INTERACTIVE EFFECTS OF GRAZING AND FIRE ON SEMIARID SHRUB AND RANGELAND: AN ASSESSMENT USING REMOTELY SENSED VEGETATION INDICES OVER LARGE SPATIAL AND TEMPORAL SCALES

Ryan Baum and Matthew Germino
Department of Biological Sciences
Idaho State University, Pocatello, Idaho.

Introduction:

- Sagebrush-steppe ecosystems are experiencing unprecedented stress due to combinations of previous and ongoing disturbances such as fire, domestic livestock grazing, and climate change.
- Ecosystem response to such disturbances has been studied primarily at the small-scale, plot level.
- Identifying changes in plant ecosystem functioning at larger scales is needed to gain a better understanding of ecological processes and mechanisms driving change in sagebrush-steppe ecosystems (Anderson and Inouye 2001). This is possible with remote sensing.

Research Question:

- Can interactive effects of fire, grazing, and climate variability on rangeland vegetation be detected using remote sensing?

Research Approach:

- Areas dominated by Wyoming Big Sagebrush (*Artemisia tridentata* spp.) with different fire and grazing histories, since 1939, were selected from Bureau of Land Management Geographic Information System (GIS) data.
- A soil-adjusted vegetation index (SAVI) was derived from multiple, co-registered and normalized Landsat 5 TM and Landsat 7 ETM+ images. SAVI is strongly correlated with leaf-area-index (LAI).
- Inter- and intra-annual variations in SAVI were assessed for grazed and non-grazed sagebrush areas that had been burned (Fig 1).
- Inter-annual variations in SAVI were assessed using one cloud-free image per year from 1984 – 2003 for a 30-day period surrounding 1-July.

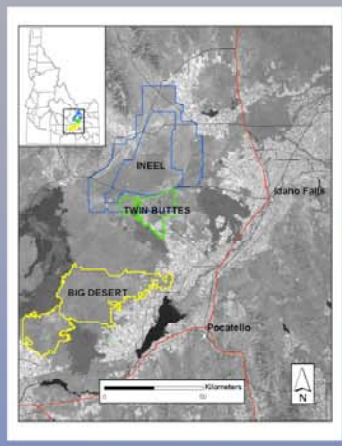

Figure 1. Study sites were located in the Big Desert and Twin Buttes BLM allotments on the Upper Snake River Plain, Idaho.

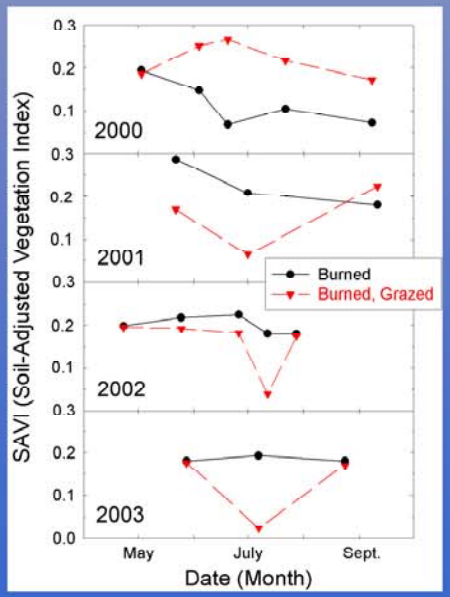

Figure 4. Comparisons of intra-annual variability in SAVI means between grazed and non-grazed areas of Basin and Wyoming Sagebrush that burned in 1999 at Twin Buttes. Grazed n = 55,460 pixels, non-grazed n = 11,536 pixels.

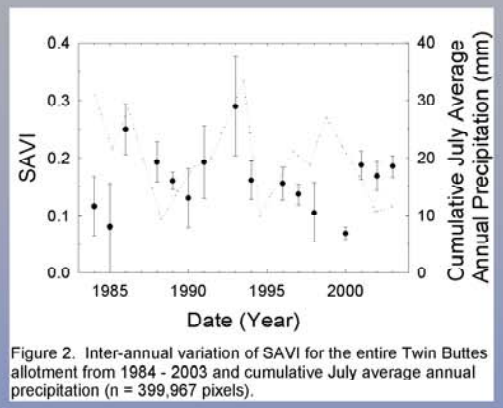

Figure 2. Inter-annual variation of SAVI for the entire Twin Buttes allotment from 1984 - 2003 and cumulative July average annual precipitation (n = 399,967 pixels).

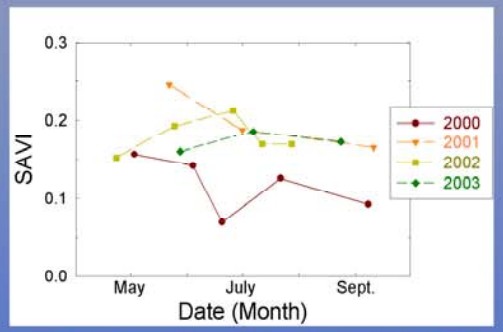

Figure 3. Intra-annual variation of SAVI from 2000-2003 for the Twin Buttes allotment.

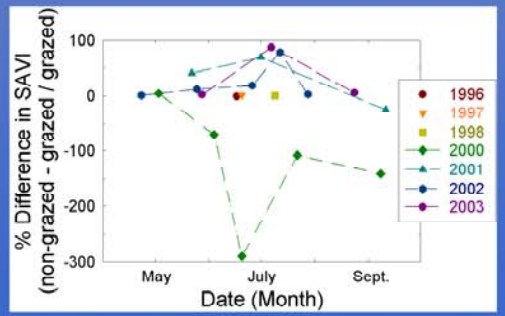

Figure 5. Percent difference of mean SAVI between grazed and non-grazed Basin/Wyoming Big Sagebrush areas that burned in 1999 at Twin Buttes.

Major Findings:

- Inter-annual variations in SAVI from 1984 – 2003 for both Twin Buttes and Big Desert allotments were almost two-fold (± 0.25) for multiple years (Fig 2).
- Regression analyses showed weak correlations between inter-annual variations in SAVI and cumulative July average annual precipitation (p-value = 0.52, F = 0.44).
- The range of variation for mean SAVI (only ± 0.1) within years (Fig 3) was less than between years (Fig 2).
- Comparison of inter-annual variation in mean SAVI showed no consistent differences for lands with different fire and/or grazing histories.
- Differences in mean SAVI within years were found between grazed and non-grazed areas in the four years subsequent to burning in 1999 (Fig 4). Specifically, mean SAVI was 85% lower for areas that were grazed compared to non-grazed three of the four years following fire (Fig 5). In the year following fire, however, mean SAVI for grazed areas was close to 300% higher than non-grazed (Fig 5).

Conclusions:

- Pending ground truthing, remote sensing appears to be sensitive to factors known to affect plant ecosystem function, such as fire and livestock grazing.
- Inter-annual variations in SAVI appeared to have a complex, inconsistent relationship to climate.
- Even though coupling of climate or fire and grazing disturbances on SAVI is not direct, these factors were related to greater intra-annual variations in SAVI.
- Overall, inter-annual variations in mean SAVI were greater than intra-annual variations, except following fire and grazing disturbances.
- Examining changes in mean SAVI provided the most insight to how vegetation may be responding to disturbances.

Acknowledgements:

- National Aeronautics Space Administration (NASA) Award to Weber, K., M. Glenn, and M. Germino.
- Dr. Edwin House, Office of Research, Idaho State University