

Aerial Photo Classification for Monitoring the Spread of *Eragrostis lehmanniana* in a Semiarid Arizona Grassland

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Introduction

Semiarid grasslands such as those in southeastern Arizona are sites of rapidly shifting vegetation patterns, and key drivers of change in the region are invasive transplanted African grasses such as buffelgrass, Boer lovegrass, and Lehmann lovegrass. These species are well-adapted to take advantage of scarce resources, enabling them to often out-compete native grasses following disturbances such as drought and fire.

During the period 2005-2007 the Kendall grassland site at Walnut Gulch Experimental Watershed underwent a change from an assemblage of native grasses to the invasive alien *Eragrostis lehmanniana* (Lehmann lovegrass). The transition followed a multi-year drought that resulted in the mortality of the native grasses in 2005. In 2007 *E. lehmanniana* became the dominant species.

A method of monitoring that would produce a quantitative spatial assessment of the invasion would be extremely useful for answering basic questions about this event that could not be definitively answered by transects alone, such as how much *E. lehmanniana* there actually is at Kendall and how it is distributed across the landscape.

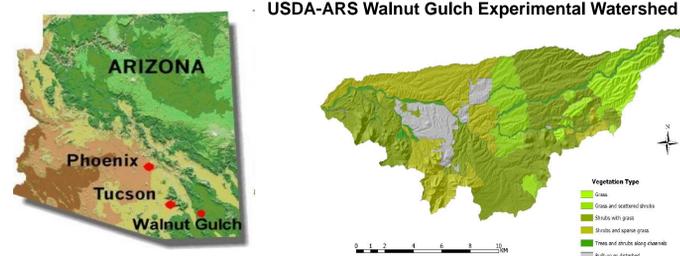
To that end, the aim of this study was to determine whether a single high resolution aerial photo could be used on an annual basis to monitor land cover change related to the *E. lehmanniana* invasion. A crucial aspect of the study was the timing of photo acquisition, which was primarily based on predicted phenological differences in appearance of senescent *E. lehmanniana* from other vegetation and cover types.

In addition to the classification methods and results from 2009 data, this study also reports findings of a return visit to Kendall in the 2010 growing season that shows nascent growth of native species in areas not occupied by *E. lehmanniana*. This continuing vegetation change highlights the need (1) to use multiple monitoring techniques to capture the full extent of ecological change and (2) to consider phenological differences among species for effective timing of different monitoring methods.

Study Site

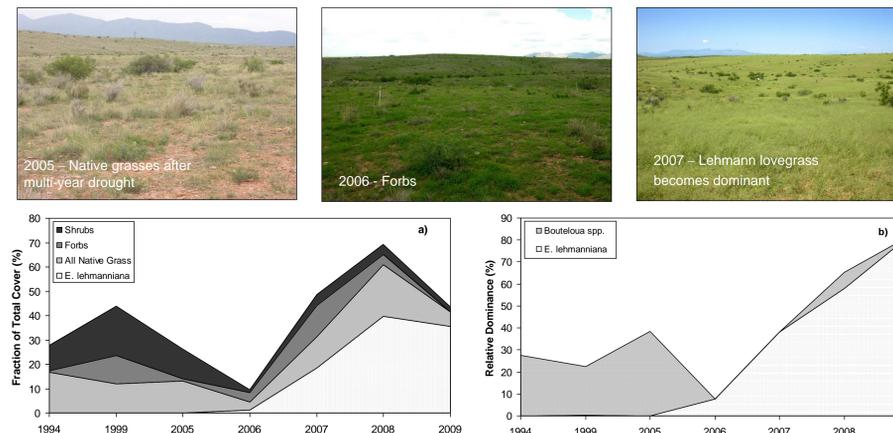
Kendall grassland in the Walnut Gulch Experimental Watershed

- Located in the Upper San Pedro Watershed
- USDA operated
- Semi-arid, sparse vegetation, sandy soils
- Historically dominated by diverse native bunchgrasses:
- *Bouteloua eriopoda* (Torr.) Torr. (black grama), *Bouteloua curtipendula* (sideoats grama), *Aristida sp.* (three-awn), and *Bothriochloa barbinodis* (cane beardgrass) from the first *in situ* measurements until 2005 (King et al., 2008)



USDA-ARS Walnut Gulch Experimental Watershed

Observing the Transition

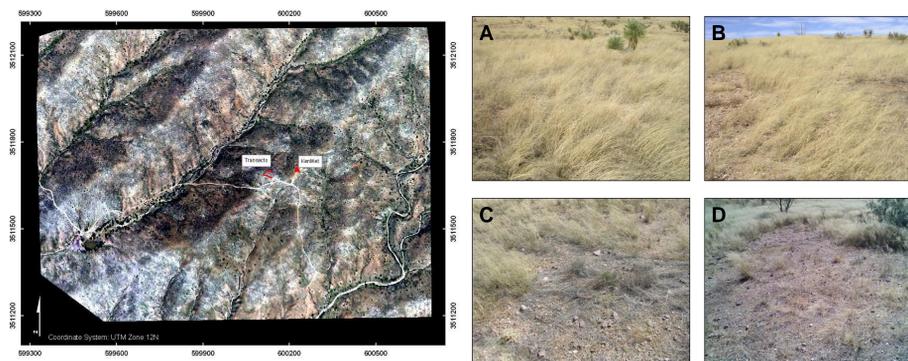


The mortality of native species and subsequent dominance of *E. lehmanniana* reported from Kendall transects as (a) percent of total cover and (b) relative to previously dominant *Bouteloua spp.*

Analysis and Methods

• The object of the analysis was to determine whether the dominance of *E. lehmanniana* at Kendall could be quantified spatially using supervised classification of a high resolution (1 m) aerial photo, thereby providing basic information that could not be obtained through transect measurements alone.

