

DETECTION, PREDICTION, IMPACT, AND MANAGEMENT OF INVASIVE PLANTS USING GIS

Executive Summary Significant Findings and Achievements

- While high spatial resolution satellite imagery seems to offer numerous advantages to the scientific community to assess and monitor rangeland ecosystems, they are currently of limited application due to cost and, more importantly, unreliable accuracy of patchy targets. This is a function of geo-registration error (RMS~5.0m) that routinely exceeds the absolute spatial resolution of the imagery (2.4m) (chapters 1, 5, and 6).
- High spatial resolution satellite imagery has limited applicability for large study areas because the method in which these data are acquired is not systematic, but rather scheduled. A large study area may be imaged over a period of several weeks. While the imagery can be atmospherically corrected to achieve a seamless and “color-balanced” product, this temporal resolution is not satisfactory for rangeland applications where the phenological state of plants changes fairly rapidly throughout the growing season.
- The accuracy of invasive weed classifications is strongly influenced by co-registration between imagery and field training sites. Since most training sites are acquired using GPS, the accuracy and precision of GPS receivers is extremely important (chapters 5 and 14).
- Reliable classification of rangeland ecosystems is a function of minimum target cover. It appears that targets need to exist at a percent cover of nearly 1/3rd (33%) within each pixel to assure reliable classification results (>70% users accuracy).
- We developed LiDAR statistical tools for detection and characterization of rangeland vegetation (chapter 3). LiDAR routinely underestimated the height of vegetation and it appears that a minimum mass of vegetation (i.e., the interior of the shrub rather than the surface canopy) was required to return the LiDAR signal. This known and consistent underestimation allows LiDAR data to be applied to numerous rangeland ecosystems studies.
- We developed LiDAR/hyperspectral data fusion methods for rangeland vegetation (chapter 2). This methodology increased overall classification accuracy (from 74% to 89%) and provided vegetation structure information previously unavailable with standard image classification techniques.
- We are applying the LiDAR methodologies pioneered by this study to areas with wind erosion/deposition. Two proposals have been submitted to continue this research.
- The effect of livestock grazing on vegetation composition in rangeland ecosystems is dependent upon stocking level and spatial distribution. As a result, we have begun investigating the temporal effect of livestock grazing animals on sagebrush-steppe rangelands.

- Vegetation structure and cover becomes variable in space and time after fire, particularly when sites were grazed extensively before the fire. We predict that where and when vegetation indices are low during the growing season, there must be resources available to exotic plants, making invasions possible (chapters 4 and 9).
- Soil water becomes more available after fire --at depth-- due primarily to the loss of sagebrush (chapter 10).
- Spotted knapweed, which appears representative of Eurasian forbs, has major growth advantages over other plants. The extra advantages arise from its ability to tap into deep soil water that is available when sagebrush or other deep-rooted species are not present (e.g., following fire). This growth advantage is linked to superior photosynthesis and morphological features of knapweed (and probably most exotic forbs of rangelands) conferring greater efficiency in its use of soil resources. Soil resources are a key driver of invasions (chapter 13).
- We addressed how invasive plants persist in the long term and felt it was necessary to first investigate factors affecting reestablishment of the community existing before fire. Herbs come back immediately (chapter 10), but sagebrush is slow to reestablish. We found recovery of mountain sagebrush is negatively affected by neighboring herbs, particularly forbs (chapters 8 and 9). The effect appears linked more to competition over nitrogen (or similar elements) rather than water (WNAN). As rangelands become enriched with forbs as a result of invasive plants like knapweed and other Eurasian forbs, we expect sagebrush recovery after fire to be more sluggish than it currently is.
- One student completed his Graduate Certificate in Geotechnologies (Luke Sander) through this research, while two others completed their Master degree (Ryan Baum and Katie DeCristina). Three students were partially funded by this study which ultimately will result in completion of doctoral degrees (Bhushan Gokhale, Judson Hill, and Erik Jackson) (degrees are expected to be conferred in August 2006).
- Public outreach events associated with this study were very successful. Over 200 people (ranchers, range scientists, range managers, and geospatial scientists) were exposed to our research at the annual Geo-spatial and Range Sciences Conference. Several have become very involved and have used products produced through our research in the ranch/range planning.