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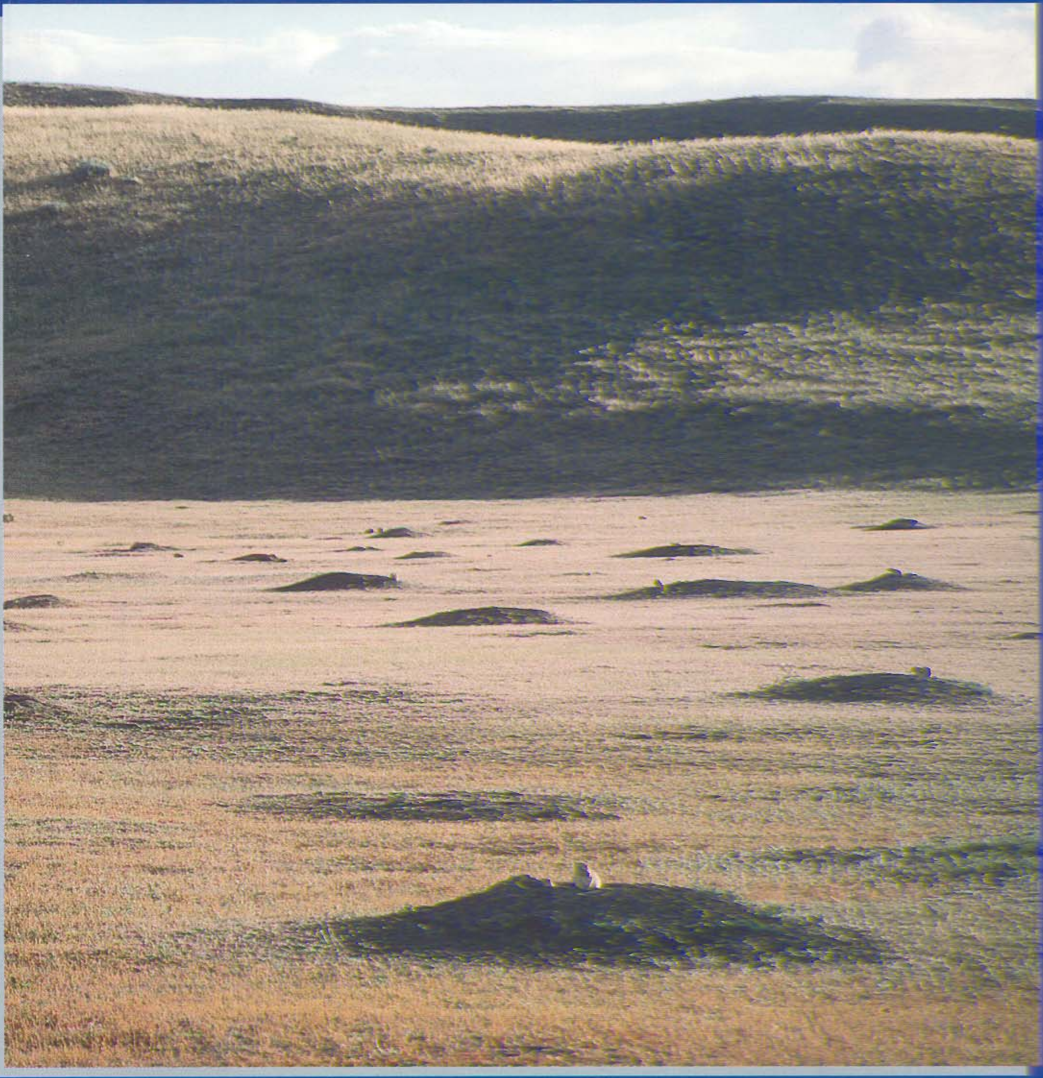
Grassland Protected Areas



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Editorial – the world's temperate grasslands: a beleaguered biome

WILLIAM D. HENWOOD

THE TEMPERATE grasslands of the world, known variously as the prairie in North America, the pampas in South America, the steppes in eastern Europe and northern Eurasia, and the grassveld in South Africa, are among the most diverse and productive of all the earth's terrestrial biomes. Yet, without exception, temperate grasslands have received very low levels of protection. According to the 1993 United Nations List of National Parks and Protected Areas, only 0.69% of the temperate grasslands biome is under some kind of protective status. This protection level ranges from a low of 0.08% in the Argentine pampas to very modest highs of 2.01% in the lowland grasslands of south-eastern Australia and 2.2% in the South African grassveld.

This protection level is not only the lowest of the globe's 15 recognised biomes, but is the lowest by several orders of magnitude. Tropical grasslands and savannas, for example, enjoy a level of protection nine times higher than their temperate cousins. Temperate broad-leaf and needle-leaf forests receive protection levels six and eight times higher than grasslands, respectively. Temperate subtropical forests, over which so much justifiable concern has been expressed, receive 14-fold greater protection world-wide than do temperate grasslands.

Why are the levels of protection for temperate grasslands so low and, perhaps more significantly, why are these low levels so universal? What is it about temperate grasslands that has failed to inspire governments to protect them? What can we do to improve this situation? This special issue of PARKS aims to both raise awareness of this important conservation issue and also begin to answer these questions. It is also the first undertaking of a relatively new and informal working group within the World Commission on Protected Areas (WCPA), known as the Temperate Grasslands Network. Created in 1996, the Network has the following aims: to assess the conservation status of temperate grasslands throughout the biome; to analyse the constraints to grasslands protection; to develop a strategy and action plan to achieve an expanded system of protected grassland areas; and to prepare a set of management guidelines designed to conserve grassland biodiversity.

I would like to thank the authors who have prepared papers for this issue of PARKS for their part in advancing this discussion. My opening paper provides a brief overview of the current protection status for temperate grasslands throughout the world. It also advances the work of identifying priorities for grasslands protection and conservation at national and international levels, and makes suggestions for a program of work for the IUCN/WCPA and the Convention on Biological Diversity (CBD) process. This overview is followed by a series of case studies representing each realm on the planet in which temperate grasslands are found.

David Gauthier and Ed Wiken use a continent-wide ecosystem classification to analyse extent and distribution of protected grassland areas in the North American Great Plains. Steve Taylor's paper describes the relatively short but intense history of degradation in the grasslands of south-eastern Australia, their current protection status, ongoing government initiatives to increase protection levels and the many constraints encountered. This paper highlights the biome's common dilemma, where the low levels of temperate grasslands protection are accompanied by high losses of native grassland ecosystems. In such situations, the opportunities for substantially increasing protection levels are very limited and require innovative solutions.

Montane grasslands are a lesser-known component in this temperate biome, and are found in several areas of the world, including New Zealand, the mountain cordillera of western North America and in high elevation areas of Asia. The paper by G.S. Rawat provides an overview of the ecology and conservation of high elevation grasslands on the trans-Himalayan steppe. In contrast to North America and Australia, the high elevation grasslands of Asia have supported mixed communities of wild herbivores, domestic livestock and agro-pastoral societies for thousands of years. Here, the origin and evolution of the grasslands has been continuously influenced by humans, primarily through livestock grazing and frequent burning. Cultural and religious practices are the primary determinants of grassland condition and will continue to be fundamental considerations in guiding the role of protected areas in grasslands conservation. Paul Goriup discusses specific challenges and opportunities for the protection of grassland ecosystems in Europe/north Eurasia, as addressed in the Action Plan for the Pan-European Biological and Landscape Diversity Strategy. A case study is presented for a Russian farm where grassland conservation and ecologically-sustainable agriculture are being integrated. Finally, in Argentina, Santiago Krapovickas and Adrián S. Di Giacomo describe the pampas and campos grasslands ecosystem and suggest ways for improving its protection.

Temperate grasslands have long awaited their due recognition as valuable habitats worthy of protection. The many grasslands conservation initiatives and protection programs under way at international, national and regional level indicate that this recognition is now emerging. The Convention on Biological Diversity and the work of its subsidiary body on scientific and technological advice will pay particular attention to grasslands and other dry ecosystems. The World Resources Institute, as part of its Millennium Assessment of the State of the World's Ecosystems, will undertake a comprehensive analysis of grassland and other arid land ecosystems, measuring the location and extent of change in these ecosystems world-wide. Regional and national initiatives such as the Pan-European Biological and Landscape Diversity Strategy, Bushcare in Australia, Canada's Prairie Conservation Action Plans and the Canada-USA Prairie Joint Venture are beginning to address specific issues on how to conserve and restore temperate grasslands. These initiatives involve such programs as land purchase for protection, stewardship with private landowners, conversion of land from former use to conservation, and restoration of former grasslands to near-natural condition. The conservation of grasslands biodiversity through the establishment of a systematic and comprehensive network of protected areas throughout the biome is the central challenge.

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An overview of protected areas in the temperate grasslands biome

WILLIAM D. HENWOOD

The current status of protected areas in the temperate grasslands biome is assessed and constraints to improving protection levels discussed. Strategic priorities are proposed for the development of a protected temperate grassland areas network across the biome, with a view to biodiversity conservation. It is recommended that the forthcoming IUCN Action Plan on grasslands should identify historical events and types of impact that have altered the incentive to conserve grasslands. It is also recommended that the socio-cultural factors influencing the use and management of grasslands should be identified. Awareness building is recommended to alter perceptions held by grasslands users and policy makers.

GRASSLANDS ARE biological communities containing few trees or shrubs distinguishable by their vast, concentrated ground cover of mixed herbaceous vegetation dominated by grasses. They can be considered transitional ecosystems, which with more moisture would become forested, or with less would turn to desert.

Grasslands occur in polar, temperate, sub-tropical and tropical latitudes, and from low to high elevations. In total, grasslands cover about 46 million km^2 and constitute about 27%, or one quarter, of the earth's surface (Curry-Lindahl 1981, Brown 1989). Temperate latitude grasslands comprise about 20% of all grasslands, and occur on all continents of the globe except Antarctica. Locations include south-eastern Australia, the pampas of Argentina, the prairie and plains of North America, the steppes of eastern Europe, northern Eurasia and eastern Asia, and the grassveld of South Africa.

Temperate grasslands represent one of the earth's major biomes and, historically at least, are one of the most productive and diverse terrestrial ecosystems (Curry-Lindahl 1981, IUCN 1994). Today, grasslands of all types are the most imperilled ecosystem on the planet, their habitats having been modified by human activity to such a degree that little remains in a natural state. Even less grassland is preserved with some form of long-term protection (IUCN 1994, Samson and Knopf 1996). There are some understandable reasons for this. Grasslands in all latitudes have historically been one of the most amenable environments for human settlement and use, and have provided for man's needs since early evolutionary times. Grasslands in temperate latitudes, with their more fertile soils and moderate climates, constitute some of the most productive agricultural lands on earth. Indeed, grassland landscapes and many species of grasses, including corn, wheat, rice and sugarcane, are a foundation of the world's food supply.

From a protected areas perspective, however, the opportunity to protect significant representative examples of this biome has been overlooked and, in many areas, irretrievably lost. Only 0.69% of the world's temperate grasslands are currently protected within the global system of protected areas (IUCN 1994). Furthermore, in many regions of the temperate world, the degree of use and physical alteration of grasslands, coupled with a lack of recognition of this ecosystem as one worthy of protection, has largely precluded protection as a viable land-use option. The purpose of this paper is to assess the current status of protected areas in the temperate grasslands biome and to consider the constraints to improving the level of protection. It then suggests some strategic priorities for developing an expanded network of protected areas to conserve temperate grasslands biodiversity throughout the biome.

Alteration and loss of temperate grasslands

Grasslands are usually found on flat-to-gently-rolling landscapes, often in rain shadows of the world's great mountain ranges. Their climates are moderate, their landscapes virtually treeless. These defining characteristics create, perhaps, their most enduring feature – vast expanse of openness, spaciousness and apparent limitlessness.

