the document, reset the document to read-only by right-clicking on the document in Windows Explorer and checking the appropriate box in the Properties popup.
   f. Inform the Data Manager so the new version number(s) can be incorporated into the project metadata.
6. As appropriate, create PDF files of the versioned documents to post to the Internet and share with others. These PDF files should have the same name and be made from the versioned copy of the file.
7. Send a digital copy of the revised monitoring plan to the Network Contact and Network Data Manager. The revised protocol will be forwarded to all individuals who had been using a previous version of the affected document. Ensure that surveyors in the field have a hardcopy of the new version.
8. The Network Data Manager will place a copy of the revised protocol in the proper folder on the Klamath Network shared drive. In addition, the Network Data Manager will archive the previous version in the Klamath Network archive drive.
9. The Network Data Manager will post the revised version and update the associated records in the proper I&M databases, including but not limited to NatureBib, NPS Data Store, KLMN Intranet and Internet web sites, and the Protocol database.

Standard Operating Procedure (SOP) #17: Sensitive Data

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP includes instructions for handling sensitive data. This document was adapted from the National Park Service North Coast and Cascades Network Landbird Protocol (Boetsch et al. 2005).

Introduction

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 can be found in the NPS Management Policies (National Park Service 2006), and in Director’s Order #66. These guidelines apply to all KLMN staff, cooperators, contractors, and other partners who are likely to obtain or have access to information about protected NPS resources. The NPS Contact 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:

1. *Protected resources*, in the context of the KLMN 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.
2. *Sensitive information* is defined as information about protected resources which 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.
3. In general, if information is withheld from one non-NPS 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.

SOP #17: Sensitive Data (continued).

4. 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:
   a. Random coordinate offsets of up to 2 km for data collection locations, and
   b. Removal of data fields from the released copy that is likely to contain sensitive information.

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.

1. *Exact coordinates* – Instead, public coordinates are to be generated that consist of rare and sensitive species locations being documented with the centroid coordinate of the park.
2. *Other descriptive location data* – Examples may include travel descriptions, location descriptions, or other fields that contain information which may reveal the specific location of the protected resource(s).
3. *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 web site 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, dataset, 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 (i.e., in the case of a small park).

Details for Specific Products

Whenever products such as databases and reports are being generated, handled, and stored, they should be created explicitly for one of the following purposes:

1. *Public or general use* – Intended for general distribution, sharing with cooperators, or posting to public web sites. 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.

When submitting products to the Network Data Manager, a Certification Form is required. If the submitted product was not meant for public use, it should be clearly noted on question 8 of the Certification Form (SOP #11: Data Transfer, Storage, and Archive) and / or question 4 of the Metadata Interview Form (SOP #13: Metadata Guidelines).

Datasets

To create a copy of a dataset that will be posted or shared outside NPS:

1. Make sure the public offset coordinates have been populated for each site with rare or endangered species documented in tbl_Locations.
2. Delete the following database objects to ensure consistent omission of fields that may contain specific, identifying information about locations of protected resources:
    a. tbl_Locations.Travel_Directions
    b. tbl_Locations.Loc_Notes
    c. tbl_Event_Details.Event_Notes
    d. tbl_Locations.(x_coord, y_coord [1-5])
    e. tbl_Locations.Section
    f. tbl_Locations.Parking_Easting, Parking_Northing

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 (for sensitive species) 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 Network 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.

SOP #17: Sensitive Data (continued).

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 including 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.

Sharing Sensitive Information

No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the NPS Data Store or another publicly-accessible web site, 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 web sites 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 dataset that includes sensitive information) may <u>only</u> 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.

Once a confidentiality agreement is in place, products containing sensitive information may be shared following these guidelines:

1. Prior to distribution, talk to the Project Manager and Park Resource Specialist to make sure they know the data are being distributed.
2. Always clearly indicate in accompanying correspondence that the products contain sensitive information and specify which products contain sensitive information.
3. 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.
4. Indicate that NPS retains all distribution rights; copies of the data should not be redistributed by anyone but NPS.
5. 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.
6. 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.

SOP #17: Sensitive Data (continued).

Confidentiality Agreements

Confidentiality agreements may be created between the 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 web sites, 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.

If mailing or directly providing data that contains sensitive information follow the procedures described above. In addition, have the individual sign a confidentiality agreement which is provided on the KLMN server at: G:\Data_Management\Standard Operating Procedures\Klamath_Network_SOP_and_Guidelines\Sensitive Information.

Freedom of Information (FOIA) Requests

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

Literature Cited

Boetsch, J. R., B. Christoe, and R. E. Holmes. 2005. Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program. National Park Service. Port Angeles, WA. Online. (http://www1.nature.nps.gov/im/units/nccn/datamgmt.cfm).Accessed 6 February 2007.

National Park Service. 2006. Management policies. Online. (http://www.nps.gov/policy/mp/policies.htm). Accessed 6 February 2007.

Director's Order Number 66. Freedom of Information Act and the protection of exempted information. National Park Service.

Appendix A: Annual Report-Fiscal Year 2008: Monitoring Vegetation Composition, Structure, and Function in Crater Lake National Park: Results from a Pilot Study

Sean B. Smith

Abstract
This report describes the results of a pilot vegetation study undertaken in Crater Lake in 2008 to test the Klamath Network's Vegetation Monitoring Protocol. The pilot study found that the protocol could be implemented with an average rate of one plot sampled per day over the field season. Some minor changes to the protocol have been made as a result of testing the procedures during the pilot study. Data from the 17 plots that were sampled are summarized in a format that provides a template for future annual vegetation monitoring reports.

Introduction
In 2008 the Klamath Network tested its draft vegetation monitoring protocol at Crater Lake in a pilot study. The main objectives of the pilot study were to evaluate time and feasibility of the proposed sampling. Results are described here in the format the Network proposes to use in the future for annual reporting of the vegetation monitoring. Annual reports are intended for park staff and partners and will summarize the work completed in a given field season and the status of vegetation composition, structure and function based on the data collected.

Methods

Site Selection
As described in the vegetation protocol, the sampling frame that will be used in monitoring excludes areas with slopes greater than 30 degrees, and less than 100 m from a road or trail or farther than 1 km from a road or trail. There are three sampling domains: 1) Elevations above 2057 m (6750') (Alpine), 2) Areas within 20 m horizontally of a perennial stream (Riparian), 3) Remaining areas (Matrix) (Figure 1**).** We randomly selected 8 riparian, 15 matrix, and 12 alpine sites in a spatially balanced arrangement for sampling (Figure 1).

Appendix A: Annual Report - Fiscal Year 2008 (continued).

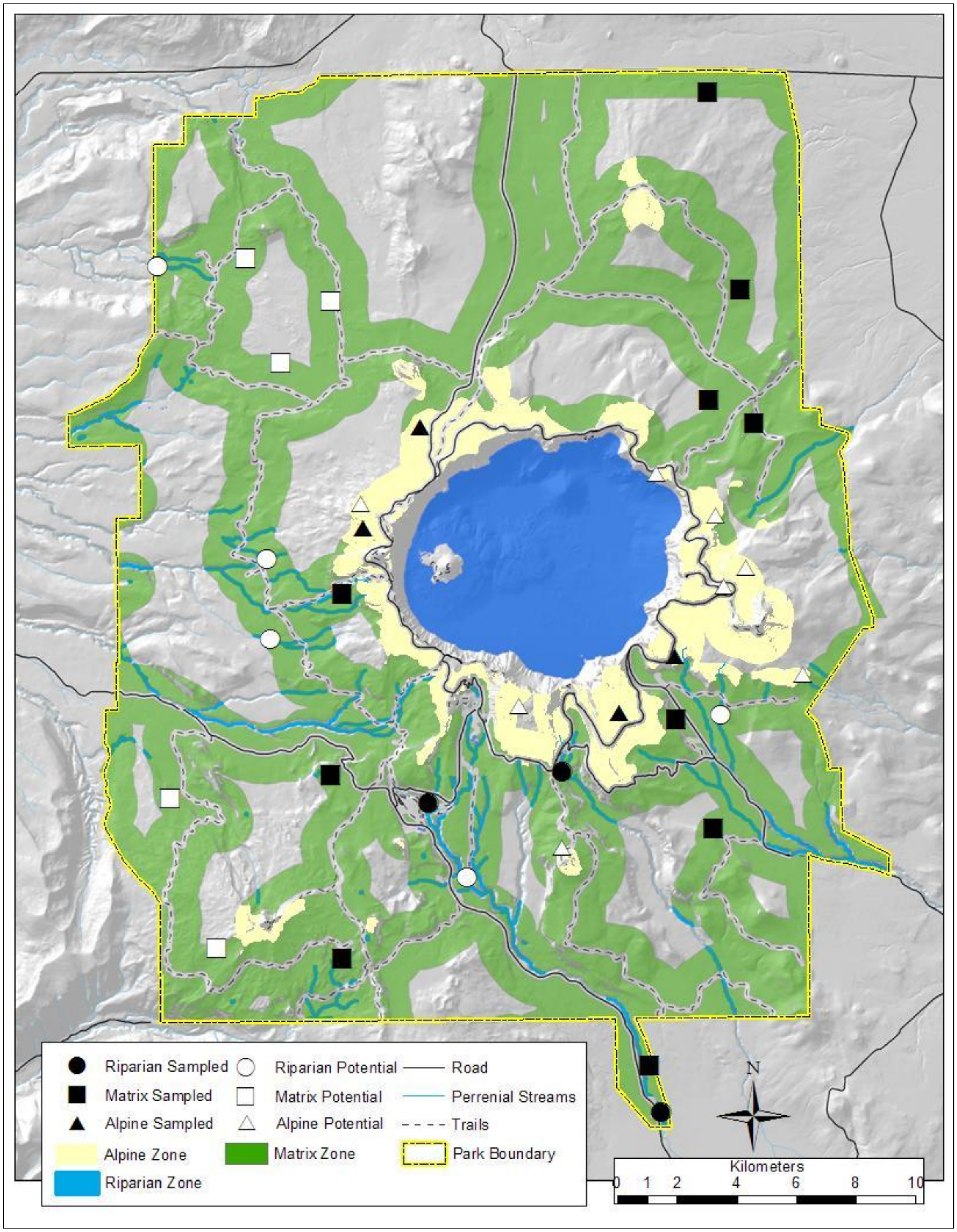

Figure 1. Sampling domains and potential sites for sampling during the vegetation Pilot Study at Crater Lake.

Field Sampling

In 2008, 17 of the 35 sites (4 alpine, 10 matrix, and 3 riparian) were sampled (Figure 1). A 20 x 50 m plot was used for matrix and alpine sites (Figure 2); a 10 x100 m plot was used for riparian sites (Figure 3). The elongated riparian plots were used to avoid going too far into the upland habitat type. Each plot consisted of ten 10 x 10 m modules, four of which were sampled intensively for cover, and seedling and sapling data.

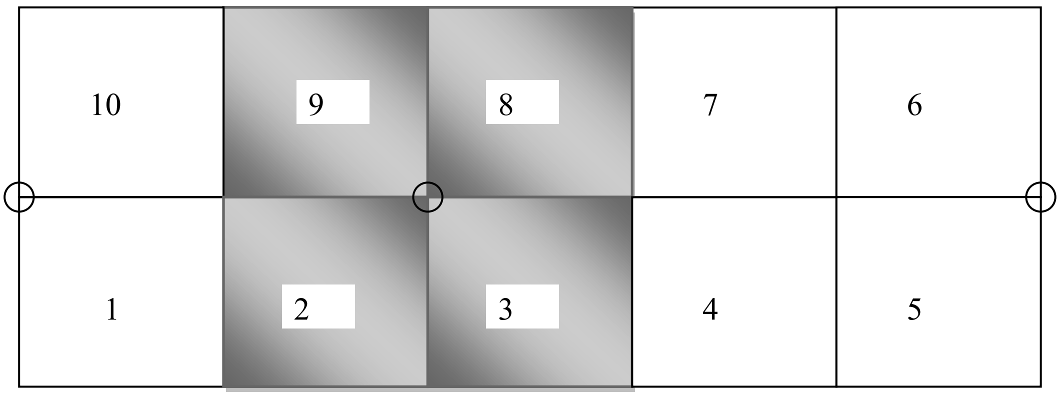

Figure 2. The 20 x 50 m matrix and alpine site layout. Each numbered square is 10 x 10 m. Shaded squares are the 4 intensive modules.

