

Rocky Mountain Network

INFORMATION BRIEF

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



Long-term Monitoring of Wetland Ecological Integrity in Rocky Mountain National Park

Wetlands provide vital ecosystem services and habitat, and are some of the most sensitive to climate change. Wetland condition is closely connected to aquatic and upland systems through hydrologic gradients, wildlife use and movement, and overlapping cover and distribution of some plant species. We define three major components to wetlands: hydrology, soil, and flora, with hydrology the primary driver of both soil and vegetation response. Anthropogenic stressors that impact wetland condition include hydrologic alteration (ditching, dams, and other diversions), nutrient loading, erosion and sedimentation, and biological alteration such as increases in invasive plants or shifts in wetland usage by species such as beaver and elk.

The Rocky Mountain Network (ROMN) began long-term monitoring of wetland ecological integrity (WEI) in Rocky Mountain National Park (NP) in 2007. Between 2007 and 2013 the network established 154 permanent wetland monitoring sites in the park and conducted 362 full sample events at these locations (Figure 1). Most sites (96) were randomly selected and are visited every ten years, with a small number revisited several times during the survey. These data are used to statistically infer park-scale condition in three important wetland types and create various models and numeric reference conditions specific to the park. A smaller number of hand-picked “sentinel” sites (28) are sampled annually to better understand site-specific wetland dynamics, especially how hydrology, vegetation, and disturbances interact. Finally, 32 additional “gradient” sites that target wetlands in likely disturbed or pristine states are sampled during the surveys and episodically after to assist in modeling.

Crews conduct a complete vegetation characterization at each site, including species-level vascular and non-vascular cover, woody stem counts, and estimates of damage to woody stems (i.e., from ungulates and beaver) for key species such as willow and aspen. Hand measures of depth to groundwater are taken at all sites with each visit and a subset of the shallow groundwater wells at each site is fitted with loggers that collect continuous data on groundwater hydrology. Soil profiles are developed every ten years with complete soil chemistry taken every five or ten years. Finally, an extensive set of site and large-scale disturbance data are collected including anthropogenic and natural stressors that influence wetland condition. Crews are trained in all methods by the ROMN. Safety is a paramount concern as is compliance with conducting research in wilderness and other related concerns. WEI methods are documented in a protocol being published



NPS, BILLY SCHWEIGER

Crews collect data at a wetland near Haynach Lakes.

in 2014 and are largely derived from well-established and existing protocols developed by ROMN partners, including the Colorado Natural Heritage Program, U.S. Environmental Protection Agency, the U.S. Geological Survey, and relevant state agencies. The application of a standardized monitoring protocol across sites facilitates comparison of wetlands within a state or ecoregion.

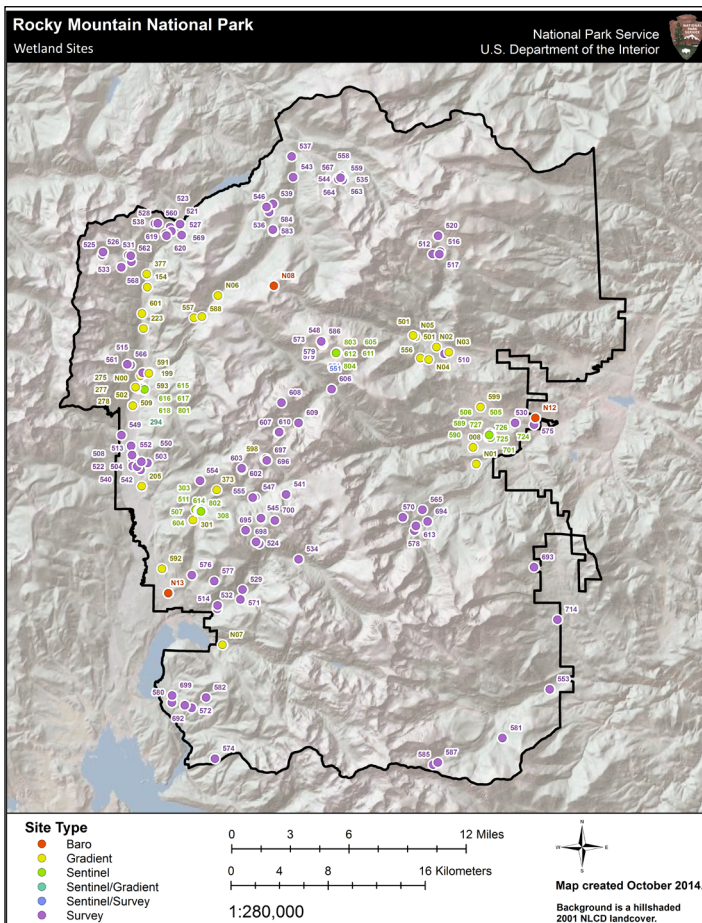


Figure 1. WEI monitoring sites in Rocky Mountain NP.

