National Park Service
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Natural Resource Stewardship and Science

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region - Klamath, Sierra Nevada, and Upper Columbia Basin Networks

Standard Operating Procedures Version 1.0

(Appendix A to Narrative Version 1.0)

Natural Resource Report NPS/PWR/NRR—2012/533

ON THE COVER

From left to right, limber pine (*Pinus flexilis*) along the edge of a lava flow, Craters of the Moon National Monument and Preserve, Idaho (D. S. Stucki); whitebark pine (*P. albicaulis*), Yosemite National Park, California (S. T. McKinney); and foxtail pine (*P. balfouriana*), Sequoia National Park, California (S. T. McKinney).

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Natural Resource Report NPS/PWR/NRR—2012/XXX

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1. Version numbers increase incrementally by tenths (e.g., version 1.1, version 1.2, …etc) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 …). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

2. Notify the Network Data Manager of any changes to the Protocol Narrative or SOPs so that the new version number can be incorporated in the Metadata of the project database.

3. Post new versions on the internet and forward copies to all individuals with a previous version of the Protocol Narrative or SOPs. A list will be maintained in an appendix at the end of this document.

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Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 1: Preparation for the Field Season

Version 1.0, June 2012

Change History

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Note: This SOP describes the step-by-step procedures for preparing for field work and for constructing, preparing, and organizing field equipment prior to the initiation of personnel training and entry into the field. Field time is expensive, both in time as well as in money. Adequate field and equipment preparation is crucial to a successful monitoring program.

Suggested Reading and Literature Cited

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapter 8 and Appendix 12 *in* Measuring and monitoring plant populations. U.S. Department of Interior, Bureau of Land Management, Denver, Colorado.

Kincaid, T., T. Olsen, D. Stevens, C. Platt, D. White, and R. Remington. 2011. *spsurvey*: Spatial survey design and analysis. R package version 2.2. Available from http://www.epa.gov/nheerl/arm/analysispages/software.htm (accessed 6 May 2011).

Odion, D. C., D. A. Sarr, S. R. Mohren, and S. B. Smith. 2011. Monitoring vegetation composition, structure and function in the parks of the Klamath Network Parks. Natural Resource Report NPS/KLMN/NRR—2011/401. National Park Service, Fort Collins, Colorado.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262–278.

Theobald, D. M., D. L. Stevens, D. White, N. S. Urquhart, A. R. Olsen, and J. B. Norman. 2007. Using GIS to generate spatially-balanced random survey designs for natural resource applications. Environmental Management 40:134–146.

Annual Review

Prior to the field season each year, beginning in December and January, the project lead should review the entire protocol, including SOPs, and should plan the field season. The season close-out checklist (SOP 6) from the previous year should also be reviewed for any outstanding tasks that need to be completed.

Annual planning includes:

- Hiring qualified field technicians
- Arranging overnight facilities and research permits
- Reviewing list of sampling locations
- Scheduling sampling
- Preparing field equipment (e.g., GPS, cameras)
- Backcountry travel

Hiring Qualified Field Technicians

Hiring of field technicians should begin in December of the preceding year. Network project leads should send advertisements and job descriptions to the Student Conservation Association (www.thesca.org) and/or work with the Network Program Managers to advertise for field technicians through other channels (e.g., an NPS STEP hire). It is important to generate interest in Network field technician positions among advanced undergraduate or post-baccalaureate students with training and experience in field botany from the Sierra Nevada and Pacific Northwest. A minimum of two dedicated field technicians per network are required each season to complete sampling. A 3- or 4-person crew is highly desirable, particularly in SIEN and KLMN where dense whitebark pine stands can be encountered. Past job descriptions and announcement documentation is stored in Network white pine project directories for personnel information. Sharing of field technicians among Networks is strongly recommended, and because of the wide phenological window within which sampling can be accomplished each season, this should be practical. Positions need to be advertised by March of each year and filled by April or at the latest May. Sharing of technicians and joint training among KLMN, SIEN, and UCBN should be pursued each year. Review of technician training including plant identification is particularly important. Training is covered in SOP 2.

Field technicians must be capable of learning the sampling methods. They must quickly learn or already know common plants found in park white pine stands where they will be sampling, and must have experience and be comfortable working independently outdoors all day in remote and sometimes arduous conditions. The Network white pine monitoring project leads should seek individuals with the following capabilities:

- College-level training in plant taxonomy or systematic botany and forest inventory methods (e.g., use of clinometers).
- Previous experience working at least seasonally under rugged field conditions and in group living situations.
- Evidence of personal initiative and an independent, self-starter work ethic.

- Meticulous attention to details and demonstrated interest in natural resource conservation.

Additional details of required and desired qualifications are available from past job announcements and descriptions in Network white pine project personnel directories.

Arranging Overnight Facilities and Research Permits

Preparation for extensive backcountry travel in SIEN should be well planned and is described in a separate section at the end of this SOP. Lodging and camping sites for field crews will need to be reserved with the separate parks or other local facilities by November preceding the field season. Campsite or other overnight facilities should be optimized in terms of convenience ahead of time based on the field schedule for plot sampling. It is also important to check to make sure research permits are up to date, and to inform the Park point-of-contact (usually a resource chief or surrogate) for the protocol of the plans for the year's sampling by March. The park contact should be consulted at this time about any potential impediments to plans due to trail, road, or campsite closures, or other planned inconveniences. Research permits can be requested through the NPS research permit and reporting system (https://science.nature.nps.gov/research/ac/ResearchIndex). Requests are coordinated through the Network Program Manager.

Review the List of Spatially-Balanced Sampling Locations

Important Note: White pine sampling locations have been drawn using the Generalized Random Tessellation Stratified (GRTS) spatially-balanced sampling algorithm (Stevens and Olsen 2004, Theobald et al. 2007, Kincaid 2011). In order for the spatial balance of the sample to be maintained, the suite of sites included in the sample must follow the GRTS ordered list (sites can be moved slightly ["offsetting"]. See SOP 4 "Plot Offsetting and Replacement" for further details.). Each panel (yearly collection of sample locations to be visited) will be an ordered subset of the GRTS list, and panel membership is noted for each sample location. Table 1 provides an example from the UCBN. The most recent and up-to-date location of sampling plot locations is provided in annual reports. Examples from 2011 can be found in Stucki and McKinney (*In Prep*) and Stucki and Rodhouse (2012). These lists should be consulted before going in to the field in subsequent years. Once all permanent plots have been established (2013 for SIEN and UCBN, 2014 for KLMN), tables will be included in a revised version of this SOP for future reference. To view the maps and coordinates of sampling locations, stored as shapefiles, use the Network white pine project GIS. The *spsurvey* package (Kincaid et al. 2011, available on-line at http://www.epa.gov/nheerl/arm/ or http://www.R-project.org) in the R statistical software and environment (version 2.11.0, 2010; R Development Core Team, Vienna, Austria, available on-line at http://www.R-project.org) was used to generate GRTS sampling locations. Example R code for drawing GRTS samples is available from each Network white pine project directory (see SOP 6 for directory structure).

Review each site within the target panel (e.g., panel 2 for start-up year 2, or for subsequent years in which panel 2 is scheduled for sampling) ahead of field work to determine *a priori* if sites need to be replaced. Criteria for dropping sites are listed in SOP 4. Use the project GIS with high resolution imagery (e.g., NAIP imagery) to determine if adequate numbers of trees appear to be within the plot area, or to identify other potential problems. ArcMap extensions, such as Hawth's Analysis Tools (H. Beyer, 2006, available on-line at http://www.spatialecology.com/htools/) can be used to draw plots to assist in this office review. Figure 1 provides an example illustration of

this procedure for CRMO. The supply of replacement sites will be drawn, in GRTS list order, from the list of oversamples provided by each Network. Track the evaluation status of each site so that inclusion probabilities can be recalculated to support the use of design-based status estimators and properly weighted trend analyses (Table 1; Kincaid 2011). Note, however, that these are equal probability surveys and GRTS weights are not used (cancel out) in the estimation procedures described in SOP 7.

Survey planning for years subsequent to start-up should also carefully review fixed sampling locations, retiring sites that can no longer be sampled, and replacing as necessary. Plan visits to sampling locations by grouping visits into "hitches." Hitches refer to time spent in the field collecting data at multiple sampling locations and usually include several overnights. Load waypoints for the final evaluated list of target panel and oversample locations into project GPS units following instructions in SOP 3.

Figure 1. A map illustrating panel 1 (year 1) and oversample survey locations, from the GRTS list, and 50 x 50 m plot outlines for a portion of CRMO. Base imagery is 1-m resolution National Agricultural Imagery Project (NAIP) aerial photography, providing a means to identify sites needing replacement *before* going into the field.

Scheduling and Organizing Field Work

Surveys will begin no sooner than early June in the lower elevations and proceed upward as the season progresses. Scheduling of fieldwork and planning of hitches also needs to begin as early as possible, no later than March of the sampling event year. Network project leads have primary responsibility for ensuring that all hiring, schedules, and logistical details are addressed. Close coordination with park resource staff is absolutely essential.

Prior to the field season, the entire schedule of locations that will be sampled should be organized so as to avoid unnecessary travel time. During the start-up period (3 years for all parks), new sample sites for each year (panel) will be visited, following the ordered GRTS lists.

Review this list carefully and prepare "hitches" or tours that enable proximal sites to be visited as efficiently as possible. Spatially proximal sites are not necessarily in GRTS order. Therefore, care should be taken to ensure that the complete suite of sites within each panel can be accomplished during the season; otherwise a spatially unbalanced "hole" in the sample will result. If it is unclear whether the full panel can be visited, then a smaller subset of panel sites, following GRTS order, should be targeted first, thereby ensuring spatial balance. In subsequent years, field routes for hitches will be established based on past experience traversing park terrain and the particular arrangement of sample locations to minimize total travel time.

Sampling period plans must include a sufficiently flexible window of dates to accommodate unusual weather events, fire activity, snowmelt, and other complications such as trail and park road maintenance. Approximately 1.5 months should be allocated for a two person crew to complete a panel in each park. This allows for excess travel time and should adequately account for other workflow challenges such as weather or fire activity and road and trail closures. Access roads and other important location information may need to be loaded into GPS units to aid in efficient orientation to sample sites. Camping sites should be planned and reserved to avoid unnecessary and unproductive travel to and from areas to be sampled. Anticipate that some sites will be dropped, particularly during the first few years of implementation when sampling frame errors have not been resolved ahead of time. Allow time at the end of each sampling session to pick up replacement points. Because of the GRTS spatially-balanced design, replacement points will not necessarily be near dropped sites (but see Odion et al. 2011 for an alternative approach used in KLMN vegetation monitoring), underscoring the importance of thorough office evaluation *before* going into the field! SOP 4 describes procedures for replacing sites during field work.

Target sample sizes are 30 per panel in the UCBN, 10 in KLMN, and 16 per panel for each year-park-species combination in SIEN, where a panel refers to a collection of plots measured in a given year. Sampling during start-up, when plot marking and tree tagging is most time consuming, will take longer. Pilot work conducted in each of the three Networks indicates that one plot can be completed per day, although remote plots that require extensive travel should be allocated extra travel time.

Anticipate that some sites will be dropped, particularly during the first few years of implementation when sampling frame errors have not been resolved ahead of time. Allow time at the end of each sampling session to pick up replacement sites.

Equipment Preparation

Equipment List: Each independent field team will need a full set of equipment. An inventory of existing equipment, needed repairs identified, and construction or purchases of additional equipment must be made well in advance of the approaching field season. The required equipment is as follows:

Measuring Equipment

- Three 50-m reel tapes
- Wire pin flags for temporary plot boundary markers (approx. 20)
- 2 small tape measures for assessing seedling/sapling height classes

- Surveyor's pins for temporarily anchoring corners
- Compass with inclinometer for estimating slopes
- Laser rangefinder with capacity for measuring tree height
- Diameter tape
- Small hatchet
- Yellow crayon for temporarily marking seedlings during counts
- Plant ID references (e.g. regional floras and photographic tree guides)
- 10x Binoculars for looking into tall trees for rust, cone production, etc.

Plot marking and Tree Tagging Equipment

- Short (e.g., 8-10 inches) ½" rebar
- Yellow rebar caps ½" dia. with "NPS" engraved
- 1 ¼" round aluminum or steel tree tags consecutively numbered in sets of 500
- Wood siding sinker head style galvanized aluminum nails, 2 ¼" length
- Steel wire for securing tags to small trees where nails won't work
- Pliers with wire cutter
- Small mallet suitable for driving rebar and tag nails

Navigation and Recording Equipment

- Weatherized data entry PDA or tablet PC with supporting data entry software (e.g., Microsoft Access, DataPlus, Pendaragon, etc.)
- GPS, preloaded with sample location waypoints
- Clipboard with mechanical pencils and extra lead
- Backup paper data forms (weatherized Rite-in-the-Rain paper; see Appendix 1 at the end of this SOP)
- USGS 7.5' topographic maps for route finding (for CRMO BLM topographic maps)
- Field reference maps identifying clusters of proximal sample points, access locations, and other key travel information

Miscellaneous Field Equipment

- Plastic file box for storage of data sheets (in vehicle) with folders and extra forms, mechanical pencils, and Rite-in-the-Rain note paper
- Wire brush for cleaning tires, boots, and trousers of weed seeds, and for exposing discolored bark on trees infected with rust
- Small spray bottle for wetting tree bark to help identify rust symptoms
- Metal detector (optional) for re-locating plot markers
- Solvent for cleaning pitch off of tapes and other equipment
- Daypack and overnight backpack
- Sunscreen
- Water bottles
- First Aid kit
- 2-way handheld radio
- Cell phone (optional)
- SPOT satellite emergency beacon (pre-programmed)
- Park 2-way radios

- Radio repeater maps for large backcountry parks
- Digital camera
- Spare batteries for GPS, PDA, and camera
- Emergency contact information
- Field-relevant SOPs (SOP 1–5)
- Fire extinguisher, shovel, and other park-specific vehicle safety equipment required

Preparation of Navigation and Field Data Management Equipment

1. The sampling point locations must be uploaded to each GPS unit following procedures outlined in SOP 3. GPS preplanning also includes review of satellite availability for the duration of the scheduled sampling window, and is described in SOP 3. Park sites may be in dense forest with closed canopy, compromising the performance of GPS units. Some sites near cliffs can have poor satellite coverage as well. Make necessary schedule changes if an unusually poor arrangement of satellites is scheduled during the sampling window. Digital data entry tools (PDAs and Table PCs) should be checked and preloaded with software and files. At least one back-up GPS unit should also be available and also have all necessary files pre-loaded.
2. Access roads and other important location information may need to be loaded into GPS units to aid in efficient orientation to sample sites.
3. Be sure to completely charge all GPS units, data entry units, radios, and digital cameras, as well as backup batteries, prior to departure for the field. Provide back-up batteries to each field crew!
4. Paper data sheets should be prepared and at least 25% printed to Rite-in-the-Rain paper for each field team. Field reference maps of park sampling areas and plot locations must be prepared in advance of field work with sample points organized and color coded by proximity in order to guide efficient field travel. Reference maps should be printed on Rite-in-the-Rain paper. Data entry forms should be revised and printed, with extra copies available for each team. Note that paper data sheets are only provided for back-up in case of tablet PC failure.

Preparation for Backcountry Travel

The Project Lead should be familiar with and 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. Links to park website information on backcountry and wilderness regulations are listed below.

CRLA NP--http://www.nps.gov/archive/crla/brochures/backcountry.htm
CRMO NP--http://www.nps.gov/crmo/planyourvisit/wilderness.htm
LAVO NP--http://www.nps.gov/lavo/planyourvisit/wilderness-permit-information.htm
SEKI NP--http://www.nps.gov/seki/planyourvisit/wilderness.htm
YOSE NP--http://www.nps.gov/yose/planyourvisit/backpacking.htm

Miscellaneous Preparatory Notes

1. Analysis and reporting of previous year's data is necessary before starting a new field effort. This is covered in SOP 6, data management, and SOP 7, data summary and analysis. It is particularly important that sampling frame errors, hitch information, and other accumulated experience from previous years be documented *prior* to season close-out the previous year. A table of GRTS plot locations annotated with plot status (e.g., dropped, established and measured, etc.) will be included in each annual report. This information must be incorporated into pre-season planning in subsequent years. Update SOPs as necessary following instructions in SOP 8. This is particularly true during the first few years of testing and implementation. Changes to sampling frames or other design features are complex decisions with potentially serious statistical implications. Consult with a statistician before making any changes. All proposed changes to the protocol should be considered by all three networks and decisions made collaboratively.

2. Parks are large, rugged, and remote. Toilets will be unavailable during the day. Personal effects carried in daypacks should include toilet paper, hand trowel, and a Ziploc plastic bag for packing out garbage. **The KLMN, SIEN, and UCBN insist that their field crew members adopt a "leave no trace" ethic during all park visits**. Safety is critical consideration in all field work planning. Each year, the project Job Hazard Analysis will be reviewed and updated if necessary. All crew members must review and sign the Job Hazard Analysis during staff training. The general safety plan (SOP 9) should be reviewed during training, and specific park hazards, emergency contact information and procedures should be reviewed with park staff at the start of each park sampling session. A park debriefing will occur with park or network contacts at this time to review any emerging developments, such as fire hazard conditions. Park safety protocols must be reviewed and adhered to. A park-issued radio will be provided in order for back-country emergencies to be reported via radio repeater towers. Park radios should contain relevant external frequencies; i.e. nearby NFS or BLM contacts. Radio training must include competency on scrolling/using alternate channels.

3. SPOT satellite beacons or GeoPro satellite devices will be provided to crews for use in emergencies. These beacons must be pre-programmed to include non-emergency and emergency signal options. Crews must be carefully trained in the use and programming of these beacons based on information contained within individual Network Safety Plans. In the Sierra Nevada Network, a GeoPro device will be used as an additional means of communication between the field crew and the project lead or other SIEN staff, via texting capabilities these devices have.

4. Cell phones can be used but coverage is spotty at best. The team must check in with park contacts periodically during park sampling sessions to keep abreast of developing safety information, and to provide park staff with locations of operation. Provide two-way radios to each team. Make sure each team member knows where vehicle keys are to be stored during field operations, the location of the nearest pay phone and/or cellular phone coverage opportunity, and emergency contact and operation procedures for each park.

5. After the field season, be sure to clean and organize all non-electronic equipment and store in well labeled plastic bins in Network headquarters. Some of this equipment will be used by other Network monitoring projects so a well organized and well stored collection of equipment is essential. Remove batteries from GPS units and data entry tools requiring long-

term winter storage. PDAs need to remain charged to prevent loss of programs such as ArcPad, so these are typically stored according to guidance from the Network data manager. All equipment should be checked in with the Network staff person responsible for equipment inventories.

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel. Panel 1 sites are targeted for the first year of implementation. Oversample locations will provide the replacements for sites dropped during office and field evaluation. Criteria for dropping and replacing sites are listed in SOP 4. Annual reports (e.g., Stucki and McKinney *In Prep*, Stucki and Rodhouse 2012) will contain the most up-to-date information on the status of each sampling location and should be consulted prior to field work.

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-001	301115	4825065	140103	Panel_1	Ok	
Site-002	300939	4824870	140103	Panel_1	Drop	No Trees
Site-003	293586	4810607	140103	Panel_1	Ok	
Site-004	293666	4814204	140103	Panel_1	Ok	
Site-005	301828	4824600	140103	Panel_1	Ok	
Site-006	295994	4811966	140103	Panel_1	Ok	
Site-007	291988	4813011	140103	Panel_1	Ok	
Site-008	294209	4814123	140103	Panel_1	Ok	
Site-009	303667	4824640	140103	Panel_1	Ok	
Site-010	294712	4811265	140103	Panel_1	Ok	
Site-011	291294	4813692	140103	Panel_1	Ok	
Site-012	296911	4800376	140103	Panel_1	Ok	
Site-013	304659	4824048	140103	Panel_1	Ok	
Site-014	293707	4811589	140103	Panel_1	Ok	
Site-015	292101	4813409	140103	Panel_1	Ok	
Site-016	296891	4801996	140103	Panel_1	Ok	
Site-017	301542	4825198	140103	Panel_1	Ok	
Site-018	305824	4823410	140103	Panel_1	Ok	
Site-019	295118	4810758	140103	Panel_1	Ok	
Site-020	294730	4814022	140103	Panel_1	Ok	
Site-021	303039	4823964	140103	Panel_1	Ok	
Site-022	295975	4811383	140103	Panel_1	Ok	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-023	290555	4812331	140103	Panel_1	Ok	
Site-024	293947	4813626	140103	Panel_1	Ok	
Site-025	303719	4824073	140103	Panel_1	Ok	
Site-026	295340	4811495	140103	Panel_1	Ok	
Site-027	291079	4814799	140103	Panel_1	Ok	
Site-028	296718	4800889	140103	Panel_1	Ok	
Site-029	304915	4823823	140103	Panel_1	Ok	
Site-030	293566	4809910	140103	Panel_1	Ok	
Site-031	291577	4813730	140103	Panel_2	NotEval	
Site-032	295472	4802778	140103	Panel_2	NotEval	
Site-033	304300	4826526	140103	Panel_2	NotEval	
Site-034	306073	4823807	140103	Panel_2	NotEval	
Site-035	295200	4811218	140103	Panel_2	NotEval	
Site-036	294766	4813556	140103	Panel_2	NotEval	
Site-037	302871	4823979	140103	Panel_2	NotEval	
Site-038	295598	4812002	140103	Panel_2	NotEval	
Site-039	290663	4811751	140103	Panel_2	NotEval	
Site-040	294355	4813440	140103	Panel_2	NotEval	
Site-041	303580	4823866	140103	Panel_2	NotEval	
Site-042	295180	4812078	140103	Panel_2	NotEval	
Site-043	293164	4813666	140103	Panel_2	NotEval	
Site-044	288434	4801641	140103	Panel_2	NotEval	
Site-045	304577	4823629	140103	Panel_2	NotEval	
Site-046	294305	4809980	140103	Panel_2	NotEval	
Site-047	292956	4814364	140103	Panel_2	NotEval	
Site-048	292834	4803156	140103	Panel_2	NotEval	
Site-049	302880	4823540	140103	Panel_2	NotEval	
Site-050	311063	4804198	140103	Panel_2	NotEval	
Site-051	295022	4810522	140103	Panel_2	NotEval	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-052	295060	4813705	140103	Panel_2	NotEval	
Site-053	302770	4824020	140103	Panel_2	NotEval	
Site-054	295907	4811324	140103	Panel_2	NotEval	
Site-055	293220	4810176	140103	Panel_2	NotEval	
Site-056	293539	4815391	140103	Panel_2	NotEval	
Site-057	305092	4824058	140103	Panel_2	NotEval	
Site-058	293668	4812967	140103	Panel_2	NotEval	
Site-059	293075	4813684	140103	Panel_2	NotEval	
Site-060	293628	4802601	140103	Panel_2	NotEval	
Site-061	300591	4824699	140103	Panel_3	NotEval	
Site-062	293978	4810413	140103	Panel_3	NotEval	
Site-063	294917	4814198	140103	Panel_3	NotEval	
Site-064	292151	4803504	140103	Panel_3	NotEval	
Site-065	304011	4824783	140103	Panel_3	NotEval	
Site-066	294908	4811493	140103	Panel_3	NotEval	
Site-067	291054	4813537	140103	Panel_3	NotEval	
Site-068	296790	4801111	140103	Panel_3	NotEval	
Site-069	304753	4823217	140103	Panel_3	NotEval	
Site-070	294080	4811914	140103	Panel_3	NotEval	
Site-071	291785	4813612	140103	Panel_3	NotEval	
Site-072	297015	4801669	140103	Panel_3	NotEval	
Site-073	302627	4825972	140103	Panel_3	NotEval	
Site-074	305535	4823870	140103	Panel_3	NotEval	
Site-075	295120	4811155	140103	Panel_3	NotEval	
Site-076	294809	4813860	140103	Panel_3	NotEval	
Site-077	303850	4823865	140103	Panel_3	NotEval	
Site-078	295168	4811396	140103	Panel_3	NotEval	
Site-079	293237	4815406	140103	Panel_3	NotEval	
Site-080	296835	4800639	140103	Panel_3	NotEval	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-081	305013	4823533	140103	Panel_3	NotEval	
Site-082	293649	4810222	140103	Panel_3	NotEval	
Site-083	291798	4814981	140103	Panel_3	NotEval	
Site-084	296125	4802713	140103	Panel_3	NotEval	
Site-085	302765	4823835	140103	Panel_3	NotEval	
Site-086	305987	4824004	140103	Panel_3	NotEval	
Site-087	294807	4810705	140103	Panel_3	NotEval	
Site-088	294619	4813224	140103	Panel_3	NotEval	
Site-089	302677	4824350	140103	Panel_3	NotEval	
Site-090	295536	4811872	140103	Panel_3	NotEval	
Site-091	293447	4810027	140103	OverSamp	Ok	Replace site 2
Site-092	294175	4813651	140103	OverSamp	NotEval	
Site-093	304496	4823240	140103	OverSamp	NotEval	
Site-094	293647	4810962	140103	OverSamp	NotEval	
Site-095	295045	4814190	140103	OverSamp	NotEval	
Site-096	293003	4803076	140103	OverSamp	NotEval	
Site-097	301546	4824656	140103	OverSamp	NotEval	
Site-098	287801	4814990	140103	OverSamp	NotEval	
Site-099	295196	4810590	140103	OverSamp	NotEval	
Site-100	294978	4814064	140103	OverSamp	NotEval	
Site-101	302472	4824455	140103	OverSamp	NotEval	
Site-102	295745	4811671	140103	OverSamp	NotEval	
Site-103	293382	4810414	140103	OverSamp	NotEval	
Site-104	295700	4814272	140103	OverSamp	NotEval	
Site-105	304899	4824020	140103	OverSamp	NotEval	
Site-106	294428	4813154	140103	OverSamp	NotEval	
Site-107	292283	4813212	140103	OverSamp	NotEval	
Site-108	296658	4801826	140103	OverSamp	NotEval	
Site-109	301555	4825114	140103	OverSamp	NotEval	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-110	305403	4823421	140103	OverSamp	NotEval	
Site-111	293677	4810343	140103	OverSamp	NotEval	
Site-112	294642	4814036	140103	OverSamp	NotEval	
Site-113	302275	4824725	140103	OverSamp	NotEval	
Site-114	296363	4811541	140103	OverSamp	NotEval	
Site-115	293386	4811280	140103	OverSamp	NotEval	
Site-116	294287	4813701	140103	OverSamp	NotEval	
Site-117	304932	4823247	140103	OverSamp	NotEval	
Site-118	293804	4809963	140103	OverSamp	NotEval	
Site-119	291520	4813280	140103	OverSamp	NotEval	
Site-120	295907	4802853	140103	OverSamp	NotEval	
Site-121	302949	4826106	140103	OverSamp	NotEval	
Site-122	305605	4823643	140103	OverSamp	NotEval	
Site-123	295375	4810819	140103	OverSamp	NotEval	
Site-124	294664	4813915	140103	OverSamp	NotEval	
Site-125	303216	4824298	140103	OverSamp	NotEval	
Site-126	295692	4812182	140103	OverSamp	NotEval	
Site-127	290585	4813182	140103	OverSamp	NotEval	
Site-128	294151	4813371	140103	OverSamp	NotEval	
Site-129	303091	4823933	140103	OverSamp	NotEval	
Site-130	309948	4809940	140103	OverSamp	NotEval	
Site-131	294592	4810538	140103	OverSamp	NotEval	
Site-132	295425	4813856	140103	OverSamp	NotEval	
Site-133	302442	4824333	140103	OverSamp	NotEval	
Site-134	295560	4811369	140103	OverSamp	NotEval	
Site-135	293327	4809866	140103	OverSamp	NotEval	
Site-136	293774	4814043	140103	OverSamp	NotEval	
Site-137	304811	4824368	140103	OverSamp	NotEval	
Site-138	294889	4813122	140103	OverSamp	NotEval	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-139	293029	4813279	140103	OverSamp	NotEval	
Site-140	288732	4808224	140103	OverSamp	NotEval	
Site-141	304159	4824010	140103	OverSamp	NotEval	
Site-142	295629	4812236	140103	OverSamp	NotEval	
Site-143	293406	4810927	140103	OverSamp	NotEval	
Site-144	295561	4814067	140103	OverSamp	NotEval	
Site-145	304876	4824692	140103	OverSamp	NotEval	
Site-146	293519	4812093	140103	OverSamp	NotEval	
Site-147	292280	4813651	140103	OverSamp	NotEval	
Site-148	296521	4801852	140103	OverSamp	NotEval	
Site-149	301092	4824809	140103	OverSamp	NotEval	
Site-150	294440	4810351	140103	OverSamp	NotEval	
Site-151	294148	4814375	140103	OverSamp	NotEval	
Site-152	291404	4803376	140103	OverSamp	NotEval	
Site-153	303254	4824527	140103	OverSamp	NotEval	
Site-154	296106	4811673	140103	OverSamp	NotEval	
Site-155	290472	4812002	140103	OverSamp	NotEval	
Site-156	293635	4813441	140103	OverSamp	NotEval	
Site-157	303463	4824107	140103	OverSamp	NotEval	
Site-158	295338	4811425	140103	OverSamp	NotEval	
Site-159	291444	4813532	140103	OverSamp	NotEval	
Site-160	296634	4801212	140103	OverSamp	NotEval	
Site-161	303513	4823379	140103	OverSamp	NotEval	
Site-162	295125	4811768	140103	OverSamp	NotEval	
Site-163	292853	4813451	140103	OverSamp	NotEval	
Site-164	296295	4797898	140103	OverSamp	NotEval	
Site-165	304473	4823877	140103	OverSamp	NotEval	
Site-166	294056	4809875	140103	OverSamp	NotEval	
Site-167	293170	4814174	140103	OverSamp	NotEval	

Table 1. Spatially-balanced list of sampling locations for CRMO, organized by panel (continued).