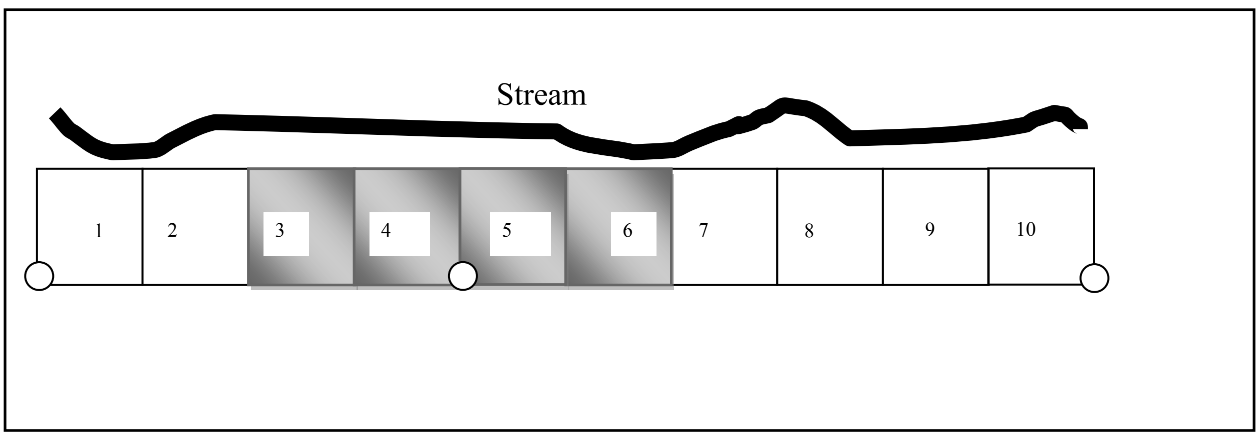

Figure 3. Ten x 100 m riparian site layout. Each numbered square is 10 x10m. Shaded squares are the 4 intensive modules.

Standard operating procedures 6-9 of the vegetation protocol (Odion et al. 2009), provide details on the collection in each plot of measurements of the following parameters:

1. Slope
2. Aspect
3. Elevation
4. Microtopography
5. Macrotopography
6. Vascular plant cover by species (three height strata)
7. Ground cover
8. Tree seedlings
9. Tree saplings by size class

10. Small trees by size class
11. Live trees (dbh, canopy position and condition)
12. Dead trees (dbh, decay class)
13. Fine wood (<7.6 cm diameter)
14. Coarse wood (>7.6 cm in diameter, size and decay class)
15. Litter and Duff: (depth/thickness)

Data Management, Analysis and Presentation

All data management followed the procedures outlined in Standard Operating Procedure 12 of the Vegetation Monitoring Protocol. General data summaries were conducted to provide measures of central tendency (mean, median) and variance (range, standard deviation) for each parameter. Select data are presented in tabular form, and where suitable, user-friendly graphical format to aid in the visualization of data distribution or geographic variation across the sampling frame. A procedure for producing bubble maps was created for use in the future. Depending on data collected in future monitoring, annual reports may show different parameters, but will use the same type of tables and illustrations.

Results

Here we summarize selected data most relevant to our pilot study and monitoring objectives. Appendix 1 provides a more comprehensive summary of the environmental data collected at each site.

Time to Complete Sampling

Travel time to and from sites ranged from 15min to 2hrs, depending upon the distance from a suitable parking area and the terrain encountered. The time required to complete the plot measurements was also highly variable and depended on vegetation density and within-site diversity. Table 1 shows time variation for completing plot parameters, while Figure 4 summarizes the completion time data. The mean completion time was 4.6 hours (range 1.5-8.5 hours). These data indicate that, notwithstanding a few plots that took extra long to get to and sample, a rate of at least one plot per scheduled field day appears feasible in Crater Lake over the course of a field season. With good logistical planning it may be possible to complete more than one plot per day, particularly in the alpine sampling frame.

Table 1. Time to complete plot measurements and the order they were completed.

Sampling parameter	Time to complete measurements
Plot Setup, photographs, measure environmental variables	30 min- 2 hours
Subplot Sampling (cover values, small tree, saplings and seedlings)	10 min-1 hour 45 min x4 (numbers are for one of 4 intensive modules)
Overstory Sampling (tree measures)	0-2 hours 30 min
Dead and down wood and litter	0-1 hour
Canopy cover and searching for new species in the 0.1ha site	0-45 min

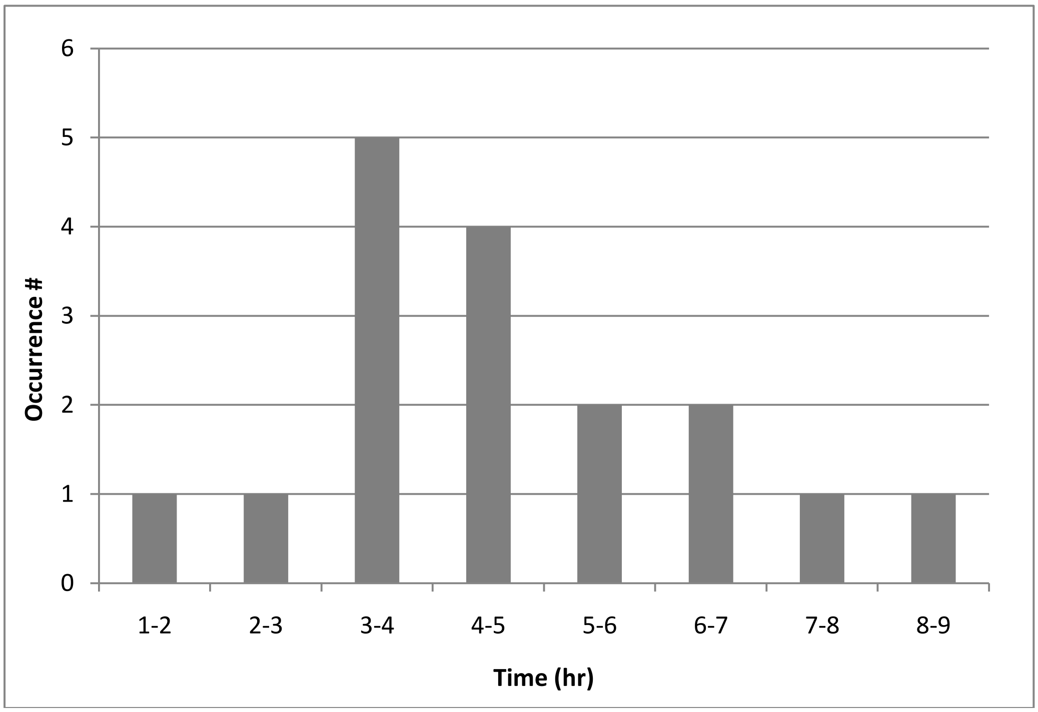

Figure 4. Histogram of the time required to complete plots during the pilot study.

Vegetation Composition

The most frequently occurring understory species by sampling frame are shown in Table 2. Four less common species were encountered that were not found in NPSpecies and were added (*Aster campestris, Ericameria greenii, Eriogonum pyrolofolium, and Salix geyeriana*). However, these were listed in Zika's 2003 Crater Lake flora. Overstory species and their relative basal areas are shown in Figure 5.

Appendix A: Annual Report - Fiscal Year 2008 (continued).

Table 2. Understory species listed which occur in at least 2 matrix, and 3 alpine and riparian sites. Actual annual reports will contain a complete list of species encountered as an appendix.

Herbs	Alpine	Matrix	Riparian
Aconitum columbianum			x
Allotropa virgata		x	
Angelica genuflexa			x
Arabis platysperma	x		
Arenaria pumicola	x		
Chimaphila menziesii		x	
Chimaphila umbellata		x	
Cistanthe umbellata	x		
Equisetum arvense			x
Eriogonum pyrolifolium	x		
Hieracium albiflorum		x	
Kelloggia galioides		x	
Lupinus andersonii	x	x	
Lupinus polyphyllus			x
Polygonum newberryi	x		
Pyrola picta		x	
Pyrola secunda		x	x

Herbs	Alpine	Matrix	Riparian
Senecio triangularis			x
Graminoides	Alpine	Matrix	Riparian
Achnatherum occidentale	x	x	
Calamagrostis canadensis			x
Carex inops ssp. inops		x	
Carex rossii		x	
Elymus elymoides	x	x	
Juncus parryi		x	
Luzula hitchcockii		x	
Poa wheeleri			x
Shrubs	Alpine	Matrix	Riparian
Eriogonum umbellatum	x		
Arctostaphylos nevadensis	x		
Arctostaphylos patula		x	
Ribes lacustre		x	
Salix scouleriana		x	
Vaccinium scoparium		x	

Appendix A: Annual Report - Fiscal Year 2008 (continued).

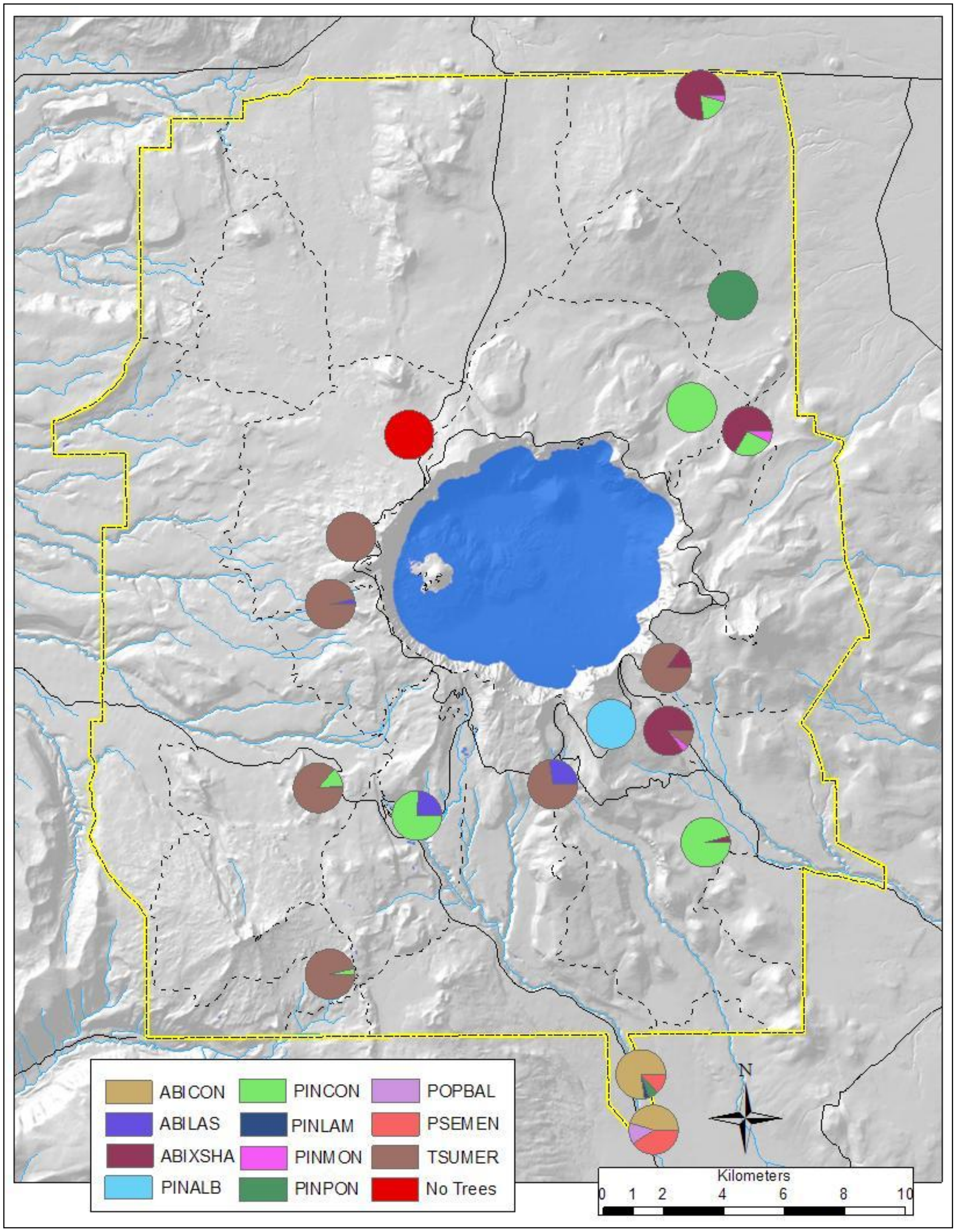

Figure 5. Individual tree species composition of the total basal area for each site. **NOTE**: the total basal area of each plot is not represented in this figure; refer to figure 8 for total basal area data. ABICON= *Abies concolor*; ABILAS= *A. lasiocarpa*; ABIXSHA= *A.* X *shastensis*; PINALB= *Pinus albicaulis*; PINCON= *P. contorta*; PINLAM= *P. lambertiana*; PINMON= *P. monticola*; PINPON= *P. ponderosa*; POPBAL= *Populus balsamifera*; PSEMEN= *Pseudotsuga menziesii*; TSUMER *Tsuga mertensiana.*

Mountain hemlock (*Tsuga mertensiana*) was the most dominant tree, followed by lodgepole pine (*Pinus contorta*). Other species were not widespread, but were locally dominant, such as white fir (*Abies concolor*) and whitebark pine (*P. albicaulis*), and Douglas-fir (*Pseudotsuga menzesii*). The riparian, alpine and matrix sampling frames had mean species richness of 62, 16 and 13 species per plot, respectively. Spatial patterns of richness are shown in Figure 6. Only one site contained a nonnative species, dandelion (*Taraxacum officinale*).