• We reasoned that an aerial photo taken in the fall following the monsoon growing season might reveal some phenological differences in appearance of live and senescent vegetation that could serve as the basis for a supervised classification scheme.



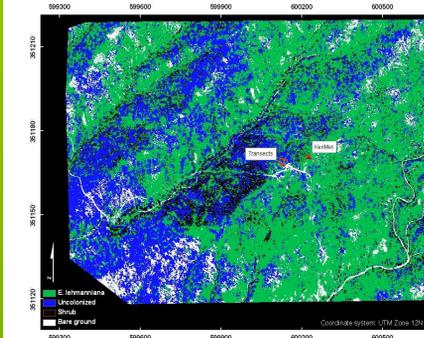
(left) aerial photo of 1.4 km² section of Kendall grassland taken October 9, 2009 by Charles Curtis/Sensair. (right) ground photos taken to assist in validation and documentation of vegetation.

Methods:

- Conducted supervised classification of three-color band (red, green, blue), 1-m spatial resolution aerial photo (Figure 5a) of Kendall taken October 9, 2009.
- Discrimination of classes was primarily based on distinguishing senescent straw-colored *E. lehmanniana* (A & B) from uncolonized areas previously dominated by native grasses but uninvaded (C & D), as well as from shrubs and bare ground.
- 204 sample points were distributed across the aerial photo for classification validation. Ground photos were taken to assist in validation and to document vegetation.

References:
King, D. M., Skirvin, S. M., Holifield Collins, C. D., Moran, M. S., Biedenbender, S. H., Kidwell, M. R., Weltz, M. A., Diaz-Gutierrez, A. (2008). Assessing vegetation change temporally and spatially in southeastern Arizona. *Water Resources Research*, 44(5). doi:10.1029/2006WR005850

Classification Results



- 2002 vegetation measurements showed no record of *E. lehmanniana* growing at the site. Classification results indicate *E. lehmanniana* had become dominant in over 56% of the total land area of the scene in 2009. 28% remained uncolonized.
- Stands of previously dominant native grasses were observed at <5% of sample sites, limiting ability to test for discrimination among grass species.
- Classification revealed variation in distribution such as greater concentrations of *E. lehmanniana* on south-facing slopes.

Supervised image classification accuracy assessment and Kappa coefficients for the 2009 aerial photo.

Class Name	Reference Totals	Classified Totals	Number Correct	Producer's Accuracy	User's Accuracy	Error of Omission	Error of Commission	Kappa
<i>E. lehmanniana</i>	155	135	121	78%	90%	22%	10%	0.57
Uncolonized	33	37	22	67%	59%	33%	41%	0.52
Shrub	8	27	6	75%	22%	25%	78%	0.19
Bare ground	8	5	3	38%	60%	63%	40%	0.58
Totals	204	204	152					

Overall Classification Accuracy = 75%

Overall Kappa Coefficient = 0.5

Cover Type	Fraction of Absolute Cover (%)	
	Photo Classification	Transects
<i>E. lehmanniana</i>	56	35
Native grasses	NC	6
Uncolonized	28	18
Shrubs	8	2
Bare soil and rock	8	38

• Comparison of methods shows similarities in estimated relative proportions of cover types, but absolute differences from historical transects and photo classification illustrate inherent biases of the two methods. Combined, they provide a more complete assessment of vegetation change.

Observing Additional Change in 2010



- Return visits to field sites near the peak of the 2010 growing season revealed the presence of native grass species in uncolonized areas. Return of native grasses was also confirmed by transect measurements (data not shown).
- Due to differences in phenology, presence of native grasses may only be detectable by aerial photos or transect measurements timed during the peak of the summer growing season.
- *E. Lehmanniana* is likely only distinguishable after the growing season

Conclusions

- Classification of high resolution aerial photography can be used to enhance understanding of vegetation change related to episodic changes and exotic invasions by providing spatial information that cannot be gleaned from transect measurements alone. *E. lehmanniana* is the dominant land cover type on 56% of the study area.
- Phenological differences in vegetation types are integral to monitoring and quantifying the extent and distribution of exotic grass invasion at this semiarid grassland site.
- The phenological traits of these species will have methodological implications for the appropriate timing of both transect measurements and aerial photo acquisition for achieving the different but closely related goals of characterizing *E. lehmanniana* invasion and assessing the stability of native grasses.