NWERN Sampling Paper

**Introduction**

Measuring ecosystem processes and functions and their indicators is critical to providing data to managers and researchers seeking to understand ecological patterns and change (CITE). Transect-based monitoring methods have long been a valuable tool in ecosystem monitoring (CITE). Monitoring plots are established based on the footprint of one or more transects that are used to sample vegetation, soils, wildlife populations to estimate ecosystem condition and dynamics (CITE). Often the same transects are used to measure multiple ecosystem attributes to establish a multi-faceted picture of the ecosystem of interest.

For instance, the Line-point intercept, Vegetation height, and Canopy gap intercept methods have together been identified as a set of “core methods” which can provide critical indicators of upland rangeland condition on rangeland ecosystems globally (Toevs et al. 2011, Herrick et al. 2018). The core methods are used to produce a broad range of indicators, including species cover and composition, vegetation height and distribution, bare soil cover, invasive species cover, wildlife habitat indicators (McCord et al. 2022). These methods can also be used to parameterize, train, and validate models such as sediment transport by wind (AERO, Edwards et al. 2022) and water (RHEM, Hernandez et al. 2017), and spatially explicit remote sensing based models such as the Rangeland Analysis Platform (Allred et al. 2021) and LandCART (CITE).

The core methods have been widely adopted within the rangeland management and research community. National monitoring programs such as the Bureau of Land Management (BLM) Assessment, Inventory, and Monitoring (AIM) program, the Natural Resources Conservation Service (NRCS) Grazing Lands On-Site National Resources Inventory (NRI), and Mongolia’s NAMEM (Kachergis et al. 2022, Densambu et al. XXXX, NRI…). Research networks, such as National Wind Erosion Research Network (Webb et al. 2016) and SageSTEP (McIver et al. 2010) leverage these methods to improve understanding of wind erosion processes and woody fuels treatment effectiveness. Other research studies also rely on these methods to study shrub encroachment treatment effectiveness (RestoreNM), oil and gas reclamation effectiveness(CITE), grazing regimes (Maestre et al. 2022), and…. In aggregate, over 85,000 locations have been sampled using these common core methods (McCord et al. In Review).

While all of these efforts rely on the same set of transect-based methods, the number, length, and sampling intensity of the transects varies by program (Figure/Table 1). or example, the NRI program leverages two intersect 150 foot transects with a total of 102 Line-point intercept pin drops representing 0.16 hectares, the AIM program standard implementation samples 0.07 hectares three 25 meter transects with a total of 150 LPI pin drops, and the National Wind Erosion Research Network sites use 3 intersecting 100 m transects with 1200 LPI pin drops total to sample 1 hectare. Other studies and monitoring programs may use other transect and sampling configurations. Although there are studies regarding the sufficient number of transects and pin drops for some methods, like the Line-point intercept method (Herrick et al. 2005, Drezner and Drezner 2020, Godinez-Alvarez 2009 paper), these studies have been isolated to a single ecosystem (e.g., Chihuahuan desert) and either focus on the number of pin drops (Drezner and Drezner 2021) or number of transects (Herrick et al. 2005, Godinez-Alvarez et al. 2009) but not both. There is limited work exploring the sampling sufficiency by transect number for the Gap intercept method (Herrick et al. 2005) and Vegetation height sample density (Toledo et al. 2010). All studies hold transect length as a constant. As a result, there is insufficient information available to researchers and land managers seeking to implement these methods on the optimal transect length and sampling interval to adequately sample ecosystems while also reducing data collection costs.

Our aim is to conduct an assessment of the sampling sensitivity of the Line-point intercept, Vegetation height, and Canopy gap methods under different transect lengths, numbers, and sampling intervals to determine: 1) minimum sampling requires to describe ecosystem characteristics and detect ecosystem change for each method, 2) the optimal transect length and number for measuring all three methods, and 3) re-evaluate the sampling approaches of widely established monitoring and research programs to make recommendations for future monitoring efforts. We use the NWERN research sites to explore these questions as the network spans the western US, includes multiple site visits, and represents a sampling effort unlikely to be surpassed by other monitoring programs and few research studies.

**Methods**

***Data***

* X number of sites

***Analysis***

* Used Fisher’s exact test to determine if the base NWERN and subsample proportions were significantly different.
  + Non-parametric
  + Any sample size (vs. chi square which requires >5 samples in a contingency table)
  + Fisher’s exact test is known to be conservative, therefore significant differences should be interpreted together with ecologically meaningful differences

**Results**

**Discussion**

* This study is isolated to determining change at the plot scale, other studies address detecting change at the landscape scale with varying numbers plots and sampling intervals (e.g., Herrick et al. 2005, Baasch et al. 2010).
* Herrick et al. 2005 found that increasing the number of transects sample at the plot decreases the number of plots need to detect change at the landscape scale.
* Drezner and Drezner found that LPI pin drop interval of at least 80% of the largest plant diameter provides the most reliable results

**Figures**