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Natural Resource Stewardship and Science

Rare Woodland and Forest Community Monitoring Protocol for Acadia National Park

Northeast Temperate Network

Natural Resource Report NPS/NETN/NRR—2012/529

ON THE COVER
Pitch pine broom crowberry woodland near Wonderland Trail in Acadia NP
Photograph by: K. Miller

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Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	Initial draft	
1.01	January 2008	Geri Tierney Kate Miller	White Pine / Red pine forest to be sampled using NETN forest protocol, rather than this protocol. Corrected locations of Pitch pine and Jack pine woodlands in Table 1. Added text on fire history, citing Patterson et al. 1983.	
1.02	February 2008	Geri Tierney Kate Miller	Minor editorial changes.	
2.00	March 2009	Geri Tierney Brian Mitchell Kate Miller	Added comment about potential pitch pine/ broom crowberry woodland at Ship Harbor. Added justification. Updated objectives to conform to NPS guidance. Added LAR SOP. Minor editorial changes	Conform to NPS guidance.
2.01	June 2009	Geri Tierney	Added sections on Field Methods, Data Man., Analysis, and Reporting, Personnel Requirements and Training, and Operational Requirements. Added SOPs for GPS and EI Reporting. Included cutoff of 2 m patch size for inclusion in monitoring program. Editorial changes	Conform to NPS guidance.
2.02	September 2009	Brian Mitchell	Changed sampling frequency from biennial to annual. Minor editorial changes and clarifications	Sampling plan changed to balance crew work load.
2.03	June 2010	Geri Tierney Brian Mitchell Kate Miller	Added Safety, LAR and Data Management & QA/QC SOPs. Corrected and standardized reference to White Pine / Red Pine Forest community. Changed from biennial to annual sampling. Increased sample size in Wonderland broom crowberry patch. Established QA/QC resampling schedule. Removed goal of calculating distance to coast. Formatting changes.	Annual sampling fits crew schedule better and improves understanding of annual variation. QA/QC resampling needed to ensure data quality.
2.04	December 2010	Kate Miller	Added note that PPC is not at Ship Harbor. Editorial changes, formatting	Conform to NPS standards

Version #	Date	Revised by	Changes	Justification
2.05	April 2012	Kate Miller	Minor editorial changes	Response to external reviewer comments.

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Background and Objectives

Acadia National Park (ACAD) lies within a transition zone of the Maine coastline, containing ecological communities typical of both southwestern and "downeast" coastal Maine. Eleven of these communities, or "associations" as defined within the United States National Vegetation Classification (Jennings et al. 2003), are rare within the state of Maine (Brooke Wilkerson, Maine Natural Areas Program, personal communication), and one is globally rare (Lubinski et al. 2003; see Table 1). The NPS Northeast Temperate Network (NETN) is establishing a long-term forest monitoring program in 10 national park units within the northeastern US. This program is designed to detect trends in forest condition. At ACAD, the network has installed 176 permanent forest plots. This sample size will allow detection of trends in park forests overall, as well as in some specific ecological communities. However, this effort will not yield sufficient sample sizes in rare community associations to assess trends in the condition of these communities. Rare communities are of particular management and conservation interest at ACAD, because they are rare and because they may be particularly sensitive to anthropogenic (human caused) impacts. This protocol was designed to provide data for the assessment of status and trend in rare woodland and forest communities within ACAD, and was adapted from the NETN Long-term Forest Monitoring Protocol. Because these communities are rare in Maine, and are not found in other NETN parks, rare communities will be monitored using a separate sampling frame (i.e., a different series of randomized plots) and modified procedures that are specific to the target communities. However, methods were kept the same between protocols where possible to facilitate data comparison and ensure the forest crew, which will be implementing this protocol, can quickly transition to this protocol. Where methods are the same, we refer the reader to the standard operating procedures in the forest monitoring protocol both to maintain consistency and because the forest crew receives more thorough training on the forest monitoring protocol. Therefore, this rare community protocol is not a stand-alone document, and should be used in conjunction with SOPs in the NETN Long-term Forest Monitoring Protocol.

Of the rare communities at ACAD, four terrestrial forest or woodland communities are recommended for long-term monitoring at this time: a) the globally rare Pitch Pine / Broom Crowberry Woodland (PPC); b) the Pitch Pine / Black Chokeberry / Wavy Hairgrass - Little Bluestem Woodland (PPW or Pitch Pine Woodland); c) the Jack Pine / Sheep Laurel - Blueberry species Woodland (JPW or Jack Pine Woodland); and d) the Eastern White Pine - Red Pine / Canadian Bunchberry Forest (WRP or White Pine / Red Pine Forest). The latter three communities are considered rare (S3) in the state of Maine. NETN originally targeted the Pitch Pine / Broom Crowberry Woodland for monitoring due to its globally rare (G2) status. The Pitch Pine and Jack Pine Woodlands share many structural, compositional and functional characteristics with the Pitch Pine / Broom Crowberry Woodland and can effectively be monitored with this rare woodland protocol. The White Pine / Red Pine Forest community shares fewer characteristics with these woodlands, but, like the woodlands, is a relatively open and fire-associated forest community. The White Pine / Red Pine Forest will be sampled using the sampling frame described in this narrative, but will use the field methods and data forms described in the NETN long-term forest monitoring protocol (Tierney et al. 2010).

The remaining eight communities that are ranked as rare in Maine are not recommended for monitoring at this time. The Pitch Pine - Heath Barren has been found only on Long Island and is

Table 1. Rare communities at ACAD. Communities shown in bold are recommended for monitoring. Rarity is denoted by The Nature Conservancy ranking system where G = global, S = state, 1 = critically imperiled, 2 = imperiled, and 3 = vulnerable. The Mount Desert Island subunit is abbreviated as MDI, and the Isle au Haut subunit is abbreviated as IAH.

Rarity	Maine Classification	National Vegetation Classification Association	NatureServe Code	Area (ha)	Polygons mapped	Avg. patch size (ha)	Location
G2	Pitch Pine Woodland	Pitch Pine / Broom Crowberry Woodland	CEGL006154	5.5	1	5.5	MDI near Wonderland
S1	Pitch Pine - Heath Barren	Pitch Pine / Blueberry species - Black Huckleberry Woodland	CEGL005046	9	3	3	Only on Long Island
S2	Dune Grassland	American Beachgrass - Beach Pea Herbaceous Vegetation	CEGL006274	1	1	1	MDI near Sand Beach
S2	White Cedar Woodland	Northern White-cedar / Black Huckleberry - Northern Lowbush Blueberry Woodland AND/OR Northern White-cedar - Green Ash / Striped Maple Woodland	CEGL006411 AND/OR CEGL006508				Map doesn't adequately distinguish this woodland.
S3	Birch - Oak Talus Woodland	(Rock Polypody, Appalachian Rockcap Fern) / Lichen species Nonvascular Vegetation	CEGL006534	11	12	1	MDI
S3	Brackish Tidal Marsh	Narrowleaf Cattail - Eastern Rose-mallow Herbaceous Vegetation	CEGL004201				Map doesn't distinguish this from Saltmeadow Cordgrass - Saltgrass - Black Needlerush Herbaceous Vegetation type (CEGL004197)
S3	Crowberry - Bayberry Headland	Northern Bayberry - Black Crowberry Dwarf-shrubland	CEGL006510	14	4	4	3 on Schoodic Peninsula, 4th on Bartlett or Little Moose Island
S3	Hardwood Seepage Forest	Red Maple - Ash species / Mountain-holly - Highbush Blueberry Forest	CEGL006220				Map doesn't distinguish this from Red Maple Swamp Woodland
S3	Jack Pine Woodland	Jack Pine / Sheep Laurel - Blueberry species Woodland	CEGL006041	84	40	2	Schoodic Peninsula, and 2 patches on MDI
S3	Pitch Pine Woodland	Pitch Pine / Black Chokeberry / Wavy Hairgrass - Little Bluestem Woodland	CEGL006116	380	47	8	MDI and IAH
S3	Red Pine - White Pine Forest	Eastern White Pine - Red Pine / Canadian Bunchberry Forest	CEGL006253	17	9	2	MDI
S3	Three toothed Cinquefoil - Blueberry Low Summit Bald	Northern Lowbush Blueberry - American Mountain-ash / Mountain-cinquefoil Dwarf-shrubland	CEGL005094	375	129	3	Common on MDI, some patches on IAH

not accessible. The Dune Grassland and Crowberry-Bayberry Headland communities are particularly sensitive because of their restricted occurrence within ACAD, but they are not appropriate for monitoring with this protocol. Any future monitoring of those communities would need to take extensive precautions to avoid trampling. The White Cedar Woodland and Hardwood Seepage Forests were not sufficiently delineated on the Acadia Vegetation Map (and the latter has not officially been documented as occurring within ACAD; Lubinski et al. 2003). The Birch-Oak Talus Woodland occurs on steep slopes, and is not suitable for plot-based monitoring. The Brackish Tidal Marsh is a wetland community that is not appropriate for monitoring with this terrestrial protocol. Finally, the Blueberry Low Summit Bald is the typical open upland community type seen across Mount Desert Island (MDI) and also on Isle au Haut (IAH). While this woodland protocol was not designed for monitoring that open upland community, the protocol could be adapted to serve that purpose at a future time.

Description of Rare Communities

Woodlands

The Pitch Pine / Broom Crowberry Woodland typically occurs on acidic rocky outcrops along the Maine coast, though disjunct patches occur in coastal MA and inland NY. This community is influenced both by its coastal position and poor edaphic (soil) conditions, and is typically fire-dependent for regeneration of pitch pine (*Pinus rigida*) and broom crowberry (*Corema conradii*) (Dunwiddie 1990, Martine et al. 2005, NatureServe 2006). However, the open conditions required by these species may have been maintained by disturbance associated with proximity to the coast rather than by fire. The tree canopy is dominated by an open canopy of stunted pitch pine (up to 5 m height), and broom crowberry is a characteristic dwarf-shrub. This community has been mapped at one location on MDI, but may also be present on IAH (Lubinski et al. 2003). An additional potential location, on MDI along the Ship Harbor trail, was investigated by NETN staff. While broom crowberry was fairly common at this location, pitch pine was absent, and the canopy was dominated by red spruce and tamarack (*Larix laricina*).

The Jack Pine / Sheep Laurel - Blueberry species Woodland (Jack Pine Woodland) reaches its southern terminus along the Maine coast within ACAD. This community develops on shallow, acidic, well-drained soils and bedrock outcrops. The tree canopy is dominated by an open canopy of stunted jack pine (*Pinus banksiana*; up to 5 m height) with some red spruce (*Picea rubens*), and is underlain by a well-developed heath shrub layer. Black chokeberry (*Photinia melanocarpa*) and mountain holly (*Nemopanthus mucronata*) are characteristic shrubs. Jack pine is typically a fire-dependent species. However, research indicates that jack pine woodlands in coastal Maine are maintained in the absence of fire (Conkey et al. 1995, Barton and Grenier 2008). Conkey et al. (1995) found jack pine serotiny (delayed seed release in response to an environmental trigger, such as fire) to be low and regeneration to be continuous within a stand on MDI, although regeneration was less vigorous in a stand on Schoodic Peninsula.

The Pitch Pine / Black Chokeberry / Wavy Hairgrass - Little Bluestem Woodland (Pitch Pine Woodland) community occurs on dry, acidic, bedrock slopes and crests. The open tree canopy is dominated by pitch pine (up to 14 m height) with some red spruce and bear oak (*Quercus ilicifolia*). The dwarf shrub layer is well developed and typically includes black huckleberry (*Gaylussacia baccata*) and lowbush blueberry (*Vaccinium angustifolium*). The rare (S3) Appalachian stitchwort (*Minuartia glabra*) may be present. Like the compositionally similar

Pitch Pine / Broom Crowberry Woodland, this community is typically fire-dependent (Lubinski et al. 2003).

Forest

The Eastern White Pine - Red Pine / Canadian Bunchberry Forest (White Pine / Red Pine Forest) occurs on well-to excessively-drained soils. This community is characterized by red pine (*Pinus resinosa*) as a co-dominant canopy species, typically with white pine (*Pinus strobus*), red spruce and red maple (*Acer rubrum*). The forest canopy is somewhat open (but not more than 40%) and 16-22 m in height. The extent of this community is restricted to nine identified patches at ACAD totaling only 17 ha, and this community is probably fire-dependent (Lubinski et al. 2003). Patterson et al. (1983) suggest that these pine forests may have been more common at Acadia a century ago than they are now.

Stressors

Key stressors potentially impacting these rare woodland and forest communities include lack of fire or other disturbance, forest succession, coastal erosion, climate change, trampling, deer browsing and invasive species.

All four of these rare communities are typically fire-dependent, and may be negatively impacted by the park's fire suppression policies. Jack pine, pitch pine, red pine and broom crowberry are all species that regenerate following fire disturbance, though the historic role of fire in maintaining ACAD's pine communities is unclear. Analysis of a lake sediment core taken from the Bowl (near the Beehive on MDI) showed some evidence of fire prior to European settlement (Patterson 1983). Many current forest and woodland stands in ACAD established after fires during the l9th and early- to mid-20th century (Patterson 1983). However, fires caused by natural ignition sources (lightning strikes) are infrequent in coastal Maine (Patterson et al. 1983) and the cool, moist climate is not conducive to fire. In the three woodland communities considered herein, harsh edaphic conditions and disturbance from salt spray may limit tree incursion and play a role in allowing these communities to persist in the absence of fire. Broom crowberry typically germinates after fire, however, it has also been observed to germinate following mechanical disturbance (Martine et al. 2005). Jack pine exhibits considerable plasticity in morphological characteristics such as cone serotiny. Populations at the edge of the species range seem to persist without fire on rock outcrops where thin soils reduce competition and provide sites for regeneration (Conkey et al. 1995, Barton and Grenier 2008). However, Conkey et al.'s research indicated that jack pine regeneration at their Schoodic Peninsula site has decreased in recent decades, while red spruce regeneration increased. Despite the lack of a clear understanding of fire's natural role here, these rare communities may benefit from the disturbance caused by prescribed fire. If monitoring shows that maintenance of these communities is threatened by tree incursion, or by regeneration failure of fire-dependent species, prescribed fire may be a useful management tool.

The three rare woodland communities occur in close proximity to the coast, and thus may be threatened by coastal erosion and sea-level rise over the mid- to long-term. In addition, because pitch pine is near its northern range limit and jack pine is near its southern range limit in ACAD, altered temperature, precipitation and disturbance regimes associated with climate change could substantially impact community composition and structure.

ACAD is a highly visited national park, receiving over 2,000,000 visitors annually, and trampling of sensitive communities is a concern. Trampling is likely to be a bigger issue for the pine woodlands on Mount Desert Island, which attract more visitors than the remote Schoodic Peninsula and Isle au Haut.

Broom crowberry populations in New York and Massachusetts have been stressed by deer browsing (Huth and Smiley 1982). Deer populations in ACAD are lower than in those regions (Miller et al. 2011), but still may be of concern. Finally, invasive species are always of concern; these pine woodlands and forest communities may be particularly at risk from incursion by Scots pine (*Pinus sylvestris*; Catling and Carbyn 2005) and Norway spruce (*Picea abies*; Kilgore and Telewski 2004).

Goals and Objectives

The overall goal of this protocol is to monitor status and trend in indicators of condition of selected rare woodland and forest communities at Acadia National Park in order to inform management decisions affecting those communities. Specific monitoring objectives are listed below, and are discussed in more detail in the Analyzing and Reporting Ecological Integrity Standard Operating Procedure (SOP):

- Determine status and trend in spatial extent of rare woodland and forest communities in Acadia NP to assess if community patch sizes are stable, declining, or increasing over time.

- Determine status and trend in community structure as percent cover in the tree canopy and high shrub layers, tree height and diameter-at-root-crown. Specifically we will evaluate whether non-focal tree and tall shrub species are sufficient in size or abundance to outcompete key community members (Table 2), all of which are shade-intolerant, by producing excess shade.

- Determine status and trend in the presence and relative abundance of key community members and invasive species by analyzing average species quadrat frequency and percent cover, regeneration composition and abundance, and canopy dominance by species for each community.

- Determine presence or absence of established seedlings and saplings of key community members and deciduous tree species to evaluate the ability of each community to maintain key community members as older individuals die off. Lack of disturbance may inhibit regeneration of key community members and may also encourage incursion of non-focal species, such as deciduous trees. Therefore this objective will focus both on overall abundance of deciduous tree regeneration and presence of key community species in the regeneration layer,

- Determine status and trend in the condition of broom crowberry populations including: presence, size, proportion of dead branches, and presence of reproductive structures.

- Determine status and trend in exposed mineral soil and litter thickness to examine if lack of exposed mineral soil and/or excess buildup of leaf litter due to lack of disturbance are inhibiting seedling establishment of jack pine, red pine, and broom crowberry.

- Qualitatively assess disturbance impacts, with special attention on trampling, to determine impacts that can be mitigated through management action (i.e., installing signs to discourage off-trail foot traffic).

Table 2. Key community members in each rare community of interest.

		Key Species	
Community	**Code**	**Scientific Name**	**Common Name**
Pitch Pine / Broom Crowberry Woodland	PPC	*Pinus rigida*	pitch pine
		Corema conradii	broom crowberry
Jack Pine Woodland	JPW	*Pinus banskiana*	Jack pine
Pitch Pine Woodland	PPW	*Pinus rigida*	pitch pine
White Pine/ Red Pine Forest	WRP	*Pinus resinosa*	red pine
All Communities		Deciduous tree species	

Extra precautions must be taken to protect these rare and sensitive communities from trampling impacts. Their restricted spatial extent means that monitoring impacts affect a larger proportion of existing patches. In addition these communities occur on shallow soils and exposed terrain positions, which are more sensitive to trampling. This protocol was developed with this programmatic objective in mind, and is the result of 4 years of field testing to find methods that are repeatable, essential for assessing condition of each community, and minimize trampling. Therefore, the following objectives from the NETN Long-Term Forest Monitoring Protocol that were not essential for assessing condition in the rare communities were dropped from this protocol: individual tree condition, coarse woody debris volume, and forest soil chemistry. For more information on procedural differences between the forest protocol and rare community protocol, refer to the Deviations, Differences, and Summary of Major Changes SOP.

Another important distinction between the goals and objectives of this protocol and the NETN Long-term Forest Monitoring Protocol is that we are not tracking the growth and mortality of individual trees in the rare woodland communities. Growth rates in the rare woodland communities are slow and diameter at root crown measurements are not precise enough to warrant the extra time and potential trampling impacts that would be required to accurately quantify growth rates. Tree height and relative dominance by species are easier to measure, require less precision, and are more important for understanding rare woodland community dynamics than individual stem growth. Another deviation from the NETN long-term forest monitoring protocol is that trend analyses will primarily take place at the scale of the plot, and all quadrat, regeneration, and tree data will be first averaged at the plot level before further analyzing data for trends.

Finally, while understory diversity is not one of the stated objectives for this protocol, the diversity in these communities is quite low, and collecting percent cover data for all vascular species in the quadrats can be done with minimal time, effort and impact. Besides the key community members, most species found in these communities are also common in forest plots,

and trends in these species will likely be detected first in the forest plots. However, it will also be important to know if similar patterns are occurring in the rare woodland communities. Therefore, while this is not one of the stated objectives, the protocol was designed to make this analysis possible.

Sampling Design

Site Selection

Generalized random tessellation stratified (GRTS; McDonald 2004, Stevens and Olsen 2004) sampling will be used to select a spatially balanced random sample within patches of each community identified on the Acadia Vegetation Map (Lubinski et al. 2003). The GRTS design employs random plot selection, which allows for statistical inference while also providing balanced spatial coverage and flexibility for post-stratification of plots based on ecological system, association, or other criteria as needed over the long-term. Further, GRTS sampling allows for sample size to be adjusted as needed after sampling has begun without sacrificing spatial balance. The GRTS design was also chosen because it is compatible with the sampling design of other NETN protocols. Further details on the reasons GRTS is preferable to alternative designs (e.g. simple random or systematic sampling) can be found in the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006).

