



## **Promoting rangeland literacy through development of agents of change and high-impact education resources**

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### **Abstract**

The sustainability of Great Plains rangelands and their ecosystem services is under threat by woody plant encroachment and climate change. Restoring coupled fire and grazing processes through pyric herbivory and mixed species grazing can effectively support rangeland ecosystem function, services, and resilience, but the adoption and public and policy support of these practices have been limited. The aim of the Educator Cohorts of the Prairie Project was to develop agents of change in secondary and undergraduate education through faculty and curricular development and action research to promote rangeland literacy. We organized three 2-year Educator Cohorts each of which starting with an intensive summer workshop focused on current science of rangeland ecology and ecosystem services as well as current learning science and high-impact pedagogy. It was followed by monthly online meetings and individual consultations focused on professional development, community building, and supporting participants in design, implementation, and assessment of their projects. Our work on developing rangeland literacy had four foci: (1) fire and grazing are fundamental processes of rangelands, (2) ecosystem services of rangelands are essential for all, (3) woody encroachment negatively impact these ecosystem services, and (4) pyric herbivory and mixed species grazing are effective climate-smart practices for sustaining rangelands and their ecosystem services. Cohort participants developed high-impact learning modules/lesson plans related to fire and grazing, implemented them in their own classes, assessed the impact on student learning, and presented their work and findings in professional or education conferences to engage peer educators to promote awareness and facilitate adoption to broaden the impact. Pre- and post-surveys of the students in the classrooms of the cohort participants and project team members have shown significant changes in knowledge and attitudes related to rangeland literacy, especially the roles of fire and grazing in sustaining rangelands and their ecosystem services.

### **Introduction**

The Great Plains rangelands are a cornerstone of U.S. livestock production, biodiversity, and other ecosystem services, including water regulation, carbon storage, and wildlife habitat (Wilcox et al. 2022). However, these landscapes are under severe stress due to woody plant encroachment and increasing frequency and intensity of droughts and wildfires associated with climate change, which collectively diminish the rangelands' capacity to sustain these ecosystem services (Derner et al. 2018). Woody plant encroachment, in particular, has transformed millions of acres of open grasslands into woodlands, reducing forage availability and biodiversity (Archer et al. 2017).

Two promising approaches to counter these threats are pyric herbivory, a management strategy that integrates fire and grazing to create a heterogeneous landscape (Fuhlendorf et al. 2009), and mixed species grazing with cattle, goats and/or sheep. They have been proven as effective climate-smart practices that can reduce woody plant encroachment, impact of drought, and the risk of wildfire while increasing livestock production (Wilcox et al. 2022). Despite their efficacy, adoption of pyric herbivory and mixed species grazing remains low due to misconceptions, cultural resistance, and a lack of public and policy support.

Recognizing the role of education in addressing these barriers, the Prairie Project launched its Educator Cohorts Program designed to cultivate agents of change in secondary and undergraduate educational institutions through faculty development, curriculum enhancement, action research, and peer engagement. It emphasizes the development, implementation and dissemination of high-impact educational resources that include the key concepts of pyric herbivory and mixed-species grazing for sustainable rangeland management. It aims to empower educators as agents of change and equipping them with the knowledge and tools needed to foster rangeland literacy among secondary and undergraduate students. In addition to rural audiences, the Educator Cohorts Program intentionally targeted urban and suburban audiences, who represent the majority of policymakers and voters in the Great Plains region, seeking to build broad-based support for sustainable rangeland management.

### **Methods**

Each of the Educator Cohorts spanned two years, with three staggered cohorts implemented to allow one year of overlap between them. The participants of the cohorts were educators from middle and high schools as well as colleges who were offered benefits such as travel support, stipends, and opportunities for continuing education or graduate credits. There were three main components of the cohorts' activities:

**Summer workshop** - Each cohort started with an intensive summer workshop and all cohort participants were required to attend this six-day workshop led by experienced facilitators from the Prairie Project's Education and Extension (E&E) team. During the workshop, the participants explored (1) the current science and practice of pyric herbivory and mixed-species grazing and how these affect the sustainability of rangelands and their ecosystem services in the Great Plains region, and (2) the current learning science and active learning pedagogies (peer instruction, case studies, authentic inquiries, citizen science projects, etc.). They then (3) participated in field tours of Prairie Project's research and demonstration ranches and met with researchers, extension specialists, and ranch managers to discuss and observe the research and management practices. Each participant (4) designed a learning module or inquiry project specifically tailored to their own class, as well as an associated assessment for assessing the impact of the module on student learning.