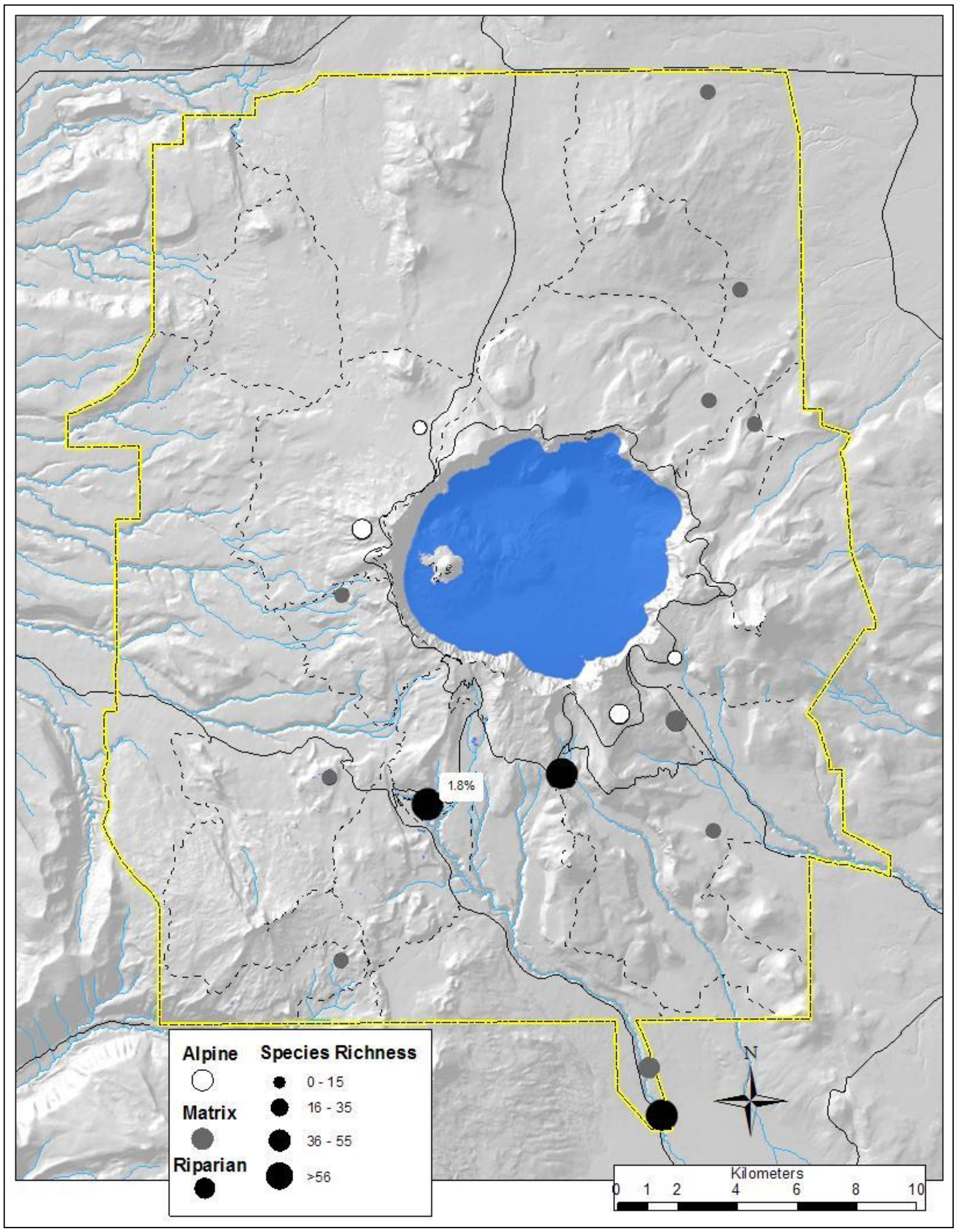

Figure 6. Site species richness from each sampling frame displayed by bubble size. Label shows percentage of species that are nonnative. Sites without a label do not have any nonnative species.

Vegetation Structure

Percent cover by stratum varied across the park (Fig. 7). Riparian sites had the highest cover for the 0-.5 m and >0.5-4.99 m strata, 56% and 47% respectively, but the lowest cover for the >5m stratum, 14%. Alpine sites had the lowest percent cover for the 0-.5 m and >0.5-4.99 m strata, 12% and 1%, respectively. Matrix sites had the highest cover for >5m stratum, 23%. Average total cover ranged from lowest in alpine (28%), to intermediate in matrix (55%), and highest in the riparian stratum (118%).

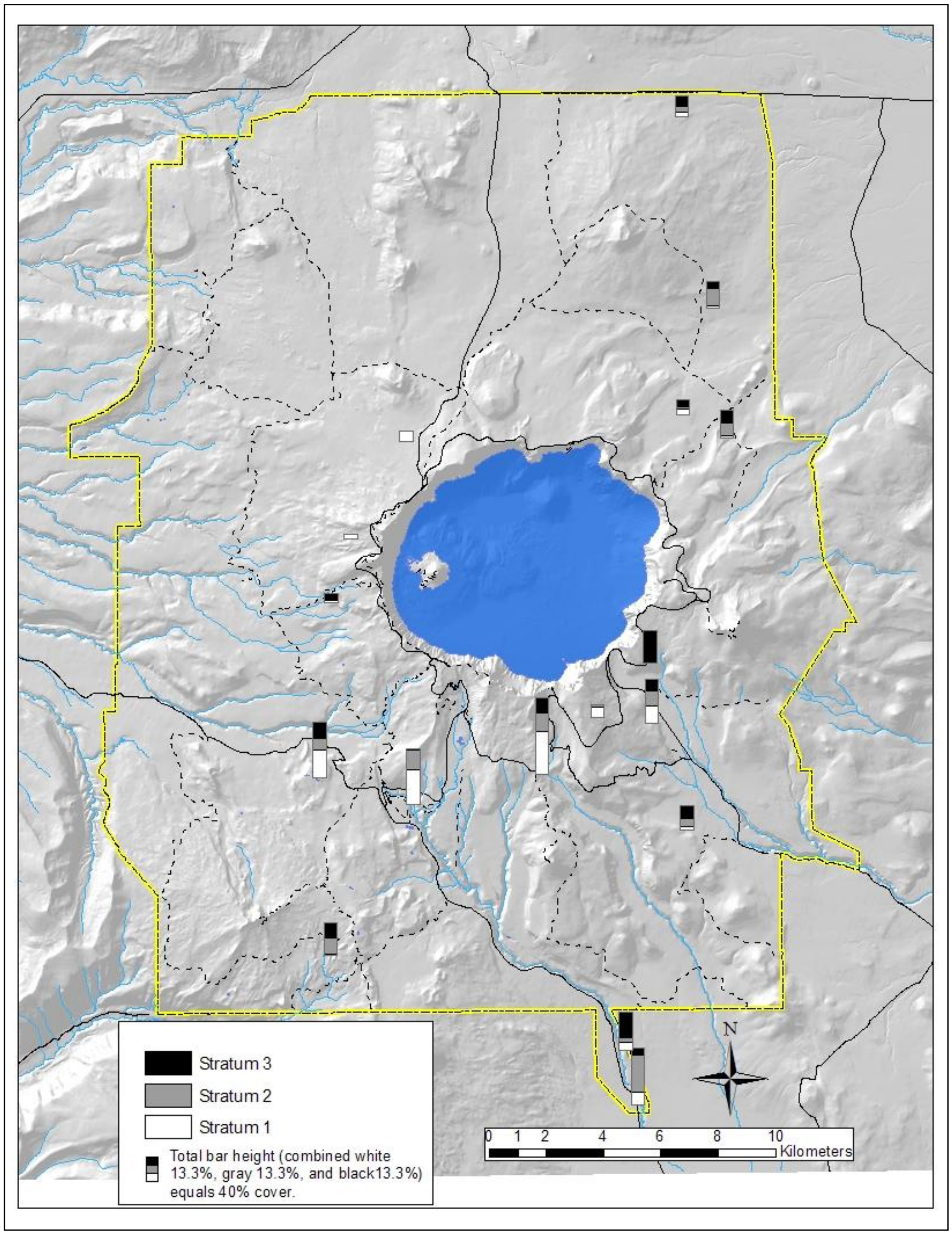

Figure 7. Vegetation cover percentages for each site by height strata Stratum 1= 0-.5m, stratum 2=>.5-4.99m, stratum 3= >5m.

Appendix A: Annual Report - Fiscal Year 2008 (continued).

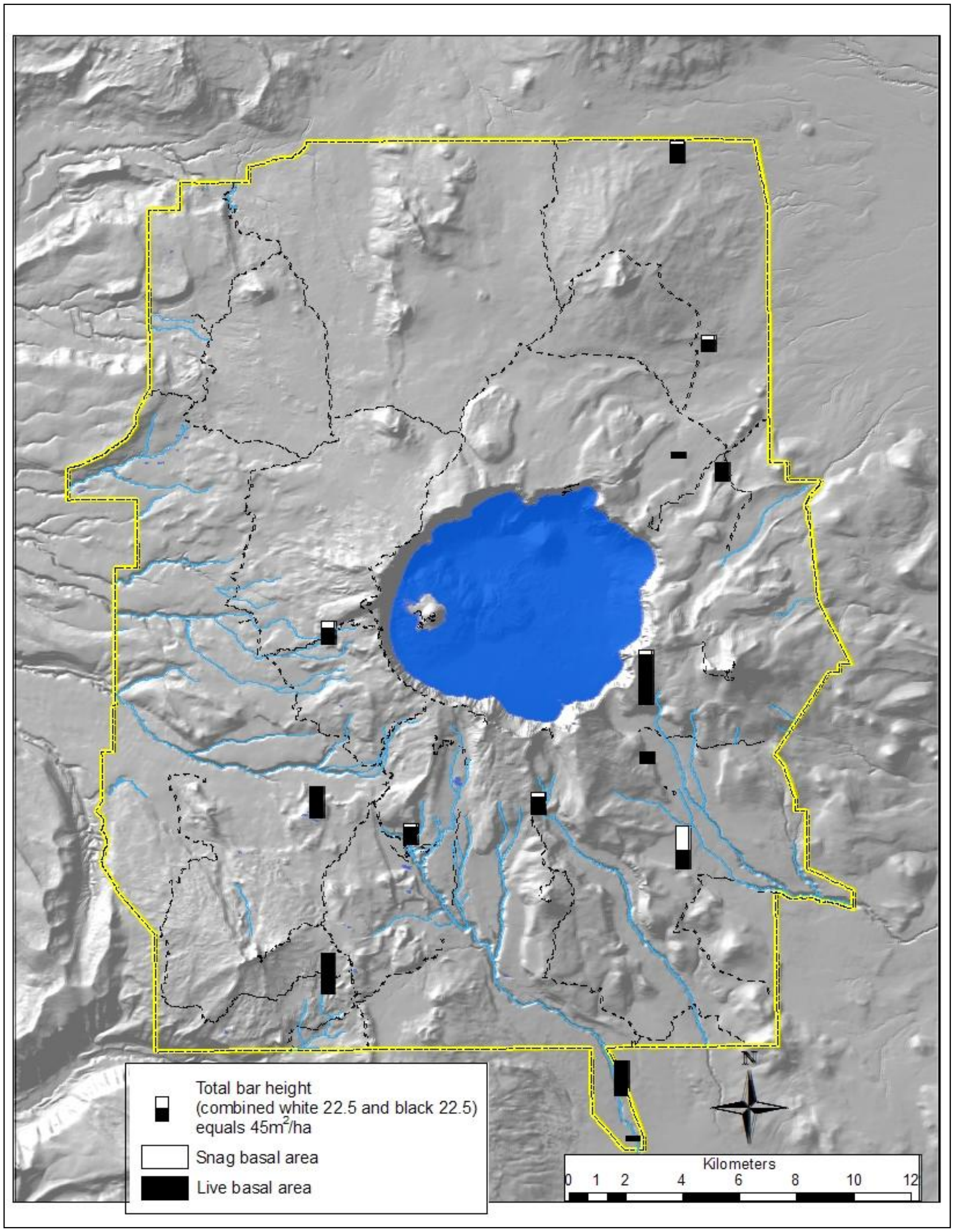

Figure 8. Live and dead tree basal area for each site. Sites with < 8m^2/ha, combined live and dead, basal area are excluded from this figure.

Live and dead tree basal area by site are illustrated in Figure 8 and summarized by sampling frame in Table 4. Basal area was highly variable and lowest in riparian areas and highest in matrix areas. Several plots lacked dead trees, while one plot dominated by mountain hemlock had mostly dead trees as a result of the Bybee Fire in 2006. Mean canopy base heights varied little between sampling frames (Table 4).

Table 4. Mean of dead and live tree parameters. Standard errors are shown in parenthesis.