Community type will be evaluated at each selected site prior to establishing plots using rules derived from the community key and description (Lubinski et al. 2003) and described within the Site Selection, Plot Establishment and Remeasurement Standard Operating Procedure (SOP). If a site is determined to be a different community type than that sought, the site will be excluded and the next potential site from the GRTS sample will be visited. Also, in order to reduce impacts on small patches and reduce edge effects, plots will only be installed within patches that are at least 2 hectares in size. Thus, for each rare community type, the population being monitored is patches ($\geq$ 2 hectares) that were correctly mapped circa 2001, in addition to selected patches identified by further investigation. The sampling frame will need to be reevaluated and adjusted on a regular basis (every 20 years or so) to accommodate natural shifts in locations of these rare communities.

Sampling Frequency and Number of Plots

Sampling of rare communities was originally scheduled to occur each year in two of the four monitored communities. In this scenario permanent plots will be revisited every 4 years, so one half of the plots in each community will be monitored during each sampling year. Ten permanent monitoring plots are recommended within each rare community occupying at least 10 hectares within the park, for a maximum total of 40 plots (Table 3).

The sample design was a compromise between available staff time (2-3 days of the forest crew's schedule per year), and sampling frequency necessary to detect changes in these communities. Ideally each community of interest would be visited every year. However, communities tend to be clustered in certain areas of the park, and considerable travel time may be involved to get to plots. Therefore it is most efficient for field crews to sample multiple plots in a specific community in a day. It is equally important that community responses to disturbance be observed soon after they happen. Therefore, each community of interest will be sampled every other year.

It is important to note that this protocol was designed primarily with the globally rare Pitch Pine/ Broom Crowberry Woodland (PPC) community in mind. However, since the three other state rare communities in the park also happen to have similar species, disturbance dynamics, structure and potential stressors, those habitats were also included in this protocol. However, since this protocol was originally developed, we have had to scale back to only monitor plots in

the PPC community to shift limited staff time and resources towards other important monitoring protocols.

The Pitch Pine / Broom Crowberry Woodland has been positively identified and mapped at a single 5.5 ha. patch on MDI near the Wonderland Trail. However, it may also be present on IAH (Lubinski et al. 2003). Six plots are recommended within the mapped patch on MDI. Depending upon the location and size of additional patches, four more plots may be installed.

The Jack Pine and Pitch Pine Woodlands cover 84 and 380 ha, respectively in 40 or more locations each within ACAD. The Jack Pine Woodland occurs primarily on the Schoodic Peninsula, but two patches have been identified on MDI. The Pitch Pine Woodland occurs primarily on MDI, but some patches have been identified on IAH. Ten plots are recommended within each of these communities.

The White Pine / Red Pine Forest covers just 17 ha at nine locations within ACAD, most within the 1947 fire boundary on MDI. Ten plots are also recommended within this community.

Table 3. Panel design and number of plots per community type.

Community	Year 1 Panel 1A	Year 2 Panel 2A	Year 3 Panel 1B	Year 4 Panel 2B	Total Number of Plots
Pitch Pine / Broom Crowberry Woodland[1]	3		3		6
Pitch Pine Woodland	5		5		10
Jack Pine Woodland		5		5	10
White Pine / Red Pine Forest		5		5	10

[1]Additional PPC plots will be established in Panel 1A and 1B if a new patch is identified.

Power to Detect Change

At a minimum, the goal is to detect a trend of 40% effect size in any metric after two survey cycles, while controlling type I error at 10% and type II error at 20%. A formal power analysis for this protocol has not been conducted. However, because this protocol is based on the NETN Long-term Forest Monitoring Protocol (Tierney et al. 2010), it is possible to apply power analysis results for a few metrics from the forest protocol to this protocol, including regeneration stocking index and native species richness. Power analyses on forest metrics that relate to trees and understory composition are less applicable to this protocol because individual trees are not monitored through time with this protocol, and understory diversity and variability are considerably greater in forest plots than in the rare community plots. For example, the average number of species in an ACAD forest plot is 17. The average number of species detected in the pilot PPC plots is 10. Species similarity is also very different. The average Sørensen similarity (statistic used for comparing the similarity of two samples) of quadrat species between pilot PPC plots is 67% (i.e., plots share on average 67% of the same species). In ACAD forest plots, the average Sørensen similarity is 34% between plots.

Using the methods described in Miller et al. (in press) power simulations were performed on the forest data for regeneration stocking index and native species richness assuming six plots in ACAD (instead of 176). With only six plots, simulations were able to detect a 40% change in the stocking index at 80% power and alpha = 0.1. Native richness power was even better, and we

were able to detect a 10% change in richness with only six plots. A complete power analysis, including evaluation of metrics that are new to this protocol, will be performed after a suitable data set is collected (likely 2012 or 2013). If after two sample cycles power analyses suggest that the current design does not provide adequate power for some or all key variables, more plots may be added to the survey and methods will be reviewed to determine if any metrics should be refined or dropped. Power is also likely to increase over time as multiple cycles of data are collected.

Field Methods

Field methods for data collection have been adapted from the NETN Long-term Forest Monitoring Protocol (Tierney et al. 2010). Methods have been modified to focus on indicators specifically related to condition of these fire-dependent woodlands and open forest communities, and to limit trampling and other monitoring impacts in order to protect these sensitive communities. Methods for the rare woodland communities differ from the rare White Pine / Red Pine Forest community, which closely follows the NETN Long-term Forest Monitoring Protocol with only a few exceptions.

Woodland site and tree data are collected within 9-m radius circular permanent plots (Figure 1). Tree regeneration data are collected within three, 9 x 1 m belt transects. Vegetation diversity (all woodland plots) and broom crowberry condition data (in the Pitch Pine / Broom Crowberry Woodland only) are collected within nine, 1-m^2 quadrats that are nested within the belt transects.

Many of the field methods that differ from the NETN Long-term Forest Monitoring Protocol were developed through multiple years of field testing in the rare woodland communities.

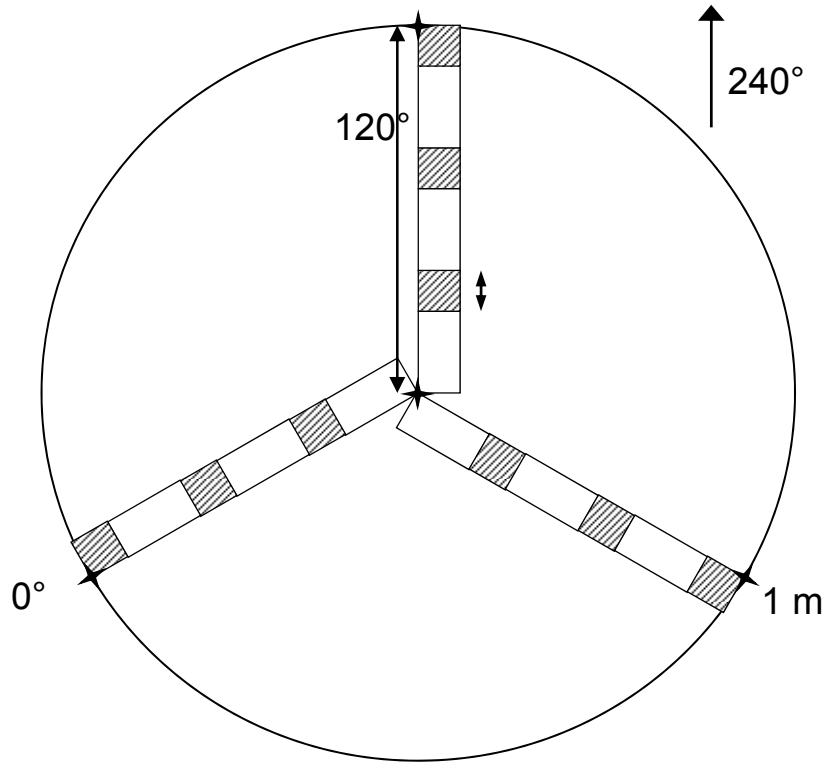

Figure 1. NETN rare community plot design with three 9 x 1 m belt transects (surveyed for tree regeneration) and nine 1 x 1 m quadrats (surveyed for plant community diversity and health of broom crowberry) nested within a 9-m radius plot (surveyed for tree structure and site conditions). ✦ indicates a permanent plot marker.

For example, the 2-m height that distinguishes juveniles (i.e., regeneration) from live trees was determined in the field, because a decent separation was observed around this height where trees below 2-m tall tend to be very spindly, small and shaded by larger trees. Trees over 2-m tall tend to be more dominant in diameter, canopy size and height, and this is the cohort of trees we are interested in tracking. In addition, circular plots were found to result in less trampling than square plots. While it is typically easier to mark the boundary of a square plot, the rare community protocol only requires the boundary to be determined for trees, which can easily be done with the laser rangefinder from plot center. Forest plots are square because there are more measurements that require the boundary to be easily determined.

The standard operating procedures (SOPs) which follow this narrative provide detailed, step-by-step instructions for data collection and analysis. The SOPs include instructions on preparation, site selection and plot establishment, data collection, and analysis. Carefully following the established methods is essential for successful long-term monitoring.

Data Management, Analysis, and Reporting

Data will be stored in an MS Access database designed by NETN staff or a cooperator and adapted from the database for the NETN Long-term Forest Monitoring Protocol. When possible, data will be entered directly into the database as they are collected using a field computer. When the field computer is not used, data will be collected using NETN datasheets designed for accurate and complete data collection (Appendix A). The procedures for careful and accurate data collection outlined in the Data Management & Quality Assurance/Quality Control SOP of the NETN Long-term Forest Protocol will also be adhered to by this protocol, with exceptions listed in the Data Management & Quality Assurance/Quality Control SOP of this rare community protocol. In particular, QA/QC resampling has been adjusted for these rare communities to minimize trampling. One plot per year is scheduled to be resampled for QA/QC during the first full 4-year cycle (that is, 10% of plots), in order to ensure procedures are sufficiently repeatable (i.e., have low sampling variability) in each rare community. Thereafter, two plots are scheduled to be resampled every 4 years (that is, 5% of plots), sampling each rare community once in 8 years. However, this schedule can be altered at the discretion of NETN staff either to reduce trampling impacts or to increase data collection, with the limit that no plot be sampled more than four times in 12 years. Results from QA/QC resampling will be reported as an appendix in annual monitoring reports and will cover any data quality issues that were detected as well as protocol changes that were made to reduce sampling error.

In order to interpret and report condition of these rare communities, "ecological integrity" will be assessed and reported from field data as described in the Analyzing and Reporting Ecological Integrity SOP. NETN will use data from the scientific literature to evaluate levels of ecological integrity as “Good”, “Caution” or “Significant concern” for specific metrics of community structure, composition and function as well as metrics indicative of key stressors or management actions affecting these communities. Ratings are based on assessment points that may be derived from natural ranges of variation, or alternatively from levels associated with negative or undesired outcomes. The interpretation of ecological integrity is a useful but developing conservation application, and ratings will be reviewed and updated as new information becomes available. A scorecard format will be used to clearly and concisely report the integrity of these rare communities to multiple audiences including park managers and decision-makers.

In addition to Ecological Integrity Scorecards, results of rare community monitoring will be reported together with results of the forest monitoring program in: 1) annual Implementation Reports, and b) periodic Integration and Synthesis Reports (Table 4).

Table 4. Northeast Temperate Network rare community reporting schedule.

Report	Purpose	Audience	Frequency
Implementation Report	Summarize information from protocol implementation	Parks, Network	Annual
Integrity Scorecard	Report Ecological Integrity	Parks, Network, Public	Annual
Integration and Synthesis Report	Report trends in rare communities. Integrate with other Vital Signs and regional data.	Parks, Network, Cooperators, External scientists	Every 4 or 5 years

Personnel Requirements and Training

This protocol for rare community monitoring is best undertaken by a crew of two in addition to a contract botanist as needed. The small crew size will help protect rare communities from excess trampling. The crew should be fully trained in the procedures of the NETN Long-Term Forest Monitoring Protocol (Tierney et al. 2010). Either a crew member or the contract botanist, if used, should be well trained in local flora at ACAD. The protocol also requires GIS mapping capabilities, and support by NETN personnel including the data manager.

Each year, the crew will participate in an on-site training session for this protocol, as described in the Preparation and Equipment List SOP.

Operational Requirements

Sampling will occur annually, in late July or August. Assuming the crew can sample two plots in a 10-hour day, 1.25 weeks should be allotted for field work. Data management and analysis will require additional staff time. A list of necessary equipment and materials is included in the Preparation and Equipment List SOP. Many of these items are also used by the NETN Long-term Forest Protocol (Tierney et al. 2010).

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Appendix A. Datasheet for Rare Woodland Community monitoring (Version 3.1).

NETN Rare Community Datasheet 3.1

Rare Community:	**Park**
Plot Info	
Time IN: OUT:	UTME:
Aspect:	UTMN:
Recorders:	Elevation:
Slope UC: BC:	GPS Accuracy:

Plot Notes

Directions

Stand Info % Cover Classes: <1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95, 95-100%				
CanopyCover:	**Litter**	2	5	8
%Cov Low (<0.5m):	0°			
%Cov Mid (0.5-2m):	120°			
%Cov High (2-5m):	240°			
% Cov Non-Vasc:	%Rock:			
%Bare Soil:	%Trampled:			
urbance Code	Threshold		%Class	
Dist 1:	1 2 3 4			
Dist 2:	1 2 3 4			
Dist 3:	1 2 3 4			
Water on Plot:	0 1 2 3 4 5 6 7			
Physiographic Class:	Dry Top	Dry Slope	Other Xeric	
Notes:		**Browse Index:**		

Plot#	**GRTS#**	**Date**

Purpose	Color	Date	Initials
Field Check	☐		
Entered to DB	☐		
100% Check	☐		
10% Check	☐		
Validation	☐		
	☐		

Photopoint	
Camera:	Photographer:
Weather:	Notes:

Tree Seedling Tally					
Trans	Species	0-15cm	15-30cm	30cm -1m	1-2m

Appendix A. Datasheet for Rare Woodland Community monitoring (Version 3.1) (continued).

NETN Rare Community Datasheet 3.1	Rare Community	Park	Plot	Date

Trees (>= 10 cm DRC) Distance and Azimuth is only for dead trees. Tree height is only for 5 tallest live trees.

Crown dieback 1:>95% foliage intact, 2: >50% foliage intact, 3: >50% of foliage absent, 4: >95% foliage absent, 5: Dead tree, no live foliage present

Tr#	Fork	Third	Species	DRC	Status	Pine Foliage Condition	Pine Foliage %	Pine Crown Dieback	Height	Azimuth	Distance	Tree Notes

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Field Check ☐ Initials:

Appendix A. Datasheet for Rare Woodland Community monitoring (Version 3.1) (continued).

NETN Rare Community Datasheet 3.1

	Rare Community:			Park			Plot#			Date	
Species Diversity (Cover classes = <1, 1-2, 2-5, 5-10, 10-25, 25-50, 50-75, 75-95, 95-100%)											
	Transect 0°			Transect 120°			Transect 240°			**G?**	**Coll?**
Quad	**3**	**6**	**9**	**3**	**6**	**9**	**3**	**6**	**9**		
Sampled											
%Trampled											
%Bare Soil											
%Rock											
%Stem											
%Wood											
% Litter											
Sphagnum											
NS Moss											
% Lichen											
Quad notes:											

Page____ of ____

Field Check ☐ Initials:

Appendix A. Datasheet for Rare Woodland Community monitoring (Version 3.1) (continued).

NETN Rare Community Datasheet 3.1

			Rare Community:			**Park**			**Plot#**		**Date:**	
Corema Stem Measurements.												
Intercepts	Quad	0°/ 3m	0°/ 6m	0°/ 9m	120°/ 3m	120°/ 6m	120°/ 9m	240°/ 3m	240°/ 6m	240°/ 9m	**NOTES**	
UC	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
UR	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
MR	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
BR	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
BC	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
BL	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
ML	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
UL	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											
Center	Height (cm)											
	# Live Branches											
	# Dead Branches											
	Reproduction											

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Field Check ☐ Initials:

SOP 1 – Safety

Northeast Temperate Network

Version 1.02

Overview

The Northeast Temperate Network (NETN) considers the occupational health and safety of its employees, cooperators, and volunteers to be of utmost importance, and is committed to ensuring that all seasonal field technicians receive adequate training on National Park Service (NPS) safety procedures, incident reporting, and emergency response prior to field work. This SOP is designed to provide a summary of safety issues that should be covered during the pre-season employee training, and to serve as a first reference in case of an incident. Topics covered include emergency procedures and contacts, incident reporting, field preparation, safe field procedures, vehicle safety, and workers compensation procedures. This SOP does not cover first aid.

Procedures

Follow the procedures described in the current version of the Safety SOP of the NETN Long-term Forest Monitoring Protocol.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2009	Brian Mitchell	Initial version	
1.01	June 2010	Geri Tierney	Editorial changes	
1.02	December 2010	Kate Miller	Editorial changes, formatting	Conform to NPS standards

SOP 2 – Preparation and Equipment List

Northeast Temperate Network

Version 1.08

Overview
This SOP delineates preparations for rare community monitoring at Acadia National Park (ACAD), and includes a list of necessary field equipment. Preparations should occur before sampling begins.

Staff
This rare community monitoring protocol is best undertaken by a crew of two in addition to a contract botanist as needed (a crew of three is acceptable in the White Pine / Red Pine Forest plots). The small crew size will help protect these rare communities from excess trampling. The crew should be fully trained in the procedures of the NETN Long-term Forest Monitoring Protocol (Tierney et al. 2010). Either a crew member or the contract botanist, if used, should be well trained in local flora at ACAD. The protocol also requires GIS mapping capabilities, and support by NETN personnel including the data manager.

Planning and Coordination
NETN personnel should ensure that the park natural resource manager has an up-to-date version of this protocol including all SOPs, as well as an up-to-date map of sampling locations. Plot marking procedures must be cleared with the park natural resource manager prior to plot establishment.

Site Pre-selection Using GRTS
During years in which new plots are installed, GRTS will be used to preselect a spatially balanced random sample within patches of each community identified on the Acadia Vegetation Map (Lubinski et al. 2003) and mapped to be at least 0.5 ha in size. This minimum patch size was included in order to reduce impacts on small patches and reduce edge effects. For each rare community, GRTS (via the U.S. Environmental Protection Agency's spsurvey package in R, available at http://www.epa.gov/nheerl/arm/analysispages/software.htm) will be used to generate an ordered list of potential site locations at least three times larger than the sample size needed. This number of potential locations will ensure that sufficient locations are available after exclusion of sites for non-matching community types, as well as safety and boundary issues. The random seed used to generate the GRTS sample will be saved in case additional sites need to be generated.

Maps
Prior to each field season, NETN personnel should prepare both GIS maps and aerial photographs showing sampling locations in the annual panel at scales of 1:24,000 or larger. Maps should clearly show the location of all plots in relation to topography, roads, trails and park features. Line and point symbols for roads, streams, plots and other features should be clearly

visible but not large enough to obscure other features. Scale bars should show miles in addition to kilometers, to aid navigation by car. If possible, smaller locator maps should be included on large scale maps. These maps and aerial photographs should be printed on Rite-in-the-Rain paper using a color LaserJet printer. Note that inkjet printing does not properly adhere to Rite-in-the-Rain paper. The crew should also be supplied with road maps for the region surrounding the park. Coordinates of each plot should be exported, printed and downloaded directly into the NETN GPS unit.

Schedule

Rare communities will be monitored every year at ACAD only. Plot establishment and tree mapping may take place up to a year prior to the vegetation sampling in each plot, and does not count as one of the four visits in 12 years that can occur in a plot. Vegetation sampling should be done at the same time each sampling year – preferably late in the field season in woodland communities, when broom crowberry is fruiting and any woody germinants from the current year are evident. If possible, the forest crew should sample rare communities as their last job at ACAD in July. However, if the forest crew has insufficient time to sample rare communities, the NETN plant ecologist (or other NETN staff) should arrange to sample these communities before the end of August, using additional personnel as necessary. Note that any sampling of rare communities on Isle au Haut (IAH) is preferentially done while the seasonal ferry to Duck Harbor on IAH is operating (mid-June until late September in 2010).

