Growing an Old Growth Grasslands Network – First Steps

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Cornell University is partnering with Grasslands Roadmap on a new initiative to identify and inventory Old-Growth Grasslands across North America as the basis for an interactive mapping website tool.

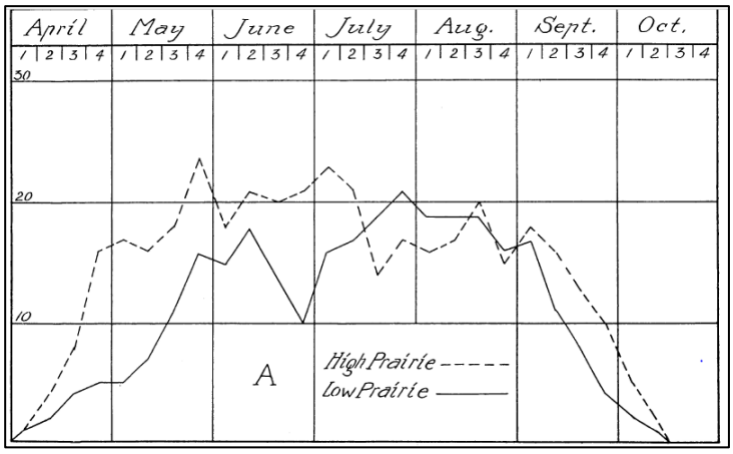
What are Old Growth Grasslands? Nearly two centuries of chronic tillage, erosion, and overgrazing have impacted grasslands throughout North America. With > 90% of former grasslands converted to agriculture globally, few have remained untilled. Monitoring by the World Wildlife Fund documents that the pressure is continuing, with an estimated 1.8 million new acres converted in 2021 across the U.S. and Canadian Great Plains alone (WWF 2022 Plowprint Report). **Old-growth grasslands (OGGs) are unique in having never been plowed, or overgrazed.** In the U.S., they exist only in a few places - as small remnants in preserves, in cemeteries, along fence rows or railways, or in a few well-managed rangelands. These remnants are an important but undervalued resource, giving us a unique window into the biophysical processes that made natural grasslands highly productive, biodiverse, and drought-resilient ecosystems.

Cultivated field (left) abuts native prairie (right) in e. Nebraska (Photo: R. Schneider)

Why are OGGs important? Old Growth Grasslands are the last-remaining fragments of one of North America's critical natural resources. Historically, the North American native grasslands had thriving plant communities that extended several meters above and below the ground surface. They functioned as a vibrant living skin interwoven into the underlying mineral bones of the landscape. Despite the global focus on reforestation to address climate change, it is grasslands, not forests, that are ideally adapted to thrive in semi-arid climates, receiving less than 20 in (500mm) of rainfall a year. Aboveground foliage intercepts the scarce rainfall as well as morning dew, funneling them to the soil water reservoir below. Decaying leaves form an insulating mulch across the soil surface which reduces evaporative losses, and beneath it, the decomposing leaves and roots form deep organic-rich soils that store rainwater for use by plants during dry periods. This highly evolved ecosystem is resilient to droughts, thriving without augmentation by irrigation, and also flexibly resistant to the disturbances of strong winds and periodic fires.

Remnants of the original grasslands still exist. **They provide numerous ecosystem services, reduced or missing in cultivated landscapes:**

- **Diverse flower and nectar resources for pollinators:** Inventories of OGGs indicate they contain hundreds of different flowering species, which bloom sequentially throughout the growing season, ensuring a constant source of nectar for pollinators.



Number of flowering species by week in remnants of tallgrass prairie located in e. Nebraska (Steiger, 1930.)

- **Reservoirs of unique microbial communities:** Recent advances in microbiological genetic techniques reveal that grassland soils contain complex and unique microbial communities. These distinctive microbes include arbuscular mycorrhizal fungi which are essential to establishment of many desirable late-successional flowers (Kozoil and Bever, 2017). A large group of bacteria, Verrucomicrobiota, dominate in OGGs but are scarce in cultivated fields (Fierer et al., 2014).

Blazing star liatris, Liatris spicata, is a late-succession prairie species which is symbiotic with, and dependent upon, specific mycorrhizal fungi to establish.

