



Vegetation Composition, Structure, and Soils Monitoring

Grasslands, shrublands, and forests are integral components of the natural and cultural landscapes of parks within the Rocky Mountain Network (ROMN). Because they can be impacted by rapid climate change, human land use, and impacts from exotic species, we monitor them closely to detect change. We communicate what we learn to inform management decisions. For example, the encroachment of annual invasive species into an intact perennial grassland can alter historic fire regimes, increase erosion potential, and affect wildlife habitat. If detected in time, park management can reduce or eliminate threats by treating the invasive plants and avoid the costly consequences of their impacts.

The ROMN vegetation composition, structure, and soils (VCSS) monitoring protocol is designed to monitor the condition of upland ecosystems park-wide at Grant-Kohrs Ranch National Historic Site (NHS), Little Bighorn Battlefield National Monument (NM), and Florissant Fossil Beds NM (Figure 1). Our objectives are to determine the status and trend of several key components of upland ecosystem integrity including plant species composition, abundance of exotic plants, soil stability, extent of bare ground and erosion, and inherent soil properties like physical texture and soil chemistry. Following a rotating panel design, ten plots in each park are monitored every year and revisited at least every five years. At each visit, the following measures are collected to characterize the ecosystem and serve as indicators of its overall health:

- site photos
- plant species present along three 36 m transect lines
- percent cover of plant species, bare soil, vegetation, litter, and other characteristics in ten 1 m² plots
- soil stability, hydrologic functioning, and biological integrity
- human and natural disturbance
- count of tree species by age group, including their diameter and general health