Monitoring Objectives

The goals for long-term ecological monitoring of wetlands in Rocky Mountain NP focus on documenting the status and trend in wetland condition (ecological integrity), understanding the causes of change in integrity, and assisting in the application of results to park resource management. Specifically, every ten years we determine the amount of wetland in the park using survey site extent data and park-scale map or imagery data. Annually at sentinel sites and every ten years park-wide, we determine condition of a suite of wetland indicators including vegetation composition, groundwater hydrology, soil chemistry, and anthropogenic and natural disturbances. Finally, we estimate annual change and long-term trend in the condition of these wetland indicators at sentinel sites and park-wide

Assessment

A key step in the reporting of WEI data in Rocky Mountain NP is interpreting the meaning behind a given result or set of results. Is a result suggestive of high quality or reference conditions, and why? Does a trend in a response suggest that condition is moving toward a non-reference state, and why? This understanding is a critical aspect of a mature long-term monitoring program and something the ROMN stresses. Generally, our approach is to compare WEI results to established or derived “assessment points” (see box)

Assessment Points

Assessment points occur along a continuum of condition states where scientists and park managers have agreed that assessment of the status or trend of a resource is warranted relative to program goals, natural variation, or potential concerns. Assessment points may take several forms:

- **Ecological thresholds** are boundaries at which a small change in external factors trigger a rapid or abrupt change in ecosystem condition. They are often difficult to estimate and in many cases are only 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 and attempt to connect ecological or management meaning to the boundary.
- **Criteria** are assessment points established for decisions that have an explicit connection to a regulatory policy. These are usually based on human health or environmental effects and generally represent the lower limits of the acceptable range in a condition gradient (or the boundary of non-reference). They are used by regulatory agencies to ensure that a resource does not become impaired.
- **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 the sites or time period they are derived from are in a reference state.
- **Management assessment points** represent a point (or several points) 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, criteria) may be adopted as management assessment points.

and evaluate responses based on these comparisons using Rocky Mountain NP resource management guidance, NPS Inventory & Monitoring Division guidance, NPS resource management policies, ecological theory, and collaborative work with ROMN partners.

Select Results

Ongoing analyses of Rocky Mountain NP WEI data has provided several interesting results, some of these are described below.

A suite of integrated, synthetic wetland vegetation multimetric models (MMI) provide synthetic estimates of wetland condition. Ongoing work is extending these models to determine causal links among ungulates, beaver, hydrology, and wetland response to provide management-relevant insight. The MMIs can be analyzed using properties of the survey design to characterize wetland condition park-wide. For example, results suggest that approximately 49% (or about 7,970 ha) of the wet meadow across the park was in reference condition in 2007-2009 (Figure 2). MMI output may be expressed at specific sites that spatially illustrate the difference between most front country and wilderness areas of the park. Using the large unbiased sample provided by the survey, we have also developed ecoregion thresholds and management assessment points using models that characterize aspects of wetland vegetation in the absence of human disturbance or statistical patterns in MMI in response to human disturbance.

An important component of WEI monitoring is understanding groundwater hydrology. Select sites are continuously monitored for groundwater height, often revealing important relationships with late summer precipitation events (Figure 3). Over time, these data should reveal any connection between climate dynamics and groundwater depths in Rocky Mountain NP's wetlands.

At sentinel sites we have generated the MMI and its component metrics to track potential changes over time. For each metric, assessment points were estimated as the lower 95% confidence bound of a linear fit model of that metric to a value of no human disturbance (the reference condition selected by park management.) At the alpine sentinel site (Figure 4) native wetland obligate species richness and a floristic quality index were above the park-specific reference threshold from 2007 to 2013. The overall MMI was generally in a reference state. At the Kaw Valley sentinel site from 2007 to 2013,