	Dead		Live			
Sampling Frame	Basal Area (m^2/ha)	stems/ha	Basal Area (m^2/ha)	stems/ha	Height to Crown (m)	Max.Tree Height (m)
Alpine	2.2 (2.2)	40 (40)	24.6 (21.6)	153 (111)	8.6 (0.8)	25.1 (2.4)
Matrix	7.3 (4.2)	70 (30)	37.1 (6.2)	370 (65)	6.6 (0.3)	23.1 (0.8)
Riparian	5.6 (3.2)	20 (10)	23.5 (7.7)	137 (30)	7.7 (1.3)	27.1 (2.2)

Table 5 shows the 1, 10, 100 and 1000 hr time lag fuels. These were highest in the matrix and lowest in the alpine sampling frame, except 1000 hr rotten wood, which was highest in the alpine sampling frame. One alpine site had a total of 177 tons per acre, due to the fact that one down whitebark pine log was mismeasured. We determined this error retrospectively. The occurrence of this measurement error lead to a change in the protocol; now each data sheet will be reviewed as soon as it is completed. In the pilot study, all data sheets were reviewed at the end of sampling a site.

Table 5. Summary of woody debris time lag classes reported in tons per acre. Standard errors are shown in parentheses. S = Sound, R = Rotten.

Sampling Frame	1 hr fuel	10 hr fuel	100 hr fuel	1000 hr S fuel	1000 hr R fuel
Alpine	0.08 (0.07)	0.29 (0.20)	0.42 (0.36)	2.5 (2.5)	66 (41)
Matrix	0.52 (0.18)	0.89 (0.16)	1.8 (.27)	17 (4.6)	17 (6.4)
Riparian	0.04 (0.03)	0.3 (0.18)	1.8 (1.1)	11 (10)	34 (26)

Ground parameters are summarized in Table 6. The matrix sampling frame had the deepest litter and duff layers, while the alpine sampling frame had the shallowest. Mean bare soil in the alpine sampling frame was over ten times higher than the matrix or riparian frames. Mean bryophyte cover was greatest in the riparian sampling frame.

Table 6. Summary of mean and standard error of ground parameters. Standard errors are shown in parentheses.

	Thickness/depth (mm)		Cover (%)			
Sampling Frame	Litter	Duff	Fine wood /litter	Coarse Wood	Bryophyte	Bare Soil
Alpine	5.0 (2.6)	6.0 (4.8)	22.5 (20.8)	4.3 (3.0)	0.0 (0)	57.0 (19.8)
Martix	14.9 (1.6)	20.5(3.6)	68.4 (5.6)	8.4 (1.6)	0.1 (0.1)	4.2 (3.1)
Riparian	7.7 (4.1)	13.3(6.8)	11.3 (5.6)	6.0 (3.5)	6.3 (5.8)	2.7 (1.8)

Vegetation Function

The matrix sampling frame had the highest numbers of seedlings saplings and small trees (Table 7). The alpine sampling frame had the lowest densities, with zero small trees in all pole classes.
Table 7. Summary of densities/ha of seedling, saplings, and small trees. Standard errors are shown in parenthesis.

Appendix A: Annual Report - Fiscal Year 2008 (continued).

Table 7. Vegetation sizes per sampling frame classification.

Sampling Frame	Seedlings <20cm tall	Saplings 20cm tall-1.4m tall	Small trees 1.4m tall-5cm DBH	Small trees >5 - 10cm DBH	Small trees 10 - 15cm DBH
Alpine	1750 (1668)	0 (0)	0 (0)	0 (0)	0 (0)
Matrix	4300 (1927)	2050 (595)	338 (103)	138 (43)	1085 (368)
Riparian	2250 (1181)	1750 (764)	50 (14)	8 (8)	383 (79)

Changes to Protocol

As a result of the pilot study a number of possible improvements to the protocol were revealed. These were evaluated with Klamath Network staff, and the following changes were made:

- **Height strata—**changed from three (<0.5 m, 0.5-4.99 m, and >5 m) to four (<0.75 m, 0.75-2.5 m, >2.5-5 m, and >5 m.
- **Shrub height—**added an average shrub height measurement for each of the 4 intensive modules. We did this to quantify potential ladder fuels in each intensive module.
- **Incidental photo metadata sheet—**added an incidental photo metadata sheet to the protocol. This will allow easier differentiation between site specific and incidental photographs.
- **Water to ground cover—**added water as a category for ground cover. This was needed especially for some riparian sites**.**
- **Double check data sheets right after sampling parameters—**In the pilot study, data sheets were double checked in the field once all field sampling was completed. One important error could have been prevented by double checking the data sheet sooner.
- **Allow plots exceeding 30 degrees slope to be sampled—** This can be at the crews discretion depending on whether the plot can be sampled safely and whether it is on a three or 30 year revisit cycle. There is greater concern for trampling damage in plots that are on a 3-year revisit cycle.

Discussion

The pilot study demonstrated the feasibility of implementing the vegetation protocol and led to a number of suggested changes. Future annual reports will discuss the status of vegetation sampled in a given year and any outstanding trends. The likely significance and cause of trends will be described based on pertinent literature. No discussion about vegetation sampled is provided here because the sample size was too limited to draw significant inferences.

Appendix A: Annual Report - Fiscal Year 2008 (continued).

Appendix 1. Site data and environmental parameters collected during the Crater Lake vegetation monitoring pilot study.

Site	Sampling Frame	Easting	Northing	Date Monumented	Macro Position	Slope Shape	Average Slope (Deg)	Average Aspect	Elevation (m)
Site-003	Alpine	568703	4759038	8/21/2008	MACPOS 2	Straight	3	180	2061
Site-004	Alpine	575389	4749419	8/5/2008	MACPOS 1	Straight/convex	16	173	2292
Site-009	Alpine	566771	4755641	8/25/2008	MACPOS 2	Straight	19	250	2184
Site-010	Alpine	577235	4751300	8/14/2008	MACPOS 2	Concave	23	45	2144
Site-013	Matrix	578390	4759947	8/19/2008	MACPOS 3	Straight	0	0	1800
Site-014	Matrix	566065	4741113	8/28/2008	MACPOS 3	Concave/straight	0	0	1890
Site-017	Matrix	579910	4759160	8/20/2008	MACPOS 3	Straight	21	100	1760
Site-018	Matrix	565679	4747304	8/6/2008	MACPOS 2	Straight	0	0	1920
Site-019	Matrix	576379	4737535	9/2/2008	MACPOS 3	Straight	0	53	1410
Site-021	Matrix	578345	4770335	8/18/2008	MACPOS 3	Straight	4	30	1699
Site-022	Matrix	566087	4753406	8/21/2008	MACPOS 3	Concave	17	347	1948
Site-023	Matrix	578529	4745493	8/26/2008	MACPOS 3	Undulating	9	87	1752
Site-025	Matrix	579425	4763682	8/19/2008	MACPOS 3	Straight	0	0	1632
Site-027	Matrix	577293	4749192	8/13/2008	MACPOS 3	Straight	45	10	1917
Site-028	Riparian	576940	4734615	8/26/2008	MACPOS 4	Straight	0	0	1340
Site-032	Riparian	573462	4747425	8/12/2008	MACPOS 4/5	Concave	30	83	1895
Site-034	Riparian	568954	4746380	8/7/2008	MACPOS 5	Straight/concave	8	60	1739

Appendix B. Univariate Power Analysis for Trend in Basal Area and Sapling Density

Kathryn M. Irvine

Abstract.

This report summarizes the preliminary univariate power analysis for the Klamath Network Vegetation protocol. The power analysis is based on the pilot study data collected at Crater Lake and US Forest Service Forest Inventory and Analysis (FIA) data from the Oregon Cascades. Pilot data are from one sample period and FIA data are from two periods that were 1 year apart. The variables analyzed were total tree basal area and saplings measured or estimated for sampling plots. Plot sizes were similar between data sources and all data were converted to per ha values for this analysis. I assume the mixed linear model for trend proposed in Urquhart et al. 1993 is appropriate for analyzing future KLMN vegetation data. I estimate the power to detect a linear trend using this model based on these limited data and the Network's temporal sampling scheme. Based on this, the sampling design seems sufficient to meet the sampling objective of detecting a 50% change over 15 years for basal area, but it may take twice that long to detect 50% change in saplings, which exhibit greater spatial and temporal variation. However, after the power analysis was conducted the Network has modified the protocol to a three year always revisit design. For estimating annual status the proposed change to the revisit design may be negatively affected. However, the switch to an always revisit design should increase the power for detecting trends as compared to the estimated power reported here. While this is encouraging, the current results are provisional; as monitoring data are gathered, power and the model used for analysis should be reassessed.

Introduction

This report summarizes the preliminary univariate power analysis for the vegetation protocol. The power analysis is based on the pilot data provided by Dennis Odion for Basal Area (meters squared/ha) and saplings (per ha) obtained and summarized from US Forest Service Forest Inventory and Analysis plots, and from the pilot study plots undertaken by the Klamath Network at Crater Lake.

Data

I used the data in *KLMNunivariateData revised DCO.xls* for the power analysis. The responses were sapling density (per ha) and plot basal area (m^2/ha). Plot sizes were similar between data sources and all data were converted to per ha values for this analysis. There was only one year of data for the sites at Crater Lake, and two observations for the FIA plots in consecutive years. Thus, it was not possible to pursue an approach that utilizes a mixed linear model for trend with temporal variance components. However, as sampling continues the Network will be able to obtain such estimates and employ the improved methods being developed for trend analysis for panel designs (Starcevich pers. comm.). Here I use the FIA dataset to provide a rough estimate of the residual variance and both the CRLA and FIA datasets to provide estimates of the site-to-site variance.

Appendix B: Univariate Power Analysis (continued).

Revisit Design

The original proposed revisit design for Klamath Network vegetation monitoring is in Table 1. This is the assumed revisit design for the power analysis. Following power analyses, in response to peer-reviews of the protocol, the Network switched to a three year, always revisit design, as shown for panel 1. This change doubles the number of sites revisited at a 3 year frequency. The first year of sampling will not be 2010. The assignment of sites to panels is based on the GRTS sampling design.

Table 1. Proposed Revisit Design for Crater Lake that was used in the power analysis.

	2010	2013	2016	2019	2022	2025	2028	2031	2034	2037	2040
Panel 1	X	X	X	X	X	X	X	X	X	X	X
Panel 2	X										X
Panel 3		X									
Panel 4			X								
Panel 5				X							
Panel 6					X						
Panel 7						X					
Panel 8							X				
Panel 9								X			
Panel 10									X		
Panel 11										X	

Exploratory Data Analysis

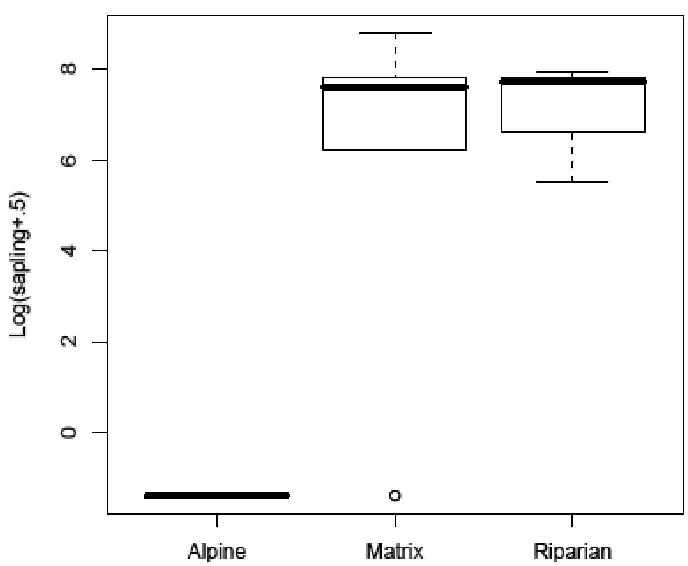

Figure 1. Boxplot of log(sapling density (ha)+.25) for three sampling frames in Crater Lake 2008

Appendix B: Univariate Power Analysis (continued).

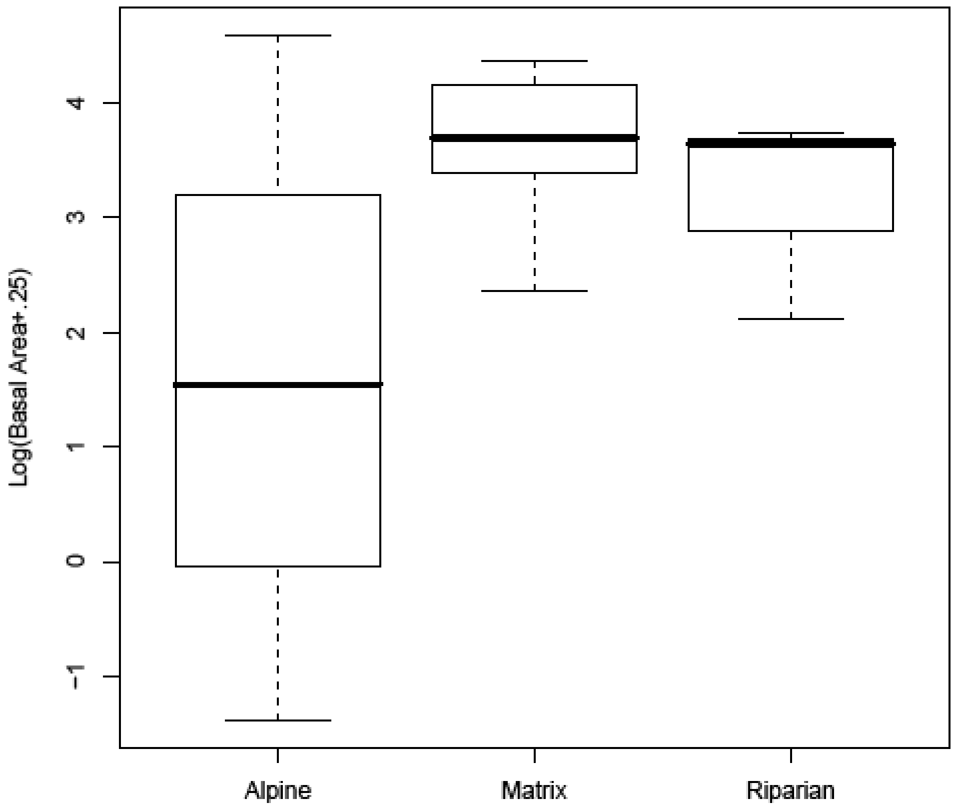

Figure 2. Boxplot of log(Basal Area+.25) for three sampling frames in Crater Lake 2008

There is evidence of one outlier for the Crater Lake matrix sites for sapling density in Figure 1, obviously with such a low sample size it is unclear if this observation is unusual or not. I include the observation for the power analysis. There are no major outliers for Basal Area (Figure 2) in the Crater Lake sites.