Training

Prior to commencement of monitoring, NETN must ensure that field personnel fully understand this protocol by conducting in-situ training sessions. Field crew preparation should involve careful review and discussion of all procedures. If possible, designated personnel should lead sessions in which training plots are established and measured. Crew must be given sufficient time to read the entire protocol thoroughly. It may be useful to divide the training into discrete "phases" – so that a particular SOP or set of SOPs can be read, learned and practiced before moving onto the next.

In addition to topics covered during training for forest monitoring (see the most current version of the NETN Long-term Forest Monitoring Protocol), training for rare community monitoring should include:

- Introduction to rare woodland and forest communities at ACAD
- Review of common trees and shrubs including broom crowberry (*Corema conradii*)
- Rare community plot layout and installation
- Practice estimating percent cover classes
- Procedures for measuring litter depth
- Procedures to minimize plot trampling

Training should include both demonstration of all measurements by trainers, and hands-on practice of all measurements by trainees. Training groups should be small to ensure that all trainees have sufficient opportunity to practice measurements thoroughly and question the trainer as needed.

Training must emphasize the critical importance of careful plot behavior to minimize plot trampling. Crew should not enter the plot or move within the plot without a specific reason to do so. Crew should arrange the taking of measurements to minimize walking within the plot. Crew should plan ahead to retrieve all gear needed for a particular set of measurements at once, rather than taking multiple trips back and forth across the plot. Extra-care must be taken to avoid trampling rare woodland community plots, especially belt transects and vegetation quadrats.

Equipment

Equipment and supplies on the attached equipment list will be needed for establishment and monitoring of rare woodland plots; all of these items (with the exception of the drill and hardware used for plot establishment) are also used by the NETN Long-term Forest Monitoring Protocol (Tierney et al. 2010). For White Pine / Red Pine Forest plots, use the equipment list in the current version of the Preparation and Equipment List SOP of the NETN Long-term Forest Monitoring Protocol. Equipment should be kept organized and maintained in good working condition. At the end of each season, the crew leader should inventory the condition of all equipment and prepare a list of equipment that needs to be repaired or replaced.

General Field Equipment

Park topo maps with plot locations
Road map for park region
Protocols
Slope conversion table
Park permits
Park plant species list
Datasheets (on Rite-in-the-Rain paper)
Enclosed clipboard
GPS unit
Compass (2)
Clinometer
NETN Park Radio
Batteries- 9v(4), AA(8), C(8)
30-m tape (2)
Pencils and permanent markers
Daypacks
First aid kit
Insect repellent
Water
Field vest and work belt (optional)
Raingear
Lens tissues

Back in Field Office

Manual of Vascular Plants of Northeastern and Adjacent Canada (Gleason & Chronquist) and Illustrated Companion (Holmgren)
Flora of Maine (Haines)
Full-size plant press
Acid-free copy paper

Plot Measurements

Small survey flags[1]
Digital camera
Quadrat frame (1x1m)
Bungee cords to locate quad midpoint (2)[2]
7.5m telescoping pole for tree height
Sturdy 30cm ruler

Herb identification guide
Sealable plastic bags (both small and large)
10x hand lens (2)

[1]For temporary use only
[2]For Pitch Pine Broom Crowberry Woodland only

Plot Establishment

35-cm fiberglass stakes
¼" x 2 ½" stainless steel lag screws
¼" x 4" stainless steel lag screws
¼" plastic screw anchor
Hammer
Mallet
36 volt Cordless rotary impact drill
  with two 1/4” carbide tipped drill bits
Plastic blow bulb
Socket wrench with ¼" hex bolt socket
Pre-numbered stainless steel plot tags
Plastic research tags
UV-stabilized nylon cable ties or stainless Steel wire to attach plot tags
Sonin electronic distance measurer
Metal detector
Laser hypsometer, GIS pole and tripod (optional)

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	June 2007	Geri Tierney	Initial version.	
1.01	August 2007	Geri Tierney	Editorial changes	
1.02	January 2008	Geri Tierney Kate Miller	Revise equipment list for plot marking and added park radio Minor editorial changes	
1.03	January 2009	Kate Miller	Added that plot establishment and tree mapping in plot can take place up to a year before vegetation sampling Added laser hypsometer and plot establishment equipment to list	
1.04	June 2009	Geri Tierney	Added description of site preselection using GRTS Added requirement that only patches >= 2ha are suitable for plot installation Added telescoping pole Minor editorial changes	
1.05	September 2009	Brian Mitchell	Added reference to spsurvey, and requirement to save the random seed used in the GRTS draw Minor editorial changes	
1.06	June 2010	Geri Tierney	Changed to annual sampling, adjusted schedule and plot behavior Editorial and formatting changes	
1.07	December 2010	Kate Miller Jesse Wheeler	Adjusted schedule of communities in panels Changed end range for plot sampling to end of August Added metal detector to list Editorial and formatting changes	Conform to NPS standards
1.08	April 2012	Kate Miller	Minor editorial changes	In response to external reviewer comments

SOP 3 – Using the Global Positioning System (GPS)

Northeast Temperate Network

Version 1.02

Overview

This Standard Operating Procedure explains the methods that all observers should follow to learn to use Global Positioning System (GPS) with the Garmin GPSMAP 60CSX unit. Forest monitoring crews use GPS to help navigate to and locate pre-existing plots as well as document the location of new plots.

Procedures

Follow the procedures described in the current version of the Using the Global Positioning System (GPS) SOP of the NETN Long-term Forest Monitoring Protocol.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2009	Brian Mitchell	New SOP	
1.01	June 2010	Geri Tierney	Editorial and formatting changes	
1.02	December 2010	Kate Miller	Editorial and formatting changes	Conform to NPS standards

SOP 4 – Using the Laser Rangefinder (LAR)

Northeast Temperate Network

Version 1.02

Overview

This SOP describes proper use of the Laser Ace GIS Pole (MDS model 5502) and Laser Ace Hypsometer (MDS model 5402). In this SOP, the combination of the GIS Pole and Hypsometer are referred to as the Laser Ace Rangefinder (LAR).

Procedures

Use of the LAR for establishing and sampling plots is optional, as most procedures can also be accomplished with compass, tapes and Sonin electronic distance measurers. To use the LAR, follow the procedures described in the current version of the Using the Laser Rangefinder SOP of the NETN Long-term Forest Monitoring Protocol, with the following exceptions:

- Setting Up the Plot: Follow the instructions in the Site Selection, Plot Establishment and Remeasurement SOP of this protocol, using the measurement tools specified in that protocol.

- Mapping Trees: Only dead trees greater than 2 m tall within the 9 m radius plot are mapped. Note that the horizontal angle (HA) to the tree should be taken at the middle of the trunk, but the horizontal distance (HD) should be taken with the reflector to the side of the trunk, and at the middle of the trunk's depth.

- Stand Height: Tree heights are recorded for the tallest five trees in the plot. This will usually be accomplished with a telescoping pole, but in some situations (e.g., tree is taller than 7.5m) the LAR will be used to determine tree heights by following the procedures described in this section.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2009	Brian Mitchell	New SOP	
1.01	June 2010	Geri Tierney	Now only map dead trees to allow calculation of mortality rate Clarified that tree heights are needed for tallest 5 trees only Added use of subtended distance for DRC. Editorial and formatting changes.	
1.02	December 2010	Kate Miller Jesse Wheeler	LAR for plot establishment and measurement is optional Removed option for using LAR subtended distance to measure DRC. Editorial and formatting changes.	Conform to NPS standards

SOP 5 – Data Management and Quality Assurance/Quality Control

Northeast Temperate Network

Version 1.02

Overview

Careful, accurate collection of data as directed in these SOPs is critical to the success of Vital Signs monitoring. This SOP describes quality assurance/quality control (QA/QC) procedures for accurate data collection, transcription and stewardship, and assessment of data quality. NETN will use a field computer database or standardized datasheet for data collection, as weather conditions and technology permit.

Procedures

Follow the procedures described in the current version of the Data Management and Quality Assurance/Quality Control SOP of the NETN Long-Term Forest Monitoring Protocol, with the following exceptions:

- One plot per year is scheduled to be resampled for QA/QC during the first full 4-year cycle (that is, 10% of plots), in order to ensure procedures are sufficient in each rare community. Thereafter, two plots are scheduled to be resampled every 4 years (that is, 5% of plots), sampling each rare community once in 8 years. However, this schedule can be altered at the discretion of NETN staff either to reduce trampling impacts or to increase data collection, with the limit that no plot will be sampled more than four times in 12 years.

- Rare woodland community data are recorded in a rare community database or on datasheets that were adapted from the forest protocol, and that include a special section for broom crowberry (Appendix A). Rare forest community data are collected using the standard forest database or datasheets.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2009	Brian Mitchell	New SOP	
1.01	June 2010	Geri Tierney	Inserted QA/QC resampling exception Editorial and formatting changes	
1.02	December 2010	Kate Miller Jesse Wheeler	Clarified that rare woodland communities have separate datasheets/database from forest communities. Editorial and formatting changes	 Conform to NPS standards

SOP 6 – Site Selection, Plot Establishment, and Remeasurement

Northeast Temperate Network

Version 1.10

Overview

This SOP provides instruction for establishing monitoring plots and collecting site information in rare woodland and forest communities at Acadia National Park (ACAD). The Site Selection and Data Collection sections apply to all four rare community types. For Site Establishment in the rare White Pine / Red Pine Forest community, follow the procedures outlined in the current version of the Site Selection, Plot Establishment and Remeasurement SOP of the NETN Long-Term Forest Monitoring Protocol. Prior to the field season, plot locations will be selected within rare community patches ≥ 0.5 ha using GRTS, as described in the protocol narrative. Locations which present a safety hazard or do not match the rare community targeted will be discarded.

Definitions

Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance.

True north is the direction of the North Pole relative to your position. This contrasts with magnetic north, which is the direction towards which a compass needle points, and which varies across the landscape and over time. To find true north, use a magnetic declination chart or table to find the correct declination between true north and magnetic north for your position at the time you wish to navigate (such as at http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp). Then, adjust your compass by dialing this declination into the faceplate. All azimuths referred to herein are based on true north. For 2009 through 2014, use 17 degrees west declination for ACAD.

Procedure

Site Selection

Examine park topographic maps to determine the best route to preselected plot locations. Using GPS and compass, travel to a proposed plot location. The GPS and compass should be held sufficiently far apart to avoid the GPS influencing the compass needle. Do not take safety risks when traveling to plots – if off-trail topography becomes too steep or difficult find an easier route to the plot location. If a safe route does not exist, discard the location and record the reason for doing so. Take care to minimize trampling of these rare communities as you travel to plot locations by planning your route in advance, making sure you have all necessary equipment before you start, and including only necessary field personnel.

As you near the pre-selected location, use the following protocol to locate the plot – do not spend time trying to find the exact pre-selection location. As soon as the GPS indicates you are within 15 m of the pre-selected location, continue exactly 10 steady paces (20 steps) in the direction of the pre-selected location and stop. Do not veer off course to avoid obstacles. This is the plot location.

Upon arrival at this plot location, visually examine the location to ensure it is a rare woodland or forest and matches the rare community type sought. The White Pine / Red Pine Forest (WRP) is dominated by a somewhat open forest canopy (> 60 but < 100% canopy cover) of red pine (*Pinus resinosa*) and white pine (*Pinus strobus*), with ≥ 40% relative dominance of red pine. Red spruce (*Picea rubens*) and red maple (*Acer rubrum*) may also be prominent in the canopy.

The rare woodlands are dominated by an open canopy (20 – 65% cover) of either open-grown jack pine (*Pinus banksiana*) or pitch pine (*Pinus rigida*) trees, over a low shrub layer upon bedrock ledges and thin organic soil. Jack Pine Woodlands (JPW) are dominated (≥ 60% relative dominance) by jack pine. Pitch Pine / Broom Crowberry Woodlands (PPC) are dominated (≥ 60% relative dominance) by pitch pine with broom crowberry (*Corema conradii*) in the understory. Pitch Pine Woodlands (PPW) are dominated by pitch pine without broom crowberry present. Another variant of rare pitch pine woodland (Pitch Pine / Blueberry spp. - Huckleberry Woodland) occurs on sandy soils and has been documented on Long Island but not elsewhere in Acadia NP, and thus is not currently monitored by this protocol.

Next, verify that plot center is ≥ 10 m (for woodland plot) or ≥ 15 m (for forest plot) from an obvious change in vegetation type, the park boundary, a road, a carriage road, a perennial stream, a water body, a mowed area, or any obstacle that would interfere with plot establishment. This will ensure that no part of the plot will fall outside the park boundary, and that roads, carriage roads and water bodies will not fall within the plot. If the plot does not meet the criteria listed herein, or if the plot presents a safety hazard such as extremely steep slopes or unstable snags, discard the plot and record the reason for doing so in the database. Proceed to add the next backup location to the list of plot locations for establishment. Then proceed to the next nearest pre-selected location currently included in the annual sample.

Plot Establishment

Follow this establishment procedure for woodland plots only; plot establishment in the rare White Pine / Red Pine Forest follows the procedures documented within the current version of the NETN Long-term Forest Monitoring Protocol.

If the woodland plot meets all criteria listed above, mark a waypoint and install a permanent marker at plot center along with a pre-printed plot tag and plastic ACAD research tag with the study number (#82) clearly written with permanent marker.

Soil depth within each site will determine the methods used to permanently mark plots. Where soil is greater than 10 cm deep, install a 35 cm fiberglass stake. Soil depths between 5 and 10 cm require a 1/4" by 4" stainless steel lag screw. Soil depths less than 5 cm require a 1/4" by 2½" stainless steel lag screw. To install a lag screw, first drill a 5 cm deep hole into the bedrock using a cordless rotary hammer drill (e.g. Hilti TE 6-A Li Standard Drill) and a 1/4" drill bit with a

carbide head. After drilling a hole, clean it out with a lag screw or blow bulb. Hand screw a 1/4" lag screw about half-way into a plastic anchor with a 1/4" x 1½" stainless steel washer in between (Figure S6.1). Insert the anchored lag screw slightly into the drilled hole, and strike it with a hammer until the top of the anchor is flush with bedrock. At this point, use a socket wrench or cordless drill to drive the screw in until it is about 2 mm above the bedrock (if using a 4" lag screw, allow screw to remain 5 cm above bedrock).

Figure S6.1. Illustration of plastic anchor with a 1/4" x 1½" stainless steel washer.

For the rest of plot setup use the laser rangefinder (LAR), the Sonin electronic distance measurer or measuring tapes. The plot layout is shown in Figure S6.2. Three 9 x 1 m regeneration belt transects are laid out at 0°, 120°, and 240°, each with 1 x 1 m vegetation quadrats at distances of 3, 6 and 9 m, respectively. Permanent markers should be installed at the end of each transect, as shown in Figure S6.2. Distances should be measured as horizontal distance to within 0.1 m error, and bearings should be sighted to within 0.5 degrees error. When sighting compass bearings, crew members must take care that metal objects such as survey flags do not affect the compass needle. Metal survey flags should not be carried by the crew member sighting the compass during plot setup.

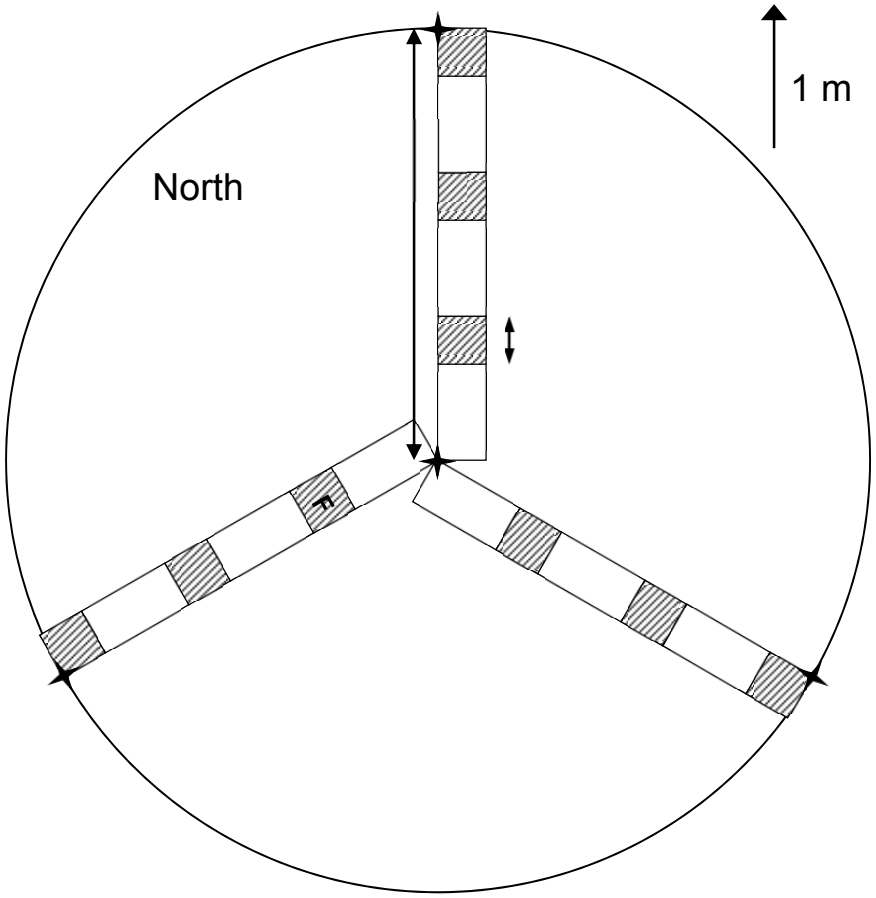

Figure S6.2. NETN rare community plot with 3 nested 9 x 1 m regen belt transects and nine 1 x 1 m veg quadrats. ✦ indicates permanent plot marker.

When using measuring tapes, hold the tape horizontally level rather than parallel to the slope. On slopes, this will result in the upslope tape end held low to the ground while the downslope end is held high. This method should also be applied to the Sonin electronic distance measurer. On steep slopes, it may be necessary to measure the horizontal distance in sequential short increments that can be held level, or alternatively to use the slope conversion table (Table S6.1). For a given slope and horizontal distance, this table provides the corresponding slope distance, allowing a plot side to be measured and laid out using slope distance.

If a plot is visible from a major trail or visitor location at ACAD, take care to ensure that plot markers are not visible from the trail or visitor location. The crew may temporarily use bright-colored survey flags to make plot makers more visible during measurement. It is important that these flags be collected and removed from the site after measurement.

Plot Remeasurement

Read the directions and plot notes that were recorded during the original and subsequent sampling events. Use the notes and field maps to find the safest and most efficient route to the plot.

Once at the plot, use the LAR, Sonin distance measurer and/or compass and tapes to locate the permanent marker at the end of each transect. As needed, use a metal detector to locate lag screws. If permanent markers are missing, replace them and record this in the notes. If at all possible, find plot center and set up the plot from that point. If plot center can't be relocated, use existing plot markers and dead tree data to reestablish plot center. If there aren't enough plot markers (i.e., less than two) or dead tree data to recreate plot center, reestablish plot center following the same procedures as described in the site establishment section, and give the plot a new number in the database. Be sure to record thorough notes in these situations so future sampling and analyses can account for these issues.

Once data collection is complete and before leaving the plot, the crew must perform several checks between the previous sampling event and the current sampling event. Crew must visually check all plot level data to ensure accuracy, and run the database check on tree, sapling and stand level data. If inconsistencies between the previous sampling event and current event are detected in the check, the crew must verify that the data collected in the current sampling event are correct, and record any inconsistencies in the notes. The crew must NOT write over any data collected during previous sampling events.

Table S6.1. Slope conversion table.

For each combination of slope and slope distance, read horizontal distance (m) from table.