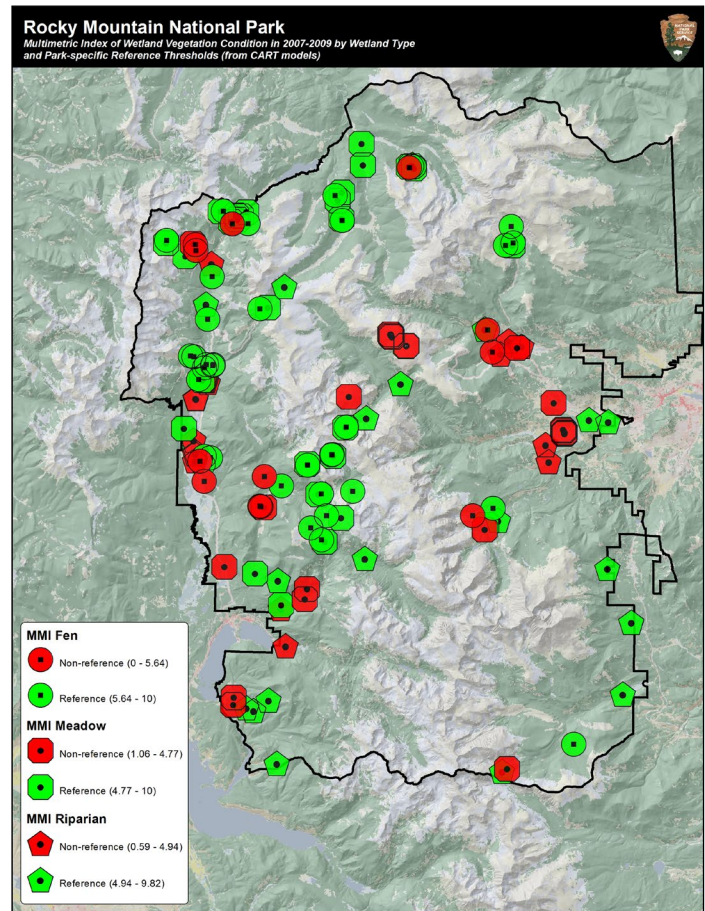


Figure 2. MMI at the site level, 2007-2009.

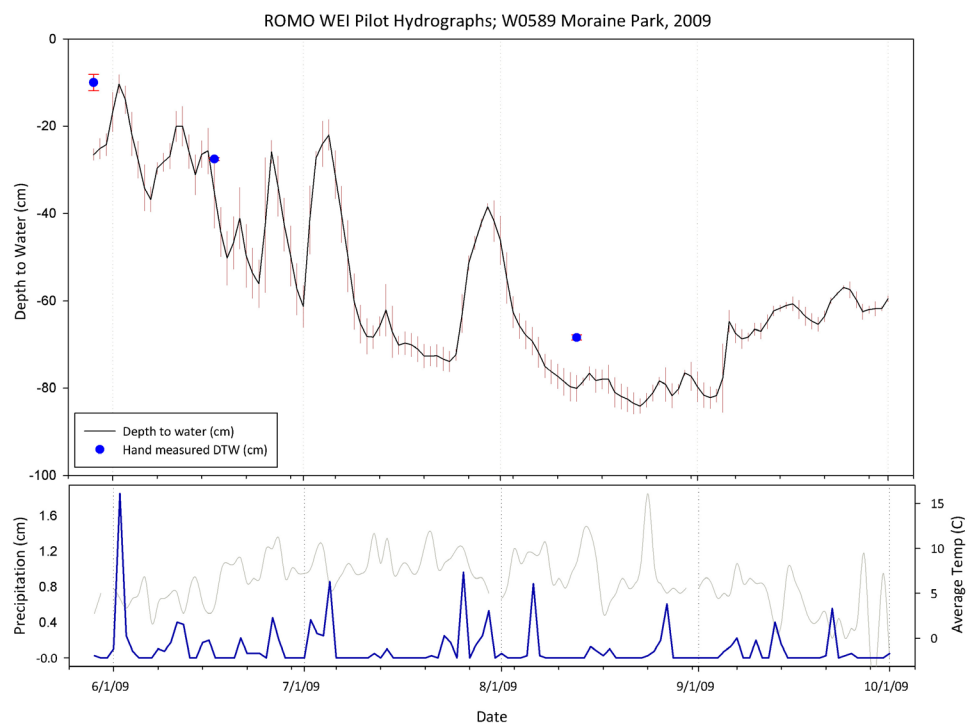


Figure 3. Groundwater depths in 2009 in Moraine Park.

