The assessment of critical forb habitat of Greater Sage Grouse (Centrocercus urophasianus) in northern prairie using field and remote sensing data

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Abstract

The northern prairie of the mixed-grass prairie is predicted to be extremely sensitive to a changing climate. Such changes will likely be hastened through the interaction of climate warming with other climate-occuring grassland disturbances. The changing community composition of northern prairie is expected to have significant effects on the populations of prairie fauna, such as the Greater Sage Grouse (Centrocercus urophasianus). In Canada, Sage Grouse are found almost exclusively within the Silver Sagebrush range of the semi and mixed-grass prairie regions of southern Alberta and southwestern Saskatchewan. However, the population of Sage Grouse in these provinces has declined significantly over the past few decades. This decline has been attributed to habitat loss, resulting in reduced nesting success. Restoring Canadian Sage Grouse populations requires the identification of critical habitat features such as forb cover, at landscape scales. Forb cover is an important food resource for Sage Grouse. We assessed the ability of spectral measurements to predict forb cover in Canadian prairie. We collected forb cover and spectral data from sampling plots (0.5 m x 0.5 m) in Grasslands National Park, Saskatchewan, in June 2004, then used a spatially nested sampling design to scale these observations up to coarser observational scales (10 m and 30 m). Our results showed that (a) the ability to predict forb cover using spectral observations is temporally-dependent; (b) the near infrared and shortwave infrared wavebands are better predictors of forb cover than the spectral vegetation indices tested; (c) forb cover is best predicted over grass-dominated communities; and (d) the predictive ability of all spectral approaches doubles as data are aggregated to coarser sampling resolutions. The temporal dependence in forb cover predictability is due to differences in plant phenology and surface water conditions across the growing season. The less accurate predictions of forb cover in shrub-dominated communities occur because shrub species dominate the spectral signal recorded by the radiometer. Refinements to this approach may permit land managers to (a) identify sites for recovery and reintroduction based on forb density potential as well as linking the fate of extant Sage Grouse populations to features of their critical habitat, and (b) assess the longer-term effects of climate on Sage Grouse recovery, by allowing climate-driven changes in forb cover to be monitored, and the identification of sites that are declining or not declining in productivity and forb density.

1. Introduction and Alms

(a) The changing community composition of northern prairie is expected to have significant effects on the populations of prairie fauna such as Greater Sage Grouse (Centrocercus urophasianus).
(b) The population of Sage Grouse in Alberta and Saskatchewan has declined significantly over the past few decades. This decline has mainly been attributed to the loss of suitable habitat, resulting in reduced nesting success.
(c) Because Sage Grouse survival is intimately tied to Sagebrush, attempts to map the critical habitat of Sage Grouse have generally been limited to studies of Sagebrush density and structure. However, there have been no attempts to map other critical habitat features to which Sage Grouse may be responding.
(d) One such feature is forb cover, which is (a) an important food resource for Sage Grouse and (b) plays a structural role in home range selection by Sage Grouse.
(e) Here, we assess the ability of spectral measurements to predict forb cover in Canadian prairie. We hypothesize that since forb cover in upland grassland in southern Saskatchewan has been shown to correlate relatively well with sward productivity, productivity-related spectral indices may be well correlated with forb abundance.

2. Study Site and Sampling Strategy

(a) Figure 1. Grasslands National Park and sample site locations

3. Statistical Methods

Parameter selection for regression models

(a) The combination of individual spectral bands and derivatives to use to predict water content were selected using the bootstrap approach for model selection described by Olsen and Jackson (2000).
(b) Separate regressions were carried out using (a) the selected combination of individual bands; (b) the selected combination of derivatives; and (c) individual spectral vegetation indices.
(c) The best approach was identified using a leave-one-out cross-validation approach.

Validation

(a) Each model was validated using a leave-one-out cross validation approach (Olsen and Jackson, 2000).
(b) The predictive ability of each model was characterized using (a) the root-mean-square error of prediction (RMSE); and (b) the correlation (r) between the observed and predicted responses (also called the cross-validated r).

4. Results

(a) The results of our 0.5 m, 10 m and 30 m-resolution studies highlight four important trends:
(1) that the ability to predict forb cover using spectral observations depends on the time of spectral data acquisition;
(2) that the best Band Combination Approach (using TM bands 4 and 5) predicts forb cover of grassland-shrubland communities with greater accuracy and precision than the “best” Vegetation Index Approach (using the NDVI, M5I or GVRM);
(3) that forb cover is predicted most accurately over grassland-dominated communities than shrubland-dominated communities, but predicted only slightly more accurately over grazed communities than non-grazed communities; and
(4) that the predictive ability of the Band Combination and Vegetation Index approaches doubles when plot-level data are aggregated to 10 m and 30 m sampling resolutions.

5. Conclusions

(a) Research presented here is encouraging for the prospect of monitoring and mapping forb cover of northern prairie grassland-shrubland using medium-resolution multispectral satellite data.
(b) Because forb cover is a critical component to Sage Grouse fledging success, a spectrally-based spectral monitoring tool will aid in the identification of Sage Grouse critical habitat at landscape scales and allow land managers to identify sites for recovery and reintroduction based on their forb potential, and attribute the fate of extant Sage Grouse populations to features of their critical habitat.
(c) The ability to predict forb cover from spectral data may provide a way for assessing the longer-term effects of climate on Sage Grouse recovery. Our spectrally-based spectral monitoring tool may allow for climate-driven changes in forb cover to be monitored, and the identification of sites that are declining or not declining in productivity and forb density.

6. References

(e) Olsen, J.D. and Jackson, D.A. (2000). Torturing data for the sake of generality: How valid are our regression models? Ecoscience. 7(4), S51-S50.