Plot ID	UTM X	UTM Y	wgt	panel	EvalStatus	EvalReason
Site-168	293147	4802810	140103	OverSamp	NotEval	
Site-169	300702	4824615	140103	OverSamp	NotEval	
Site-170	293599	4810996	140103	OverSamp	NotEval	
Site-171	294501	4814468	140103	OverSamp	NotEval	
Site-172	292226	4803247	140103	OverSamp	NotEval	
Site-173	301546	4824790	140103	OverSamp	NotEval	
Site-174	295805	4811144	140103	OverSamp	NotEval	
Site-175	294623	4811194	140103	OverSamp	NotEval	
Site-176	294080	4813699	140103	OverSamp	NotEval	
Site-177	300998	4824669	140103	OverSamp	NotEval	
Site-178	293957	4810738	140103	OverSamp	NotEval	
Site-179	294140	4814465	140103	OverSamp	NotEval	
Site-180	291407	4803515	140103	OverSamp	NotEval	

Appendix 1. Field Data Sheet

Plot Field ID	Lower Left Corner (1) X	Lower Left Corner (1) Y	Date
Corner 1 to 2 azimuth (deg.)	Lower Right Corner (4) X	Lower Right Corner(4) Y	Observer
Corner 2 to 3 azimuth	Upper Left Corner (2) X	Upper Left Corner (2) Y	Plot Photo File 1
Corner 3 to 4 azimuth	Upper Right Corner (3) X	Upper Right Corner (3) Y	Plot Photo File 2
Slope (deg.)	Aspect (deg.)	Elevation (m)	Plot Photo File 3
Regeneration Plot 1 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 2 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 3 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 4 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 5 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 6 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 7 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 8 Count	20-50 cm	51-100 cm	101-137 cm
Regeneration Plot 9 Count	20-50 cm	51-100 cm	101-137 cm
Notes			

Appendix 1: Field Data Sheet (continued)

Subplot ID (1-5)	Tree ID	Species	Clump #	Stem Letter	DBH (≥1.37 m)	Height (m)	Status (L, RD, D)	Branch Cankers (Upper Third)		Branch Cankers (Middle Third)		Branch Cankers (Bottom Third)		Bole Cankers (Upper Third)		Bole Cankers (Middle Third)		Bole Cankers (Bottom Third)		Rodent Chewing	Flagging	Oozing	Roughened Bark	Swelling	Crown Kill (%)	Crown Kill (%)	Crown Kill (%)	J-shaped gallery	Pitch tubes	Frass	Mistletoe (y/n)	Cause of Death	Cones (Y/N)
								A	I	A	I	A	I	A	I	A	I	A	I														

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 2: Training Field Personnel

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes the step-by-step procedures for training field personnel. Definitions for terms crew members are required to know are presented in Table 2. Use of the GPS to locate waypoints and navigate to field sites is discussed in SOP # 3 and should also be reviewed and practiced before commencing field work. Procedures for plot set-up and measurements are detailed in SOPs # 4 and # 5. Procedures for data management are in SOP # 6. These SOPs should be used as training manuals and hard copies provided to each technician for reference throughout the field season. Note that field SOPs are not meant to be stand-alone training manuals replacing the thorough documentation available for GPS and field botany techniques. Training personnel should refer to these SOPs as a guide and seek out additional information in the suggested reading and through hands-on training courses provided by NPS and outside sources. A list of technical references for plant identification, including regional floras as well as park plant species lists, is provided at the end of this SOP. Up-to-date and certified park species lists are available through the IRMA Portal (https://irma.nps.gov/App/Portal/Home)

Suggested Reading

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Hagle, S. K., K. E. Gibson, and S. Tunnock. 1990. Field Guide to disease and insect pests of Northern and Central Rocky Mountain Conifers. USDA Forest Service, Report Number R1-03-08, 197 pp.

Hawksworth, F. G. and D. Wiens. 1996 Dwarf mistletoes: Biology, pathology and systematic. USDA Forest Service. Agriculture Handbook No. 709, 410 pp.

Hoff, R. J. 1992. How to recognize blister rust infection on whitebark pine. Research Note INT-406. US Forest Service, Intermountain Research Station, Ogden, Utah.

Six, D. L., and M. Newcomb. 2005. A rapid system for rating white pine blister rust incidence, severity, and within-tree distribution in whitebark pine. Northwest Science 79:189-195.

Tomback, D. F., S. F. Arno, and R. E. Keane. 2001. Whitebark pine communities: ecology and restoration. Island Press, Washington D.C.

Roles and Responsibilities

It is important to identify a lead trainer, typically the project lead, if present, or the designated field lead. This person should be well versed in the protocol and SOPs, and have considerable experience both conducting field work as well as training and directing technicians. Furthermore, the trainer must have either previously worked in the field implementing this protocol for one of the three networks, or have had direct experience working in white pine systems infected with blister rust. The lead trainer should provide field technicians with a copy of the narrative and SOPs prior to technicians arriving on site for training. At the start of field training, technicians should be familiar with program objectives, ecological context, and field methods.

Training Location

Field measurement operations are best taught outside, at a park white pine site, or another analogous woodland location. Indoor lab environments with sufficient space to set up laptops and to project presentations are also very helpful. It is recommended that the group complete data collection as a training exercise for 1 or more of the actual plots in that year's panel to simultaneously deliver hands-on experience and to "get some work done." Ideally, the group can visit a site where a range of blister rust infection symptoms can be seen (e.g., the rim of Crater Lake at CRLA). Currently this may be difficult at SIEN parks and LAVO due to rarity of infections. Recent infections in CRMO trees will provide such an opportunity in the northern portion of that park. Actual signs of mountain pine beetle and other wood-boring beetles should be located ahead of training and these locations visited during training. Also, practice sample points located in an anticipated training area can be included in the waypoint list, enabling participants to practice GPS navigation and plot set-up without trampling vegetation in an actual plot. Instruct the crew on how to relocate plot markers.

Training Outline

Goals

- Understand and demonstrate a sincere appreciation for, and commitment to follow, safety procedures, including regular communication with Park points of contact and Network headquarters.
- Backcountry travel and safety procedures must be carefully reviewed and practiced.
- Review plant identification terminology.
- Review use of plant identification manuals, keys, and photos.
- Acquire proficiency in identification of common native and invasive herbs, shrubs, and trees found in respective park white pine stands. A list of common species for each park is included in Appendixes 2-4, which are located at the end of this SOP.
- Acquire confidence and consistency in measuring tree diameters at 1.37 m above ground.
- Understand and be able to demonstrate an ability to distinguish trees, stems, and clumps and assign identification codes to them. Discuss the relative difficulty of this determination in high alpine site such as those at YOSE where stem/clump distinction becomes challenging.
- Accurately measure tree heights with both a clinometer and a laser rangefinder (in case the rangefinder is not available).

- Acquire confidence in recognizing the signs of blister rust, mistletoe infection, and mountain pine beetle.
- Acquire confidence and consistency in visually estimating the amount of live and dead canopy, and the amount of canopy and bole infected with blister rust (hypothetically, at least, during training).
- Acquire proficiency in use of GPS equipment and navigation to sampling points.
- Acquire proficiency in use of PDA and/or Tablet PCs and accompanying data entry software, including troubleshooting and procedures for backing up data.
- Demonstrate competence in all field skills, including meticulous data entry, compass reading, and attention to detail in the field environment.
- Understand procedures for plot boundary decisions, sampling frame errors, and dropping and adding sites.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, safety procedures, including regular communication with Park points of contact and Network headquarters.
- Backcountry travel and safety procedures must be carefully reviewed and practiced.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, procedures for the prevention of non-native species spread during field work.
- Demonstrate appreciation of overall program monitoring goals.

Agenda

Day 1

Morning

Arrival and orientation
Get acquainted, backgrounds of participants, team building
Individual protocol study

Afternoon

Group program orientation and protocol discussion
Data management and QA/QC
Introductory review of safety procedures and contact information
Additional network or park-specific safety training will be done on-site in the parks where monitoring is conducted.
Review of procedures for preventing the spread of non-native species

Day 2

Morning

Field demonstration of all field methods, including use of PDA/Tablet PCs
GPS practice
Review of plot boundary decisions, add/drop criteria, procedures, and documentation

Afternoon

Plant identification

Blister rust, mistletoe, and pine beetle identification
Methods practice and calibration among observers (i.e., repeatability among observers for measuring dbh, tree ht., etc…)

Day 3

Morning

Practice navigating to plots and plot set up
Field walk identifying plants
Familiarization with park terrain, safety, and general travel and hazard issues, and procedures to prevent non-native species spread

Afternoon

Group field methods practice and calibration

Day 4

Morning

Group practice – set-up of 1 real plot

Afternoon

Group practice – completion of 1 real plot

Day 5

Morning

Group practice, troubleshooting, GRTS and field decisions

Afternoon

Review, scheduling, planning
Outstanding issues

Definitions

Definitions for key field terms are presented in Table 2 and should be reviewed during training.

Table 2. Important field definitions for monitoring white pine plots in the Pacific West Region.

Term	Definition
Dbh	Diameter of the tree bole at 1.37 m above ground.
Panel	A panel of sampling locations or plots consists of a subset of the total sample size that is visited within a given year or season. For example, for a total of 90 sample points, 3 panels of 30 points each are visited once each year for 3 years, and then this rotation is repeated.
Plot	The defined unit of measurement (e.g., 50 x 50 m), with boundaries framed permanently by rebar corner and center pins, and temporarily during sampling along sides and center by 50-m reel tapes. The plot is anchored by a corner pin in the lower right corner at the GRTS sample point UTM coordinates. The plot is oriented along the contour.
Target Population	The predetermined collection of plant communities (limber pine woodlands in CRMO; whitebark pine woodlands and mixed whitebark/other conifer forest in KLMN and SIEN; foxtail pine woodlands in SIEN) within PWR parks for which statistical inference is desired.
Sampling Frame	The physical representation of the target population. This is always imperfect and sampling frame errors and procedures for addressing them must be addressed in training.

Miscellaneous Training Topics to be Covered

1. Adequate time must be given to properly set up plots, and for decision-making associated with plot boundaries and dropping plots. While effort has been made to minimize these decisions (e.g., through office evaluation with a GIS), problems will inevitably be encountered. Each technician should understand that in order for the GRTS sample to remain valid, a plot location must be selected in the immediate vicinity of the GRTS point. A rejected plot location may be replaced by using an offset procedure described in SOP # 4, or via sequential selection of new sites from the GRTS sample.

2. Objective positioning of the plot is essential for unbiased parameter estimates. Placement of the plot is described in SOP # 4, but needs to be demonstrated for circumstances that may not be straightforward in training.

3. Train the technicians on compass use in establishing 90° plot corners. Teach the mnemonic "red in the shed" for orienting the compass correctly with magnetic north. Make sure that compass declinations are set correctly. Obtain proper declinations for each park from USGS topographic maps. Updated declinations can be found online at: http://www.ngdc.noaa.gov/geomagmodels/struts/calcDeclination.

4. Plot measurements should be practiced repeatedly as a group and by individuals who then compare results among group members. Repeatability is an important goal and needs to be assessed. Observers need to be calibrated. Placing the diameter tape consistently at 1.37 m is important to not give a false impression of rapid tree growth, for example, between consecutive sampling events. Practice dbh measurements on challenging trees (e.g., where slopes are steep) with multiple observers to calibrate. Refer to the Forestry Suppliers technical bulletin for instructions on using the clinometers. Print hard copies of the diagram included in the bulletin for field reference. Proper use of diameter tapes to measure dbh is described on page 92 of the NPS Fire Monitoring Handbook (www.nps.gov/fire/download/fir_eco_FEMHandbook2003.pdf).

5. Plant identification should be practiced throughout the training week in both a lab and field setting, and must include inspection of tree trunks and conifer needles. Emphasize the importance of plant recognition despite the emphasis on tree measurements. Recognizing other plants helps prevent misidentification of target species, and may also fuel important ancillary observations made in the notes field, such as an unusually dense understory of *Ribes*, an alternate host of blister rust. Another important opportunity for our teams to contribute to park management and conservation exists when field crews identify a previously unknown infestation of a noxious weed and promptly report its location to Park staff for immediate treatment. KLMN has a list of priority early detection plant species, and identification cards for these species, which will be reviewed and provided to field crews sampling at Crater Lake National Park and Lassen Volcanic National Park. Appendixes 2-4 list the principal species that should be emphasized during training for sampling in other parks. In some cases, the field leader must provide additional training on species identifications at the start of sampling in a new area. Typically this will occur during the first morning of field work at a different location, and will provide an opportunity for the team to re-calibrate to the new surroundings and vegetation. Training should include use of the quasi-

technical key FloraID Northwest (www.xidservices.com, Pendleton, OR), which will be loaded on laptops for use throughout the season.

6. Use of the tablet PCs and Microsoft Access data entry forms must be practiced and thoroughly understood by all field personnel. Tablet PCs use Windows 2007 operating systems, and are intuitively like desktop PCs. Practice with a stylus is required to gain proficiency in moving through screens and selecting options and keyboard use. Allow time for field practice as a group in data entry and in post-field backup procedures. Troubleshooting tips should be reviewed.

7. Safety procedures are outlined in SOP # 9. These must be reviewed as a group in a focused session, and the Job Hazard Analysis worksheet must be reviewed, and signed by all field personnel. For Yosemite and Sequoia and Kings Canyon National Parks, where backcountry travel is required, training will also include a review of park backcountry procedures, safe travel on steep and snow-covered terrain, camping logistics and preparation, and leave-no-trace ethics and techniques.

8. Weed spread prevention is a critical issue in all NPS field activities. The old adage "first do no harm" used in medicine applies to ecological monitoring as well. A wire brush should be kept in project vehicles at all times, and tires, undercarriage (**do not scratch paint!**), boots and clothing should be cleaned of as much weedy debris and seed as possible, as often as possible. Puncture vine (*Tribulus terrestris*) seeds may be picked up in tires and boots and should be removed before moving to new locations. It is particularly important that attention is given to travel from infested to uninfested Park areas. For example, moving from the Laidlaw Park area of CRMO back up to the Monument area is a concern, as the risk of weed spread into the (currently) relatively weed-free environment in the northern portion of CRMO is high. Regular practice should include brushing down vehicles, boots, and trouser legs at arrival and departure for each field jump-off point. This should only require a few minutes of extra time and is an important gesture of care and stewardship for our parks. Periodically, vehicles should be hosed down as an extra measure of prevention. Opportunities for this exist at the end of each day when passing through park headquarters. Park-specific procedures should be followed when provided, and this topic should be discussed with park staff at the beginning of each park sampling session.

9. As a service to our parks, please request that crew members remain alert for noxious weeds while working in plots and while traveling to and from plots. The location and species should be recorded in the data entry plot notes section. Information on the number of plants should be provided if possible. This information should be shared with park staff as soon as possible, and it will also be included in annual reports.

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Appendix 2. Common plants in KLMN whitebark pine communities that field technicians should be able to identify

	Common Name (Scientific Name)
Trees	
	whitebark pine (*Pinus albicaulis*)
	mountain hemlock (*Tsuga mertensiana*)
	lodgepole pine (*Pinus contorta*)
	red fir (*Abies magnifica*)
	western white pine (*Pinus monticola*)
Shrubs	
	Crater Lake currant (*Ribes erythrocarpum*)
	sulphur buckwheat (*Eriogonum umbellatum*)
	Greene's goldenbush (*Ericameria greenei*)
Graminoids	
	bottlebrush squirreltail (*Elymus elymoides*)
	western needlegrass (*Achnatherum occidentale*)
	Wheeler's bluegrass (*Poa wheeleri*)
	long-stolon sedge (*Carex inops*)
	Hitchcock's wood-rush (*Luzula hitchcockii*)
Forbs	
	Howell's rockcress (*Arabis platysperma*)
	Newberry's knotweed (*Polygonum newberryi*)
	Anderson's lupine (*Lupinus andersonii*)
	Pacific lupine (*Lupinus lepidus*)
	Cascade desert-parsley (*Lomatium martindalei*)
	cobwebby Indian paintbrush (*Castilleja arachnoidea*)
	pussy paws (*Calyptridium umbellatum*)

Appendix 3. Tree species in Sierra Nevada Network Parks that field crews need to be able to identify

	Common Name (Scientific Name)
Trees	
	whitebark pine (*Pinus albicaulis*)
	foxtail pine (*Pinus balfouriana*)
	limber pine (*Pinus flexilis*)
	western white pine (*Pinus monticola*)
	sugar pine (*Pinus lambertiana*)
	lodgepole pine (*Pinus contorta*)
	red fir (*Abies magnifica*)
	white fir (*Abies concolor*)
	Douglas-fir (*Pseudotsuga menziesii*)
	mountain hemlock (*Tsuga mertensiana*)
	giant sequoia (*Sequoiadendron giganteum*)
	incense cedar (*Calocedrus decurrens*)

Appendix 4. Common plants in CRMO limber pine communities that field technicians should be able to identify

Reference the CRMO vegetation inventory and mapping report by Bell et al. (2009) for additional descriptions of limber pine plant communities.

	Common Name (Scientific Name)
Trees	
	Douglas fir (*Pseudotsuga menziesii*)
	limber pine (*Pinus flexilis*)
	quaking aspen (*Populus tremuloides*)
	Rocky Mountain juniper (*Juniperus scopulorum*)
Shrubs	
	low sagebrush (*Artemisia arbuscula*)
	big sagebrush (*Artemisia tridentata*)
	threetip sagebrush (*Artemisia tripartita*)
	green rabbitbrush (*Chrysothamnus viscidiflorus*)
	gray rabbitbrush (*Ericameria nauseosus*)
	antelope bitterbrush (*Purshia tridentata*)
	wax currant (*Ribes cereum*)
	fern bush (*Chamaebatiaria millefolium*)
	ocean spray (*Holodiscus discolor*)
	mock orange (*Philadelphus lewisii*)
	chokecherry (*Prunus virginiana*)
Graminoids	
	bluebunch wheatgrass (*Pseudoroegneria spicata*)
	needle-and-thread (*Hesperostipa comata*)
	Idaho fescue (*Festuca idahoensis*)
	Sandberg bluegrass (*Poa secunda*)
	cheatgrass (*Bromus tectorum*)
	crested wheatgrass (*Agropyron cristatum*)
Forbs	
	dwarf goldenbush (*Haplopappus nanus*)
	cushion buckwheat (*Eriogonum ovalifolium*)
	silverleaf phacelia (*Phacelia hastata*)
	Douglas dustymaiden (*Chaenactis douglasii*)
	bitterroot (*Lewisia rediviva*)
	Anderson's larkspur (*Delphinium andersonii*)

Appendix 4. Common plants in CRMO limber pine communities that field technicians should be able to identify (continued).

Reference the CRMO vegetation inventory and mapping report by Bell et al. (2009) for additional descriptions of limber pine plant communities.

	Common Name (Scientific Name)
	sulphur buckwheat (*Eriogonum umbellatum*)
	tapertip hawksbeard (*Crepis acuminata*)
	prickly phlox (*Leptodactylon pungens*)
	sand gilia (*Gilia leptomeria*)
	slender woodland-star (*Lithophragma tenellum*)
Noxious Weeds	
	spotted knapweed (*Centaurea maculosa*)
	diffuse knapweed (*Centaurea diffusa*)
	Russian knapweed (*Acroptilon repens*)
	rush skeletonweed (*Chondrilla juncea*)
	leafy spurge (*Euphorbia esula*)
	Canada thistle (*Cirsium arvense*)
	musk thistle (*Carduus nutans*)
	scotch thistle (*Onopordum acanthium*)
	dalmatian toadflax (*Linaria dalmatica*)
	field bindweed (*Convolvulus arvensis*)
	Dyer's woad (*Isatis tinctoria*)

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 3: Finding GPS Waypoints

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: The purpose of this SOP is to describe the procedures necessary to navigate to sampling locations using GPS units, particularly the Garmin Map 76CSx. Information on GPS specifications and settings are also included. This SOP is not intended as a substitute user's guide for GPS units. Please consult the appropriate user's guide for more detailed information on unit functionality.

Suggested Reading

Garmin. 2005. GPSMAP 76CSx Owner's Manuel. Garmin International, Olathe, Kansas. Available online athttp://www8.garmin.com/support/userManual.jsp

Before the Field

Preparation is essential to successful field work, particularly when that field work relies on GPS data collection or navigation. The baseline GPS constellation consists of 24 satellites that orbit the earth approximately every 12 hours. The position and time signals transmitted by these satellites are used by GPS receivers to triangulate a location on Earth. While this process is subject to various sources of error, pre-planning can minimize the impacts.

Setting GPS Specifications

Verify Time: Time synchronization of the GPS receiver and GPS satellites is critical for the most accurate data collection and navigation. With the Garmin MAP76CSx, use the Time Setup Menu to set the time format, zone, and to conform to Daylight Savings Time.

Verify Projection and Datum: All GPS positioning information is referenced to the World Geodetic System 1984 (WGS84) datum (Figure 2). While the difference between WGS84 and NAD83 is minimal (<1 m), best practice is to navigate and collect data in WGS 84. For the five Pacific West Region parks being monitored for white pine dynamics, select the appropriate projection and datum listed in Table 3. With the Garmin MAP76CSx, use the Units Setup Menu to select the position format and map datum.

Table 3. Map datum and Transverse Mercator projection for each park unit.

Park	Datum	Projection
CRMO	WGS 84	UTM Zone 12N
YOSE	WGS 84	UTM Zone 11N
KICA	WGS 84	UTM Zone 11N
SEQU	WGS 84	UTM Zone 11N
CRLA	WGS 84	UTM Zone 10N
LAVO	WGS 84	UTM Zone 10N

Enable WAAS: Enabling WAAS (Wide Area Augmentation System) allows for real-time correction of GPS coordinates as long as the WAAS satellites are in view. Due to the fixed position of these satellites over the equator, signal reception is best in open areas with a clear view of the southern sky. With the Garmin MAP76CSx, use the System Setup Menu to enable WAAS.

Calibrate the Compass: The internal compass in the Garmin MAP76CSx should be calibrated prior to each use for increased accuracy in navigation. Use the Calibration Setup Menu to calibrate the compass. Follow the directions on screen.

Batteries: Lastly, fully charge the batteries and remember to take spares! The Garmin Map76 units tend to fail on battery power quickly and without warning.

Loading Waypoints: Sample points are generated using ArcGIS 9.1 and exported to a shape or dBase file for each park. Uploading these locations to the Garmin Map76CSx as waypoints is simplified by using DNRGarmin, a freeware program developed and maintained by the

Minnesota Department of Natural Resources. The program can be downloaded from http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html. The site has information on the application including installation guidelines and documentation.

To upload waypoints to the Garmin Map76CSx, connect the GPS unit to the PC and open DNRGarmin. DNRGarmin should display your GPS unit and say connect. If it does not, go to GPS and open port.

Use the File Menu to set the correct projection (Table 3 and Figure 3). Next go to 'Load Data' in the File Menu and select your shapefile or dBase file of interest. You can delete and or edit points, add comments, etc. if necessary. Use the GPS Menu to open the port to the GPS unit. Then, use the Waypoint Menu to upload the points to the GPS unit.

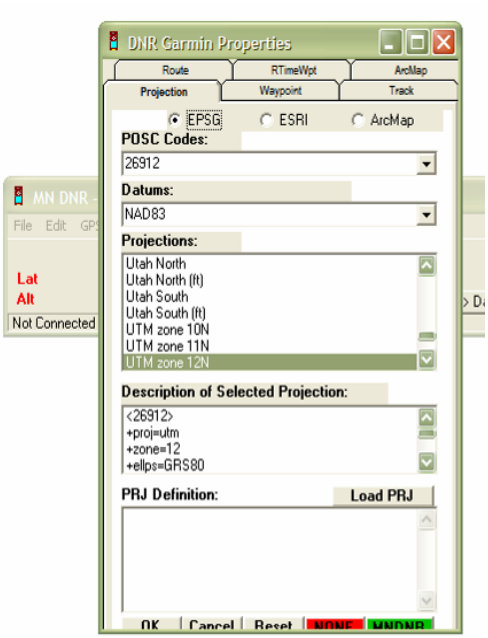

Figure 2. Screenshot from DNRGarmin used to set the correct map projection.

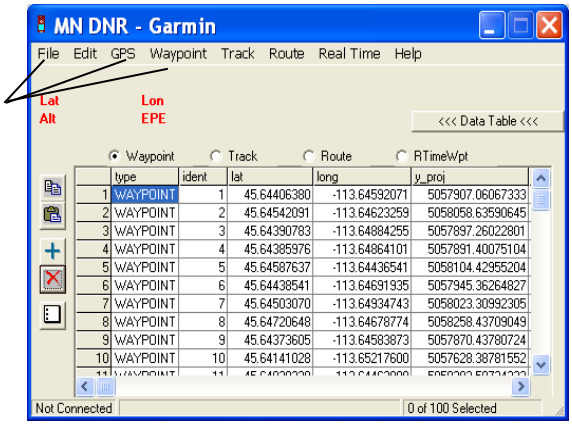

Figure 3. Screenshot from DNRGarmin used to view and upload selected waypoints.

In the Field

Monitoring Location Error

Ideally, you would be able to set thresholds for the maximum PDOP (Position Dilution of Precision) allowed as well as the minimum number of satellites. While you cannot set these values in the Garmin MAP76CSx, you can monitor the satellite strength and relative location error by using the Satellite Main Page (Figure 4).

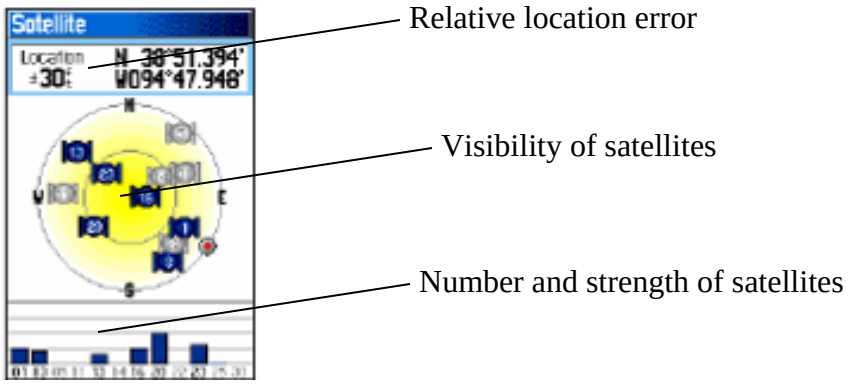

Figure 4. Screenshot from GPS unit for satellite information.