Appendix B: Univariate Power Analysis (continued).

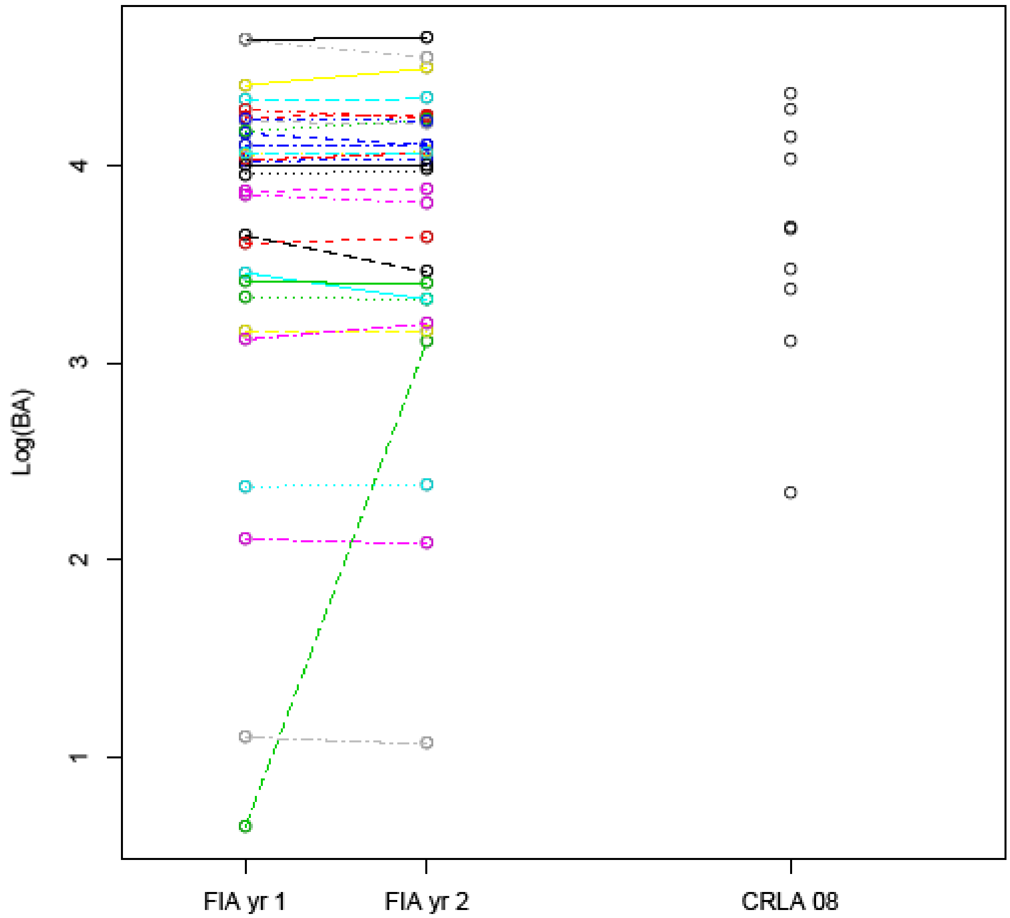

Figure 3. Basal Area for FIA plots and CRLA plots

In the FIA data, plot 5611 is the only one that showed a major increase in log(BA) from year 1 to year 2 in Figure 3. This site is driving the estimate of the residual variance component (site*year). The CRLA matrix sites have less variability among sites compared to the FIA sites.

Appendix B: Univariate Power Analysis (continued).

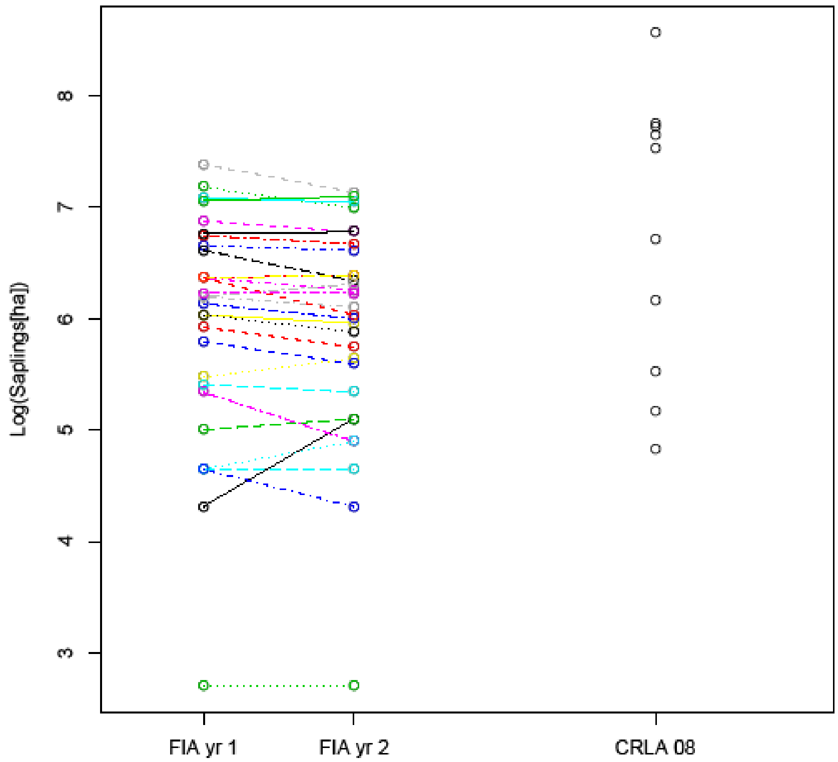

Figure 4. Sapling density for FIA and CRLA plots

Figure 4 displays Sapling density for both the FIA sites and CRLA matrix sites. There is a general pattern of a slight decline in sapling density between the two years FIA data was collected. The CRLA matrix sites appear to have similar site-to-site variability compared to the FIA plots.

Power Analysis

In order to perform a power analysis for univariate trend, a model must be assumed for the future data. I adopt the linear model presented in Urquhart and Kincaid (1999);, Larsen et. al (2001); Kincaid et. al (2004); and Urquhart et. al (1993). The model is as follows $\log(Y_{ij}) = \mu + S_i + T_j + E_{ij}$ where Y_{ij} is the observed characteristic of interest (e.g., BA) for site i in year j, $S_i \sim N(0, \sigma^2{}_{SITE})$, $T_j \sim N(0, \sigma^2{}_{YEAR})$, $E_{ij} \sim N(0, \sigma^2{}_{RESIDUAL})$, and the components are assumed independent. There have been many modifications to this general model idea (Piepho and Ogutu, 2002, Van-Leeuwen et al. 1996). I used the functions written by Tom Kincaid to estimate power based on model above, for specific details refer to the paper by Urquhart et al 1993. These are *estimates* of the power because we are estimating the variance components. These estimates will be improved once more sampling is conducted. The model cannot be fully implemented using the Klamath Network's Crater Lake dataset because we do not have estimates for $\sigma^2{}_{YEAR}$ or $\sigma^2{}_{RESIDUAL}$. Instead we fit a simplified model assuming different values for $\sigma^2{}_{RESIDUAL}$ and $\sigma^2{}_{SITE}$ based on the pilot datasets from Crater Lake and FIA plots. We use a log transformation such that trend is in terms of a multiplicative change in the medians over time, this is typically appropriate for biological data that display exponential growth and increasing variability with an increase in mean.

Appendix B: Univariate Power Analysis (continued).

Estimated Variance Components

I used the MIXED procedure in the SAS system which can be used to estimate the random and fixed components of mixed models. The estimated variance components using SAS are displayed in Table 2 for Basal Area and Table 3 for Sapling Density.

Table 2. Estimated Variance Components using REML for Basal Area.

DATA	Parameter	Estimate
FIA and CRLA	σ^2_{SITE}	0.547
	σ^2_{YEAR}	0
	$\sigma^2_{RESIDUAL}$	0.093
FIA	σ^2_{SITE}	0.636
	σ^2_{YEAR}	0
	$\sigma^2_{RESIDUAL}$	0.094
CRLA	σ^2_{SITE}	0.38
	σ^2_{YEAR}	0
	$\sigma^2_{RESIDUAL}$	0

Restricted maximum likelihood (REML) estimates are preferred for unbalanced designs (split panel designs). For the power calculations for Basal Area I assume that $\sigma^2_{YEAR} = 0, \rho_s = 0, and\ \rho_{yr} = 0$, the power is sensitive to the assumption that $\sigma^2_{YEAR} = 0$. The estimated site-to-site variability was less for the matrix sites at Crater Lake compared to the FIA sites. To be conservative I will use the estimated variance components for FIA only for Basal Area.

Table 3. Estimated Variance Components using REML for Sapling Density.

DATA	Parameter	Estimate
FIA and CRLA	σ^2_{SITE}	1.216
	σ^2_{YEAR}	0.000596
	$\sigma^2_{RESIDUAL}$	0.024
FIA	σ^2_{SITE}	0.964
	σ^2_{YEAR}	0.000539
	$\sigma^2_{RESIDUAL}$	0.024
CRLA	σ^2_{SITE}	1.63
	σ^2_{YEAR}	0
	$\sigma^2_{RESIDUAL}$	0

Appendix B: Univariate Power Analysis (continued).

To be conservative for the power calculations for sapling density, I use the estimated variance components for all observations (FIA and CRLA) for $\sigma^2{}_{RESIDUAL}$ and $\sigma^2{}_{YEAR}$. Also, I investigate two different values for $\sigma^2{}_{SITE}$ and assume $\rho_s = 0, and\ \rho_{yr} = 0$ for sapling density.

Results

For the following power analysis results I investigate four different three-year percent changes in the medians 2.5%, 3.0%, 6.0%, and 10.0%. A 2.5% and 3% per 3-year change correspond to a net change of 25 and 30 percent in the median after 10 sampling occasions (30 years); whereas a 6.0% and 10% per 3-year change corresponds to a net change of 30% and 50% in the median after 5 sampling occasions (15 years).

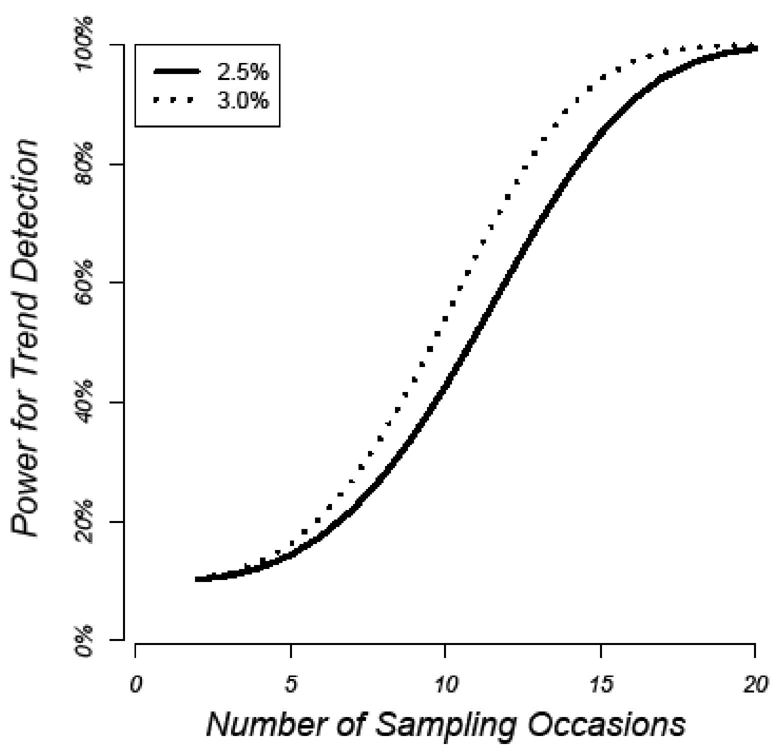

Figure 5. Power for 2.5% and 3.0% three-year trends in median Basal Area.

Appendix B: Univariate Power Analysis (continued).

