Yale SCHOOL OF THE ENVIRONMENT

Ucross High Plains Stewardship

FELLOWSHIP BRIEF

Assessing big sagebrush (Artemisia tridentata) plant community recovery on natural gas well pads in southwestern Wyoming

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The Need.

The sagebrush steppe ecosystem makes up the majority of the western U.S., but is vulnerable to loss and conversion. Big sagebrush (Artemisia tridentata) and perennial grasses dominate these plant communities, which are defined by low water availability. This makes the regeneration of the dominant species characteristically unreliable following a disturbance. The magnitude of anthropogenic disturbances on plant communities has motivated U.S. federal agencies to prioritize restoration and strategic management of big sagebrush steppe. The U.S. Bureau of Land Management (BLM) oversees mineral leasing on federal lands, which contributes to large-scale ecosystem degradation across areas where mineral leasing is prominent. Oil and gas development involves total vegetation removal and significant disturbance to the soil surface and upper soil layers, which makes them a good case study to understand the dynamics involved in regeneration and restoration of big sagebrush plant communities. However, there are few studies that have attempted to characterize the effectiveness of historic restoration to return native big sagebrush plant communities. Importantly, under climate change, rising temperatures and increasingly variability in precipitation are projected to exacerbate issues with regeneration and restoration.

The Project.

This study consisted of three phases: (1) plant community data collection, (2) restoration data collection, and (3) simulation modeling. Damaris's work as a Western Resources Fellow during the summer of 2023 comprised the first phase. Damaris surveyed areas that had been disturbed by natural gas (i.e. well pads) 14-27 years ago, were restored and seeded, and are now in various stages of recovery. She assessed plant community composition and structure along transects that crossed over the edges of the disturbances to describe the disturbed plant communities and their undisturbed counterparts. She collected soil samples to characterize the species composition of seeds that were present in the surface soils (i.e. the seed bank). In the second phase

of the project, Damaris will compile satellite imagery and data from government repositories to assemble a complete history of the restoration activities that have occurred at well pads. Using the combined field and restoration data, she will conduct simulation modeling during the third phase. She will use a simulation model to evaluate the success of historic restoration efforts and simulate restoration dynamics at large spatial scales and under projected future climate change.

The Findings.

Damaris's preliminary analysis of the field-collected data at well pads shows high variability in the cover of the dominant plant species and in the abundance of certain invasive species. Invasive forb cover was between 5-30% in disturbed areas, compared to 5% in the undisturbed reference areas. Disturbed areas with high invasive forb cover also had high perennial grass cover, and either low or no big sagebrush cover. Additionally, an invasive forb, desert madwort (Alyssum desertorum), was a prominent member of the seed bank and germinated easily under greenhouse conditions compared to the native forbs and grasses that were present. In the second and third phases of the project, it will be important to uncover potential drivers of the limited recovery that was observed on some well pads. Contributing factors might include the species mix used for seeding, the timing and recurrence of seeding, and climate during and after seeding.

The Impact.

Climate change is expected to exacerbate issues with regeneration and restoration of big sagebrush in the future. This study will provide underrepresented field data and model projections to ascertain constraints on big sagebrush regeneration and recovery. One of the data products characterizes the spatial distribution of seeds in the seed bank at natural gas disturbances. The spatial distribution of the seed bank can indicate whether seed abundance or seed viability are acting as constraints on regeneration. The simulation modeling phase of the study will also yield information about water-availability as a limitation on regeneration. Given the uncertainty of projected future precipitation regimes, understanding the impact of water availability on regeneration will be even more important to for planning cost-effective and strategic seeding of disturbed areas. The data products from this project can be used directly by energy operators to inform their strategic restoration and monitoring.

The Student.

Damaris Chenoweth, Western Resource Fellow | Damaris is a plant community ecologist and doctoral student at Yale School of the Environment. Her dissertation work focuses on restoration and recovery dynamics of big sagebrush plant communities at natural gas disturbances in southwestern Wyoming. She is particularly interested in the role of recruitment and early successional dynamics in determining restoration outcomes under climate change and uses a combination of field work and simulation modeling to investigate these topics. Damaris is from Princeton, New Jersey and has a BA in Biology from Skidmore College and an MESc from Yale School of the Environment. See what Damaris has been up to. | Blog