It is these attributes of grasslands, however, that have also led to their extreme vulnerability to human disturbance. This ideal combination of open, treeless expanses, low-relief topography, fertile soils and a moisture regime sufficient to support rich plant growth, and hence abundant wildlife populations, has set the stage for "one of the great historical convulsions of the earth's biota" (Mack 1989, Parsons 1994). Throughout the world, grasslands have been valued for their dark, rich soils, abundant natural forage and their relative ease of use, especially when compared with heavily-forested environments. The temptation to convert temperate grasslands to agricultural use has been enormous and loss of grassland habitats has been extensive. In south-eastern Australia, 99.5% of native grasslands have now been lost from what was one of the largest grassland areas in the world. This has been replaced by cereal crops and introduced grasses for sheep and cattle pastures (Taylor 1998). Native grasslands are now the most endangered ecosystem in the country (McDougall and Kirkpatrick 1994). In North America, the prairie and plains grasslands were once the dominant vegetation type across the entire continent. Similar levels of alteration have occurred here. In several states and provinces in Canada and the USA, under 0.1% of native grasslands remain in a natural state. In many other states and provinces, declines are lower but still significant. The tall grass prairie, in particular, has all but vanished in both countries (Packard and Mutel 1997). As in Australia, these temperate grasslands of the North American prairie have been declared the most endangered ecosystem on the continent (Samson and Knopf 1996).

Valley bottom grasslands of Okanagan Valley, British Columbia, Canada, have experienced high levels of alteration from market gardening, residential and tourism development. Photo: Bill Henwood.

On a more regional level, the montane grasslands of the inter-mountain basins in western North America have also been heavily exploited. The interior montane grasslands of British Columbia in western Canada are recognised as one of the province's most threatened ecosystems (CPAWS 1996). In Argentina, the pampas grasslands support the country's most developed and densely-populated region. Here too, temperate grasslands have experienced the highest degree of alteration of any region in the country. Only those remnants unsuitable for agriculture remain in a relatively natural state (McNeely *et al.* 1994, Krapovickas and Di Giacomo 1998).

Table 1. Protected areas coverage of the world's temperate grasslands (adapted from: IUCN 1994).

realm and biogeographic province	area (km²)	number of protected areas	protected area (ha)	protected area (%)
Nearctic:	2,442,342	126	1,240,185	0.51
Grasslands				
Palaearctic realm:				
Mongolian-Manchurian steppe	2,605,123	19	2,302,980	0.88
Pontian steppe	1,945,402	27	1,313,837	0.68
Neotropical realm:				
Argentinian pampas	512,152	10	42,235	0.08
Australian realm:				
Eastern grasslands and savannas	527,831	58	1,059,030	2.01
totals	**8,032,850**	**240**	**5,958,267**	**0.69**

In the lowland grasslands of central and eastern Europe, the situation is repeated. Though few precise figures are available, it is generally recognised that only "...a minute fraction of the potential grassland area remains in a natural state..." (IUCN 1991). In contrast to North America and Australia, where the impacts of settlement have occured within the last 150 years, grasslands in much of Europe have been influenced by human use and activity for thousands of years. In much of eastern Europe and the former USSR, steppe grasslands remained relatively intact until the 1950s and 1960s, when they too were largely transformed through cultivation. In the Ukraine, up to 88% of the steppe has been converted to agricultural use, with only 3–5% remaining in its natural state (Goriup 1998). South Africa's grassveld is found mostly in that country's high central plateau. These grasslands are extensively used for agriculture and are the mainstay of South Africa's dairy, beef and wool production. This biome also supports much of the country's maize, wheat and sunflower crops (Low and Rebello 1996). Urbanisation, industrialisation and mining are also significant threats. The levels of transformation in the lower elevation grasslands in South Africa are between 55% and 89% (Low and Rebello 1996).

The lower elevation grasslands of North and South America, Australia, Europe and South Africa have been changed far more by man than the higher elevation grasslands of the steppes in northern Eurasia and eastern Asia. In these latter regions, there remain significant expanses of grasslands that have not been significantly altered through such practices as cultivation. Most of these high elevation grasslands, as in China (Inner Mongolia, Xinjiang and Tibet), Outer Mongolia, Kazakhstan and Uzbekistan, have been grazed for thousands of years and today continue to support millions of sheep, goats, cattle, camels and horses (WRI 1994). The relative degree of alteration among the world's temperate grasslands is an important indicator of the potential for the long-term protection and, where possible, the restoration of grassland ecosystems.

The changes wrought by humans include irreparable destruction from building and flooding and significant alteration from cultivation, overgrazing, desertification or irrigation. More moderate alterations and associated extirpation or reduction of native species, have been caused by less intensive land-use or introduction of exotic species.

The role of protected areas in temperate grasslands

Historically, protected areas have not played a significant role in the management and use of temperate grassland ecosystems. In fact, it is only recently that grasslands in temperate climates have been perceived as a valued ecosystem that is worth protecting. When the concept of protected areas was emerging in the late 19th and early 20th centuries, efforts focused on scenically spectacular areas, mountain environments, unique land forms or features and areas that could support a growing tourism industry. At the same time, the wildlife in temperate grasslands of North and South America and Australia was being decimated, with land being given away to encourage settlement and agricultural exploitation. In Europe, by the time the protected areas movement began, the grasslands were already significantly degraded.

The interior montane grasslands of British Columbia, Canada, have been subjected to intensive grazing for over a century, and have very low protection levels. Photo: Bill Henwood.

Of the 14 biomes world-wide, temperate grasslands have by far the lowest protection. According to the *1993 United Nations List of National Parks and Protected Areas*, only 0.69% of the biome's total area had some form of protected status (IUCN 1994). By comparison, tropical grasslands and savannas, temperate broad-leaf forests, needle-leaf forests, and temperate and subtropical rainforests enjoyed far higher protection levels: nine-fold higher (6.35%), six-fold (4.0%), eight-fold (5.79%) and 14-fold (9.88%), respectively. Even more striking than this lack of protection is the universality of neglect. Nowhere that temperate grasslands occur in the world do protection levels come close to half those considered acceptable (see Table 1).

Another region of the temperate grasslands biome, the grasslands in South Africa (not included in Udvardy's 1975 classification) has a protection level of 2.2%, the highest globally for this biome. Among the 14 types of grasslands within South Africa, the protection level ranges from 0 to 12.53%, with a distinct bias favouring higher elevation grasslands (Low and Rebello 1996, Tarboton 1997). This brief analysis of protection at the biogeographic province level requires further refinement. However, at this level of analysis, a number of immediate observations can be reached:

- The protection of temperate grasslands on a global scale is perilously low and should be substantially increased to levels conducive to the long-term maintenance of grassland biodiversity throughout the biome;
- Situations of crisis proportions exist in many areas of the world, regarding not only the area of natural grasslands protected, but also the area of grasslands remaining in a natural or near-natural state; and
- In most, if not all cases, there is a continuing decline in natural grasslands and the wildlife species that depend on them.

Protection dilemma and an emerging action plan

The protection dilemma for temperate grasslands is that because so little has been protected to date, there is now relatively little left to protect. The ratio of the amount of protected temperate grassland to the amount remaining in a natural or fundamentally unaltered state will be a key issue. This will allow global and regional protection strategies and action plans to be developed. IUCN's World Commission on Protected

Areas, through the Temperate Grasslands Network, will identify strategic priorities and develop an action plan to improve protection of temperate grasslands. This will be done in conjunction with other international efforts, such as the Convention on Biological Diversity, through development of a program of work for dryland ecosystems, including grasslands. A global assessment of the condition of the world's grasslands ecosystems is being undertaken by the World Resources Institute and this will provide essential information. In addition, several regional initiatives are already working towards a similar goal. In Europe, much is already under way through the Pan-European Biological and Landscape Diversity Strategy (Goriup 1998).

This action plan will rest on a comprehensive and systematic analysis of existing levels of protection, and an assessment of the potential for improvement and the means for such improvement, within each region of the biome. The analysis of temperate grasslands protected areas and remaining natural areas would be undertaken at the ecoregion level. This work would record the number, average size and distribution of protected areas, the location and size of remaining natural areas and begin to identify those lands where the potential for additional protection exists.

Grassland species like the Denham's Bustard of Africa are at risk from declining habitat. Photo: Dave Richards.

This analysis would also include the identification of:

- Historical events and impact types leading to the alteration of current incentives or disincentives to conserve grasslands;
- Socio-economic and cultural factors influencing use and management of grasslands; and
- Other constraints impacting upon the potential to improve protection.

Considerable work will be required to examine the potential for restoring altered grassland ecosystems to convert intact grasslands under other uses into protected lands, and to develop policies and mechanisms to halt the continuing decline of grasslands and their dependent wildlife.

The action plan would also need to include a way of building awareness of the values of grassland ecosystems. To a great extent, temperate grasslands have been a victim of how people perceive them. Significant change in their use, management and long-term protection is unlikely to occur without a dramatic shift in that perception. Historically, while grasslands have been recognised for their rich soils and utility for agriculture, they have also been described as "barren wastelands" and the "quintessence of monotony" (Brown 1989).

Grasslands do not currently incite the same passionate demands for their protection as witnessed for tropical or temperate rainforests, mountain landscapes or coral reefs. There are, however, recent indications that this is changing, and a renewed interest is emerging that recognises the ecological value of grasslands and a need to conserve what remains of their rich biodiversity.

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The Great Plains of North America

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Using a standardised ecosystem classification system for North America and the IUCN classification system for protected areas, data is presented summarising the distribution and extent of protected areas for the Great Plains of North America. The Great Plains consists of five major ecological sub-divisions, and three federal and 24 state or provincial jurisdictions. The USA contains 80% of the Great Plains, while Canada contains 16% and Mexico 4%. Around 6% of the Great Plains is contained within areas managed for conservation purposes. The USA contains 74% of the protected areas >1,000 ha while Canada contains the remaining 26%. Of the area protected, 99% occurs within only three of the five ecological regions that comprise the Great Plains. Of those three ecological regions, the majority of the area protected occurs in the west-central semi-arid prairie. Eighty percent of the protected areas are coded as IUCN VI, while 5% fall into IUCN classes I to III.

INFORMATION ON the extent and distribution of protected areas throughout North America is often difficult to locate and interpret. Protected area information is often collected and maintained by different agencies. National Park databases are often separate from state, provincial or territorial park databases. Park databases also tend to be separate from databases for wildlife reserves, heritage rivers or forest reserves. Where such information is combined, it is generally organised at the level of states, provinces or territories. Seldom is protected area information presented in terms of ecosystems.

In this paper, information on various types of protected areas is drawn together from across North America. Information is presented for major North American ecosystem units, particularly the Great Plains, and for administrative units. The rationale is presented for an ecosystem approach, then protected area information is summarised for each major ecosystem of North America. Descriptive information characterising the Great Plains of North America is then presented as context for summary information that follows on a variety of protected area types for the Great Plains. The Great Plains protected area information is presented according to ecological sub-units of the Great Plains, as well as by administrative units.

Ecosystem framework

North America is commonly thought of in the context of its three major nations (Mexico, USA and Canada), or, perhaps in terms of those states and provinces which comprise each nation. Protected areas are most often discussed in terms of those jurisdictional boundaries. However, in reporting on the status and general purposes of protected areas, these types of jurisdictional units are insufficient benchmarks. Protected areas can often be established to secure both representative and pristine portions of major ecosystems. Therefore, as well as jurisdictional boundaries, protected areas need to be assessed against an ecological framework.

