Forb Counts in Grassland Are Sensitive to Analytical Method

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The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress

Published by the Kenya Agricultural and Livestock Research Organization

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Key words: Forbs; Plant Census; Land Hierarchy

Abstract

An analysis of forbs from 9 years of Plant Census protocol (NRI 2019) is compared to data from the Line Point Intercept (LPI) protocol. Both protocols were conducted on the same geospatially separate macroplots (N=1230). The macroplots locations were stratified by NRI based on a land hierarchy which has had long-term use in the United States (Salley etal 2015). This ties vegetation and land together in the data. The analysis showed that the 15-minute plant census method increased forb species data by 29 percent over the LPI method which takes 40-60 minutes. Both methods captured similar total ratios and rank of all functional groups inventoried. The inventory, measured from a uniform plot size, allows plant census forb data to be further analysed by constancy at various land scales. Results provide examples of the forb data used to help identify character species affinity for land hierarchical sites, regional floristics, functional-structural group composition, and assist in future plant identification and awareness training. The Plant Census protocol increases data with very little time investment. Ecological studies with deeper forb focus would benefit by adding the Plant Census protocol.

Introduction

Forbs are important for Ecological Site resilience, wildlife and pollinator habitat, as well as soil and forage management issues. The multi-faceted ecology that forbs are known to express discourage a focus on forbs in range ecology studies. The seasonal timing of bloom and interannual variability of bloom flushes limit observation at time of data collection. Protocols that measure total annual production kg/ha/yr often show forbs making up less than 10% of the total weight. Yet forbs constitute the largest component of herbaceous species richness in world grasslands, shrublands, and savanna ecosystems as reviewed by Siebert and Dreber (2019). Inventory protocols that increase forb species diversity as part of the data collection answers Siebert and Dreber's call for more organized forb studies.

Data used in this analysis was collected generally within a 90-day collection period each of the 9 years. Ecological site land units inventoried over the years accumulated some interannual variability in forb expressions. Flush of blooms draws attention during the protocol and certainly aides in positive species identification of forbs by the data collection teams.

Methods and Study Site

I reanalysed 9 years (2009-2017) of plant species composition data from 2 protocols to compare success at capturing forb data. The data was obtained from the U.S. NRI nation-wide longitudinal sample of on-site conditions of grassland and shrublands. The NRI applies a stratified weighting to each location. That was not applied here. The analysis used species counts from 1,230 macroplots (0.162 ha) collected over 9 years in a single Major Land Resource Area (MLRA). I compared the Plant Census protocol to the Line Point Intercept from the same macroplot data set to determine if the interpretations were sensitive to the method of data collection.

The Plant Census protocol is a 15 minute species search. Identify all plants in the macroplot (60-meter diameter circle) by genus and species. Time used to key out/identify plants is not included as search time. A macroplot tally is estimated for each species and placed in one of five different categories from 10-1,000 individuals. The Line Point Intercept protocol captures foliar canopy by species including understory foliar canopy hits. A 2-mm diameter wire pin flag of adequate length is dropped vertically at 90 degrees over the mark on the transect. Foliar or basal contact with the wire captures up to 6 species hits, litter layer, and basal cover per mark for 101 marks.

Constancy of all forb species data is summarized at the MLRA scale containing 60 Ecological Sites. Constancy at the Ecological Site scale was filtered to include only the forbs that had at least 6 locations of data collected on the same site over the 9 years.

The data locations are in the Malheur High Plateau MLRA-23 comprised of 59,320 square kilometres with 84% grassland cover. The elevation is from 1,190 to 2,105 meters and precipitation is in the 150-305 mm precipitation zone in the Pacific Northwest of the United States. The Malheur High Plateau geology of andesite

and basalt is entirely on an intermontane Plateaus. The present grasslands have high botanical diversity potential with minimal landscape disturbances or fragmentation.

The Ecological Sites were confirmed in the field by soil type, physiognomy, and landscape position. An Ecological Site is a conceptual division of land for management and inventory. Defined as a distinctive kind of land based on recurring soil, landform, geological, hydrological, and climate characteristics that differs from other kinds of land in its ability to produce distinctive kinds, amounts, and proportions of vegetation and in its ability to respond similarly to management actions and natural disturbances.

