

Rocky Mountain Network

INFORMATION BRIEF

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



Monitoring Alpine Wetland Ecological Integrity in Glacier National Park

The Rocky Mountain Network (ROMN) began piloting alpine wetland ecological integrity (AWEI) monitoring in 2012 to determine the feasibility of long-term work in high-elevation riparian wetlands in Glacier National Park (NP) and to develop a baseline dataset to better understand the relationships between climate-driven shifts in hydrology and alpine wetland condition.

Alpine riparian wetlands in the park are diverse, dynamic, and complex. They provide important ecosystem services including wildlife habitat, stream temperature moderation, and water quality protection. They are primarily structured by the amount and timing of groundwater and surface water (hydrologic regime), which in turn responds to climate drivers (Figure 1). Warming in the middle to high latitudes is occurring at two to three times the rate of the global average, and in mountainous regions like Glacier NP, recent data show increased magnitude and rate of warming with extensive loss of glaciers and snowpack. Loss of glaciers and snowpack may threaten alpine wetlands by impacting flood and debris flows that form and maintain these habitats. ROMN monitoring of alpine wetlands will help park resource managers understand threats to rare alpine species, wetland habitat, and water quality and availability.

Monitoring Objectives

The goals for long-term ecological monitoring of alpine wetlands in Glacier NP focus on documenting the status and trend in condition (ecological integrity), especially as driven by climate-mediated hydrologic changes. Specifically, annually at select sentinel sites and every ten years at all sites, we will determine the condition of a suite of wetland indicators including vegetation composition, channel geomorphology, and water physiochemistry and compare these across hydrologic contexts. We will estimate annual change and long-term trend and relate spatial or temporal patterns to important ecological and anthropogenic drivers, especially climate-driven shifts in hydrologic regime as mediated by changes in the prominence of glaciers in a basin, stream water temperature, and sediment and nutrient concentrations.



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The field crew prepares for backcountry, alpine wetland data collection.

Methods

Sites above 5,000 feet were selected based on accessibility and presence of a distinct hydrologic regime or water source. These included 17 sites on glacier-fed streams, 10 on permanent snowfield-fed streams, and 13 on spring- or groundwater-supported streams. Hydrologic regime was confirmed at each site by analyzing the silica content of surface or groundwater samples and through analysis of continuously logged water temperatures. Silica is a common tracer used to differentiate groundwater and snowmelt contributions to surface water. The three hydrologic contexts represent extant and future conditions in alpine areas near current or former glaciers. As glaciers melt, they transition to permanent snowfields, then to temporary snowfields, and then springs. Most AWEI sites experience rapid environmental and ecological changes

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.

<http://science.nature.nps.gov/im/units/romn/index.cfm>

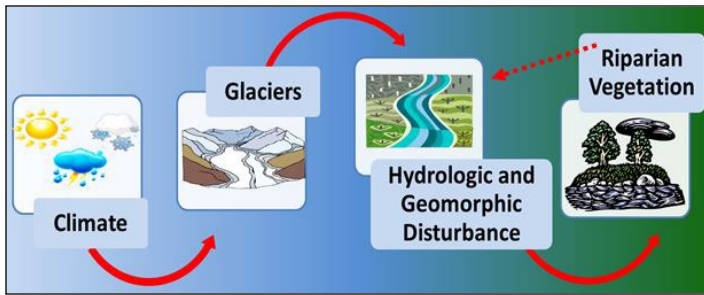


Figure 1. A conceptual model illustrating the interaction of climate, glaciers, disturbance, and riparian vegetation.

from glacial retreat and snowpack loss. These changes can impact abiotic factors such as stream morphology and the biological communities that are supported by water sources.

