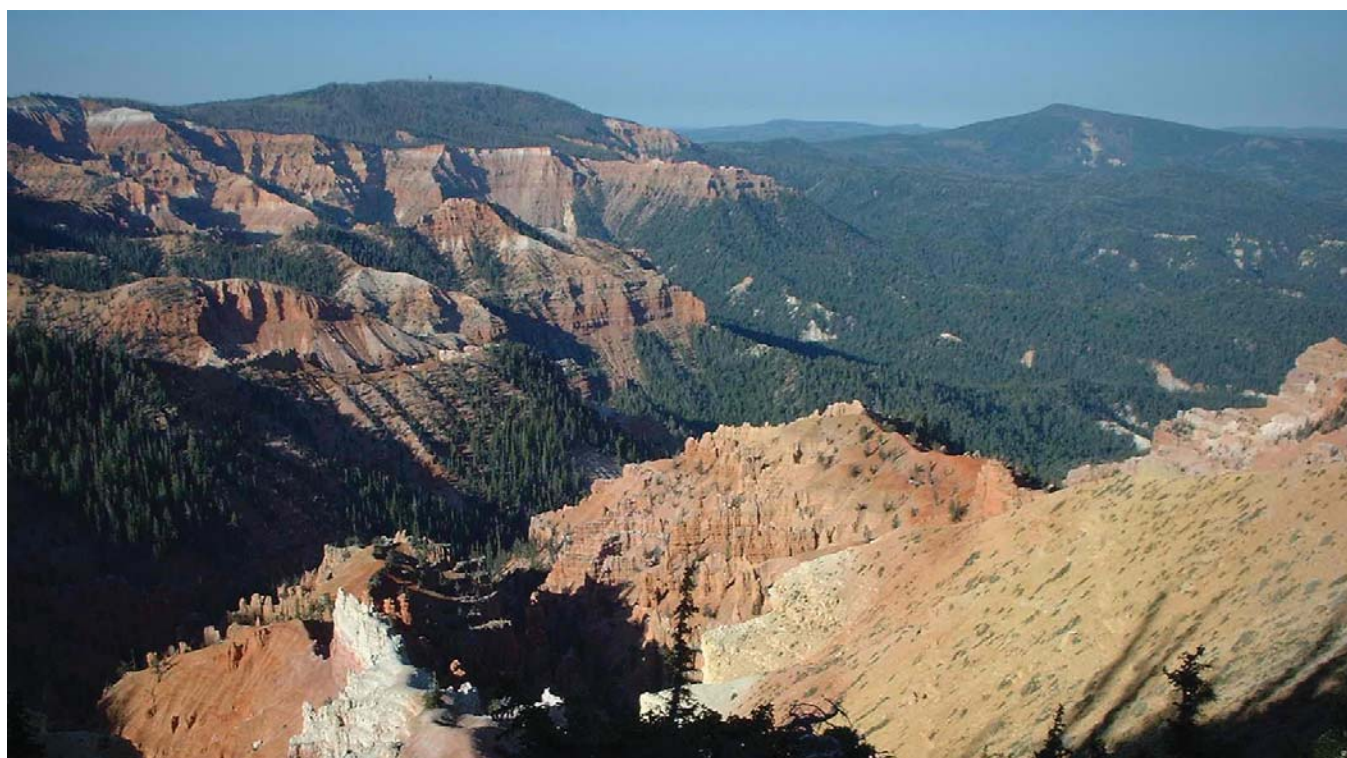




# Integrated Upland Monitoring in Cedar Breaks National Monument

## *Annual Report 2009 (Non-sensitive version)*

Natural Resource Technical Report NPS/NCPN/NRTR—2010/394.N



## ON THE COVER

Amphitheater, Cedar Breaks National Monument. NPS photo.

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# Integrated Upland Monitoring in Cedar Breaks National Monument

## *Annual Report 2009 (Non-sensitive version)*

Natural Resource Technical Report NPS/NCPN/NRTR—2010/394.N

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# Executive Summary

The goal of the Northern Colorado Plateau Network (NCPN) integrated upland monitoring effort is to provide park managers with status and trend information on vegetation and soil attributes. This information is intended to determine natural variability of upland resources and provide early warning of resource degradation.

In 2009, the NCPN initiated upland monitoring of forests and meadows above the rim in Cedar Breaks National Monument. This report outlines goals and objectives of NCPN upland monitoring, methods of the upland monitoring protocol, and procedures for defining and mapping target populations for monitoring, and describes the results of this year's efforts and plans for future monitoring. Early monitoring data describe status of sites, and interpretation is limited until additional data are acquired and more rigorously analyzed.



# 1 Introduction

Uplands represent the vast majority of land area in national parks of the Colorado Plateau. Plateau uplands include rock outcrops, badlands, shrublands, grasslands, woodlands, and forests, with local vegetation determined by soil type and depth, topography, climate, and disturbance history. Upland vegetation supplies most regional primary productivity, which translates to energy for other trophic levels. The condition of upland vegetation influences soil stability, which, in turn, determines potential above-ground production of native plant species and the propensity for invasion by non-native species. Vegetation also provides habitat for various organisms. The ability of uplands to retain soil and nutrients, absorb and release water, and buffer high-runoff precipitation events also influences riparian conditions.

