Yale SCHOOL OF THE ENVIRONMENT

Ucross High Plains Stewardship

FELLOWSHIP BRIEF

Patterns of Productivity and Radiation Use Efficiency in the Upper Green River Basin

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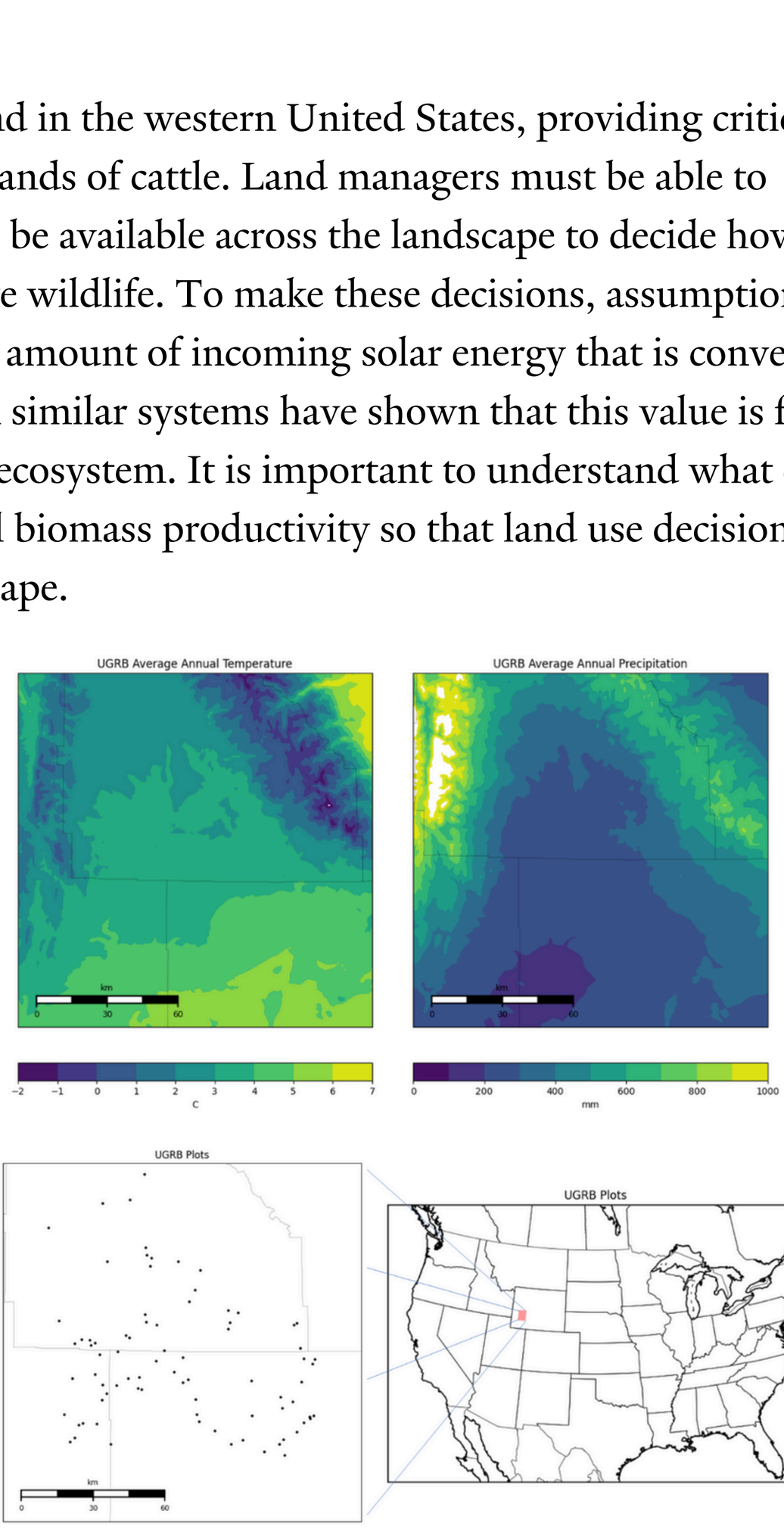
The Need.

