INTEGRATING FIELD SAMPLING AND REMOTELY SENSED DATA FOR MONITORING THE FUNCTION AND COMPOSITION OF NORTHERN MIXED GRASS PRAIRIE

by

Andrew Davidson

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ABSTRACT

This dissertation explores the use of remote sensing data for monitoring mixed-grassland function and composition. The field data used in this study were collected over a northern prairie (Grasslands National Park, Canada). First, I investigated whether nested sampling or geostatistics best characterized the spatial structure of computer-simulated grassland landscapes. This study showed that the most accurate estimates of structure under a limited sampling budget were those derived from nested sampling. This nested approach was implemented in my subsequent field studies. Second, I investigated the relationship between early- to late-season biomass and C4 species cover in upland prairie. Spectral radiometer-derived estimates of biomass and C4 cover information were collected over nested sample points (0.5m resolution) during the 1995 growing season. Nested sampling allowed the relationship between variables to be investigated at 0.5m, 2.5m, 10m and 50m resolutions. Strong, significant and negative relationships between early-to-late season biomass and C4 species cover were found at the coarsest resolutions. Third, I investigated the relationship between multi-date spectral indices and more complex measures of plant community composition. Using nested sampling data from 1998, the scale-dependence of relationships between five productivity metrics and species and functional group diversity were investigated. Richness-productivity relationships were asymptotic, richness-evenness relationships were linear, the effects of species were greater than those of functional groups, and the presence of particular species and functional groups significantly affected diversity-productivity relationships at 0.5m. These results were consistent with those reported for other grassland studies. Fourth, I evaluated three techniques for predicting C4 species abundance at within- and across-community scales. The former analysis utilized nested sampling data from 1998, while the latter used satellite remote sensing data (Landsat-TM (30m); AVHRR (1km)) and a Parks Canada vegetation survey of GNP (30m resolution). All three techniques performed well at the within-community scale, but only one performed adequately at the across community scale, indicating that monitoring techniques that work well at finer resolutions are not necessarily transferable to coarser-resolution studies. Together, these studies highlight the encouraging potential of remote sensing information for the monitoring of grassland function and composition.

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LIST OF ABBREVIATIONS

Listed in alphabetical order:

%C4. .....Percent of ground covered by C4 species.
ALB. .....Aboveground live biomass.
ANPP.....Aboveground net primary productivity.
$ANPP_{AV}$.....Aboveground net primary productivity using averaging method.
$ANPP_{IBP}$.....Aboveground net primary productivity using IBP standard method.
$ANPP_{MM}$. .....Aboveground net primary productivity using max-min method.
$ANPP_{PB}$. .....Aboveground net primary productivity using peak biomass method.
$ANPP_{TI}$.....Aboveground net primary productivity using time-integrated method.
AVHRR. .....Advanced Very High Resolution Radiometer.
B_{early}.....Early-season aboveground live biomass.
B_{early}/B_{late}.....Ratio of Early- to Late-season aboveground live biomass.
B_{late}. .....Late-season aboveground live biomass.
DA. .....Discriminant Analysis.
DOY.....Day of year.
DOYEND. .....Day-of-year of end of growing season.
DOYMAX.....Day-of-year of time of maximum NDVI.
DOYON. .....Day-of-year of time of greenup.
DOYRAN. .....Length of growing season.
DVI. .....Difference Vegetation Index.
$e^{H'}_{FR}$.....Effective functional group richness.
$e^{H'}_{SR}$.....Effective species richness.
FOV.....Field of View.
FR. .....Functional group richness.
GDD.....Growing degree day.
GDD_n. .....Growing degree day at which *n* percent of the total seasonal time-integrated NDVI has been accumulated.
GNP.....Grasslands National Park.
H'. .....Shannon evenness.
IPVI. .....Infrared Percentage Vegetation Index.
MSAVI2. .....Second Modified Soil-Adjusted Vegetation Index.
MSR. .....Modified Simple Ratio.
MSS. .....Multispectral Scanner (Landsat).
ND_{early}.....Early-season NDVI.
ND_{early}/ND_{late}. .....Ratio of Early- to Late-season NDVI.
NDEND.....NDVI value at end of growing season.
ND_{late}. .....Late-season NDVI.
NDMAX.....NDVI value at time of maximum greenness.
NDON. .....NDVI value at time of greenup.
NDTIN.....Time-integrated NDVI
NDVI.....Normalized Difference Vegetation Index.

NOAA. .....National Oceanic and Atmospheric Administration.
NRFC. .....Number of realized functional group combinations.
NRSC.....Number of realized species combinations.
RAGUP. .....Rate of greenup.
RASEN.....Rate of senescence.
RDVI. .....Ratio Difference Vegetation Index.
RMSE. .....Root mean square error.
RMSEP. .....Root mean square error of prediction.
RVI. .....Ratio Vegetation Index.
SAVI. .....Soil-Adjusted Vegetation Index.
SPOT-P. .....Système pour l'observation de la terre (Panchromatic).
SR. .....Species richness.
TLB. .....Total live biomass.
TM. .....Thematic Mapper (Landsat).
TTI.....Temporal trajectory Index.
VIs. .....Vegetation Indices.
VLU. .....Vegetation land unit.
VT. .....Vegetation type.

This thesis is dedicated to my grandparents,

in memoriam.