The maximum relative location error allowed should be set prior to beginning field work. For this monitoring protocol, the maximum location error allowed is 3 m. If a GPS unit is used that allows for user-defined PDOP thresholds, the maximum should be set at 6.

Selecting and Navigating to Waypoints

With Garmin Map76CSx, use the Find Menu to search for a waypoint of interest. Select 'Find by Name' and scroll to the point ID of interest. Conversely, you can select the waypoints icon and scroll to the Point ID of interest. Note that often the menu is set to 'Find by Nearest' and if no points are near, no points will be displayed (although because sample locations are clustered in a spatially balanced design this may be the most efficient setting for locating sample points). To change this setting, go to the waypoint menu, push the menu button, and select 'Find by Name.'

Once selected, the items information page for the waypoint opens, allowing you to show the item on the map (by selecting Map) or create a route to the point (select GoTo). Select 'GoTo' to navigate to the point. You can use the 'Page' button to switch through various pages, select the Compass page (Figure 5) and, holding the GPS level, walk in the direction indicated by the compass until the 'Dist to Dest' window reads zero.

When the person, navigating with the GPS unit, first approaches the waypoint location, the person will focus on the coordinates and ignore the vegetation. Once the GPS unit registers "zero" (or otherwise shows that the coordinates have been reached exactly), the person stops immediately. The location is marked with a chaining pin/screwdriver midway between the locator's boots. This will fix the southwest (lower left-hand) corner of the quadrat. The quadrat will be oriented along the line of travel to avoid trampling vegetation in that area before the quadrat frame is established.

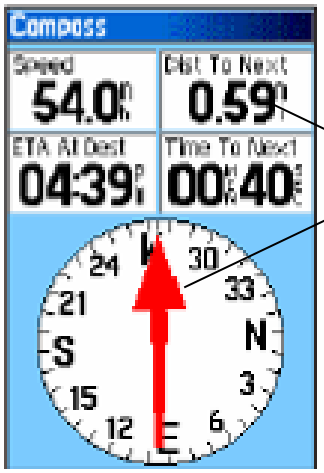

Figure 5. Screenshot from GPS unit compass page for navigation to a waypoint.

After the Field

Deleting Waypoints

After completion of fieldwork, delete any waypoints on the GPS units. Go to the Find Waypoints page, select Menu – Delete – All waypoints. Remove batteries from units before any long-term winter storage to prevent corrosion and leakage.

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 4: Locating an Establishing Plots

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: The purpose of this SOP is to describe the step-by-step procedures for establishing permanent sampling plots for long-term monitoring of high-elevation white pine forest dynamics. This SOP begins where SOPs 1, 2, and 3 leave off, with field preparations complete, crews trained and ready to hit the field with equipment, GPS units, and field reference maps.

Suggested Reading

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapter 8 *in* Measuring and monitoring plant populations. U.S. Department of Interior, Bureau of Land Management, Denver, Colorado.

Driving Directions

Craters of the Moon National Monument and Preserve

CRMO is a vast park that spans over 500,000 acres between Highway 93 and the Snake River north of Interstate 86. The park headquarters is located along Highway 93 on the north end of the monument, approximately 30 miles northeast of Carey, Idaho, and 18 miles west of Arco, Idaho. Park visits should always begin at the headquarters unless otherwise arranged with park staff. Remote camping is necessary during work in southern portions of the Preserve. Arrangements must be made with park staff. Check-in with park staff is essential before accessing the park to begin work, and daily when feasible. There are considerable challenges to driving and accessing areas of this large and rugged park. There are three main access roads into the interior of the park: the Park Loop Road, Laidlaw Park Road., and the Minidoka-Arco Road. Sampling of limber pine will require driving on all three of those roads. Most of the work will occur in the northern portion of the Monument and will be accessed from the Loop Road. Hitches should be organized around groups of plots accessible from each of the three roads. The Laidlaw Park Road is accessed north of the town of Carey and from the southern end of the Preserve is also referred to as the Carey-Kamima Road, eventually connecting to highway 24 between the towns of Shoshone and Minidoka. The Minidoka-Arco Road also connects to highway 24, and can be used to access sampling locations on the northeast corner of the Preserve near the town of Arco and Huddle's Hole.

Sequoia and Kings Canyon National Parks

SEKI is made up of two large adjoining parks (Sequoia National Park and Kings Canyon National Park) that are managed as one unit. SEKI is large, rugged, and mostly roadless wilderness. Monitoring crews will need to carry previously obtained research permits with them at all times. There is not a specific road or entrance that will lead crews to all field sites. Instead, hitches will be determined prior to the sampling season and will include specific directions for driving, trail routes, and direction of cross-country travel along with associated maps. For example, some sites will be accessed from the west side of the Sierra Nevada crest, while others will be accessed from the east side. Monitoring crews may or may not drive through a park entrance for trips originating from the west side, and will not enter through a park entrance for east side trips as no roads penetrate the park from the east side. Therefore each hitch will be unique with respect to directions for accessing sites.

Yosemite National Park

Like SEKI, YOSE is large, rugged, and mostly roadless wilderness. Monitoring crews will need to carry previously obtained research permits with them at all times. There is not a specific road or entrance that will lead crews to all field sites. However, Tioga Pass Road will be a primary corridor for accessing whitebark pine sites in YOSE as it is the only road through the park that penetrates the high-country environment of whitebark pine. Hitches will be determined prior to the sampling season and will include specific directions for driving, trail routes, and direction of cross-country travel along with associated maps.

Crater Lake National Park

Take HWY 62 northeast from Interstate 5 to Crater Lake NP, enter the park at Annie Spring Entrance Station. The previously obtained research permit will need to be presented to park staff,

in order for entry fees to be waved. After that, monitoring crews will need to carry research permits with them at all times. Whitebark pine sites at Crater Lake are accessed from either the Rim Drive or from the North Entrance Road. Crew should park as close to sites as possible, but parking is only allowed in designated parking areas or paved pull outs, do not park on the road shoulder. Specifics of each hitch will be determined prior to the sampling season and will include specific directions for driving, trail routes, and direction of cross-country travel along with associated maps. Therefore each hitch will be unique with respect to directions for accessing sites.

Lassen Volcanic National Park

The travel route to Lassen from the north is to drive south on Interstate 5 to exit 736 just south of the town of Mt Shasta. Drive on HWY 89 to Lassen Volcanic NP, enter the park at the Manzanita Lake Entrance station. The previously obtained research permit will need to be presented to park staff, in order for entry fees to be waved. After that, monitoring crews will need to carry previously obtained research permits with them at all times. Nearly all sites will be accessed from HWY 89 near the Bumpass Hell trail head. Sites on Loomis Peak are the exception; these will be accessed via the Manzanita Creek Trail. Crews should park as close to sites as possible, but parking is only allowed in designated parking areas or paved pull outs, do not park on the road shoulder. Specific logistics for each hitch will be determined prior to the sampling season and will include specific directions for driving, trail routes, and direction of cross-country travel along with associated maps. Therefore, each hitch will be unique with respect to directions for accessing sites.

Establishing Permanent Macroplots

All networkswill use a 50 x 50 m macroplot consisting of five, 10 x 50 m subplots. Recording data at the same plot size (i.e., 10 x 50 m) will allow the networks to make direct quantitative comparisons with each other as well as with other monitoring projects (e.g., Greater Yellowstone Network and The Whitebark Pine Ecosystem Foundation). For plot monitoring procedures follow the procedures below.

Upon arrival at the selected point (SW (lower-left) corner of macroplot, see Figure 6), verify that the location is suitable for plot establishment following criteria listed in Table 4. In particular, at least one living white pine tree must be rooted within the plot. If this criterion is not met, then refer to the section *Plot Offsetting and Replacement* in this SOP. If this criterion is not clearly met, approximate boundaries should be established and the plot searched for a white pine tree. Plots are oriented in right angles to the slope and contour such that two parallel sides of the plot run along (are parallel to) the steepest axis of the slope (fall line) and the opposite parallel sides of the plot run horizontal to the contour (i.e., at a right angle to the slope, Figure 6).

Table 4. Plot accept/reject criteria. Use the codes in bold font and parentheses to note the criteria used to drop a plot.

Rejection Criteria:
• Outside park boundary (**bndry**) • Dangerous/prohibitively difficult to work on (e.g., slope >35° (30° KLMN), talus or rimrock; **unsafe**). • Road or improved trail (**road** or **trail**) • No live white pine trees; (**trees**) • Other circumstances – detail this in the notes (**other**)

The plot anchor point becomes the lower left corner of the plot (corner #1, Figure 6). Use the GPS and arrive at the specified plot location by following instructions in SOP 3. Place a temporary surveyor's pin at the location between the boots of the GPS operator to temporarily mark corner #1. This is the SW corner of the macroplot. Find the north azimuth and run the tape out 50 meters to establish the NW corner. Turn 90 degrees east and go 50 m to establish the NE corner. Turn 90 degrees south to establish the SE corner. Turn 90 degrees west to meet back at the SW corner.

It is imperative to maintain straight lines along plot boundaries, even if vegetation is in the way. When trees are encountered along the plot boundaries, use temporary survey markers to start and stop reel tape lines on either side of a tree, maintaining a straight layout. Two people should perform this task with one person holding one end of the meter tape and a second person measuring out the 50 m distances and placing the flags in the ground at the corners. Both people should check that the correct azimuth is being followed. It is critical to take care at this step to ensure the plot is correctly laid out as this will be the permanent plot for the life of the project. If a mistake is made, go back and correct it, not matter how far back in the process the mistake occurred.

Use the compass to follow the correct azimuth between any two corner points, run the meter tape out 25 m, and place a temporary pin flag at the 25 meter mark (midpoint) between two corners. Follow the correct azimuth *into* the plot (i.e., 90° from the previous line of travel) for 25 meters. This is the macroplot center; mark it with a pin flag (Figure 6). Verify that the center is accurately marked by checking its azimuth and distance to another midpoint, or, using the Pythagorean Theorem, check that the distance from the center point to any one of the four corner pins is 35.4 m. From the plot center point measure and record the plot aspect (in degrees) with a compass and the plot slope (in degrees) with a clinometer or rangefinder.

Drive ½" rebar into the ground at each corner point and at the plot center point, leaving 5 cm sticking up above the ground. Place a yellow rebar cap on each rebar. Wire a tree tag to the lower left plot rebar (corner #1) and record the number of that tag in the database.

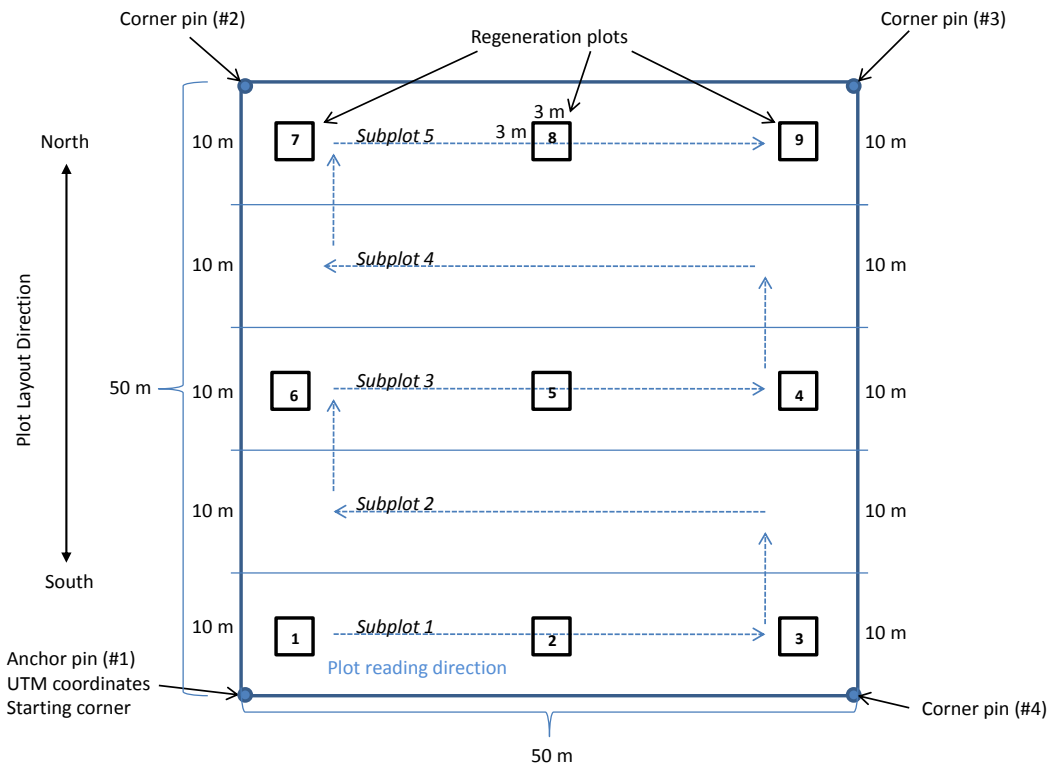

Figure 6. Plot design used in SIEN and UCBN. Macroplot is 50 m x 50 m and consists of five, 10 m x 50 m subplots to facilitate plot reading and quantitative comparisons with other monitoring projects. Within each macroplot are nine, 3 m x 3 m regeneration plots.

Subplot Boundary Layout

The following procedures are to facilitate plot reading and are not part of the permanent marking procedure. Therefore, these procedures are conducted each time a plot is visited and measurements taken. After the permanent markers at the four macroplot corners and center are located, place temporary pin flag markers at 10 m intervals starting at the anchor pin (i.e., corner #1) and moving upslope to corner #2 (Figure 6). Repeat this procedure on the opposite side of the macroplot, moving downslope from corner #3 to corner #4. Now mark the 25-m midpoint between each of the four temporary pin flag pairs with another temporary pin flag (Figure 6). This is the plot center line. Finally, place a pin flag at the 25-m midpoint between corner pins #2 and #3, and between corner pins #1 and #4 (Figure 6). There should now be a total of 14 temporary pin flags; four on each side and six down the center line (Figure 6), outlining the five 10 x 50 m subplots.

Take three photos once the macroplot and subplot boundaries are delineated. Take one picture from corner point #1 toward the plot center and another picture from corner point #3 toward the plot center. Record the picture file names, their locations, and azimuth direction. Take a third picture from a landmark feature (e.g., large boulder) where the general nature of the stand that the macroplot sits in is apparent. Record the picture file name, distance and direction from the

landmark to corner point #1, and take descriptive notes of the landmark feature. Detailed notes should also be made describing the plot setting and landscape configuration that will aid plot revisits (e.g., very few trees situated on a saddle, or dense stand lying in a gully), and note any unique aspects about the area.

Regeneration Plots

There are nine regeneration plots in each macroplot; three sets of three running parallel (and perpendicular) to the slope (Figure 6). These plots are 3 x 3 m and are not permanently marked, but they are numbered consecutively beginning at corner #1 and moving across the slope contour (Figure 6). From each corner point, measure 3 m in either direction of the plot boundary, and then measure 3 m *into* the plot. This point, marked with a pin flag, represents the outer corner of each of the four corner regeneration plots–numbers 1, 3, 7, and 9 (Figure 6). Establish the other three corners for each of these regeneration plots by measuring 3 m in the appropriate direction and marking the corners with a pin flag (Figure 6).

Establish regeneration plot #5, located at the macroplot center, by measuring 1.5 m from the center rebar toward any of the four sides of the macroplot using the appropriate azimuth previously recorded during macroplot establishment. For example, if the azimuth between corners #1 and #2 is 0°, shoot your compass 0° and measure 1.5 m from the center rebar. Measure 1.5 m in opposing right angle directions from this point; 270° and 90° for this example. Mark these two corner points with pin flags, measure 3 m from each flag so that the center rebar is in the center of the regeneration plot, and mark the remaining two corners with pin flags. Verify that your pins are placed in the correct location by checking that the distance between the center rebar and any of the four corner pins is equal to 2.1 m.

The four remaining regeneration plots (number 2, 4, 6, and 8) are located near the 25-m midpoints of each macroplot side (Figure 6). Follow the correct azimuth from corner #1 to corner #2 for 23.5 m using the reel tape. Turn 90° from this point *into* the plot (should be equal to the azimuth from corner #2 to corner #3) and follow for 3 m. Mark this point with a pin flag. This is the lower left corner of regeneration plot #4. Follow the same procedures to mark the other three corners as given above for regeneration plots 1, 7, 9, and 3. Move to corner #2 and follow the correct azimuth from corner #2 to corner #3 for 23.5 m using the reel tape. Turn 90° from this point *into* the plot (should be equal to the azimuth from corner #3 to corner #4) and follow for 3 m. Mark this point with a pin flag. This is the upper left corner of regeneration plot #8. Follow the same procedures to mark the other three corners as given above for regeneration plots 1, 7, 9, and 3. Move to corner #3 and follow the correct azimuth from corner #3 to corner #4 for 23.5 m using the reel tape. Turn 90° from this point *into* the plot (should be equal to the azimuth from corner #4 to corner #1) and follow for 3 m. Mark this point with a pin flag. This is the upper right corner of regeneration plot #6. Follow the same procedures to mark the other three corners as given above for regeneration plots 1, 7, 9, and 3. Move to corner #4 and follow the correct azimuth from corner #4 to corner #1 for 23.5 m using the reel tape. Turn 90° from this point *into* the plot (should be equal to the azimuth from corner #1 to corner #2) and follow for 3 m. Mark this point with a pin flag. This is the lower right corner of regeneration plot #2. Follow the same procedures to mark the other three corners as given above for regeneration plots 1, 7, 9, and 3.

Plot Offsetting and Replacement

If a plot meets any of the rejection criteria listed in Table 4, initiate offsetting procedures. To do this, draw a random azimuth between 0° and 359° and a random distance between 5 m and 100 m, and move to that location and review the rejection criteria again. Accept this point as the new permanent plot location if none of the rejection criteria are met. A list of random numbers for distance (between 5 m and 100 m) and azimuth (between 0° and 359°) will be provided to crews before each hitch. Random numbers will be automatically generated in digital data entry programs, if used. If using a paper random number table, use the list in sequential order such that the first site where the initial point is unsuitable uses the first set of numbers from the random numbers list, etc. Permanently establish the plot following the above procedures. Note **Offset** in the notes field of the data sheet and note the direction and distance used.

If the new offset point is also unsuitable, the site is dropped and replaced with the first (or next to be used) GRTS point on the oversample list (SOP # 1). Navigate to the next point (plot location) on the original trip (hitch) list. Note that the replacement point will likely not be near the dropped site, and may not be visited until another hitch to another part of the park. The project or crew leader will coordinate the inclusion of new oversample sites into hitch planning. Note that this issue will be rarely encountered once all three panels have been visited and sites established. However, there may be occasions when plots need to be retired and replaced over time.

If a plot fails to meet the rejection criteria in most of its area, and at least one live white pine tree is in the plot, but a portion of the plot lies in an inaccessible area, then the plot is shifted away from the area and into accessible terrain. For example, if a 50 x 50 m plot has 10 meters at one of its edges land against a cliff face, the plot is shifted away from the cliff by 10 meters. This is only done for inaccessible areas, and not for 'non-target' vegetation or land cover. Examples of inaccessible areas include bodies of water, slopes >35°, and glaciers. Examples of non-target vegetation or land cover include a dense stand of lodgepole pine or a cinder garden in CRMO. If there is a single live white pine tree near the beginning of the plot, and the plot then runs into a pure lodgepole pine stand, for example, the plot is still established in its intended direction. Non-target forest and land cover types are included as long as the minimum requirements of plot establishment are met. If the plot is shifted, notes are made recording the direction, distance, and reason for the shift. A new anchor point (i.e., corner point #1) will result in these cases; therefore, proper documentation of the new anchor point must also be made. However, if a plot intersects a permanently altered and non-natural land cover type, such as a parking lot or paved road, where there is no real possibility of white pine tree establishment and growth, the plot should be offset or replaced.

Tagging Trees

All living trees taller than breast height (1.37 m) will be tagged at breast height. A tree, or cluster of trees, is included if at least half of the bole lies within the plot boundary. For trees smaller than 5 cm diameter at breast height (dbh), tags will be loosely wired near breast height. For trees 5 cm dbh or larger, tags will be nailed to the tree at breast height with the nail head pointing slightly downward so that moisture runs away from the bole, and driven in only deep enough to secure the tags. It is essential that the tags be nailed at breast height so that future diameter re-measurements are taken at precisely the same location, and thus allow tree diameter growth to be accurately calculated for long-term trend analyses. The sequentially-numbered tags are made of

stainless steel or aluminum. The tags are about 2.5 cm in diameter and are generally inconspicuous. Tree tags are placed on the same side of the bole (e.g., north facing side) throughout the macroplot. The direction of tag placement is determined by considering the relative position of the macroplot to features that may bring park visitors near the plot. For example, if there is a trail east of the macroplot, tree tags should be placed on the west side of trees–away from visitor site. If there are no perceivable impacts to visitors, then the north side of the trees should be tagged (i.e., the default). The direction of tag placement is recorded on the data sheet.

Whitebark pine and limber pine often grow in what are referred to as "tree clumps." Tree clumps are groups of stems that may be branches of the same individual (i.e., same genotype) or multi-genic clusters of individual trees (i.e., multiple genotypes in the same clump). This characteristic growth form is usually the result of the caching behavior of Clark's nutcracker (Linhart and Tomback 1985). Nutcrackers place multiple seeds in a cache and these seeds are often gathered from more than one parent tree. The distinction between multi-genic tree clusters and multiple stems of the same individual is impossible to make in the field. However, given the monitoring objectives, it is important to accurately quantify tree clump structure so that estimates of plot structure and composition are reasonably accurate. The section below outlines how to distinguish among individual trees, stems that are part of a clump, and branches of a stem; and describes how to treat each condition as it relates to tagging and recording trees. This procedure is similar to that used in the Whitebark Pine Ecosystem Foundation methods (Tomback et al. 2005) and by the Greater Yellowstone Network (Greater Yellowstone Whitebark Pine Monitoring Working Group 2007).

1. Individual tree: If a stem is growing in a tree clump and can be traced separately to ground level (i.e., not connected to another stem), then it is considered a separate tree and not a member of the tree clump. It receives a tree tag with a unique number and no letter designation (see below).
2. Stem part of a tree clump: If a stem is growing in a tree clump and is attached to another stem above ground level but below 1.37 m (dbh), then it is considered to be a member of the tree clump (i.e., not an individual tree). It receives a tree tag with a unique number and a letter designation. (Stems attached to other stems but that split apart *above* 1.37 m are treated as the same tree because 'they' would only have one dbh.) Each stem in a tree clump receives a tree tag with a unique tag number and letter on the datasheet or database; letters are assigned in consecutive order. See example below.
3. Branches: A stem is considered to be a branch of another stem if any of the following three conditions are met. If there is not a discernible growth groove that separates the stem from another stem, then it is a branch. If the diameter of the stem is < 25% of the diameter of the main bole, then it is a branch. If the angle of the stem is > 45° from the main stem, then it is a branch. Branches do not receive tree tags.

An example: The crew member approaches a cluster of trees. The first stem is growing in association with the cluster, but its stem extends to the ground uninterrupted by another stem. It is considered a tree and receives a tree tag with a unique number (e.g., #100) and does not have a clump letter assigned to it. The second tree has four stems that are joined above ground level, but below 1.37 m. Each stem has a growth groove, is > 25% the diameter of the largest stem, and is

growing at an angle < 45° from the main stem. These four stems would be counted as part of a tree clump and would be assigned the following tree tags with clump letter designation: 101a, 102b, 103c, and 104d. The unique tag numbers tell us that these stems are individual stems, and not branches, and therefore are included in calculations for basal area and composition, for example. The letter designation tells us that they are located within a tree clump.

Lastly, each tree clump is given a number in the data sheet that is assigned in a consecutive order. For the example given above, if this was the fourth tree clump found in the plot, the data sheet would indicate tree clump 4 for each tagged tree (101a, 102b, 103c, and 104d).

Literature Cited

Greater Yellowstone Whitebark Pine Monitoring Workgroup. 2007. Interagency whitebark pine monitoring protocol for the Greater Yellowstone Ecosystem, v 1.0. Greater Yellowstone Coordinating Committee, Bozeman, Montana.

Linhart, Y. B., and D. F. Tomback. 1985. Seed dispersal by Clark's nutcracker causes multi-trunk growth form in pines. Oecologia 67:107-110.

Tomback, D. F., R. E. Keane, W. W. McCaughey, C. Smith C. 2004 (revised 2005). Methods for surveying and monitoring whitebark pine for blister rust infection and damage. Whitebark Pine Ecosystem Foundation, Missoula, Montana.

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 5: Measuring Response Variables

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: The purpose of this SOP is to describe the step-by-step procedures for measuring response variables within sampling plots for the purposes of long-term monitoring of high-elevation white pine forest dynamics.

Suggested Reading

Hagle, S. K., K. E. Gibson, and S. Tunnock. 1990. Field Guide to disease and insect pests of Northern and Central Rocky Mountain Conifers. USDA Forest Service, Report Number R1-03-08, 197 pp.

Hawksworth, F. G. and D. Wiens. 1996 Dwarf mistletoes: Biology, pathology and systematic. USDA Forest Service. Agriculture Handbook No. 709, 410 pp.

Hoff, R. J. 1992. How to recognize blister rust infection on whitebark pine. USDA Forest Service, Research Note INT-406, 8 pp.

McDonald, G. I. and R. J. Hoff. 2001. Blister rust: An introduced plague. Pages 193–220 *in* D. F. Tomback, S. F. Arno, and R. E. Keane, editors. Whitebark pine communities: Ecology and restoration. Island Press, Washington, D.C.

McKinney, S. T. and D. F. Tomback. 2007. The influence of white pine blister rust on seed dispersal in whitebark pine. Canadian Journal of Forest Research 37:1044–1057.

Before the Field

Crew members meet with the appropriate network staff member and go over an equipment checklist to ensure that they have all of the necessary sampling equipment. Equipment is checked for proper functioning and any necessary repairs or replacements are made prior to departure.

Measuring Response Variables

The macroplot is 'read'–measurements made–by following the subplot delineations previously established (SOP #4). Begin at macroplot SW corner #1 and move toward corner #4 reading subplot #1 for a 10-m swath and 50-m length. Move north into subplot #2 and read the plot back across the plot and toward the other side for another 10-m swath and 50-m length (Figure 7). Repeat this procedure until all five subplots have been read.

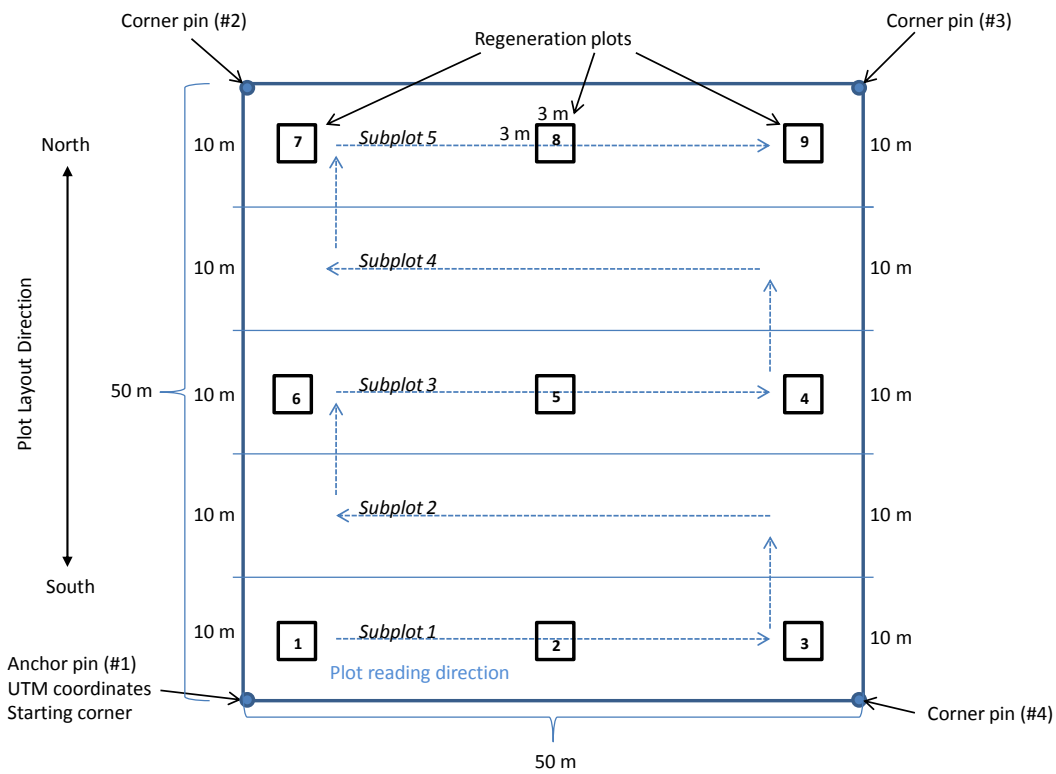

Figure 7. Plot design. Macroplot is 50 m x 50 m and consists of five, 10 m x 50 m subplots to facilitate plot reading and quantitative comparisons with other monitoring projects. Within each macroplot are nine, 3 m x 3 m regeneration plots.