ROMO Alpine Wetland Sentinel Site, 2007 - 2013; Select Component Metrics from MMI

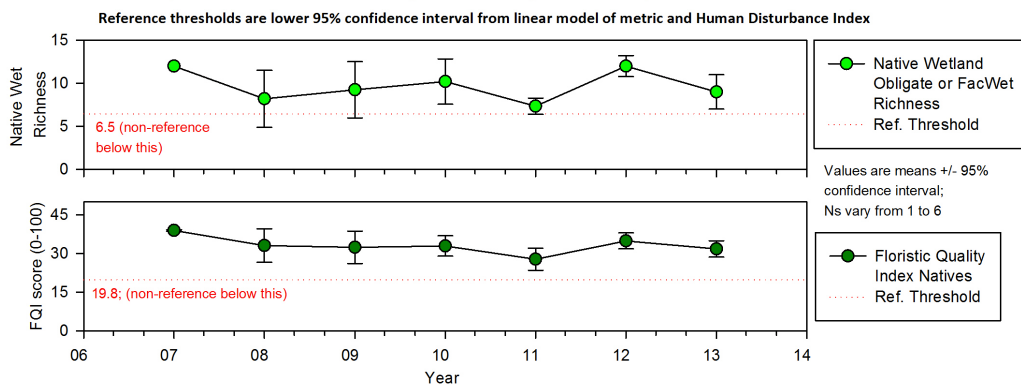


Figure 4. Select MMI component metrics at the alpine WEI sentinel site.

ROMO Kaw Valley Wetland Sentinel Site, 2007 - 2013; Select Component Metrics from MMI

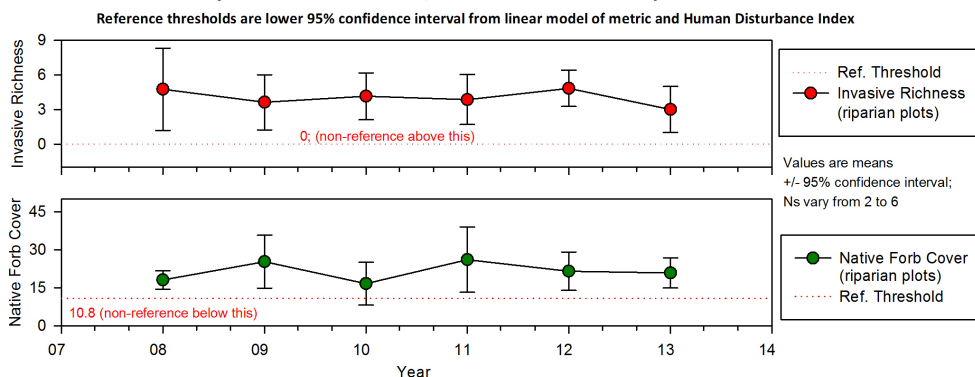


Figure 5. Select MMI component metrics at the Kaw Valley WEI sentinel site.

however, while native forb cover was above the park-specific reference threshold, invasive species richness was in a non-reference state (Figure 5). This consistently drove the overall MMI at these sites below the reference threshold.

Application and Future Work

WEI monitoring has generated useful data for the management and interpretation of important wetland habitat in Rocky Mountain NP. It is the first statistically rigorous sample of the park's wetlands and provides unbiased estimates of wetland condition across the park. Ongoing work will estimate long-term trend in condition at select sentinel wetlands, and when the survey is repeated, change and trend will be estimated for all the wetlands in the park. The WEI protocol includes an emphasis on developing park-specific reference conditions that can be used along with existing criteria to assess or interpret data.

WEI monitoring will continue to help park resource managers understand the dynamics between ungulates, beavers, hydrology, and woody stand composition; climate change-induced shifts in wetland hydrology; the biological response to stressors within and outside the park; and detection of invasive plants. This understanding can inform site-specific restoration by providing important context and tools for focused decisions and across large spatial and temporal scales (such as the Grand Ditch project or the parks response to the flooding of 2013). Monitoring of wetlands in Rocky Mountain NP complements other

efforts being done by the ROMN and our partners such as extensive stream monitoring and work at alpine sites focused on vegetation and climate response.

References

- Schweiger, E. W., L. O'Gan, M. Britten, and D. Shorrock. 2014. Rocky Mountain Network wetland ecological integrity monitoring protocol: Narrative, version 1.0. Natural Resource Report NPS/ROMN/NRR—2014/XXX. National Park Service, Fort Collins, Colorado.
- Schweiger, E. W., L. O'Gan, M. Britten, and D. Shorrock. 2014. Rocky Mountain Network wetland ecological integrity monitoring protocol: Standard operating procedures, version 1.0. Natural Resource Report NPS/ROMN/NRR—2014/XXX. National Park Service, Fort Collins, Colorado.

For more information, contact:

Mike Britten, Program Manager
970-267-2150, mike_britten@nps.gov

Billy Schweiger, Ecologist
970-267-2147, billy_schweiger@nps.gov

Rocky Mountain Network
1201 Oakridge Drive
Fort Collins, CO 80525