**Implementation and assessment** - During the following fall and spring semesters, participants refined and implemented their learning modules or projects and conducted assessment research of student learning. A collaborative learning community, comprising facilitators and cohort peers, provided ongoing support through (1) monthly online meetings to share progress, reflect on successes and challenges, and brainstorm solutions as well as (2) one-on-one consultations with facilitators for personalized guidance in module implementation and assessment research.

**Broader engagement** - In the second year, participants presented their curriculum designs, implementation strategies, and research findings at professional conferences and outreach events. These presentations aimed to inspire peer educators to adapt these learning modules and resources, professionals and ranch managers, while also recruiting participants for future cohorts. Potential venues include the Society for Range Management and Ecological Society of America meetings, the National Center for Case Study Teaching in Science conference, the Life Discovery-Doing Science Biology Education Conference, and the Lilly Conference on College and University Teaching.

The work of the educator cohort focused on developing **rangeland literacy** which had four key components: (1) fire and grazing are fundamental processes of rangelands, (2) ecosystem services of rangelands are essential

for all, (3) woody encroachment negatively impact these ecosystem services, and (4) pyric herbivory and mixed species grazing are effective practices for sustaining rangelands and their ecosystem services. A survey focused on rangeland literacy was developed and all cohort participants administered this survey before and after the implementations of their learning modules, in addition to any other assessments they used, to assess student learning gains in rangeland literacy.

## **Results**

### ***High-impact learning module development and implementation***

Over 30 participants of the Educator Cohorts have developed effective learning modules and projects in both secondary and high-education settings. They employed diverse approaches of high-impact pedagogies, from active and experiential learning, case studies, game-based learning, technology-enhanced learning, free response questions (FRQ), authentic inquiries, and course-based undergraduate research experiences (CURE). Many of them incorporated the use of Prairie Protector game developed by the Prairie Project team and/or the Rangeland Analysis Platform (RAP) along with other activities to engage students and develop deeper understanding and place-based relevancy. All participants developed effective assessments, both formative and summative, for and of their students learning.

### ***Impact on student learning***

Preliminary results from the pre and post surveys have shown significant positive impact of the education modules and projects on rangeland literacy of the students. For example, through an inquiry project focused on fire and grazing, significant changes occurred in student understanding of the effect of woody plant encroachment on both livestock production and biodiversity (Fig. 1a, b), rangelands providing ecosystem services to both rural and urban residents (Fig. 1c, d), and the importance of fire in rangelands and its suppression leading to woody encroachment (Fig. 1e, f).