Upland ecosystems of the Colorado Plateau are characterized by low resistance and resilience. Even moderate disturbances can affect vegetative composition and structure, and recovery to pre-disturbance conditions is relatively slow. Grazing, which has been a traditional land use throughout much of the plateau, has resulted in shifts in vegetation composition (Harris et al. 2003) and ecological states (Miller 2005). Increasing recreational use and unauthorized social trailing threatens the integrity of upland systems through soil disturbance and resulting increases in soil erosion by water and wind. Global climate change is expected to change levels and seasonality of dominant precipitation events, with unknown implications for plateau systems.

The Northern Colorado Plateau Network (NCPN), as part of the National Park Service's Inventory and Monitoring Program, has identified plant communities, hydrologic function, soil stability, biological soil crust (BSC), and nutrient cycling as important components to understanding the health of upland systems (O'Dell et al. 2005). The indicators that apply to these components are listed below.

- *Plant communities*: species and functional group composition and diversity, and vegetation structure
- *Hydrologic function*: basal-gap size, cover and development of BSC, and infiltration rate
- *Soil stability*: cover of vegetation, litter, and BSC, and soil aggregate stability
- *Biological soil crust*: BSC cover
- *Nutrient cycling* is not currently measured

The goals of NCPN upland monitoring are to increase fundamental understanding of upland systems and provide managers with early warning of undesirable change. These goals will be accomplished partly through sampling design and data analysis. Evaluation of upland monitoring data relative to other vital signs will facilitate identification of drivers and distinguish “natural” from anthropogenic change. This effort will document the variability in upland systems while providing information needed for resource management decisions.

Specific objectives of the NCPN integrated upland monitoring protocol are:

- To determine annual status and trends in ground cover (live and standing dead vegetation, litter, rock, biological soil crust, and bare ground); vegetation by life form; soil aggregate stability; hydrologic function; and nutrient cycling;
- To determine annual status and trends in cover of biological soil crusts by morphological group; and
- To determine annual status and trends in cover of exotic plants in upland areas.



## 2 Methods

### 2.1 Integrated upland monitoring in Cedar Breaks National Monument

#### 2.1.1 Resource issues driving upland monitoring

Discussion with Cedar Breaks NM staff identified high-elevation meadows, spruce-fir forests, and aspen stands as the highest priority for long-term monitoring. Management issues of concern included expansion and contraction of vegetation types, recovery of spruce-fir forests from beetle kill, sudden aspen decline (SAD), and the spread of smooth-brome invasion. Currently, the area above the rim in Cedar Breaks NM is dominated by a mixture of meadows and spruce-fir forest (Figure 2-1). Although there are large patches of forest in many areas, there are also islands and fingers of forest interspersed throughout the meadows. How climate change will favor certain community types and reposition their distribution across the landscape is of interest to resource managers. Spruce-fir forests, especially Engelmann spruce (*Picea engelmannii*) within the forests, have been heavily attacked by bark beetles, creating a high percentage of dead trees through-

out these forests. Tracking recovery of these forests is a high priority to managers due to the extent of the affected area. Although aspen stands make up a relatively small part of high-elevation vegetation in Cedar Breaks NM, they are of particular concern due to the threat of SAD. Smooth brome is an invasive exotic perennial grass that exists along roadsides and has expanded into other areas of the monument. Although Cedar Breaks NM actively treats some areas to remove this species, there is concern that it is displacing native grasses and forbs in the meadows.

#### 2.1.2 Mapping and selecting target populations

##### 2.1.2.1 Accessibility

An accessibility map was created for Cedar Breaks NM based on road and trail access. Steep slopes (>50%) and areas isolated due to steep slopes (e.g., mesa tops) were considered inaccessible for upland monitoring. Accessibility in Cedar Breaks NM was derived using the NCPN LAM system (Landscape Accessibility Model, <http://science.nature.nps.gov/im/units/ncpn/Tools.cfm>). A 25-m buffer was applied to roads, trails, the park boundary, non-target vegetation, and inaccessible areas.



Figure 2-1. Examples of dominant vegetation types, Cedar Breaks National Monument.

#### 2.1.2.2 Selection of target vegetation types

Defining the target population typically involves determining the ecological sites that correspond to the resource of interest. Dixie National Forest mapped soils for Cedar Breaks NM, but did not include associated ecological sites (USFS unpublished). Instead, broad categories of vegetation were associated with each soil map unit. Comparing the soil map to the draft NCPN vegetation map showed that the priority vegetation types were not well distinguished by soil map units. Therefore, ecological sites and soil map units were not incorporated into the survey design for Cedar Breaks NM.

