Photo: Kirsti Harms

Wright, C.K., and Wimberly, M.C. (2013). Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *Proceeding of the National Academy of Science* 110(10): 4134-4139

COLLABORATIVE ADAPTIVE RANGELAND MANAGEMENT: A MODEL FOR GRASSLANDS CONSERVATION?

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Understanding the human dimensions of decision-making for socio-ecological systems in complex semiarid rangelands is needed for sustainable management. The vast majority of prior research on this system has focused on biophysical responses to management with human dimensions largely excluded. There is an emergent need for novel approaches that incorporate science into management decisions to optimize tradeoffs between conservation and production goals. Here, we showcase the inclusive, participatory approach of 11 Stakeholders in the Collaborative Adaptive Rangeland Management (CARM) initiated in 2012 that enhances learning and trust through a facilitated stakeholder engagement process. This process is compared and contrasted with the current predominant conservation approaches associated with private land owners and governmental agencies.

UNDERSTANDING AND ADDRESSING THREATS ON NATIONAL GRASSLANDS: A REVIEW OF FOREST SERVICE RESEARCH

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The USDA Forest Service manages 20 National Grasslands and 1 tall grass prairie, the majority located in the Great Plains. This presentation seeks to increase the visibility of National Grasslands by providing an overview of their history, mission and distribution, and offers a snapshot of the research that Forest Service conducts on grasslands. Topics include studies of invasive plant species and methods for controlling them, energy development, landscape level patterns of grazing effects, and plant - pollinator interactions with climate. In addition, methods and models for restoring resilience and resistance of grasslands depending on types of threats, soil moisture and climate, and restoration objectives are explored.

THE RANGELAND VEGETATION SIMULATOR: A DECISION SUPPORT TOOL FOR MONITORING AND PROJECTING GRASSLAND CONDITIONS

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Rangeland landscapes occupy roughly 662 million acres in the coterminous U.S. (Reeves and Mitchell 2011) and their vegetation responds quickly to climate and management, with high relative growth rates and inter-annual variability. Current national decision support systems in the U.S. such as the Interagency

Fuels Treatment Decision Support System (IFT-DSS) require spatially explicit information describing production, fuels, grazing capacity and successional trajectory. However, no single system presently offers this information. In addition, issues of increasing national attention, such as preservation of lekking birds (e.g. greater sagegrouse *(Centrocercus urophasianus),* and greater prairie chicken *(Tympanuchus cupido),* has prompted new management guidelines such as stubble height standards. Currently, ecological tools for predicting this type of management outcome on rangelands are quite limited in their ability to predict these variables. We developed a program for simulating succession, productivity, and fuels in non-forest environments called the Rangeland Vegetation Simulator (RVS). The RVS uses Normalized Difference Vegetation Index from a variety of sensors (it is agnostic to spatial resolution), combined with Biophysical Settings (Bps) from the LANDFIRE Project, and includes subroutines for management options including fire, and herbivory. The RVS can also work in concert with Ecological Sites to produce annual estimates of vegetal structure and composition. In addition, subroutines or parameters from the RVS can be used in concert with ST-Sim, an ecological simulation program aimed at probabilistic estimation of landscape conditions. Planners and managers alike can benefit from using RVS to understand likely management outcomes. In this vein, we have deployed the program to aid the National Forest System in Regions, 3, 4, and 5, and to provide a demonstration of the capabilities of the RVS. This project provides the best available science and information for planning and management activities, especially where geo-referenced plot data are lacking. In this paper we discuss applications and results derived for grasslands and shrublands in varied habitats across the extent Regions 3, 4, and 5.

Study Area and Methods

We focused on Regions 3, 4, and 5 of the USDA Forest Service (Figure 1). RVS was applied to these regions to assist Forest Plan Revision and NEPA assessments. Grazing allotments under USFS jurisdiction were obtained and used to aggregate results to represent allotment–wide trends (Figure 1). In addition, we wanted to examine how much variability could be explained in the trends of annual production by the US Drought Monitor (https://www.drought.gov/drought/) given its linkage with the numerous disaster relief programs such as the Livestock Forage Payment program. To do this we quantified the annual summation of drought monitor values and compare these with the production trends in allotments of Region 5. In Regions 5 and 4 we focused on quantifying trends in annual production (pounds per acre) from 2000 to 2015 and 2000 to 2016, respectively, whereas in Region 3, we focused on characterizing the range of variability of forage from 2000 to 2016. To quantify annual production for Regions 4 and 5, the RVS was run in a spatially explicit mode, at 250 m spatial resolution, with no presumed management actions (such as prescribed fire or herbivory). For each year in the analysis, and for each allotment, average annual production was quantified and linearly related (Pearson) to time as a means of detecting trends in annual production. For Region 3 the linear correlation (Pearson) of production with time was calculated in addition to the coefficient of variability (C.V.) (standard deviation as a proportion of the mean) from 2000 to 2016.