The plot recorder has information about which subplot each tagged tree is located in (SOP 4) and should communicate with the plot reader about this. In plot revisits, it is critical that the reader carefully search for trees that were missed during plot establishment and does not get complacent when all of the tagged trees have been found. In addition, seedlings (defined as an individual

<1.37 m height) will recruit into the tree class (i.e., ≥1.37 m height) over time, and therefore, new untagged trees will be encountered. What to do with untagged trees is discussed below.

All information is called out by the plot reader and verbally repeated by the plot recorder. It is the reader's responsibility to correct the recorder if s/he has made a mistake in repeating the information. If the recorder does not hear a correction, then they enter the information on paper data sheet or data tablet (depending on the specific network).

As a service to our parks, please note the location, species, and if possible, an approximate count of the number of plants within any patches of noxious weeds that are encountered while working in parks. For abundant species like cheatgrass this is not necessary. However, for rare and incipient infestations, pine crews may provide invaluable early detection. Provide this information in plot notes in the data entry form, and alert park staff as soon as possible.

Tree-level Data

For live trees measure and record the following: subplot number, tag number (only live trees are tagged), tree clump number and clump letter if applicable (see SOP 4), species, diameter (±0.1 cm) at breast height (dbh, 1.37 m, the location where the nail is in the tree), and height (±0.1 m). Note that equipment may differ among networks. For example tree height may be measured with a clinometer or a laser rangefinder; therefore specific instructions are not provided here. Instead crews receive rigorous formal training and must know how to use sampling equipment prior to the field season (SOP 2). For dead trees measure dbh and height, and determine which category the tree belongs to: recently dead (no green needles present) or dead (no needles on the tree). If a tagged tree is found to be dead during a revisit, record dead or recently dead, and make an attempt to determine its proximal cause of death by the categories: fire, beetle, rust, mistletoe, mechanical, or unknown. Measurements and assessments are no longer made in subsequent revisits once a tree is determined to be dead.

Note that crews must receive formal training for how to identify health-related variables, including white pine blister rust symptoms, pine beetle occurrence, and dwarf mistletoe infection. If there is not a staff member qualified to train crews on how to identify insects and disease, the network project lead needs to seek out training opportunities from a local forest pathologist (e.g., US Forest Service or state forestry department) for themselves and/or the crew. The seminal document for identifying white pine blister rust in the field is Hoff (1992). Each network has an electronic and reference copy of this paper. Copies are provided to monitoring crews prior to each field season and used during training. Please also read and refer to the papers under "Suggested Readings" of this SOP. It is imperative to understand that extensive training is required to identify cankers and other symptoms of blister rust infection.

For living trees that are a white pine species (i.e., foxtail, limber, and whitebark pine), ocularly divide the bole and the branches each into thirds (thus six areas). Use binoculars to carefully and systematically search the bole and branches of the tree for signs of blister rust infection, looking on as many sides of the tree as is possible. Record an 'A' for an *active* canker (i.e., a canker with visible aecia, or fruiting bodies containing spores), or an 'I' if at least three of the following five *indicators* are present in the same location on the tree (e.g., upper third branches): rodent chewing, flagging, swelling, roughened bark, and oozing sap. Pictures and descriptions of each

of these indicators are presented in Hoff (1992). Mark the indicators used to determine an 'I' designation on the data sheet.

For the purposes of this protocol, a bole is defined as the vertically oriented part of the tree extending from the ground to a division point or split where the observer can no longer discern the bole from a branch based on diameter. A bole can be considered to end at the last vertical section of the main stem. If a bole canker extends across two different thirds of the bole, its location is assigned to the lower third. Branches are defined as all the main branches that begin as bifurcations off the bole, encompassing all foliage and supporting twigs and side branches. We use the term "Branches" by convention and for similarity with established monitoring projects, however, this definition is the same as that for canopy.

The percentage of the total tree's canopy (defined above) that has been killed is estimated by visually dividing the tree's crown into thirds, and estimating the percentage crown kill for each third (McKinney and Tomback 2007). Therefore, a crown kill (%) value is recorded for each third of the crown. All dead branches are considered, whether caused by blister rust, bark stripping, or mechanical damage. These are often difficult to distinguish; however, one can later group the data by crown kill for infected and uninfected white pines. The three crown kill values are averaged for each tree during data analysis so that each tree has one crown kill value.

For living *Pinus* trees, look for signs of mountain pine beetle current or past infestation and record presence/absence of: pitch tubes, J-shaped galleries, and frass. It is important to note that J-shaped galleries (or 'crooks' at the lower end of the gallery) are only searched for on dead or recently dead pine trees because bark has to be peeled away to determine if this condition is present. Therefore, living pine trees can only receive a positive indication of beetle infestation by the external signs of pitch tubes and/or frass. For dead pine trees use a hatchet to peel away bark and look for the characteristic J-shaped gallery in the tree's cambium. Also search for indications of dwarf mistletoe infection and record yes or no for mistletoe infection.

Search each live white pine tree with binoculars for the presence of ovulate (female) cones and record whether cones are present or absent. Ovulate cones are quite small in early summer and put on most of their growth throughout the summer. It is therefore important to take care when surveying trees for cones during this time period (June to early-July). Use multiple vantage points and look within needle bundles for signs of emerging cones.

During plot revisits, locate the corner of each subplot where initial tree tagging occurred. The data recorder should look at the data record and tell the field reader what the first tag number is. The crew should move throughout the sub-plot, beginning with the first tree previously tagged. All trees should be systematically searched for a tag. Trees previously tagged are re-measured and recorded. All new trees (i.e., untagged trees) are tagged. Record the tag number, subplot number, and in the notes indicate the tag number, distance, and direction of its closest neighbors. Make and record all necessary measurements. Record on the data sheet the total number of 'new' trees that were tagged during the sampling event.

If a previously recorded tree is not found during a plot revisit, look at the data sheet to determine which subplot it was in and which trees were its closest neighbors. Systematically search the

ground area where the tree is believed to have been and record the outcome in the notes section of the data sheet or PDA. For example, whether the tag was found on the ground, or not found at all.

Regeneration Data

Seedling densities are estimated in the nine 3 x 3 m regeneration plots situated within each macroplot (Figure 7). Regeneration subplots are numbered, and data are recorded by regeneration plot number. Beginning at regeneration plot #1 (lower left corner of the macroplot, corner #1, Figure 7), find the regeneration plot temporary pin flags and determine its boundaries. Within each regeneration plot, tally all conifer seedlings and record them by species and height class as follows: class 1 = 20 to <50 cm; class 2 = 50 to <100 cm; class 3 = 100 to <137 cm). Multiple handheld tally devices should be used to keep track of seedling counts for dense regeneration plots. Begin with a single species (e.g., whitebark pine). Use one tally device to record the number of whitebark pine seedlings in height class one, a second tally device for class two, and a third for class three. Be sure to mark tally devices with tape or pen so that they are labeled as to which height class they are recording. Once you have finished with all the whitebark pine seedlings in a given regeneration plot, repeat the procedure for the next species until all species have been recorded.

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 6: Data Management

Version 1.0, June 2012

Change History

Version #	Date	Revised By	Changes	Justification

Note: This SOP provides documentation for the project database PWR_five_needle_pine_monitoring.mdb and provides instructions for the development, maintenance, archiving, and distribution of the database or datasets.

Suggested Reading

Cook, R. R., and P. Lineback. 2008. Sierra Nevada Network data management plan. Natural Resource Report NPS/NRPC/NRR—2008/070. National Park Service, Fort Collins, Colorado. Available at https://science1.nature.nps.gov/naturebib/biodiversity/2008-11-26/SIENDMP_CompletePlan_20081125.pdf (accessed 11 August 2010).

Dicus, G. H., and L. K. Garrett. 2007. Upper Columbia Basin Network data management plan: Version 1.0. Natural Resource Report NPS/UCBN/NRR—2007/020. National Park Service, Moscow, Idaho. Available from http://www.nature.nps.gov/publications/NRPM/nrr.cfm (accessed 11 August 2010).

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, Colorado. Available from https://science1.nature.nps.gov/naturebib/biodiversity/2008-5-22/DataPlan_FINAL_20080307.pdf (accessed 11 August 2010).

National Park Service. 2007. Natural resource database template. Version 3.2 documentation. Natural Resource Program Center, Division of Inventory, Monitoring, and Evaluation, Fort Collins, Colorado. Available from http://science.nature.nps.gov/im/apps/template/ (accessed June 2010).

Introduction

This SOP describes data management procedures. The database model is described in detail, including definitions of all input and computed data fields. Procedures for data certification, data archiving, QA/QC, and handling of sensitive information are also provided. Yearly data management tasks are presented, including the scheduled timing of those various tasks.

Database Model

The databases used by the PWR white pine monitoring protocol have been developed within Microsoft Access and conform to the standards of version 3.2 of the Natural Resource Database Template (NRDT).

The database consists of a user interface front-end (holding user forms for data entry, review, and export) that is linked to a back-end database file (holding the core protocol data tables), and to a data dictionary database file (holding various lookup tables). The general data management strategy employs a "working copy" of the database (used to enter the current season's data, conduct error-checking, and perform validation) and a "master version" of the database, which stores all validated data and facilitates multi-year analyses by providing specific data summaries and export formats. A physical data model for the white pine monitoring protocol shows the relationships among the core data tables, lookup tables, and cross reference tables (Figure 8).

The core tables in the white pine database are the tbl_Sites, tbl_Locations, tbl_LocData_PlotInfo, and tbl_Events tables. There are four additional tables for plot data (tbl_EvData_SeedlingCounts, tbl_EvData_TreeData, tbl_EvData_WildlifeObs, and tbl_EvData_PlotPhotos). The plot data tables are supported by several lookup tables that hold code values (e.g., seedling height codes, tree status codes, infection indicator codes, and beetle sign codes) and definitions of those codes. The tbl_Sites table stores descriptive data about white pine stands. The tbl_Locations and tbl_LocData_PlotInfo tables store the unique physical location information for each white pine sampling plot. The tbl_Events table, storing information about sampling visits to a given white pine sampling plot, links to all of the sampling data (e.g., tbl_EvData_SeedlingCounts and tbl_EvData_TreeData) and to a cross reference table that stores data about the contacts associated with each sampling visit. The protocol version in use at the time of data collection is linked to tbl_Events through use of a tlu_Protocol_Ver lookup table, and revisions to the white pine monitoring database are captured in two metadata tables, tbl_Db_Meta and tbl_Db_Revisions.

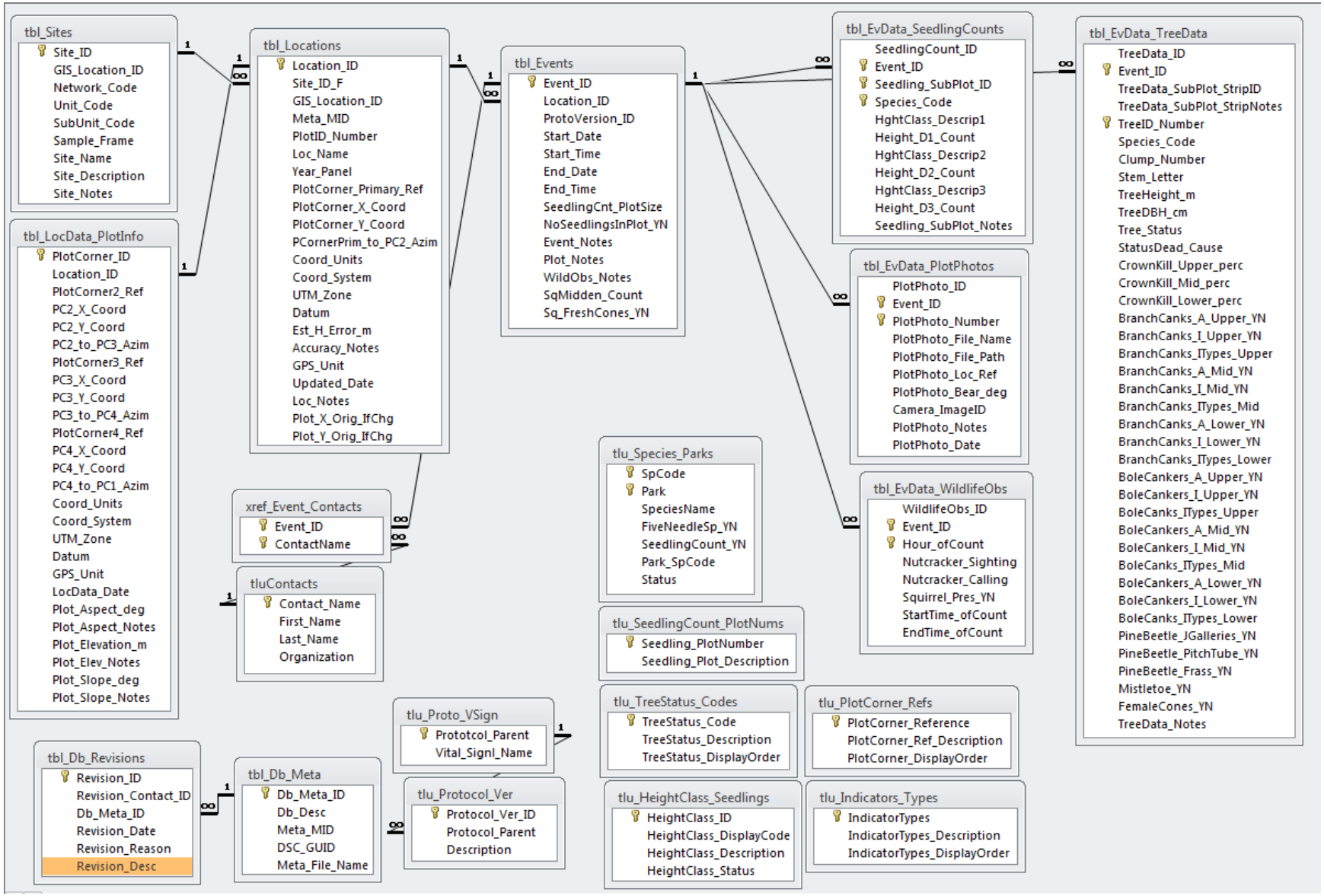

Figure 8. The PWR white pine monitoring protocol database model.

Database Dictionary

This data dictionary provides a description for every table in the database back-end file, and for each table, lists the field names and their associated field type, size, and description. Tables from the data dictionary are shown below [Tables 5(a) to 5(l)].

Table 5. Tables and data fields from the white pine database.

(a) Table name: *tbl_Sites*. A Site can be a Park, a Park Sub-Unit, or a Sampling Frame within a Park or Park Sub-Unit. All sampling plots fall within a Site.

Field Name	Type	Format	Description
Site_ID	GUID ReplicationID	alphanumeric	Primary key, uniquely identifying each tbl_Sites record
GIS_Location_ID	GUID ReplicationID	alphanumeric	Link to GIS feature, if applicable
Network_Code	text	4-letter code	Network code
Unit_Code	text	4-letter code	Park unit code
SubUnit_Code	text	4- to 8-letter code	Park sub-unit code, if applicable
Sample_Frame	text	4- to 8-letter code	Sampling frame (if applicable) in which Plots are located
Site_Name	text	(e.g., Unit_SubUnit_SampleFrame)	Unique name for a site (includes UnitCode and/or SubUnitCode)
Site_Description	text	up to 255 characters	Description for a site, if applicable
Site_Notes	text	up to 255 characters	General notes on the site, if applicable

Table 5. Tables and data fields from the white pine database (continued)

(b) Table name: *tbl_Locations*. A Location is a Plot to be sampled. UTM Coordinates are associated with the SW corner of the Plot.

Field Name	Type	Format	Description
Location_ID	GUID ReplicationID	alphanumeric	Primary key, uniquely identifying each tbl_Locations record
Site_ID_F	GUID ReplicationID	alphanumeric	Link to tbl_Sites (foreign key)
GIS_Location_ID	GUID ReplicationID	alphanumeric	Link to GIS feature, if applicable
Meta_MID	GUID ReplicationID	alphanumeric	Link to Metadata record (e.g., NPS Data Store recordID)
PlotID_Number	Integer	numeric	Location (PlotID) number
Loc_Name	text	up to 100 characters	Name of the location (constructed from SiteName [tbl_Sites] and PlotID_Number)
Year_Panel	text	YYYY_##	Year and Panel (YYYY_##) that Location (Plot) was sampled
PlotCorner_Primary_Ref	text	up to 10 characters	Plot Corner used as primary XY Coordinates for Plot (Default is SW)
PlotCorner_X_Coord	Double	decimal	X coordinate of Plot Corner Primary Reference
PlotCorner_Y_Coord	Double	decimal	Y coordinate of Plot Corner Primary Reference
PCornerPrim_to_PC2_Azim	Integer	numeric	Azimuth (degrees) from Primary Plot Corner to Plot Corner 2 (Default is 0)
Coord_Units	text	(e.g., meters)	Coordinate distance units (meters)
Coord_System	text	(e.g., UTM)	Coordinate system
UTM_Zone	text	(e.g., 11N)	UTM Zone
Datum	text	(e.g., NAD83)	Datum of mapping ellipsoid
Est_H_Error_m	Double	decimal	Estimated horizontal accuracy in meters
Accuracy_Notes	text	up to 255 characters	Positional accuracy notes, if applicable
GPS_Unit	text	up to 100 characters	GPS unit used to collect Location coordinates, if applicable
Updated_Date	Date	mm/dd/yyyy	Date of entry or last change
Loc_Notes	text	up to 255 characters	General notes on the location, if applicable
Plot_X_Orig_IfChg	Double	decimal	Original X Coordinate (stored if Coordinate changed via frontend DB form)
Plot_Y_Orig_IfChg	Double	decimal	Original Y Coordinate (stored if Coordinate changed via frontend DB form)

Table 5. Tables and data fields from the white pine database (continued)

(c) Table name: *tbl_LocData_PlotInfo*. UTM Coordinates and Azimuths of Corner Points of the Location (plot). Coordinates are collected with GPS unit, and Azimuths are collected with compass.

Field Name	Type	Format	Description
PlotCorner_ID	GUID ReplicationID	alphanumeric	Primary key, uniquely identifying each tbl_LocData_CornerPoints record
Location_ID	GUID ReplicationID	alphanumeric	Link to tbl_Locations (foreign key)
PlotCorner2_Ref	text	up to 10 characters	Plot Corner 2 name (Default is NW)
PC2_X_Coord	Double	decimal	X coordinate of Plot Corner 2
PC2_Y_Coord	Double	decimal	Y coordinate of Plot Corner 2
PC2_to_PC3_Azim	Integer	numeric	Azimuth (degrees) from Plot Corner 2 to Plot Corner 3 (Default is 90)
PlotCorner3_Ref	text	up to 10 characters	Plot Corner 3 name (Default is NE)
PC3_X_Coord	Double	decimal	X coordinate of Plot Corner 3
PC3_Y_Coord	Double	decimal	Y coordinate of Plot Corner 3
PC3_to_PC4_Azim	Integer	numeric	Azimuth (degrees) from Plot Corner 3 to Plot Corner 4 (Default is 180)
PlotCorner4_Ref	text	up to 10 characters	Plot Corner 4 name (Default is SE)
PC4_X_Coord	Double	decimal	X coordinate of Plot Corner 4
PC4_Y_Coord	Double	decimal	Y coordinate of Plot Corner 4
PC4_to_PC1_Azim	Integer	numeric	Azimuth (degrees) from Plot Corner 4 to Plot Corner 1 (Default is 270)
Coord_Units	text	(e.g., meters)	Coordinate distance units (meters)
Coord_System	text	(e.g., UTM)	Coordinate system
UTM_Zone	text	(e.g., 11N)	UTM Zone
Datum	text	(e.g., NAD83)	Datum of mapping ellipsoid
GPS_Unit	text	up to 100 characters	GPS unit used to collect Plot Corner coordinates
LocData_Date	Date	mm/dd/yyyy	Date on which Plot Corner data collected
Plot_Aspect_deg	Integer	numeric	Orientation of Plot (degrees, 0-359)

Plot_Aspect_Notes	text	up to 255 characters	Notes regarding plot aspect measurement
Plot_Elevation_m	Integer	numeric	Elevation (meters) above sea level of Plot
Plot_Elev_Notes	text	up to 255 characters	Notes regarding plot elevation measurement
Plot_Slope_deg	Integer	numeric	Slope of Plot (degrees)
Plot_Slope_Notes	text	up to 255 characters	Notes regarding plot slope measurement

Table 5. Tables and data fields from the white pine database (continued)

(d) Table name: *tbl_Events*. An Event is a sampling occurrence at a Plot. Observers (from tluContacts) are recorded in xref_Event_Contacts table.

Field Name	Type	Format	Description
Event_ID	GUID ReplicationID	alphanumeric	Primary key, uniquely identifying each tbl_Events record
Location_ID	GUID ReplicationID	alphanumeric	Link to tbl_Locations (foreign key)
ProtoVersion_ID	text	alphanumeric	Link to tlu_Protocol_Ver (indicates the Protocol version in use at time of Event)
Start_Date	Date	mm/dd/yyyy	Starting date for the event
Start_Time	DateTime	24 HR time	Starting time for the event
End_Date	Date	mm/dd/yyyy	Ending date for the event
End_Time	DateTime	24 HR time	Ending time for the event
Event_Notes	text	up to 255 characters	Notes regarding the sampling Event, if applicable
Plot_Notes	text	up to 255 characters	Notes regarding conditions/observations at the Plot at time of sampling, if applic
WildObs_Notes	text	up to 255 characters	Notes regarding wildlife observations at the Plot at time of sampling, if applic
SqMidden_Count	Integer	numeric	Count of Pine Squirrel middens within the Plot
Sq_FreshCones_YN	text	Yes/No	Presence (Yes/No) of fresh sign of cone consumption by Pine Squirrels in Plot

(e) Table name: *tbl_EvData_PlotPhotos*. This table holds information about Plot Photos taken during a sampling Event.

Field Name	Type	Format	Description
PlotPhoto_ID	GUID ReplicationID	alphanumeric	Unique identifer for each tbl_EvData_PlotPhotos record
Event_ID	GUID ReplicationID	alphanumeric	Co-Primary key. Link to tbl_Events (foreign key)
PlotPhoto_Number	Integer	numeric	Co-Primary key. Plot Photo number (sequential for photos taken at a given Plot)
PlotPhoto_File_Name	text	up to 255 characters	Name of Plot Photo file. SiteName_PlotNumber_Date (where Date in yyyymmdd format)
PlotPhoto_File_Path	text	up to 255 characters	File Path (directory folder location) of Plot Photo file

PlotPhoto_Loc_Ref	text	up to 25 characters	Locatoin Reference for Plot Photo (Corner1, Corner3, or See_Notes)
PlotPhoto_Bear_deg	Integer	numeric	Bearing (in degrees) on which Stand Photo taken, if applicable
Camera_ImageID	text	up to 55 characters	Image ID from the field camera
PlotPhoto_Notes	text	up to 255 characters	Notes regarding Plot Photo, if applicable
PlotPhoto_Date	Date	mm/dd/yyyy	Date on which Plot Photo taken

Table 5. Tables and data fields from the white pine database (continued)

(f) Table name: *tbl_EvData_SeedlingCounts.* This table holds all of the Seedling Counts associated with a sampling Event.

Field Name	Type	Format	Description
SeedlingCount_ID	GUID ReplicationID	alphanumeric	Unique identifer for each tbl_EvData_SeedlingCounts record
Event_ID	GUID ReplicationID	alphanumeric	Co-Primary key. Link to tbl_Events (foreign key)
Seedling_SubPlot_ID	Integer	numeric	Co-Primary key. SubPlot number associated with seedling count record
Species_Code	text	6 characters	Co-Primary key. Species code (from tlu_Species_Parks); includes Dead
HghtClass_Descrip1	text	up to 55 characters	Height Class Description 1 (from tlu_HeightClass_Seedlings)
Height_D1_Count	Integer	numeric	Count of Height Class Description 1 seedlings for the given species
HghtClass_Descrip2	text	up to 55 characters	Height Class Description 2 (from tlu_HeightClass_Seedlings)
Height_D2_Count	Integer	numeric	Count of Height Class Description 2 seedlings for the given species
HghtClass_Descrip3	text	up to 55 characters	Height Class Description 3 (from tlu_HeightClass_Seedlings)
Height_D3_Count	Integer	numeric	Count of Height Class Description 3 seedlings for the given species
Seedling_SubPlot_Notes	text	up to 255 characters	Notes regarding SubPlot seedling count, if applicable

Table 5. Tables and data fields from the white pine database (continued)

(g) Table name: *tbl_EvData_TreeData*. This table holds all of the Tree Data associated with a sampling Event.

Field Name	Type	Format	Description
TreeData_ID	GUID ReplicationID	alphanumeric	Uniquely identifer for each tbl_EvData_TreeData record
Event_ID	GUID ReplicationID	alphanumeric	Co-Primary key. Link to tbl_Events (foreign key)
TreeData_SubPlot_StripID	Integer	numeric	Identification (numeric) of sub plot strip (1-5) in which tree data collected
TreeData_SubPlot_StripNotes	text	up to 255 characters	Notes regarding the sub plot strip
TreeID_Number	Integer	numeric	Co-Primary key. Tree tag number
Species_Code	text	alphanumeric	Species code (from tlu_Species_Parks)
Clump_Number	Integer	numeric	Clump number, if applicable
Stem_Letter	text	1-2 characters	Stem letter identifier, if applicable
TreeHeight_m	Double	decimal	Tree height (m) measured with range finder
TreeDBH_cm	Double	decimal	Tree diameter-at-breast-height (cm)
Tree_Status	text	up to 25 characters	Status of tree (from tlu_TreeStatus_Codes)
StatusDead_Cause	text	up to 255 characters	If Status = Dead, then note probable cause of death (from tlu_DeathCause_Codes)
CrownKill_Upper_perc	Integer	numeric	Ocular estimate of kill (%) in upper third of canopy
CrownKill_Mid_perc	Integer	numeric	Ocular estimate of kill (%) in middle third of canopy
CrownKill_Lower_perc	Integer	numeric	Ocular estimate of kill (%) in lower third of canopy
BranchCanks_A_Upper_YN	text	Yes/No	Presence (Yes/No) of branch cankers with aecia in upper third of canopy
BranchCanks_A_Mid_YN	text	Yes/No	Presence (Yes/No) of branch cankers with aecia in middle third of canopy
BranchCanks_A_Lower_YN	text	Yes/No	Presence (Yes/No) of branch cankers with aecia in lower third of canopy
BranchCanks_I_Upper_YN	text	Yes/No	Presence (Yes/No) of branch cankers without aecia in upper third of canopy. Requires at least 3 indicators in upper canopy.

Table 5. Tables and data fields from the white pine database (continued)

(g) Table name: *tbl_EvData_TreeData*. This table holds all of the Tree Data associated with a sampling Event.