#### 2.1.2.3 Mapping of target vegetation types

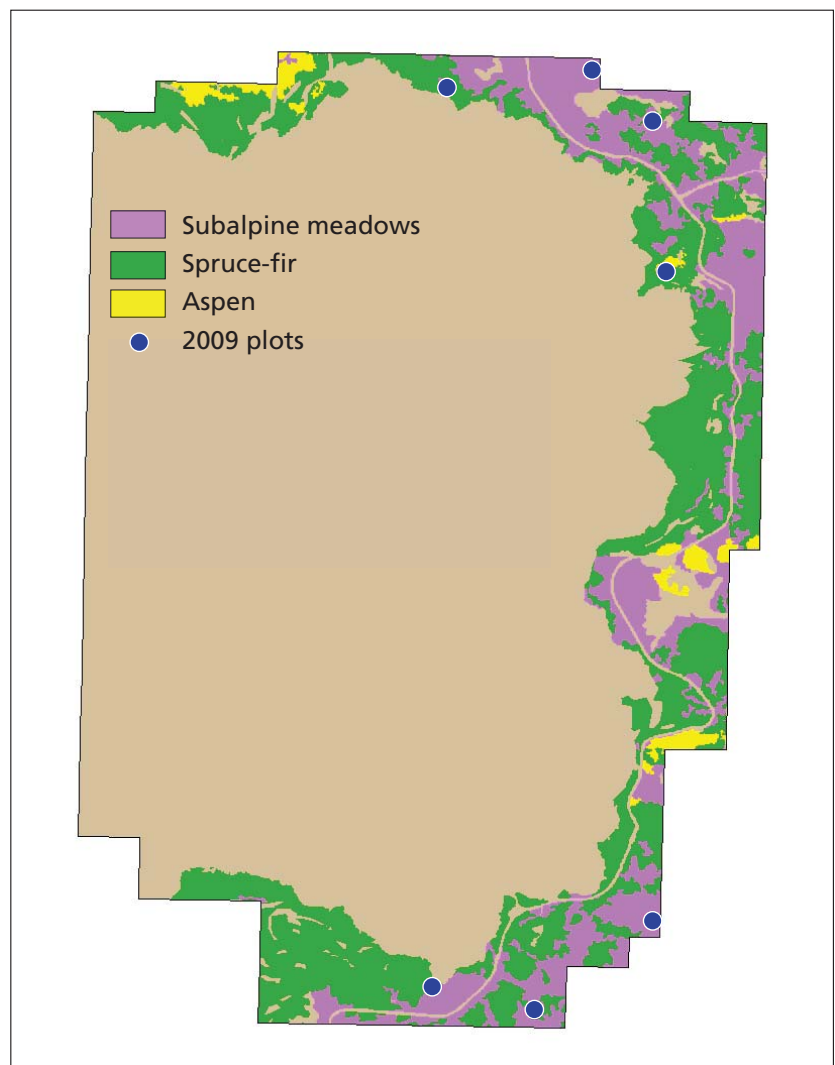
Due to issues with the soil survey and the relatively small area of the monument, we decided to use a simple mapping process for Cedar Breaks NM. Stratification of the sampling frame was

minimized, using the natural barrier of the breaks to distinguish high and low elevation. Within the accessible area of the monument, all target vegetation types (subalpine meadow, aspen, and spruce-fir) were included in the sampling frame using their associated vegetation map units (Figure 2-2). This represented 88% (or 548 ha) of the accessible area of the monument above the rim.

#### 2.1.3 Selection of monitoring locations

Using the entire map area, monitoring plots were selected using the Generalized Random Tessellated Stratified (GRTS) method (Stevens and Olsen 2004) to create a spatially balanced design. Coordinates corresponded to the centroid of a plot. To accommodate rejection, 56 sites were selected. Plots were established in ascending order of plot number. If a plot was rejected (e.g., due to transects' crossing a road or trail), the next sequentially ordered plot was used.

Figure 2-2. Location of monitoring plots in Cedar Breaks National Monument. Colors illustrate sampling frame above the rim, 2009.



Combining all target vegetation types in the sampling frame allowed plots to fall near the boundary of different vegetation types so that expansion and contraction of communities can be monitored.

#### 2.1.4 Revisit design

A rotating-panel revisit design (Figure 2-3) was created that samples eight plots each year and a total of 28 plots over seven years. Plots are sampled in two consecutive years (in order to detect year-to-year differences due to temperature, precipitation, etc.) and then rested for five years. The sampling scheme repeats itself every seven years. The number of plots in each vegetation type should approximately represent the area of each vegetation type in the sampling frame.

| Panel | Year |   |   |   |   |   |   |
|-------|------|---|---|---|---|---|---|
|       | 1    | 2 | 3 | 4 | 5 | 6 | 7 |
| 1     | 4    | 4 |   |   |   |   |   |
| 2     |      | 4 | 4 |   |   |   |   |
| 3     |      |   | 4 | 4 |   |   |   |
| 4     |      |   |   | 4 | 4 |   |   |
| 5     |      |   |   |   | 4 | 4 |   |
| 6     |      |   |   |   |   | 4 | 4 |
| 7     | 4    |   |   |   |   |   | 4 |

Figure 2-3. Number of plots sampled each year based on 7-year rotating panel revisit design for long-term upland monitoring at Cedar Breaks National Monument.

## 2.2 Integrated upland monitoring procedures

### 2.2.1 Response design

The response design (methods used to collect observations) for integrated upland monitoring in NCPN parks is based largely on rangeland assessment procedures (Herrick et al. 2004) and standard forest, woodland, and fuels procedures (NPS 2003; Brown 1974), with modifications by Miller et al. (2007).