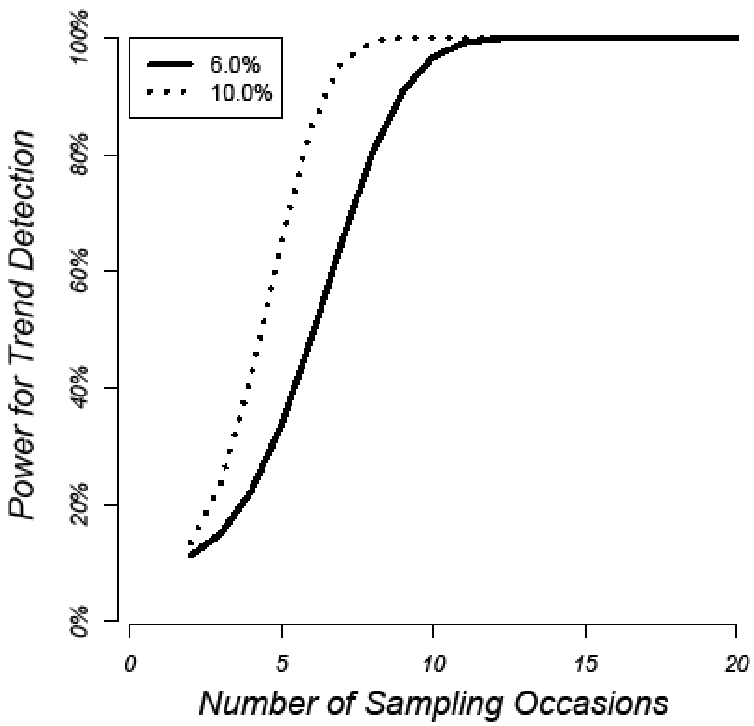

Figure 6. Power for 6% and 10% three-year trends in median Basal Area.

Figure 5 suggests for the proposed revisit design (Table 1) and the given estimated variance components (Table2), the desired 80% power to detect a 2.5% three-year change in median Basal Area will be reached after 14 sampling periods (42 years). For a greater three-year percent change (3.0%) the desired power will be reached after 11 sampling periods (33 years) of every three year sampling for Basal Area. This is an estimate of the power for the chosen sampling design to detect trend, the power will decrease if the true variance components are larger.

The stated objectives of 30% to 50% change over 15 years corresponds to a 6% and 10% three-year percent change, Figure 6 shows that for that magnitude of change it would take 8 sampling occasions or 24 years to detect a 6% three-year trend with 80% power and greater than 15 years (or greater than 5 sampling occasions)to detect a 10% three-year trend in median Basal area with 80% power. Considering that after 5 sampling occasions the total sample size is 90, 6 panels will be visited for one year and 15 sites (1 panel) will be visited every 3-years, the design seems sufficient to meet the sampling objective of detecting a 50% change over 15 years. Again this is assuming that there is no temporal variation or regional variation due to climatic factors or other regional-scale factors, if there is temporal variation the power will decline (see Figure 10). Larsen et. Al 2004 claim that the time variance component cannot be reduced through design choices, but instead through identifying controlling factors (i.e. including regional scale covariates).

Appendix B: Univariate Power Analysis (continued).

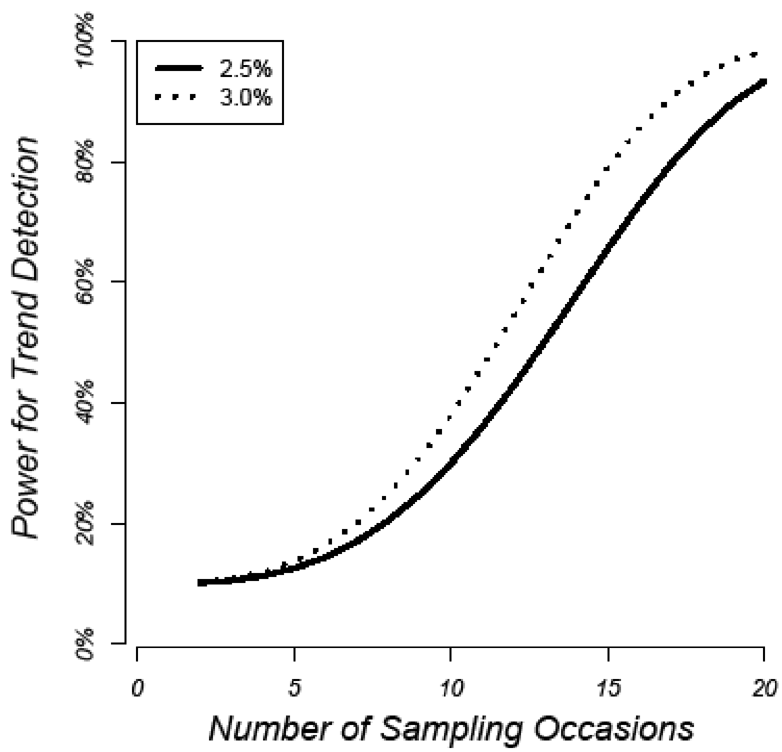

Figure 7. Power for 2.5%and 3.0% three-year trends in Sapling Density $\sigma^2{}_{SITE} = 1.216$.

Figure 7 suggests for the proposed panel revisit design (Table 1) and the given estimated variance components (Table 3) the desired 80% power to detect a 2.5% three-year change in median sapling density will be reached after 17 sampling periods (51 years). For a greater % change (3.0) the desired 80% power to detect trend will be reached after 14 sampling periods (42 years).

Appendix B: Univariate Power Analysis (continued).

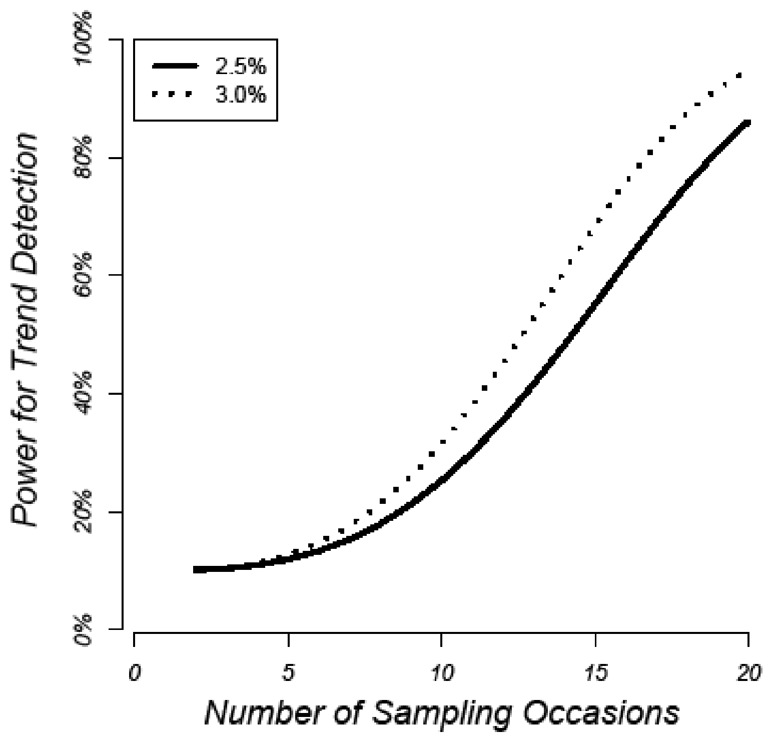

Figure 8. Power for 2.5%and 3.0% three-year trends in Sapling Density $\sigma^2_{SITE} = 1.63$.

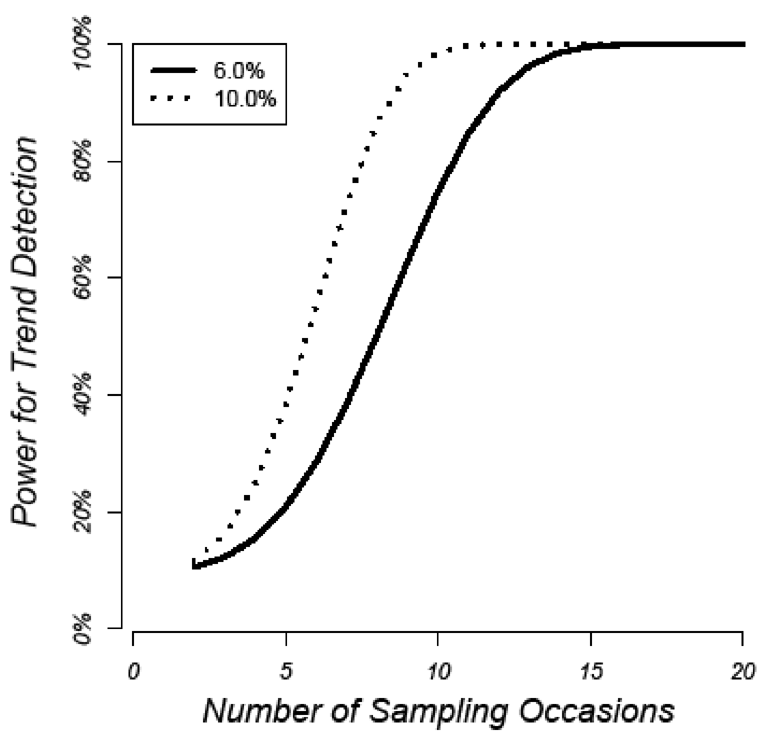

Figure 9. Power for 6.0%and 10.0% three-year trends in Sapling Density $\sigma^2_{SITE} = 1.63$.

Appendix B: Univariate Power Analysis (continued).

Figure 8 suggests that with a larger estimated variance component for site-to-site variability the power decreases, as expected. The power to detect a trend is only .70 after 17 sampling periods for a 2.5% three-year trend whereas it is only .61 after 14 sampling periods for a 3.0% three-year trend. The compiled results are presented in Table 4.

Figure 9 shows for a 6% three-year trend in median sapling density it would take more than 30 years to reach the desired power of 80%. For a 10% three-year trend it would take more than 21 years of sampling to detect that level of change in median sapling density with 80% power. It will take longer to reach the desired level of power to detect change in the median sapling density compared to median Basal area primarily because of the non-zero estimate of the variance component for year and the larger estimated variance component for site.

Table 4. Estimated Power for different three-year trends and σ^2_{SITE} estimates for Sapling density.

Sampling Occasion	$\sigma^2_{SITE} =$	1.216	$\sigma^2_{SITE} =$	1.63
(every 3 yrs)	2.50%	3.00%	2.50%	3.00%
2	0.101	0.102	0.101	0.101
3	0.105	0.107	0.104	0.105
4	0.113	0.118	0.109	0.114
5	0.125	0.136	0.119	0.127
6	0.144	0.163	0.133	0.148
7	0.17	0.2	0.153	0.176
8	0.204	0.248	0.179	0.213
9	0.247	0.308	0.212	0.259
10	0.299	0.378	0.252	0.314
11	0.36	0.458	0.3	0.379
12	0.428	0.543	0.354	0.451
13	0.501	0.63	0.415	0.528
14	0.578	0.714	0.482	0.607
15	0.655	0.79	0.551	0.685
16	0.728	0.855	0.621	0.758
17	0.794	0.906	0.69	0.822
18	0.851	0.943	0.754	0.875
19	0.898	0.968	0.812	0.918
20	0.934	0.984	0.861	0.949

To illustrate the importance of the assumption of $\sigma^2_{YEAR} = 0$, I assume a minimal variance component for Basal area of .05 and the power decreases substantially (Figure 10).

Appendix B: Univariate Power Analysis (continued).

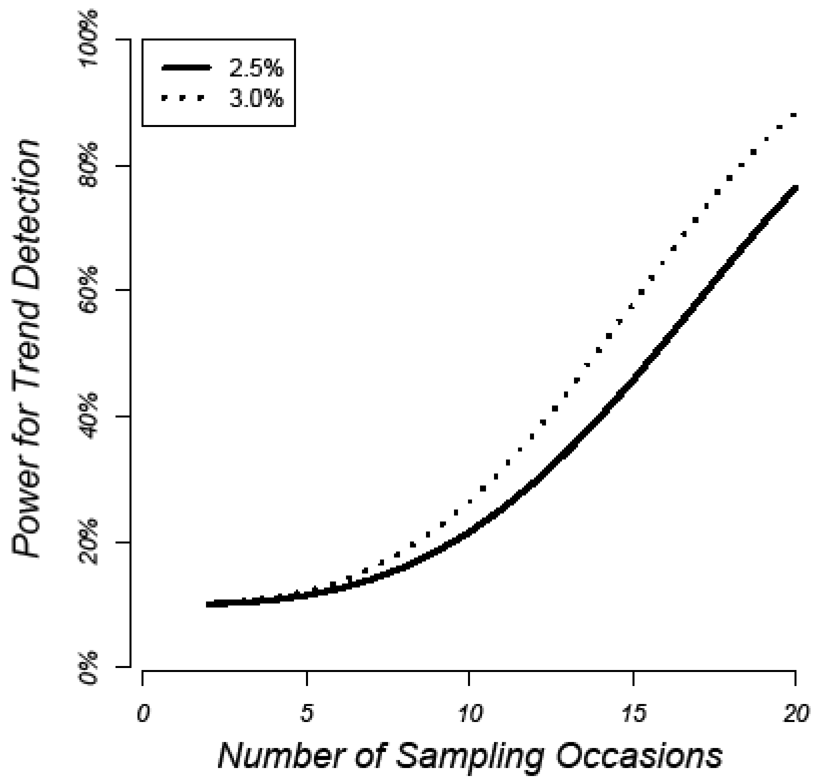

Figure 10. Power for 2.5% and 3.0%three-year trends in Basal Area with ${\sigma^2}_{YEAR} \neq 0$.

