Title: Scaling Prairie Conservation Through Deep Learning and Remote Sensing Approaches

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Abstract: Hill prairies in the Driftless Region are home to rare and endangered species yet lack comprehensive inventories due to the cost and time requirements of manual field surveys, leaving conservation efforts unable to track loss or prioritize restoration at landscape scales. We developed and compared machine learning, deep learning, and semantic segmentation architectures trained on multi-temporal high-resolution imagery (2017-2022) integrated with topographic and spectral data to automate prairie detection and enable landscape-scale monitoring. Preliminary validation shows performance exceeding 90% F1-score with balanced precision and recall, with multi-year training strategies improving temporal generalization by approximately 5% over single-year approaches. Manual inventory and temporal analysis across a subset study area found 681 patches covering approximately 244.83 ha. Network connectivity analysis identified 25 components, with fewer than 2% of patches completely isolated. Multiyear assessment of an intensively managed prairie complex showed net habitat gain of 17% over seven years, though gains concentrated in specific large sites while smaller locations continued shrinking. This framework enables conservation stakeholders to efficiently map previously unknown remnants, quantify restoration effectiveness, and strategically prioritize protection of network-critical hubs and corridor establishment between isolated patches, directly addressing the data deficit limiting adaptive management at necessary landscape scales.