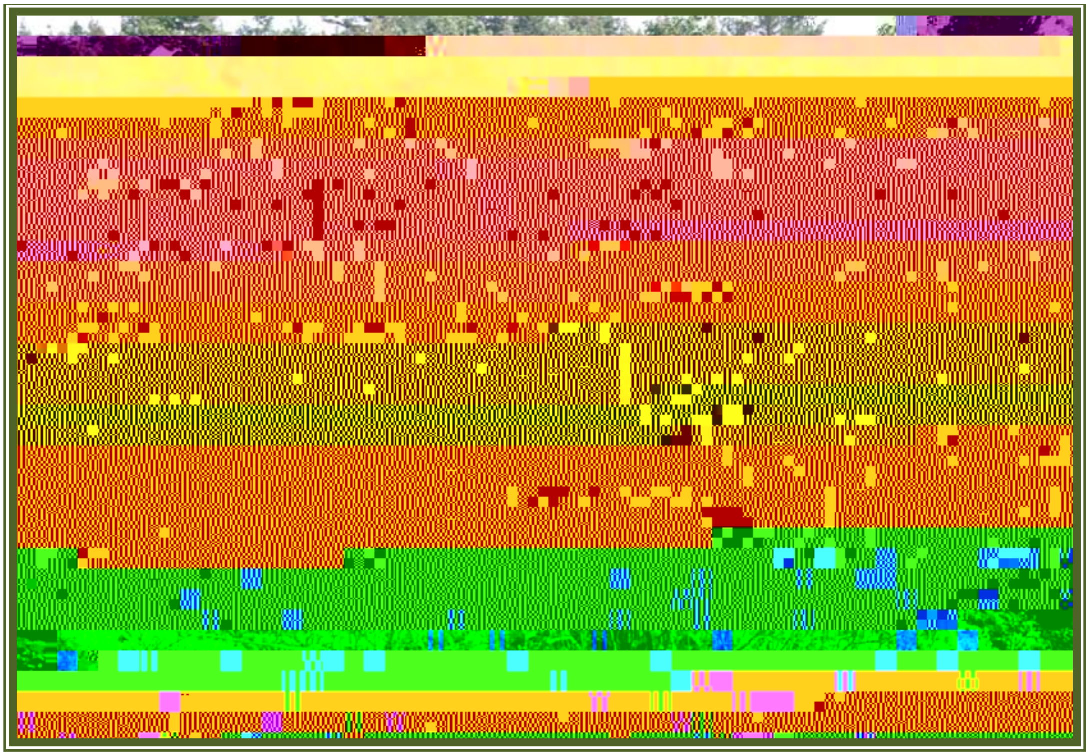
WORLD GRASSLANDS AND BIODIVERSITY PATTERNS



A Report to IUCN Ecosystem Management Programme

NatureServe

A Network Connecting Science With Conservation

NatureServe is a nonprofit organization dedicated to providing the scientific basis for effective conservation action.

Photo: Measuring biodiversity in an alvar in eastern Ontario, Canada, 2003. Don Faber-Langendoen.

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September 2010

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These data are first approximations of patterns of species richness for grasslands around the world. They should be interpreted cautiously because we did not have access to the original plot data.

The best data provided are at the 0.01 to 0.1 ha (or 101–1,000 m^2) range of plot sizes, based on which there appear to be formation-specific patterns. As an example, Tropical grasslands appear to be the most diverse, followed in order by Mediterranean, Temperate, Tropical Montane, and finally Cool Semi-Desert grasslands. Alpine vegetation was not well-represented. Thus, definitions of highly biodiverse grasslands may need to be specified by formation.

We were not tasked to develop the thresholds and criteria for what defines "highly biodiverse grasslands". Rather, we compiled information that can help the European Commission and others determine the feasibility of developing these criteria, to be used against a finalized grassland classification system. Nevertheless, it proved hard to find papers that consistently assessed the same area for species richness. We provide some suggestions for how a more thorough analysis might be conducted:

- Obtain raw plot data. Working with data that has already been averaged will make it hard to see how this data compares to actual field data gathered by someone making decisions for the implementation of RED.