Slope in degrees

Slope distance	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0
1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1
1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2
1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3
1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4
1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5
1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6
1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.7
2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8
2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9
2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0
2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1
2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2
2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3
2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.3
2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.4	2.4
2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5	2.5
3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6
3.1	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.7	2.7	2.7
3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8
3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9
3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	2.9
3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0
3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.1	3.1
3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.2	3.2
3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.3	3.3
3.9	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.4	3.4	3.4
4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.5	3.5	3.5
4.1	4.1	4.1	4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.6	3.6	3.6
4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7	3.6
4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.7
4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.0	4.0	4.0	3.9	3.9	3.8	3.8
4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.1	4.1	4.1	4.0	4.0	4.0	3.9	3.9
4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.1	4.1	4.1	4.0	4.0
4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.2	4.1	4.1	4.1
4.8	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.2	4.2	4.2
4.9	4.9	4.9	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.5	4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.2

Horizontal distance shown in italics does not differ from slope distance. Blank cells exceed 11 m horizontal distance.

Table S61. Slope conversion table (continued).

For each combination of slope and slope distance, read horizontal distance (m) from table.

Slope in degrees

Slope distance	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.8	4.8	4.7	4.7	4.7	4.6	4.6	4.6	4.5	4.5	4.5	4.4	4.4	4.3
5.1	5.1	5.1	5.1	5.0	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.7	4.6	4.6	4.5	4.5	4.5	4.4
5.2	5.2	5.2	5.1	5.1	5.1	5.1	5.1	5.1	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6	4.6	4.5	4.5
5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.2	5.2	5.1	5.1	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6	4.6
5.4	5.4	5.4	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.1	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.9	4.8	4.8	4.7	4.7
5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.1	5.1	5.1	5.0	5.0	4.9	4.9	4.9	4.8	4.8
5.6	5.6	5.6	5.5	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.2	5.2	5.2	5.1	5.1	5.0	5.0	4.9	4.9	4.8
5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.3	5.3	5.2	5.2	5.2	5.1	5.1	5.0	5.0	4.9
5.8	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.5	5.5	5.5	5.5	5.4	5.4	5.3	5.3	5.3	5.2	5.2	5.1	5.1	5.0
5.9	5.9	5.9	5.8	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.5	5.5	5.5	5.4	5.4	5.3	5.3	5.3	5.2	5.2	5.1
6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.6	5.6	5.6	5.5	5.5	5.4	5.4	5.3	5.3	5.2	5.2
6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.6	5.6	5.5	5.5	5.4	5.4	5.3	5.3
6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.1	6.0	6.0	6.0	6.0	5.9	5.9	5.9	5.8	5.8	5.7	5.7	5.7	5.6	5.6	5.5	5.5	5.4	5.4
6.3	6.3	6.3	6.2	6.2	6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.0	6.0	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.6	5.6	5.5	5.5
6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.2	6.2	6.2	6.2	6.1	6.1	6.1	6.0	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.6	5.5
6.5	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.2	6.2	6.2	6.1	6.1	6.1	6.0	6.0	5.9	5.9	5.8	5.8	5.7	5.7	5.6
6.6	6.6	6.6	6.5	6.5	6.5	6.5	6.5	6.4	6.4	6.4	6.3	6.3	6.3	6.2	6.2	6.2	6.1	6.1	6.0	6.0	5.9	5.9	5.8	5.8	5.7
6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.5	6.5	6.5	6.4	6.4	6.4	6.3	6.3	6.3	6.2	6.2	6.1	6.1	6.0	6.0	5.9	5.9	5.8
6.8	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.5	6.5	6.5	6.4	6.4	6.3	6.3	6.3	6.2	6.2	6.1	6.1	6.0	5.9	5.9
6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.5	6.5	6.4	6.4	6.4	6.3	6.3	6.2	6.1	6.1	6.0	6.0
7.0	7.0	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.4	6.3	6.3	6.2	6.2	6.1	6.1
7.1	7.1	7.0	7.0	7.0	7.0	7.0	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.4	6.3	6.3	6.2	6.1
7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.0	7.0	7.0	7.0	6.9	6.9	6.8	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.4	6.3	6.2
7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.0	7.0	6.9	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.4	6.4	6.3
7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.1	7.0	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.5	6.5	6.4
7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.0	7.0	7.0	6.9	6.9	6.8	6.7	6.7	6.6	6.6	6.5
7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.3	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.6	6.6
7.7	7.7	7.6	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.7	6.7
7.8	7.8	7.7	7.7	7.7	7.7	7.7	7.6	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	6.9	6.9	6.8	6.8
7.9	7.9	7.8	7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.0	7.0	6.9	6.8
8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1	7.1	7.0	6.9
8.1	8.1	8.0	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3	7.3	7.2	7.2	7.1	7.0
8.2	8.2	8.1	8.1	8.1	8.1	8.0	8.0	8.0	8.0	7.9	7.9	7.8	7.8	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.4	7.3	7.2	7.2	7.1
8.3	8.3	8.2	8.2	8.2	8.2	8.1	8.1	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3	7.3	7.2
8.4	8.4	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.3	7.3
8.5	8.5	8.4	8.4	8.4	8.4	8.3	8.3	8.3	8.2	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.4	7.4
8.6	8.6	8.5	8.5	8.5	8.5	8.4	8.4	8.4	8.3	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6	7.5	7.4
8.7	8.7	8.6	8.6	8.6	8.6	8.5	8.5	8.5	8.4	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.5
8.8	8.8	8.7	8.7	8.7	8.7	8.6	8.6	8.6	8.5	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.6
8.9	8.9	8.8	8.8	8.8	8.8	8.7	8.7	8.7	8.6	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	7.9	7.9	7.8	7.7
9.0	9.0	8.9	8.9	8.9	8.9	8.8	8.8	8.8	8.7	8.7	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.0	7.9	7.9	7.8
9.1	9.1	9.0	9.0	9.0	9.0	8.9	8.9	8.9	8.8	8.8	8.7	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.0	8.0	7.9
9.2	9.2	9.1	9.1	9.1	9.1	9.0	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.1	8.0	8.0
9.3	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.2	8.1	8.1
9.4	9.4	9.3	9.3	9.3	9.3	9.2	9.2	9.2	9.1	9.1	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.5	8.4	8.4	8.3	8.2	8.1
9.5	9.5	9.4	9.4	9.4	9.4	9.3	9.3	9.3	9.2	9.2	9.1	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.5	8.5	8.4	8.3	8.2
9.6	9.6	9.5	9.5	9.5	9.5	9.4	9.4	9.4	9.3	9.3	9.2	9.2	9.1	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.4	8.3
9.7	9.7	9.6	9.6	9.6	9.6	9.5	9.5	9.5	9.4	9.4	9.3	9.3	9.2	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.7	8.6	8.6	8.5	8.4
9.8	9.8	9.7	9.7	9.7	9.7	9.6	9.6	9.5	9.5	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	9.0	8.9	8.8	8.7	8.7	8.6	8.5
9.9	9.8	9.8	9.8	9.8	9.7	9.7	9.7	9.6	9.6	9.6	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8	8.7	8.7	8.6

Horizontal distance shown in italics does not differ from slope distance. Blank cells exceed 11 m horizontal distance.

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Table S6.1. Slope conversion table (continued).

For each combination of slope and slope distance, read horizontal distance (m) from table.

Slope distance	Slope in degrees																									
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10.0	9.9	9.9	9.9	9.9	9.8	9.8	9.8	9.7	9.7	9.7	9.6	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.8	8.7	8.7
10.1	10.0	10.0	10.0	10.0	9.9	9.9	9.9	9.8	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.0	8.9	8.8	8.7
10.2	10.1	10.1	10.1	10.1	10.0	10.0	10.0	9.9	9.9	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.5	9.4	9.3	9.2	9.2	9.1	9.0	8.9	8.8
10.3	10.2	10.2	10.2	10.2	10.1	10.1	10.1	10.0	10.0	9.9	9.9	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1	9.0	8.9
10.4	10.3	10.3	10.3	10.3	10.2	10.2	10.2	10.1	10.1	10.0	10.0	9.9	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.3	9.3	9.2	9.1	9.0
10.5	10.4	10.4	10.4	10.4	10.3	10.3	10.3	10.2	10.2	10.1	10.1	10.0	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.4	9.4	9.3	9.2	9.1
10.6	10.5	10.5	10.5	10.5	10.4	10.4	10.4	10.3	10.3	10.2	10.2	10.1	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.5	9.4	9.4	9.3	9.2
10.7	10.6	10.6	10.6	10.6	10.5	10.5	10.5	10.4	10.4	10.3	10.3	10.2	10.2	10.1	10.1	10.0	9.9	9.8	9.8	9.7	9.6	9.5	9.4	9.4	9.3
10.8	10.7	10.7	10.7	10.7	10.6	10.6	10.6	10.5	10.5	10.4	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.6	9.5	9.4	9.4
10.9	10.8	10.8	10.8	10.8	10.7	10.7	10.7	10.6	10.6	10.5	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.7	9.6	9.5	9.4
11.0	10.9	10.9	10.9	10.9	10.8	10.8	10.8	10.7	10.7	10.6	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.0	10.0	9.9	9.8	9.7	9.6	9.5
11.1	11.0	11.0	11.0	11.0	10.9	10.9	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.1	10.0	9.9	9.8	9.7	9.6
11.2					11.0	11.0	11.0	10.9	10.9	10.8	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.3	10.2	10.2	10.1	10.0	9.9	9.8	9.7
11.3								11.0	11.0	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.3	10.2	10.2	10.1	10.0	9.9	9.8
11.4										11.0	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.4	10.3	10.2	10.2	10.1	10.0	9.9
11.5												11.0	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.4	10.3	10.2	10.2	10.1	10.0
11.6													11.0	11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.1	10.0
11.7															11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.1
11.8																11.0	10.9	10.9	10.8	10.7	10.6	10.5	10.4	10.3	10.2
11.9																	11.0	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.3
12.0																		11.0	11.0	10.9	10.8	10.7	10.6	10.5	10.4
12.1																				11.0	10.9	10.8	10.7	10.6	10.5
12.2																					11.0	10.9	10.8	10.7	10.6
12.3																						11.0	10.9	10.8	10.7
12.4																						11.0	10.9	10.8	10.7
12.5																							11.0	10.9	10.8
12.6																								11.0	10.9
12.7																									11.0

Horizontal distance shown in italics does not differ from slope distance. Blank cells exceed 11 m horizontal distance.

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Data Collection

Follow data collection procedures found in the current version of the NETN Long-term Forest Monitoring Protocol, with the following exceptions:

Rare Community

Record community code describing the vegetation at this site (JPW, PPC, PPW, or WRP), respectively for Jack Pine Woodland, Pitch Pine / Broom Crowberry Woodland, Pitch Pine Woodland, or White Pine / Red Pine Forest. If during plot establishment phase the site vegetation does not match the community sought, record 'No match' in the database, do not collect data on the plot, and proceed to the next backup location.

Plot number

Record the plot identification number (#1 - 40), which corresponds with the number on the pre-printed plot tag.

Slope

Slope across the plot may be measured with clinometer rather than LAR.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney	Increased plot size to 9 m radius. Adjusted distance to obstacle for plot establishment to be 10 m.	
1.02	January 2008	Geri Tierney Kate Miller	Amended plot marking procedure pending further evaluation. Plot setup to use laser hypsometer. Minor editorial changes.	
1.03	February 2008	Kate Miller	Replaced terrain position with physiographic class.	
1.04	April 2008	Kate Miller	Added instruction to visually assess vegetation before installing plot.	
1.05	January 2009	Kate Miller	Changed permanent markers to only be located at plot center and at the end of each 9m transect. Added directions to install lag screws with washers where soil is too thin for fiberglass stakes.	
1.06	June 2009	Geri Tierney	Clarified that potential sites will be pre-selected using GRTS Added requirement that only patches >= 2 hectares are suitable for plot installation. Clarified that rare forest sites will be evaluated using criteria included herein. Clarified that rare forest plots will be established and monitored using NETN Forest Protocol. Added identification criteria for rare forest. Added slope conversion table as Table 1. Minor editorial changes.	
1.07	September 2009	Brian Mitchell	Bearings for plot establishment using the LAR should be within 0.5 degrees. Added GRTS number to data collected. Minor editorial changes.	

Version #	Date	Revised by	Changes	Justification
1.08	June 2010	Geri Tierney	Clarified procedures for White Pine / Red Pine Forest. Changed plot setup to use Sonin and tapes, rather than LAR, to improve accuracy. Plot slope can be measured with compass. Referred to Forest Protocol for Data Collection. Editorial and formatting changes.	
1.09	December 2010	Kate Miller Jesse Wheeler	Changed SOP name to Site Selection, Plot Establishment and Remeasurement. Added Remeasurement section. Added use of metal detector to locate lag screws. Added that plots are numbered consecutively (1-40). Added new slope conversion table that uses degrees instead of % slope. Editorial and formatting changes	Conform to NPS standards
1.10	April 2012	Kate Miller	Minor editorial changes	In response to external reviewer comments.

SOP 7 – Photopoint

Northeast Temperate Network

Version 1.07

Overview
This SOP documents the procedure for photographing plots in rare woodland communities at Acadia National Park (ACAD). Photopoints for White Pine / Red Pine Forest community plots are collected according to the current version of the Photopoint SOP of the NETN Long-term Forest Monitoring Protocol. Photographs will be archived and used as visual reference for change in appearance of plots over time. Photographs should be taken shortly after plot setup in order to visually record the plot before significant field crew impacts occur.

Data collection
A total of five photographs are taken at each plot prior to beginning a survey. Four scenes are photographed at each plot – the first three scenes document the plot overall and the fourth is a close-up of the ground vegetation. The first three scenes are photographed from plot center and face the 0°, 120°, and 240° transects. The scene facing 0° is oriented in the portrait position, and the 120° and 240° scenes are oriented in the landscape position. The fourth photo is a close-up of the vegetation along the 0° transect at the first quadrat location (2 - 3 m). The veg quadrat should be placed on the transect for this photopoint, and the photograph should be taken from a position standing directly above the quadrat. After the scenes are photographed, a final picture is taken of the plot tag, clearly showing the plot number.

Capture one digital photograph of each scene. Do not zoom in on the scene. Allow the camera to automatically select the appropriate aperture for the given light conditions. Allow the camera to use flash if necessary for the close-up, but do not use a flash for the overall plot scenes. Photos should be 24-bit color photographs, taken at the highest resolution available on the network camera. Photos should be compressed using the high-quality JPEG compression setting on the camera. If the camera has a date stamp function, make sure the date and time are set correctly and turn this function on. Use the macro setting (flower icon) for the plot tag photo.

In re-measured plots, the field crew should examine photographs from previous visits and attempt to recreate the position and angle used.

Camera
Use a designated network digital camera for all pictures. Record the brand and model number of this camera.

Time
Record the time of day at which the photograph was taken.

Weather
Record the presence of sun, clouds or fog.

Data Management
After field work is complete for the day, download the photos to the laptop photograph directory. View the photos and rename them using the following format.

NETN uses a 4-character park code + 3 digit habitat code (PPC, PPW, JPW) + 3 digit plot code + Scene (000, 120, 240, Quad, ID = ID photo) + Date (YYYYMMDD), with each element separated by an underscore (_). An example of a valid photo name is:

ACAD_PPC_001_000_20090714

White Pine / Red Pine Forest plot photos will be named as described in the current version of the Photopoint SOP of the NETN Long-term Forest Monitoring Protocol. The exception is that the community code (WRP) will be included in the file name. An example of a photo name for this community is:

ACAD_WRP_004_UR_20100801

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney Kate Miller	Adjusted location of close-up for new plot size.	
1.02	January 2008	Geri Tierney Kate Miller	Added backup photo locations in case view is obstructed Clarified instructions for ID card Added record of transect used for location	
1.03	January 2009	Kate Miller	Changed protocol to correspond with newest version of the forest protocol photopoint SOP.	
1.04	June 2009	Geri Tierney	Minor editorial changes	
1.05	September 2009	Brian Mitchell	Minor editorial changes	
1.06	June 2010	Geri Tierney	Editorial and formatting changes	
1.07	December 2010	Kate Miller	Clarified directions for naming WRP community photopoints Editorial and formatting changes	 Conform to NPS standards

SOP 8 – Site Measurements

Northeast Temperate Network

Version 1.09

Overview

This SOP describes site measurements within 9-m radius circular plots in rare woodland communities at Acadia National Park (ACAD). White Pine / Red Pine Forest plots are monitored using the current version of the Stand and Site Measurements SOP of the NETN Long-term Forest Monitoring Protocol with one exception noted below. These data allow proper interpretation of other measures, and will be used to assess site factors and disturbance. This SOP is designed to be used only during the leaf-on period of the summer months (about June 1 to August 31).

The crew may temporarily enhance plot edge markers with bright-colored survey flags to make them more visible during measurement. It is important that these flags be collected and removed from the site after measurement.

When canopy closure and cover class are assessed, notice the exact breakpoints (e.g., 25%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake – it is to allow the crew to better manage their time budget and not spend time trying to decide if the correct value is exactly 25%. The most suitable class should be rapidly assessed and recorded.

Data collection

In the White Pine / Red Pine Forest community, follow the NETN Long-term Forest Monitoring Protocol with this exception:

For Crown Closure, use the following classes:

1	< 10%
2	10 to 25%
3	25 to 65%
4	65 to 85%
5	> 85 %

Note that Crown Closure classes were adjusted from the NETN Long-term Forest Monitoring Protocol to better assess structural changes in this relatively open forest community (see Ecological Integrity SOP).

In the three rare woodland communities, collect the following data.

% Vascular cover by layer

Estimate the total cover of vascular plant foliage by layer within the plot. A rapid cover estimate is made, ignoring overlap among species. It may help to visualize cover by collapsing each layer

into a 2-dimensional space, ignoring normal spaces occurring between leaves. Estimate total cover for each layer: Ground (< 0.5 m above ground); Mid-understory (0.5 – 2 m above ground); High-understory (2 – 5 m above ground); and Canopy (≥ 5 m above ground). Use these cover classes: < 1, 1-5, 5-10, 10-25, 25-40, 40-60, 60-95, 95-100%. Note that many broom crowberry and jack pine woodlands are likely to lack vegetation cover above 5 m.

Note the difference in % cover classes and addition of the Canopy layer from the NETN Long-term Forest Monitoring Protocol. These measurements were adapted to assess status and trend in woodland structure (see Ecological Integrity SOP).

% Cover rock

Record the percentage of the plot covered by exposed bedrock or rocks, including gravel (> 2 cm maximum diameter of piece) as: < 1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95 or 95-100%.

% Cover bare mineral soil

Record the percentage of the plot covered by bare mineral soil as: < 1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95 or 95-100%. Bare mineral soil is defined as exposed mineral soil with no leaf litter or duff layer (i.e., O horizon) present. Include fine gravel (particle size ≤ 2 cm maximum diameter of piece) and bare soil area beneath water drainage channels.

Note that crews should not spend a lot of time distinguishing between bare mineral soil and rock, and should not measure more than a few pebbles to assess whether the gravel is rock or mineral soil. If gravel sizes are fairly uniform and around 2 cm diameter, crew should assess if gravel pieces are generally over or under 2 cm at their maximum diameter and classify the whole group as either bare soil or rock.

% Trampled

Record the percentage of the plot showing evidence of trampling by humans, wildlife or livestock. Trampling is assessed relative to the conditions of adjacent undisturbed substrate. Include visible disturbance to rock surfaces, including damage to lichens on the rock surface or newly exposed rock surface. Include area occupied by established or unofficial trails traversing the plot, and record type of trail in Site Notes. Estimate the percentage as: < 1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95 or 95-100%.

Deer Browse Index

Visually inspect the plot and record the level of deer impact observed (adapted from Brose et al. 2008). In ACAD use the following codes and criteria:

1 Very low impact: No observed browse. Found only inside well maintained, deer-exclosure fences.

2 Low impact: No observed browse. If browse-preferred (Table S8.1) regeneration or stump sprouts are present, there is no evidence of browse. In some cases browse preferred regeneration or stump sprouts are not present on a plot in ACAD for reasons other than deer browse. In these situations, crew should record "2" unless there are other signs of deer activity on the plot, including a deer trail, deer scat and/or browse of any plant species on the plot. Be sure to distinguish between hare and deer browse. Hare browse is low to the ground and is a clean, angled cut on the twig (i.e., looks like it was cut by

clippers). Because deer lack teeth on the upper jaw, deer browse appears more ragged on one end and can occur at varying heights.