Results

Overall, in Region 5, about 34% of the area experienced positive or flat trends in annual production. However, less than 1 percent of the region exhibited strong positive correlation (0.7 or greater). In comparison, 6% of rangeland vegetation analyzed exhibited correlation coefficients of annual production with respect to time of -0.7 or less (increasingly more negative) (Figure 2). This is somewhat expected since the Region has experienced very significant drought, over the study period. However, the US Drought Monitor only explained, on average, about 31% of the variation in annual production. This suggests that other factors are influencing the trends we observed, or that the US Drought Monitor is not a good indicator of rangeland production on annual time-steps. In Region 4 the production situation was markedly different. From 2000 to 2016 in Region 4 only 3.2% of grazing allotments exhibited negative trends in excess of

-0.7 while not a single allotment exhibited a positive correlation in excess of 0.7. Note the prevalence of estimated declines in the northern part of Region 4. The region has experienced many wildfires from 2000 to 2016 so it is reasonable to expect that some of this decline could be explained by wildfires and this should be considered for another study. This demonstrates the capacity of RVS to support an objective assessment of conditions to identify where rangelands are trending in one direction or the other, indicating where further study or monitoring are needed. In Region 3, extreme variability (up to 81% C.V.) was observed in rangeland production in the region. This situation is exemplified by the extreme range of production from about 400 to over 1,100 pounds per acre in 2006. For context, average variability of production on U.S. rangelands is about 15%. Interestingly, in 2006 in New Mexico, the first 6 months of the year were some of the driest on record while the last 6 months were some of the wettest and the production response was captured by the RVS. This represents one of the strengths of the RVS which is consistent and objective monitoring across large areas enabling comparison between areas and to identification of "hot spots" or areas requiring further examination. Figure 2 demonstrates that a good number of grazing allotments in California have seen steep declines in rangeland production and that, in some cases, these allotments are in close proximity to allotments where little or decline is observed. One explanation is different soil or vegetation conditions, or perhaps fire has influenced the trends in production. In either case the RVS offers a platform to examine these trends and provide impetus and rationale for pinpointing or prioritizing monitoring and possibly management actions.

Conclusions

Here we offer examples of how the RVS can be used to quantify rangeland conditions. The most significant findings and implications can be characterized with three points. First, significant trends in rangeland production in Regions 3, 4, and 5 have been quantified using the RVS. These trends are both positive and negative depending on the allotment being analyzed. Second, extreme variability in rangelands of Region 3 have been quantified and this information can be directly used by managers and producers alike to put upper and lower bounds on expected forage yield. In this manner, the RVS and will be helpful for both ranch planning and allotment management. Third, overall, southern California has experienced significant declines in rangeland production, explained in part by the serious droughts that have manifested across that region. The data produced by the RVS clearly indicate that it can support activities such as Forest Plan revision, NEPA analysis, and improve communication between land managers and constituents, such as permittees, to manage expectations more efficiently.

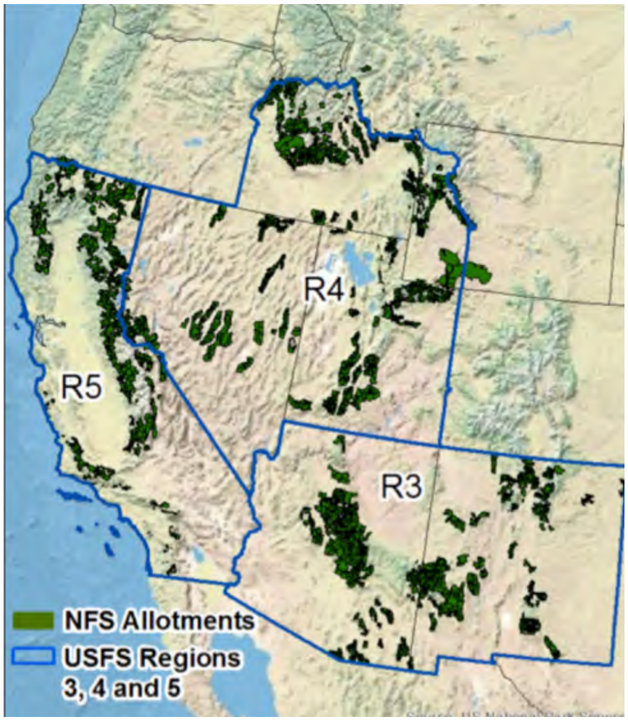

Figure 1. Regions and allotment. Location of Regions 3, 4 and 5 and grazing allotments used in the analysis.