At each plot, observations were recorded along three parallel, 50-m transects spaced 25 m apart (Figure 2-4). A point-intercept method was used to record percent cover of understory (<2 m) and ground-cover attributes at 0.5-m intervals along each transect (Table 2-1). All species and the number of shrubs (by species and height class) and exotic perennials (by species) were recorded in a 1-m belt upslope of each transect. Saplings were identified to species, and density was tallied in a 5-m belt transect centered on Transect 2. Within Quadrant 1, species and dbh (diameter at breast height) were recorded for all mature trees. Overstory cover was recorded along each transect using a concave spherical densiometer. Fuels were measured using Brown's planar method (Brown 1974) along four 15-m transects that extend beyond the plot on two corners. All measures recorded along transects were sub-samples scaled to the plot level. The plot-level measures were the primary values used in summaries and statistical analyses. Disturbances observed on and around the site were also recorded.

## 2.3 Database

All observations recorded in the field are stored in an Access database maintained by the NCPN. Quality assurance and quality control (QA/QC) procedures include domain checking in data-entry procedures, checks for missing values, and logic checks. All spatial data used in selecting monitoring locations, the sampling frame map, and the GRTS-generated sampling locations are GIS-ArcMap shape files and are stored with the Access database on NCPN servers.

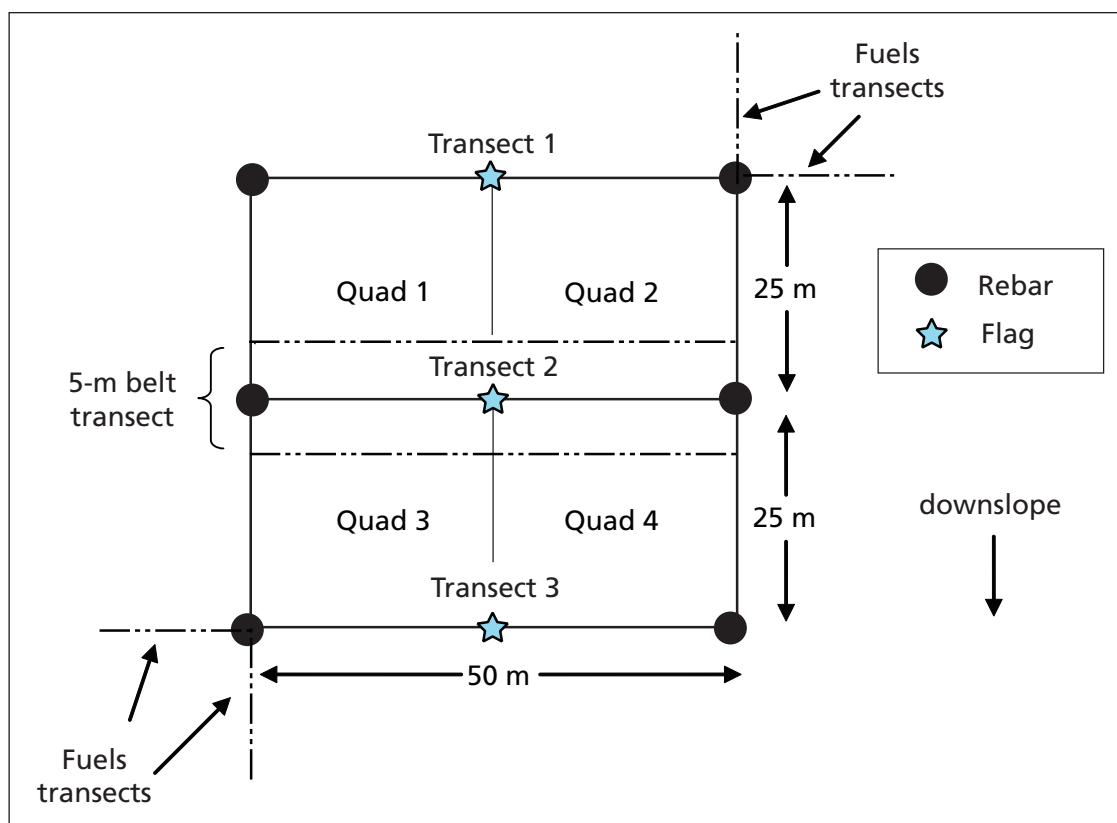


Figure 2-4. Plot layout for upland monitoring of forests and subalpine meadows.

Table 2-1. Plot-level measures for forests and subalpine meadows.

| Measure                | Attribute/Context                                                                                                                                                | Sampling method/Spatial scale(s) of observation                                                                      |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Plant species richness | Number of species detected                                                                                                                                       | Point-intercept for understory, 1-m belt transects for all species, 5-m belt transect for saplings, ¼ plot for trees |
| Percent cover          | Life form (trees, shrubs, annual and perennial grasses, forbs/herbs)                                                                                             | Point-intercept along all three transects (150 m)                                                                    |
|                        | Individual plant species                                                                                                                                         | Point-intercept along all three transects (150 m)                                                                    |
|                        | Overstory canopy cover                                                                                                                                           | 15 point samples across plot                                                                                         |
|                        | Surface features (undifferentiated crust, cyanobacteria, lichen, moss, bare soil, litter, woody debris, small and large rock, bedrock)                           | Point-intercept along all three transects (150 m)                                                                    |
|                        | Disturbance features (livestock and wildlife scat, ant mound, wildlife excavation, tracks from wildlife, livestock, humans, bicycles, or motor vehicles, other). | Point-intercept along all three transects (150 m)                                                                    |
| Density                | Individual tree species and total tree density                                                                                                                   | Quadrant 1 for trees; one 5-m belt for saplings                                                                      |
|                        | Individual tree seedlings, shrubs, and exotic perennials by species; and total tree seedlings, shrubs, and exotic perennials combined by group                   | 1-m belt transects upslope of all 3 transects                                                                        |
| Fuel loading           | Woody fuel volumes; duff and litter depth                                                                                                                        | Four ~15-m transects                                                                                                 |

