Integrating Functional Perspective of Plant Co-Occurrence with Rare Species Distribution Models: An Approach to Maximize Remotely Sensed Prediction Accuracy of Low Prevalence Species

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In general, species of conservation concern have smaller population sizes with limited geographical coverage. Identification of large scale geographical and temporal variations of such rare plant species distributions is an essential aspect for managing species of special concern. Usually, inherited nature of limited occurrences of rare species reduces species distribution model (SDM) robustness. This concern is much more serious in SDM processes with remotely sensed (RS) predictors as direct spectral signatures of rare plant species are hard to distinguish using air-born or space-born sensors. Therefore, interdisciplinary approaches combining geographical and ecological perspectives into one framework likely to provide feasible way forward to increase prediction accuracies of SDMs. The main purpose of our effort is to test the capabilities of various SDM methodological procedures to handle low occurrence-rate data with RS predictors and develop a hybrid approach to SDMs that accounts for plant community structure (species co-occurrence at the small-plot scale) with observed ecologically meaningful remotely sensed predictors.

The study focuses on a remnant fescue mixed prairie system contains mosaics of different assemblages of plant communities. Evaluation of relative strength of SDM techniques was implemented across different SDM algorithms and different species with contrasting prevalence patterns. The study evaluates probabilistic co-occurrence analysis approaches to assess the strength of association of each rare species with common species and evaluate how rare species prediction accuracies vary on the basis of association strength to the common species.

Ground-truth species data were collected from 16x16m grid (cell size of 1x1m) at each sample point and in total 19 sample locations were surveyed to identify species relative abundance, presences, and absences. The grassland foliage reflectance was measured in July-2016 using MicaSense RedEdge multispectral camera (five bands) designed for unmanned aerial vehicle (UAV). We evaluate connection between focal species functional traits and RS data to avoid non-stationarity over different spatial and temporal scales. The indices in consideration include Normalized Different Vegetation Index (NDVI), Fraction of photosynthetically Active Radiation (fPAR), Normalized Different Water Index (NDWI), Normalized Difference Senescent Vegetation Index (NDSVI), Cellulose Absorption Index (CAI), soil moisture and the land Surface Temperature (LST). The modelling of each individual species then will be based on the non-correlative direct or indirect indices and finally staked with co-occurring (positive or negative) species to produce probability surface that can potentially maximize estimation precision of rare plant species.

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