An ecological framework is a powerful tool. It provides a spatial context that facilitates the application of the ecological perspective, can be used to analyse and interpret changes in the environment and socio-economic conditions, and to understand the extent and distribution of resource assets at various scales. Ecological changes can be evaluated and documented. The occurrence and extent of protected areas constitute one measure or indicator of ecological health or integrity. While there are very important reasons for examining those measures according to political jurisdictions, it is also useful to place them within the context of ecological regions.

Viewing protected areas according to ecological regions allows the dialogue to focus on ecological issues rather than primarily administrative or jurisdictional mandates, permits an analytical focus on specific themes, such as the extent of protection within North American deserts or forests and promotes cooperation and collaboration in environmental planning among diverse agencies and groups.

In the context of current day issues like biodiversity, protected areas serve other needs. They are used as a measure of success in ecosystem biodiversity protection. Promoting the conservation of whole ecosystems protects the inherent complement of species and gene pools that exist within ecosystems. Table 1 provides information on the three hierarchical levels of ecological regions of North America developed by the Commission for Environmental Cooperation's (CEC) Ecosystem Working Group (EWG 1997). The CEC's Level I and II ecological regions are used as the ecosystem units for this analysis. Table 2 provides information on the names and size of Level II ecological regions.

North American protected areas

In North America, there are many terms that may be used interchangeably for protected areas. These include parks, wilderness, refuges, conservation areas, reserves, sanctuaries and wildlife areas. They afford various forms of protection, depending on their management and purpose. To date, most of the areas protected in North America are associated with the landscape and far fewer are linked to the seascape. To provide a brief overview of the status of protected areas in North America, this analysis at the level of North America is based only on federal, provincial and state parks. Parks are fairly exemplary of other types of protected areas. The data are taken from a number of sources. The Canadian Council on Ecological Areas (CCEA) has been working with many organisations (e.g. World Conservation Monitoring Centre, Commission for Environmental Cooperation) to develop a standardised database of protected areas for North America. This database builds upon the Canadian Conservation Areas Database (CCAD) developed by Environment Canada.[1]

The database contains information on the distribution of national, state and provincial parks for North America according to both political jurisdictions and ecological regions. Table 3 summarises some information about these parks according to Level I ecological regions.

Some of the earliest park areas were established in the late 1800s. The numbers and area of parks have increased significantly towards the mid-1900s. By 1997, over 3,000 had been established. Tables should be interpreted cautiously as the database has yet to be completed and not all sites are represented.

The pattern of occurrence and distribution of parks often mimics the human population map. The Pacific and Atlantic coastal areas and the Great Lakes area show a marked concentration of parks. In North America, about two thirds of the parks are

[1] More details on the CCEA WWW home page: http://www.cas.uregina.ca/~cprc/ccea/

located in three ecological regions – the Eastern Temperate Forests, the Great Plains and the Northern Forests (Table 3).

The distribution within an ecological region is not necessarily even. The Great Plains, for example, show a heavy weighting of parks toward the northern end of the region. In part, this distribution pattern is a mirror image of the cultural patterns. In Canada, for example, political, cultural and economic factors have strongly influenced development along the 49th parallel, whilst in Mexico, Mexico City has been the centroid of culture and economics for thousands of years.

The location pattern gives no indication of the size of parks. Within Canada and the USA, the bulk of the larger parks and the area under overall park management authority is larger in the northern parts of the continent even though fewer individual parks are shown there. The Arctic Cordillera, a relatively small ecological region, has few parks, but those few parks cover a large proportion of the region.

Examination of data for the frequency of parks locations shows a number of the ecological regions to be well represented. However, the actual area of each ecological region contained within the parks is generally very low. Of course, this picture is incomplete as data is not presented for all categories of protected area.

The North American Great Plains ecosystem setting

The protected areas database can be examined in more detail for any of the ecological regions. This paper, however, focuses on the Great Plains. The prairies that occur around the world share common characteristics. Whether they are called prairies, grasslands, pampas or steppes, they are relatively large areas dominated by grasses and forbs. Grasslands are one of the largest ecosystems occurring in many relatively dry climates in both temperate and tropical regions world-wide. They cover about one quarter of the earth's land surface.

The Great Plains ecological region (Figure 1) occupies the central part of the continent and extends over the widest latitudinal range of any single North American ecological region. It is a relatively continuous, roughly triangular area covering about 3 million km^2. They extend for about 1,500 km north to south, from Alberta, Saskatchewan and Manitoba in Canada, south through the Great Plains of the USA to southern Texas and adjacent Mexico. The Plains also extend approximately 600 km east to west, from western Indiana to the foothills of the Rockies and into north-eastern Mexico. The majority of the Great Plains, approximately 80%, is found within the USA, with 16% in Canada and 4% in Mexico. This large ecological region is

Table 1. *Levels of ecological regionalisation, North America.*

	Level I [1]	Level II [2]	Level III [3]
number of ecological regions	15	52	approx. 200
scale of presentation	1:20 million	1:10 million	1:2 million
geographical perspective	continental	national/regional	regional

Sources:
[1]Satellite imagery and appropriate natural resource maps at broad scales (approx. 1:10 million–1:20 million).
[2]Satellite imagery and appropriate natural resource maps at broad scales (approx. 1:5 million–1:10 million).
[3]Remote sensing techniques and appropriate regional natural resource maps (approx. 1:1 million–1:2 million).

generally distinguished by the following characteristics: relatively little topographic relief; grasslands and a paucity of forests; and a sub-humid to semi-arid climate.

Physical setting

The prairies range from smooth to irregular plains. In Canada they are generally flat to slightly-rolling plains but sizeable portions in the USA are hilly or classified as tablelands with moderate relief (100–175 m). The Mexican landscape alternates between flat areas and low hills. The landscape of the Canadian prairies (as well as the northern prairies of the USA) has been shaped by a variety of glacial deposits consisting mostly of undulating and kettled glacial till, and level to gently-rolling lacustrine deposits associated with intermittent sloughs and ponds. Surficial geology in the remainder of the Great Plains ecological region is varied. Major portions are eolian, others are stream deposits, and much of the region is comprised of thin residual

Table 2. *Level II ecological regions of North America.*

level	name	area (km^2)
1.1	Arctic Cordillera	218,225
2.1	Northern Arctic	1,495,255
2.2	Alaska tundra	390,490
2.3	Brook’s Range Tundra	162,835
2.4	Southern Arctic	808,270
3.1	Alaska Boreal Interior	459,780
3.2	Taiga Cordillera	223,870
3.3	Taiga Plains	701,625
3.4	Taiga Shield	1,413,955
4.1	Hudson plains	334,530
5.1	Softwood Shield	1,427,115
5.2	Mixed Wood Shield	569,245
5.3	Atlantic Highlands	367,465
6.1	Boreal Cordillera	647,830
6.2	Western Cordillera	1,141,120
7.1	Marine West Coast Forest	692,970
8.1	Mixed Wood Plains	490,590
8.2	Central USA Plains	253,665
8.3	South-eastern USA plains	943,770
8.4	Ozark Ouachita, Appalachian Forests	518,690
8.5	Mississippi Alluvial, and South-east USA Coastal Plains	368,720
9.1	Boreal Plains	644,560
9.2	Temperate Prairies	785,400
9.3	West-central Semi-arid Prairies	911,425
9.4	South-central Semi-arid Prairies	1,003,375
9.5	Texas-Louisiana Coastal Plain	64,615
9.6	Tamaulipas-Texas Semi-arid Plain	134,500
10.1	Western interior Basins and Ranges	1,014,840
10.2	Sonoran and Mojave Deserts	398,120
10.3	Baja California Desert	103,935
10.4	Chihuahuan Desert	510,565
11.1	Mediterranean California	198,975
12.1	Piedmonts of Western Sierra Madre	194,945
12.2	Mexican High Plateau	75,395
13.1	Upper Gila Mountains	105,255
13.2	Western Sierra Madre	203,625
13.3	Eastern Sierra Madre	58,105
13.4	Neovolcanic Sierras and Plains	118,795
13.5	Southern Sierra Madre	118,025
13.6	central American Sierra Madre and Chiapas highlands	26,240
14.1	Dry Gulf of Mexico Coastal Plains and Hills	33,885
14.2	North-west Plains of the Yucatan Peninsula	14,165
14.3	Western Pacific Coastal Plains, Hills and Canyons	84,225
14.4	Interior Depressions	64,900
14.5	Southern Pacific Coastal Plains and Hills	39,915
14.6	Sierra and Plains of del Cabo	9,170
15.1	Humid Gulf of Mexico Coastal Plains and Hills	141,390
15.2	Plains and Hills of the Yucatan Peninsula	115,820
15.3	Sierra de los Tuxtlas	4,280
15.4	Everglades	21,300
15.5	Western Pacific Plains and Hills	19,165
15.6	South-eastern Pacific Coastal Plains and Hills	9,165

Table 3. Occurence of level I ecological regions within national parks (IUCN II), and state and provincial parks, and extent of protection by national parks.

Level I ecological region	number of national parks	national parks protected area (%)	number of state and provincial parks
Arctic Cordillera	3	33	0
Tundra	2	<1	4
Taiga	2	<2	31
Hudson Plains	0	0	4
Northern Forests	14	<1	575
North-western Forested Mountains	17	<2	322
Marine West Coast Forests	2	1	246
Eastern Temperate Forests	7	<1	961
Great Plains	9	<1	772
North American Deserts	13	1	201
Mediterranean California	2	<1	50
Southern Semi-arid Highlands	2	<1	2
Temperate Sierras	41	<1	4
Tropical Dry Forests	6	<1	0
Tropical Wet Forests	4	1	5

sediments. The Mexican portion is underlain by Cenozoic sedimentary rocks with recent continental deposits on the coast. Most rivers of the northern and central Great Plains have their origins in the Rockies where rainfall, snowmelt and glacial run-off in the north contribute to their formation. The soils are commonly deep and were originally highly fertile throughout most of the region. Today, soils of agricultural potential throughout the Great Plains face problems of reduced nutrient potential, increasing salinity and susceptibility to wind and water erosion. The climate is dry and continental, characterised in the north by short hot summers and long cold winters, with periodic intense droughts and frosts. High winds are also an important climatic factor in this ecological region.

Biological setting

The Great Plains ecological region was once covered with natural grasslands that supported rich and highly specialised plant and animal communities. The interaction of climate, fire and grazing influenced the development and maintenance of the Great Plains. Rainfall increases from west to east, defining different types of native prairies. Short-grass prairie occurs in the west, in the rain shadow of the Rocky Mountains, with mixed-grass prairie in the central Great Plains and tall-grass prairie in the wetter eastern region. In the Mexican Great Plains, prickly scrub vegetation dominates the landscape in transition between the desert conditions and the warmer and wetter conditions of the Prickly Tropical Forest (warm, dry jungles). Because of the suitability of the Great Plains for agricultural production, many native prairie vegetation types have been radically transformed. The short-grass, mixed-grass and tall-grass prairies now correspond to the western rangelands, the wheat belt and the corn/soybean regions. In the northern Canadian prairies, the remaining natural vegetation is dominated by spear grass, wheat grass and blue grama grass, while local saline areas feature alkali grass, wild barley, greasewood, red samphire and sea blite. Drier northern sites are home to yellow cactus and prickly pear, with sagebrush also abundant.