One point I would like to stress is that this power analysis is based on the assumed model. Starcevich (personal communication) is working on a model for improved trend detection that should be used in the future. At this point it is unknown how the estimated power based on current model versus the revised model will compare.

Appendix:
Example SAS code used to estimate random effects for site and year

```
proc mixed data=FIA method=REML;
  class Site Year;
  model lnBA = ;
  random Site Year;
  run;
```

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Appendix C: Job Hazard Analysis for the Klamath Network Vegetation Monitoring Protocol

Version 1.00 (March 2010)

The Klamath Network will make every effort to comply with the NPSafe program and with local park safety programs. The Network takes safety seriously, and it is the number one priority when developing and implementing these protocols. Crews are expected to be trained on all safety aspects of this project prior to entering the field.

The vision of the NPSafe program is:

> *"The NPS is widely recognized for providing world-class resource stewardship and visitor experiences. Just as the NPS excels at protecting natural and cultural resources and serving park visitors, the NPS can excel in providing our employees with a safe work environment. All employees deserve the opportunity to do their jobs safely and effectively so they can go home healthy at the end of the day to fully enjoy their lives and families."*

The beliefs of the NPSafe program are:

- We believe that healthy, productive employees are our most important resource, and employee safety is our most important value.
- Injuries and occupational illnesses are unacceptable and all are preventable.
- At risk behaviors can be eliminated.
- Operating hazards and risks can be controlled.
- Safety is everyone's responsibility.
- Managing for safety excellence can enhance employee productivity, save millions of dollars in workers compensation costs, and improve overall management effectiveness.

The goals of the NPSafe program are:

1) The NPS becomes the safest place to work in DOI.
2) Safety is integrated into all NPS activities.
3) The NPS organizational culture values employee safety as much as it values protecting resources and serving visitors.
4) Employees, supervisors, and managers demonstrate unwavering commitment to continuous improvement in employee health and safety.

To meet these goals, the Klamath Network has included several Job Hazard Analyses (JHA) in this appendix that should be followed while implementing this protocol.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		Date: 1/21/2010	
Park Unit: KLMN	Division: IMD	Branch: NRPC	Location: Ashland, Oregon
Task Title: Driving vehicles in the course of one's job		JHA Number: KLMN JHA 1	Page: 1 of 3
Job Performed By: ALL	Analysis By: Daniel Sarr	Supervisor: Daniel Sarr	Approved By: Daniel Sarr
Required Standards and General Notes:	Employees driving as part of their duties must have a valid state issued driver's license.		
Required Training:	Standard drivers training. Also need to know how to change tires and jump start vehicle.		
Required Personal Protective Equipment:	Seatbelts must be used.		
Tools and Equipment:	Vehicle		

Sequence of Job Steps	Potential Hazards	Safe Action or Procedure
Starting vehicle, basic operation	• Lights not functioning, visibility impaired • Low tire pressure • Low fluid levels • Spare tire not in vehicle or deflated • Low gas	• Test headlights, turn signals, brake lights, breaks, tire pressure and all fluids • Check status of spare; insure that jack, properly sized lug wrench and all necessary tools are present in vehicle • Check gas
Using 4 wheel drive, if applicable.	• Not knowing how to engage, getting stuck in the field • Unsafe driving procedures due to perceived safety of 4 wheel drive	• Practice engaging 4 wheel drive • Engage 4 wheel drive prior to rough conditions • Use 4 wheel drive when increased traction is necessary; e.g., steep slopes, slick conditions, snow • Even in 4 wheel drive, do not assume safety is enhanced. Use cautious and defensive driving practices.
Driving in reverse	• Hitting objects, people, wildlife	• Check area behind vehicle prior to leaving site • Use a person outside the vehicle (other crew member) to direct traffic • Back into parking spots, so leaving sites after long field day is easier and less likely to result in fatigue related mishap

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)	JHA Number: KLMN JHA 1	Page: 2 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**
Transporting gear and heavy equipment	• Gear flying around, hitting driver and passenger in accident • Damage to gear during turns or stops	• Ensure that gear is adequately stowed. • If the gear comes with protective gear (e.g., electrofisher), properly stow in container. • Do not put gear on top of vehicle; stow inside.
Passenger/driver safety	• Distracted driving	• Wear seatbelts at all times while driving. • Practice safe and defensive driving habits. • Obey traffic laws. • Do not text. Pull over and stop to use phone. • Keep windshields clean. • Drive with both hands on the wheel at 10 o'clock and 2 o'clock. • Do not pick up hitch hikers. • Use turn signals/indicators. • Plan route in advance. • Make sure seat and mirrors are properly adjusted for driver • Use headlights, even during day time driving.
	• Driving on narrow, single lane roads with bumpy or "washboard" surfaces.	• Maintain a safe speed (this may be below the legal limit). • Stay to the right, especially on curves, and be aware for oncoming traffic. • If turning around, "face the danger," in other words, turn towards a steep slope, instead of backing into a steep slope cliff.
	• Driving with limited visibility, as in heavy rain, fog, or dust.	• Slow down. • If possible, wait for conditions to imporve. • Drive with lights on. In some conditions, low lights may penetrate better than brights.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		JHA Number: KLMN JHA 1	Page: 3 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**	
Passenger/driver safety	• Fatigue driving	• Be aware of signs of fatigue. Pull over and catnap if necessary, eat a snack, or have a partner drive. If in doubt, do not drive.	
	• Storm conditions (snow, mud, wind)	• Keep informed of the weather. • If excess wind (tree top swaying, twigs falling) consider postponing trip. • Avoid wet clay roads as much as possible.	
	• Road obstacles	• Get out and move rocks in the road as necessary. If large amounts of rockfall or trees, report to the park staff. • If you hit rocks, stop and check tire conditions (wear, sidewall, and inflation) for damage. • If obstacle is an animal, slow down! Be aware of high animal traffic areas and drive appropriately. It is better to "ride out" an impact than suddenly swerve. This is true for animals of all sizes, from squirrels to cattle.	
Working/Parking on or near a roadside	•Being hit by a car	• Stay off of the road. • Use pullouts or secondary road when parking. • Be aware of the traffic. • Walk on the side of the road facing traffic. • Always set out safety triangles or flares behind the vehicle before starting any maintenance. • Never go under the vehicle while it is up on a jack.	
Working/Parking on or near a roadside	•Running into objects, parking too far off the road, getting stuck, rolling vehicle	• Park on stable surface. • Don't park on a blind corner or a solid striped road area. • Set parking break.	

Description of Task When it is Done Safely

Crew returns safe from the field day/season, with no injuries, damages, or law suit.

JOB HAZARD ANALYSIS (JHA)		Date: 1/21/2010	
Park Unit: KLMN	Division: IMD	Branch: NRPC	Location: Ashland, Oregon
Task Title: Remote field site access/ trail travel/ cross-country travel		JHA Number: KLMN JHA 2	Page: 1 of 3
Job Performed By: ALL	Analysis By: Daniel Sarr	Supervisor: Daniel Sarr	Approved By: Daniel Sarr
Required Standards and General Notes:	Crew members should be physically fit		
Required Training:	None required.		
Required Personal Protective Equipment:	Footwear appropriate to terrain (probably hiking boots); pants if hiking through brush or poison oak; Tecnu poison oak pre-exposure lotion, park radio with charged batteries, GPS units, eyewear, first aid kit.		
Tools and Equipment:			

Sequence of Job Steps	Potential Hazards	Safe Action or Procedure
Hiking on and off trails	• Getting lost	• Use and be trained in navigation techniques using both maps and GPS units. • Allow ample time to access site and return. • Bring safety gear (e.g., radio); extra clothes, water, food, etc. • Look at notes from crews that previously accessed this site.
	• Physical injury (e.g., twisted ankle, broken bones)	• Wear appropriate footwear, preferably boots with vibram soles and tops above the ankle, broken in prior to field season. • Walk cautiously and don't run. • Take breather breaks as necessary. • Stay physically fit. • Know basic first aid. • Be trained in radio SOP. • Avoid talus slopes. On steep slopes, avoid walking directly below others. • Take care walking on wet or slippery ground, especially bridges.
	• Getting hit with tool, implement, or vegetation branch	• Maintain 6 foot spacing • Warn people behind of "snap-back" from vegetation branches; wear safety glasses (or other glasses).

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)	JHA Number: KLMN JHA 2	Page: 2 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**
Hiking on and off trails	• Blisters	• Wear broken in and proper fitting boots. • Bring moleskin and use if blisters develop.
	• Carrying heavy loads	• Use backpack appropriate to load; do not carry heavy items in arms or hands; make hands available to break a fall. • Properly fit backpack. • Use crew member to assist in putting pack on. • Be physically fit. • Report problems or issues to supervisor. • Stay hydrated.
	• Loose footing; falls, broken bones, etc.	• Avoid steep slopes. • If unavoidable, walk at angle up slope; not straight up. • Wear good boots. • Do not go up hazardous slopes. • Watch for branches, wet, slick rocks, etc. Avoid as necessary. • Take your time, ascending and descending. • Plan your route so that hazardous terrain is minimized and the use of trails is maximized. • Do not travel alone (e.g., if one crew member is faster, only travel as fast as your slowest person).
	• Branches and trees, other dangerous obstacles	• Examine for the safest way around. • Do not jump off trees. • Avoid going underneath large trees that could shift and crush a person.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		JHA Number: KLMN JHA 2	Page: 3 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**	
Wildfires	• Exposure to smoke and fire	• Don't panic. Be alert. Keep calm. Think clearly & act decisively. Get out of the area immediately. • Maintain communication with other crew members and with dispatch. Follow local district policies regarding reporting fire.	
Water Crossing	• Loose footing; falls, broken bones, etc.	• Choose stream crossing routes by scouting the area first • Avoid crossing when water levels are higher than knee height. Avoid crossing on logs whenever possible. • Use a stick or pole to secure footing. Place it upstream at a slight angle. Use pole to test for depth & walk to the pole. • Stay out of areas with swift current, especially after heavy snowfall, rain, or spring melt. • Use footwear with non-slip soles while walking in streams. Do not wear sandals in streams. • When possible, step on streambed proper instead of the tops of boulders that may be slippery.	

Description of Task When it is Done Safely

Crew returns safe from the field day/season, with no injuries, damages, or law suit.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		Date: 1/21/2010	
Park Unit: KLMN	Division: IMD	Branch: NRPC	Location: Ashland, Oregon
Task Title: Environmental Exposure		JHA Number: KLMN JHA 3	Page: 1 of 3
Job Performed By: ALL	Analysis By: Daniel Sarr	Supervisor: Daniel Sarr	Approved By: Daniel Sarr
Required Standards and General Notes:	Field crew members in the field are expected to use common sense in dealing with exposure to elements or wildlife. Ideally, they have experience in outdoor work prior to initiating the field season.		
Required Training:	None required.		
Required Personal Protective Equipment:	Appropriate clothing for conditions.		
Tools and Equipment:			

Sequence of Job Steps	Potential Hazards	Safe Action or Procedure
Being outdoors, far from facilities for long time periods	• Hypothermia	• Consult First Aid book for treatment. • Seek assistance. • Recognize the signs: Shivering; Numbness; Drowsiness; Muscle Weakness; Dizziness; Nausea; Unconsciousness; Low, weak pulse; Large pupils. • Practice prevention: stay dry; wear appropriate clothing; cotton kills; wear layers, shed layers as needed (don't overheat as sweat can cause hypothermia); watch or listen to the weather forecast, and plan accordingly; stay hydrated, cover head with warm clothing, stay active. • Be aware of the role that wind-chill can play in hypothermia; under certain conditions, hypothermia can occur without any rain or being wet.
	• heat exhaustion; heat stroke	• Consult First Aid book for treatment but generally get the victim to cooler conditions. NOTE: HEAT STROKE IS A LIFE THREATENING CONDITION. • Recognize signs: above normal body temps; headaches, nausea, cramping, fainting, increased heart rate, pale and clammy skin, heavy sweating, etc. • Practice prevention: Stay hydrated: in the midst of the summer, it may be necessary to drink 1 liter of water per hour; wear a broad brimmed hat; take rest stops in shade. • Reschedule work day to do hot, heavy work in cooler hours of the day, or during cooler weather

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)	JHA Number: KLMN JHA 3	Page: 2 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**
Being outdoors, far from facilities for long time periods	• Electrical Storms – lightning	• Watch the sky for signs of thunderstorms and seek shelter before the weather deteriorates. • Stop work in streams and lakes. • If caught in electrical storms, seek shelter inside a vehicle or building; keep away from doors and windows, plugged in appliances, and metal. Avoid contact with metal objects in vehicles.
	• Electrical Storms – lightning	• Do not use telephones. • If outside with no shelter, do not congregate. In case of lightning strike, someone must be able to begin revival techniques (e.g., CPR). • Do not use metal objects. • Avoid standing near isolated trees. • Seek lower elevations such as valleys or canyons; avoid being on peaks and trees. • If you feel your hair standing on end and your skin tingling, this is a sign that lightning might be about to strike – crouch immediately (feet together, hands on knees).
	• Sunburn	• The risk of sunburn is higher when working at high elevations, or when working around water (from reflection). In these conditions, you can be burned even in overcast conditions. • Wear protective clothing and use sunscreen.
	• High wind events	• Severe wind events can create "windthrows" where strong winds can blow down trees, causing hazardous conditions to field personnel. Crews should avoid areas during high wind, exhibiting obvious previous wind damage.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		JHA Number: KLMN JHA 3 | Page: 3 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**
	• Altitude sickness	• Know and recognize signs of "acute mountain sickness:" headaches; light-headedness; unable to catch your breath; nausea; vomiting. • Practice prevention: acclimate to high elevations slowly and stay hydrated. • If symptoms progress and include: difficulty breathing, chest pain, confusion, decreased consciousness or loss of balance, descend to lower elevations immediately and seek medical attention.
	• Giardia	• Treat, filter, or boil all drinking water. Do not drink untreated water from streams, lakes, or springs.

