Ann Rodman

Using climate data and remote sensing to inform best opening dates for stock use in Yellowstone's backcountry meadows

Ann Rodman, Ella Morrow, Alex Zaideman, Mike Tercek, David Thoma

Issue: Approximately a third of Yellowstone National Park's backcountry campsites allow stock use. Meadows adjacent to these sites are vulnerable to grazing damage if the stock use occurs too early in the season, when the soil is still wet and the native plants are early in their growing cycle. Impacts can include increased bare ground, decreased productivity of native vegetation, shifts in species composition, compacted soil and severed roots. Monitoring efforts show that patches of bare ground and areas of impacted vegetation at stock sites are increasing parkwide, and there is a positive correlation between increasing use and impacts. The park has the authority to designate an opening date for stock use based on meadow conditions, but in practice, a default date of July 1 is almost always used for all sites. Because the stock sites vary in total annual precipitation (15" to 75") and elevation (5,370' to 9,720'), the climate at each site also varies, including the amount of snow, the timing of melt, and summer temperatures. This results in a wide range of soil moisture conditions and vegetative phenological states at these meadows on July 1.

Methods: This project uses a combination of remotely sensed data from satellites, real-time climate data, and modeled monthly water balance parameters (snowpack, soil moisture, water deficit, and actual evapotranspiration) to determine the best date to open backcountry campsites for stock use and explores the feasibility of accurately predicting summer conditions months before summer begins. MODIS data was used to calculate NDVI values, a measure of greenness, to determine the 1) start of green-up, 2) when peak green-up occurs, and 3) the length of the growing season for each meadow, for each year between 2000-2023. Field observations were correlated with the corresponding "NDVI curve" to relate greenness to plant phenology. We determined which climate variables were the best predictor of 1 and 2 above. We also explored how well these variables predicted the upcoming summer conditions.

Conclusion: Although July 1 might be perfect for some sites, it is later than necessary at other sites, and too early at many sites, especially in wetter years, or summers following a deep snowpack. Assigning a different best date for each meadow is impractical, but grouping sites into "early", "middle", and "late" categories and determining an average best date for each category is reasonable. Snowpack status early in the year is a promising predictor of meadow conditions, though earlier predictions (January 1) are less accurate than later predictions (April 1). Using this technology and data provides us with a much better understanding of the differences between meadows, and their sensitivity to wet, dry, and average years. These tools allow us to improve how we manage this resource now, and also lets us anticipate future conditions in light of climate change.