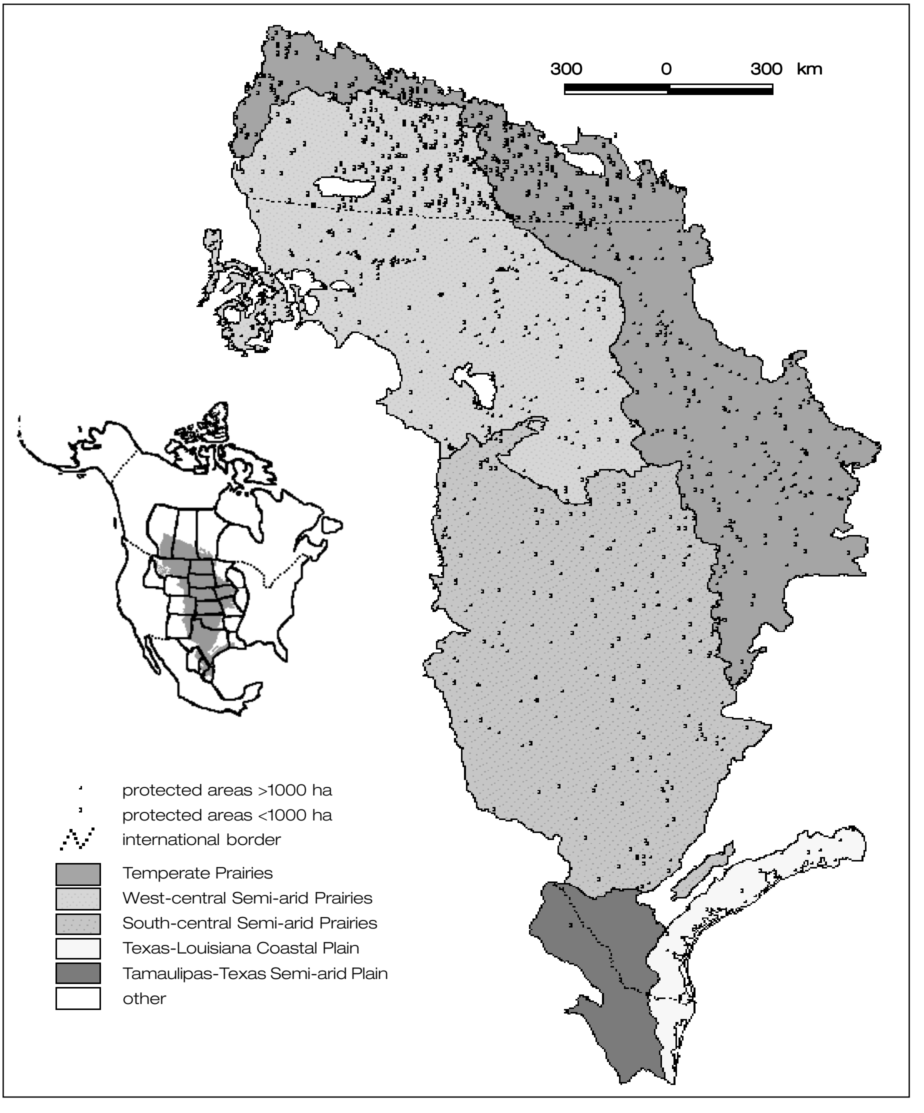

Figure 1. *Location of protected areas and Level II ecological regions in the North American Great Plains.*

The northern transition zone to the boreal forest has expanded south into former grasslands since settlement effectively stopped prairie fires. In the USA, native prairie vegetation ranges from grama grass, wheat grass and bluestem prairie in the north to different shrub and grassland combinations (e.g. mesquite-acacia savanna and mesquite-live oak savanna) and grassland and forest combinations (e.g. juniper-oak savanna and mesquite-buffalo grass) in the south. There are also patches of blackland prairie, bluestem-scachuista and southern cordgrass prairie in the southern USA. The eastern border of the region, stretching from central Iowa to Texas, shows patterns of grassland and forest combinations mixed with oak-hickory forest. Throughout the remainder of the Great Plains there are few native deciduous trees, except in the eastern regions, in very sheltered locations along waterways or at upper elevations. In Mexico, the characteristic natural vegetation consists of prickly scrubs, with dominant species including mesquite, acacia, paloverde, silverleaf, hackberry, Texas olive, barreta, corbagallina, and ocotillo. Salt-tolerant communities are common in the lower portions of the Mexican Great Plains near the Laguna Madre.

Wetland concentrations are generally greatest in the glaciated, sub-humid northern grasslands and adjacent aspen parkland of the northern Great Plains, where up to half of the land can be wetland. Significant wetlands are also found in the Nebraska Sandhills and a large area of playas located in south-western USA. During winter, Mexican bodies of water provide habitat for numerous migrant waterfowl from Canada and the USA. Prairie wetlands provide major breeding, staging and nesting habitat for migratory waterfowl using the central North American flyway. Prior to European settlement, the Great Plains supported millions of bison, pronghorn antelope, elk, mule deer, plains grizzly bears and plains wolves. Today, this area is home to a disproportionately high number of rare, threatened, vulnerable and endangered species. Drainage of wetlands and conversion of wildlife habitat for agriculture, industry and urban development are significant issues in this ecological region.

Human activities

The Great Plains is currently a culturally-moulded ecosystem. The first European settlers began their move westward into the northern and central Great Plains from the eastern forest regions. At first, settlers considered the prairies to be infertile, so they stayed where trees persisted, but soon they realised that the prairie soil was one of the most productive soils in the world. Today, the prairie grasslands are among the largest farming and ranching areas on the Earth. Agriculture is the most important economic activity as well as the dominant land-use and main cause of stress to this ecological region.

Crop types vary from north to south with differences in growing seasons and temperatures. Spring wheat and other grain crops such as barley and oats are common in the north. Corn is grown along the moister northern and central portions, whereas winter wheat and sorghum predominate in the central and southern parts. While agricultural activities dominate the rural landscape, population is centred in urban areas and rural depopulation is a continuing trend in Canada and the USA.

There is a general trend in Canada and the USA away from small and medium-sized farms towards large agribusiness operations. The change to a more complex economic structure in this region, influenced by international market forces, is also reflected in a growing service sector. Mining, gas and oil extraction are also important activities. In the southern Great Plains, irrigation agriculture along the Rio Grande is very important, as it is in the southern portion of the Mexican Great Plains. The main cultivated crops are sorghum, corn, sunflowers, canola and beans. In the undulating and drier land of open scrub vegetation in the north-west, there is extensive cattle and goat ranching. In portions of the region, scrub vegetation has been replaced by hay meadow. The Rio Grande crosses this region, acting both as an international border for 650 km and as an area of extensive commercial activity. Overall, approximately 34 million people live within this ecological region, with some 32 million occupying the USA portion alone.

Great Plains protected areas

The Great Plains ecological region of North America includes 3 national and 24 state or provincial jurisdictions. There are five major ecological sub-divisions of the Great

Plains (Figure 1). Figure 1 also shows the distribution of protected areas (greater and less than 1,000 ha) throughout the five sub-divisions. The remainder of the analysis in this paper will focus on the areas greater than 1,000 ha.

There are 603 protected areas over 1,000 ha occurring in the Great Plains of North America. Table 4 shows that, in total, the protected areas occupy just under 6% of the Great Plains. Of the area protected, 99% occurs within only three of the five ecological regions that comprise the Great Plains. Of those three ecological regions, the majority of the area protected (72%) occurs in the West-central Semi-arid Prairies. The Texas-Louisiana Coastal Plain and the Tamaulipas-Texas Semi-arid Plain contain less than 1% of the area protected in the Great Plains.

The IUCN protected area category system is useful for comparisons of protected areas across ecological and jurisdictional boundaries (Table 4). Of the area classed as protected area in the Great Plains, 60% has been coded using the IUCN criteria. Of this coded area, 80% has IUCN VI status. Only 5% of this coded area falls into IUCN categories I to III, those considered to be managed for the highest degree of protection.

It is also useful to examine these data by country (Table 5). Canada contains 16% of the Great Plains in two ecological regions, the Temperate Prairies and the West-Central Semi-arid Prairies. These two regions comprise the prairie ecozone of Canada, occupying 5% of Canada's total land area. Of the protected areas above 1,000 ha in the Great Plains of North America, 26% occur in the Canadian Great Plains.

The Great Plains occupy approximately 29% of land area within the continental USA and that country contains 80% of the Great Plains of North America. Almost three-quarters of Great Plains protected areas larger than 1,000 ha are in the USA. When all IUCN classes are considered, those areas provide protection for approximately 7% of the Great Plains within the USA.

Five percent of Mexico's land area is prairie, representing 4% of the total area of the Great Plains of North America. While there are protected areas within the Mexican Great Plains, they are few and relatively small (under 1,000 ha).

Open grassland and coulees provide habitat for pronghorn antelope. Photo: Canadian Plains Research Center.

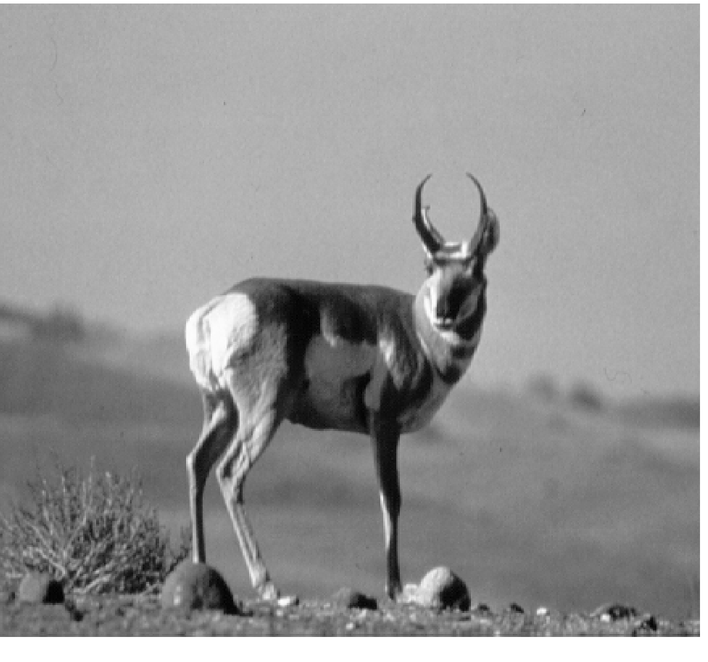

Table 6 summarises protected area information for Canada and the USA according to ecological regions. While the USA and Canada have similar proportions of protected areas in the Temperate Prairies, the USA has substantially higher proportions of managed conservation areas for its portion of the West-central Semi-arid Prairies.

Table 7 examines the distribution of protected areas above 1,000 ha according to either country or administrative jurisdiction (state or province). Three of Canada's 12 provinces and territories, 18 states within continental USA and three of Mexico's states contain portions of the Great Plains. When federal management agencies are included, these figures reflect the multiplicity and inherent complexity

Table 4. *Frequency and area of coverage of protected areas >1,000 ha in size for the ecological regions of the Great Plains of North America according to IUCN categories.*

IUCN Category	Temperate Prairies	West-central Semi-arid Prairies	South-central Semi-arid Prairies	Texas-Louisiana Coastal Plain	Tamaulipas-Texas Semi-arid Plain	Great Plains total
IUCN I:						
number of sites	2	8	1	1	0	12
area (ha)	6,253	46,492	5,526	50	0	58,321
area (%)	0.008	0.05	0.006	0.0005	0	0.02
lIUCN II:						
number of sites	8	10	1	0	0	19
area (ha)	162,963	252,964	1,056	0	0	416,983
area (%)	0.21	0.29	0.001	0	0	0.14
IUCN III:						
number of sites	4	6	4	0	0	14
area (ha)	7,014	15,154	3,188	0	0	25,356
area (%)	0.009	0.02	0.003	0	0	0.008
IUCN IV:						
number of sites	46	47	13	9	0	115
area (ha)	307,459	647,741	76,484	118,124	0	1,149,808
area (%)	0.39	0.7	0.08	1.23	0	0.40
IUCN V:						
number of sites	22	6	18	3	1	50
area (ha)	128,529	29,445	49,924	36,233	7,563	251,694
area (%)	0.16	0.03	0.05	0.56	0.05	0.09
IUCN VI:						
number of sites	31	78	3	0	0	112
area (ha)	620,223	7,238,411	636,596	0	0	8,495,230
area (%)	0.80	7.9	0.65	0	0	2.93
unclassified:						
number of sites	107	97	71	8	1	284
area (ha)	752,484	3,929,975	1,872,338	19,273	1,620	6,575,690
area (%)	0.97	4.6	1.93	0.29	0.01	2.27
all IUCN categories:						
number of sites	220	252	111	21	2	606 [1]
area (ha)	1,984,925	12,160,182	2,645,112	173,680	9,183	16,973,082
area (%)	2.6	13.3	2.7	2.7	0.07	21.37
Great Plains area (%)	0.7	4.2	0.9	0.06	0.003	5.9

[1] Some protected areas overlap across ecological region boundaries and hence are recorded in more than one ecological region yielding a frequency count that is higher than the actual count of 603.