Sites are discretely marked with monuments and small water temperature loggers are installed at most locations. The following are measured at each site to inform models and data analysis:

- Plant species composition, abundance, frequency, and cover
- Fluvial landforms such as gravel bars, channel islands, and channel banks
- Hydrologic source (glacier, permanent snowfield, or spring)
- Proxies for hydrologic disturbance
- Presence/absence and of invasive plants
- Water chemistry and temperature

A typical AWEI survey requires a crew of at least three people and takes between two and five hours to complete. Survey crews are trained in all methods and particular attention is paid to crew safety with an emphasis in Glacier NP on backcountry travel in steep, rugged terrain and the presence of large carnivores. All monitoring efforts are in compliance with conducting research in wilderness and other related concerns.

Preliminary Results

Forty AWEI sites were sampled between 2012 and 2014 (Figure 2). Preliminary results show differences in the average abundance of important plant community metrics across hydrologic types. Forbs, graminoids, shrubs (non-willow), and willows were examined across stream type. Willows and forbs dominate vegetation cover along streams fed by glaciers, while spring-fed streams are mostly composed of forbs and have little willow cover (Figure 3). Willows are

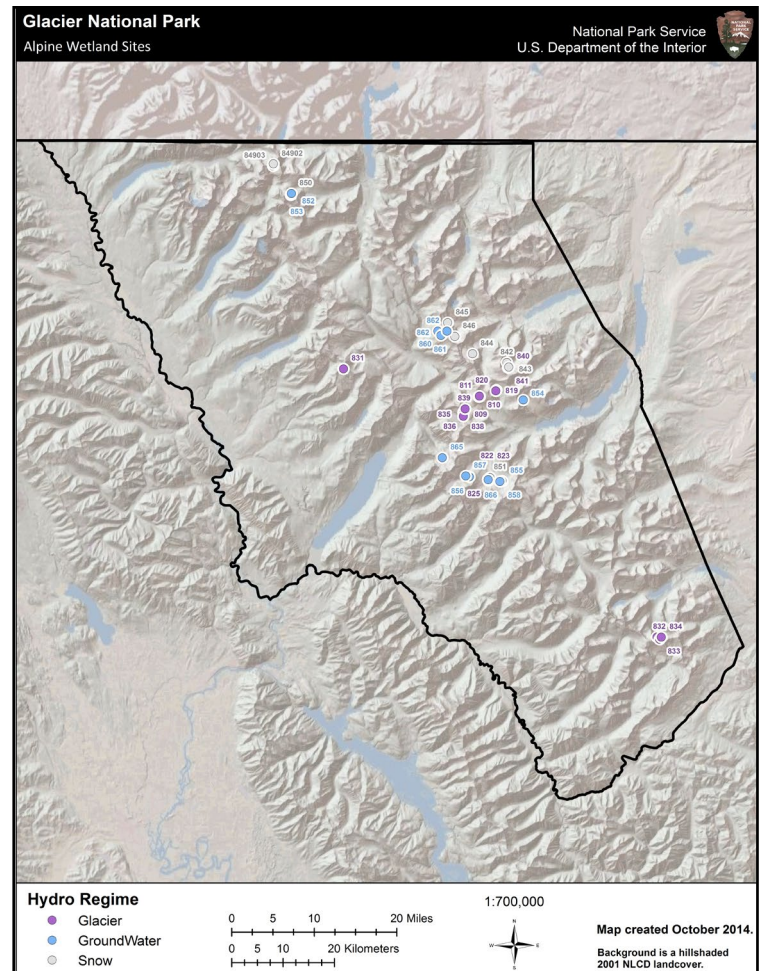


Figure 2. A map of all sampling sites within Glacier NP.