## 3 Results

### 3.1 Monitored plots

In August 2009, seven plots were established and monitored as part of the long-term revisit design. This was one fewer plot than anticipated, and all that the field crew could accomplish in allotted time. Appendix A lists physical attributes of individual plots visited in 2009.

### 3.2 Summaries

Status and trend assessments are more meaningful after many years of monitoring, and as the number of monitoring plots increases. More intensive evaluation of monitoring data is slated to commence after five full years of monitoring have been completed.

For this annual report, plot-level summaries of the measures listed in Table 2-1 were generated for each monitoring plot, then summarized for the entire area above the rim. Summaries are simply a mean and the range (minimum, maximum) for a measured attribute. For each plot, the percent cover of all species and additional species recorded in the 1-m belt is included in an electronic appendix that accompanies this report (cebr09\_species.xls).

Qualitative assessments of summary measures could be misleading, given the small sample sizes. The reader is cautioned not to draw wide-reaching conclusions from this initial set of results.

#### 3.2.1 Species richness

Eighty-one species were detected during monitoring. Species richness by life form is reported in Table 3-1 (tables begin on page 8). Recorded species were compared to the NPSpecies database to determine first-time observations in Cedar Breaks National Monument. One new species, umbrella starwort (*Stellaria umbellata*), was detected in the park in 2009. The species was collected, and a voucher was created for the park.

#### 3.2.2 Overstory cover and understory cover by life form and dominant species

Percent cover of overstory, and of live and total vegetation in the understory by life form, is shown in Table 3-2. Live cover includes photosynthetic and live woody tissue. Total cover additionally in-

cludes dead plants, dead parts of live plants, and senesced tissue that was alive earlier in the growing season.

Live and total percent cover of dominant understory species are shown in Table 3-3. Dominant species were selected using species frequently detected in plots.

#### 3.2.3 Shrub density

Density of shrub species is shown in Table 3-4. Shrubs were relatively uncommon, with the exception of alpine prickly currant (*Ribes montigenum*).

#### 3.2.4 Tree density

Density of live seedlings, saplings, and overstory trees is shown in Table 3-5. Density, dbh, crown class, and crown health for all overstory trees >15 cm dbh is shown in Table 3-6.

Crown health describes the percent of live foliage for each tree. Crown class describes the relative position of a tree in the canopy. The NCPN uses the following crown classes (Figure 3-1):

- **Dominant:** Crowns extend above the general level of the main canopy of adjacent trees. They receive full light from above and partial light from the sides.
- **Codominant:** Crowns form the general level of the main canopy of adjacent trees. They receive full light from above and comparatively little from the sides.

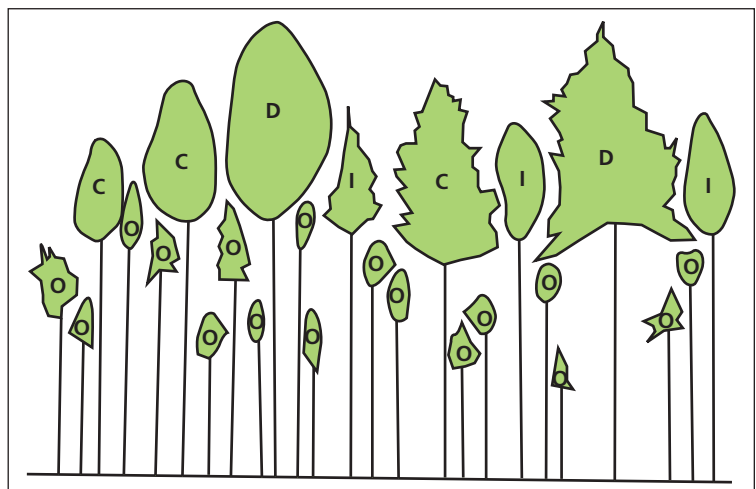


Figure 3-1. The relative positions of trees using four classes for crown classification. D=Dominant, C=Codominant, I=Intermediate, O=Overtopped.

- *Intermediate*: Crowns extend into the lower portion of the main canopy of adjacent trees, but are shorter in height than the codominants. They receive little direct light from above and none from the sides. Intermediate crown-classed trees usually have small crowns that are crowded on the sides.
- *Overtopped*: Crowns are entirely below the general level of the canopy of adjacent trees, and receive no direct light from above or from the sides.