Table 5. *Protected areas (>1,000 ha) according to ecological region and country for the Great Plains of North America.*

country	area (km^2)	prairie area (km^2)	prairie area (%)	Great Plains area (%)	number of protected areas	protected prairie area (km^2)	protected prairie area (%)
Canada	9,970,610	457,308	5	16	159	15,874	3.5
USA[1]	7,825,161	2,287,486	29	80	444	153,856	6.7
Mexico	1,958,201	105,532	5	4	0	0	
total	19,753,972	2,850,327	14	100	603	169,730	5.9

[1] Excluding Alaska or Hawaii.

Table 6. *Protected areas (>1,000 ha) according to ecological region and country for the Great Plains of North America.*

	Canada				USA			
ecological region	**ecological region (%)**	**no. of protected areas**	**protected areas (km²)**	**protected areas (%)**	**ecological region (%)**	**no. of protected areas**	**protected areas (km²)**	**protected areas (%)**
Temperate Prairies	29	69	6,332	2.8	71	151	13,517	2.4
West-central Semi-arid Prairies	27	90	9,542	1.5	73	162	112,059	17.7
South-central Semi-arid Prairies	0	n/a	n/a	n/a	100	111	26,451	2.7
Texas-Louisiana Coastal Plain	0	n/a	n/a	n/a	82	21	1,736	2.2
Tamaulipas-Texas Semi-arid Plain	0	n/a	n/a	n/a	37	2	91	0.2
total for Great Plains	**16**	**159**	**15,874**	**2.1**	**80**	**447**[1]	**153,856**	**6.7**

[1] Some protected areas overlap across ecological region boundaries and hence are recorded in more than one ecological region yielding a frequency count that is higher than the actual count of 444.

Table 7. *Protected areas (>1,000 ha) according to country and state or province for the Great Plains of North America.*

country	state or province	area (km²)	prairie area (km²)	prairie area (%)	Great Plains area (%)	number of protected areas	protected prairie area (km²)	protected prairie area (%)
Canada	Alberta	660,457	152,295	23	5.3	19	1,150	0.8
	Manitoba	649,937	70,075	10.8	2.5	29	2,455	3.5
	Saskatchewan	649,187	234,938	36.2	8.2	111	12,269	5.2
USA	Arkansas	137,540	28	0.02	0.001	0	0	
	Colorado	270,865	114,318	42.2	4	26	9,326	8.2
	Idaho	215,739	84	0.04	0.003	1	71	86
	Illinois	146,385	56	0.04	0.002	1	1	2.4
	Iowa	145,048	136,172	93.9	4.8	49	379	0.3
	Kansas	211,873	211,869	100	7.4	32	2,521	1.2
	Louisiana	121,909	16,330	13.4	0.6	7	361	2.2
	Minnesota	218,357	80,386	36.8	2.8	27	2,544	3.2
	Missouri	180,443	88,724	49.2	3.1	6	137	0.2
	Montana	380,100	280,260	73.7	9.8	91	43,514	15.5
	Nebraska	199,844	199,844	100	7	16	4,280	2.1
	New Mexico	315,155	67,390	21.4	2.4	14	1,662	2.5
	North Dakota	182,056	182,056	100	6.4	70	19,846	10.9
	Oklahoma	180,895	158,677	87.7	5.6	13	8,617	5.4
	South Dakota	198,282	193,432	97.6	6.8	40	47,558	24.6
	Texas	687,711	481,706	70	16.9	46	5,392	1.1
	Wisconsin	146,323	854	0.6	0.03	2	25	3
	Wyoming	252,996	75,295	29.8	2.6	12	7,620	10.1
Mexico	Coahuila	150,747	25,818	17.1	0.9	0	0	0
	Neuvo Leon	65,227	33,592	51.5	1.2	0	0	0
	Tamaulipas	78,178	46,127	59	1.6	0	0	0
total		**6,445,256**	**2,850,327**	**44.2**	**100**	**612** [1]	**169,730**	**6**

[1] Protected areas that cross state boundaries are recorded for each state, resulting in a total of 612 areas instead of 603, the real total.

of attempting to achieve coordinated ecosystem management over such a large ecological region.

In Canada, Saskatchewan contains the greatest area of the Great Plains. It also has the greatest number of protected areas over 1,000 ha and the largest proportion (5%) of protected prairie in Canada. Within the USA, states that have at least 70% of their land area as prairie (e.g. North Dakota, Nebraska, Kansas, Iowa, Montana, South Dakota, Texas and Oklahoma) vary widely in the proportion of that prairie that is protected. Less than 1% of Iowa's prairie is protected, whereas up to 25% is protected in South Dakota.

Rolling plains and mixed-grass prairies are typical of the northern Great Plains. Photo: Great Plains Research Center.

Concluding comments

Examining protected area data according to both ecosystem and administrative jurisdiction provides a useful means of evaluating those areas according to different perspectives and requirements. The diversity of land forms, soils, hydrologic regimes, climate, vegetation, wildlife species and communities, and human activities across the Great Plains of North America yields numerous ecosystems that require a multitude of management approaches to insure their protection. Multiple jurisdictions can better coordinate their efforts through a standardised ecosystem classification scheme in combination with a standardised protected area classification method, such as the IUCN categories.

In North America, the 'Old West' and the 'grasslands' are often thought of as synonymous terms. The Old West signified an era of hardy and colourful characters, a dynamic environment with spectacular and vibrant landscapes. That era only survives as a legacy recorded in history books. The remnant and often-isolated spots of former grasslands are now typically contained within protected areas. These areas scattered across the plains are the few remaining pages of the natural grasslands legacy that have not yet been relegated to the natural history books. They have become a fleet of Noah's arks moored in a sea of agricultural lands and ranches.

The grasslands have been and still remain productive areas for many resource sectors such as agricultural, gas, oil and mining. While these ecosystems have been widely supportive of human endeavours, that support has come at the cost of natural values. The analysis in this paper has provided an initial look at the presence and absence of conservation areas across the continent's core, once dominated by native grasslands. It is a general indication of where the assets remain. The pattern of protected areas shows a generally wide dispersal northwards from the Rio Grande River. The success with conservation of areas is lowest in Mexico and highest in the USA. Of the remainder that exists, most of the larger and probably the more viable properties (over 1,000 ha) are in the USA. The amount of land protected within North America is a relatively low proportion of the total landscape (5.9%). By many world-wide standards, this is insufficient.

Ecosystem analyses are initial assessments. A more formal gap analysis is now required to build on this grassland ecosystems review. The work of the Canadian Council on Ecological Areas (Gauthier 1992, Gauthier *et al.* 1995) could serve as a possible model in that regard.

Acknowledgements

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South-eastern Australian temperate lowland native grasslands: protection levels and conservation

STEVE C. TAYLOR

South-eastern Australian temperate lowland native grasslands are the most threatened ecosystems in Australia. Since European settlement in 1788, Australia has lost over 99.5% of these grasslands. Some of the causes of this loss are clearing and conversion to crops, invasion by exotic plants, altered fire regimes and overgrazing by introduced herbivores such as cattle and sheep. In recent years there has been a commitment by governments to fund remnant grassland projects through nationally-coordinated grants and programs such as Bushcare, Landcare, the Grasslands Ecology Program and Save the Bush. New reserves are planned, reflecting growing community awareness of the importance of our remaining native grasslands. The main impediments to conservation of what remains include lack of resources to deal with overgrazing and weed invasion, inadequate fire management and the small size of many remnants, making them prone to further degradation.

AUSTRALIAN TEMPERATE native grasslands have an irregular distribution, located across the states of South Australia (SA), New South Wales (NSW), Australian Capital Territory (ACT), Victoria and Tasmania. Average annual rainfall over these areas of grassland varies from 500 to 1,000 mm per year (Groves and Williams 1981). The south-eastern temperate lowland native grasslands (a subset of the temperate native grasslands) occur below the altitude of montane forest (Kirkpatrick 1994). They are found as remnants in eastern SA, southern NSW, ACT, Victoria and eastern Tasmania.

In the lowlands, grasslands have undergone greater changes than those found in the montane and sub-alpine areas. This has been the result of intensive grazing, cropping and pasture improvement activities being concentrated in more hospitable climates rather than the relatively cold and wet mountain regions.

History of degradation

Scientists have expressed concern about the mismanagement of temperate lowland native grasslands for over 100 years. In the late 1880s, J.H. Maiden, the government botanist, expressed concern about overstocking and the damage it caused (Kirkpatrick *et al.* 1995). Needless to say, the advice was ignored and the degradation accelerated. Initially, this was caused by a lack of tolerance to hard-hoofed herbivores and overgrazing. In addition, exotic seed was spread in feed, dung and later, deliberately, through pasture improvement activities. Cropping, urban expansion and changes to fire regimes were also responsible for the decline in native grasslands.

The enormous cumulative effect of these catastrophic disturbances is evident when we look at what is left today. The south-eastern lowland native grasslands covered an area of approximately 2 million ha before the European colonisation of 1788. In 1992, this had shrunk to a mere 10,000 ha of natural remnants, totalling a loss of 99.5% of these native ecosystems (Kirkpatrick *et al.* 1995). The remaining areas are highly fragmented and found in diverse locations, including travelling stock routes, railroad reserves, private grazing properties, cemeteries and in urban open space.

Biodiversity protection

Rare orchids, lilies and pea species are characteristic of south-eastern temperate lowland native grasslands. One reason for their rarity is a sensitivity to grazing by introduced herbivores (rabbits, sheep and cattle). Only 7 of the 24 nationally rare or threatened grassland flora species are adequately protected (Kirkpatrick *et al.* 1995).

There is also a range of rare lowland-grassland fauna. These include the plains wanderer (*Pedionomus torquatus*), the striped legless lizard (*Delma impar*) and the golden sun moth (*Synemon plana*). Long-term species survival depends on maintaining native grasslands, which themselves are also listed as threatened or endangered in some states. For example, in the ACT natural temperate grassland is listed as an endangered ecological community under the Nature Conservation Act (1980), while in Victoria a number of natural temperate grassland communities are listed as threatened under the Flora and Fauna Guarantee Act (1988) (ACT Government 1997). Such legislation, combined with clearance control legislation, provides the legal backing for grasslands conservation. However, protective legislation is only as good as the level of political commitment to enforce it. There also needs to be a balance between legal sanctions and incentives. Incentives are discussed later.

Temperate lowland native grassland types

Tables 1–4 summarise the reservation status for south-eastern Australian temperate lowland native grassland based on the community definitions developed by Kirkpatrick *et al.* (1995).[1] Further details about these and other communities can be found in ACT Government (1997), Benson (1994), Benson *et al.* (1997), McDougall and Kirkpatrick (1994), and Hyde (1995), cited in Davies (1997).

