Grassland disturbance classification with field data and remote sensing

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Introduction

- Remote sensing is a cost-effective technology used to study landcover and wildlife habitat at multiple thematic-spatial-temporal scales, to inform wildlife monitoring and management.
- It is particularly valuable for studying the habitat of animals with varied habitat requirements that fluctuate over time and space, like the ring-necked pheasant (*Phasianus colchicus*) in grassland ecosystems. However, current landcover sensing products do not adequately characterize grasslands at a scale relevant to pheasants.
- Disturbances, including events like haying, grazing, and fire, play a crucial role in shaping grassland vegetation structure. These disturbances significantly impact pheasant habitat. Remote sensing indices can help identify these habitat disturbances.
- This study uses remote sensing, field observations, and machine learning to classify grasslands according to ecologically informed disturbance levels. Results will contribute to the development of models and decision-support tools for improved landscape management for pheasants.

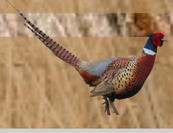
Methods

- Pheasant abundances (crow counts) and habitats were sampled across two eastern Nebraska landscapes (21 counties). Between April and May from 2021 to 2023, grassland was visually assessed as highly disturbed, moderately disturbed, or undisturbed (Figure 1).
- Each year around 1500 field parcels were classified and so far around 10% (around 2000 parcels) of them have been digitized from paper maps. Of such digitized parcels, 16% (around 600 parcels) were visually classified as grassland. Of such grassland parcels, 44% (275 parcels) were classified as highly disturbed, 27% (167 parcels) as moderately disturbed, and 28% (175 parcels) as undisturbed.

Figure 1. Example sites of visually classified A) highly disturbed grasslands; B) moderately disturbed grasslands and C) undisturbed grasslands.

- The Sentinel 2 dataset from the European Space Agency at a spatial resolution of 10 meters and a temporal resolution of 2-3 days was accessed using Google Earth Engine (GEE) to compute various vegetation indices from the observed fields.
- The computed vegetation indices were: The Mid-Infrared Burn Index (MIRBI), Enhanced Vegetation Index (EVI), Palmer Drought Severity Index (PDSI), Disturbance Index (DI), Normalized Difference Vegetation Index (NDVI) up until 27 months before the disturbance observation date.
- The grassland classification was performed in R using a machine-learning approach (random forest) using both field observations of grassland disturbance and the extracted parcel vegetation indices and characteristics from Sentinel 2.

Results and Discussion



- The selected vegetation indices and land field characteristics area are good indicators of field disturbance with an error rate of 39% according to preliminary results of the random forest model (Figures 2, 3, and 4).

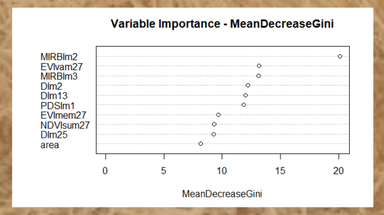


Figure 2. Results from the random forest classification show the best-performing variables. The higher the Mean Decrease Gini, the better the variable performed at classifying grassland disturbance. M and the corresponding number next to the index indicates how many months prior the index is calculated before the observation date. Va means variation. Me means median. Su means cumulative sum.

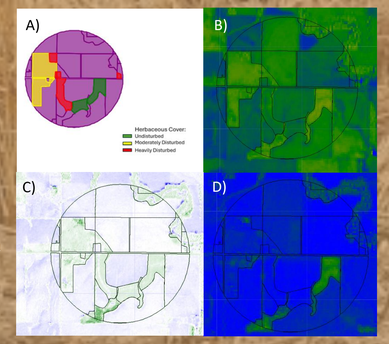


Figure 3. Example of grassland disturbance classification at a single sample survey point entailing the three best disturbance predictor variables: A) digitalization of paper habitat maps, highlighting grassland disturbance categorization; B) the Mid-infrared Burn Index (MIRBI) two months before the disturbance observation date (the warmer the color the more likely a fire occurred); C) the Enhanced Vegetation Index (EVI) variation between fields 27 months before the disturbance observation date (greener areas correspond with greater vegetation variation productivity); and D) MIRBI three months before the disturbance observation date (the warmer the color the more likely a fire occurred).

- So far MIRBI two months before the disturbance observation date is the best predictor of grassland disturbance (Figure 2) indicating that fire is an important component of grassland disturbance in Eastern Nebraska. The lower the disturbance, the higher the index and hence higher the fire occurrence in the field (Figure 4).

Figure 4 Mid-infrared Burn Index (MIRBI) for classified grassland disturbances 2 months before the disturbance observation date. The higher the index the higher the probability that a fire occurred.

- As more data is classified using the random forest algorithm, the classification is expected to become more accurate. More vegetation indices and land characteristics such as soil indices will be calculated to improve the classification.
- Remote sensing has the potential to be able to classify grassland disturbance enabling the remote identification of pheasant habitat. This will aid management decisions regarding this avian and potentially of other species as well.

References: Please scan the QR code to access the reference list