- **Stepping stones for migrating birds and other wildlife:** 74% of grassland bird species are in severe decline, with an estimated 700 million breeding individuals across 31 species lost since 1970 (Rosenberg et al., 2019). Many species migrate annually and depend on the remaining patches of OGGs as stopovers for critical food resources or as summer nesting sites.

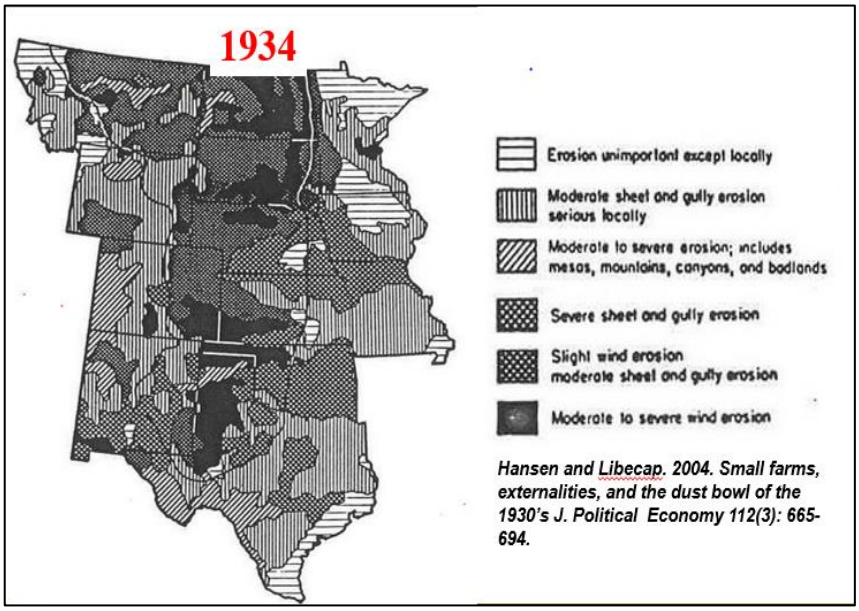
- **Refugia for metapopulations of ground-dwelling organisms**: Many types of wildlife depend on resource patches to sustain their populations over time. As interannual weather patterns shift from wet to dry, the population numbers also fluctuate, so populations persist by dispersing among patches. OGG remnants are serving as refugia for many species of insects, mammals and reptiles. Decreasing remnant sizes and increasing distances among patches threaten these creatures.

Whitcomb's beauty, Stirellus bicolor, is a unique leafhopper restricted to little bluestem grass in the Canadian prairie. (photo: from Hamilton and Whitcomb, 2010)

- **Plant and soil systems adapted for carbon sequestration:** Grasses annually produce lots of foliage and roots, which decompose and accumulate as deep soil layers rich in organic matter, effectively sequestering carbon. Improved health of grassland soils globally could potentially contribute to sequestering ~2.4 billion metric tons of carbon per year (Lal 2018). OGGs provide important insights into these processes.

Remnant soil rich in organic matter sampled in e. Nebraska (photo: R. Schneider).

What happened to the original grasslands? Transformation of midwestern U.S. grasslands for agriculture was incentivized by the 1862 Homestead Act which provided 160 acres of land to each pioneer but required land clearing within five years. It was accelerated by the concurrent inventions of the steel plow and the steam-driven tractor in the mid-1800s. But plowing the dense sod destroyed the networks of tough roots and fungal hyphae which held the soil together. Tilling overturned the soil, exposing it to extreme temperatures. Overgrazing by livestock similarly degraded the grass-soil system. The unprotected subsoils were then vulnerable to subsequent erosion by wind and water. By the late 19th century, scientists were already documenting the serious impacts to the land. Cultivated soils had lost as much as 50% of their organic matter and these changes happened rapidly, within the first decade after clearing. Nutrient availability also declined, which translated into reduced crop yields, and necessitated ever greater inputs of chemicals and irrigation. This culminated in catastrophic land degradation during the 1930s' droughts. In the worst areas, desertification and land abandonment occurred. Now, only scattered remnants of the original grasslands remain. There is an urgent need to identify these remaining remnants of Old-Growth Grasslands, and where possible to preserve them.