The grassland communities listed in Tables 1–4 are grouped into the following four categories, which are named after the dominant native perennial grass species:

- Kangaroo grass (*Themeda triandra*) communities;
- Tussock grass (*Poa* spp.) communities;
- Spear grass (*Stipa* spp.) communities;
- Wallaby grass (*Danthonia* spp.) communities.

Kangaroo grass and tussock grass are mainly found in higher rainfall areas. In drier areas spear grass and wallaby grass are mixed with herbland (Kirkpatrick *et al.* 1995).

Tables 1–4 show that most of the south-eastern temperate lowland native grasslands are either unreserved (e.g. Wimmera herb/grassland-W2), or inadequately reserved (e.g. Tasmanian valley grassland-T2). This low level of reservation is reflected in all temperate grassy ecosystems. For example, in the riverine plains of NSW less than 1% of native grasslands and grassy woodlands are reserved (AACM 1995).

The threats to remaining areas include overgrazing, changed fire regimes and weed invasion, for example the Tasmanian flood plain grassland-T3, the South Gippsland kangaroo grass grassland-G1 and the basalt plains grassland-B1, respectively. Some of these threats are exacerbated by the linear and fragmented nature of the remnants, for example the marsh margin grassland-S1.

[1] Porcupine grass (*Triodia scariosa*) communities have been omitted from the tables because they are more characteristic of semi-arid areas. Mat rush (*Lomandra* spp.) communities have also been omitted.

Some of the small remnants in cemeteries, rail reserves and airfields have a disproportionately large number of rare species (Kirkpatrick *et al.* 1995). An example is the Central Gippsland kangaroo grass grassland. Rare plant species survive, mainly because these sites have not been continually over-grazed or ploughed. However, these remnants are at high risk from not being burnt frequently enough, ill-informed tree planting, herbicide spraying and road grading. Reserved native grasslands are usually designated as nature reserves (e.g. Monaro grassland-M2) or are part of national parks (e.g. Tasmanian grassland-T8) corresponding to IUCN protected area categories Ia and II, respectively. Category Ia areas are managed mainly for science while category II areas are managed mainly for ecosystem protection and recreation.

Simply reserving a species-rich remnant is not always enough to ensure long-term conservation. The one remaining species-rich site for Stony Rise kangaroo grass grassland-B3 is at a roadside, where it is highly prone to further degradation. This site could be used as a seed source for restoration projects on private land, but to succeed such a plan requires commitment by private landholders to alter grazing regimes.

Reserved remnants must also be properly managed. In kangaroo grass grasslands that have been left unburned for a long time the native herbs or forb species in the inter-tussock spaces are replaced by spreading kangaroo grass tussocks. Burning such grassland is recommended every two to five years (McDougall 1989). Lack of fire or grazing can lead to self-shading of kangaroo grass plants from accumulated dead grass litter. This weakens the plants and leaves them more susceptible to disturbance.

Correctly timed burning, grazing and mowing are also important management tools for maintaining secondary or derived grasslands, including areas where original woodland trees were cleared. Such places are sometimes the only refuges for rare or threatened grassland species, so are inappropriate areas for replanting or regenerating trees. Remnants of the Victorian Central Gippsland kangaroo grass grassland of Table 1 are found along a rail corridor (Lunt 1995) containing nationally endangered plant species. Trees were cleared from this area in the past for train safety reasons.

Government initiatives

On an optimistic note, additional reserves are planned to protect grassy ecosystems, such as the Monaro basalt grassland-M3 and the basalt plains grassland-B4. Even with the declaration of new reserves most of the remaining temperate lowland native grassland will remain on private land. Therefore conservation initiatives have focused on providing assistance from local, state and national government to land holders to manage the remnant grassland. Such assistance is for all types of native vegetation.

Some local governments provide tax discounts and other assistance on land zoned for conservation (Paris 1998) to reward commitments to native vegetation management. Initiatives from state governments include establishment of legal frameworks for conservation covenants that are binding for current and future farm owners. In the state of Victoria, conservation covenants are administered by the Trust for Nature, a non-governmental organisation. This helps to dissolve some of the farmers' traditional suspicions of government agencies (pers. com. Tim Barlow, Victorian National Parks Association 1998). Some conservation covenants are equivalent to IUCN protected area category VI, where the area is managed mainly for the sustainable use of natural ecosystems. Thus while overgrazing continues to threaten native grasslands, there are examples where private landholders have achieved compatibility between grazing and conservation of native grasslands and the associated rare native fauna (Francis

Table 1. *SE temperate lowland kangaroo grass-dominated communities.*

community[1]	**region**[2]	**reservation status and comments**
Monaro grassland-M2	southern NSW	Unreserved but a nature reserve and voluntary conservation agreements have been proposed.[3]
Canberra grassland-M4	ACT	Inadequately reserved.[4]
Basalt Plains grassland-B1	western Vic.	Small remnants are reserved. Threatened by weed invasion. Inadequately reserved.
Basalt Plains grassland-B2	western Vic.	Some is reserved but mostly threatened.
Stony Rise kangaroo grass grassland-B3	western Vic.	Unreserved. Only species rich example is on a roadside.
Basalt Plains grassland-B4	southern Vic.	A new reserve is proposed for this inadequately reserved community.[5]
South Gippsland kangaroo grass grassland-G1	mid-east Vic.	Unreserved and threatened by shrub invasion due to changes in the fire regime.
Central Gippsland kangaroo grass grassland	mid-east Vic.	Restricted to rail-lines, roadsides and cemeteries.
Mount Lofty Range grassland-S4	south-eastern SA	Mostly located on roadsides.
Tasmanian grassland-T5	mid- & eastern Tasmania	Inadequately reserved with most remnants on private land.
Tasmanian grassland-T6	mid-Tasmania	Inadequately reserved as it mainly occurs on roadsides and private land.
Tasmanian grassland-T7	mid- & eastern Tasmania	Inadequately reserved. Degraded by stock grazing.

[1] The full grassland community names including the characteristic species are in Kirkpatrick *et al.* (1995). The codes attached to the grassland community names are used to uniquely identify the community.
[2] 'Region' refers to the area in Australia where the community is found. State abbreviations are: SA (South Australia), NSW (New South Wales), ACT (Australian Capital Territiory) and Vic. (Victoria). More details about the actual location are in McDougall and Kirkpatrick (1994) and Kirkpatrick *et al.* (1995).
[3] Pers. com., Rainer Rehwinkel, NSW National Parks and Wildlife Service 1998
[4] Pers. com., Sarah Sharp, Environment ACT 1998.
[5] Pers. com., Tim Barlow, Victorian National Parks Association 1998.

1997). In such cases government assistance should be aimed at helping private landholders or farmers to continue their good management.

There are also state-based voluntary conservation agreements which allow farmers or graziers to receive assistance with fencing materials, animal and plant surveys, and certain specialist advice. There are planned voluntary conservation agreements for several remnant temperate grasslands in NSW, e.g. Monaro basalt grassland-M3 and Monaro grassland-M5. In Victoria there is a voluntary conservation agreement scheme called Land for Wildlife. Experience has shown that this scheme is often a stepping stone to the more legally-binding conservation covenants (Paris 1998).

The national government has established the Bushcare program to fund and coordinate revegetation initiatives and the conservation of remnant native vegetation. Bushcare provides funds to landholders, community groups and state government agencies for a range of conservation activities. These include:

- Provision of fencing subsidies to landholders to allow a switch from continuous grazing in one location (overgrazing) to short bursts of grazing in the correct seasons (some state governments also provide fencing assistance).
- Distribution of information through pamphlets and magazines like *Bush*, the magazine of the Bushcare program.
- Funding restoration and revegetation projects, and providing specialist advice.

In addition, Bushcare, and past national programs like Save the Bush, finances practical research aimed at managing grassland remnants. One example is a recent study that trialed a number of different herbicide and mowing techniques to control weeds in South Australia's grasslands and grassy woodlands (Davies 1997).

Table 2. *SE temperate lowland tussock grass-dominated communities.*

community	region	reservation status and comments
Monaro basalt grassland-M3	southern NSW	A reserve is planned along with voluntary conservation agreements on private land.[1]
Monaro grassland-M5	ACT & southern NSW	Some of the best examples are reserved. A voluntary conservation agreement is also planned for one private land site.[2]
Tasmanian valley grassland-T1	mid- & eastern Tasmania	Inadequately reserved. Most of what remains is under threat from agricultural practices.
Tasmanian valley grassland-T2	eastern Tasmania	Inadequately reserved.
Tasmanian flood plain	eastern Tasmania	Inadequately reserved. Threatened by grassland-T3 over-grazing and weed invasion.
Tasmanian rock outcrop	eastern Tasmania grassland-T4	Inadequately reserved.

[1] Pers. com., Rainer Rehwinkel, NSW National Parks and Wildlife Service 1998.
[2] *Ibid*.

Table 3. *SE temperate lowland spear grass-dominated communities.*

community	region	reservation status and comments
Monaro grassland-M1	southern NSW	Unreserved but a local government reserve is planned for one site.[1] Most is over-grazed and some is in travelling stock routes.
Wimmera grassland-W1	western Victoria	Inadequately reserved. Degraded by tree planting.
Mallee annual grassland-S2	SA	Well reserved.

[1] *Ibid*.

Table 4. *SE temperate lowland Wallaby grass-dominated communities.*

community	region	reservation status and comments
Lake Omeo grassland-O1	NE Victoria	Unreserved.
riverine plains grassland-R1	SW NSW & northern Vic.	Small reserve. Most on private property and travelling stock routes.
Wimmera herb/grassland-W2	western Victoria	Unreserved and highly vulnerable to degradation.
marsh margin grassland-S1	eastern SA	Unreserved roadside fragments.
Tasmanian grassland-T8	eastern Tasmania	Mostly reserved in national parks.

Conclusions

In conclusion most of the lowland temperate native grasslands are either unreserved or inadequately reserved. Furthermore around half of the rare or threatened grassland plant species are found on private land (Kirkpatrick *et al.* 1995). This indicates that conservation of what remains is highly dependent on appropriate management practices by private landholders. This is one reason why there has been an increased commitment to programs like Bushcare and protection measures such as conservation covenants and Land for Wildlife schemes.

The main threats and impediments to conservation of what remains (apart from lack of resources), include:

- Lack of political will to enforce legislation that would conserve native grasslands, in contrast to strong will to conserve rainforests. Two reasons for this are:

  (i) it is harder to persuade the public about the importance of native grasslands than to persuade them of the importance of native forests; and

  (ii) farmers and other private land-holders sometimes mistrust government agencies, leading them to misunderstand reasons for legal prescriptions to protect native grassland;

- Ad hoc management. This includes fencing off a remnant native grassland without having a management plan in place;
- Continuous grazing in one location (overgrazing). Lower stocking rates and appropriate fencing would allow a switch to short bursts of grazing in the most appropriate seasons. This requires further government financial assistance;
- Invasion by exotic plants. Exotic plants represent around one third of temperate grasslands species (Kirkpatrick *et al.* 1995). There is increasing knowledge about the control of weed infestations (Davies 1997) but more resources are needed to apply the weed control techniques; and
- High edge effects due to the small linear nature of many remnants, making such areas more prone to catastrophic disturbances.

A commitment of government resources combined with community participation can deal with many of these threats. A growing public awareness of the importance of the remaining temperate lowland native grassland biodiversity will hopefully create the political will to allocate further government resources.