- Ensure that data comes from sites that are considered to be in "good ecological condition," meaning avoid sites that are heavily grazed, disturbed by roadside activities, or recently established after farm abandonment, etc.

- Seek out a broader set of data within each formation to assess spatial scales of species richness, from 100 m^2 to 1,000 m^2

- Presuming some level of sufficient data, assess the most applicable species-area curve models, keeping in mind the following issues:

    - Assess potential effect of non-random placement of plots on species richness

    - Assess which species-area model to use (log-log or semi-log)

    - Assess whether species-area curves differ by formation

    - Based on species-area curves, determine whether some grassland types can be labeled as "biodiverse grasslands," i.e., whether there are thresholds at multiple spatial scales (or perhaps at some optimal spatial scale)

- A species-area curve may not be critical if sufficient data could be attained at the 100 m^2 or 1,000 m^2 level. But if good species-area curves can be established, they would allow for greater flexibility in the choice of plot sizes.

INTRODUCTION

Grasslands have many biodiversity values, including wildlife habitat, occurrence of rare species, intrinsic ecosystem properties of structure, function and composition, and ecosystem services such as watershed protection, grazing and scenery. In addition, some grasslands are seen as having high biodiversity values because of their high species richness. As part of a global strategy to maintain the world's biodiversity, there is a need to ensure that these types of grasslands are not negatively impacted upon by human uses.

THE POLICY OBJECTIVE

The European Union (EU) Directive on the promotion and use of energy

Conservation of Nature (IUCN); and highly biodiverse grassland areas, including natural and non-natural grasslands".

The challenge is to provide both a methodology and relevant information for the categories included in Article 17 (3c) regarding highly biodiverse grasslands that an operator can follow to avoid them. Biofuels produced from feedstock sourced from grassland outside of these areas can then count for a respective Member State's target within the framework of RED.

IDENTIFYING THE ISSUES

Within the overall challenge of providing a methodology and relevant information to meet the policy objectives of RED, we specifically address the challenge of defining and characterizing highly biodiverse grassland. In order to meet that challenge, a sequence of issues must be addressed:

- How are "grasslands" defined around the world?
- How are "natural" and "non-natural" grasslands defined?
- How can we classify the full range of grassland types around the world?
- How do we define "highly biodiverse grassland"?
- Will both exotics and native species be included within the definition of highly biodiverse grassland?
- Can we establish a consistent meaning for highly biodiverse grasslands around the world for both natural and non-natural grasslands?

MEETING THE CHALLENGE

To address the challenge we took the following approach:

1. Define grasslands, emphasizing differences between a land-use approach versus an ecosystem/land-cover approach

2. Provide information on distinctions between natural and non-natural grasslands, as established by the IVC and other publications

3. Sketch out a world classification of grasslands, using the structure of the International Vegetation Classification (I3(o)1.aM cldatur00 Tc 0 Tw“turecf1(r)(a)-03 Tw13(s)5(,

5. Summarize issues regarding inclusion of both exotics and native species in measures of species richness

6. Compile a wide range of data on measures of species richness in grasslands around the world, organizing the informatio n by IVC formation, division, and macrogroup, and provide an initial synopsis of how “highly biodiverse grasslands” might be defined; a formal analysis of the compiled data is not part of the project,

rainfall, temperature, soil type, and fire are further major determinants of grassland structure and these are strongly interactive (Walker 1993, in Mucina et al. 2006).

A major subdivision of grasslands is that of tropical/subtropical versus temperate ones, and it is in the tropics where the mixture of grasslands and shrubs/trees originates an almost continuum of "open savanna" to woodland to seasonal forest, with increasing levels of tree coverage. The main environmental requirements for the existence of savanna vary across latitudes and continents, but in general they require warm temperatures year round, a strongly seasonal rainfall ranging from 300–1,800 mm, and an interaction of soils and precipitation that either allows