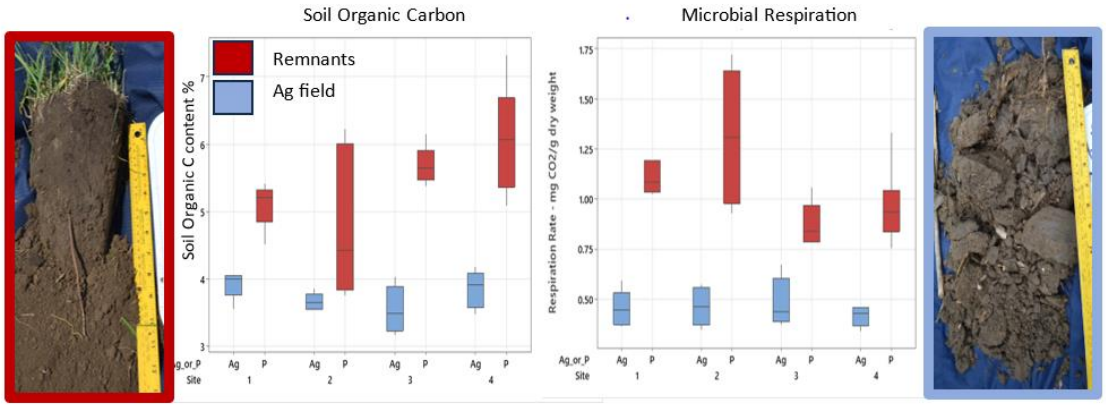
Earliest map of the extent of erosion across the midwestern U.S. (excerpted from Hansen and Libecap, 2004).

How many OGG remnants are needed? There is now growing acknowledgment that there are many more types of North American grasslands than indicated by the traditional three category system of tall, mixed, and short-grass prairies. Analogous to the rich diversity of wetlands distributed along flooding gradients, grasslands represent the other end of the water availability continuum, with a mosaic of plant communities organized by differences in soil moisture. Limited rainfall combined with high rates of evaporation drives water scarcity, and the resulting subtle differences in patterns of soil moisture influence plant communities' productivity and diversity. At the continental scale, soil moisture is driven by west to east gradients in rainfall and north to south gradients in average annual temperature. These are superimposed over more localized effects of topographic features and soil type. Temporally, interannual variation in rainfall results in shifting boundaries between the wetter and drier grassland types. Sustainability of this extensive dynamic grassland mosaic therefore depends on protection of numerous Old Growth Grassland remnants throughout North American in order to allow the whole system to adapt to changing climatic conditions.

Cornell University, working with Grasslands Roadmap, has started a new program to create an Old-Growth Grassland Network. Our joint vision is to compile information on remaining remnant grasslands in the North American Grasslands and build an interactive website where landowners can access information about nearby remnant soils and plant communities. This website will allow visitors to see OGGs in their area, photos of healthy topsoil and plant communities, and data on some of the key environmental features of these patches.

First steps: Comprehensive soil health will be the primary focus of the program in the initial phase. It expands the evaluation of soil chemical and physical properties, and additionally considers the microbiological health of the soil. It recognizes that soil is a living system, whose microbial communities are critical to sequestering carbon, storing water, increasing nutrient availability for plants, as well as preventing erosion. Data on a suite of aspects of soil health from the remnant soil profile can be used as a powerful diagnostic reference tool to help guide management decisions. Using published scientific studies, we have already accumulated limited soil data from over 200 remnants, which will form the foundation of the website. However, we are seeking information from more sites and more comprehensive soil information from remnant sites that already are catalogued. Later, we will incorporate information on plants and other organisms.

Comparison of soil profiles from 4 OGG remnants and nearby farm fields in e. Nebraska showing significant differences in soil organic carbon and microbial respiration in the top 15 cm.



We are currently working towards developing several Outreach Hubs across the North American Grasslands where we can collaborate with stakeholders to discuss and sample remnant soils in 2024. Workshops will be held at each location to discuss the importance of considering soil health holistically. A team of researchers, local professionals, and interns will work with land managers to collect soil samples in remnants and on nearby private lands for comparison.

We are looking for partners who are interested in participating in the workshops and/or are willing to provide access to a remnant grassland. Costs for workshops and sample analyses are covered by a seed grant from the Cornell University's Atkinson Center for Sustainability.

Let us know if you are interested in learning more. We are happy to give presentations or provide other resources while the website is being developed. We would love to hear about OGG remnants near you and see photographs. We respect privacy and can restrict access to location data if desired.

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