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Temperate and alpine grasslands of the Himalaya: ecology and conservation

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The ecology and conservation of grasslands within the Himalayan region are reviewed. Five grassland types are defined and described: warm temperate grasslands; cool temperate grassy slopes; sub-alpine meadows; alpine meadows; and steppe formations of the trans-Himalaya. The floral structure, successional trends in meadow and forest regions, and biomass productivity are examined. Mammalian and bird species are listed as an indicator of biodiversity. The human effects of pastoralism, collection of medicinal herbs, and collection of fuel wood are then described. The paper concludes by looking at aspects of conservation and management, touching on the sustainability of different land-use.

THE HIMALAYAN region, one of the most astounding physical features on the surface of the earth, is well known for its diverse landscapes and aesthetic, cultural, biological and hydrological values. It has witnessed a series of changes in its geomorphology, climate and biota since its origin during Cretaceous-Oligocene periods (Vishnu-Mittre 1984). These changes, coupled with more recent human activities, have given rise to present day vegetation which ranges from lower montane, wet, evergreen forests to cold, arid, steppe communities and several secondary formations (Singh and Singh 1988, Mani 1974). Of these, the natural and semi-natural grasslands are of particular interest due to their relatively recent origin, dynamics and close co-evolution with grazing ungulates.

The grassland vegetation in the Indian Himalaya occupies nearly 35% of the geographical area and includes the warm temperate grasslands, sub-alpine and cool temperate grassy slopes, alpine meadows of the greater Himalaya and the steppe formations of cold arid regions or alpine dry scrub. These grasslands form distinct categories of their own and differ from one another in terms of origin, structure and composition. However, like all other grasslands of the world, these formations support a large number of wild herbivores, domestic livestock and several agro-pastoral cultures.

The temperate and alpine grasslands of the Himalaya have been studied by a large number of ecologists, e.g. Patil and Pathak (1978), Gupta (1990), Numata (1986), Ram *et al.* (1989), Rikhari *et al.* (1992), Sundriyal (1989, 1995), Bawa (1995), Bhat and Kaul 1989, and Kala *et al.* (1998) to name a few. Most of these authors have focused on the flora, use as grazing for domestic livestock and biomass production in the alpine meadows of the western and central Himalaya. But the trans-Himalayan steppe formations and grasslands of cool temperate and sub-alpine regions, which support a considerable number of wild herbivores and birds, have not been studied in detail. Thus, there is a need to collate the available information on the various grasslands in the Himalaya and identify the gaps in information which would be pertinent for further research and conservation efforts.

This paper is an overview of the ecology and aspects of the conservation of various grasslands within the Himalayan region based on the available literature and the author's own experience of the vegetation and wildlife in the Himalaya.

Origin and classification

The history of grasses and grasslands in the temperate belt of Asia begins with the progressive uplift of the Himalaya which increased aridity in north-west India. The cyclic shifts in climate since the Pleistocene and the aridity and warmth of the Neothermal period permitted diversification and spread of grasses and herbaceous flora (Blow and Hamilton 1975). Subsequent introduction of cattle, fire and the widespread impact of humans over the last 5,000 years has reduced the forest cover and resulted in a spread of grass cover. According to Whyte (1976), and Yadava and Singh (1977) most of the grasses of western monsoon Asia are of recent origin derived through immigration of ancestral species from other areas such as semi-arid Africa, the Mediterranean and continental Asia. Clearing and opening the forests for various land-use practices and frequent burning of steeper south facing slopes for the production of hay and intensive livestock grazing have converted a considerable area under herbaceous vegetation. Such areas include forested blanks in humid areas, mid-elevation hay fields, fallow lands and village grazing grounds. Such areas are frequently termed 'rangelands' or pastures. In fact, the Himalayan rangelands and natural grasslands, including the cold arid pastures of the trans-Himalaya, cover as much as 50% of the geographical area of the Himalaya (Table 1).

Cattle camp; sub-alpine meadows and the alpine pastures of the western Himalaya.
Photo: G. S. Rawat.

Several authors have made attempts to classify Himalayan grasslands based on cover and composition of species (Agarwal and Tiwari 1988, Dabadghao and Shankarnayan 1973, Singh and Saxena 1980). While community-based classification holds true for prominent species and associations representing certain edaphic and climatic climaxes, many intermediate seral stages and loose associations are too dynamic to be classified. For conservation and management purposes a broad level

Table 1. *Land cover (km²) under the natural/semi-natural grasslands in the Himalaya. (J & K: Jammu & Kashmir, HP: Himachal Pradesh, UP: Uttar Pradesh, AP: Arunachal Pradesh. Source: Kawosa, 1988 and Lal* et al. *1989).*

country/ state	geographical area (km²)	temperate grassland/ pastures	cultivable waste	alpine pastures & blanks
J & K	222,240	1,240	1,490	131,587
HP	55,670	10,240	1,360	17,296
UP	51,103	91	68	8,524
Nepal	140,800	52,110	23,050	32,616
Sikkim	7,300	1,030	10	1,626
Bhutan	46,500	200	2,540	15,500
AP	83,585	500	850	12,335

classification of Himalayan grasslands is being suggested based on their origin and geographical distribution. Various associations and community types identified by earlier workers can be grouped under these types:

- Warm temperate grasslands;
- Cool temperate grassy slopes;
- Sub-alpine meadows;
- Alpine meadows; and
- Steppe formations of trans-Himalaya.

Warm temperate grasslands

The warm temperate belt (1,500–2,500 m) in north-western, western and central Himalaya, especially on the south and south-eastern slopes, are characterised by extensive grassy slopes dotted with scattered trees and shrubs. Most of these grasslands or 'hill savannas' have been derived as a result of frequent burning and livestock grazing on gentler slopes. According to Dabadghao and Shankarnarayanan (1973) the grass cover in these areas fall under the *Themeda-Arundinella* type. This category also includes the hay fields intensively managed for grass production by local people. Such grasslands are locally known as 'ghasnis' in Himachal Pradesh (HP) and the hills of Uttar Pradesh (UP). Quite a few slopes with abandoned agriculture are dominated by more fire-hardy species such as *Imperata cylindrica* and *Cymbopogon distans*, and can be termed semi-natural or secondary grasslands.

Cool temperate grassy slopes

The steeper (>45°) slopes with thin soil in the cool temperate and sub-alpine zone (2,600–3,300 m) do not favour the tree growth and generally support herbaceous or grassland vegetation. The common species of grasses in such areas in the west are *Chrysopogon gryllus*, *Dactylis glomerata*, *Koeleria cristata*, *Andropogon munroii*, *Danthonia jacquemontii* and *Themeda triandra*. These areas also burn during winter, either accidentally or intentionally.

Sub-alpine meadows and 'thaches'

Forest blanks within the cool temperate and sub-alpine forests have been created by migratory graziers, and in HP are frequently termed 'thaches'. Unlike the above category, these areas are dominated by a large number of herbaceous plants such as *Origanum vulgare, Taraxacum officinale, Ranunculus hirtellus, Rumex nepalensis, Anemone rivularis, Senecio chrysanthemoides* and *Anaphalis cuneifolia*, many of which are unpalatable and weedy. Only a few grasses (e.g. *Poa alpina, Phleum alpinum* and *Stipa* sp.) are found in these areas.

Alpine meadows

These are the natural herbaceous formations located above the natural limit of forest and scrub vegetation, covering an area of approximately 171,646 km^2 or 25% of the Indian Himalaya area (Lal *et al.* 1991). The meadow vegetation typically comprises a large number of herbaceous plants with varying proportions of tussock forming grasses, sedges and matted shrubs. Although grasses form a large proportion in the flora in the alpine region, many herbaceous plants belonging to other families, e.g. Rosaceae, Leguminosae, Asteraceae, Lamiaceae and Scrophulariaceae, dominate the meadows in terms of cover and abundance (Rawat and Rodgers 1988). The following communities and associations of grasses have been reported from the alpine regions of the western Himalaya: *Deyuxia-Deschampsia*, *Danthonia cachemyriana* patches, species of *Festuca* and *Poa*. Kala *et al*. (1998) have reported as many as 22 herbaceous communities from the alpine meadows of the Valley of Flowers National Park in the western Himalaya.

Steppe formations of trans-Himalaya

The cold arid regions in the trans-Himalaya are characterised by the Mediterranean type of vegetation, i.e. scattered low shrubs with sparse grasses and forbs. Several communities are reported from the cold arid regions of Ladakh and Spiti regions of north-west Himalaya, e.g. *Artemisia-Caragana*, *Ephedra-Juniperus*, *Salix-Myricaria* and *Lonicera-Rosa*. Manjrekar (1998) reported nine associations of herbaceous and shrubby species from Pin Valley National Park in HP which represents typical steppe vegetation of trans-Himalaya.

Structure and function

Flora

Grass families (Graminae or Poaceae) occupy the top positions in the flora of western Himalaya in terms of species number (Uniyal *et al*. 1994). Based on the published literature on the Himalayan flora, Singh and Saxena (1980) listed 73 prevalent grass species at 350–1,800 m, 51 species at 2,200–2,500 m and 2,550–3,000 m belts with 62 species above 3,000 m. Uniyal *et al*. (1994) enumerated 450 species of grasses from UP, of which more than half are from the Himalayan region which covers only 18% of the state. A closer look at the morphology of various species reveals that most of the grasses in the warm temperate region are rhizomatous and with the increase in the altitude proportion of tussock-forming grasses increases.

Based on the floristic composition and species dominance Tsuchida and Numata (1983) have identified four zones of grasslands in Nepal. These are:

- Zone I (<1,100 m): *Cynodon dactylon*, *Chrysopogon aciculatus*, *Desmodium triflorum*.
- Zone II (1,100–2,600 m): *Paspalum scorbiculatum*, *Pycreus sanguinolentus*, *Fimbristylis* spp. *Setaria* spp.
- Zone III (2,600–3,800 m): *Carex* spp. *Poa* spp.
- Zone IV (>3,800 m): species of *Carex*, *Calamogrostis*, *Festuca* and *Agrostis*.

Successional trends

The grasslands on the steeper south facing slopes in the temperate and sub-alpine regions of the Himalaya have not been investigated in terms of community dynamics and succession. According to Dabadghao and Shankarnarayan (1973) *Themeda anathera* represents the higher seral stage in the *Themeda-Arundinella* type of cover. As grazing pressure increases, the *Themeda* community is replaced by *Arundinella nepalensis* and *A. bengalensis*. On heavily grazed areas *Cynodon dactylon* replaces all other communities. Towards higher altitudes the *Poa annua*, *Koeleria-Chrysopogon gryllus* and *Agrostis munroana* communities occupy the frequently grazed sites (Singh and Saxena 1980). Sundriyal (1995) has given the floristic composition of grasses within various climatic zones and traced climax species (trees and shrubs) for each zone assuming that all the grasslands below the natural treeline are seral in nature and would be changed to forest vegetation if kept free from human interference.

The alpine meadows exhibit a complex mosaic of plant succession. The species which occur on frequently grazed sites include *Danthonia cachemyriana*, *Calamogrostis* sp., *Stipa* spp. and *Agrostis munroana*. Kala *et al*., (1998) have suggested two parallel courses of succession for the alpine meadows near the treeline (3,500+200 m) in the Valley of Flowers National Park, western Himalaya:

- *Meadow succession*: The moss-lichen (pioneer) community in a glaciated valley on the terminal and south-facing lateral moraines give rise to several annual herbaceous formations. The *Cyananthus-Kobresia-Anaphalis* association and *Danthonia cachemyriana* patches form the climatic plant community on such slopes; and
- *Forest succession*: The north and north-eastern aspects, due to higher moisture regime and less exposure to sun and wind, promote the growth of shrubby species which thrive well under heavy snow, i.e. snow-bed communities. Some of these shrubby intermediate communities will eventually give way to a birch-rhododendron (*Betula utilis-Rhododendron campanulatum*) community on more stable slopes with deeper soil.