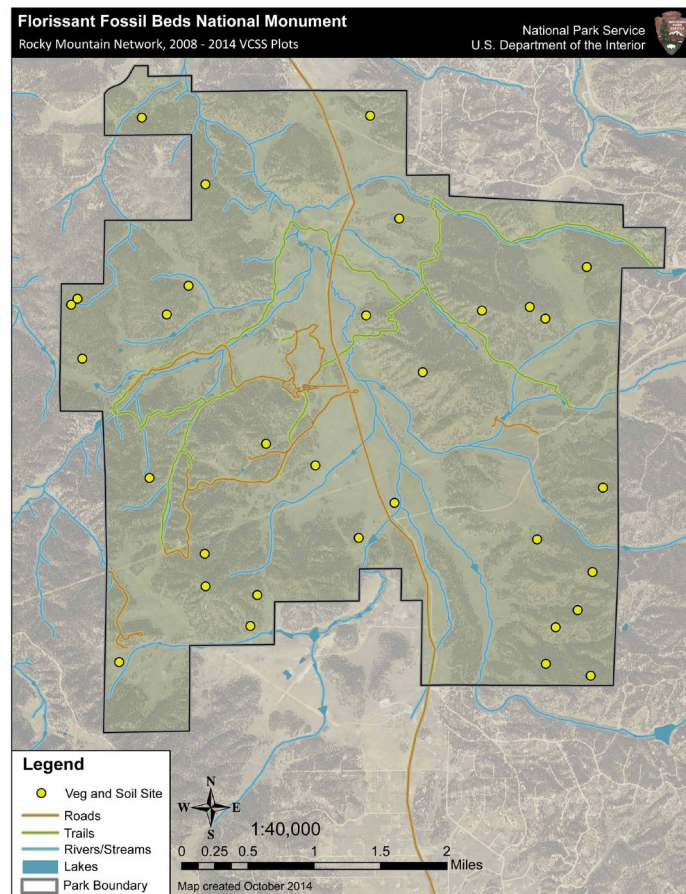
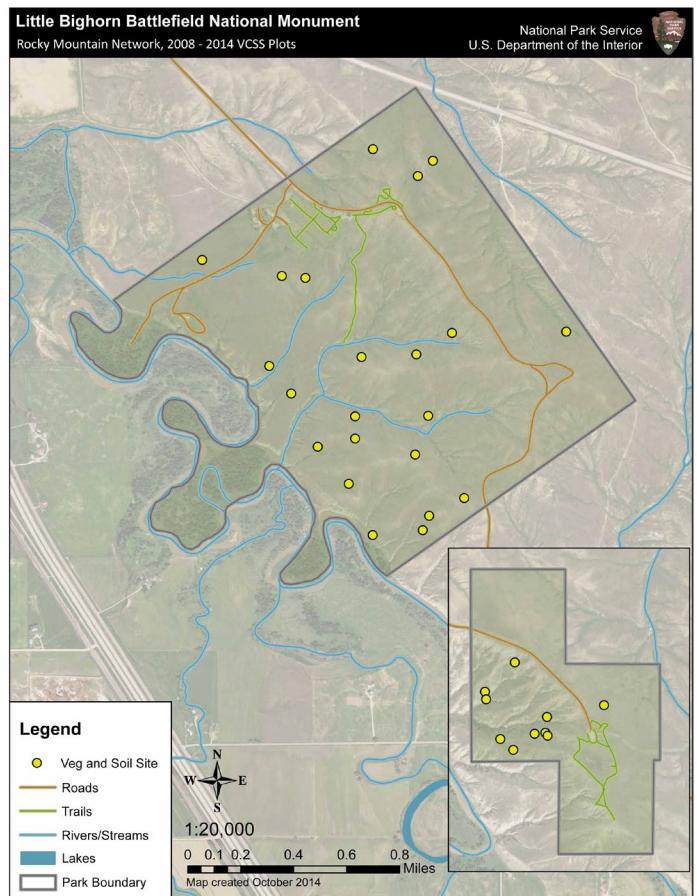
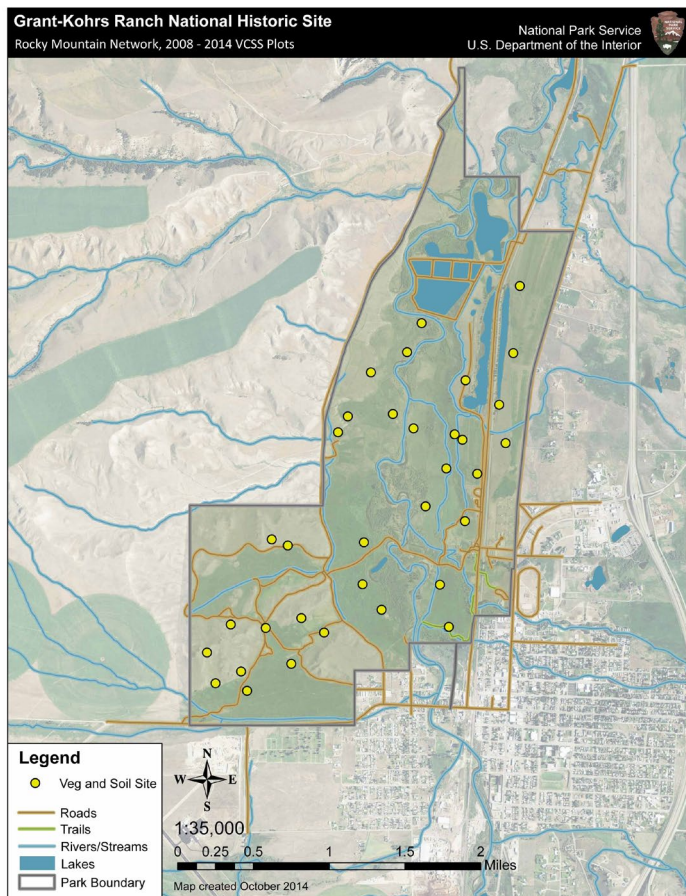
Select Results

The ROMN has a VCSS dataset of at least five years that begins to tell a story about the vegetation composition and soils at each park. We briefly summarize a few interesting



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Monitoring vegetation and soils at Florissant Fossil Beds NM.



results we have seen in these data. Native species richness, or the number of different native species in a community, is a simple measure of plant diversity and can be a useful indicator of ecosystem health. In Florissant Fossil Beds NM, there was a higher percentage of native species richness than non-native in 2013 (Figure 2), suggesting a rich composition of native plants.