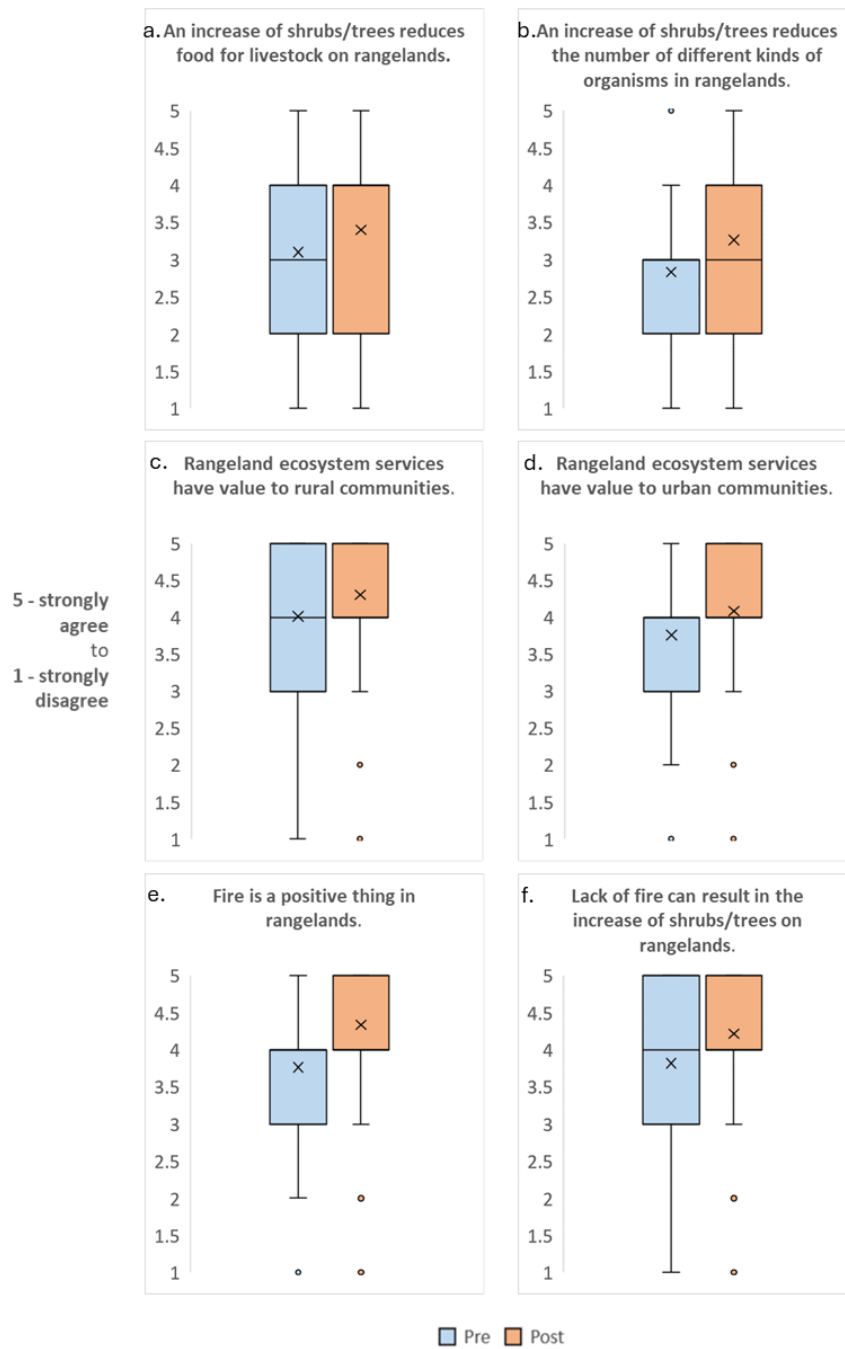


Figure 1. Pre- and post-survey results showing changes in student rangeland literacy.

**Engaging peers as agents of change**

The Educator Cohort participants has presented their work, often in collaboration with the Prairie Project E&E team members, in national and international conference in science and education, such as the Society for Range Management annual meetings, Ecological Society of America annual meetings, the Wildlife Society conference, National Science Teaching Association conferences, Advanced Placement Annual Conference, National Association of Biology Teachers conference, and the Lily Conference. Several of the participants have also presented, some together with their students, in regional conferences such as Nebraska Summit on Math and Science Education, Nebraska Association of Teachers of Science meeting, Oklahoma Academy of Science conference, Texas Chapter Wildlife Society meeting, Texas Society for Ecological Restoration conference.

Prairie Project E&E team members and the cohort participants have also collaborated in organizing symposium/organized sessions featuring our E&E work, including a symposium, an Ignite session, and a workshop at the SRM annual meetings, an organized session at ESA annual meeting, an organized session at the AP Annual Conference, and an educator workshop in Austin Texas.

### **Discussion**

The Prairie Project Educator Cohorts have successfully developed agents of change who are advancing rangeland literacy and fostering support for climate-smart management practices. The educators' work has led to significant improvement in their students' rangeland literacy, and they have become effective advocates of rangeland literacy and high-impact pedagogy with their peers. By combining ecological science with innovative education strategies, the program provides a scalable model for addressing complex environmental challenges. Challenges remain, including the need to scale the program to reach more educators and students and to secure sustained funding for long-term impact. Future initiatives should prioritize policy engagement, broader dissemination of resources, and the integration of new technologies to enhance learning experiences. Continued investment in such initiatives will be critical for ensuring the sustainability of rangelands and their vital ecosystem services.

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### **References**

- Archer SR, Anderson EM, Predick KI, et al. (2017) Woody plant encroachment: causes and consequences. In: Briske DD (Ed). *Rangeland systems: processes, management and challenges*. Cham, Switzerland: Springer.
- Derner J, Briske D, Reeves M, Brown-Brandl T, Meehan M, Blumenthal D, Travis W, Augustine D, Wilmer H, Scasta D, Hendrickson J, Volesky J, Edwards L, Peck D (2018) Vulnerability of grazing and confined livestock in the Northern Great Plains to projected mid- and late-twenty-first century climate. *Climatic Change* 146:19-32.
- Fuhlendorf SD, Engle DM, Kerby J, Hamilton R (2009) Pyric herbivory: rewilding landscapes through the recoupling of fire and grazing. *Conservation Biology* 23:588-598.
- Wilcox BP, Fuhlendorf SD, Walker JW, Twidwell D, Wu XB, Goodman LE, Treadwell M, Birt A (2022) Saving imperilled grassland biomes by recoupling fire and grazing: A case study from the Great Plains. *Frontiers in Ecology and the Environment* 20(3): 179–186.