Field Name	Type	Format	Description
BranchCanks_I_Mid_YN	text	Yes/No	Presence (Yes/No) of branch cankers without aecia in middle third of canopy. Requires at least 3 indicators in middle canopy.
BranchCanks_I_Lower_YN	text	Yes/No	Presence (Yes/No) of branch cankers without aecia in lower third of canopy. Requires at least 3 indicators in lower canopy.
BoleCankers_A_Upper_YN	text	Yes/No	Presence (Yes/No) of bole cankers with aecia in upper third of canopy
BoleCankers_A_Mid_YN	text	Yes/No	Presence (Yes/No) of bole cankers with aecia in middle third of canopy
BoleCankers_A_Lower_YN	text	Yes/No	Presence (Yes/No) of bole cankers with aecia in lower third of canopy
BoleCankers_I_Upper_YN	text	Yes/No	Presence (Yes/No) of bole cankers without aecia in upper third of canopy. Requires at least 3 indicators in upper canopy.
BoleCankers_I_Mid_YN	text	Yes/No	Presence (Yes/No) of bole cankers without aecia in middle third of canopy. Requires at least 3 indicators in middle canopy.
BoleCankers_I_Lower_YN	text	Yes/No	Presence (Yes/No) of bole cankers without aecia in lower third of canopy. Requires at least 3 indicators in lower canopy.
BranchCanks_ITypes_Upper	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BranchCanks_I_Upper is Yes.
BranchCanks_ITypes_Mid	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BranchCanks_I_Mid is Yes.
BranchCanks_ITypes_Lower	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BranchCanks_I_Lower is Yes.
BoleCankers_ITypes_Upper	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BoleCankers_I_Upper is Yes.
BoleCankers_ITypes_Mid	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BoleCankers_I_Mid is Yes.

Table 5. Tables and data fields from the white pine database (continued)

(g) Table name: *tbl_EvData_TreeData*. This table holds all of the Tree Data associated with a sampling Event.

Field Name	Type	Format	Description
BoleCankers_ITypes_Lower	text	up to 25 characters	Indicator Types observed (from tlu_Indicator_Types). Required if BoleCankers_I_Lower is Yes.
PineBeetle_JGalleries_YN	text	Yes/No	Presence (Yes/No) of pine beetle J-shaped galleries (only recorded for Dead or RecentlyDead trees)
PineBeetle_PitchTube_YN	text	Yes/No	Presence (Yes/No) of pitch tubes
PineBeetle_Frass_YN	text	Yes/No	Presence (Yes/No) of frass
Mistletoe_YN	text	Yes/No	Presence (Yes/No) of mistletoe on tree.
FemaleCones_YN	text	Yes/No	Presence (Yes/No) of female cones on tree.
TreeData_Notes	text	up to 255 characters	Notes regarding tbl_EvData_TreeData record, if applicable

(h) Table name: *tbl_EvData_WildlifeObs*. This table holds the Wildlife Observation data associated with a sampling Event.

Field Name	Type	Format	Description
WildlifeObs_ID	GUID ReplicationID	alphanumeric	Primary key, uniquely identifying each tbl_EvData_WildlifeObs record
Event_ID	GUID ReplicationID	alphanumeric	Co-Primary key. Link to tbl_Events (foreign key)
Hour_ofCount	Integer	numeric	Co-Primary key. Hour of Count of wildlife sign (Clark's nutcrackers and pine squirrel). Sequential, whole number value (e.g., 1, 2, 3).
Nutcracker_Sighting	Integer	numeric	Count of Clark's nutcracker sightings
Nutcracker_Calling	Integer	numeric	Count of Clark's nutcrackers calling
Squirrel_Pres_YN	text	Yes/No	Presence (Yes/No) of pine squirrels
StartTime_ofCount	DateTime	24-HR time	Start Time of the Hour Count
EndTime_ofCount	DateTime	24-HR time	End Time of the Hour Count

(i) Table name: *tlu_TreeStatus_Codes*. Lookup table of TreeStatus Codes for Tree Data.

Field Name	Type	Format	Description
TreeStatus_Code	text	1–2 characters	Primary key. Unique tree status code
TreeStatus_Description	text	up to 255 characters	Description of tree status

Table 5. Tables and data fields from the white pine database (continued)

(j) Table name: *tluContacts*. Lookup table of Contacts associated with protocol data collection and entry. Contacts linked to Events in xref_Event_Contacts table.

Field Name	Type	Format	Description
Contact_ID	GUID ReplicationID	alphanumeric	Primary key uniquely identifying each tluContacts record associated with this protocol
First_Name	text	up to 50 characters	First name of contact person
Last_Name	text	up to 150 characters	Last name of contact person
Initials	text	2–3 characters	Initials of contact person
Organization	text	up to 255 characters	Organization with which contact person is affiliated

(k) Table name: *tlu_Species_Parks*. Lookup table of Species_Codes, Park, and Species Names. Allows park-specific species lists for Seedling Counts and Tree Data.

Field Name	Type	Format	Description
SpCode	text	6 characters	Co-Primary key. Unique species code (3 letters from Genus plus 3 letters from Species).
Park	text	4-letter code	Co-Primary key. Park Code (4 letter) for the Park in which protocol data will be collected for this species.
SpeciesName	text	up to 150 characters	Full species name (Genus and Species).
FiveNeedleSp_YN	text	Yes/No	Is species a 5-Needle pine? (Yes/No). Used to refine data fields for Tree data entry.
SeedlingCount_YN	text	Yes/No	Include species in seedling counts? (Yes/No). Used to refine species lists for Seedling counts.
Park_SpCode	text	10 characters	ParkCode_SpeciesCode. Unique field tag comprised of the Park Code and the Species Code.

Table 5. Tables and data fields from the white pine database (continued)

(l) Table name: *tlu_HeightClass_Seedlings.* Lookup table of HeightClass Codes for Seedling Counts.

Field Name	Type	Format	Description
HeightClass_Code	Integer	numeric	Primary key. Unique height class code
HeightClass_Description	text	up to 255 characters	Description of height class for seedlings

Data Entry

All protocol field data is recorded using field tablet PCs, so that plot data is entered directly into the protocol database. Paper field forms serve as a backup in case problems are encountered with the tablet PCs. Accurate data recording is viewed as an important step in the overall QA/QC process, and care should be taken to review all plot data while the observers are in the field so that any inconsistencies or questions can be resolved without relying on distant or hazy memories. Data entry is a group process, with a designated data entry crew member working the tablet PC. Other crew members carefully call entries, such as tree diameter or height, and wait for a correct return verification call from the crew member entering data. In this way a real-time double-checking process is established. In addition, the database has built-in quality assurance components such as pick lists to standardize entries and validation rules to prevent illogical data entries or omissions. If paper data forms are used in the field, data transcription from paper forms into the MS Access database is accomplished as soon as possible.

Quality Review

After a given network's data have been entered and processed, they are reviewed by the network Project Lead for quality, completeness, and logical consistency. The working database application facilitates this process through pre-built queries that display, in a spreadsheet format, both raw data records and summarized data allowing the user to find and examine data outliers and illogical values. The user may then fix these problems and document the fixes, using the front-end application to re-open the problematic plot record, correct data discrepancies, and document corrections in the plot notes field. Not all errors and inconsistencies can be fixed, in which case the persistent errors are then documented and included in the metadata and certification report.

After each network has completed their quality review and compiled metadata information, they can certify the current season's data as described below. Once all networks have certified their current season's data, the datasets are merged into the master database application. Each network will archive their certified datasets, while one network (currently designated as the UCBN) will manage and archive the master database. As described below and in SOP 6, the master database will be posted to the national web-accessible Integrated Resource Management Application (IRMA).

Metadata Procedures

Data documentation is a critical step in ensuring that data sets remain useable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, and condition of data. Additionally, metadata provide the means to catalog data sets within intranet and internet systems, making data available to a broad range of potential users. Metadata for the PWR white pine monitoring data will conform to Federal Geographic Data Committee (FGDC) standards and NPS guidelines when applicable and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized. The metadata requirements and standards described here also apply to other forms of data and information associated with the project including photographs, videos, analyses, and reports.

For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata

records in subsequent years then only require updating to reflect current publications, references, taxonomic conventions, contact information, data disposition and quality, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for metadata development and posting are outlined in the various network Data Management Plans. In general, the Project Lead and the Data Manager (or Data Technician) work together to create and update an FGDC- and NPS-compliant metadata record in XML format. The Project Lead should update the metadata content as changes to the protocol are made, and each year as additional data are acquired. Edits within the document should be tracked so that any changes are obvious to those who will use it to update the XML metadata file. At the conclusion of the field season, the Project Lead will be responsible for providing complete, up-to-date metadata to the Data Manager (or, at a minimum, a completed metadata questionnaire that captures all of the required metadata information). The Data Manager will facilitate metadata development by creating and parsing metadata records, and by posting such records to national clearinghouses as described below.

Sensitive Information

Metadata development includes determining if the data contain sensitive information such as specific locations of rare, threatened, or endangered species. In some cases, it may be necessary to restrict access to data containing sensitive information, except where a written confidentiality agreement is in place. The Project Lead and Park Resource Manager should work together to identify any sensitive information in the data. Their findings should be documented and communicated to the Data Manager. We currently do not anticipate that sensitive information will be present in the white pine monitoring data.

Data Certification and Delivery

Data certification is a benchmark in the project information management process that confirms 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks; and 3) that they are appropriately documented and in a condition for archiving, posting, and distribution. Certification is not intended to imply that the data are completely free of errors or inconsistencies, which may not have been detected during quality assurance reviews.

The PWR white pine database provides data review queries that enable the database user to examine both raw data records and summarized data in order to identify any data outliers or illogical values. From the main database menu, the user clicks the Open/Export Data Summaries button to open a menu of data review options. The user may next click the Go To Raw Data View/Export Form to select from the collection of raw data record formats – tree data, seedling count data, wildlife observation data, and plot photo data. The user also may click the Go To Summarized Data View/Export Form to select from the collection of summarized data formats – canker presence and crownkill data, canker sign by canopy level and crownkill data, and seedling count data. All of these data query formats facilitate the review of records either in a MS Access query or in a MS Excel spreadsheet. Any text field can be sorted alphabetically, any number field sorted numerically, and any date or time field sorted sequentially, which readily allows the user to examine the data for unusual or illogical values. If data values need correction, the user returns to the front-end database's main menu and uses the Data Gateway form to return to the Event (the day a given Plot was sampled) and make the necessary Plot data edits via the Data Entry

form. All edits should be described in the Event_Notes field provided on the Data Entry form. In addition, the discovery and correction of data errors should be thoroughly described in a certification report by the Project Lead.

To ensure that only data of the highest possible quality are included in reports and other project deliverables, the data certification step is an annual requirement for all deliverables in all of the networks implementing this protocol. The Project Lead is primarily responsible for completing certification. The completed certification form, certified data, and updated metadata should be delivered to the Data Manager as outlined in the following steps and in Table 6.

Data certification steps

To package the certification materials for delivery, the Project Lead should follow these steps:

1) Use the Open/Export Data Summaries option on the white pine database's main menu to perform data quality review. Correct errors as necessary, using the Enter/Edit Data option on the database's main menu, and document edits in the Event_Notes field for each Plot sampling Event that is modified.

2) Create a compressed file (using WinZip® or similar software) and add the back-end database file to that file. Note: The front-end application does not contain project data and as such should not be included in the delivery file.

3) Add the completed metadata to the compressed file (or, at a minimum, a completed metadata questionnaire).

4) Add the completed certification report to the compressed file.

5) Add any geospatial data files that are not already in the possession of the Data Manager.

6) All file names – except for image files and geospatial data files – should include the assigned network project code, in addition to the year or span of years for the data being certified. For example: WhitePine_2007_certified.mdb, WhitePine_2007_cert_report.doc.

7) The compressed file may then be delivered to the network Data Manager.

Upon receiving the certification materials, the Data Manager will check them in, store them in the network Digital Library, and update the project GIS data sets with any geospatial data that are submitted. Each network will archive their certified datasets, while one network (currently designated as the UCBN) will manage and archive the master database. Once all networks have certified their datasets, the data will be delivered to the network managing the master database so that all records can be merged into the master database. The master database will serve long-term trend analyses, and will be posted to the national Integrated Resource Management Application (IRMA), as described below. Upon notification that the year's data have been uploaded and processed successfully, the Project Lead may then proceed with data summarization, analysis and reporting.

Data Archiving

Paper data sheets, if used, will be archived indefinitely according to NPS policy and network Data Management Plans. In general, original paper data sheets will be archived and photocopied or scanned versions will be stored on the network digital file server(s).

Digital datasets generally are stored indefinitely, with local copies stored on network file server(s) and master datasets posted to the national Integrated Resource Management Application (IRMA) system. Upon certification, data and reports will be archived on the network's file server, and posted to network websites according to individual network practices. Each year, after all certified records have been merged into the master database, the white pine master database will be archived and posted to the national web-accessible IRMA system thereby making it readily available to all networks and parks.

A review of archive and expendable data products will be undertaken by the Project Lead and Data Manager during season close-out each year. An example of an expendable data product is an intermediate draft of an annual report that was saved during report preparation.

Directory Structure

The project directory structure for organizing documents and data associated with this protocol will follow guidelines and policies established by each network implementing it. These directives can be found in the network's Data Management Plan. The project directory structure should provide a foundation and a minimum standard of organization and consistency. The goal is to organize all project materials in an efficient hierarchical structure that reflects the life cycle and workflow of the project. Additional subfolders may be added as needed, but a strong emphasis must be placed on keeping the structure as simple and logical as possible.

Schedule of Data Management Tasks

Table 6. The yearly white pine monitoring data management task list. This table identifies tasks by project stage, indicates who is responsible for the task, and establishes the timing for its execution.

Project Stage	Task Description	Responsibility	Timing
Preparation	Notify Data Manager of needs (field maps, GPS support, training)	Project Lead	ASAP, before Feb 1
	Ensure that project workspace is ready for use and GPS download software is loaded	Data Manager	by May 1
	Prepare and print field maps and data sheets	Project Lead /Data Manager	by May 1
	Update and load data dictionary, background maps, and target coordinates into GPS units	Project Lead/Data Manager	by May 1
	Provide database/GPS training as needed	Data Manager/Project Lead/Field Lead	May
	Train field crew in tree and blister rust identification and field sampling protocols	Project Lead and/or Field Lead	May
	Examination and certification of field observer qualifications, enter training results into database	Project Lead and/or Field Lead	May
Data acquisition	Collect field observations and position data during field trips	Technicians/ Volunteers	June–Sep
	Review data sheets after each day	Field Lead	daily
Data entry & processing	Enter data into working copy of the database	Technicians	after each tour
	Verification of accurate transcription as data are entered	Technicians	after each tour
	Periodic review of database entries for completeness and accuracy	Field Lead	As needed
	Upload processed and verified data to archive master database copy	Data Manager and/or Technician	July-Sept.
Product development	Complete field season report	Project Lead / Field Lead	Sep-Nov
Product delivery	Send field season report to Data Manager	Project Lead / Field Lead	by Dec 1
Quality review	Quality review and data validation using database tools	Project Lead/Data Manager	Jul–Oct
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review and reports	Data Manager	by Sep 15
Metadata	Identify any sensitive information contained in the data set	Project Lead and Park Resource Manager	Aug–Oct
	Update project metadata records	Project Lead	Aug–Oct

Table 6. The yearly white pine monitoring data management task list. This table identifies tasks by project stage, indicates who is responsible for the task, and establishes the timing for its execution.

Project Stage	Task Description	Responsibility	Timing
Data certification	Certify the season's data and complete the certification report	Project Lead	October
Data delivery	Deliver certification report, certified data, and updated metadata to Data Manager	Project Lead	by Oct 31
	Upload certified data into master project database, store data files in the network Digital Library [1]	Data Manager	July-October
	Notify Project Lead of uploaded data ready for analysis and reporting	Data Manager	July-October
	Update project GIS data sets, layers and associated metadata records	Data Manager	Sept–Dec
	Finalize and parse metadata records, store in the network Digital Library [1]	Data Manager	by Dec 1
Data analysis	Sample site selection for upcoming season	Project Lead/Data Analyst	October
	Status and Trend Analyses (within networks)	Project Lead/Data Analyst	Sept–Nov
	Status and Trend Analyses (among networks)	Alternate among SIEN ecologist, UCBN ecologist, and KLMN ecologist, beginning with SIEN.	Nov-Dec 2013
Product development	Export automated summary queries and reports from database	Data Analyst	Oct-Nov
	Produce park-wide and stand/plot map output for archives	Data Manager / Data Analyst	Oct-Nov
	Generate report-quality map output for reports	Data Manager / Data Analyst	October
	Acquire the proper report template from the NPS website, create annual report	Data Analyst and Project Lead	Sep–Nov
	Screen all reports and data products for sensitive information	Project Lead and Park Resource Manager	October
Product delivery	Submit draft report to Network Coordinator for review	Project Lead	by Nov 15
	Review report for formatting and completeness, notify Project Lead of approval or need for changes	Network Coordinator	by Dec 1
	Upload completed report to the network Digital Library [1] submissions folder, notify Data Manager	Project Lead	by Dec 15
	Deliver other products according to the delivery schedule and instructions	Project Lead	upon completion
	Product check-in	Data Manager	upon receipt

Table 6. The yearly white pine monitoring data management task list. This table identifies tasks by project stage, indicates who is responsible for the task, and establishes the timing for its execution.

Project Stage	Task Description	Responsibility	Timing
Posting & distribution (Section 4k)	Create IRMA Data Store [3] record, and link reports	Data Manager	upon receipt
	Update NPSpecies[4] records according to data observations.	Data Manager	Dec
	Submit certified master (multi-network) database, GIS data, and metadata to IRMA Data Store.[2]	Data Manager	Dec
Archival & records management	Store finished products in the network Digital Library.[1]	Data Manager	upon receipt
	Review, clean up and store and/or dispose of project files according to NPS Director's Order #19.[5]	Project Lead	Dec
Season close-out	Meet to discuss the recent field season, and document any needed changes to field sampling protocols or the working database.	Project Lead, Park Resource Manager and Data Manager	Sep-Dec
	Discuss and document needed changes to analysis and reporting procedures.	Project Lead, Park Resource Manager and Data Manager	Sep-Dec

[1]The network Digital Library is a hierarchical digital filing system stored on the network file server. Network users have read-only access to these files, except where information sensitivity may preclude general access.

[2]IRMA Data Store is an NPS clearinghouse for natural resource data and metadata (https://irma.nps.gov/App/Reference/Welcome). Only non-sensitive information is posted to NPS Data Store. Refer to the protocol section on sensitive information for details.

[3]IRMA Data Store includes bibliographic citation records (https://irma.nps.gov/App/Reference/Search?SearchType=N). This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record.

[4]NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data (https://irma.nps.gov/App/Species/Welcome).

[5]NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://www.nps.gov/refdesk/DOrders/DOrder19.html

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 7: Data Analysis and Reporting

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP provides details of the recommended analytical approaches and reporting guidelines for the KLMN, SIEN, and UCBN I & M monitoring programs. Code written for the R statistical software and language environment is included in the accompanying CD and in the project directories of the Networks.

Suggested Reading

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Maindonald, J., and W. J. Braun. 2007. Data analysis and graphics using R – an example-based approach. Cambridge University Press, UK.

National Park Service. 2006. Instruction to authors—Natural Resource Report and Natural Resource Technical Report. Natural Resource Report NPS/NRPC/NRR—2006/001. National Park Service, Fort Collins, Colorado.

Stevens, D. L., and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics 14:593–610.

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Stucki, D. S., and S. T. McKinney. *In Prep*. Sierra Nevada Network white pine community dynamics 2011 annual monitoring report. Natural Resource Data Series NPS/SIEN/NRDS—2012/XXX. National Park Service, Fort Collins, Colorado.

Stucki, D. S., and T. J. Rodhouse. 2012. Upper Columbia Basin Network limber pine community dynamics 2011 annual monitoring report. Natural Resource Data Series NPS/UCBN/NRDS—2012/266. National Park Service, Fort Collins, Colorado.

Theobald, D. M., D. L. Stevens, D. White, N. S. Urquhart, A. R. Olsen, J. B. Norman. 2007. Using GIS to generate spatially-balanced random survey designs for natural resource applications. Environmental Management 40:134–146.

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Analytical Procedures

The statistical methods outlined below are described for implementation with the statistical freeware R, an open source version of S-Plus. R is a powerful system for statistical computations and graphics, which runs on Windows, Unix, and Mac computers. R is a combination of a statistics package and a programming language. It can be downloaded for free from http://www.r-project.org/ . The R Wiki provides an online forum http://wiki.rproject.org/rwiki/doku.php and documentation. R is one of the analytical environments of choice for the Networks involved in this protocol. Computational code for procedures outlined in this SOP written for R statistical language and environment (http://www.r-project.org/) are provided on the CD that accompanies this manual or by request from the involved networks. Direct references to R commands in the text are distinguished by `Courier New Font` rather than Times New Roman, with arguments for the commands noted by closed parentheses `()`.

Inference on status and trends for white pine communities is desired at three scales: park, network, and regional. Park- and network-level inference is straightforward because parks and networks can be treated as strata in the sampling design. Regional level inference will span the three networks and three pine species (whitebark pine, foxtail pine, and limber pine). Status and trend estimation approaches are discussed first, and then issues involving regional trend inference are addressed.

Status Analysis

Status analyses will provide a static view of target parameters (infection, mortality rates) at a given point in time for each scale of analysis. The goal of status analyses will be to provide visualization and parameter estimates for a given sampling frame (park) or aggregations of sampling frames (network, region). Visualizatons may be as simple as bubble maps that show the infected site with bubble icons scales by parameter estimates. The development of such values

will be directly affected by the sampling designs used. The membership design specifies how the units in a sample are chosen at a given time (McDonald 2003). A simple random sample is a familiar example of a membership design. The membership design for all three networks is generalized random tessellation stratified (GRTS) with equal probability sampling (Stevens and Olsen 2004). This sampling approach provides spatially-balanced random samples to obtain widespread coverage across the areas of interest. The estimates for each parameter will be summarized by sites and across the sample frame. Variance estimates will be created by standard approaches and by customized approaches that accommodate spatial patterns in variance more closely. The neighborhood variance estimator, for instance, used with GRTS designs for status estimates, provides variance estimates that are 22% to 58% smaller than variance estimates computed assuming a simple random sample (Stevens and Olsen 2003).

We will use the *spsurvey* package in R (Kincaid et al. 2011) for our status analyses. The *spsurvey* package in R contains functions used to draw GRTS samples from sampling frames summarized in shapefiles. GRTS sample output files contain x- and y-coordinates and inclusion probabilities for each selected site. The *spsurvey* package also provides useful analysis tools for GRTS samples. The `total.est()` function in this package allows the estimation of means and totals as well as standard errors computed using the local neighborhood-weighted GRTS variance estimator. Inclusion probabilities from the GRTS sample are applied in these functions for unbiased estimation, and the neighborhood variance estimator capitalizes on the spatially-balanced sample for precise estimation. Stratification by networks and parks may be incorporated into these functions to obtain region-, network-, and park-level status estimation.

For any given year, it is possible that modeling analyses will also be augmented by modeling efforts to more effectively display the spatial patterns in the parameter of interest across park landscapes, either through purely spatial modeling approaches (kriging) or through more analytical models that incorporate environmental variables (logistic regression co-kriging). These supplemental analyses will depend upon the funding and staffing resources available in that year.

Trend Analysis

Because this protocol describes the presence and spread of an invasive pathogen in national park landscapes, accurate trend analyses will be crucial. The white pine protocol requires trend monitoring of several indicators such as mean diameter at breast height (DBH), site basal area, and blister rust infection rates. As an example, an outline for the analysis of trends in pine DBH is provided. Pilot data from a similar survey in the Rocky Mountains are used to demonstrate a trend analysis with a linear mixed model. Linear mixed models are not the only way to analyze these data, but they present a feasible approach that can accommodate fixed and random effects on the parameters of interest.

Linear mixed model approach: The linear mixed model provides a flexible approach for trend analysis by combining terms for fixed linear trend with random effects to account for year-to-year variation, site-to-site variation, and variation among site-level trends (Piepho and Ogutu 2002; VanLeeuwen et al. 1996). This model-based approach does not incorporate aspects of the survey design. Given that an equal-probability sample is used, the spatial balance is not expected to adversely affect estimates of trend.

For inference at the park-level, the following mixed model for the white pine protocol was derived from the approach proposed by Piepho and Ogutu (2002):

$$y_{ijk} = \mu + w_j\beta_i + a_{k(i)} + b_{j(ik)} + \gamma_i + w_j t_{k(i)} + e_{j(ik)} \qquad (1)$$

where:

$i = 1, \ldots, 5$ indexes the five parks
$k = 1, \ldots, k_i$ indexes the kth site within the ith park
$j = 1, \ldots, j_{k(i)}$ indexes the jth survey year of the kth site in the ith park
μ = fixed intercept of the linear time trend
w_j = is a constant representing the jth year (covariate) which is centered such that the year of least variation occurs at $w_j = 0$
β_i = fixed linear slope of the ith park
$a_{k(i)}$ = the random intercept of the kth site in the ith park, assumed independent and identically distributed as $N\left(0, \sigma^2_{a(i)}\right)$
$b_{j(i)}$ = random effect of the jth year in the ith park, assumed independent and identically distributed as $N\left(0, \sigma^2_{b(i)}\right)$
γ_i = fixed effect of the ith park
$t_{k(i)}$ = random slope of the lth site in the kth park in the ith network, assumed independent and identically distributed as $N\left(0, \sigma^2_{t(ik)}\right)$
$e_{j(ik)}$ = unexplained error, assumed independent and identically distributed as $N\left(0, \sigma^2_{e(ij)}\right)$.

For regional inference, a single overall fixed slope is estimated across all parks using the following model:

$$y_{ijk} = \mu + w_j\beta + a_{k(i)} + b_{j(ik)} + \gamma_i + w_j t_{k(i)} + e_{j(ik)}. \qquad (2)$$

Note that, in the regional model, β is no longer indexed by *i* and represents the overall trend for the region represented by the five parks.

Several terms are not estimable in the proposed linear mixed model due to the lack of balance among several factors. First, because UCBN only monitors a single park, there is insufficient within-network replication to model specific network effects. Network-level inference is obtained by generalizing across parks similarly to the approach for regional inference. Second, sites are not visited more than once each year, so site-by-year interactions are inestimable. Site-by-year variation is included in the residual error term. Finally, effects of each white pine species are not incorporated in the model because the design does not allow for separation of species-park-network combinations of grouping factors. For example, limber pine is only monitored at Craters of the Moon NM within the UCBN.

Given appropriate replication of parks over time, R code is provided in the CD accompanying this document or by request from a participating Network to analyze the site-level means of

DBH outcomes with the linear mixed model given above in R using the *lme4* R package. Data analysis will require a data set (in this example named "DBHmean") formatted with columns for Year, WYear (w_j), Site, Park, Species, and the site-level means, Y. Note that the Site variable must be unique across all parks and that Site, Year, and Park must be defined as factors.

Estimate trend within each park

```
trendfit.ByPark<-lmer(Y ~ WYear * Park + (-1+Park + Park:WYear|Site) +
(-1+ Park|Year), data= DBHmean)
summary(trendfit.ByPark)
```

Estimate trend across parks

```
trendfit.Regional <-lmer(Y ~ WYear + Park + (-1+Park +
Park:WYear|Site) + (-1+ Park|Year), data= DBHmean)
summary(trendfit.Regional)
```

The first model provides R code to estimate trends in time within each park as well as to measure components of variation such as site-to-site variation, year-to-year variation, and variation among site-level trends. Output from the second model will provide an estimate of the regional trend across all parks.

Pilot Data

Pilot data from a survey of whitebark pine forests in the northern Rocky Mountains (McKinney et al. 2009, McKinney and Fiedler 2010) are used to demonstrate the use of the linear mixed model for trend analysis. The data come from three ecosystems which fall within the boundaries of two national parks and five national forests. We will treat the three ecosystems as analogous to national parks since they were summarized at this level. Surveys were conducted for three years spanning from 2004 to 2006.

While the pilot data represent whitebark pine populations from a similar system, some differences are discussed. First, the sites were not randomly selected but were selected to fall along a gradient of forest conditions including varying levels of mortality and blister rust infection rates and a range of ecosystems (McKinney et al. 2009). Secondly, 10 x 50 m belt transects are used, which are smaller than those used in the proposed response design. Finally, transects were located with additional hierarchical structure not present in the sampling design proposed in this narrative. In the pilot study, a site was defined as a contiguous set of two to four 100 x 100 m squares containing two transects each. This provided some spatial control over the allocation of transects. In this protocol, a single transect is located per site. The additional structure will be ignored in the data analysis example, so results provided in this data analysis example should not be used for inference. The pilot data are given in the form of an R list structure in the script on the accompanying CD. All R code for the following trend analysis is provided in that script.