Results

The constancy analysis of species from three primary functional groups of grass, forb, and woody revealed that both methods captured an equal proportionality of species. Forbs made up 61% of the Plant Census while LPI forbs were 56% of the total. Grasses made up 18% and 24% and Woody (includes subshrub) was 20% and 19% respectively. However, the total number of species was 24% higher from the plant census compared to LPI. The Plant Census functional group Forbs were 29% higher; Grasses were about equal in number and Woody species were 28% higher. The Plant Census method yielded more species and higher percentages of forb and shrub species. This indicates that resilience of functionality is supported by many forb species.

Estimated number of individual plants/species were tallied during the plant census 15-minute protocol. Forbs collectively averaged slightly above 100 plants per 0.162 ha while grass plants averaged above 500 and woody averaged in the 11-100 tally.

I tested to see if spatial scale influenced forb numbers. I compared data sets limited to one State, one MLRA and 60 Ecological Sites to a larger scale of 5 states, 6 MLRAs, and 12 Ecological Sites. The 5-state spatial scale showed a similar dominance ratio of Forbs (43%) more than Grass (31%) more than Wood (26%).

Results of the analysis at the MLRA scale (1:3,500,000) counted 209 individual forb species with a resulting mean constancy of 0.03 with a range of 0.02-0.13 at the 25 and 75 percentiles. The highest individual constancy of 0.63 belonged to a native perennial leguminous forb (Lupineus) with toxic compounds. Livestock are managed to avoid consuming this plant which may make it more observable on-site and across the season and years.

Forbs were identified into 12 functional groups using USDA Plants Database for duration, introduced or native, and seasonality. Seasonality of flowering is important to timing of inventroy. Five broad groups resulted in 56% Perennial Forbs: 6% Introduced Perennial Forbs; 23% Annual Forbs; 14% Introduced Annual Forbs; 4% Perennial Monocot Forbs for the entire MLRA data set. Spring flowering perennial forbs had the highest constancy while introduced summer annual forbs had the lowest. Perennial forbs averaged 9% constancy while Annual Forbs averaged 8%. Introduced forbs made up less than 20% of the total forb species in number but had only slightly less constancy than the native species.

Goodness of Fit analysis compared the number of locations per ecological site with the corresponding number of cumulative species encountered. Between 83 (R2 =0.82) and 248 (R2 =0.57) locations per ecological site are needed to fully characterize the total forb species diversity. Two Ecological Sites: Sandy Loam (28 locations) and a Claypan (47 locations), still had new forb species being encountered on more than 70% of their macroplot locations. Grass and Woody seem to have met a sampling plateau of adequate locations collected for the purpose of developing a species list common to the MLRA.

Results of the analysis at the Ecological Site scale (1:24,000), dataset was limited to 32 Ecological Sites and 70 forb species which occurred on Ecological Sites with at least 6 macroplot locations. Of these, 9 forbs had average constancies greater than 0.40. Less constant or rare forbs (0.03 or less) included 25 species. Data collection team's recognition of these low constancy forbs can clarify if these are rare or just inconspicuous.

The species scale (x, y) were grouped by mean constancies of 0.21-1.00; 0.11-0.20; and 0.06-0.10. Resulting in forb species groups of 14%, 33%, and 53% respectively.

A native annual forb (Collinsia grandiflora COGR2) was found on 11 of the MLRA's ecological sites with a mean constancy of 0.23 on a possible 236 locations. With Ecological Site names like Pumice Claypan; Gravelly Terrace; and Lava Benches this Native Annual Forb might be an indicator or character species for these harsher/drier sites.

Discussion

The number of unique forb species identified at the MLRA land hierarchy scale increased by 29% with the more inclusive time-limited plant census protocol. Flush of blooms draws attention during the protocol and certainly aides in positive identification. The multi-year sampling design helps capture interannual variation.

Constancy is not a measure of ecological change by itself but can be used for comparing functional groups if the sampling or monitoring designs are established on a sufficiently sized macroplot. Constancy helps with organizing functional groups like forbs that are occupied by numerous species.

The Plant Census protocol is inclusive and time efficient for collecting inventory data at broad MLRA and local Ecological Site scales. The inventory gathered can further inform which elements to include in studies of ecological change; identify character species; and serve as preliminary database of forb species in regional floristics.

Acknowledgements

Dr. Joel Brown (USDA-NRCS) for review recommendations.

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