Description of Task When it is Done Safely

Crew returns safe from the field day/season, with no injuries, damages, or law suit.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		Date: 1/21/2010	
Park Unit: KLMN	Division: IMD	Branch: NRPC	Location: Ashland, Oregon
Task Title: Wildlife and Botanical Exposure		JHA Number: KLMN JHA 4	Page: 1 of 3
Job Performed By: ALL	Analysis By: Daniel Sarr	Supervisor: Daniel Sarr	Approved By: Daniel Sarr
Required Standards and General Notes:	Field crew members in the field are expected to use common sense in dealing with exposure to elements or wildlife. Ideally, they have experience in outdoor work prior to initiating the field season.		
Required Training:	None required.		
Required Personal Protective Equipment:	Appropriate clothing for conditions.		
Tools and Equipment:			

Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**
Driving to the site	• Animal in the road	• Slow down! Be aware of high animal traffic areas and drive appropriately. It is better to “ride out” an impact, rather than a sudden swerve. This is true for animals of all sizes, from squirrels to cattle.
Being in the field	• Rattlesnakes	• Be alert • Do not put your feet or hands where you cannot see • Do not pick up rattlesnakes • Give a wide berth • Avoid stepping over logs, when you cannot see the other side • If bitten, seek immediate professional medical attention if possible send someone for aid. • Lower bitten extremity below your heart, cover wound with sterile bandage while en route to medical attention.
	• Bears	• Be alert and stay calm. • If you encounter a bear, give it as much room as possible. • Try to leave the area but DO NOT RUN. Back away slowly, but if the bear follows, stop and hold your ground. • Wave your arms, make yourself look big, and talk in a normal voice • If the bear makes contact, surrender! Fall to the ground and play dead. Typically, a bear will break off its attack once it feels the threat has been eliminated. If the bear continues to bite after you assume a defensive posture, the attack is predatory and you should fight back vigorously.

JOB HAZARD ANALYSIS (JHA)		JHA Number: KLMN JHA 4	Page: 2 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**	
Being in the field	• Mountain Lions	• Be alert, calm, and do not panic. • If you see a mountain lion, do not run; you may stimulate its predatory nature. Shout and wave arms to let it know that you are not prey. FIGHT BACK.	
	• Ticks	• Use DEET based repellants on exposed skin. • Check for ticks during and after field work. • Remove with tweezers within 24 hours, preferably immediately. • DO NOT leave the head imbedded. • DO NOT extract with matches, petroleum jelly, or other coatings (e.g., motor oil).	
	• Roughskin newts (*Taricha granulosa*)	• Avoid handling Roughskin newts; their skin contains a potent neurotoxin. If necessary for the protocol, handle only when wearing gloves. Do not "lick" for "killer buzz." People have died from attempting to eat roughskin newts.	
	• Insect Sting	• Do not provoke insects by swatting at them. Remain calm and move away from the area. • Be alert for buzzing insects both on the ground and in the air. Walk around any nests you encounter. Inform others of nests. • Flag if necessary. Wear long sleeved shirt and pants. Tuck in shirt. Wear bright colors. Perfumes & metal objects may attract bees. • If stung, scrape stinger off skin. Cold can bring relief. Do not use tweezers. Tweezers can squeeze venom sac and worsen injury. • If you are allergic, carry an unexpired doctor prescribed bee sting kit (EpiPen) with you at all times. • Know the allergic reactions of co-workers as well as the location of the bee sting kit. If victim develops hives, asthmatic breathing, tissue swelling, or a drop in blood pressure, seek medical help immediately. Give victim antihistamine (Benadryl or chol-amine tabs). Use EpiPen. • Prevent bug/mosquito bites by using repellent. Spray on clothing to avoid prolonged exposure to skin. Wear long sleeved shirts and pants. • Be aware of insect transmitted diseases (West Nile Virus, Lyme Disease, Plague).	

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		JHA Number: KLMN JHA 4	Page: 3 of 3
Sequence of Job Steps	**Potential Hazards**	**Safe Action or Procedure**	
Being in the field	• Rabies	• Be aware of animals acting strangely. If bitten by a wild or domestic animal get medical attention and report to local health authorities or animal control officer. Locate animal if possible. Follow accident procedures for animal bites.	
Encountering irrigation pipes, marijuana plantation, or grow operations.	• Unfriendly encounters with criminal elements	• Do not wear uniforms. • Carry radio in backpack, not visible. • Act like tourists (i.e., act unsuspicious). • Work in pairs or larger groups. • If working in areas likely to contain operations, check in with park staff when leaving vehicle and returning to vehicle. • Do not confront strangers. • Watch for suspicious vehicles and people and report to rangers. • Watch for black piping or other signs. • If finding a definite grow operation, LEAVE IMMEDIATELY, note location, and report to park ranger.	
Travel, movement or work in area with Poison Oak	• Allergic reaction to poison oak plants	• Learn to recognize Poison Oak. • Avoid contact and wear long pants and long-sleeve shirts if travelling in dense areas. • If skin contact is made, flush with cold water as soon as possible. • DO NOT flush with warm water or use soap. This can open your pores and increase the reaction. • Use Tec-nu or similar product to wash and rinse with cold water to remove oils (follow label instructions).	

Description of Task When it is Done Safely

Crew returns safe from the field day/season, with no injuries, damages, or law suit.

Appendix C. Job Hazard Analysis (continued).

JOB HAZARD ANALYSIS (JHA)		Date: 1/21/2010	
Park Unit: KLMN	Division: IMD	Branch: NRPC	Location: Ashland, Oregon
Task Title: Communication		JHA Number: KLMN JHA 5	Page: 1 of 2
Job Performed By: ALL	Analysis By: Daniel Sarr	Supervisor: Daniel Sarr	Approved By: Daniel Sarr
Required Standards and General Notes:			
Required Training:	Radio / Spot use		
Required Personal Prospective Equipment:			
Tools and Equipment:	Professional Grade Radio, SPOT Monitoring System		

Sequence of Job Steps	Potential Hazards	Safe Action or Procedure
Radio communication	• Communication not possible	• Make sure radio is working before you leave the office or field station. Make sure batteries are changed. Carry a second rechargeable battery as back up. • Check in mornings and evenings. If in a dead zone, try to check in from a better location throughout the day. Be prepared to relay messages in an emergency. If you are working alone, be sure to check in and out with dispatch. • Make sure that your supervisor knows your planned itinerary before you leave in case your radio fails. Follow crew-specific safety check in/checkout procedures. • Know which radio frequencies to use and which to monitor. Know who to call in case of an emergency. Know how to reach repeaters. • Carry a list of employee call numbers. Be prepared to relay messages in an emergency. • Keep messages short, less than 30 seconds per transmission. If a longer message is necessary, break every 30 seconds. • Conserve batteries. Carry a spare and don't leave scanner on. Turn radio off over night. Your life may depend on it.
Spot System	• Communication not possible	• Make sure system is working before you leave the office or field station. Make sure batteries are changed. Carry a second rechargeable battery as back up. • Make sure that your supervisor knows your planned itinerary before you leave in case your system fails. Follow crew specific safety check in/checkout procedures. • Make certain system is setup properly and includes an accurate contact list.

Description of Task When it is Done Safely

Crew returns safe from the field day/season, with no injuries, damages, or law suit.

Appendix D. Park Sampling Frame Coverages and their Location in the Klamath Network's GIS Data.

Park	***Path***	***GIS Feature Class Name***
Crater Lake	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*CRLA_sampling_frames_20100322*
Lava Beds	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*LABE_sampling_frames_20100322*
Lassen Volcanic	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*LAVO_sampling_frames_20100322*
Oregon Caves	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*ORCA_sampling_frames_20100322*
Redwood	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*RNSP_sampling_frames_20100322*
Whiskeytown	*I:\Data_Management\GIS\DATABASE\KLMN\DATA\MONITORING.mdb\Vegetation*	*whis_sampling_frames_20100322*

Appendix E. Comparison of FIA and FMH Methods and those Presented in this Protocol.

Measureable attribute or method	FIA	FMH	Klamath
General plot layout	Main sampling units are 4 24‘ radius circular subplots, each containing 1 6.8‘ microplot and 3 $1m^2$ understory plots.	20 x50 m for forests with 50 m outer lines serving as transects for understory sampling.	20 x50 m plot with 4 10 x10 m modules each containing 1 $10m^2$ and 1 $1m^2$ nested plots.
Plots slope corrected?	Yes	No	No
Witness trees for plot relocation	Yes	No	Yes. In non-forest vegetation, features other than trees will be used.
Photographs	yes		yes
Plant cover	1 m2 plots all cover up to 6‘. 24‘ subplots, all cover by layer (visual estimate). Layers= 02‘,2-6‘, 6-16‘, >16‘	Point intercept, line intercept (optional)	Ocular estimate by height strata (S1 = (<0.75 m height), S2 = (0.75-2.5 m), S3 = 2.6-5 m), S4 = >5.
Tree seedlings	<2.54 cm dbh	<2.5 cm dbh, counted in plot quarters	< 2.54 cm tallied in 4 10m 2 subplots in two size classes (0-15 cm tall and 15 cm tall to 2.54 cm dbh)
Saplings and poles	1-5” (2.54- 12.7 cm) dbh	> 2.5 < 15 cm dbh tallied for whole plot or subset depending on circumstances	> 2.54 < 15 cm tallied entire plot into three size classes
Trees	Tag and measure greater than 5” (12.7 cm) dbh	Tag and measure dbh of trees > 15cm dbh.	Tag and measure dbh of trees > 15 cm dbh. Dbh can be measured to the nearest cm for 10-25 cm trees using a ruler, and for trees greater than 25 cm using a diameter tape..
Crown position	All trees > 1 in. (2.54 cm dbh, 4 categories(superstory, overstory, understory, open)	Optional. Crown position, an assessment of the canopy position of live overstory trees (Avery and Burkhart 1963), is recorded in the column marked CPC (crown position code) using a numeric code (1–5). Dominant, co-dominant, intermediate, subcanopy, open.	All trees greater than 15 cm to be classified according to FMH definitions.
Overstory cover	Not measured, closely correlated with dbh.	Not measured, closely correlated with dbh.	Visual estimate and densitometer measure of canopy opening.
Crown base height	Estimated for each tree.	Not measured	Use FIA method to measure on each tree.
Snags	Greater than 5” (12.7 cm)	Optional. > 15 cm dbh	> 12 cm dbh tallied in whole

Appendix E. Comparison of FIA and FMH Methods (continued).

	dbh. 5 decay class categories based on Douglas-fir	Classified into categories: Recent snag, loose bark snag, clean snag, broken above BH, broken below BH.	plot. Condition classified according to FMH categories.
Down wood	Separate cwd (>3"x 3') and fwd (< 3"). 58.9' transects, planar intercept method. 1 transect per subplot. Diameters classes for fwd are <0.25", 0.25"-1.0", 1.0-3.0". Total length of transects sampled for whole plot is 24', 40', and 40' for fwd classes and 2 x 58.9' for cwd.	Planar intercept method. Woody fuel is tallied by size class (diameters of <0.25", 0.25"-1.0", 1.0-3.0", >3.0") and litter and duff depth is measured for different lengths of 4 50' randomly oriented transects. Total distance is 24' for 0-1", 48' for 1-3", and 100' for cwd.	FIA/FMH approach (planar intercept) used on center transect with slightly reduced overall distance sampled.
Downed wood decay classes	5 class system based on Douglas-fir. Decay class 5 treated differently	Sound vs. rotten distinguished.	Sound vs. rotten distinguished.
Duff/litter depth	Measured at center of 2 transects per 4 subplots.	Measure at 10 points along all 4 transects.	Measure at 10 points along one fuel transect.

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