An initial plot of the data reveals lack of balance in plots over time relative to the three parks (Figure 9). Park 3 only contains two sites (15 and 16) collected in a single year, 2006. Since this level of replication in time and space is inadequate for trend analysis, Park 3 is removed from the

pilot data set. Almost all of the sites that were surveyed in both 2005 and 2006 exhibit an increasing trend between the two years.

Preliminary data analysis included analysis of both the untransformed site-level means and the natural logarithmic transformation of the site-level means. In all cases, the untransformed data satisfied model assumptions nearly as well as the logarithmically-transformed site-level means of DBH measurements. The transformed outcomes allow a convenient interpretation of multiplicative change over time, so the logarithmic transformation is used for site-level means. The model for park-level inference generated estimates of year-to-year variation near zero, so those effects were removed from the random effects portion of the model. This reduced model yielded non-zero variance components but a convergence error occurred. The model was further reduced by omitting the fixed park slope effect (t-statistic = -0.6376, $p = 0.7208$) so that a common trend was assumed for both parks. This model, which is analogous to the regional analysis with equal slopes among parks yielded valid variance component estimates without convergence issues. Residual diagnostics suggested that these data meet the assumptions of equal variance (homoscedasticity) and normally-distributed errors for this model (Figure 10).

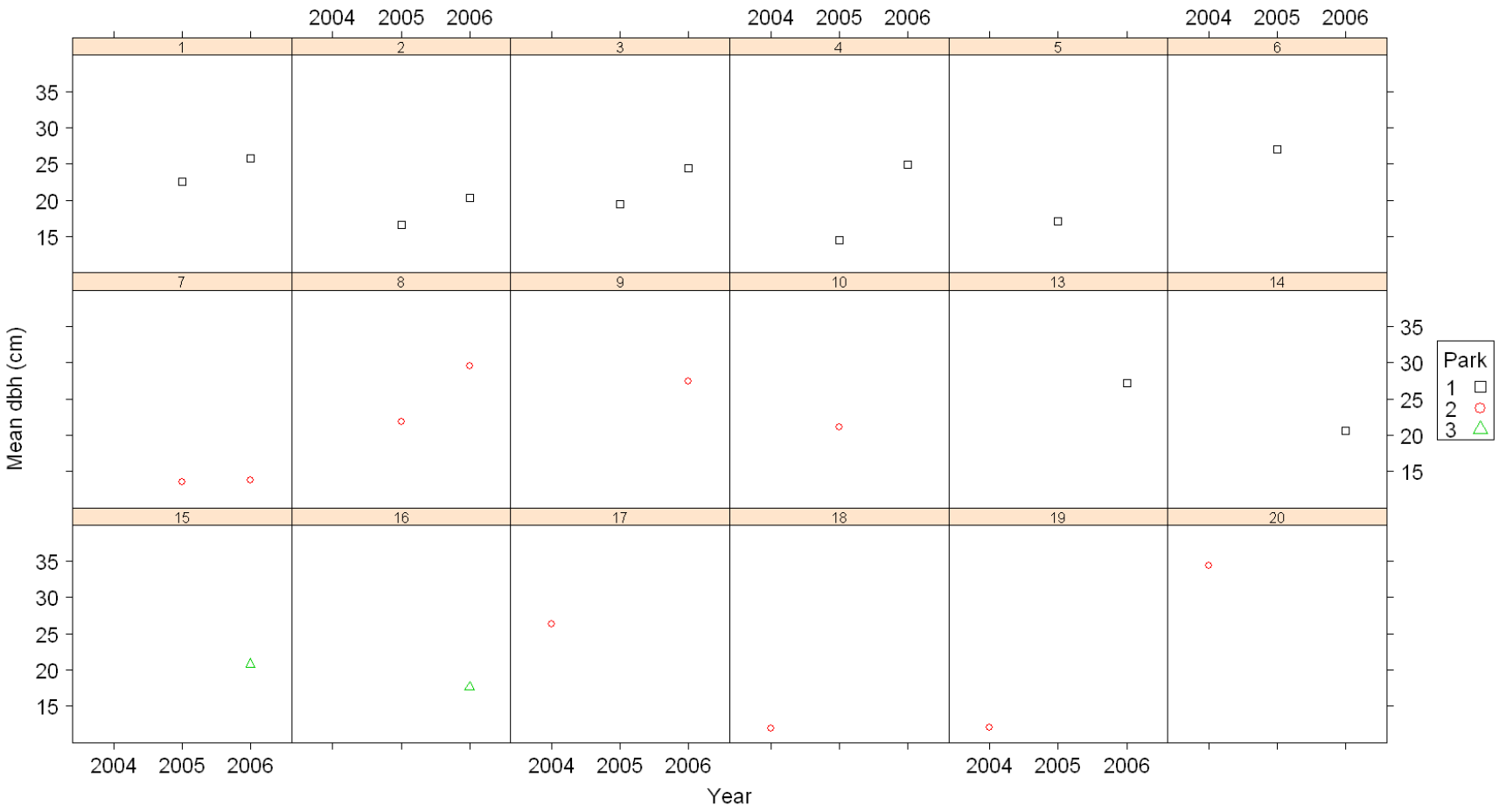


Figure 9. Site-level means of DBH by year for sites within each of three "Parks."

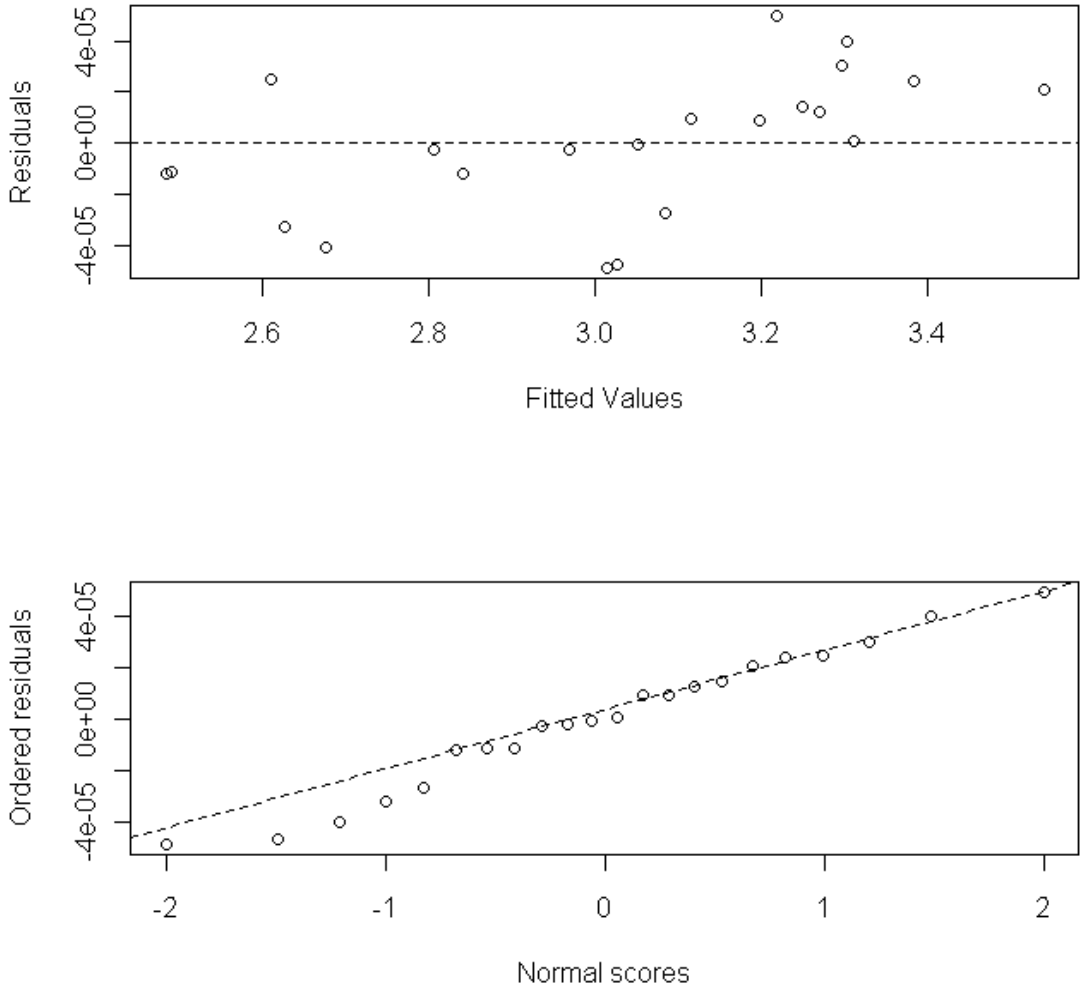


Figure 10. Residual diagnostics for the reduced model for regional inference.

The reduced linear mixed model for trend is applied to the pilot data using the following code in R:

```
trendfit.ByPark3<-lmer(log(MeanDBH) ~ WYear + Park + (-1+Park +
Park:WYear|Site), data= DBHmean)
summary(trendfit.ByPark3)
```

Output:

```
Linear mixed model fit by REML
Formula: log(MeanDBH) ~ WYear + Park + (-1 + Park + Park:WYear | Site)
  Data: DBHmean
  AIC  BIC logLik deviance REMLdev
 30.92 46.19 -1.458  -7.334  2.917
Random effects:
 Groups  Name    Variance  Std.Dev. Corr
 Site   Park1    1.6224e-01 0.4027876
     Park2    1.5104e-01 0.3886346 0.408
     Park1:WYear 3.8329e-02 0.1957768 -0.954 -0.360
     Park2:WYear 2.1066e-02 0.1451407 0.134 0.052 -0.128
 Residual       4.6199e-06 0.0021494
Number of obs: 22, groups: Site, 16

Fixed effects:
      Estimate Std. Error t value
(Intercept) 2.76626  0.12773 21.657
WYear    0.20478  0.06286  3.258
Park2    0.09681  0.18218  0.531

Correlation of Fixed Effects:
   (Intr) WYear
WYear -0.929
Park2 -0.624 0.568
```

The coefficient of WYear (w_j), $\beta_1 = 0.20478$, is the estimate of the slope for the log-transformed outcome for Park 1. Therefore, the multiplicative annual trend on the original scale is $e^{\beta_1} - 1 = 0.2273$. This implies that the population median is increasing by 22.73% each year. An annual change in median dbh of 22.73% should not be assumed to be representative of expected annual growth as the raw data used in this analysis were for illustrative purposes only. The 90%-confidence interval is computed based on Satterthwaite degrees of freedom of 5.0033 calculated with the Geisbrecht and Burns (1985) approach and is obtained as follows:

$$\left(\exp\left(\beta_1 - t_{(1-\alpha/2,df)} SE\left(\beta_1\right)\right) - 1, \exp\left(\beta_1 + t_{(1-\alpha/2,df)} SE\left(\beta_1\right)\right) - 1\right)$$
$$= \left(\exp\left(0.20478 - 2.0148 * 0.06286\right) - 1, \exp\left(0.20478 + 2.0148 * 0.06286\right) - 1\right)$$
$$= \left(0.0813, 0.3929\right)$$

Therefore, the 90%-confidence interval for the annual multiplicative change is 8.13% to 39.29%. Note that, because the park-level analysis was reduced to have a common slope, this estimate of trend and its 90%-confidence interval also represents the regional analysis across parks.

Regional Inference: Inference on regional trends across networks is of great interest to managers at KLMN, SIEN, and UCBN. Stressors that impact all white pine species may induce similar changes in the three white pine populations. Large-scale changes to white pine populations would be important to detect as early as possible. Analyses of measures that are summed at the site-level, such as basal area, should be standardized across networks. Furthermore, differences in the sampled populations must be assumed negligible.

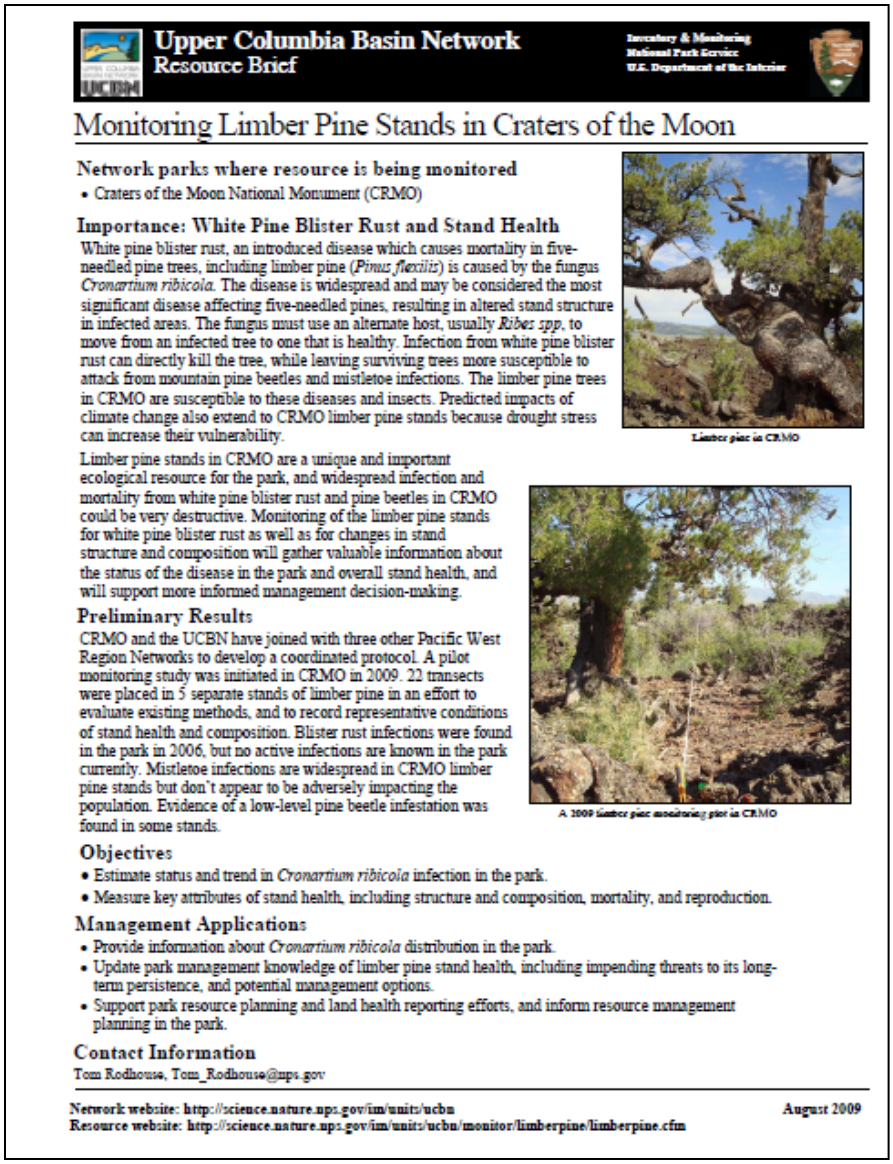
Reporting

A summary report will be produced after each year of data collection by each Network, with a more detailed report trend report produced in collaboration among the 3 Networks after every 3-year completion of the rotating panel cycle. The annual report will:

- Provide a summary history of the samples taken during each year of the study, tabulating numbers of samples for each sampling frame and showing these locations on maps of the parks
- Provide summary status statistics, maps, and interpretation of the results relative to management goals.
- Provide a summary table of key resource condition indicators for use in park reporting and resource stewardship strategies.
- Evaluate data quality and identify any data quality concerns and/or deviations from protocols that affect data quality and interpretation.
- Evaluate and identify suggested or required changes to the protocol.

Good example report templates were developed in 2011 by SIEN (Stucki and McKinney *In Prep*) and UCBN (Stucki and Rodhouse 2012).

A 1-2 page resource brief will also be prepared from this annual report that will be provided to superintendents, park interpretive staff, and resource managers (Figure 11). The 2009 limber pine monitoring resource brief produced by the UCBN can be used as a template and is available at http://science.nature.nps.gov/im/units/ucbn/. A template for the resource brief is included in Figure 11. An NPS template for producing maps with ESRI ArcGIS or ArcView software is available at http://imgis.nps.gov/templates.html. Information from the annual summary report will also be provided to parks in time for park Government Performance Results Act (GPRA) goals reporting and for informing and evaluating park resource stewardship strategies. Table 7 presents an example status summary report of indicators for CRMO within HAFO from 2009 sample data. Finally, invasive weed locations should be reported to the park resource managers immediately following completion of field activities. Reported information should include GPS locations and maps of locations with weeds encountered (if any) both within plots and as noted during travel between sampling locations.



Upper Columbia Basin Network
Resource Brief

Inventory & Monitoring
National Park Service
U.S. Department of the Interior

Monitoring Limber Pine Stands in Craters of the Moon

Network parks where resource is being monitored

- Craters of the Moon National Monument (CRMO)

Importance: White Pine Blister Rust and Stand Health

White pine blister rust, an introduced disease which causes mortality in five-needled pine trees, including limber pine (*Pinus flexilis*) is caused by the fungus *Cronartium ribicola*. The disease is widespread and may be considered the most significant disease affecting five-needled pines, resulting in altered stand structure in infected areas. The fungus must use an alternate host, usually *Ribes spp*, to move from an infected tree to one that is healthy. Infection from white pine blister rust can directly kill the tree, while leaving surviving trees more susceptible to attack from mountain pine beetles and mistletoe infections. The limber pine trees in CRMO are susceptible to these diseases and insects. Predicted impacts of climate change also extend to CRMO limber pine stands because drought stress can increase their vulnerability.

Limber pine stands in CRMO are a unique and important ecological resource for the park, and widespread infection and mortality from white pine blister rust and pine beetles in CRMO could be very destructive. Monitoring of the limber pine stands for white pine blister rust as well as for changes in stand structure and composition will gather valuable information about the status of the disease in the park and overall stand health, and will support more informed management decision-making.

Preliminary Results

CRMO and the UCBN have joined with three other Pacific West Region Networks to develop a coordinated protocol. A pilot monitoring study was initiated in CRMO in 2009. 22 transects were placed in 5 separate stands of limber pine in an effort to evaluate existing methods, and to record representative conditions of stand health and composition. Blister rust infections were found in the park in 2006, but no active infections are known in the park currently. Mistletoe infections are widespread in CRMO limber pine stands but don't appear to be adversely impacting the population. Evidence of a low-level pine beetle infestation was found in some stands.

Limber pine in CRMO

A 2009 limber pine monitoring plot in CRMO

Objectives

- Estimate status and trend in *Cronartium ribicola* infection in the park.
- Measure key attributes of stand health, including structure and composition, mortality, and reproduction.

Management Applications

- Provide information about *Cronartium ribicola* distribution in the park.
- Update park management knowledge of limber pine stand health, including impending threats to its long-term persistence, and potential management options.
- Support park resource planning and land health reporting efforts, and inform resource management planning in the park.

Contact Information

Tom Rodhouse, Tom_Rodhouse@nps.gov

Network website: http://science.nature.nps.gov/im/units/ucbn
Resource website: http://science.nature.nps.gov/im/units/ucbn/monitor/limberpine/limberpine.cfm

August 2009

Figure 11. The UCBN 2009 limber pine monitoring resource brief.

An in-depth trend report will be produced every three years, beginning with year nine, that summarizes results among networks. This report will provide greater analytical and interpretive detail, and will evaluate the relevance of findings to long-term management and restoration goals. The report will also evaluate operational aspects of the monitoring program, such as whether sample frame boundaries need to be changed or whether the sampling period remains appropriate (the optimal sampling season could conceivably change over time in response to climate change). The report will also evaluate the monitoring protocol. For instance, does allocation of samples among parks appear to be adequate for all parks, are there new management concerns that might dictate some reallocation of effort or additions to the indicator metrics that are routinely examined annually, is the sampling time still appropriate, etc.

Annual reports and three-year analyses of status and trend will use the NPS Natural Resource Publications Natural Resource Technical Report series template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Template guidelines and documentation of the NPS publication standards are available at the following address: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Current versions of the protocol, resource briefs, and annual and five-year technical reports will be made available on the network websites (e.g., http://science.nature.nps.gov/im/units/UCBN/index.cfm). The protocol and technical reports will also be available from the national NRPM website (http://www.nature.nps.gov/publications/nrpm/nrr.cfm). All NPS protocols are available from (http://science.nature.nps.gov/im/monitor/protocoldb.cfm).

Table 7. Example summary table for several of the principal metrics used to estimate status for the population of whitebark pine in a park. A more in-depth table is provided by Stucki and McKinney (*In Prep*) and Stucki and Rodhouse (2012).

Vital Sign		
Whitebark Pine	**Metric**	**20xx Status**
	Live *P. albicaulis* Basal Area (m^2/ha)	2.5
	Blister Rust Infection Rate (%)	1.2
	Regeneration 20-50cm (seedlings/m^2)	2.1
	Regeneration 50-100cm (seedlings/m^2)	1.3
	Regeneration 100-137cm (seedlings/m^2)	0.8

Schedule for White Pine Community Dynamics Monitoring Project Deliverables

Project deliverables from each white pine monitoring project are listed below (Table 8) along with responsible parties, target dates, and destinations for each product.

Table 8. Schedule for white pine monitoring project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Weed location data	Project Lead	Immediately and no later than 2 weeks after completion of field work	CRMO, CRLA, LAVO, YOSE, SEKI, Network Digital Library[1]
Raw data files	Field Lead	November 1 of the same year	Network Digital Library[1]
Photographs (select, quality images for long-term storage)	Project Lead	November 1	Network Digital Library[1]
Certified working database and geospatial data with draft metadata	Project Lead with Data Manager assistance	November 1	Master project database and GIS data sets, copy to Network Digital Library [1], and NR-GIS Metadata and Data Store[2]
Full metadata (parsed XML)	Data Manager	December 15	NR-GIS Metadata and Data Store[2], Network Digital Library[1]
Resource Brief	Project Lead	November 1	CRMO, CRLA, LAVO, YOSE, SEKI, Network Digital Library[1]
Annual report (NRTR publication)	Project Lead	January 15, following year	NatureBib[3], Network Digital Library [1], printout to local park collections, NRPS website[5]
Season close-out checklist	Project Lead	January 15, following year	Data Manager, Coordinator, and project directory
3-year comprehensive report	Project Lead	Every 3 years by March 15	NatureBib[3], Network Digital Library [1], printout to local park collections, NRPS website[5]
Regional synthesis report (Regional trend analysis)	SIEN, KLMN & UCBN Program Managers	One Year following the completion of three full panel rotations and every three years thereafter	NatureBib[3], Network Digital Library [1], printout to local park collections, NRPS website[5]
Other publications	NPS Lead, Project Lead, Data Manager	As completed	NatureBib[3], Network Digital Library[1], printout to local park collections
Other records	NPS Lead and Project Lead	Review for retention every December	Retain according to NPS Director's Order #19 [4]

[1]The Network Digital Library is a hierarchical digital filing system stored on the Network file server. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2]NR-GIS Metadata and Data Store is a clearinghouse for natural resource data and metadata (http://science.nature.nps.gov/nrdata). Only non-sensitive information is posted to NR-GIS Metadata and Data Store. Refer to the protocol section on sensitive information for details.

[3]NatureBib is the NPS bibliographic database (http://www.nature.nps.gov/nrbib/index.htm). This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record.
[4]NPS Director's Order #19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://www.nps.gov/refdesk/DOrders/DOrder19.html
[5]NPS Natural Resource Publication Management Website, available at: http://www.nature.nps.gov/publications/nrpm/.

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Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 8: Protocol Revision

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes the recommended practices for revision of the narrative and SOPs and provides a history of the protocol development process.

Procedures

This monitoring protocol is an actively evaluated and updated document that reflects the latest procedures of the monitoring program. Revisions are expected, and can involve only minor changes with little overall impact or occasional major revisions and course corrections. Evaluation and revision of the protocol is directed by the project leader on an annual basis in association with season close-out. The narrative as well as each SOP has a change history log whereby changes can be recorded. Older versions of the narrative and SOPs should be archived to ensure proper legacy of past work is maintained. Each revision will require the updating of the version number. Minor changes are recorded as decimal numbers (e.g. 1.0, 1.1, 1.2, etc…). Major changes are recorded as a change in the primary number of the protocol version (e.g. 1.0, 2.0, 3.0, etc…). In some cases, major revisions to the protocol may prompt the need for additional peer-review. The project lead and Program Manager will coordinate this with the Pacific West Region (PWR) I&M Program Manager.

Timing

SOPs can be changed at any time, however it is often most convenient for the changes to be made during reporting and project close-out and to take effect at the beginning of the next calendar year. Changing an SOP during a data collection period should be avoided. However, testing of proposed new methodologies with the existing approaches is highly desirable and provides invaluable information necessary for evaluating whether the new methods are superior and how their measurements will correlate with the previous methods.

Instructions

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

1. Discuss proposed changes prior to making modifications. It is important to consult with Data Managers and other Network white pine project leads prior to making changes because certain types of changes may jeopardize dataset integrity unless they are planned and executed properly. Also, because certain changes may require altering the database structure or functionality, advance notice of changes is important to minimize disruptions to project operations. Consensus should be reached on who will be making the changes and in what timeframe.
2. After all relevant parties agree to a particular set of changes, 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. Also, the project task list and other appendices may need to be updated to reflect changes in timing or responsibilities for the various project tasks.
3. Document all edits in the Change 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 and not in the narrative). 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 tenths (e.g., version 1.1, 1.2) for minor changes. To ensure that minor errors noted or recommendations are not lost, changes should be made within 30 days of when they are noted, once the network team has reviewed and approved the recommended changes. Major revisions will 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 the three networks' project staff (project leads, technicians, data managers, and program managers, where appropriate). 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 research and statistical 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 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 will 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 will have the same name and be made from the versioned copy of the file.
7. Send a digital copy of the revised monitoring protocol to the Resource Chiefs of the parks and the Project Lead at each network. The revised monitoring protocol should also be forwarded to all individuals who had been using a previous version of the affected document. Ensure that field staff has a hardcopy of the new version.
8. Each Network' Data Manager will place a copy of the revised protocol in the proper folder on Network shared drives. In addition, the Network Data Manager will archive the previous version on the archive drives.
9. Network Data Managers will identify one Data Manager who will post the revised version and update the associated records in the proper I&M databases, including but not

limited to NPS Data Store and the Protocol database. Individual Network Data Managers will update their respective Network Intranet and Internet websites.

Development History

Table 9 summarizes the development process and major events leading to the initial approval of the PWR white pine vegetation monitoring protocol (version 1.0) for implementation.

Table 9. Protocol development history.

Date	Development Step	Documentation
January 2010	Protocol development initiated by KLMN, SIEN, and UCBN after consultation with PWR regional coordinator and NCCN.	Conference call notes available on project Basecamp website and by request from protocol development lead.
January 2010	Available pilot data from Networks provided to statisticians for power analyses. Draft narrative background complete. Sampling design discussion initiated.	Results reported in protocol and notes available upon request.
July–August 2010	Pilot field work and plot size calculations completed in SIEN and UCBN.	Results reported in protocol and notes available upon request.
September 2010	Version 1.0 protocol submitted for peer review to PWR I&M Program Manager (Latham) and PWR Protocol Review Coordinator (Agee).	Protocol is available upon request.
December 2010	Received decision letter that protocol is ‘Acceptable with Moderate Revision’ and comments from anonymous reviewers.	Decision letter from Agee and Latham.
June 2011	Revised protocol submitted to peer review process.	Protocol is available upon request.
August 2011	Received decision letter that protocol ‘needs substantial revision’ and administrative review comments from Latham.	Decision letter from Agee and Latham.
September 2011	Protocol Revision Plan and Schedule submitted to Latham and Agee	Revision Plan dated 20110922.

Monitoring White Pine (*Pinus albicaulis, P. balfouriana, P. flexilis*) Community Dynamics in the Pacific West Region

Standard Operating Procedure (SOP)
SOP 9: Safety

Version 1.0, June 2012

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes recommended safety practices and emergency contact information. Cited appendixes are located at the end of this SOP.