3 Moderate impact: Browse evidence is observed but not common in browse-preferred regeneration or stump sprouts. Other signs of deer activity are observed on the plot, including a deer trail, deer tracks and/or deer scat.

4 High impact: Browse evidence is common. Non-preferred and browse-resilient regeneration (Table S8.2) shows signs of browse and browse preferred species are absent.

5 Very high impact: Browse evidence is omnipresent. Browse-resilient regeneration shows signs of heavy repeated browsing and a browse line is evident.

Table S8.1. Preferred browse regeneration species.

Scientific Name	Common Name
Acer rubrum	red maple
Acer saccharum	sugar maple
Magnolia acuminata	cucumbertree
Prunus pensylvanica	pin cherry
Sorbus americana	mountain ash
Thuja occidentalis	northern white cedar
Tsuga canadensis	Eastern hemlock

Table S8.2. Non-preferred / browse resilient regeneration and herbaceous plant species.

Scientific Name	Common Name
Abies balsamea	balsam fir
Acer pensylvanicum	striped maple
Fagus grandifolia	American beech
Pinus resinosa	red pine
Pinus rigida	pitch pine
Pinus strobus	white pine

Disturbance code

Visually inspect the plot and record any disturbances observed that seem to have occurred since the previous monitoring visit and have caused "significant threshold" damage as defined here. "Significant threshold" damage affects either 1) 25% of trees in a plot, 2) 50% of an individual tree species' count (but must include at least two trees in or near the plot), 3) disturbance to at least 25% of the soil surface or understory vegetation; or 4) disturbance to at least 25% of the broom crowberry population. If you record an unknown disturbance, attempt to capture a picture illustrating the disturbance. On the first visit, record any disturbances which are evident, regardless of when they may have occurred.

00 None – no observable disturbance
10 Insect damage
  11 insect damage to understory vegetation
  12 insect damage to trees, including seedlings and saplings
20 Disease damage

21 disease damage to understory vegetation
22 disease damage to trees, including seedlings and saplings
30 Fire – prescribed or natural
40 Animal damage – identify animal in Site Notes or photograph
50 Weather damage
51 ice/snow
52 wind including hurricane, tornado
53 flooding caused by weather
54 drought
55 earth movement/avalanches
60 Vegetation – suppression, competition, or vines
70 Unknown/not sure/other. Describe in Site Notes and take photo.
80 Human-caused damage – describe in Site Notes.

Disturbance threshold

For each disturbance recorded above, record which threshold was triggered: 1) damage to 25% of trees in a plot, 2) damage to 50% of an individual tree species' count, 3) disturbance to at least 25% of the soil surface or understory vegetation or 4) disturbance to at least 25% of the broom crowberry population (for Pitch Pine / Broom Crowberry Woodland only).

Disturbance % class

For each disturbance recorded above, record an approximate disturbance percentage to the nearest 10%. If the recorded disturbance was triggered by threshold 1, record the approximate % of trees in the plot damaged by that disturbance. If triggered by threshold 2, record the approximate % of an individual tree species' count damaged by that disturbance. If triggered by threshold 3, record the % of the soil surface or understory affected by that disturbance. If triggered by threshold 4 (Pitch Pine / Broom Crowberry Woodland only), record the % of the broom crowberry population affected.

Water on plot

Record the water source having the greatest impact on the plot using codes below. These data will be recorded during the first visit, and verified or updated on subsequent visits. It will be necessary to re-examine the plot for temporary water sources during each visit.

0 None – no water sources on plot
1 Permanent streams or ponds
2 Permanent water in the form of deep swamps, bogs, marshes
3 Ditch/canal – human-made channels such as for irrigation or drainage
4 Temporary streams
5 Flood zones – evidence of flooding when bodies of water exceed their natural banks
6 Vernal pool
7 Other water – specify in Site Notes

Litter thickness

Litter is un-decomposed or partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.). Three litter thickness measurements are taken along each transect, for a total of nine measurements per plot. Measurements are taken at 2, 5 and 8 m while the

quadrat is in place. At each location, carefully insert a trowel into the soil surface to examine the depth of the litter layer. Use a ruler to measure the depth at which plant litter is no longer recognizable (as leaves, twigs, etc.) and record to the nearest cm. If the soil surface consists of bare rock or mineral soil, record "0". The location of a litter measurement can only be moved if a tree bole is obstructing the location. In this case move the litter depth location clockwise (if you're facing plot center) around the quadrat corners until a suitable location is found. Record notes on where depth was sampled and why it was removed. Note that a boulder or bedrock outcrop is not a reason for moving the location. In this case measure litter on top of the boulder or record "0" if litter is absent.

Site notes

Record any unusual features, or as directed above.

Literature cited

Brose, P. H., Gottschalk, K. W.,Horsley, S. B., Knopp, P. D., Kochenderfer, J. N., McGuinness, B. J., Miller, G. W., Ristau, T. E., Stoleson, S. H., Stout, S. L. 2008. Prescribing regeneration treatments for mixed-oak forests in theMid-Atlantic region. Gen. Tech. Rep. NRS-33. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 100 p.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney Kate Miller	Increased plot size to 9m radius. Removed deer browse line observation.	
1.02	January 2008	Geri Tierney Kate Miller	Added % non-vascular ground cover measure. Clarified bare soil measurement. Increased number of litter measurements. Minor editorial changes.	
1.03	February 2008	Kate Miller	Altered position of litter measurement.	
1.04	January 2009	Kate Miller	Removed maximum stand height because it's already collected with tree data.	
1.05	June 2009	Geri Tierney	Amended disturbance instructions to record all evident disturbances during first visit. Adjusted location of litter depth measurement and increased to 9 per plot. Minor editorial changes.	
1.06	September 2009	Brian Mitchell	Minor editorial changes.	
1.07	June 2010	Geri Tierney	Moved litter measurement back to transect axis, since crew does not walk along transect, and thus trampling isn't an issue. Set threshold particle size between rock and mineral soil substrate, including fine gravel substrate within soil class. Added lichen and rock component to trampling metric. Changed % cover classes for WRP canopy cover and % cover by layer for the woodland communities. Editorial and formatting changes.	Improves ability to asses structure for EI metrics.

Version #	Date	Revised by	Changes	Justification
1.08	December 2010	Kate Miller Jesse Wheeler	Changed sample period back to June 1 to August 31. Added justification for changes in % cover classes for WRP canopy cover and % cover by layer in woodlands. Clarified that the bare mineral soil cutoff is ≤ 2cm maximum diameter of piece, and rock is > 2 cm maximum diameter of a piece. Added note that crews should not spend a lot of time determining bare mineral soil from gravel. Added that the litter depth location can be moved clockwise around quadrat corners if a tree bole is obstructing, but bedrock and boulders do not trigger moving the location. Clarified that litter thickness is measured while the quadrat is in place Editorial and formatting changes	Crew will sample this protocol during forest field season Conform to NPS standards
1.09	April 2012	Kate Miller	Added ACAD deer browse index Minor editorial changes	To be consistent with forest protocol In response to external reviewer comments

SOP 9 – Tree Measurements

Northeast Temperate Network

Version 1.07

Overview
This SOP describes measurement of all live trees and standing dead trees at least 2 m in height in rare woodland communities at Acadia National Park (ACAD). Tree measurements for White Pine / Red Pine Forest community plots should follow the current version of the Tree Measurements SOP of the NETN Long-term Forest Monitoring Protocol. These data will yield information on tree composition and community structure.

Definitions
Diameter-at-root-crown (DRC) is measured at the base of the tree just above the point where the base flares or the ground, whichever is higher.

Live trees are trees ≥ 2 m tall with any living parts (leaves, buds, cambium) present at or above DBH, including trees that have been temporarily defoliated.

Dead standing trees are dead trees that lean < 45 degrees from vertical. They need not be self-supported. Once included, dead trees are tracked until they no longer qualify as standing dead.

Note: Dead trees can be a safety hazard. Crews must exercise caution – trees that are deemed unsafe (e.g., trees that are leaning and not solidly attached to the base) to measure should be estimated but not touched.

Procedure
Delineate the plot by placing temporary survey flags at the end of each transect. Begin tallying trees from the center-up position and continue clockwise through the plot. Tally each live or dead tree that is ≥ 2 m tall. Use the telescoping pole to determine if a tree reaches the minimum 2 m threshold for measurement. A tree which occurs on the plot boundary is included only if the center of the stem base lies directly on or within the boundary. Dead trees (no live foliage) are mapped the first time they are observed to be dead, in order to determine tree mortality rates. Live trees are not mapped because tree growth rates have not been included as an integrity metric for these rare communities.

In rare woodland plots, trees are considered forked if a fork occurs below ground level. In this case, treat each fork as an individual tree. Trees which fork partially at or above ground level are considered a single individual. Note that this differs from methods in the NETN Long-term Forest Monitoring Protocol.

Tree height is measured only for the tallest five trees in the plot.

Data collection

Tree number

Record the tree number which uniquely identifies each tree on the plot. Note that numbers are assigned but trees are not tagged.

Third

Record the plot third within which the tree resides: upper right (UR), upper left (UL) or lower (LL).

Horizontal angle

For dead trees only, use the laser rangefinder or a compass to determine the horizontal angle (relative to true north) from plot center to the tree (middle of the trunk). Measure to the nearest 0.1 degrees. Record horizontal angle only the first time a tree is observed to be dead.

Horizontal distance

For dead trees only, use the laser rangefinder (LAR) or the Sonin distance measurer to record the horizontal distance (to the center of the trunk) of the tree from plot center. If using the LAR, this will require having an observer hold a reflector at the correct distance, just to the side of the tree and in the middle of the trunk's depth. Measure to the nearest 10 cm. Record horizontal distance only the first time a tree is observed to be dead.

Tree height

For the five tallest live trees in the plot only, use the telescoping pole to measure the tree height to the nearest 0.1 m. If tree is alive but has a dead crown, measure to top of live foliage. If the tree height cannot be easily obtained with the pole, use the laser rangefinder to record **Vertical angle up**, **Vertical angle down**, and **Horizontal distance (for height)**, then verify the tree height automatically calculated by the database. If the calculated height looks wrong, recheck your measurements. Tree height may also be determined using a clinometer and Sonin distance measurer.

Vertical angle up

For the five tallest live trees in the plot only, and when the telescoping pole cannot be used, use the laser rangefinder to measure the vertical angle to the top of the tree. Measure to the nearest 0.1 degrees.

Vertical angle down

For the five tallest live trees in the plot only, and when the telescoping pole cannot be used, use the laser rangefinder to measure the vertical angle to the base of the tree. Measure to the nearest 0.1 degrees. This measurement must be taken from the same location as the vertical angle up.

Horizontal distance (tree height)

For the five tallest live trees in the plot only, and when the telescoping pole cannot be used, use the laser rangefinder to measure the horizontal distance to the tree. Measure to the nearest 10 cm. This measurement must be taken from the same location as the vertical

angles, and will differ from the horizontal distance measured earlier if the rangefinder has been moved. Horizontal distance should be at least 8 m.

Species code

Record species code using the first three letters each of genus and species. If species cannot be determined in the field, bring a twig sample with foliage, buds, cones, or flowers, and/or a photograph to your supervisor for identification. If possible, collect samples outside the plot from similar specimens and make a note to correct the species code later. Record genus or family if known, or use "Unk Con" for unknown conifer, "Unk Har" for unknown hardwood or "Unk" for unknown tree; this is often the case with standing dead trees on newly established plots.

DRC

Estimate tree diameter-at-root-crown (DRC) to the nearest 1 cm using calipers. Measure across the base of tree at the ground, or just above the location at which the base flares with root growth, avoiding any knobs or irregularities in the stem. For trees with bent stems, measure DRC at the lowest suitable location above the bend. For clumps of stems sharing a common base above ground, record as a single tree.

Tree Status

Record a status code for each tree to track status over time. Tree status codes are based on two letter codes. The first letter designates whether the tree is alive (A) or dead (D). The second letter designates whether the tree is standing (S), leaning (L), broken (B), or fallen (F). For example, "AS" indicates a live standing tree (Table S9.1).

Table S9.1. Tree status codes.

	Alive	**Dead**
Standing	AS	DS
Leaning	AL	DL
Fallen	AF	DF
Broken	AB	DB

Pine Foliage Condition

For live pine trees only, visually assess foliage and record up to three problems as chlorosis/browning (C), necrosis (N), small leaves (S), red tips on this year's needles (R), or other (O—describe in Tree Notes). Chlorosis/browning is yellowing or browning of needles associated with loss of chlorophyll or other damage. Foliage necrosis is dead needles or dead patches on needles. Red tips on this year's needles are associated with ozone damage.

Note that the list of potential conditions differs from the NETN Long-term Forest Monitoring protocol; the red tips (R) condition was added to this protocol.

Pine Foliage Percentage

For live pine trees only, Estimate the total percentage of needles affected by foliage conditions and the percentage of needles affected by each foliage condition using the following classes: 1-10, 10-50, 50-90, 90-100%. Estimate using the number of needles affected. Do not attempt to estimate the percentage of needle area affected. For example, if approximately 20% of needles are affected but only a small amount of surface area of each needle is affected, choose class 2 for 20%. Notice the exact breakpoints (e.g., 10%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake—it is to allow the crew to better manage their time budget and not spend time trying to decide if the correct value is exactly 10%. The most suitable class should be rapidly assessed and recorded.

Pine Crown Dieback

For live or dead pine trees only, visually assess the tree crown for dieback. Dieback is recent mortality of branches with fine twigs, which begins at the terminal portion of a branch and proceeds toward the trunk. Dieback is only considered when it occurs in the upper and outer portions of the tree crown. When whole branches are dead in the upper crown, without obvious signs of damage such as breaks or animal injury, assume that the branches died from the terminal portion of the branch and include as dieback. Dead branches in the lower portion of the live crown are not considered as part of crown dieback, unless there is continuous dieback from the upper and outer crown down to those branches**.** Classify as:

1 No crown dieback evident. Virtually all (> 95%) terminal foliage of the upper crown is intact. Crown density may vary from tree to tree but no dead branches in the upper tree crown.
2 Some dieback evident. Loss of some terminal foliage in the upper crown although most (> 50%) terminal foliage is still present. Dead branches are present in the upper tree crown although most (> 50%) branches retain their terminal foliage.
3 Absence of most (> 50%) terminal foliage in the upper crown. Dead branches are emergent from the upper crown.
4 Virtually all (> 95%) terminal foliage is absent. Epicormic foliage may be present.
5 Dead tree. No live foliage present.

Tree notes

Record any unusual tree features or notes required above.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	January 2008	Geri Tierney Kate Miller	Revised tree size classification. Revised location measurement from "quarter" to "third". Eliminated tree DRC/DBH and crown measurements. Added tree height measurement.	
1.02	January 2009	Kate Miller	Added comment on potentially using telescoping poles for tree height. Added need to move LAR, after all trees have been mapped, to measure tree height accurately. Revised vertical angle up measurement for live trees with dead tops vs. snags. Defined fork at DRC (different from forest protocol).	
1.03	June 2009	Geri Tierney	Added telescoping pole to determine tree height threshold Adjusted tree height measurement to apply only to 5 tallest trees per plot. Included DRC estimate. Removed decay class measurement. Minor editorial changes.	
1.04	September 2009	Brian Mitchell	Tree heights should use the telescoping pole, then the LAR if needed. A HD measurement for tree height is needed, in case the rangefinder is moved to a better location. Added comment to the LAR's "subtended distance" function might be useful for DRC measurements. Editorial changes.	
1.05	June 2010	Geri Tierney	Now map dead trees only, in order to calculate tree mortality. Altered tree height measure to assess live trees only. Updated tree status codes to match the Long-term Forest Monitoring Protocol. Added pine foliage condition and pine crown dieback metrics. Editorial and formatting changes.	

Version #	Date	Revised by	Changes	Justification
1.06	December 2010	Kate Miller Jesse Wheeler	Added 8m minimum for HD of tree height. Removed LAR subtended distance function. Removed Cut, Missed, Not Located, Excluded and Recruit tree status codes. Added note that foliage condition R was added, and differs from forest protocol. Removed suggestion to map trees first, then measure tree height with LAR. Changed DRC to be measured to nearest 1cm. Added ≥ 2m tall as minimum height for live trees Editoral and formatting changes.	 Calipers are easier and more accurate. We're not tracking individual trees between sample periods. Tree heights and mapping procedures have been reduced to the point that this isn't necessary. Calipers can easily measure to nearest 1cm. Conform to NPS standards
1.07	April 2012	Kate Miller	Clarified hazard trees	In response to a comment during the external review.

SOP 10 – Tree Regeneration

Northeast Temperate Network

Version 1.07

Overview
This SOP describes measurement of tree regeneration in rare woodland communities at Acadia National Park (ACAD), and was adapted from the Microplot SOP of the NETN Long-term Forest Monitoring Protocol. Tree regeneration measurements for White Pine / Red Pine Forest community plots should follow the current version of the Microplot SOP of the NETN Long-term Forest Monitoring Protocol. Juvenile trees less than 2 m tall are measured within three 9 x 1 m belt transects.

Definitions
Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance.

Juvenile tree is a seedling or sapling of a tree species that is less than 2 m tall at the top of live foliage, and has at least one set of true leaves (i.e., not a recent germinant).

Data collection
Three belt transects extend 9 m horizontal distance from the plot center to the plot edge at azimuths of 0°, 120° and 240°, respectively. Each belt transect extends 1 m horizontal distance in a clockwise direction from the permanent stakes. To monitor these belt transects, lay out a tape along each marked transect from plot center to the end marker (at 0°, 120° or 240°, respectively. Then, one crew member stands at plot center and extends a tape or one side of the quadrat to a second crew member standing 1 m horizontal distance perpendicular to the tape. The crew members walk each transect together remaining 1 m apart. Both crew members should carefully examine the belt transect as they progress, identifying and recording tree regeneration by size class.

Belt transect
Specify which belt transect has been observed as 0°, 120° or 240°.

Regeneration species
For each juvenile tree (< 2 m tall) encountered, record species as the first three letters each of the genus and species. If species cannot be determined in the field, bring a twig sample or photograph to your supervisor for identification. If possible, collect samples outside the entire tree plot from similar specimens and make a note to correct the species code later. Record genus or family if known, or use “Unk Con” for unknown conifer and “Unk Har” for unknown hardwood. Note that recent germinants, which still have cotyledons and/or have not produced true leaves, are not recorded as established regeneration.

Regeneration tally

Within each belt transect, tally the number of live juvenile trees by species within each height class listed below. Count up to five individuals per species and height class; once five individuals of a species have been counted within a size class, estimate additional individuals in multiples of five to expedite the process.

0-15 cm tall
15-30 cm tall
30-100 cm tall
1-2 m tall

Height is defined as the distance from the root crown to the top of the terminal bud, or to the top of the tallest fork. Do not include leaves or needles in this measurement. To determine height class, gently align plant along a ruler or use the telescoping pole. Disregard any curves that may be present in the stem. Note that this method differs from the NETN Long-term Forest Monitoring Protocol.