Big sagebrush ecosystems dominate large tracts of land in the western United States, providing critical habitat for many wildlife species and forage for thousands of cattle. Land managers must be able to estimate how much herbaceous biomass (forage) will be available across the landscape to decide how many cattle can be supported, in addition to the native wildlife. To make these decisions, assumptions about herbaceous plants’ radiation use efficiency (the amount of incoming solar energy that is converted to plant material) must be made. However, studies in similar systems have shown that this value is far from constant and often varies widely across a single ecosystem. It is important to understand what drives variability in both radiation use efficiency and general biomass productivity so that land use decisions can be made that will have the best impacts for the landscape.

The Project.

Sam selected a study site that would allow him to capture a wide range in environmental variables (precipitation, temperature, grazing intensity, soil texture) and vegetative variables (shrub density, species composition) while remaining within a big sagebrush ecosystem. He selected the Upper Green River Basin in western Wyoming because it has large variability in all the variables listed above and is almost entirely public lands. Within the basin, Sam randomly selected 80 plots and then collected biomass samples from each plot during summer 2023. Samples were weighed and then this value was used it to calculate herbaceous biomass and radiation use efficiency of each plot. Sam



The map in the bottom right shows the continental United States, with a red box showing the boundaries of the map on the bottom left. The bottom left is a map of the Upper Green River Basin in Wyoming. Each point represents a sample plot visited by Sam. The map in the upper left shows mean annual temperature across the study area. The map in the upper right shows mean annual precipitation across the study area.

compared how these variables changed across the range of the environmental and vegetative factors of interest.

The Findings.

Sam found that both herbaceous productivity and herbaceous radiation use efficiency varied greatly across the study sites. Vegetative productivity varied greatest with annual precipitation as well as elevation. Precipitation increases with elevation in this area and past research suggests that precipitation is likely the driver of this trend. In addition, vegetative productivity also showed strong trends regarding shrub density and soil texture. Productivity increased with increasing shrub cover, suggesting that, shrubs might provide more favorable growing conditions for herbaceous plants than the space in-between shrubs. We found increased production with increasing clay content, a result that perhaps suggests that shrubs are out competing their herbaceous counterparts on less clay rich soils. Use efficiency showed no clear trends across any of these variables. In addition, it also showed no clear trends across grazing intensity, a result that surprised us greatly based on other studies. There was some evidence that the amount of precipitation in contrast to the annual average also impacts use efficiency, but due to the above average precipitation during our study, the results are difficult to interpret.

The Impact.

Prior to this study, very little has been studied about herbaceous use efficiency in a big sagebrush ecosystem and the value is typically treated as a constant in biomass modeling. The most impactful finding of Sam's study was the incredible variability that exists in radiation use efficiency across this landscape. These results suggest that further research will be needed if we truly want land managers to be making informed decisions about stocking rates. The findings about productivity and precipitation confirm what was believed to be true about the system, however the results about shrub density and soil texture may require further thinking about how productivity is modeled in this area. Overall, the findings of this study will assist in future decision making and inspire others to improve our understanding of the variability of radiation use efficiency in this system.

The Student.

Sam Wilson, Research Assistant and Western Resource Fellow | Sam Wilson is a graduate student at Yale School of the Environment working towards a Masters in Environmental Science, focusing on using remote sensing, big data, and field work to analyze relationships in rangeland ecosystems. He received a B.S. in Geography from Montana State University in 2019 and spent the next few years living in Bozeman, Montana. While there summers were spent working in rangelands on a long term monitoring protocol with the BLM and winters were spent using satellite imagery to map wetlands for the National Wetlands Inventory. In his free time he enjoys skiing, hiking, reading, and learning! | Blog