### 3.2.5 Exotic species

Cover of exotic plant species is shown in Table 3-7. Four exotic species were detected in monitoring plots. Kentucky bluegrass (*Poa pratensis*) was detected at all plots, with cover as high as 12.0%. Common dandelion (*Taraxacum officinale*) was detected at approximately one-half of the plots. Although cover was low (<1%), the density was higher than that of any other exotic species. Smooth brome (*Bromus inermis*) and yellow sal-sify (*Tragopogon dubius*) were also detected at one plot, but the cover and density of these species were very low.

NCPN upland sampling methods are not intended as an early detection survey; therefore, lack of detection does not mean that other exotic species were not present in plots.

### 3.2.6 Threatened and endangered species

Although Cedar Breaks NM does not have any populations of federally listed threatened or endangered plant species within its borders, at least 18 species of special concern exist within the monument. Two of these species, Cedar Breaks wild buckwheat (*Eriogonum panguicense*) and least lomatium (*Lomatium minimum*) were each detected in one monitoring plot in 2009.

### 3.2.7 Surface features

Surface-feature cover is shown in Table 3-8. Litter was the dominant surface cover at all plots.

### 3.2.8 Fuels

Fuel volumes and depth of litter and duff are reported in Table 3-9. Fuels ranged from nothing in meadow plots to substantial amounts of fuels in forest plots with significant tree mortality.

**Table 3-1. Mean (range) number of plant species detected per monitoring plot, Cedar Breaks NM, 2009.**

| Total           | Tree         | Shrubs       | Perennial grasses | Annual grasses | Forbs/Herbs     |
|-----------------|--------------|--------------|-------------------|----------------|-----------------|
| 34.3<br>(25–45) | 1.9<br>(0–3) | 1.0<br>(0–2) | 7.4<br>(5–9)      | 0              | 24.0<br>(20–32) |

**Table 3-2. Mean (range) percent cover of overstory, and understory vegetation by life form, Cedar Breaks NM, 2009.**

| Overstory        | Tree            |                 | Shrubs          |                 | Perennial grasses  |                     | Annual grasses |       | Forbs/Herbs         |                     |
|------------------|-----------------|-----------------|-----------------|-----------------|--------------------|---------------------|----------------|-------|---------------------|---------------------|
|                  | Live            | Total           | Live            | Total           | Live               | Total               | Live           | Total | Live                | Total               |
| 11.2<br>(0–36.0) | 5.2<br>(0–18.7) | 5.7<br>(0–19.7) | 6.5<br>(0–16.3) | 6.9<br>(0–17.3) | 14.2<br>(8.0–24.3) | 21.9<br>(10.7–47.7) | 0              | 0     | 46.2<br>(25.0–77.0) | 48.6<br>(29.3–78.3) |

**Table 3-3. Mean (range) percent cover of dominant understory species, Cedar Breaks NM, 2009.**

| Scientific name              | Common name              | Life form | Duration  | Nativity   | No. of plots with species present | Percent cover    |                   |
|------------------------------|--------------------------|-----------|-----------|------------|-----------------------------------|------------------|-------------------|
|                              |                          |           |           |            |                                   | Live             | Total             |
| <i>Abies lasiocarpa</i>      | subalpine fir            | Tree      | Perennial | Native     | 5                                 | 3.3<br>(0–14.7)  | 3.4<br>(0–15.0)   |
| <i>Achillea millefolium</i>  | common yarrow            | Forb      | Perennial | Native     | 7                                 | 4.0<br>(1.3–6.0) | 4.5<br>(1.3–6.7)  |
| <i>Agoseris glauca</i>       | pale agoseris            | Forb      | Perennial | Native     | 5                                 | 0.7<br>(0–2.3)   | 0.8<br>(0–2.3)    |
| <i>Bromus ciliatus</i>       | fringed brome            | Graminoid | Perennial | Native     | 5                                 | 1.7<br>(0–5.0)   | 1.9<br>(0–5.0)    |
| <i>Delphinium barbeyi</i>    | subalpine larkspur       | Forb      | Perennial | Native     | 5                                 | 3.4<br>(0–16.7)  | 3.6<br>(0–17.7)   |
| <i>Elymus trachycaulus</i>   | slender wheatgrass       | Graminoid | Perennial | Native     | 7                                 | 2.7<br>(0.3–5.7) | 4.0<br>(0.3–8.7)  |
| <i>Erigeron ursinus</i>      | bear daisy               | Forb      | Perennial | Native     | 6                                 | 1.7<br>(0–3.7)   | 1.9<br>(0–3.7)    |
| <i>Mertensia arizonica</i>   | Aspen bluebell           | Forb      | Perennial | Native     | 6                                 | 17.0<br>(0–46.0) | 17.6<br>(0–46.7)  |
| <i>Osmorhiza depauperata</i> | blunt sweet-cicely       | Forb      | Perennial | Native     | 5                                 | 0.7<br>(0–2.0)   | 0.7<br>(0–2.0)    |
| <i>Picea engelmannii</i>     | Engelmann spruce         | Tree      | Perennial | Native     | 5                                 | 1.7<br>(0–4.0)   | 2.0<br>(0–4.7)    |
| <i>Poa fendleriana</i>       | muttongrass              | Graminoid | Perennial | Native     | 5                                 | 1.4<br>(0–3.7)   | 2.0<br>(0–5.7)    |
| <i>Poa pratensis</i>         | Kentucky bluegrass       | Graminoid | Perennial | Non-native | 7                                 | 3.4<br>(0–6.7)   | 6.0<br>(0.3–12.0) |
| <i>Populus tremuloides</i>   | quaking aspen            | Tree      | Perennial | Native     | 1                                 | 0.2<br>(0–1.7)   | 0.3<br>(0–2.0)    |
| <i>Ribes montigenum</i>      | alpine prickly currant   | Shrub     | Perennial | Native     | 6                                 | 6.4<br>(0–16.3)  | 6.9<br>(0–17.3)   |
| <i>Solidago multiradiata</i> | Rocky Mountain goldenrod | Forb      | Perennial | Native     | 6                                 | 4.3<br>(0–16.7)  | 4.6<br>(0–17.0)   |
| <i>Stipa lettermanii</i>     | Letterman's needlegrass  | Graminoid | Perennial | Native     | 7                                 | 4.7<br>(0–13.3)  | 7.6<br>(0.3–27.0) |
| <i>Thalictrum fendleri</i>   | Fendler's meadow-rue     | Forb      | Perennial | Native     | 5                                 | 3.8<br>(0–9.3)   | 3.9<br>(0–9.3)    |
| <i>Trifolium longipes</i>    | longstalk clover         | Forb      | Perennial | Native     | 6                                 | 1.4<br>(0–2.7)   | 1.5<br>(0–2.7)    |