Multiple "suckers" that originate from a common base are considered one seedling. Do not count stump sprouts from a live tree; however do count stump sprouts from a dead bole, counting all sprouts from a common base as one seedling. Do not count "layers" – undetached branches partially or completely covered by soil, usually at the base.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney Kate Miller	Increased length of belt transect to 9m.	
1.02	January 2008	Geri Tierney Kate Miller	Eliminated DRC and revised height classes.	
1.03	June 2009	Geri Tierney	Changed height measurement to disregard curves in stem. Minor editorial changes.	
1.04	September 2009	Brian Mitchell	Minor editorial changes.	
1.05	June 2010	Geri Tierney	Clarified procedure. Editorial and formatting changes.	
1.06	December 2010	Kate Miller Jesse Wheeler	Added use of quadrat sides for belt transect. Editorial and formatting changes.	Conform to NPS standards
1.07	April 2012	Kate Miller	Defined juvenile tree Added to Overview that this SOP was adapted from the NETN Forest protocol. Editorial changes	In response to external reviewer comments

SOP 11 – Quadrat Measurements

Northeast Temperate Network

Version 1.08

Overview

This SOP describes measurement of the composition and abundance of understory plants in rare woodland communities at Acadia National Park (ACAD). Vegetation diversity measurements for White Pine / Red Pine Forest community plots should follow the current version of the Quadrat SOP of the NETN Long-term Forest Monitoring Protocol. Species cover data are collected in nine 1-m^2 quadrats nested within each plot. This SOP is designed to be conducted by two people, one of whom must be a vegetation specialist or crew member familiar with vegetation at ACAD. This protocol should be used only during the leaf on period of the summer months (about June 1 to August 31).

Use these cover classes: 0, <1, 1-2, 2-5, 5-10, 10-25, 25-50, 50-75, 75-95, 95-100%.

Notice the exact breakpoints (e.g., 25%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake - it is to allow the crew to better manage their time-budget and not spend time trying to decide if the correct value is exactly 25%. The most suitable class should be rapidly assessed and recorded. Also note that while crews may be tempted to assign one person to sample quadrats to reduce trampling, understories are often very dense in these communities. It is important that two people sample the quadrats to ensure species are not missed.

Definitions

Figure S11.1. Typical Pitch Pine / Broom Crowberry Woodland type. Kate Miller photo.

Broom crowberry (*Corema conradii*) is a low, spreading, dwarf shrub characteristic of the rare Pitch Pine / Broom Crowberry Woodland (Figure S11.1). It grows up to 60 cm in height, has narrow yellow-green needles (brown in winter) 3-5 mm long, produces small terminal clusters of inconspicuous purple or reddish flowers early in the season (March-May), and small (< 1.5 mm diameter) dry, brown berries with three (occasionally 4-5) seeds in July-August. Broom crowberry grows either as a dense cushion or tussock (up to 1 m diameter) which may die back from the center, or as scattered stems. Plants may live up to 50 years; adult plants are typically killed by fire which stimulates broom crowberry seed germination to create an even-aged population structure. Broom crowberry can be distinguished from black crowberry (*Empetrum nigrum*) by its slender, unstriped needles (vs. wider *E. nigrum* needles with a white stripe along the underside midvein) and dry 3-5 parted fruits (vs. *E.*

nigrum's juicy, 6-9 seeded berries). Broom crowberry germinants appear as single stems that look like small adult plants with no side branches – branching begins during the subsequent year.

Data collection

Three 1 x 1 m vegetation quadrats are placed along each of three belt transects originating at plot center for a total of nine quadrats as shown in Figure S11.2. Transect axes radiate from plot center at 0°, 120° and 240°, and each belt transect extends clockwise 1 m from the axis. The quadrats are placed from 2-3, 5-6, and 8-9 m, respectively, within each belt transect. The outward left corner of each 8-9 m quadrat is permanently marked as shown in Figure S11.2. Put the PVC quadrat frame in place, propping up the quadrat corners if necessary. In areas of thick vegetation, quadrat sides should be slid through the vegetation.

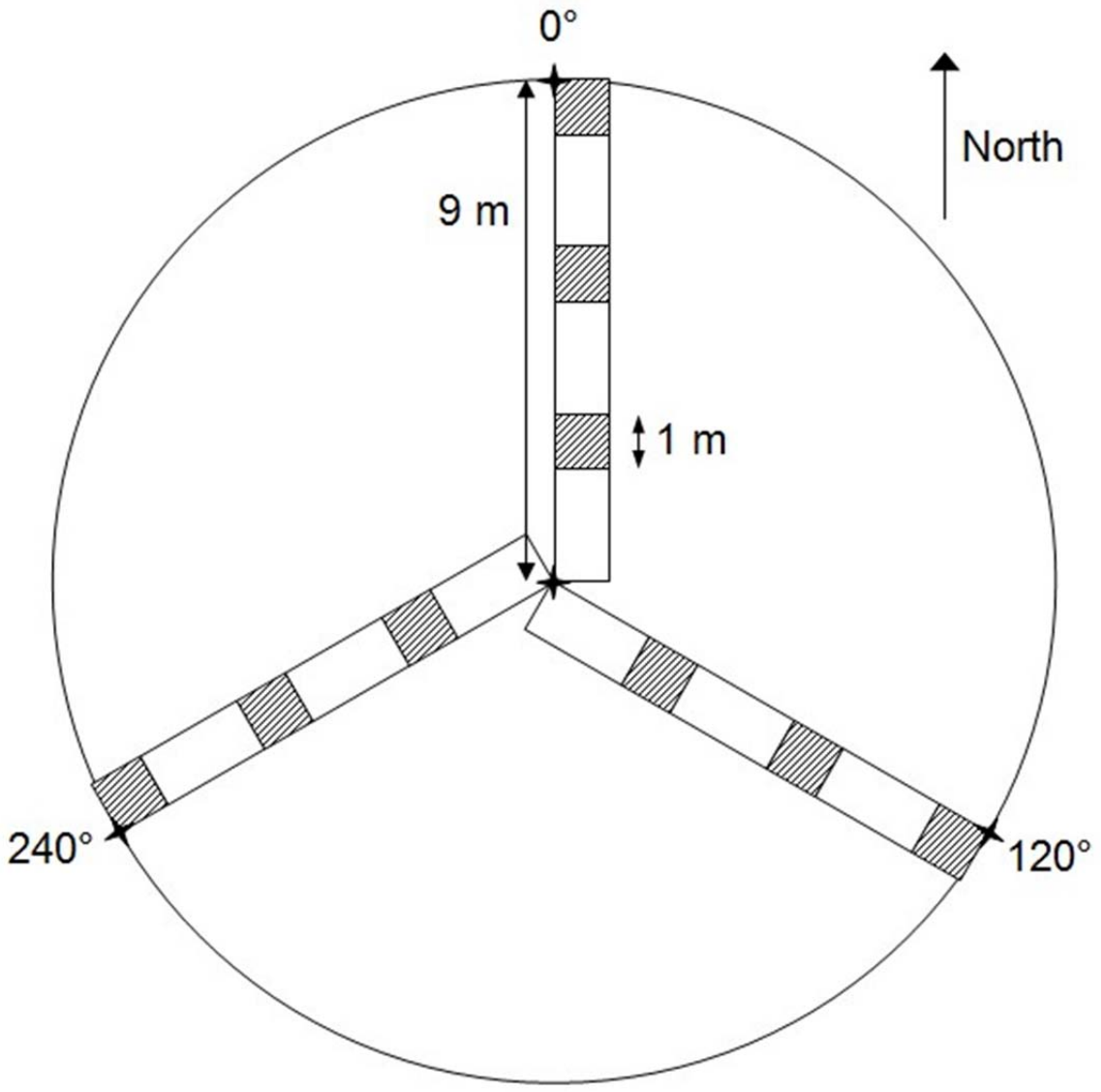

Figure S11.2. NETN rare community plot with 3 nested 9 x 1 m regeneration belt transects and nine 1 x 1 m vegetation quadrats. ✦ indicates permanent plot marker.

% Quadrat trampling
Examine each quadrat prior to sampling and record % of quad area with noticeable trampling impacts using the cover classes listed above. Trampling is defined as damage to plants or lichens,

Quadrat code
Record the code(s) corresponding to each belt transect and quadrat within which the species was found: 0-3, 0-6, 0-9, 120-3, 120-6, 120-9, 240-3, 240-6, or 240-9.

Quadrat sampling status
Record whether each quadrat was sampled (1) or not (0). If a quadrat was not sampled, record the reason in Quad Notes. This might occur if a safety hazard exists, or disturbance of the ground layer by humans, livestock, or wildlife. Include visible disturbance to rock surfaces, such as damage to lichens on the rock surface or newly exposed rock surface. Include trampling caused by the field crew, and note this in Quad Notes.

<u>The next three measurements are made to determine the % of quadrat area unavailable to vascular plants.</u>

% Stem
Record % cover of woody stem ≥ 1 cm DRC within the quadrat using the cover classes listed above.

% Wood
Record % cover of live or un-decomposed dead wood (large root or coarse woody debris ≥ 5 cm diameter) that is touching the ground within the quadrat using the cover classes listed above.

% Rock
Record % cover of exposed rock within the quadrat using the cover classes listed above. Include mineral fragments > 2 cm across (i.e., larger than fine-gravel size). Do not include area covered by moss, lichen (including crustose) or litter (either unconsolidated or aggregated). Note that this differs from the NETN Long-term Forest Monitoring Protocol in that crustose lichen cover is not included in the % rock estimate for this protocol.

% Litter
Record % cover of organic litter (either unconsolidated or aggregated) within each quadrat using the cover classes listed above. Litter is undecomposed or partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.).

% Mineral soil
Record % cover of exposed mineral soil including sand within each quadrat using the cover classes listed above. Include mineral particles ≤ 2 cm across (i.e., fine gravel particles).

% Bryophyte
Record % bryophyte cover within the quadrat using the cover classes listed above.

% Lichen
Record % cover of lichens "rooted" in the quadrat substrate (e.g. rock, soil, CWD, or tree stem) using the cover classes listed above. Do not include lichens that have fallen from the canopy or are attached to recently fallen branches.

In addition to % lichen cover, estimate % cover for each lichen morphotype listed below. Lichen morphotypes are non-taxonomic groups that are based on the physical appearance of lichens, and consist of crustose, foliose, fruticose, squamulose and umbilicate groups. Examples of morphotypes may be seen at http://www.lichen.com/vocabulary.html.

% Crustose
Lichens that are attached to rocks or trees that form a tight crust and are not easily removed from substrate.

% Foliose
Lichens that are somewhat leaf-like, composed of many lobes, and often form a rosette.

% Fruticose
Lichens that are usually round in cross-section, and many branched. Fruticose lichens can be shrubby, stalked or hair-like (e.g., reindeer lichen and old-man's beard)

% Squamulose
Lichens that have a combination of scale-like lobes at the base and fruticose fruiting structures (e.g., Pixie cup lichens)

%Umbilicate
Lichens that are similar to foliose, but are only attached to their substrate at a central point, have few lobes and are dark grey, brown or black (e.g., rock tripe).

Quadrat species
Each quadrat is examined for vascular plant species found rooted in or overhanging within 1.5 m above the ground by a team of two people, one of which must be familiar with vegetation in ACAD (i.e., a crew member familiar with flora of the park or a contract botanist). A list of species is recorded. Then, % cover of each species is jointly estimated and recorded by the team of two people. Use the cover classes listed above. Cover is based on a vertically-projected polygon described by the outline of the foliage, ignoring any normal spaces occurring between leaves, up to a maximum height of 1.5 m.

If a plant cannot be identified to species quickly and confidently, assign the species a specimen number, record genus or family, if possible, and give a short descriptive name. If the unknown plant is not locally sparse, collect a specimen away from the quadrat as described below. Do not collect any plants that are represented by five or fewer individuals (i.e., locally sparse) in the general vicinity of the plot. Do not collect if plant occupies less than 1% canopy cover on subplot AND no mature foliage or reproductive parts are present; these plants would be too difficult to identify. Any time it is not possible to collect a specimen, collect a photograph. Place a ruler in

the photograph for scale, and allow the camera to automatically select the appropriate aperture for the given light conditions. Use the macro setting for close up photos.

New germinants of woody species receive special treatment because their cover fluctuates greatly within and among years. For each woody species, record and estimate cover of this year's germinants separately from more established specimens. Specify records for germinants by checking the "germinant" box. The germinant category only refers to seedlings that have germinated from seed within the current growing season. These seedlings typically are very small (< 5 cm tall), and will display cotyledons (rudimentary seed leaves) and possibly 1-2 true leaves or a single whorl of fine needles. In the Pitch Pine / Broom Crowberry Woodland, take special care to search for broom crowberry (*Corema conradii*) germinants.

Quadrat notes

Record any note-worthy observations, including reason quadrat was not sampled, or trampling of quadrat by the field crew.

Plant collection

Do not collect any plant that is locally sparse as described above. Use a digging tool to extract the entire plant, including any underground portions, flowers, fruits, and leaves. Collected unknown specimens should be transported from the field in zip-lock bags. Bag must be labeled with day of collection, plot, and specimen number. It is essential that each specimen be assigned a number to allow accurate matching of identified species with field measurements. Promptly identify collected plants, present plants to your supervisor for identification, or press specimens for later identification.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney	Increased plot size to 9m radius.	
1.02	January 2008	Geri Tierney Kate Miller	Added description of broom crowberry. Noted that quad frame midpoints must be marked. Changed % Stem cutoff to 1cm. Changed % Wood diameter cutoff to 5cm. Changed % Moss to % Bryophyte cover. Added % Lichen cover. Included lichen genus or morphotype to quadrat species. Added separate woody germinant record. Minor editorial changes.	
1.03	February 2008	Kate Miller	Added text describing lichen morphotypes.	
1.04	January 2009	Kate Miller	Added more on how to identify broom crowberry from black crowberry. Adjusted Figure 1 so that plot marks are only located at the transect ends and plot center. Also changed this in text	
1.05	June 2009	Geri Tierney	Clarified rock and litter categories for % cover measure. Adjusted trampling metric to use cover classes. Minor editorial changes.	
1.06	September 2009	Brian Mitchell	Minor editorial changes.	
1.07	June 2010	Geri Tierney	Set threshold particle size between rock and mineral soil substrate, including fine gravel substrate within soil classes. Added lichen and rock component to trampling metric. Editorial and formatting changes.	
1.08	December 2010	Kate Miller Jesse Wheeler	Added August 31 as end date for this sampling protocol. Changed height from 1m to 1.5m. Clarified that % rock doesn't include crustose lichen. Revised format for % cover lichen groups and definitions. Editorial and formatting changes.	 Maintains consistency with forest protocol. Conform to NPS standards

SOP 12 – Broom Crowberry Population

Northeast Temperate Network

Version 1.08

Overview

This SOP assesses condition of the broom crowberry (*Corema conradii*) population within the globally rare Pitch Pine / Broom Crowberry Woodland (PPC) only. Measurements are made within nine 1-m^2 quadrats nested within each plot.

Definitions

Broom crowberry (*Corema conradii*) is a low, spreading, dioecious dwarf-shrub characteristic of the rare Pitch Pine / Broom Crowberry Woodland. It can reach up to 60 cm in height, and grows either as a dense cushion or tussock (up to 2 m diameter) which may die back from the center, or as scattered stems (Martine et al. 2005). However, in the ACAD PPC, broom crowberry tends to either occur as scattered individual plants or as smaller tussocks ranging from 10-20 cm in diameter. Broom crowberry has narrow yellow-green needles (brown in winter) that are 3-5 mm long, produces small terminal clusters of inconspicuous purple or reddish flowers early in the season (March-May). Female plants produce small (< 1.5 mm diameter) dry, brown berries with three (occasionally 4-5) seeds in July-August (Gleason and Chronquist 1991, Martine et al. 2005). Plants may live up to 50 years; adult plants are typically killed by fire which stimulates broom crowberry seed germination to create an even-aged population structure.

Broom crowberry can be distinguished from black crowberry (*Empetrum nigrum*) by its slender, unstriped needles (vs. wider *E. nigrum* needles with a white stripe along the underside mid-vein) and dry 3-5 parted fruits (vs. *E. nigrum*'s juicy, 6-9 seeded berries). Broom crowberry germinants appear as single stems that look like small adult plants with no side branches - branching begins during the subsequent year.

Data collection

Condition of individual broom crowberry plants is monitored within vegetation quadrats. Three 1 x 1 m quadrats are placed along each of three belt transects originating at plot center for a total of nine quadrats as shown in Figure S12.1. Transect axes radiate from plot center at 0°, 120° and 240°, and each belt transect extends clockwise 1 m from the axis. The quadrats are placed from 2-3, 5-6, and 8-9 m, respectively, within each belt transect. The outward left corner of each 8-9 m quadrat is permanently marked as shown in Figure S12.1.

Up to nine individual broom crowberry plants per quad are selected for monitoring using the following method. The 1 x 1 m^2 quadrat is marked at the midpoint of each side. Using the midpoint marks as a guide, stretch two bungee cords so they intersect at the center of the quadrat. This creates a grid with nine intercept points – one at each corner or midpoint, including the center. Select the broom crowberry plant (i.e., branch) directly beneath each intercept point. If no broom crowberry plant is present directly beneath the intercept, record this information and continue to the next intercept. If several broom crowberry plants are layered beneath the

intercept, select the uppermost broom crowberry plant (i.e., branch). Carefully trace the selected branch back to the main stem and down to the ground. Visually assess the branches connected to this main stem to quantify live and dead branches as directed below.

Quadrat code

Record the code(s) corresponding to the belt transect and the quadrat being measured: 0-3, 0-6, 0-9, 120-3, 120-6, 120-9, 240-3, 240-6, or 240-9.

Intercept code

Record the code corresponding with the intercept point (Figure S12.2) being measured: UL (upper-left), UC (upper-center), UR (upper-right), ML (middle-left), MC (middle-center), MR (middle-right), BL (bottom-left), BC (bottom-center), or BR (bottom-right). Bottom is always the position nearest to plot center.

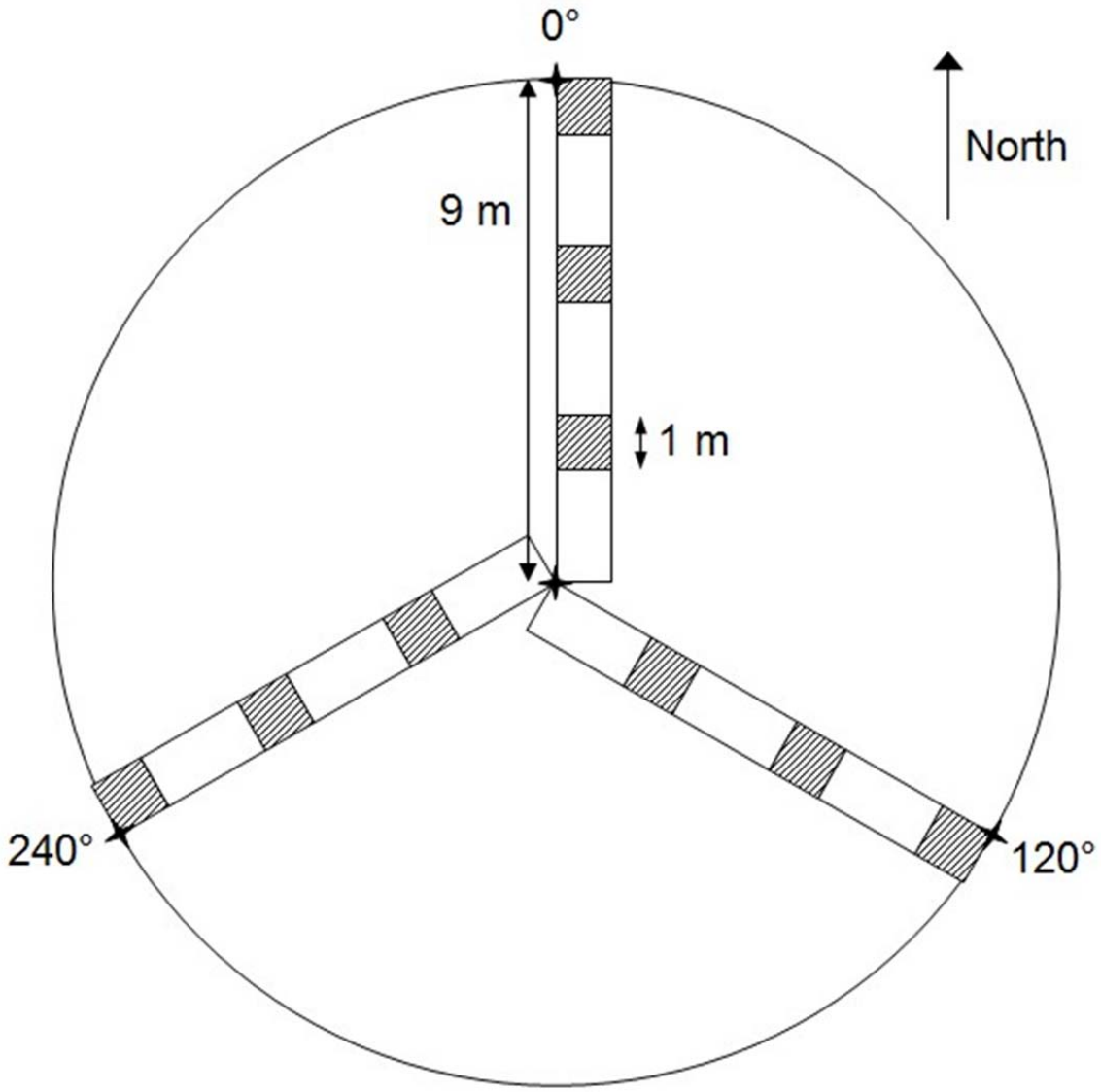

Figure S12.1. NETN rare community plot with 3 nested 9 x 1 m regeneration belt transects and nine 1 x 1 m vegetation quadrats. ✦ indicates permanent plot marker.