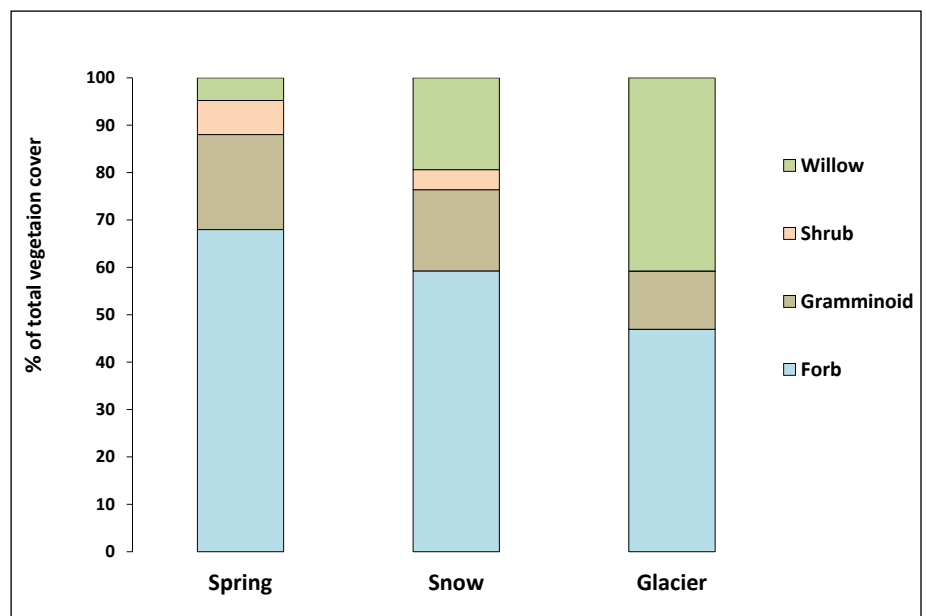


Figure 3. Total average cover of plant functional groups across stream type.



Channel survey.

common riparian plant species that tolerate hydrologic and geomorphic disturbance. Initial analysis suggests that higher abundance of willows on glacier streams may signify a relationship between water sources, hydrologic and geomorphic disturbance, and riparian plant species. This is just one example that suggests a distinct glacier-mediated, climate-driven successional pattern that will likely have important consequences to wetland condition.

Hydrogeomorphic disturbance patterns are also important drivers of riparian and change as a result of glacier mass loss. Data from channel surveys are used to calculate hydrogeomorphic disturbance patterns, such as shear stress (the ability of a stream to move bed particles as a function of the fluid forces per unit area) and stream power, which will be used to connect riparian plant communities to their hydrologic context (glacier, permanent snow/ice field, or early snowmelt/spring).

Preliminary work suggests that there are differences in these parameters across hydrologic regimes with a marginal decrease in shear stress from glacier to snow/ice field, to groundwater-supported streams (Figure 4). More complex modeling will further understanding of how this and other stream metrics such as channel confinement and substrate type might respond to changes in climate.

Finally, water temperature loggers placed in streams show that water from glacier streams is colder than water from permanent snowfields and springs (Figure 5). More information about stream temperature will be available after all loggers from 2013 and 2014 have been collected; however, stream water temperature has a cascade of important impacts on wetland and aquatic condition, and even though this is an intuitive result and seen in other research efforts in the park as well, it suggests another way in which loss of glaciers will impact important wetland communities in the park.

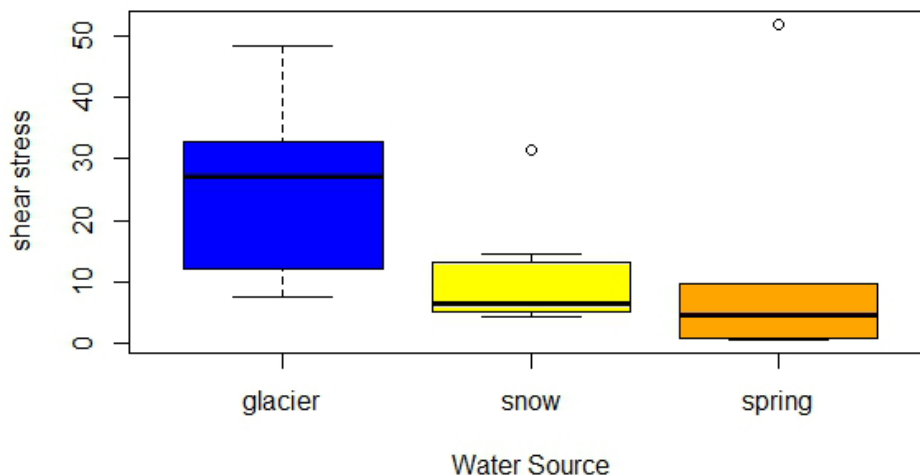


Figure 4. Shear stress by water source.

