An Integrated Assessment and Management Optimization System for Grazinglands

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An Integrated Assessment and Management Optimization System for Grazinglands

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Abstract

Rangelands and pasturelands are often assessed using different methodologies. The Interpreting Indicators of Rangeland Health and Pasture Condition Scoring methodologies, two techniques used widely across the USA, were developed for rangelands and pasturelands respectively. These two grazingland assessment techniques were determined to be complementary and if integrated could provide an optimized approach to measure grazinglands without regards to specific use (i.e. range or pasture). We present an improved grazingland assessment protocol that merges indicators and attributes from Interpreting Indicators of Rangeland Health and Pasture Condition Scoring methodologies. This Integrated Grazingland Assessment (IGA) approach allows evaluators to assess site conditions and to make interpretations regarding management based on site-specific attributes (soil and site stability, hydrologic function, biotic integrity) that can potentially optimize the ecological potential and livestock carrying capacity of a site. The IGA provides a way of detecting changes in these ecological attributes relative to a site's ecological potential. The IGA can also inform land managers about the utility of an area for livestock production or factors that could be keeping the area from operating at its full productive potential, while accounting for the different management objectives (e.g. increase productivity while maintaining native rangeland, optimizing seed mixes to improve planted pasture productivity) for the grazinglands where these methods are usually applied.

Introduction

In many parts of the world grazinglands have traditionally been assessed based on a particular use. Some are managed as pastures where the grazingland is devoted to the production of introduced or indigenous forage for harvest by grazing, cutting, or both; while others are managed as rangelands in which the native vegetation is predominantly grasses, grass-like plants, forbs, or shrubs that are grazed or have the potential to be grazed (Allen et al. 2011). In the United States of America, the most used rangeland health assessment protocol is the Interpreting Indicators of Rangeland Health (IIRH; Pellant et al. 2020) and the most common pastureland assessment protocol is the Pasture Condition Score (PCS; Ogles et al. 2020). Individually, the IIRH protocol provides a detailed, site-specific ecological assessment of the area being evaluated while the PCS provides a broader ecological assessment that can be used as a monitoring and management tool. Together, these tools can provide an ecological assessment and management optimization approach for all grazinglands. An integrated grazingland assessment approach would expand on the strengths of the IIRH and PCS methods to provide a detailed assessment of the ecological attributes of an area and inform management (Toledo et al. 2016). Relevant ecological attributes include soil and site stability, hydrologic function, biotic integrity, and livestock carrying capacity. These attributes contribute to forage/fodder production and to additional services such as sequestration of soil carbon (C), nutrient cycling, and prevention of soil erosion (Nelson 2012).

Methods and Study Site

Experts in either or both types of assessments were convened into a focus group to determine method commonalities, differences, potential for unification, and potential for adoption of a new unified approach (Toledo et al. 2014). A field study using each assessment methodology was performed at 4 different locations in the northern Great Plains region of the United States to determine methodological overlap and gaps (Toledo et al. 2014). This is a semi-arid to dry sub-humid region where most rangelands are dominated by perennial grasses. An integrated assessment methodology was developed based on qualitative and quantitative results from these efforts. Tests for the resulting integrated assessment methodology were performed at two different locations in the northern Great Plains region of the United States (Toledo et al. 2016).

Results

Focus group discussions suggested that most indicators in each of the two protocols could be combined into one common approach. Based on our data, we have identified redundancies between the two protocols in ecologically based indicators of cover, erosion, compaction, and plant vigor for this region. Quantitative comparisons of erosion indicators were correlated with indicators related to soil compaction; plant mortality was correlated with plant vigor; and litter amount was correlated with plant residue. Although statistically significant, the strength of the relationships between both protocols were not as high as predicted. It was especially striking to see that erosion could be rated very differently by the two methods even at the same site, where it should be both quantitatively and qualitatively identical. The focus group also identified indicators that have no close matches between IIRH and PCS but are important in terms of ecology and management interpretation. These indicators included, but were not limited to, soil surface resistance to erosion, plant community composition and distribution relative to infiltration and runoff, uniformity of use, and livestock concentration areas.

Since the IIRH method provides a standardized, site-specific way of evaluating ecological indicators, the integrated assessment system recommends using IIRH indicators to assess soil and site stability, hydrologic function and biotic integrity. PCS indicators that are specifically related to the ability of an area to support a sustainable livestock grazing operation and were recommended for the integrated assessment are: percentage desirable forage species, forage plant diversity, plant residue, percentage legume, uniformity of use, and livestock concentration areas (Table 1).

Table 1. Twenty-three indicators of the integrated grazingland health assessment tool used to rate four attributes of grazingland health. The 23 indicators rate the following four attributes of grazingland health: soil and site stability (SSS), hydrologic function (HF), biotic integrity (BI), and livestock carrying capacity (LCC) (adapted from Toledo et al. 2016).

Ind No.	Core Set of Qualitative Indicators	Attribute
1	Rills	SSS, HF
2	Water-flow patterns	SSS, HF
3	Pedestals and/or terracettes	SSS, HF
4	Bare ground %	SSS, HF, LCC
5	Gullies	SSS, HF
6	Wind-scoured, blowouts, and/or deposition areas	SSS
7	Litter movement	SSS
8	Soil surface resistance to erosion	SSS, HF, BI
9	Soil surface loss or degradation	SSS, HF, BI
10	Plant community influences on infiltration and runoff	HF
11	Soil compaction layer (surface and subsurface layers)	SSS, HF, BI
12	Functional/structural groups	SSS, HF, BI
13	Plant mortality/decadence	BI, LCC
14	Litter amount	HF, BI
15	Annual production	SSS, HF, BI, LCC
16	Invasive plants	BI
17	Plant vigor	BI, LCC (vigor)
18	Percent desirable plants	LCC
19	Forage diversity	LCC
20	Plant residue	BI, HF, LCC
21	Percent nontoxic legume	LCC
22	Uniformity of use	LCC
23	Livestock concentration areas	LCC

While the comparisons focused on semi-arid grassland, we believe that the improved grazingland assessment system would be applicable to other types of grazinglands. It allows evaluators to assess site conditions, and to make interpretations regarding management based on site-specific attributes that can potentially optimize the ecological potential and livestock carrying capacity of a site. For site specificity, assessments rely on Ecological Site Descriptions and Forage Suitability Groups (in the USA). For areas where Ecological Site Descriptions and Forage Suitability Groups do not exist, it is important to develop references for each type of land based on land potential, as determined by soil, climate and topographic conditions.

Discussion [Conclusions/Implications]

We developed an integrated grazingland assessment system that capitalizes on existing methodologies to make ecologically based assessments that can be used for evaluating the outcome of current management practices, and for identifying areas where those practices may be improved. This approach, combined with proper adaptive management, can optimize the ecological potential and livestock carrying capacity of a site over time.

Management optimization requires the selection of management actions that will maximize the productive potential of a parcel based on a land manager's particular objectives and the ecological potential of an area. Management optimization through the introduction of agronomic inputs (e.g. irrigation, fertilization, etc.) can have both positive and adverse effects on ecosystem structure and function; such management actions require monitoring to maintain and improve the long-term sustainability of a grazing operation. Treatments in a degraded area are unlikely to have the intended consequences unless the factors causing degradation are addressed. The use of an ecological-based integrated assessment protocol will enable the identification of these factors, and facilitate adaptive management of all grazing systems, when used consistently and thoughtfully.

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