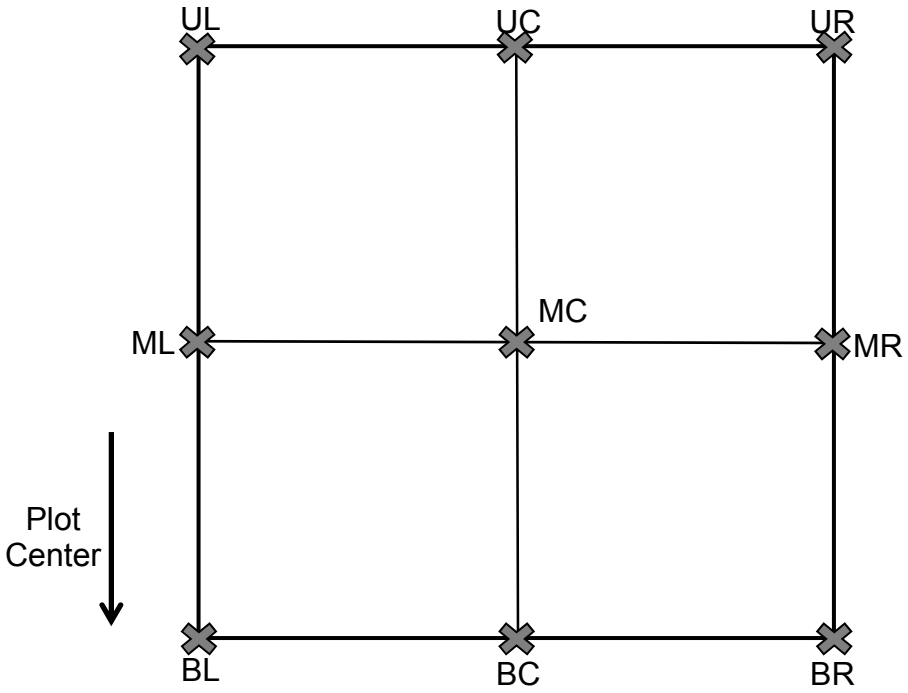

Figure S12.2. Diagram of broom crowberry intercept locations (✖ and names) on 1-m^2 quadrats.

Broom crowberry presence

Record the presence (1) or absence (0) of at least one broom crowberry plant directly beneath the intercept point.

Broom crowberry height

Measure plant height to the nearest cm at the tallest point on the selected plant. Measure as height from ground to top of uppermost branch; do not attempt to stretch plant or lay tape along stem to find true height (i.e., length) of plant. Note that this method differs from the NETN Long-term Forest Monitoring Protocol.

Broom crowberry live branches

Carefully count the total number of live branches off the main stem of the selected plant. Branches must be ≥ 1cm long to be counted.

Broom crowberry dead branches

Carefully count the total number of dead branches off the main stem of the selected plant. Branches must be ≥ 1cm long to be counted.

Broom crowberry reproduction

Record the presence (1) or absence (0) of any fruiting structures on the selected plant. See above for description of broom crowberry reproduction.

Literature Cited

Gleason, H.A., and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd Edition. New York Botanical Garden, Bronx, NY, USA.

Martine, C. T., D. Lubertazzi, and A. DuBrul. 2005. The biology of *Corema conradii*: Natural history, reproduction, and observations of a post-fire seedling recruitment. *Northeastern Naturalist* 12(3):267-286.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	January 2008	Geri Tierney Kate Miller	Eliminated stem tally and tussock measurements. Added plant condition measurement.	
1.02	February 2008	Geri Tierney Kate Miller	Minor editorial changes.	
1.03	January 2009	Kate Miller	Added more on how to identify broom crowberry from black crowberry. Adjusted Figure 1 so that plot marks are only located at the transect ends and plot center. Also changed this in text. Removed estimation of Corema dieback, and instead count number of live and dead stems. Added 1cm as size cutoff for a branch to be counted. Adapted the sample frame to use bungee cords.	
1.04	June 2009	Geri Tierney	Increased intercept points from 5 to 9. Minor editorial changes.	
1.05	September 2009	Brian Mitchell	Updated intercept codes for 9 intercepts, and using naming conventions in forest protocol. Minor editorial changes.	
1.06	June 2010	Geri Tierney	Editorial and formatting changes.	
1.07	December 2010	Kate Miller	Editorial and formatting changes.	Conform to NPS standards
1.08	April 2012	Kate Miller	Revised broom crowberry description Revised the broom crowberry reproduction measurement to only consider presence of fruit. Added diagram of quadrat intercepts	In response to external reviewer comments

SOP 13 – Landscape Context

Northeast Temperate Network

Version 1.09

Overview
This SOP describes procedures for landscape context metrics for rare forest and woodland communities at Acadia National Park (ACAD). Change over time will be monitored using field measures and analysis of Digital Orthophoto Quarter-Quadrangles (DOQQs).

Sources of spatial data
Vegetation maps of NETN parks are being developed as one of the Natural Resource Challenge base inventories by the USGS/NPS Vegetation Mapping Program (http://biology.usgs.gov/npsveg/) and distributed in digital and paper format. These maps will show National Vegetation Classification (NVC) vegetation communities within and surrounding each park using a minimum mapping unit of 0.5 ha. These maps also designate human land use and cultural vegetation areas to standard land use/land cover (LUC) classification Level II.

While these USGS/NPS Vegetation maps provide a useful starting point for analysis, new spatial data will be needed for reassessment of landscape metrics. NETN should monitor change over time by periodically acquiring and analyzing high-resolution Digital Orthophoto Quarter-Quadrangles (DOQQs). DOQQs are digital images of aerial photographs that have been rectified to remove distortion from terrain and filming. A standard DOQQ is a grayscale or color-infrared image with 1 m ground resolution, covering an area 3.75 minutes longitude by 3.75 minutes latitude – an area equivalent to one-quarter of a USGS quadrangle – plus 50 to 300 m additional edge to facilitate mosaicking of adjacent images. DOQQs should be referenced to the North American Datum of 1983 (NAD83) and cast on the Universal Transverse Mercator (UTM) projection. For this analysis, we recommend color infrared images be used, and that imagery be photographed during the growing season when leaves are on trees.

Every 10 years, NETN should acquire recent (< 5 years old) DOQQs from the U.S. Geologic Survey (USGS) and/or the National Digital Orthophoto Program (NDOP) for NETN park regions. These organizations create and distribute high-resolution DOQQS. If updated DOQQs photographed during the growing season are not available from these sources every 10 years, NETN may need to contract to have DOQQs created. Acquisition of DOQQs should be done in conjunction with NETN's Landscape Dynamics protocol.

In addition, periodically updated digital spatial data showing the location of roads, carriage roads and trails will be needed. These data can be acquired directly from the park in some cases. If the park does not maintain this GIS data, road data should be available from state GIS clearinghouses.

Spatial analysis

Locations of established plots are used to conduct spatial analyses of rare woodland and forest communities. Spatial analysis should be performed using ArcGIS, FRAGSTATS, or a program with similar capabilities. Patch size and distances should be digitized at the 1:6,000 scale or finer, and patch size should be at least 0.5 ha.

Community patch size

Calculate size in hectares of the woodland or forest patch within which each plot resides. If using an unclassified image (e.g., a DOQQ or aerial photo), this will require digitizing the patch on the screen, and then calculating its area.

NOTE: This metric needs further development to ensure that changes in the resolution or quality of the base layers do not impact the measurements.

Distance to road

Calculate the shortest distance in meters from the plot to the nearest paved road.

Distance to trail

Calculate the shortest distance in meters from the plot to the nearest trail or carriage road.

Field metric

In the Pitch Pine / Broom Crowberry Woodland only, the crew will walk five pre-selected transects through each known patch, stopping every 20 m to record GPS location and note if the community matches this type. To do so, the crew will make a rapid visual assessment of canopy and understory vegetation in all directions to verify whether a) the overstory within about 10 m of the observation point is dominated (≥ 60% relative dominance) by pitch pine (*Pinus rigida*); and b) broom crowberry (*Corema conradii*) is present in understory within about 3 m of the observation point. Both criteria must be met for a positive measurement to be recorded. Transects will be pre-selected within each patch using GIS. Each transect will extend across the entire patch appearing on the Acadia Vegetation Map. During field observation, the crew will extend each transect beyond the mapped patch until three successive negative assessments.

To generate the five pre-selected transects for this metric, start with the Data View in ArcMap zoomed to the extent of the patch plus a 50 m buffer. Use a random point generator (such as Hawth's tools) in ArcMap to generate a random point in the view. Next generate a grid in Toolbox that is 20 m tall by 50 m wide and that originates from the random point. Finally convert the grid to point features, or calculate centroids for the grid, and add XY to get the GPS coordinates.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	July 2007	Geri Tierney	New SOP	
1.01	August 2007	Geri Tierney	Minor editorial changes.	
1.02	January, 2008	Geri Tierney Kate Miller	Added field measurement of rare community extent.	
1.03	February 2008	Geri Tierney Kate Miller	Minor editorial changes.	
1.04	January 2009	Kate Miller	Added comment about whether we're targeting Corema or the pitch pine broom crowberry woodland in the field metrics.	
1.05	June 2009	Geri Tierney	Adjusted field metric to search for rare community, rather than broom crowberry species. Added note that patch size metric needs further development. Minor editorial changes.	
1.06	September 2009	Brian Mitchell	Clarified community patch size measurement. Minor editorial changes.	
1.07	June 2010	Geri Tierney	Adjusted PPC field metric based on field experience. Removed distance to coast metric. NETN could undertake a vulnerability assessment for ACAD coastline. Editorial and formatting changes.	
1.08	December 2010	Kate Miller	Set 1:6,000 as the standard scale for digitizing. Set 0.5 as minimum patch size. Added distance to coast back in. Added instructions for generating field metric sample points. Kept field metric to require 3 successive negative measurements.	PPC is patchy within the mapped 5ha are, and walking another 20m to be sure is worth the risk of missing a patch.
1.09	April 2012	Kate Miller	Minor editorial changes	In response to external reviewer comments.

SOP 14 – Analyzing and Reporting Ecological Integrity

Northeast Temperate Network

Version 1.04

Overview

This SOP describes how ecological integrity is assessed and reported from field data collected by the NETN Rare Woodland and Forest Community Protocol in four rare woodland and forest communities at Acadia National Park (ACAD). These four communities are all characterized by relatively open tree canopies, and are dominated by species which require fire or other disturbance to regenerate. NETN will use data from the scientific literature to evaluate levels of ecological integrity as "Good", "Caution" or "Significant concern" for specific metrics of community structure, composition and function as well as metrics indicative of key stressors or management actions affecting these communities. Ratings are based on assessment points that may be derived from natural ranges of variation, or alternatively from levels associated with negative or undesired outcomes. The interpretation of ecological integrity is a useful but developing conservation application, and ratings will be reviewed and updated as new information becomes available. A scorecard format will be used to clearly and concisely report the integrity of these rare communities to multiple audiences including park managers and decision-makers.

Approach

The concept of "ecological integrity" is increasingly being used as a measuring tool to assess the state of ecosystems and the effectiveness of land management actions upon those ecosystems (Tierney et al. 2009). "Ecological integrity" has been defined as a measure of the composition, structure and function of an ecosystem in relation to the system's natural or historical range of variation and the perturbations imposed upon it by natural or anthropogenic agents of change (Parrish et al. 2003). Building upon the well-known Index of Biological Integrity (IBI; Karr 1981), ecological integrity can be assessed by developing suites of indicators or metrics comprising key biological, physical and functional attributes of those ecosystems (Andreasen et al. 2001). This approach is well-suited to the needs of the NPS Inventory and Monitoring Program (I&M), which seeks to improve understanding of the condition of park ecosystems by monitoring the status and trends of a selected group of indicators.

Following the NPS I&M rating system, condition is rated as "Good", "Caution" or "Significant concern" for each metric. "Good" represents acceptable or expected conditions; "Caution" indicates a problem may exist; "Significant concern" indicates undesired conditions that may need management correction. Ratings are assigned based on assessment points that may be derived from natural ranges of variation, or alternatively from levels associated with negative or undesired outcomes.

Metrics, Calculations and Ratings

Metrics and ratings for interpretation of ecological integrity are presented for four rare communities at ACAD. These rare communities are: a) the globally rare Pitch Pine / Broom Crowberry Woodland (PPC); b) the Pitch Pine / Black Chokeberry / Wavy Hairgrass - Little Bluestem Woodland (PPW or Pitch Pine Woodland); c) the Jack Pine / Sheep Laurel - Blueberry species Woodland (JPW or Jack Pine Woodland); and d) the Eastern White Pine - Red Pine / Canadian Bunchberry Forest (WRP or White Pine / Red Pine Forest). The latter three communities are considered rare in the state of Maine (Brooke Wilkerson, Maine Natural Areas Program, personal communication).

These four communities are all characterized by relatively open tree canopies, and are dominated by species which require fire or other disturbance to regenerate. As discussed in the protocol narrative accompanying this SOP, the historic role of fire in maintaining ACAD's pine communities is unclear. Harsh edaphic conditions and disturbance from salt spray may limit tree incursion and play a role in allowing these communities to persist in the absence of fire. The selection of ecological integrity metrics reflects the need for disturbed conditions to maintain the structure and composition characteristic of these communities.

Metrics and ratings are summarized in Table S14.1. The text that follows provides an overview, justification, calculation description, and rating for each metric.

Community Patch Size

Overview

This metric monitors trend in size of rare community patches.

Justification

Community patch size will fluctuate over time due to a variety of natural and anthropogenic factors. In general, larger patches better support the vegetation and wildlife found in these rare communities.

Calculation

Patch size is calculated using GIS as described in the Landscape Context SOP. For rare communities other than PPC, this metric will only be calculated approximately every 10 years, when new spatial data are obtained. For PPC, patch size will be estimated from field transect data after each measurement. To estimate patch size from field transect data, first plot the five field transects on a map using GIS. Then, enclose the transects in a polygon of minimum area by drawing a straight line from each transect endpoint to the adjacent transect endpoint. Finally, use GIS to calculate the area of the polygon. Ratings are applied to each rare community based on average patch size.

Rating

Good: Average patch size stable or increasing since previous analysis

Caution: Average patch size declined up to 10% since previous analysis

Significant Concern: Average patch size declined >10% since previous analysis

Table S14.1. Summarized ecological integrity metrics and ratings.

Metric Type	Metric	Metric Ranking		
		Good	Caution	Significant Concern
Landscape Structure	Community patch size	Avg. patch size stable or increasing	Avg. patch size declined <= 10%	Avg. patch size declined > 10%
Community Structure	Cover – tree and high shrub		Varies by community	
	Exposed mineral soil	> 10%	1-10%	< 1%
	Litter thickness		Varies by community	
	Trampling	< 1%	1-5%	> 5%
Community Composition	Canopy dominance		Varies by community	
	Regeneration		Varies by community	
	Pine tree condition	Avg. foliage problem < 20% and avg. dieback class < 2	Avg. foliage problem 20-50% or avg. dieback class 2-3	Avg. foliage problem > 50% or avg. dieback class > 3
	Exotic plant species	No exotic species present	>= 1 exotic species present	>= 1 invasive exotic species present
	Lichen condition	Fruticose freq. avg. ≥ 1 quad per plot and no decline in frequency	Foliose or umbilicate freq. avg. ≥ 1 quad per plot and no decline in frequency	Combined freq. avg. < 1 quad per plot and overall decline in freq. of all three morphotypes.
	Broom crowberry condition	≤ 50% dead branches and no decline in frequency	50-75% dead branches or decline in frequency	≥ 75% dead branches
	Broom crowberry reproduction	Fruiting structures observed in last 15 years in at least one plot	No evidence of fruiting structures in last 15 years	No evidence of fruiting structures in last 30 years
Function	Tree mortality	Rate ≤ 1.6%	Rate >1.6%	

Cover − Tree and High Shrub

Overview

This metric assesses cover in the tree canopy and high shrub layers across each plot. Cover in these layers shades understory plants and tree regeneration, strongly influencing composition in these open communities.

Justification

Increased tree and high shrub cover stemming from disruption of natural disturbance cycles or exotic species invasions can increase shading which in turn can alter community composition.

Calculation

Vegetation cover by layer across the plot is qualitatively assessed onsite.

Rating

Jack pine is one of the least shade-tolerant pines; seedlings are unable to survive shading beneath crown cover of 60% or more (Burns and Honkala 1990). Red pine seedlings establish well under about 35% or more open canopy, but establishment is poor with about 17% or less open canopy (Burns and Honkala 1990, Hepola et al. 2005). Ratings for both pitch pine woodlands are based on NatureServe community definitions (Table S14.2; Lubinski et al. 2003).

Table S14.2. Ratings for tree canopy and high shrub layers in rare communities at Acadia National Park.

Community	Good	Caution	Sig. Concern
JPW	Both canopy and high shrub cover < 40%	Either canopy or high shrub cover 40 - 60%	Either canopy or high shrub cover > 60%
PPC and PPW	Both canopy and high shrub cover < 60%	Either canopy or high shrub cover >= 60%	
WRP	Both canopy and high shrub cover < 65%	Either canopy or high shrub cover 65 - 85%	Either canopy or high shrub cover > 85%

Exposed Mineral Soil

Overview

This metric visually assesses exposed mineral soil within the plot overall and within nine 1-m^2 quadrats.

Justification

Exposed mineral soil provides a site for seedling establishment for jack pine, red pine and broom crowberry (Burns and Honkala 1990, Martine et al. 2005).

Calculation

Exposed mineral soil is visually estimated across the plot by percentage class. An independent assessment is performed in each of nine vegetation quadrats per plot, and a plot level assessment

of exposed mineral soil is estimated. To rate, first calculate mean percentage of exposed mineral soil from the nine quadrat measurements using the midpoints of each class. This metric is rated by using the larger of the mean quadrat value or the overall plot estimate.

Rating

Ratings are based on levels that we expect to be observed, rather than ideal levels for regeneration of key species. Ratings should be updated if and when additional data become available.

Good: > 10%

Caution: 1-10%

Significant Concern: < 1%

Litter thickness

Overview

This metric measures litter thickness at nine locations per plot.

Justification

In the absence of disturbance, buildup of organic litter can inhibit establishment of seedlings of fire-dependent species.

Calculation

Litter thickness is measured at nine locations per plot. For each plot, the mean value is calculated from all nine measurements. Individual measurements are also considered as described below.

Rating

Jack pine and red pine seedlings typically do not survive if litter thickness exceeds values indicated in Table S14.3 (Burns and Honkala 1990, Mallik and Roberts 1994).

Table S14.3. Ratings for litter thickness in rare communities at Acadia National Park.