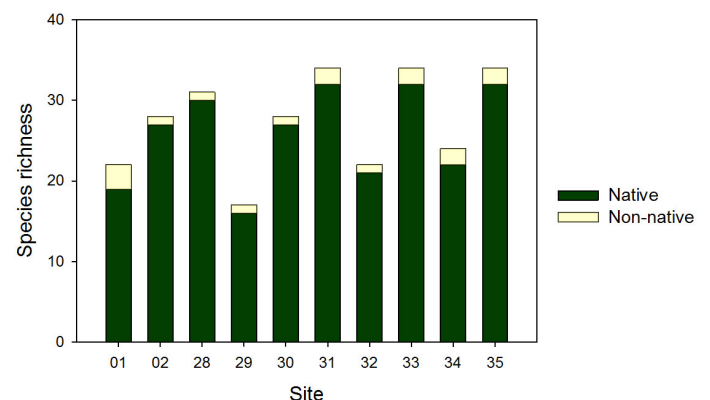


Figure 2. Species richness data for native species (green) and non-native plant species (yellow) at Florissant Fossil Beds NM sites in 2013 reveal a significantly higher percentage of native plant species.

Figure 1. Maps showing monitoring plot locations at Grant-Kohrs Ranch NHS (top, left), Little Bighorn Battlefield NM (top, right), and Florissant Fossil Beds NM (above).

At Little Bighorn Battlefield NM, there appears to have been an increase in percent relative cover of *Bromus tectorum* (cheatgrass) at site 32 between 2010 and 2014, though across all sites it did not increase during this time period (Figure 3).

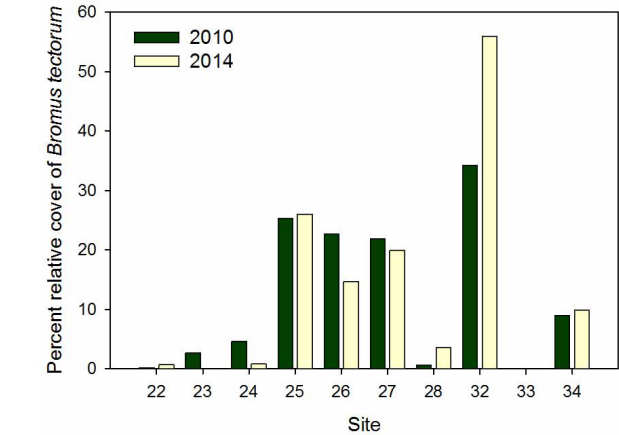


Figure 3. The percent relative cover of *Bromus tectorum* (cheatgrass) at Little Bighorn Battlefield NM sites in 2010 and 2014 shows a marked increase in relative cover at site 32, although the overall relative cover of cheatgrass averaged over all sites did not increase between years.

At Grant-Kohrs Ranch NHS, there was a positive relationship between relative cover of exotic species and human disturbance at sites measured from 2009 to 2013, where higher levels of anthropogenic disturbance were loosely correlated with higher cover of exotic species (Figure 4). The measure of human disturbance is a composite index that combines potential disturbances such as proximity to roads or buildings and the intensity of land use in and around the site.

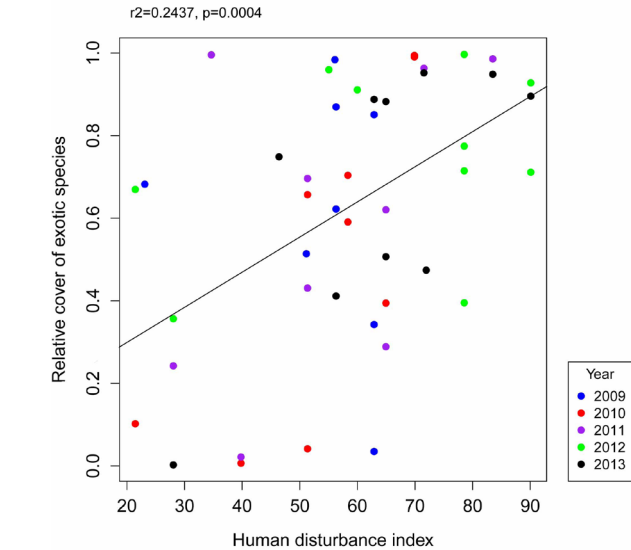


Figure 4. There is a positive relationship between relative cover of exotic species measured at sites in Grant-Kohrs Ranch NHS between 2009 and 2013 and the human disturbance index, where increasing disturbance is related to increasing relative cover of exotic plants. Points show the relative cover sum of all exotic species at each plot for each sample year from 2009 to 2013.

