Yale SCHOOL OF THE ENVIRONMENT

Ucross High Plains Stewardship

FELLOWSHIP BRIEF

Long-term Recovery of Herbaceous Plant Production and Plant Functional Type Composition on Reclaimed Wellpads

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The Need.

The dryland ecosystem of the upper Green River basin of Wyoming is dominated by big sagebrush (Artemisia tridentata), bunchgrasses, and a mix of perennial and annual forbs. This plant community maintains ecosystem structure and function, supporting soil stability, wildlife habitat, and nutrient cycling. However, rising energy demands have led to widespread development of natural gas infrastructure in the basin, including the construction of wellpads that remove vegetation. The understanding of long-term recovery after reclamation remains limited. Therefore, Jianing investigated how aboveground net primary production (ANPP) and plant functional type change over time by comparing reclaimed wellpads with adjacent undisturbed sites and examining wellpads of different reclamation ages (time since reclamation) to create a chronosequence. Documenting any patterns of ecosystem recovery will guide future reclamation strategies of wellpads in the western United States.

The Project.

Jianing employed a chronosequence approach to assess long-term plant recovery on wellpads by integrating field measurements with remotely sensed data. Jianing selected sites at wellpads constructed consecutively from 2005 to 2018, and all wellpads were located on sandy clay loam soils. At each site, she collected plant and soil samples and assessed the plant composition on paired disturbed and adjacent undisturbed areas. Data collection included:

- Plant samples: Perennial grasses, annual forbs, and perennial forbs were clipped to measure biomass and estimate the ANPP.
- Soil samples: Soil was collected at depths of 0-10 cm and 10-20 cm.
- Fecal pellet counts: Pellet counts were conducted around each sampling quadrat to estimate grazing intensity.
- Plant composition: Plant composition was assessed to describe recovery trajectory over time.

The Findings.

ANPP and plant functional type composition exhibited substantial variability among individual wellpads, regardless of reclamation time. For both big sagebrush and herbaceous plants, average ANPP did not show consistent change with increasing time since reclamation on either disturbed or adjacent undisturbed sites, nor did reclaimed wellpads consistently converge toward patterns observed on undisturbed sites. In some years, reclaimed wellpads exhibited comparable or even higher big sagebrush ANPP (200 g m^{-2} yr^{-1}) than adjacent undisturbed areas (maximum of approximately 100 g m^{-2} yr^{-1}).

Herbaceous ANPP on undisturbed sites was generally dominated by perennial grasses and perennial forbs, while disturbed wellpads were more often dominated by perennial grasses and annual forbs. (Fig. 1) On the undisturbed sites, annual forbs were rare, whereas their contribution increased on some disturbed wellpads that were more recently reclaimed. Patterns of plant composition further revealed the irregular shift of functional dominance over time, rather than following a smooth or predictable recovery trajectory.