**Table 3-4. Density of shrub species, Cedar Breaks NM, 2009.**

| Scientific name          | Common name            | No. of plots with species present | Density (number of shrubs/ha) |         |         |
|--------------------------|------------------------|-----------------------------------|-------------------------------|---------|---------|
|                          |                        |                                   | Mean                          | Minimum | Maximum |
| <i>Ribes montigenum</i>  | alpine prickly currant | 6                                 | 562                           | 0       | 2,200   |
| <i>Sambucus racemosa</i> | red elderberry         | 1                                 | 10                            | 0       | 67      |

**Table 3-5. Mean (range) density of live seedlings, saplings, and overstory trees, Cedar Breaks NM, 2009.**

| Scientific name            | Common name      | No. of plots with species detected | Density of trees by dbh class (no. of trees/ha) |               |               |              |               |
|----------------------------|------------------|------------------------------------|-------------------------------------------------|---------------|---------------|--------------|---------------|
|                            |                  |                                    | Seedling                                        | Sapling       |               |              | Tree          |
|                            |                  |                                    | <2.5 cm                                         | 2.5–5.0 cm    | 5.1–10.0 cm   | 10.1–15.0 cm | >15 cm        |
| <i>Abies lasiocarpa</i>    | subalpine fir    | 6                                  | 962<br>(0–4,067)                                | 40<br>(0–280) | 46<br>(0–320) | 17<br>(0–80) | 78<br>(0–288) |
| <i>Picea engelmannii</i>   | Engelmann spruce | 5                                  | 86<br>(0–400)                                   | 34<br>(0–160) | 17<br>(0–80)  | 17<br>(0–80) | 27<br>(0–80)  |
| <i>Populus tremuloides</i> | quaking aspen    | 1                                  | 819<br>(0–5,733)                                | 0             | 0             | 0            | 14<br>(0–96)  |

**Table 3-6. Mean (range) density, diameter at breast height (dbh), crown class, and crown health for all trees >15 cm dbh, Cedar Breaks NM, 2009.**

| Scientific name            | Common name      | Density<br>(no. of trees/ha) | dbh (cm)      | Crown class   |              |              |             | Crown health  |             |             |             |               |
|----------------------------|------------------|------------------------------|---------------|---------------|--------------|--------------|-------------|---------------|-------------|-------------|-------------|---------------|
|                            |                  |                              |               | %D            | %C           | %I           | %O          | 1             | 2           | 3           | 4           | 5             |
| <i>Abies lasiocarpa</i>    | subalpine fir    | 130<br>(0–640)               | 33<br>(22–54) | 15<br>(0–100) | 20<br>(0–67) | 8<br>(0–38)  | 6<br>(0–33) | 34<br>(0–100) | 8<br>(0–33) | 3<br>(0–23) | 3<br>(0–15) | 9<br>(0–55)   |
| <i>Picea engelmannii</i>   | Engelmann spruce | 82<br>(0–160)                | 34<br>(23–46) | 0<br>(0–20)   | 4<br>(0–20)  | 16<br>(0–60) | 4<br>(0–20) | 19<br>(0–80)  | 4<br>(0–20) | 0<br>(0–10) | 1<br>(0–10) | 47<br>(0–100) |
| <i>Populus tremuloides</i> | quaking aspen    | 16<br>(0–112)                | 38            | 14            | 57           | 14           | 0           | 71            | 14          | 0           | 0           | 14            |

Crown class codes: D=Dominant, C=Codominant, I=Intermediate, O=Overtopped.

Crown health codes: 1=90–100% live foliage, 2=50–89% live foliage, 3=16–49% live foliage, 4=0.1–15% live foliage, 5=standing dead. Because there was only one aspen plot, no range is shown for that type.