Introduction and Objectives

This SOP provides safety information, checklists, and forms for Network and contract personnel or cooperators who are involved with field activities. This SOP should be used in conjunction with more comprehensive manuals and regulations and recommendations that apply to specific locales and field conditions. This SOP summarizes basic safety information and procedures, but does not comprehensively cover every safety issue. This SOP is intended to engage all personnel and to provide a foundation for an on-going open and dynamic process for addressing field safety. The protocol lead and crew lead are responsible for updating this SOP to keep it current. Park safety offices should be consulted to ensure that crews comply with all park-specific safety policies.

Safety of field personnel is always the first concern in conducting a sampling program and in the selection of sampling sites. Field work requires an awareness of potential hazards and knowledge of basic safety procedures. Field personnel routinely come in direct and indirect contact environmental hazards such as waterborne pathogens, difficult terrain, challenging weather conditions, and potentially hazardous plants and animals. Advanced planning can reduce or eliminate many safety hazards and better prepare staff for dealing with these issues.

Risks include working in small teams in rugged and isolated environments, long driving trips between Parks and Network offices, backcountry roads and trails, hiking over rough terrain, extreme weather and hazardous fire conditions, and traversing steep slopes. Extended backcountry travel and overnight camping will be required in some parks. Roles and responsibilities of each party in implementing a safety program are discussed. General safety preparation is reviewed and job hazards and mitigations measures are summarized for driving, wilderness travel, and monitoring field work. Further details are contained in appendixes to this SOP which should be reviewed and updated each year by all field staff (a fundamental step in building operational leadership capacity). An emergency contact form is provided to obtain emergency information for each employee. Park-specific contacts are provided for field-related emergencies. Field communications for backcountry travel are outlined.

Roles and Responsibilities

The following roles and responsibilities are adapted from the NPSafe program. In addition, we have incorporated principles from Operational Leadership (California Training Institute 2008) to empower all employees to take responsibility for safety and wellness. All Program Managers and Project Leads will take Operational Leadership (OL) training and apply OL principles in assessing risk and managing field crew safety. According to these principles, program managers and team leaders are responsible for setting the standards, articulating the standards to employees, and following and enforcing the standards. All staff are responsible for knowing, understanding, following, and encouraging others to follow the standards. Standards include the standard operating procedures specific to this protocol as well as overall safety standards for the monitoring program (i.e. those that are common across protocols such as communication and vehicle safety).

Network Program Manager

- Communicate vision clearly and continually.

- Monitor employee/unit performance, recognize successes, and take corrective actions when needed.
- Incorporate safety as a critical result in supervisors' and employees' performance plans.
- Incorporate safety into all decision-making processes.
- Ensure requests are submitted for adequate funding of safety programs and training.
- Integrate audit findings into existing performance management and training processes.
- Ensure all employees are aware of their job hazards.
- Incorporate principles from operational leadership to help all employees take responsibility for safety, understand human error and accident causation, manage stress, evaluate risk, maximize situational awareness, make appropriate decisions, communicate effectively, and be assertive regarding safety in the workplace.
- Ensure all employees understand their roles and responsibilities in implementing a safety program.

Project Managers/Field Supervisors

- Monitor employee/unit performance, recognize successes, and take corrective actions when needed.
- Incorporate safety into all decision-making processes.
- Incorporate safety as a critical result in all employees' performance plans.
- Develop and use employee safety and health orientation checklist identifying job specific hazards and safety concerns.
- Develop and continuously improve Job Hazard Analyses or Guidelines for all tasks.
- Integrate audit findings into existing performance management and training processes.
- Incorporate principles from operational leadership to help all employees take responsibility for safety, understand human error and accident causation, manage stress, evaluate risk, maximize situational awareness, make appropriate decisions, communicate effectively, and be assertive regarding safety in the workplace.
- Ensure all employees understand their roles and responsibilities in implementing a safety program.
- Ensure all employees are aware of and control their job hazards.
- Investigate all accidents and near misses, and implement corrective actions for identified hazards.
- Model and participate in periodic to frequent de-briefings or after action reviews with field crews throughout the season to ensure safety remains a central focus for each employee.

Employees

- Collaborate with supervisor to develop Job Hazard Analyses or Guidelines, and review, implement, and use employee safety and health orientation checklists.
- Integrate audit findings into existing performance management and training processes.

- Incorporate safety into all decision-making processes and job tasks.
- Ensure all employees understand their roles and responsibilities in implementing a safety program.
- Ensure all employees are aware of and control their job hazards.
- Identify and report hazards to immediate supervisor, program manager, or park management.
- Apply principles from operational leadership to understand human error and accident causation, manage stress, evaluate risk, maximize situational awareness, make appropriate decisions, communicate effectively and be assertive regarding safety in the workplace.
- Participate in periodic to frequent de-briefings or after action reviews to identify risks, near misses, weak signals, and any other concerns that may compromise field safety.

General Safety Preparation

It is desirable to begin training well before the field season begins to allow adequate time for thorough understanding of field procedures and to obtain any additional training, such as first aid and CPR. Field crews must be familiar with the general safety protocol in the following sections and complete any required training that is protocol specific.

Knowledge of Standard Operating Procedures

Reading and understanding the protocol and in particular, the SOPs, are crucial prior to initiating field work. This basic understanding of the protocol and the ability to recognize bad data in the field can improve safety by enabling teams to address errors before leaving the plot, eliminating unnecessary sampling trips, and reducing unnecessary exposure to risk. Recognition of data errors on site allows for immediate adjustment in the field. The protocol lead will allow adequate time for all field crew members to become familiar with SOPs and check their work in the field. Field-related SOPs will also be covered as part of the hands-on training.

Hands-on training and practice prior to the first sampling period will help ensure high quality data collection. Familiarity with the use and maintenance of equipment and safe Wilderness travel practices are essential to the success of the project.

Weather and Field Gear

Field work in PWR parks can involve challenging weather extremes. Cold rainy weather can be encountered during hot summer months, and unseasonably hot weather may also be encountered. It is essential to the success of the program that all field staff and associates are well prepared for weather extremes. Good rain gear, clothes for a range of temperatures, sunhats, sunscreen, and mosquito repellant are essential.

First Aid and CPR

Training in the basic first aid and CPR is required for all field crew leaders, is strongly recommended for all crew members, and will be paid for by the Network. Certification is valid for two years. Protocol leads should make arrangements for those needing training prior to the field season.

Driver Safety

Travel between parks often requires long road trips under varied weather and road conditions. It is incumbent upon field staff to drive responsibly and to monitor fatigue while driving. Employees should pull over to rest when necessary. In addition to the typical hazards of everyday driving, drivers will encounter additional hazards in national parks, including vehicles driven by distracted visitors, wildlife, stopped vehicles, and fallen debris on roads, steep, winding, and rough roads in mountainous areas, inclement weather, and poor visibility due to storms or smoke. When driving on park roads for work purposes, employees may carry a park radio to report accidents, broken down vehicles, inappropriate behavior around wildlife (such as feeding) or other road-related problems to Park Dispatch. See the Driving JHG (Appendix 10) for guidance on addressing these and other hazards.

Field Safety for White Pine Monitoring

Safety of field personnel is always the first concern when sampling field sites. No sample or sampling site is worth the risk of injury or death. If employees perceive a risk at any time, they should stop the task immediately and mitigate the risk. This policy applies to all aspects of the work including prep for field work, travel to and from sites, and actual field sampling.

Field work requires an awareness of potential hazards and knowledge of basic safety procedures. Advanced planning can reduce or eliminate many safety hazards. An integral part of informed awareness and successful mitigation of potential hazards is a process that helps to reveal hazards. Networks implementing this protocol use either Job Hazard Analyses (JHAs) or Job Hazard Guidelines (JHGs) to critically examine tasks, identify specific hazards, and reduce or eliminate these risks. A set of these documents is created for each protocol, is reviewed prior to field implementation, and evolves with the input of subsequent employees to remain a current and effective safety tool. All employees are expected to know, understand, and contribute to these documents.

Presented below is a general summary of inherent risks associated with white pine monitoring. See additional guidelines for mitigating risk in Appendix 10 on Driving Safely, Appendix 11 on Wilderness Travel, and Appendix 12 on White Pine Monitoring.

The parks involved in this protocol are extremely rugged and remote. Steep slopes and cliffs are routinely encountered; however crews are not trained to undertake technical routes and must follow routes that are Class 3 or less in technical difficulty. When route maps are provided by the project lead, these are the intended safest routes that crews must follow between sites. Slopes over 30° may need to be traversed when traveling between sites, but route planning ahead of time will focus on limiting routes to areas less than 35° in steepness. Conservative decision making is imperative. An injury, even a minor one, could cause a substantial interruption in field schedules and overall monitoring program progress. Minor injuries can become serious life-threatening incidents if complications such as cold weather and long distances back to a vehicle are present. Be prepared, and always make decisions with safety as the highest priority!

Working in Small Teams

Field staff will primarily operate in teams of two or more when traveling to and from remote sites and when sampling vegetation in the field. Field staff will work alone only when necessary. When working in such small teams, particular attention must be given to safety and

communication. Team members must make an extra effort to work within sight and earshot of one another. See the Field Communications section for further guidelines on establishing travel plans and check-in/check-out procedures.

Backcountry Roads and Trails

To reach sampling locations at some parks, field crews may have to travel on secondary roads that are graveled or dirt and may be poorly maintained. Drivers should be keenly aware of risks. For example, high vegetation growing up through roads can block view of lava rocks which can damage vehicles. A damaged vehicle could lead to a life-threatening situation if the vehicle cannot be driven out and no communication to call for help is available (e.g., no cell phone coverage, no radio contact). Jeep roads can also pose serious fire hazards when hot vehicle engines pass over top of dry vegetation. Late season access, which could begin as early as June in some drought years, may be prohibited if fire risk is too high. Vehicle fire prevention and response kits per park instruction should also be available at all times. At a minimum this will include a 5 lb. fire extinguisher, well charged, and a shovel. Always check with parks regularly for updates on fire weather and road closure information.

Many sampling locations are remote and difficult to access and require extensive backcountry hiking to reach. Trails may be steep, rutted, slippery, or covered with loose materials, thus requiring appropriate footwear and technique to traverse. For off-trail travel, backcountry crews must be trained in orienteering using GPS and map/compass techniques. Route maps will be provided to crews with the safest known routes between sites indicated, however, crews will still need to make decisions when traveling on routes in the field and occasionally modify their route. When crews must change their planned route of travel, they will communicate their proposed change to the project lead or other contact. Crews will carry heavier loads due to gear associated with backcountry camping and will need to use proper packing and carrying techniques. Appendix 11 on Wilderness Travel contains additional guidance.

Varied Weather Conditions

The PWR region is characterized by weather conditions that vary considerably through the seasons, day-to-day, and even hour-by-hour. Snow and rain, wind and freezing temperatures can occur during field operations, particularly during early spring sampling. More commonly, heat and sun are problems, and heat exposure or dehydration potential risks. As a result, field work requires preparation for this range of conditions. Hypothermia and heat-related injury are possible and occasional discomfort is certain. Extreme weather can contribute to fatigue and increase the risk of injury from falls. Appendix 11 on Wilderness Travel contains additional guidance.

In the upper subalpine zone, weather can change rapidly, and heavy rain, hail, and life-threatening lightning storms occur even in apparently clear summer weather. Field crew leaders should check the National Weather Service websites for their region before going on the field hitch. Field crews should learn to watch skyline for cumulonimbus cloud development and avoid being on exposed ridges during afternoon hours if storms are developing. Most thunderstorms occur in late spring June in all three regions, with occasional to frequent monsoon thunderstorms arriving in late summer. Monsoon thunderstorms typically occur between 2-5 pm in the afternoon. Appropriate weather sites include:

KLMN
National Weather Service- Medford, Oregon

http://www.wrh.noaa.gov/mfr/

SIEN
National Weather Service-Hanford, California

http://www.wrh.noaa.gov/mfr/

UCBN
National Weather Service-Boise, Idaho

http://www.wrh.noaa.gov/boi/

Activities During Sampling

Vegetation sampling will require hiking over rugged and steep terrain. While an effort has been made to reduce exposure to unsafe terrain with restricted sampling frames, exposure to some unsafe terrain is unavoidable. It is incumbent upon field personnel to make conservative decisions and choose safest routes possible to access sampling areas. Traverses across steep snowfields are to be avoided. Hike around, if possible. This may require longer travel times in order to circumvent risky terrain. This may reduce the number of plots sampled in a day or hitch. Safety is more important than productivity, and the NPS does not want the drive to complete plots to cloud good judgment. In other words, stay alert and take it easy out there! Proper field gear, including good footwear, long pants, sun and rain protection, adequate food and water, will help mitigate many of the risks encountered in the field. The White Pine JHA (Appendix 12) contains additional information on risks and mitigation during whitebark pine sampling.

Incidents, Accidents, and Emergency Contact Information

In the event of an accident or incident, get immediate medical attention if required. To report an accident or incident, local park policy should be followed. At a minimum, the employee will report any injury to their immediate supervisor as soon as possible. The supervisor needs to report the incident/accident to appropriate personnel, and complete any park specific reporting forms (e.g., SEKI-134B the Sequoia and Kings Canyon NP Incident/Accident Report, or the Yosemite National Park Supervisor Incident/Accident or Close-Call Reporting Form (2-1a)). Supervisors and employees are required to complete a Department of Labor Form CA-1 (Federal Employee's Notice of Traumatic Injury and Claim for Continuation of Pay/Compensation) or CA-2 (Notice of Occupational Disease and Claim for Compensation) when work related injuries or diseases require medical treatment. The Safety Management Information System (SMIS) is the automated system for reporting Form CA-1 or CA-2 for the Department of the Interior (https://www.smis.doi.gov). Employees complete a CA-1/2 electronically at https://www.smis.doi.gov before the end of the next work shift after an accident. After the employee completes the CA-1/2, the supervisor logs onto SMIS and completes the supervisor portion of the electronic CA-1/2. The supervisor takes any corrective action necessary to prevent similar incidents.

Each employee should complete and submit an emergency contact form (that also identifies medical conditions; Appendix 5) and submit it to their supervisor. Park-specific emergency contacts are provided for employee use as needed in Appendix 6.

Field Communications for Wilderness and Backcountry Travel

Having established lines of communication and a Check-in/Check-out procedure are essential to employee safety and ensuring timely assistance in case of a mishaps or delays.

Upon arrival and check-in at each park, establish a clear procedure of communication between field teams and park staff. Cell phone coverage at park sites is intermittent and should not be relied upon in case of an emergency. Arrange to call a primary park contact, even at home, upon safe return in the evening, particularly when operating in the backcountry, where extreme distances, the remoteness of the park, and hazardous terrain combine into a serious safety issue. Park radios may be issued as a means for field personnel to be able to contact the park, or, after hours, a BLM or Forest Service dispatch office in case of serious emergency. Check with park contacts for radio availability and use procedures.

These guidelines apply for any unroaded area where the supervisor feels the employee should be tracked or the employee may be at risk. Employees are responsible for communicating their travel plans or backcountry travel intentions to their supervisors and/or dispatch regardless of the distance or level of risk.

Communications Equipment

Employees traveling in the wilderness/backcountry should carry or have immediate access to a park radio and spare battery. The radio should be programmed with applicable radio frequencies used by each park and those used by the BLM/USFS district, if appropriate. A working satellite phone with fully charged battery may be used as backup in some areas, but satellite coverage is not currently consistent and reliable in many parks. Cell phones should be carried when working in parks with adequate cell phone coverage. GeoPro satellite devices are used for communication between crew and project lead in SIEN parks, and are in-process of being set up for emergency communication.

When traveling in a group, all persons are strongly encouraged to carry their own communications equipment if possible. An unplanned event may force the group to split up; anyone traveling on their own is required to carry communications. If sufficient radios/sat phones are not available, staff should not travel alone.

As part of trip planning, employees should be aware of repeaters and radio coverage in the area they will be traveling. Maps of repeaters and dead zones will be provided to employees by their supervisors. Many of the low-lying areas in wilderness have dead zones, and employees will need to get to higher terrain to communicate reliably by radio in some areas. A risk assessment and travel plan should be completed that provides a back-up for staff entering or camping in these areas. This might include use of a satellite phone, a GeoPro device, relaying to other staff, or contacting dispatch before entering those areas. Supervisors should be alerted to staff traveling in areas with marginal or no radio coverage.

Backcountry Travel Plan

When entering and leaving the backcountry, all employees shall implement a notification process that establishes how they will report their location and status. A Travel Plan will be filed if the employee will be leaving the trail, if the risk assessment shows potential for dangerous situations, and/or if the employee is on a multi-day trip. An example "Wilderness Travel Plan" may be found in Appendix 13. The completed Travel Plan is given to a supervisor or other responsible party for crew whereabouts.

If traveling or working in a group of two or more, only one travel plan is required for the group. If persons within the group split up, a deviation to the travel plan must be reported to Dispatch if they are doing the tracking, or to the responsible party. If the travel plan involves a complicated route, and/or it involves cross country travel, it is highly recommended (or mandatory in some units) that you leave a map and a verbal description of your intended route.

Prior to trips, employees must meet with their supervisor or other responsible party to review routes, itinerary, and radio status. During this session it is crucial to review the location of relevant ranger stations, trail crew camps, field camps, and local radio information, including appropriate repeaters and alternatives should the main radio system fail. When working alone, employees must follow park- or network-specific check-in/check-out procedures, such as the Sequoia and Kings Canyon National Parks 'daily round up' through the Wilderness Office.

At SIEN, field crews will monitor the park radio from 0830 to 0900 in case information must be relayed from the front country. In the event of an emergency, SIEN crews will contact Park Dispatch via radio to request assistance. If unable to transmit to Dispatch, the Wilderness Office, or Fire Dispatch (in that order), they will attempt to call the local ranger using line of sight or the most appropriate repeater. If this fails, a message can be transmitted "in the blind" to any NPS unit in the area. Help should then be sought directly from the nearest ranger.

Upon completion of a backcountry trip, employees must close out their travel plan and communicate trip completion to the responsible party via phone or radio. Failing to close out an itinerary may lead to a time intensive, costly, and unnecessary search that places other employees at risk.

Travel Plan Deviations and Status Checks

Employees may change their travel plan when necessary (e.g. to avoid unforeseen hazards). All deviations from travel plans must be reported immediately and verbally confirmed with the party tracking your trip (e.g. Wilderness Office, Dispatch, or other).

An employee or group of employees may request status checks from Park Dispatch when traveling in areas of higher risk. Examples include traveling solo off trail, crossing an unbridged creek in high water, and traveling in winter conditions where the trail is not easy to follow or visibility is limited. When requesting a status check, employee notifies Dispatch when they are entering the higher risk area, gives an estimated time frame for when they will be back to a trail or lower risk area, and checks back in with Dispatch when clear. In general, high risk areas should be avoided and alternative routes located, however, in wilderness travel, there will sometimes be circumstances where passing through a higher risk area may be unavoidable.

Communications Equipment Failure

If communication equipment fails while in the backcountry, the employee must leave the backcountry or locate another unit with communications equipment, such as a wilderness ranger, trail or other field crews, or other parties with communication equipment; else search efforts may ensue. Exiting the backcountry is preferred unless the exact location of the other unit with communications equipment is known and can be reached in a timely manner. The employee's supervisor and division chief/program manager will be notified when efforts are initiated to follow up on employees who fail to check-in on the predetermined schedule.

Communication Training

Crews will receive training from knowledgeable park or Network staff on the operation of park radios at the beginning of the season. This orientation will include an overview of how to talk appropriately on the radio, how to decide what channel to use, the Park repeater system, areas of the Parks where radio communications are difficult, and proper care of radios and batteries.

Other Forms and Checklists

Checklists are helpful for ensuring that personnel have the appropriate safety equipment available during field work. The following pages contain an emergency contact form (for the Network and Park Dispatch, as needed) and equipment checklists for field personnel (adapted from Lane and Fay 1997; Appendixes 5-9). Field crew members should consider their specific needs and should customize the checklists as necessary. The field crew and project manager will discuss the checklists and determine which items are necessary. Field staff should confirm all contact information annually and ensure that medical information is up-to-date.

Appendix 5. Emergency Contact Form (Office)

The form below is used by the SEKI Dispatch Office and may be modified for individual network use. Dispatch answers all incoming calls, is responsible for keeping a database of Park Employees, and thus request the below information to facilitate the proper routing of emergency and non-emergency calls, memos, and information to staff.

NAME: _____SUPERVISOR: _____
[PLEASE PRINT]
POSITION TITLE: _____ WORK AREA: _____

RADIO CALL NUMBER_____

STATUS: Permanent: _____ Seasonal: _____ BEGINNING OF SEASON: _____

ANTICIPATED END OF SEASON: _____Work Phone Ext._____

CURRENT ADDRESS: _____

CONTACT PHONE # HOME_____ CELL_____

WILL YOU BE OCCUPYING PARK HOUSING: YES / NO (Temporary / Permanent)

VEHICLE MAKE:_____ COLOR_____ LICENSE/STATE #_____

EMERGENCY CONTACT INFORMATION

(Please list two contacts)
Name _____ Relationship _____
Address_____ Phone (H) _____
City _____ State ____ Zip _____ (W)_____

Name _____ Relationship _____
Address _____Phone (H) _____
City _____ State ____ Zip _____ (W)_____

Please list all Medical Conditions or special medications a medical provider might need to be aware of in an emergency: _____
_____

Physician Name/Phone #:_____

In accordance with the Privacy Act and Office of Personnel Management regulations, home telephone numbers and/or home addresses of employees are not given out over the phone unless there is a signed release on file with this office. Please be assured that if for any reason you wish to change your release you may do so at any time. By regulation this memo will remain on file. If you have any questions please contact Dispatch at Ext. 3196. Thank you for your assistance.

"I authorize the release of my home phone number and/or home address to callers requesting it."
(Green all callers – Yellow only NPS personnel - check one)

SIGNATURE: _____ DATE: _____ GREEN _____ YELLOW_____

"I Do Not authorize the release of my home phone number and/or home address to callers requesting it."

SIGNATURE: _____ DATE: _____ **RED (DO NOT)** _____

Appendix 6. Local Contacts for Field Personnel

Park	Position	Telephone
CRLA	Resource Chief	541-594-3071
	Lead Ecologist	541-594-3072
	Superintendent	541-594-3001
CRMO	Integrated Resource Program Manager	208-527-1350
	Ecologist	208-527-1351
	Superintendent	208-527-1300
	Emergency	208-527-8206 or 911
		208-527-8553
YOSE	SIEN Data Manager	209-379-3268
	SIEN Ecologist	559-561-3765
	YOSE Botanist	209-379-2177
	YOSE Hydrologist	209-379-1446
	Emergency	911
SEKI	SIEN Program Manager	559-565-3788
	SIEN Physical Scientist	559-565-3786
	SIEN Administrative Technician	559-565-3787
	SEKI Plant Ecologist	559-565-3769
	SEKI Fire Ecologist	559-565-3126
	Emergency	**559-565-3195 or 911**
LAVO	Resource Chief	530-595-6180
	Lead Botanist	530-595-6187
	Superintendent	530-595-6101

Appendix 7. Basic Safety Equipment Checklist

Items needed for the White Pine Monitoring are listed below.

Basic Safety Equipment Checklist	
	List of emergency phone numbers and office contacts
	List of radio call numbers
	First aid kit (in vehicle and in backcountry trip supplies)
	Fire extinguisher (in vehicle)
	Park radio
	Cellular phone
	Flashlight and spare batteries
	Fluids (e.g., water, sports drinks)
	Tool box with basic tools
	Antibacterial soap or hand cleaner
	Material safety data sheets (MSDS) – for bleach and propane gas
	Accident reporting forms
	JHG(s) or JHA(s)

Appendix 8. Personal Protective Equipment Checklist

Personal Protective Equipment (PPE) must be selected based on the hazards likely to be encountered. Items needed for White Pine Monitoring are listed below.

PPE Checklist	
	Boots
	Hat with a brim
	Insect repellent
	Rain gear
	Sunglasses
	Sunscreen
	Work gloves
	Lightweight long-sleeve shirt and pants for sun protection
	Wool or polypropylene long underwear
	Lightweight warm hat and gloves
	Traffic vests (keep in vehicle)

Appendix 9. Vehicle Checklist

Items needed for White Pine Monitoring are listed below.

Vehicle Checklist	
Communications and instructions	
	Field folder (including maps, emergency phone numbers for medical facilities, office contacts, family contacts)
	Cellular phone/park radio (check that the service is operational for the area to be
First aid and protective equipment	
	Complete change of clothes (stored in dry area)
	Fire extinguisher (safely secured)
	First aid kit and manual (check for missing or old, expired items and replace if necessary)
	Orange reflective vest
Miscellaneous equipment	
	Bungee cords (to secure loose articles)
	Flagging
	Flares
	Flashlight (including fresh batteries)
	Shovel and other fire protection equipment
	Tool kit

Appendix 10. Job Hazard Guideline: Driving Safety

This safety protocol is not designed to comprehensively cover all safety issues that may be encountered. It is to be used as a starting point for field work where everyone is involved in creatively enhancing and bringing personal additions to the process.

SIEN Job Hazard Guideline

Job Description:			Date of last update:
Driving Safely			July 22, 2009
Division with primary responsibility for this JHG:	Last updated by:	Reviewed by:	Approved by:
Klamath, Sierra Nevada, & Upper Columbia Basin Networks	John Austin	Linda Mutch	Bob Montgomery

Required standards & general notes:	Both general and winter driver safety training provided by the park Maintenance standards set by the auto shop This JHG does not cover the proper use of bicycles, motorcycles, ATVs, mules, or similar vehicles.
Recommended personal protective equipment:	Two or more high-visibility safety road vests, two or more traffic cones, stop/slow paddle First-aid kit Radio
Typical tools & equipment:	Emergency and unusual condition equipment such as ice scraper, fire extinguisher, snow chains, jack, and lug wrench

Activity	Potential Hazards	Safe Action or Procedure
Vehicle Maintenance	Vehicle malfunctions leading to breakdown, injury, or accident.	• Take the vehicle in for regular scheduled maintenance or when any problem arises with vehicle performance.
Pre-driving inspections	Vehicle malfunctions leading to breakdown, injury, or accident. Lack of crucial equipment that might be needed. Accidents or injuries caused from unsecured loads.	• During winter, check road conditions before leaving, carry additional clothing, and make sure that someone knows where you are going and when you should be back. • Ensure that vehicle has appropriate equipment such as first-aid kit, snow chains, ice scraper, and cones. • Do a walk around of vehicle, inspecting it for damage and potential hazards. Secure all items that might become projectiles in the event of a crash. • Familiarize yourself with jack, spare tire, tools and other equipment. • Familiarize yourself with the use of the lights, wipers, radio, climate control system, and cruise control. It is not safe to be trying to figure these out while you're driving. • Adjust seat and mirrors to fit the driver.