“Non-natural” grasslands

A DRAFT CONSPECTUS OF WORLD GRASSLANDS

Introduction to the International Vegetation Classification

We approach the description and characterization of grasslands around the world using the International Vegetation Classification. The overall purpose of the IVC is to characterize world vegetation and ecosystems in a scientifically consistent and repeatable manner, and to use it to permit users to produce uniform statistics about ecosystem resources around the globe, facilitate interagency cooperation on ecosystem-based management issues that transcend jurisdictional boundaries, and encourage partners to work together on a common system. To achieve this goal, NatureServe has worked with a variety of partners to guide the initial development of the IVC. Information is now available on the structure and naming of the upper levels of the vegetation classification hierarchy, refined definitions for the lower, floristic levels of the hierarchy, and restructuring the classification from a content standard to a dynamic process standard (Faber-Langendoen et al. 2009, Jennings et al. 2009). Partners are now engaged in a sustained effort to build and provide this classification to users. The IVC has already been shown to provide a framework to guide development of world grassland types (Gibson 2009, Table 8.1).

Formation, Division, and Macrogroup

These three levels are the primary levels we use to develop an initial conspectus of grassland types (see Appendix A for details).

Table 1. The Main Levels of the IVC Hierarchy Used for This Report.

Hierarchy Level	Criteria	Example
L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions	Temperate Grassland & Shrubland
L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes	Great Plains Grassland & Shrubland
L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub	

Methods for an Initial Conspectus of World Grassland Types

We took the following steps to develop a classification:

1. We first conducted a very rapid review of literature. We assessed ecoregional patterns based on WWF (Olson et al 2001) to make sure we include all major grasslands of the world.
2. We developed comprehensive world grassland types for all formations and divisions.
3. We then developed macrogroups for all grasslands that are fairly extensive (many km^2 in area) and for which available literature could be found.
4. We developed IVC-type names, but we provide synonymy of types to literature names, so that users can see the basis for our concepts. We then developed a brief description and short geographic distribution for each division.

We summarize our primary classification results in a Table of Formation and Division units (Table 2). The grasslands classification is a basis for the assessment of where highly biodiverse grasslands are found.

Table 2. List of World Grassland Formations and Divisions, and the Literature on Species Richness

Formation	Division Key	Division

Formation	Division Key	Division
	D061	2.C.1.Nd Western North America Interior Sclerophyllous Chaparral Shrubland

A recent study of various biodiversity measures by Wilsey et al. (2005) highlighted the value of species richness as a measure of biodiversity, but they noted that other measures do have important additional information. Reitula et al. (2009) report that interpretations of changes in small-scale (50 x 50 cm plots) patterns of biodiversity in semi-natural grasslands depend on whether one is assessing species richness or species evenness. For example grassland plant species richness was positively associated with present-day availability of grassland species in the surrounding landscape, whereas evenness was mainly related to the historical landscape.

Of the various other measures of biodiversity, Wilsey et al. (2005) recommend the Bergen-Parker index, because it only requires that a field team measures the abundance of the most common species (e.g. its cover or biomass) versus the total abundance. But values have not been widely reported for this measure. Species evenness is another

original plot data. Typically, a paper might provide an average (mean) species richness and standard deviation (or standard error), and perhaps a range across the set of plots. If we have three papers that describe species richness at the 0.1 ha level, and each provides an average species richness, we then took each of those averages and we created a summary average, and report the range of the averages. Thus the ranges are quite conservative.

There were also a number of studies in the temperate grassland that reported exceptionally high values of richness. We have reported those separately, as they appear to be outliers (Walker and Peet 1983, Ryser et al 1995).

Table 3. Summary of Species

- Some studies provided multiple controlling factors of richness within a broad type (e.g., mowing, haying, burning)
- Some studies reported richness for both degraded and typical natural sites; we have omitted the degraded patterns here
- Some studies provided multiple subtypes of richness within a broad type (e.g., with the Great Plains grasslands, separate values are provided for shortgrass, mixedgrass, and tallgrass prairie); commonly, the drier and wetter ends were less species rich
- Some studies provided combinations of the above

The best data we have are at the 0.1 ha (or 101–1,000 m^2) range. Based on those data, there do appear to be formation-specific patterns. For example, Tropical grasslands appear to be quite diverse (as diverse as some of the very rich temperate sites), followed by Mediterranean, Temperate, Tropical Montane, and finally Cool Semi-Desert. Alpine vegetation was not well-represented, and the one large plot size study may be atypical. Thus, definitions of highly biodiverse grasslands may need to be specified by formation. Tropical grasslands might be expected to be 65+ species per 0.1 ha, Temperate and Mediterranean 45+ species per 0.1 ha, Tropical Montane grasslands 36+ species per 0.1 ha, and Cool Semi-Deserts to be 25+ species per 0.1 ha.