**Table 3-7. Mean (range) cover and density of exotic plant species detected in Cedar Breaks NM, 2009.**

| Scientific name             | Common name        | Life form | Duration  | No. of plots with<br>exotic species<br>detected | Percent cover  |                   | Density (number<br>of exotic<br>perennials/ha) |
|-----------------------------|--------------------|-----------|-----------|-------------------------------------------------|----------------|-------------------|------------------------------------------------|
|                             |                    |           |           |                                                 | Live           | Total             |                                                |
| <i>Bromus inermis</i>       | smooth brome       | Graminoid | Perennial | 1                                               | 0<br>(0–0.7)   | 0.1<br>(0–0.7)    | 0                                              |
| <i>Poa pratensis</i>        | Kentucky bluegrass | Graminoid | Perennial | 7                                               | 3.4<br>(0–6.7) | 6.0<br>(0.3–12.0) | 476<br>(133–1,267)                             |
| <i>Taraxacum officinale</i> | common dandelion   | Forb      | Perennial | 3                                               | 0.7<br>(0–2.3) | 0.8<br>(0–2.7)    | 3,229<br>(133–14,600)                          |
| <i>Tragopogon dubius</i>    | yellow salsify     | Forb      | Biennial  | 1                                               | 0              | 0                 | 0.7<br>(17–67)                                 |

**Table 3-8. Mean (range) percent cover of surface features, Cedar Breaks NM, 2009.**

| Crust,<br>undifferentiated | Cyanobacteria | Lichen | Moss | Bare soil      | Litter              | Woody debris   | Small rock      | Large rock | Bedrock |
|----------------------------|---------------|--------|------|----------------|---------------------|----------------|-----------------|------------|---------|
| 6.6<br>(0–13.0)            | 0             | 0      | 0    | 3.3<br>(0–7.3) | 69.0<br>(49.7–86.3) | 2.7<br>(0–5.7) | 7.7<br>(0–23.7) | 0          | 0       |

**Table 3-9. Mean (range) fuel volume and depth of litter and duff, Cedar Breaks NM, 2009.**

| Total            | Fuel volume (tons/acre) |                |                |                 |                | Depth (cm)       |                |
|------------------|-------------------------|----------------|----------------|-----------------|----------------|------------------|----------------|
|                  | 1-hr                    | 10-hr          | 100-hr         | 1,000-hr        |                | Litter           | Duff           |
|                  |                         |                |                | Sound           | Rotten         |                  |                |
| 13.6<br>(0–44.1) | 0.1<br>(0–0.7)          | 0.7<br>(0–2.2) | 1.6<br>(0–5.9) | 8.9<br>(0–28.6) | 2.3<br>(0–9.2) | 2.1<br>(0.2–4.0) | 1.9<br>(0–4.0) |

## 4 Discussion

This was the first year of monitoring at Cedar Breaks NM. Early monitoring data, which describe status and conditions of sites inside the park, may be useful in understanding reference conditions of more intensively managed sites outside the park. All plots, whether subalpine meadow, spruce-fir forest, aspen forest, or any combination of the three, had high richness and cover of forbs. All plots except one had at least some trees present. Aspen was only detected at one plot, which had overstory trees and a high density of seedlings, but no intermediate size classes. Engelmann spruce and subalpine fir (*Abies lasiocarpa*) were the dominant tree species, although bark beetles have significantly affected mortality of Engelmann spruce. Nearly 50% of overstory Engelmann spruce was standing dead trees, and a much lower density of seedlings was detected for this species compared to all other tree species. In a drought year, areas with higher fuels from tree mortality will have an increased risk of fire.

Four species of exotics were detected in Cedar Breaks NM, half of which were common. Kentucky bluegrass was detected at all plots, and common dandelion was detected at approximately half of the plots. Smooth brome, a species the monument is interested in controlling, was only detected at one monitoring plot in the northern part of the park.

After the first day of scouting potential monitoring plots, we discovered that the 25-m buffer used on the sampling frame was not large enough, and over one-third of points were rejected because they were too close to a road, trail, cliff, or monument boundary. We soon realized that we would need to select additional monitoring plots in order to accommodate the full seven years of the revisit design. The seven plots established in 2009 will remain in the sampling design, and a new GRTS run will be used to generate additional plots for years 2–7. The revisit design may be modified based on the actual affordable sampling effort; for instance, the number of plots sampled each year may be reduced to seven.

In 2010, we plan to monitor eight plots according to the full operational monitoring design. One-half of the plots visited in 2009 will be revisited, and the remaining plots will be established. Further discussion will occur with park resource staff to ensure that park expectations and needs are satisfied by NCPN integrated upland monitoring. A status and trend report will be produced after five full years of monitoring have been completed.



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# Appendix A. Supplemental Information

Table A. Physical attributes of upland monitoring plots, Cedar Breaks NM, 2009.

| Plot ID | Elevation (m) | Percent slope | Azimuth (degrees) |
|---------|---------------|---------------|-------------------|
| 11      | 3,165         | 12            | 354               |
| 16      | 3,171         | 17            | 141               |
| 22      | 3,152         | 9             | 116               |
| 23      | 3,194         | 5             | 312               |
| 26      | 3,111         | 8             | 331               |
| 27      | 3,181         | 7             | 268               |
| 30      | 3,098         | 6             | 100               |



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