Activity	Potential Hazards	Safe Action or Procedure
		• Do not ride in the back of a truck or anywhere else that is not equipped with a seatbelt. All vehicle occupants must have seat belts fastened before vehicle begins to move. Seatbelts should remain fastened whenever the vehicle is moving. • Leave early enough so that you don't feel rushed and tempted to compromise your safety.
Driving speed	Accidents caused from following a vehicle too closely or driving too fast for conditions.	• Obey speed limits. Drive at a reasonable speed. Getting to your destination a few minutes quicker is not worth exposing yourself or others to an accident. • Allow at least two seconds between your vehicle and the one in front of you. This is the minimum for ideal conditions. Increase this cushion at night or during adverse driving conditions.
Stopping quickly	Being hit from behind. Whiplash.	• Watch for traffic making unexpected turns or stops, especially near intersections. • Watch for pedestrians unexpectedly stepping into the roadway, especially at intersections and near parked cars. • Watch for potholes and for fallen rocks and trees. Use caution when driving in areas of known rock slide potential such as the section of 180 leading down into Kings Canyon. Pay particularly care during the spring when moisture combined with freezing increases the risk of rockfall and slides. If you find a new or active slide do not drive by it until you evaluate the safety of it. Stop well outside of the fall area and listen and look for sliding debris, if there is active movement do not drive through. Be extremely cautious when clearing debris from the roadway. Evaluate the safety of the area before you go into it, again spend some time listening and looking for movement. If there is any recent or active movement do not go into the area. If you decide you are going to clear debris make sure you have a spotter to warn you if rocks start moving again. • Scan well ahead, drive defensively. • Drive at speeds that are safe for the road conditions, thus allowing for reasonable stopping. • Check rear-view mirror regularly.
Distractions	Accidents (collisions, driving off road, etc.)	• Do not talk on a cell phone or text while driving. Even when used hands free, a cell phone is still a significant distraction. NPS employees and volunteers are prohibited from using a cell phone while driving, even if used with a hands-free device. Texting is particularly distracting; don't do it. NPS employees are prohibited from reading, composing, or sending text messages or e-mails while driving. The prohibitions against using a cell phone or texting while driving applies whenever you're on official business, regardless of whether the vehicle you're operating is owned by the government, leased,

Activity	Potential Hazards	Safe Action or Procedure
		rented, or is a private vehicle. NPS employees and volunteers are permitted to talk on the park radio while driving, but be aware that this is still a significant distraction. • Don't take your eyes off the road to retrieve something on the seat, untangle a radio cord, read the display on your Blackberry, etc. If something demands your attention, stop the vehicle before dealing with it. Getting to your destination a few minutes quicker is not worth exposing yourself or others to an accident. • Always keep at least one hand on the steering wheel. It's best to have two hands on the steering wheel whenever possible. • Don't check your appearance in the mirror while driving. • Be careful when drinking while driving. Exercise even greater care when eating while driving. In some cases, eating while you drive may increase your alertness and therefore your safety. Snacks are comparatively safe, but eating a double cheeseburger while driving is pushing your luck. • Don't let yourself become distracted by events taking place outside of the vehicle (gawking at accident, arrival at destination, etc.).
Driving when visibility is impaired due to elements (rain, fog, smoke, snow, dust, etc.)	Accidents (collisions, driving off road, etc.)	• Reduce speed. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time. • Keep windshield clean and clear. • Turn on headlights. Also turn on four-way flashers if conditions warrant. • If conditions are too bad to drive safely, find a safe place to pull off the road and stop.
Driving narrow and/or winding roads	Head-on collisions	• Where possible, avoid roads such as the Hogback that don't have at least a stripe to separate traffic lanes. When a choice of two roads is available; take the safer route. Getting to your destination a few minutes quicker is not worth exposing yourself or others to an accident. • Be especially careful on curves. Stay within your lane. • If you must drive a road without a lane divider, reduce speed and allow at least four seconds between you and the vehicle ahead of you. • Scan ahead for oncoming traffic and slow down when approaching blind curves. When sight distance is limited, anticipate that oncoming traffic may be driving in your lane. • If a vehicle wants to travel faster than you, find a safe place to pull off the road and let

Activity	Potential Hazards	Safe Action or Procedure
		them by. Do this even if you think they are wrong to want to drive faster than you. Your ego will survive and the other driver won't be tempted to pass you in an unsafe area.
Driving on unpaved or damaged roads	Accidents (collisions, driving off road, etc.)	• Reduce speed. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time. • When a choice of two roads is available; take the safer route. Getting to your destination a few minutes quicker is not worth exposing yourself or others to an accident. • Be especially careful on curves. Stay within your lane. • On very bad roads, scout ahead if in doubt. • Report hazards such as fallen rocks or trees to park dispatch.
Driving when road is slippery (rain, ice, snow, etc.)	Accidents (collisions, driving off road, etc.)	• Reduce speed. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time. • When a choice of two roads is available; take the safer route. Getting to your destination a few minutes quicker is not worth exposing yourself or others to an accident. • Use proper equipment as stated by road signs (chains, 4-wheel-drive, etc.)
Driving on closed roads	Accidents (collisions, driving off road, etc.)	• Use caution when traveling the closed portion of any road. Notify Dispatch when entering the closed area, also notify Dispatch when you have cleared the closed area.
Night driving	Pedestrians, animals, obstacles not visible, glare from oncoming traffic.	• Turn headlights on; keep windshield clean. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time.
Following vehicles with different characteristics (i.e., motorcycles and trucks)	Collisions	• Reduce speed. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time.
Towing trailer	Collisions	• Reduce speed. • Allow at least four seconds between you and the vehicle ahead of you to allow stopping time. Extra weight of load requires greater stopping distance. • Be aware of extra length added to your vehicle when making turns

Activity	Potential Hazards	Safe Action or Procedure
	Back-up problems	• Practice backing up with a trailer in a safe environment such as an empty parking lot.
Emergency/breakdown (your vehicle or when stopping to assist others)	Exposure due to being stranded. Being hit by passing vehicles.	• If possible, pull off road • If there is risk of being hit by passing traffic, turn on four-way flashers. Use cones or flares to provide a buffer around your vehicle. • If you need to stand on or near the roadway (e.g., to direct traffic), wear a safety road vest. If possible, stand in a location with good sight distance. • Report all accidents to park dispatch. Let them know what help is required such as medics, ambulances, people to direct traffic, etc.
Physical and mental fatigue	Falling asleep at wheel, accidents	• Get needed rest, avoid driving when tired, and take breaks as needed. Be particularly cautious when driving late at night. • If a replacement driver is available, trade off driving when you start to feel tired. If you get tired and no replacement driver is available, pull off the road and take a break or a nap. If you're yawning, you probably shouldn't be driving; take a break. • Plan the trip so that no person will be driving more than ten hours (behind the wheel) within any duty-day. If an unexpected situation develops and there is no good alternative, then it is okay to drive longer than ten hours. But such situations should rarely happen. • Plan the trip so that no person will be driving unless they have had at least eight consecutive hours off duty before beginning a shift. Exception to the minimum off-duty hour requirement is allowed when essential to address immediate and critical employee or public safety issues (e.g., emergency bear management call-out in the middle of the night). Exception is also allowed when an unexpected situation develops and there is no good alternative. • Mitigation measures must be taken to reduce fatigue for drivers who exceed 16 hour work shifts. This is required regardless of whether the driver is still compliant with the 10 hour individual (behind the wheel) driving time limitations.
Ascending steep grades	Overheating leading to breakdown	• Watch temperature gauge. • Turn-off air conditioning if vehicle starts to overheat.
Descending steep grades	Brake failure Loss of control	• Reduce speed. • Shift to a lower gear to conserve brakes.
Passing traffic	Collision when changing lanes	• Look carefully before changing lanes. Visually check any blind spots left by mirrors.

Activity	Potential Hazards	Safe Action or Procedure
		• Signal before changing lanes.
U-turns	Collision with on-coming traffic, road barriers or off-road features	• Ensure that point selected for turn has good view of oncoming traffic and space to negotiate turn. Position lookouts/flaggers when needed.
Parking	Collision with rock, pedestrian, or other hazard while backing into or out of a parking site; exhaust system igniting a grass fire. Parked vehicle moving on its own.	• Park off of the road or in a designated parking area. Find a safe location to park that will provide safe exiting. • Ensure that fuels are clear beneath vehicle so as not to start a fire. • Use a backer to guide you into a safe place that will be easy to pull forward out of later. Use mirrors, or look over your shoulder, and be sure that you can see the backer and that you understand the hand signals being used. If no backer is available, then look behind the vehicle before backing. • Put transmission in Park or in low gear. If parking on a slope, set parking brake.

Appendix 11. Job Hazard Guideline: Wilderness Travel

This safety protocol is not designed to attempt to comprehensively cover all safety issues that may be encountered. It is to be used as a starting point for field work where everyone is involved in creatively enhancing and bringing personal additions to the process.

SIEN Job Hazard Guideline

Job Description:			Date of last update:
Wilderness Travel			June 23, 2009
Division with primary responsibility for this JHG:	Last updated by:	Reviewed by:	Approved by:
Klamath, Sierra Nevada, & Upper Columbia Basin Networks	Linda Mutch		Bill Putre

Required standards & general notes	Employees are traveling in groups of two or more, or they report daily by radio if traveling alone. Supervisor knows destination and route and return date.
Required personal protective equipment	Radio, first-aid kit, cold and wet-weather gear, appropriate foot wear, solar protection (hat, bandana, and/or sun block), appropriate water purification equipment (usually a filter), flashlight, and minimal pack weight (1/3 of body weight).
Typical tools & equipment	Backpack (or rucksack if traveling by stock), bear-proof food storage canister or pannier (if necessary), cold and wet-weather gear, appropriate foot wear (boots for rugged areas, footwear for wading streams, etc.), tent (optional), adequate sleeping bag, solar protection (hat, bandana, and/or sun block), water purification equipment (usually a filter), food and food preparation equipment, first aid kit (including snake bite kit), park radio, mosquito repellent (optional), compass and map, flashlight, work gear

Activity	Potential Hazards	Safe Action or Procedure
Backpacking with heavy loads	Heavy loads	Carry no more than 1/3 of your body weight while traveling in the backcountry.
	Load instability	When carrying heavy loads, pack the gear so that heavy equipment is carried low on your back to increase stability. Consider using hiking poles.
	Excessive loads	Assess equipment needs to ensure only required equipment is being carried.
	Muscular pain & soreness	Start slowly to ensure muscle groups are given adequate time to warm up. Use stretching exercises before starting.
	Fatigue	Take frequent breaks for food & water. Stop hiking for the day after reasonable distance is achieved.
	Back strain	Lift loads with your legs to avoid back injuries.
Hiking on steep or rough terrain off trail	Steep slopes & poor footing (falls)	Move slowly & deliberately across steep areas. Use trees & solid rocks for handholds when they are available. Check footholds before using them. Fall into the slope if you slip or slide. Have a companion spot you from a more secure location.

Activity	Potential Hazards	Safe Action or Procedure
	Footing	Plan to cross snow or ice fields late in the day for better footing; cross streams early before flow increases due to increased run-off & unbuckle waist belt on pack—use hiking poles.
	People above you or below you	Never be above or below someone on a loose or unstable slope. Be aware of the ground surface in front of you - watch for slick, sloped & unstable areas surfaced by loose rock, leaves or sticks. Members of a party should move up such slopes one at a time, together at the same elevation at all times, or parallel to each other & out of rock fall danger.
Route finding	Hazardous obstacles	Plan routes to avoid or limit exposure to known hazards such as steep slopes, river crossings, poisonous vegetation, etc.
	Crossing streams	Bring extra shoes for water crossings. Take extra time to scout for the safest place to cross. Avoid making crossings without a partner present. Cross with a hiking pole or large stick to provide additional stability. Unbuckle your pack's hip strap to facilitate ejection of your pack if you slip. Avoid areas with deep water or swift currents. Abort crossing if water levels or environmental conditions are too dangerous.
	Disorientation	Ensure all personnel are knowledgeable with map & compass as well as GPS usage.
		Keep track of current position & location of prominent landmarks with frequent map updates.
		Whenever possible, stick to established trails.
Inclement weather	Unfamiliarity with current & forecasted weather	Obtain weather forecasts prior to beginning back country travel & monitor weather broadcasts via radio during trip.
	Inappropriate gear for the conditions	Assess anticipated routes, elevations, & weather conditions when planning what gear to carry.
		Always carry rain gear, a warm hat, gloves, & a warm jacket when traveling in the backcountry.
	Thunderstorms	Avoid exposed ridge tops and being on or near lakes, meadows or other exposed areas if thunderstorms are approaching or developing nearby.
		Move to lower elevations away from tall trees as storms approach.
		If hair begins to stand up, immediately minimize exposure by moving to lower elevations away from isolated trees & crouch down on the balls of your feet to reduce ground contact.
	White outs	In the event of white out conditions, immediately seek shelter & wait for conditions to improve. Do not attempt to "feel your way" over the pass.
	Hypothermia	Layer your clothing such that it will be easy to regulate your body temperature by adding or subtracting layers. DO NOT wear cotton as a layer.

Activity	Potential Hazards	Safe Action or Procedure
	Heat stress	Drink plenty of liquids, keep hydrated, & take frequent breaks for snacks & water.
Camp cleanliness & health	Contamination of shared food	Wash hands thoroughly with dirt, silt, duff, sand, or if available hand sanitizer before handling food, dishes, utensils, etc.
	Contamination of shared water	Wash hands before gathering and/or filtering water; avoid contaminating filtered water with unfiltered water at source.
	Contamination of anything common (i.e., tools, dishes, paperwork, etc)	Wash hands (especially after bathrooming) before handling anything common to the crew. Crew health and morale depends on it; project success the same.
	Bathroom habits in the backcountry	Before touching anything common, WASH!
	Bears & other wildlife	Properly store food, thoroughly wash dishes and keep a clean camp area. Fermenting seed heads become odoriferous & attractive to wildlife. STORE SEED HEADS IN BEAR BOX, BURN OR PACK OUT IMMEDIATELY.

Appendix 12. Job Hazard Analysis for White Pine Monitoring

Each vegetation monitoring project lead will, in conjunction with his/her supervisor (and, if appropriate, other knowledgeable persons), develop a Job Hazard Analysis (JHA) of the task to be performed within each park. At the beginning of each sampling season all personnel will review the appropriate JHA and make modifications as necessary. The procedure to be used for writing a JHA is presented in NPS Reference Manual #50B, Occupational Safety and Health Program (NPS 1999).

Suggested topics to be addressed in the White Pine Monitoring Job Hazard Analysis.

General Job Activity	Basic Job Step	Potential Hazards
All field activities	Environmental conditions	Temperature and sun exposure
		Adverse weather (rain, snow, lightning and wind)
		Hazardous animals, plants, people
Accessing sites	Highway driving	Varied road conditions
		Fatigue
		Behavior of other drivers
		Animals and other obstructions
	Driving on unimproved roads	Rough and vegetated roads
		Muddy roads
		Fire ignition during dry weather
		Narrow roads with poor visibility
	Hiking	Steep/slippery terrain, rocky slopes
		Stream crossings

2011 Job Hazards Analysis for Pacific West Region White Pine Monitoring

Job Hazard Analysis

Pacific West Region White Pine Monitoring Program

U.S. Department of Interior **National Park Service**	**WORK PROJECT/ACTIVITY** **White Pine Monitoring**	**LOCATION:** **Klamath, Sierra Nevada, & Upper Columbia Basin Networks**	**UNIT: CRLA, CRMO, LAVO, SEKI, YOSE**
JOB HAZARD ANALYSIS (JHA)	**DEVELOPED BY** **Tom Rodhouse**	**JOB TITLE** **UCBN Ecologist**	**DATE PREPARED** **14 July 2010**

APPROVED BY:
DATE:

Required and/or Recommended Personal Protective Equipment:

Sturdy hiking boots
Long pants
Warm clothing / hat
Rain gear
Sun hat
Sunscreen
Sunglasses
Personal water bottles
Food
First Aid Kit
Park radio
Compass / GPS Unit
Maps
Emergency contact information

Tasks/Procedures	Hazards	Abatement Actions
		All people (permanent, seasonal, VIPs) involved in any project should receive a general orientation and tailgate safety session specific to the task prior to beginning of work.
1. Driving to and from remote field sites	1a. Narrow roads with bumpy or “washboard” surfaces	WEAR SEATBELTS AT ALL TIMES WHEN VEHICLE IS MOVING 1a. Maintain a safe speed (this if often below the legal speed limit) for the road conditions; stay clear to the right, especially on curves, drive with headlights on at all times; when turning around on mountain roads always “face the danger”(versus backing toward the cliff edge, e.g.); the passenger should get out and spot for driver when backing up.
	1b. Driving with limited visibility	1b. Maintain windshield cleaner fluid level and clean both sides of windows regularly (remember back window); slow down; if blinded by sun or dust, proceed slowly or pullover and wait for hazard to pass; keep to the right hand side of the road and drive with your lights on.

Tasks/Procedures	Hazards	Abatement Actions
	1c. Sharp rocks on edge or in middle of road	1c. Get out and move sharp rocks out of the way, reduce speed substantially in places with large amounts of rockfall; make sure tires are properly inflated and check tread and walls regularly for damage; make sure tire jack fits the vehicle and all parts are in the vehicle.
	1d. Large animals crossing or standing in roads	1d. Slow down where animals might be present to allow for reaction time; do not swerve abruptly to avoid hitting an animal, if necessary it's better to ride out the impact.
	1e. Fatigue at night and after a long shift in the field	1e. Be aware of signs of fatigue- pull over and rest! Take a short nap, eat a snack or have a partner drive; do not take chances by continuing to drive; communicate with your field partner.
	1f. Storm conditions – wind, lightning, muddy/ slippery roads	1f. Keep informed on the current weather- check www.weather.com or www.wrh.noaa.gov; if winds exceed 15 mph, or the excessive wind category on Beaufort scale (tree tops swaying, twigs and leaves falling, etc.), do not travel into the field; avoid going to the field if lightning is present and avoid using radios; drive slowly when roads are muddy and slippery or snow covered, check with park staff if you are uncertain of back road conditions; avoid wet clay roads as much as possible, these roads can fail after storms, especially in spring, maintain a slow speed when driving on these roads!; if you damage waterbars make sure you repair them immediately.
	1g. Fallen trees on road	1g. For small trees, try and remove tree or cut with a handsaw and remove portion of tree; for large trees, notify support crew to remove tree.
	1h. Others driving on the road	1h. Be aware that tourists driving on park roads are often distracted. Do not assume you are the only one on the road behind locked gates (day or night); people from other agencies use these roads. Be alert to the idea that others may be coming in from the field in the early a.m.; drive slow and keep right! If you encounter an unusual situation, contact your partner to inform and notify the supervisor or park ranger- avoid confrontational situations with visitors- let the proper authorities handle it!
	1i. Wildfire ignition from vehicle undercarriage/catalytic converter	1i. Track fire hazard warnings from Park and other agencies; Obey road closures, such as occur in late summer when fire hazards are extreme; Avoid driving over vegetated two-track roads whenever possible; constantly monitor accumulated vegetation underneath, and watch behind for smolder; ALL VEHICLES MUST HAVE BASIC FIRE PREVENTION AND EXTINGUISHING EQUIPMENT AT ALL TIMES!

Tasks/Procedures	Hazards	Abatement Actions
2. Communication	2a. Loss of contact with field partner(s)/team member(s)	2a. Make sure radios are charged and on the correct channel. Use cell phone (if available and coverage), as this may be more reliable for communication in remote locations. Establish regular contact/meeting times where failure to contact triggers emergency procedures. Clearly establish triggers for emergency procedures, avoid false alarms.
	2b. Unable to reach a radio repeater in a remote location	2b. Make sure radio is charged- try to contact someone on the radio to inform him/her of your predicament; if you are unable to reach a repeater from your location climb upslope toward a ridgetop or knoll and try again; try at regular intervals, meandering around may help in getting a signal; Use cell phone in vehicle (if available), as this may be more reliable for communication in remote locations.
3. Hiking	3a. Steep, rugged, and slippery terrain	3a. Assess terrain conditions to find safe route and modify sampling plans to avoid unsafe areas; proper footwear is VERY important- wear boots with slip-resistant soles with tops well above the ankle, broken in before the field season, plus extra socks, NO TENNIS SHOES or open toed sandals; maintain an erect posture when contouring steep slopes; avoid walking below another person due to the potential for rocks to dislodge from above. Use hiking poles.
	3b. Undergrowth	3b. Wear safety glasses (or other glasses) when hiking in brushy areas to protect eyes from protruding objects.
	3c. Rocks/climbing	3c. It is likely that hiking may occur over large or steep rocks, broken lava terrain. Follow procedures in 3a. for travel across lava.
	3d.Crossing fences	3d. It is likely that multiple fences will be crossed during the course of work. When possible use gates (leave them open or closed depending on how you find them) if no gate is available cross under or over with caution.
	3f. Crossing snow or ice fields	It is strongly preferable to find an alternative route to avoid crossing a steep snow or ice field. If there is no safe route without snow available, you must determine if the snowfield can be crossed safely. Never glissade or slide to get down a snowfield. Plan to cross snow or ice fields late in the day for better footing. Kick steps into the snowfield as you go to make sure your footing is secure. Use hiking poles to assist with balance, but never use them in place of an ice-axe. If the snowfield cannot be crossed safely, find another route, or abandon the sample site you are trying to reach.

Tasks/Procedures	Hazards	Abatement Actions
4. Encountering noxious plants, animals, disease, and people	4b. Bees/Wasps/Hornets	4b. Determine if any field crew are allergic to bee stings. Notify other crew members and the supervisor if you know you are allergic to bee stings; ensure that individual carries prescribed medication to prevent anaphylactic shock; carry a bee sting kit or Benadryl or other antihistamine; be aware of the ground where you step- some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs- watch for bees buzzing in and out of holes or around ground level; if possible, flag a nest so future surveyors won't run into it.
	4c. Ticks	4c. If bitten by a tick, remove it (grasp tick with tweezers at head and pull straight out); fill out an accident report in the event that symptoms of Lyme disease appear (red bull's eye rash);
	4d. Scorpions	4d. Inspect items left lying on the ground, e.g., clothing, for scorpions prior to putting them on, especially after camping
	4e. Mosquitoes	4e. Wear bug repellent and long sleeve shirt to prevent bites; be aware of West Nile Virus symptoms.
	4f. Rattlesnakes	4f. Avoid rattlesnakes by inspecting the ground near logs before stepping over them; avoid placing hands on rock ledges or other natural hoists without visually inspecting them first; in the unlikely event you're bitten by a rattlesnake, stay calm, sit still, and call and wait for help.
	4g. Mountain lions	4g. Avoid solo travel near dusk in densely vegetated terrain; if you encounter a lion that doesn't run from you- leave the area; if attacked- fight back!
	4h. Bears	4h. Properly store food, using bear canisters and bear boxes when available. Thoroughly wash dishes and keep a clean camp area. Stay at safe distance. If bluff-charged, look big, raise arms, stand your ground. If attacked, roll into ball with face toward ground and hands over neck. If attack continues, fight back.
	4i. Disease (bubonic plague and Hanta Virus)	4i. Stay away from dead rodents and rodent feces, especially in closed buildings.
	4j. Encounters with strangers	4j. Report uncomfortable encounters with strangers in the park to a supervisor as soon as possible; report apparent illegal activity to a park ranger, do not get into a confrontation with visitors in the park.
	4k. Poison Oak	4k. Try to avoid contact with the plant, or anything that has come into contact with the plant. If you are sensitive, use Ivy Block before exposure and Tecnu after exposure. If Tecnu isn't available, wash with soap & water as soon as possible.
5. Exposure to environmental variables	5a. Treatment of general injuries	5a. All NPS field staff and contractors should have current first aid and CPR certification.

Tasks/Procedures	Hazards	Abatement Actions
	5b. Hypothermia	5b. Always anticipate bad weather and dress accordingly, or carry warm clothes with you; keep clothing as dry as possible; use synthetic fleece and non-cotton outdoor clothing in inclement weather; eat high energy nutritional supplements between meals; cover the head and neck to prevent heat loss; keep active to maintain the body's metabolism; drink plenty of liquids to prevent dehydration, although an individual does not "feel" thirsty; drink warm liquids not cold; understand the effects of cold and wind; most hypothermia cases develop between 30°F and 50°F.
	5c. Hyperthermia	5c. Hyperthermia may occur during high temperatures, monitor for dehydration, heat exhaustion, heat cramps, and heat stroke; symptoms include nausea, headache, and flushed, red skin; drink plenty of water (even when you are not thirsty); as heat increases, take frequent breaks in cool locations; wear a light shirt.
	5d. Giardia	5d. Giardia is caused by drinking contaminated water- carry plenty of water on outings; Carry water treatment tablets and/or water filtration units. Consider all streams contaminated.
	5e. Sunburn	5e. Field work takes place in full sunlight so use 30+ or greater SFP sunscreen and lip balm; and wear a hat, sunglasses, and shirt.
	5f. Whiteouts	5f. In the event of a snowstorm and white out conditions, immediately seek shelter & wait for conditions to improve. Do not attempt to "feel your way" over the pass.
	5g. Thunderstorms	5g. Avoid exposed ridge tops and being on or near lakes, meadows or other exposed areas if thunderstorms are approaching or developing nearby. Move to lower elevations away from tall trees as storms approach. If hair begins to stand up, immediately minimize exposure by moving to lower elevations away from isolated trees & crouch down on the balls of your feet to reduce ground contact.

Tasks/Procedures	Hazards	Abatement Actions
HA Instructions The JHA shall identify the location of the work project or activity, the name of employee(s) involved in the process, the date(s) of acknowledgment, and the name of the appropriate supervisor approving the JHA. The supervisor acknowledges that employees have read and understand the contents, have received the required training, and are qualified to perform the work project or activity. Identify all tasks and procedures associated with the work project or activity that have potential to cause injury or illness to personnel and damage to property or material. Include emergency evacuation procedures (EEP). Identify all known or suspect hazards associated with each respective task/procedure listed. For example: a. Research past accidents/incidents. b. Research the Health and Safety Code, or other appropriate literature. c. Discuss the work project/activity with participants. d. Observe the work project/activity. e. A combination of the above.		**Emergency Evacuation Instructions** Work supervisors and crewmembers are responsible for developing and discussing field emergency evacuation procedures (EEP) and alternatives in the event a person(s) becomes seriously ill or injured at the worksite. Be prepared to provide the following information: a. Nature of the accident or injury (avoid using victim's name). b. Type of assistance needed, if any (ground, air, or water evacuation). c. Location of accident or injury, best access route into the worksite (road name/number), Identifiable ground/air landmarks. d. Radio frequencies. e. Contact person. f. Local hazards to ground vehicles or aviation. g. Weather conditions (wind speed & direction, visibility, temperature). h. Topography. i. Number of individuals to be transported. j. Estimated weight of individuals for air/water evacuation. The items listed above serve only as guidelines for the development of emergency evacuation procedures.
Identify appropriate actions to reduce or eliminate the hazards identified. Abatement measures listed below are in the order of the preferred abatement method: a. Engineering Controls (the most desirable method of abatement). For example, ergonomically designed tools, equipment, and Furniture. b. Substitution. For example, switching to high flash point, non-toxic solvents. c. Administrative Controls. For example, limiting exposure by reducing the work schedule; establishing appropriate procedures and practices. d. PPE (least desirable method of abatement). For example, using hearing protection when working with or close to portable machines (chain saws, rock drills, and portable water pumps). e. A combination of the above. Copy of the JHA as justification for purchase orders when procuring PPE.		JHA and Emergency Evacuation Procedures Acknowledgment We, the undersigned work leader and crewmembers, acknowledge participation in the development of this JHA (as applicable) and accompanying emergency evacuation procedures. We have thoroughly discussed and understand the provisions of each of these documents: DATE PRINT NAME SIGNATURE _____

Appendix 13. Wilderness Travel Plan

Wilderness Travel Plan

Start Date/Time: Entry Point:		End Date/Time: Exit Point:		Tracked by dispatch? YES NO

PARTY					
Trip Leader:		Radio call sign:		Pack Color:	
Name:		Radio call sign:		Pack Color:	
Name:		Radio call sign:		Pack Color:	
Name:		Radio call sign:		Pack Color:	

ITINERARY				
Date:	Starting Point:	Ending Point:	Route:	Mode:
	→	via	by	foot/stock/boat
	→	via	by	
	→	via	by	
	→	via	by	
	→	via	by	
	→	via	by	
	→	via	by	
	→	via	by	

RISK MANAGEMENT-*request status checks as needed*
Considerations: (radio dead spots, river crossings, weather forecasts, snow/ice, insects/animals, other-specify)
Known or potential off-trail travel route description
What time will you be monitoring the radio?

CONTACTS		
Responsible party:	Phone #:	Radio call sign:
Supervisor's name:	Phone #:	Radio call sign:

VEHICLE				
License Plate	Make	Model	Color	Parked at

EQUIPMENT							
	Bivy gear		Head lamp		Rope		Cell phone #
	Compass		Helmet		Shovel		Satellite phone #
	First aid kit		Ice ax		Signal mirror		Tent color
	Flagging		Map		Space blanket		Tent fly color
	Flare		Matches		Spare battery		Weapon
	Flashlight		Probe pole		Tent		How many days worth of food
	GPS		Radio		Whistle		Other

NOTES

Fax to Yosemite ECC (209) 379-2728 Entered into CAD by:

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 963/114730, June 2012

National Park Service
U.S. Department of the Interior

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