



Climate, Disturbance, and Wetland Condition at Florissant Fossil Beds National Monument, 2009–2019

Lush sedges, delicate mosses, and a rich variety of water-loving plants grow in the wetlands of Florissant Fossil Beds National Monument. But past and present disturbances, along with changing climate conditions, affect wetland condition in the park. As the climate warms and drought increases, park managers need information and tools to boost wetland resiliency and guide potential restoration.

To track wetland conditions and alert park managers to concerning changes, Rocky Mountain Inventory and Monitoring Network scientists have been monitoring climate, human disturbance, groundwater hydrology, soil and groundwater chemistry, and vegetation indicators in the park since 2009. This brief summarizes results of monitoring fens and wet meadows at 10 sites in 3 wetland complexes—Hornbek, Red Barn, and Barksdale—through 2019¹. Figure 1 summarizes the report’s findings. Figure 2 provides a site map.

Climate

Some of the most concerning stressors to Florissant’s wetlands are tied to climate, which is projected to become warmer, with variable precipitation. Climate change models predict increasing summer temperatures, decreasing snow fall, and earlier peak stream flows in the region, which will likely decrease water available for wetland plants. This climatic water deficit increases the likelihood of drought stress and is expected to reduce the number and overall area of wetlands in the park. Indeed, two drought cycles occurred during the study period in the region (2009–2013, 2017–2019). Our modeling of climate and groundwater data suggests that climate changes may decrease groundwater levels, which can have important impacts on wetland vegetation.

Disturbance

Human disturbance at multiple scales, from past and present activities—such as a century of historical cattle ranching—affects Florissant’s wetlands. At the landscape level, disturbance was quantified by examining land use (e.g., agriculture, urban development, and roads and trails). These kinds of disturbances were lower in the valley bottoms, where many wetlands occur, but increased if wetland sites were

Vital sign	Indicator	Status, trend, and confidence
Climate	Temperature and precipitation	
Climate	Water balance (deficit, runoff)	
Disturbance (landscape scale)	Landscape Disturbance Index (LDI)	
Disturbance (local scale)	Human Disturbance Index (HDI)	
Groundwater hydrology	Groundwater depth measured by hand once per year	
Groundwater hydrology	Groundwater depths measured continuously during the growing season at Hornbek	
Groundwater hydrology	Groundwater depths measured continuously during the growing season at Red Barn	
Groundwater hydrology	Groundwater depths measured continuously during the growing season at Barksdale	
Nativity (wetland condition)	Relative cover of native plant species	
Wetland affinity (wetland condition)	Relative cover of water-loving (hydrophytic) plant species	
Conservatism (wetland condition)	Floristic Quality Index	
Bioassessment (wetland condition)	Vegetation Index of Biotic Integrity	

Figure 1. Summary of indicators of wetland condition at Florissant Fossil Beds National Monument between 2009 and 2019. Color of the circle shows condition (green = reference/good condition, yellow = intermediate condition, red = non-reference). Arrow indicates direction of change in condition (upwards = improving, sideways = unchanging, downward = deteriorating, no arrow = unknown). Circle border line indicates our confidence in the assessment (heavy line = high, medium line = medium, dashed line = low).

near roads. At a smaller, local scale around wetland sites, disturbance scores account for hydrologic changes, such as water diversions and physical or chemical impacts, such as bank stability, algal blooms, turbidity, and heavy metal toxicity, which have an immediate effect on wetland plants. Most wetland sites had intermediate levels of local disturbance, with a decrease from 2009 to 2019. Overall, both landscape and local level human disturbance indicators showed an intermediate level of disturbance in and around the wetland monitoring sites.

Groundwater

Wetland plants need a steady and shallow groundwater supply to persist. In general, wetness measured once or twice at all sites each summer increased from 2009 to 2019, perhaps driven most by increases in fens. However, relative to assessment points from wetlands across Florissant's ecoregion, the park's wetlands were drier than ideal, and our assessment of overall hydrologic condition is thus "intermediate."

Automated loggers collect continuous and more detailed groundwater data at specific sites in each wetland complex. From this type of information, we can build statistical models of trends in groundwater and its relationship with climate. An interesting pattern emerged at the Hornbek complex, where restoration work to fill in incised channels was completed in October 2012. Water tables increased after restoration; however, 2011–2013 was also a drought. We lack monitoring data prior to 2011, so it is not clear if the stable and high water tables we saw at Hornbek beginning in 2014 were due to the 2012 restoration or due to the return of wetter, non-drought conditions. Either way, wetter conditions provided more water to plants during the growing season and likely enhanced wetland condition. Restoration did appear to increase the site's resilience to a second drought in 2017–2019.