At the 30–100 m^2 scale, all good-condition grasslands appeared fairly equally diverse, between 35–40 species per 100 m^2 range, but the range is rather high (19 to 65). Thus it may be that 100 m^2 provides a useful standard level for assessing species richness, but using a larger 0.1 ha plot may also improve consistency in recognizing the distinction between highly biodiverse and non-highly biodiverse grasslands.

Still, it was hard to find papers that consistently assessed the same area for species richness. We do provide some suggestions for how that analysis might be conducted:

- Obtain raw plot data. Working with data that have already been averaged makes it hard to see how these data will correspond to actual field data gathered by a team seeking to provide information on

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to use it to facilitate uniform statistics about ecosystem resources around the globe, facilitate interagency cooperation on ecosystem-based management issues that transcend jurisdictional boundaries, and encourage partners to work together on a common system. To achieve this goal, NatureServe has worked with a variety of partners to guide the initial development of the IVC. A recent release of a revised federal vegetation standard in the U.S. (FGDC 2008) has increased support for the system in that country, adoption of the hierarchy in Canada has begun to facilitate integration of Canadian types at multiple scales, and applications in Latin America and Africa have spurred on continental development of units. Information is now available on the structure and naming of the upper levels of the vegetation classification hierarchy, refined definitions for the lower, floristic levels of the hierarchy, and restructuring the classification from a content standard to a dynamic process standard (FGDC 2008, Jennings et al. 2009). Partners are now engaged in a sustained effort to build and provide this classification to users.

Guiding Principles

(modified from FGDC 2008)

- Develop a scientific, standardized classification system, with practical use for conservation and resource management.
- Classify existing vegetation—the plant cover, or floristic composition and vegetation structure, documented to occur at a specific location and time, preferably at the optimal time during the growing season. This standard does not directly apply to classification or mapping of potential natural vegetation.
- Classify vegetation on the basis of inherent attributes and characteristics of the vegetation structure, growth form, species, and cover, emphasizing both physiognomic and floristic criteria.
- Base criteria for types on ecologically meaningful relationships; that is, abiotic, geographic, and successional relations help organize vegetation types and levels.
- The upper levels of the IVC are based primarily on the physiognomy (growth form, cover, structure) of the vegetation (not individual species), lower levels are based primarily on floristics (species composition and abundance), and mid levels are based on a combination of vegetation criteria and abiotic factors.
- Describe types based on plot data, using publicly accessible data where possible.
- Modify the classification through a structured peer-review process. The classification standard shall be dynamic, allowing for refinement as additional information becomes available.
- Facilitate linkages to other classifications and to vegetation mapping (but the classification is not a map legend).

Table 2. Example of the International Vegetation Classification.

Revised Hierarchy: Natural Vegetation	Example (only common names shown)
Upper	
Level 1 – Formation Class	Shrubland & Grassland
Level 2 – Formation Subclass	Temperate & Boreal Shrubland & Grassland
Level 3 – Formation	Temperate Grassland & Shrubland
Middle	
Level 4 – Division	Great Plains Grassland & Shrubland
Level 5 – Macrogroup	Tallgrass Prairie Grassland & Shrubland
Level 6 – Group	Northern Tallgrass Prairie
Lower	
Level 7 – Alliance	Big Bluestem – Indian grass Grassland
Level 8 – Association	Big Bluestem – Indian grass / Gayfeather Grassland

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APPENDIX B. CLASSIFICATION DESCRIPTIONS AND DETAILS OF SPECIES RICHNESS I