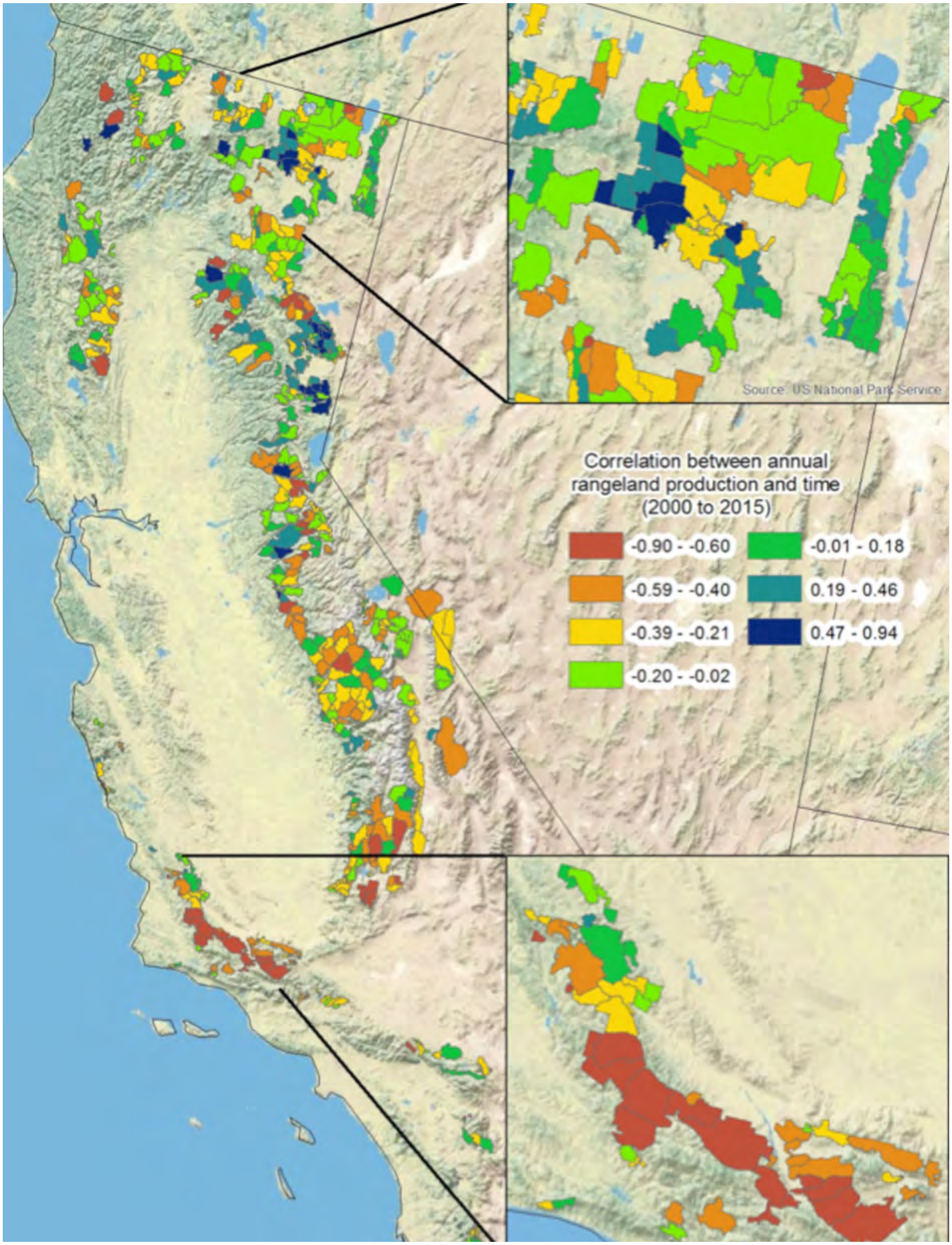

Figure 2. An analysis of annual rangeland production from 2000 to 2015 in Region 5. Shown are grazing allotments and the correlation between annual rangeland production and time. Data were aggregated to grazing allotments for display purposes.