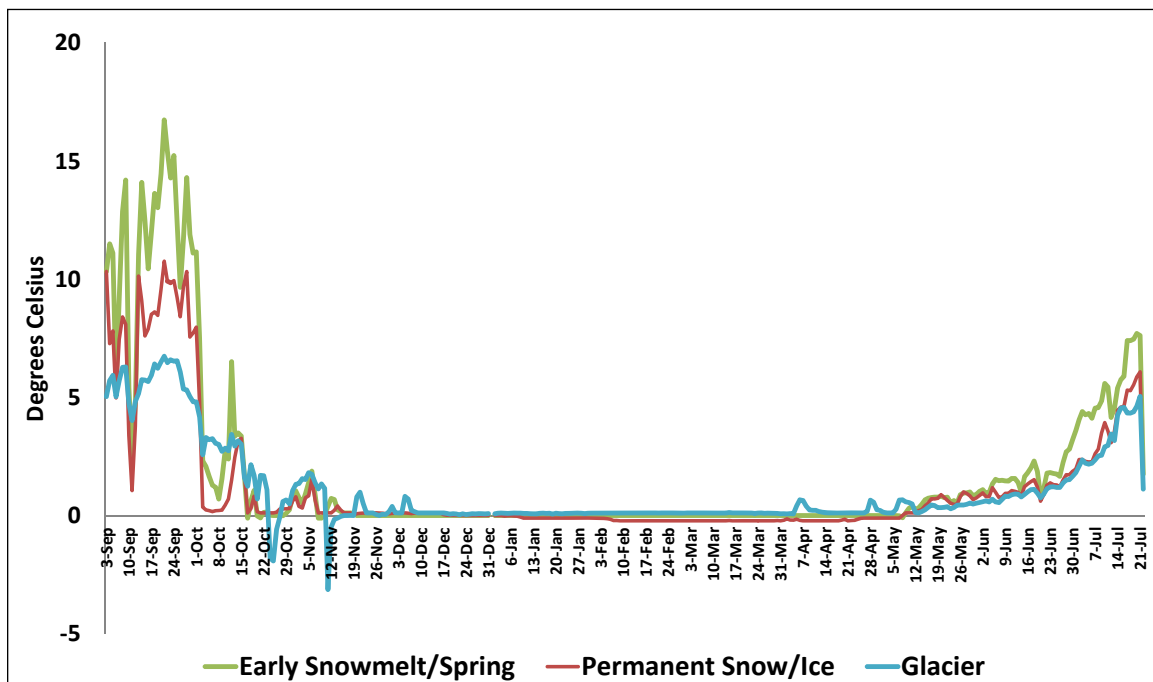


Figure 5. Average daily stream temperatures from September 2012 to July 2013.

Resource Management Implications

A large body of research in Glacier NP suggests that shifts in climate have had and will likely continue to have a strong impact on several important aspects of the park's ecology. Alpine wetlands in the park support many unique species and important ecological functions. As glaciers recede, we expect hydrologic regimes will continue to change. Data suggest this can lead to changes in channel geomorphology and water temperature that, along with the direct effect of altered hydrology, can impact wetland vegetation. This has implications for channel stability, flood control, water chemistry, and biodiversity, all high-priority concerns for the park.

Future Work

AWEI methods are documented in a protocol being published in 2014. Results will be published in a thesis, peer-reviewed scientific journals, and in an NPS technical series reports. Outreach materials and presentations on AWEI will be created for park staff and visitors.

Ongoing U.S. Geological Survey (USGS) long-term research on glacier loss will help inform the AWEI monitoring plan. We will continue to work with Glacier NP and USGS staff, researchers, and other technical partners in sharing monitoring data and information as results are analyzed and interpreted.

Conducting a vegetation survey at Blackfoot Glacier.



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