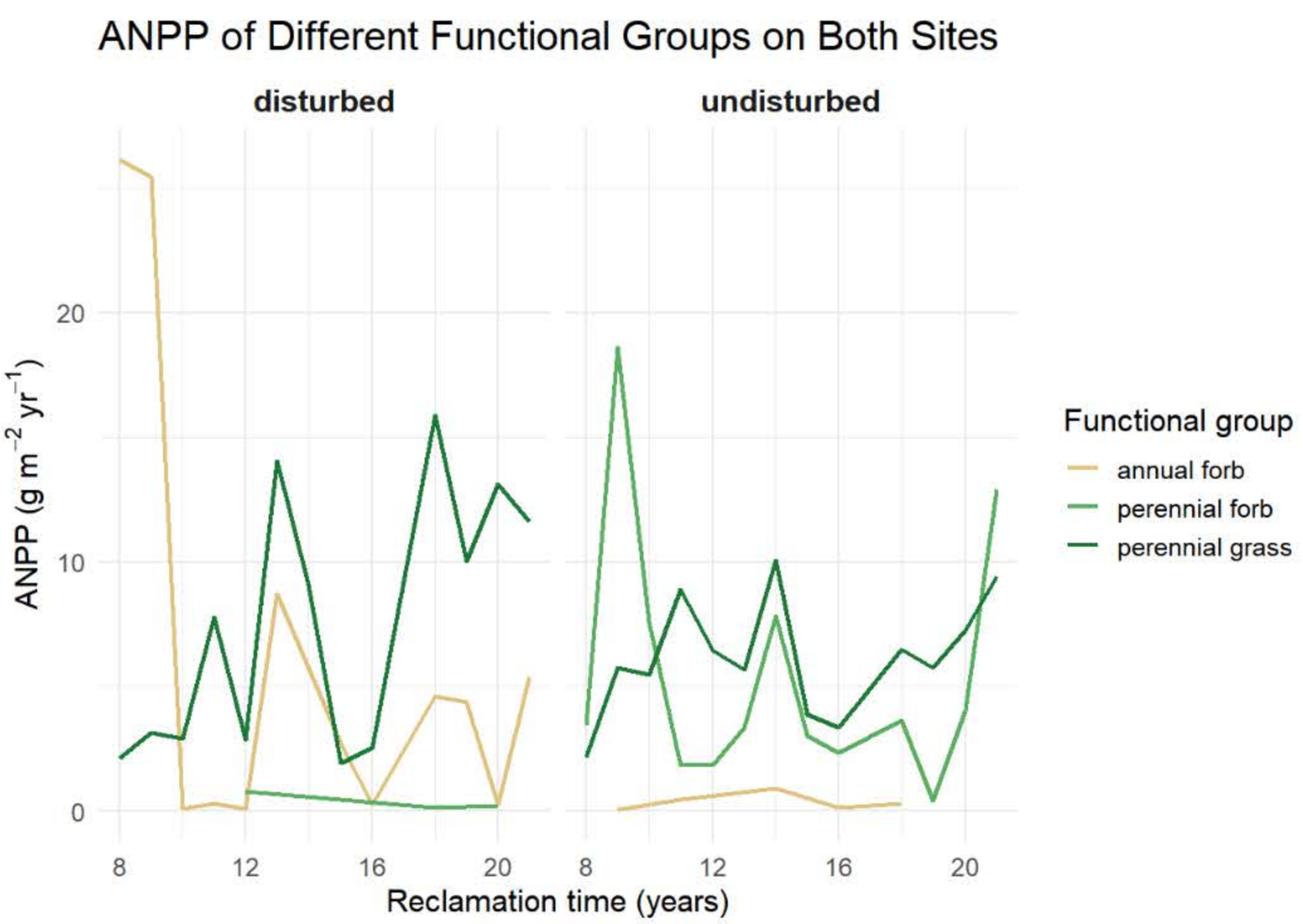

Figure 1: ANPP of functional groups (annual forb, perennial forb, and perennial grass) on both disturbed and adjacent undisturbed sites.

The Impact.

The high variability in ANPP and plant functional type composition among wellpads suggests that reclamation in dryland sagebrush ecosystems does not follow a predictable, linear recovery trajectory driven solely by time since reclamation. Although longer reclamation periods may increase the likelihood of plants to reach the dynamic equilibrium, the absence of consistent trends across the chronosequence indicates that secondary succession on reclaimed wellpads is strongly contingent on site-specific factors. These findings indicate that secondary succession in this system is characterized by multiple endpoints, with some wellpads transitioning toward shrub-dominated communities while others dominated by herbaceous plants for certain periods and time since reclamation is not the single reason contributing to the secondary succession. Recognizing variability of secondary succession is critical for improving reclamation practices and setting realistic expectations for long-term ecosystem recovery in dryland wellpad ecosystem.

The Student.

Jianing Tian, Western Resource Fellow | Jianing is a Master of Environmental Science candidate at the Yale School of the Environment (YSE), where she specializes in dryland ecology and ecosystem recovery. She is particularly interested in the carbon cycle, including carbon emissions, soil carbon sequestration, and overall ecosystem carbon balance. Before YSE, Jianing earned a dual B.S. degree in Environmental Science from Duke Kunshan University and Duke University. During her undergraduate studies, she conducted research on agricultural carbon emissions, and she now aims to apply geospatial analysis and remote sensing to study vegetation recovery and carbon dynamics in semi-arid landscapes. In her free time, Jianing enjoys jogging, hiking, and playing musical instruments.