Community	Good	Caution	Sig. Concern
JPW	Mean < 1.5 cm	Mean >= 1.5 cm and at least one measurement < 1.5 cm	All measurements ≥ 1.5 cm
WRP	Mean < 3 cm	Mean >= 3 cm and at least one measurement < 3 cm	All measurements ≥ 3 cm

Trampling

Overview

This metric visually assesses trampling impacts within the plot overall and within nine 1-m^2 quadrats.

Justification
ACAD is one of the most visited national parks, receiving on the order of two million visitors annually, and trampling of sensitive communities is a concern. Trampling is likely to be a bigger issue for the pine woodlands on Mount Desert Island, which attracts more visitors than the remote Schoodic Peninsula or Isle au Haut.

Calculation
Trampling is visually estimated across the plot by percentage class. An independent assessment of trampling percentage class is performed in each of nine vegetation quadrats per plot. To rate, first calculate mean percentage trampled from the nine quadrat measurements using the midpoints of each class. Then use the larger of the mean quadrat value or the overall plot estimate.

Rating
Ratings are based on levels that may expect to be observed, rather than ideal levels for protection of key species. Ratings should be updated if and when additional data become available.

Good: < 1%

Caution: 1-5%

Significant Concern: > 5%

Canopy dominance

Overview
This metric estimates status and trend in canopy tree dominance. Dominant canopy trees are foundation species that exert a strong influence over site conditions.

Justification
Dominant canopy species exert strong influence over site conditions which in turn affects overall community composition. In these open pine woodlands and relatively open pine forest, a shift in canopy dominance to broadleaf or exotic trees would dramatically alter the community.

Calculation
Relative canopy dominance in woodlands is estimated as relative basal area from tree diameter-at-root-crown (DRC) measurements in woodlands, and from tree diameter-at-breast-height (DBH) measurements in forest.

First, basal area (BA in m^2) is calculated for each tree in a plot as:

$$BA = \pi * \left(\frac{diam}{2*100} \right)^2$$

where *diam* is DRC for trees in woodland plots and DBH for trees in forest plots.

Next, relative canopy dominance per species is calculated for the plot by summing the BA for each species, and then dividing by the sum basal area of all trees in the plot.

Rating

Ratings are based on relative canopy dominance (RCD) expected in these rare communities (Table S14.4; Lubinski et al. 2003). Relative Canopy Dominance is the proportion of the total canopy occupied by a species. If *Picea rubens*'s cover value is 30%, in a setting in which the canopy cover totals 60%, *Picea rubens*'s relative dominance is 50% (Lubinski et al. 2003).

Table S14.4. Ratings for canopy dominance in rare communities at Acadia National Park.

Community	Good	Caution	Sig. Concern
All	< 25% RCD deciduous trees	≥ 25% RCD deciduous trees	
JPW	≥ 60% RCD Jack pine	< 60% RCD Pitch pine	
PPC	≥ 60% RCD Pitch pine	< 60% RCD Pitch pine	
PPW	≥ 60% RCD Pitch pine	< 60% RCD Pitch pine	
WRP	≥ 40% RCD Red pine	< 40% RCD Red pine	

Regeneration of Key Species

Overview

This metric assesses the composition of tree regeneration in rare woodland and forest communities. Tree seedlings and saplings are tallied by species and size class in three 9 x 1 m^2 belt transects.

Justification

The species composition of tree regeneration (i.e., seedlings and saplings) will impact future community structure and composition. In these rare woodland and forest communities, regeneration of key species (including both dominant pine trees and broom crowberry) may be inhibited by lack of fire or other disturbance, or due to soil and litter characteristics, as well as other factors. Furthermore, jack pine in ACAD occurs at the southern terminus of its range, and higher temperatures associated with global climate change may negatively impact regeneration of this species at these sites (Day et al. 2005, Greenwood et al. 2002).

Calculation

Tree seedlings and saplings are tallied onsite.

Rating

Regeneration of pitch pine, jack pine, red pine and broom crowberry are all typically fire dependent, requiring fire or a similar disturbance to create conditions which allow regeneration and seedling establishment. However, regeneration of jack pine at the edge of the species range, as in coastal Maine, seems to be continuous in the absence of fire (Conkey et al. 1995, Barton and Grenier 2008). Thus, absence of jack pine regeneration (i.e., established seedlings and saplings) in a plot would merit significant concern and consideration of management action; while presence of jack pine regeneration in multiple size classes merits a "Good" rating. Alternatively, regeneration of pitch pine, red pine and broom crowberry is expected to be cyclical, following fire disturbance or similar disturbance (for example, limited mechanical disturbance, such as from a single automobile, has been observed to stimulate broom crowberry germination; Martine et al. 2005). Thus, absence of regeneration merits caution and further

monitoring. Rating for deciduous sapling incursion is based on NatureServe community definitions (Table S14.5; Lubinski et al. 2003).

Table S14.5. Ratings for regeneration of key species in rare communities at Acadia National Park.

Community	Key regen species	Good	Caution	Sig. Concern
ALL	Deciduous trees	≤ 25% deciduous regeneration	25-50% deciduous regeneration	≥ 50% deciduous regeneration
JPW	Jack pine	Regen in ≥ 1 size classes	Regen in one size class	No regeneration present
PPC	Broom crowberry	Seedlings present	No seedlings present	
PPC and PPW	Pitch pine	Regen in ≥ 1 size classes	Regen in one size class	No regeneration present
WRP	Red pine	Regeneration present	No regeneration present	

Pine Tree Condition

Overview

This metric qualitatively assesses foliage condition and dieback in dominant pine species within these rare communities.

Justification

Foliage condition and dieback can provide an early warning indicator of problems or decline in these key species or the community overall.

Calculation

Foliage of pine trees is visually assessed for obvious problems (chlorosis/browning, necrosis, small leaves, red tips on this year's needled, or other. Pine tree crowns are visually assessed for crown dieback class.

Rating

Good: Average foliage problem < 20% and average dieback class < 2, for all pines or single species in plot (represented by at least two trees).

Caution: Average foliage problem 20-50% or average dieback class 2-3, for all pines or single species in plot (represented by at least two trees).

Significant Concern: Average foliage problem > 50% or average dieback class > 3, for all pines or single species in plot (represented by at least two trees).

Exotic Plant Species

Overview

This metric assesses the presence of exotic species within nine 1-m^2 quadrats per plot in these rare communities.

Justification

The effects of exotic species on the structure, composition and function of natural systems have become a chief concern of ecologists and land managers over the last 20 years due to the growing number of species successfully exploiting and altering non-native habitats (Drake et al. 1989). Generally, ACAD's undisturbed natural communities remain free from invasive species (Greene et al. 2004). Careful monitoring for and prompt management of new invasions in these rare communities could maintain this ideal situation. At least 22 invasive exotic species are documented within the park (mostly in disturbed locations) and have management plans in place (Weber and Rooney 2007). Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) may pose a particular risk to these rare pine woodland and forest communities (Catling and Carbyn 2005, Kilgore and Telewski 2004).

Calculation

Plant species presence and percent cover are recorded at each plot within nine 1-m^2 quadrats. Data are examined for presence of any exotic species. Exotic species present are considered "invasive" if: a) included as an invasive species in the report 'Management Plans For Invasive Plant Species of Acadia National Park' (Weber and Rooney 2007); or b) identified as having high or medium invasive Species Impact Rank in NatureServe Explorer (http://www.natureserve.org/explorer/servlet/NatureServe?init=Species); or c) considered invasive by the Invasive Plant Atlas of New England (IPANE; http://nbii-nin.ciesin.columbia.edu/ipane/); or d) deemed invasive in this habitat by the NETN plant ecologist at ACAD. Very few exotic plants currently occur in rare woodland communities at ACAD, and so these will be evaluated as "invasive" or not as they are found to occur.

Presence of an exotic or invasive exotic species in any quadrat or plot warrants the caution or significant concern rating, respectively.

Rating

Good: No exotic species present

Caution: ≥ 1 exotic species present, but no invasive exotic species present

Significant Concern: ≥ 1 invasive exotic species present

Lichen Condition

Overview

This metric will assess lichen community condition and composition over time. We will use relative frequency of lichen morphotypes to assess lichen communities in these rare communities.

Justification

Lichens are an important component of these rare woodlands, and are sensitive indicators of trampling as well as air pollution. While air pollution may be impacting lichens in these communities, we are primarily interested in quantifying the impacts of trampling because it is a stressor that is possible for park managers to control.

Lichen species in similar morphotypes tend to respond similarly to environmental conditions and stressors and are relatively easy for field crews to identify (Will-Wolf et al. 2006). Fruticose lichens are most sensitive to trampling (Farris 1998, Rosentreter and Eldridge 2002). Foliose and umbilicate lichens are intermediate in their sensitivity to trampling, and crustose and squamulose groups are least sensitive to trampling, but do show decline in high use areas (Rosentreter and Eldridge 2002).

Calculation

Frequency data on each lichen morphotype is collected in each of nine vegetation quadrats per plot. To rate, calculate relative frequency of each morphotype from the nine quadrat measurements. For park level reporting, plot values are averaged for each community.

Rating

Good: Fruticose lichen frequency averages ≥ 1 quadrat per plot and no decline in frequency of occurrence.

Caution: Either umbilicate or foliose lichen frequency averages ≥ 1 quadrat per plot and no decline in frequency of occurrence.

Significant Concern: Fruticose, umbilicate and foliose lichen combined frequency average < 1 quadrat per plot, and decline in frequency of occurrence of all three morphotypes.

Broom Crowberry Condition

Overview

Condition of this characteristic rare species in the Pitch Pine / Broom Crowberry Woodland is assessed from quantification of live and dead branches, as well as trend in frequency of occurrence.

Justification

Broom crowberry (*Corema conradii*) is the characteristic species distinguishing the Pitch Pine / Broom Crowberry Woodland community. Quantification of live vs. dead branches of this densely-branched evergreen dwarf shrub provides an estimate of overall condition of the population. Lifespan of a broom crowberry plant has been estimated at up to 40 or 50 years, and the proportion of dead branches increases as older plants senesce (Martine et al. 2005). Tracking

of percent dead branches will give an estimate of population condition, with percent dead branches increasing as the population senesces, or alternatively remaining stable in a younger, vigorous population. In addition, trend in frequency will be calculated to better understand the broom crowberry population.

Calculation

Live and dead branches > 1 cm long are quantified on plants at up to nine intercept points in each of nine quads per plot. Percentage of dead branches is calculated for each plant as:

$$\left(\frac{dead\_branches}{total\_branches}\right)*100\%$$

where *total_branches* is the sum of live and dead branches counted for that plant. Percentage is averaged for all broom crowberry plants quantified within a plot. For park level reporting, plot values are averaged.

In addition, frequency of occurrence will be calculated for each quad as the percentage of broom crowberry presence observations out of the total nine observations per quad, and then averaged across all nine quads to yield a plot mean. Trend over time will be assessed as change in plot mean frequency since the previous visit.

Rating

Good: ≤ 50% dead branches and no decline in frequency of occurrence since previous sampling date

Caution: 50-75% dead branches or decline in frequency of occurrence since previous sampling date

Significant Concern: ≥ 75% dead branches

Broom Crowberry Reproduction

Overview

Reproduction of broom crowberry in the Pitch Pine / Broom Crowberry Woodland is assessed by tracking presence/absence of fruiting structures over time.

Justification

Martine et al. (2005) describe the lifespan of broom crowberry plants in New Jersey pine plains in three stages following germination. The first 5-10 years following germination are the immature growth phase. Around 10-25 years of age broom crowberry plants are reproductively active and produce copious fruits. Plants are thought to enter senescence between 25 to 35 years of age, where reproduction is slow and plants begin to die back. In the absence of a large disturbance, plants can persist in the final senescence stage for more than 2 decades, but reproduction rates are much reduced (Martine et al. 2005).

Calculation
Presence/absence of fruiting structures on broom crowberry is recorded on plants at up to nine intercept points in each of nine quadrats per plot.

Rating
We are unsure how the lifespan of broom crowberry in Maine compares to that described for this species at the southern terminus of its range (i.e., New Jersey pine plains). It is also possible that because we employ a rotating panel as our sample design, fruiting may occur during a year that this community is not sampled. Moreover, during 4 years of field testing, no evidence of broom crowberry fruiting has been observed, and this is suggestive of an older population. Therefore, current ratings are based on the minimum rate of reproduction we expect is needed and that we anticipate can be observed, for the community to persist. Ratings should be updated if and when additional data become available.

Good: Reproductive structures observed in last 15 years in at least one plot.

Caution: No evidence of reproductive structures in last 15 years.

Significant Concern: No evidence of reproductive structures in last 25 years.

Tree Mortality

Overview
Tree mortality rate provides an integrative metric of tree health problems. Annual mortality rate (% stems/year) of canopy trees is calculated from repeated observation. Rates will be assessed by size class.

Justification
Elevated mortality rate in trees of a particular species can indicate a particular health problem for that species, while altered rate for multiple species across a region may indicate a regional environmental stress.

Calculation
Annual mortality rate (*MR*; % stems/year) is calculated from successive observations as the percent of stems that died during an interval converted to an annual basis. This rate should be calculated for each plot, and also for individual species within a plot as:

$$MR = \frac{Stems\_died_{t1-t2} * 100}{Stems\_alive_{t1} * Time}$$

where $Stems\_died_{t1\text{-}t2}$ is the number of stems that died during a measurement interval, and $Stems\_alive_{t1}$ is the number of stems that were alive during the measurement prior to the interval. *Time* is the number of years between interval 1 and interval 2.

Rating

Ratings are based on data from forests (range from 0.3% to 1.6%; Busing 2005, Runkle 2000, Woods 2000) and should be re-examined for these communities.

Good: Mortality rate ≤ 1.6%; for park and all individual species.

Caution: Mortality rate > 1.6%; for park or any individual species.

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Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	June2009	Geri Tierney	Initial version.	
1.01	September 2009	Brian Mitchell	Formatting changes. Minor editorial changes. Numerous comments.	
1.02	June 2010	Geri Tierney	Added tree condition and mortality rates. Added placeholder for lichen condition metric. Added patch size metric. Clarified meaning and calculation of relative dominance. Adjusted regeneration metric ratings for pitch and jack pine to include multiple size classes. Editorial changes.	
1.03	December 2010	Kate Miller and Geri Tierney	Drafted lichen condition metric. Added broom crowberry reproduction metric. Added calculation for community patch size metric Editorial and formatting changes.	Conform to NPS standards
1.04	April 2012	Kate Miller	Minor editorial changes Revised the broom crowberry reproduction metric to only consider fruiting structure.	

SOP 15 – Deviations, Differences, and Summary of Major Changes

Northeast Temperate Network

Version 1.0

Overview

This SOP documents:

- ► Differences between methods used by the NETN Long-term Forest Monitoring Protocol and the NETN Rare Woodland and Forest Community Protocol.
- ► Known deviations from established methods. Deviations are situations where data were collected in a manner that is substantially different from the methods documented within the SOPs used during a particular field season.
- ► Major changes in the protocol. Major changes are fundamental shifts in the way data are collected that cannot easily be rectified with earlier data. Major changes are not deviations, provided that the changes are documented in the SOPs. Ideally, any time there is a major change in methods both methods will be used long enough to determine whether the results from the different methods are sufficiently correlated to allow old data to be corrected. In some cases (especially early in the use of the protocol), the small amount of data lost by the protocol change will not be worth the cost of overlapping methods.

Differences between Forest Protocol and Rare Community Methods

Table S15.1 documents any known differences between the established methods used by NETN Long-term Forest Monitoring Protocol and NETN Rare Woodland and Forest Community Protocol. The purpose of this portion of the SOP is to facilitate the task of the NETN forest crew in adapting to the change in methodology when moving between protocols.

Table S15.1. Differences between established methods used by forest protocol and rare community protocol, by SOP.

SOP	Forest Protocol	Rare Community Protocol
Site Establishment	1) Square plot with fiberglass stakes in plot corners and midpoints	1) Circular plot with lag bolts or fiberglass stakes (where soil is sufficient) at plot center and transect ends.
	2) Plot oriented upslope or North	2) Plot oriented to true North
	3) Slope measured from plot center to UC and BC	3) Slope measured across the plot
Site Measurement	1) % Cover by layer classes are all : < 1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95 or 95-100%.	**1) Woodlands Only:** % Cover of vascular layer classes are < 1, 1-5, 5-10, 10-25, 25-40, 40-60, 60-95, and 95-100%
	2) Crown Closure % cover classes are < 10, 10-25, 25-50, 50-75, and > 75%	**2) White Pine/ Red Pine Forest Only:** < 10, 10-25, 25-65, 65-85, and > 85%
Laser Rangefinder	1) LAR is required to establish and map trees	1) LAR is optional for establishing and sampling plots
Photopoint	1) Five plot scenes and one	1) Five plot scenes and one quadrat

Table S15.1. Differences between established methods used by forest protocol and rare community protocol, by SOP(continued).

SOP	Forest Protocol	Rare Community Protocol
	regeneration photo are taken per plot 2) Photopoint file names include park, plot, scene and date.	photo are taken per plot 2) Photopoint file names also require 3-letter community code
Soil	1) Litter depth measurement and soil sample collected outside of plot	1) Leaf litter depth measured along transect. No soil sample collected.
Trees	1) Trees measured at DBH (unless stunted woodland plot) using d-tape 2) All live and dead trees are mapped 3) All trees are tagged/numbered 4) Tree height using LAR is measured on 3 codominant trees. Minimum horizontal distance is 10 m in ACAD. 5) Tree status codes include missed, not located and excluded trees 6) Tree and foliage condition are assessed for each tree ≥ 10 cm 7) Trees must be ≥ 10 cm DBH	1) Trees measured at DRC using calipers 2) Only dead trees are mapped the first time they are observed dead 3) Trees are not tagged 4) Tallest five live trees are measured for height using 7.5 m height pole or LAR. Minimum horizontal distance is 8 m. 5) Tree status codes only include standing, leaning, fallen, broken or cut. 6) Foliage condition is only assessed for pine species. Pine crown dieback is also assessed. 7) Trees must be ≥ 2 m tall
Regeneration	1) Sampled in three, 2 m radius microplots 2) Height classes are 15-30 cm, 30-100 cm, 1-1.5 m and > 1.5 m 3) Height measured by straightening stem along ruler	1) Sampled along three, 1x9 m belt transects 2) Height classes are 0-15 cm, 15-30 cm, 30-100 cm and 1-2 m tall. 3) Height measured from ground to top of stem, without straightening
Quadrat	1) Located in corners and midpoints of plot boundary. 2) Broom crowberry not treated differently from vascular plants 3) Trampled is recorded as 0 or 1, and must be ≥ 10% to be given 1. 4) % Litter is not estimated 5) % Lichen is estimated	1) Located along 0, 120 and 240º transects at 2-3, 5-6, and 8-9 meters. 2) Special procedures for broom crowberry 3) % Trampled is recorded using quadrat percent cover classes, and includes visible damage to lichens or soil. 4) % Litter is estimated 5) % Lichen estimated by functional group (e.g., foliose, fruticose, crustose)

Known Deviations and Major Changes

This portion of the SOP documents the major changes over time in the procedures, so that changes that may impact data analyses are all summarized in one place. This portion of the SOP also documents situations where procedures were not followed as specified in the SOPs that were current at the time of data collection.

Site Establishment

1) 2010 (DEVIATION FROM SOP): Instead of sampling three PPC plots in 2010, as suggested in the narrative, five PPC plots were sampled. In Panel 2B, we will resample two of the PPC plots and add an additional plot.

Stand and Site Measurements

1) 2010 (DEVIATION FROM SOP): % cover of vascular by layer was estimated using forest protocol cover classes, instead of rare community cover classes.

Quadrats

1a) 2010: Quadrats were measured up to 1 m height.

1b) 2011 and later: Quadrats will be measured up to 1.5 m height to maintain consistency with forest protocol.

2) 2010 (DEVIATION FROM SOP): Assessing trampling in quadrat followed the forest protocol (i.e., presence/absesence), instead of estimating percent cover of trampling in the quadrat.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version	Date	Revised By	Changes	Justification
1.00	November 2010	Kate Miller	New SOP	

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 123/114640, June 2012

National Park Service
U.S. Department of the Interior

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