Finally, soil aggregate stability of the top 1 cm of soil, a measure of the ability of soil particles to bind together, increased at Florissant Fossil Beds NM sites between 2009 and 2014, but there was no significant change in sub-surface soil stability (Figure 5). Sites with lower soil stability indicate increasing susceptibility to erosion and loss of soil carbon, while increasing stability can signify soil compaction, affecting soil drainage and plant growth.

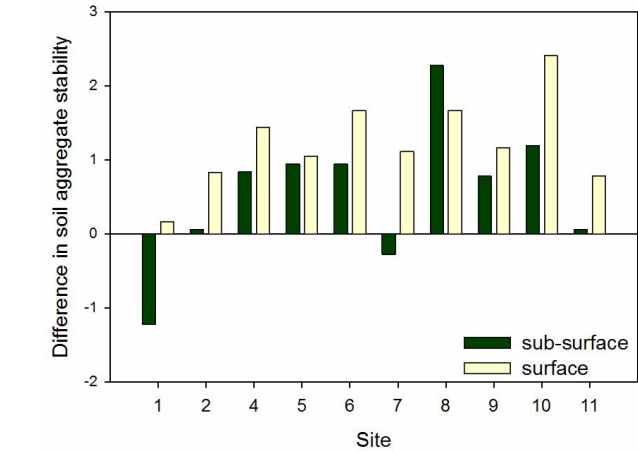


Figure 5. The difference in soil aggregate stability between 2009 and 2014 for sub-surface (green) and surface (yellow) samples at Florissant Fossil Beds NM shows an increase in surface soil stability and no significant change in sub-surface stability between years. Values above 0 indicate higher soil aggregate stability in 2014.



Monitoring plot at Grant-Kohrs Ranch NHS.

Assessment and Future Work

Monitoring vegetation composition and soils complements other efforts conducted by the ROMN, including wetland ecological integrity monitoring and monitoring of alpine vegetation and soils. VCSS monitoring will continue to inform park resource management understanding about the impact of a changing climate on the park's ecology, the response of vegetation and soil conditions to disturbance within and outside the park, and change in cover or abundance of invasive species.

As more data are collected over the next several years, we may recognize patterns and trends that could signal a shift away from healthy ecological conditions. In broad stroke, our approach is to compare results to established assessment points (see box) and evaluate responses based on these comparisons using NPS guidance, NPS resource management policies, ecological theory, and collaborative work with partners.

Assessment points can be developed in a variety of ways, ranging from complex statistical models to the stated desired condition of a park's resource management team. Selecting the most appropriate assessment points will be a team effort engaging park resource managers, ROMN ecologists, and other partners and is an important next step in applying long-term monitoring data as useful management tools.

References

Britten, M., E. W. Schweiger, B. Frakes, D. Manier, and D. Pillmore. 2007. Rocky Mountain Network vital signs monitoring plan. Natural Resource Report NPS/ROMN/NRR-2007/010. Fort Collins, Colorado.

Manier, D., D. Shorrock, E. W. Schweiger, I. Ashton, B. Frakes, M. Britten, D. Pillmore, and J. Burke. 2011. Rocky Mountain Network vegetation composition structure and soils monitoring protocol: Small park grasslands, shrublands, and woodlands; Version 1.0. Natural Resource Report NPS/ROMN/NRR—2011/383. National Park Service, Fort Collins, Colorado.

Assessment Points

- **Ecological thresholds** are points at which a small change in external factors causes a rapid or abrupt change in ecosystem condition. They are often difficult to estimate and are, in many cases, approximations.
- **Ecoregion thresholds** are boundaries within distributions of a response as measured at reference sites within a park or broader ecoregion. They may be arbitrary (a percentile) or derived from modeling that attempts to connect ecological or management meaning to the boundary.
- **Baseline assessment points** are summary statistics (a mean and its confidence interval) derived from a sufficient spatial or temporal data set for an indicator. They may estimate a natural range in variation if derived from sites or a time period that are in a reference state.
- **Management assessment points** represent a point(s) for a response defined by park management that triggers management action (including additional sampling or research). Management assessment points are often set to avoid undesirable ecosystem changes (e.g., ecological thresholds) and enable more proactive management responses. They can be estimated by modeling, but are often derived from informed professional judgment. Most other types of assessment points (e.g., baselines or criteria) may be adopted as management assessment points.



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