Vegetation

A wetland's condition can be understood by the kinds of plants it supports. Plants that need consistently wet areas (hydrophytic plants) have higher wetland affinity. Plants that are more conservative require specific habitats, have a narrow range of environmental conditions, and do not tolerate disturbance. This is measured by the Floristic Quality Index. Native plant species tend to decrease with human disturbance, which opens the door to invasive nonnative plant species. Finally, multiple indicators can be synthesized into an overall index of condition—a Vegetation Index of Biotic Integrity. At Florissant, all four of these measurements showed relatively stable and healthy conditions in the park, except for native species cover, which was in intermediate condition. Some sites in the Hornbek complex had nearly 50% cover of invasive species immediately after restoration activities, bringing this score down, though invasive cover later decreased at this complex.

Interactions

Human disturbance, especially as it affected groundwater levels, had a negative effect on wetland health at Florissant. For example, wetland

plants were impacted in some sites by the density of nearby road-stream crossings and other human land uses. Tracking the connection between human disturbance and wetland condition is a core aspect of the network's long-term monitoring, and it has direct implications for resource management.

Management Applications

Continued monitoring of Florissant's valuable wetlands will help park managers better understand what drives wetland condition. Monitoring specifically reveals where nonnative plants occur. It reveals how and where human disturbance is impacting native species cover and groundwater levels. Knowing the condition of individual wetland sites can also prioritize and guide future restoration projects. Recent research suggests that impacts from climate change may be offset by reducing other stressors, such as raising groundwater levels through restoration. As a protected area, Florissant is well positioned to do this.

As climate change advances, so too are decision-making tools to address it. A new [Climate Projections dashboard](#) specific to Florissant Fossil Beds NM includes fire ignition projections and is available on [climateanalyzer.org](#). NPS scientists are applying [water balance modeling](#) to parks to help managers plan for climate change, and to potentially guide restoration timing and priorities. These models could be developed for wetland habitats at Florissant as well. [Vulnerability assessments](#) of key natural resources in parks are another valuable management tool for addressing climate change.

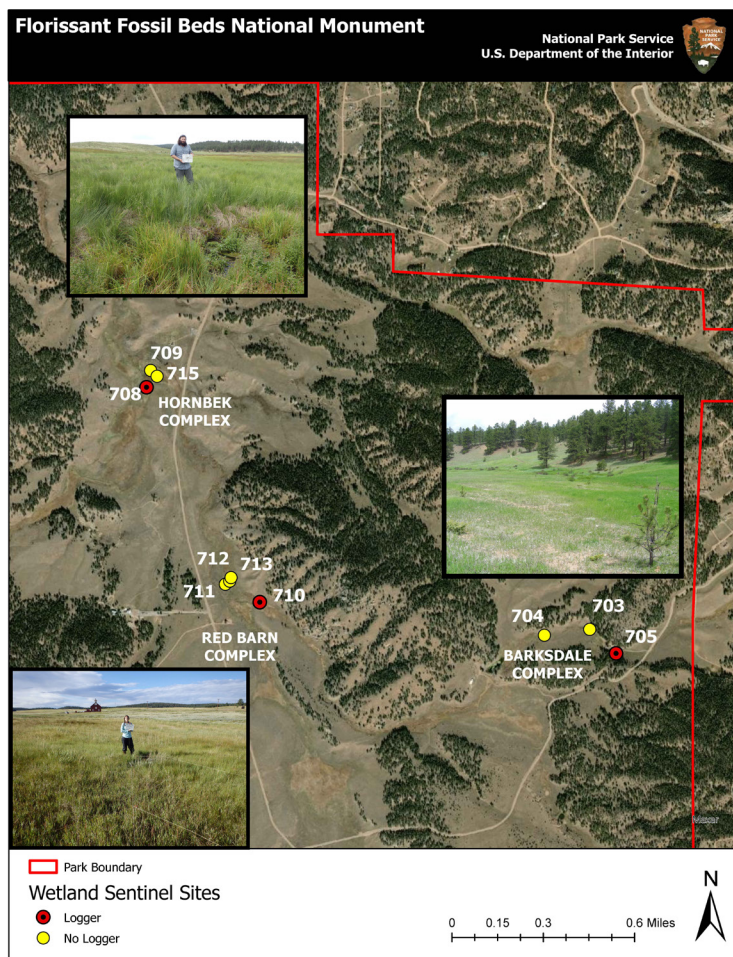


Figure 2. Hornbek wetland area (top left), Barksdale wetland area (right), and Red Barn wetland area (bottom left) in Florissant Fossil Beds National Monument, Colorado.

More Information

¹ 2009–2019 wetland synthesis report
(<https://irma.nps.gov/DataStore/Reference/Profile/2300778>)

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