Biomass productivity

The above-ground biomass in these grasslands varies from 1,000 kg/ha to 10,000 kg/ha for warm temperate grassland and 400–5,000 kg/ha for high altitude grasslands (Gupta 1990, Sundriyal 1995). It has been estimated that due to increase in the cover of unpalatable species the herbage production in the Himalayan grasslands has decreased by 20–50% in terms of quantity and 10–15% in terms of quality compared with their potential (Patil and Pathak 1978). In parts of Garhwal and Kumaon Himalaya the standing biomass of grasses was found to increase with increasing altitude up to about 3,750 m (Dabadghao and Shankarnarayan 1973). However, no detailed studies on the productivity are available along the entire gradient. The dry matter yields (in kg/ha) of certain indigenous fodder grasses (within pure stands) are reported to be up to 7,440 for *Andropogon pumilus*, 11,040 for *Apluda mutica*, 6,986 for *Arundinella nepalensis*, 6,951 for *Bothriochloa intermedia*, 4,975 for *Chrysopogon fulvus*, 6,941 for *Chrysopogon gryllus*, 6,925 for *Heteropogon contortus*, 9,918 for *Pennisetum orientale* and 4,836 for *Themeda anathera*. In terms of nutrient value, i.e. crude protein content, *Apluda mutica*, *Bothriochloa intermedia* and *Chrysopogon fulvus* are considered to be the best grazing (Singh and Saxena 1980).

Unlike the tropical grasslands, the temperate and alpine grasslands exhibit a strong seasonality. While the growing season in the temperate region generally begins in April, the sub-alpine and alpine grasslands start sprouting in June to July. Thus, the biomass production in these grasslands is lower than in tropical grasslands (Misra 1987, Ram *et al.* 1989) due to the shorter growing season.

Wildlife

The Himalayan grasslands support a diverse array of animal communities. The typical mammalian fauna inhabiting grassland habitats in these mountains include wild sheep, goats, goat antelopes and rodents. In addition, a number of avian communities, especially partridges and other members of the phasianidae, depend on the grasslands and meadow vegetation for their survival (Table 2).

Table 2. *Major grassland types in the Himalayan mountains, distribution and characteristic (wild) faunal elements. Grassland types: WTGS: warm temperate (semi-natural) grassy slopes; CTGS: cool temperate grassy slopes; SAM: sub-alpine meadows; AM: alpine meadows and SFTH: steppe formations of the trans-Himalaya.*

SN grassland type	distribution	faunal elements
1. WTGS	Frequently burnt and grazed south facing slopes (<2,500 m) J & K, HP, UP hills, Sikkim.	Goral, Himalayan Y-throated marten, Partridges, cheer pheasant.
2. CTGS	Steep slopes with scattered woody vegetation, less freqently burnt (2,500–3,000 m) Western Himalaya.	Him. tahr, goral, serow, monal Kashmir stag.
3. SAM	Man made openings in the sub-alpine forests, openings near treeline and rocky slopes (30–3,500 m)	Him. musk deer, Pica, monal, wild pigs.
4. AM	Natural herbaceous formations above 3,600 m in the western and >4,000 m in the eastern Himalaya more stable compact soils.	Blue sheep, Himalayan tahr, Pica, Voles, Himalayan marmot, long-tailed marmot, snow cock, snow partridge.
5. SFTH	Scattered, stunted scrubby vegetation with sparse grass cover in the cold arid areas of Ladakh, Lahul & Spiti, northern parts of UP hills Sikkim (>4000 m asl).	Blue sheep, Tibetan wild ass, Tibetan woolly hare, Tibetan antelope, Tibetan gazelle, Nayan, snow leopard, snow cock and wild yak.

Mammals

Goral (*Nemorhaedus goral*), Himalayan tahr (*Hemitragus jemlahicus*), blue sheep (*Pseudois nayaur*), Himalayan ibex (*Capra ibex sibirica*), Tibetan antelope (*Pantholops hodgsoni*), Tibetan gazelle (*Procapra picticaudata*), Ladakh urial or shapu (*Ovis vignei vignei*), Tibetan argali or nayan (*Ovis ammon hodgsoni*) and Tibetan wild ass (*Equus kiang*) are the typical grazing ungulates of the high altitude grasslands and scrubs. Mishra and Johnsingh (1996) studied the habitat use by goral in western Himalaya and found that this species feeds almost entirely on grasses (92.2% in the cold season and 98.3% in the warm season) and prefers open grass-dominated vegetation and avoid shrub-rich patches. Schaller (1977), Chundawat (1992), Sathyakumar (1994), Bhatnagar (1997) and Manjrekar (1997) give some more information on the use of temperate-alpine grasslands by mountain ungulates.

Birds

The bird species diversity in the Himalayan grasslands is relatively low compared to forested habitats. This is evident from the fact that the western Himalaya, with more area under one or other type of grassland, has fewer number of bird species (nearly 405 species in Jammu and Kashmir and 375 species in HP) compared with Arunachal Pradesh (642 species) which is largely forested (Singh 1994). Nevertheless, grasslands support some of the most highly threatened and vulnerable bird species such as Tibetan sandgrouse (*Syrraptes tibetanus*), snow partridge (*Lerwa lerwa*), chukar partridge (*Alectoris chukar*), snow cocks (*Tetraogallus tibetanus* and *T. himalayanus*), cheer pheasant (*Catreus wallichii*) and supposedly-extinct mountain quail (*Ophrysia superciliosa*) (Ali and Ripley 1983). Status surveys and ecological studies are lacking on the habitat use of these birds as well as many associated raptors.

Human use and abuse

Pastoralism

Most of the grasslands in the lower temperate belt of western and central Himalaya are grazed by domestic livestock throughout the year. It is estimated that the Himalayan region supports nearly 12 million sheep and goats, 10 million cattle, 3–4 million buffaloes, 400,000 horses and donkeys, and up to 350,000 pigs (Kawosa 1988). Since the lower altitude grazing lands are limited in area and the livestock population in these areas far exceeds the carrying capacity, the practice of summer migration to the higher altitude alpine meadows has become necessary to sustain the number of livestock. It has been observed that agro-pastoralists in the western and central Himalaya generally keep more cattle than they really need because of easy access to free grazing areas and their inability to dispose or cull the population due to religious sentiments. Uncontrolled grazing on the steeper slopes reduces water holding capacity and compaction reduces the permeability of the soil. Continuous grazing also creates channels or paths on hill slopes which remove huge quantities of soil during rains. Over-grazed areas near mid- and high-elevation villages in Nepal shows a decrease in grasses and an increase in the unpalatable species such as *Rhododendron anthopogon*, *Berberis* spp. *Euphorbia wallichii*, *Euphorbia longifolia* and *Iris kumaonensis* (Numata 1986). However, Brower (1990) has stressed that the migratory lifestyle of Sherpa communities in Nepal was better for the conservation of rangelands than a sedentary lifestyle would have been.

A flock of migratory sheep and goats on their way to higher pastures in the Himalaya. Photo: G. S. Rawat.

Despite the fact that domestic animals are an integral part of agro-pastoral ecosystems and that grazing-based animal husbandry is the mainstay of the economy in many parts of the Himalaya, no studies and policy guidelines are available for optimal use of grazing resources. Plantation of agroforestry trees and round the year production of fodder would be the best option for the agro-pastoralists, but excessive use of resources for horticulture (orchards) and heavy use of pesticides to promote fruit production may, as practices in the states of HP, and Jammu and Kashmir (J&K) show, have severe ecological consequences and loss of biodiversity in the long run.

Collection of medicinal herbs

Alpine meadows, besides being popular summer grazing grounds for a large number of migratory livestock, harbour numerous medicinal herbs which are extracted in large quantity by many local communities for their own consumption, as well as for sale. Over-exploitation of some of the herbs from high altitude areas has caused serious concern amongst conservationists (Edwards 1996 and Tandon 1997). Most of the medicinal plants growing in the alpine meadows have tuberous or rhizomatous roots. Digging of fragile alpine soil for such medicinal herbs and subsequent trampling and grazing by livestock spreads weeds and causes soil erosion. In the western Himalayan meadows, exploitation pressure is particularly high on

Dactylorhiza hatagirea, *Picrorhiza kurrooa*, *Jurinea macrocephala* and *Aconitum heterophyllum*. Presently, there are only a few protected areas in the western Himalaya where extraction of medicinal herbs is prohibited. Kala *et al.* (1998) compared the density and abundance of various medicinal herbs in and around the Valley of Flowers National Park and found that some of the rare and threatened medicinal plants were completely absent in the grazed and unprotected alpine meadows.

Collection of brush from the steppes has been a major anthropogenic factor influencing the vegetation in the trans-Himalaya. Photo: G. S. Rawat.

Collection of fuel wood

Livestock grazing and extraction of woody plants by the pastoral communities go together. Consumption of firewood is very high around treeline and sub-alpine zones of the greater Himalaya and thickly populated areas of trans-Himalaya. There are clear indications that the natural treeline in many parts of the Himalaya has lowered considerably as a result of regular camping and removal of woody vegetation (Rawat and Uniyal 1993). Selective removal of highly preferred species such as *Juniperus macropoda* and *J. communis* can also lead to local extinction of such species. Extraction of fuel wood, particularly from the low productive areas of trans-Himalaya, is one of the burning issues in the conservation of steppe communities. In the absence of larger trees and shrubs local people dig out the low shrubs and undershrubs in large quantities in order to warm their houses and cook during long and severe winters (Manjrekar 1997). In addition, collection of livestock dung from the higher pastures for fuel is a common practice in the trans-Himalaya. The ecological implications of such practices have not been fully understood so far.

Conservation and management

The mid-elevation grasslands, particularly the hay fields, or 'ghasnis', are maintained by regulation of livestock grazing and winter season burning. This system has been successful in many parts of western Himalaya through village level cooperatives and personal care of ghasnis which are passed on within families. However, no management system has evolved for the village grazing lands which are considered to be common property. Raina (1960) has pointed out the plight of such grazing lands, locally known as 'charand' in HP, stating that these areas have been "nobody's child". Despite a number of government departments operating in the region, including Revenue, Animal Husbandry, and Agriculture and Forestry, none are responsible for the restoration of grazing lands. Thus it is imperative to develop a better management system for village pastures to increase fodder production and to reduce pressure on the natural grasslands which act as refuges for the wild grazing ungulates.

The sustainability of seasonal grazing by large flocks of migratory sheep and goats in the alpine meadows in summer and the Himalayan foot-hills in winter has been much debated recently (e.g. Saberwal 1996, Mishra and Rawat 1998). Alpine pastures play an important role in relieving the grazing pressure on the forests and grazing lands of the lower altitudes, but the increased number of livestock and overuse of certain pastures can lead to degradation of high altitude grasslands including habitats for wild herbivores (Bhatnagar 1997). Restriction of grazing by migratory livestock in crucial wildlife areas, especially within the national parks, and limiting the number of livestock in other areas would be the most practical solution. Johnsingh *et al*. (1998) have given more recommendations for the conservation of various species and ecosystems in the trans and alpine areas of the Greater Himalaya.

Ecodevelopment plans to address the problems of fuel wood and non-timber forest products (including medicinal plants) in the high altitude areas are needed, especially for the people living in and around the protected areas in the Himalaya. More concerted efforts in monitoring the health of threatened grassland ecosystems and representative biota will be crucial in achieving the long term conservation goal.

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The Pan-European Biological and Landscape Diversity Strategy: integration of ecological agriculture and grassland conservation

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Following the adoption of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) by European environment ministers in 1995, IUCN has played a leading part in the development of a Pan-European Grasslands Action Plan. Grasslands in Europe and northern Eurasia are greatly diminished from their extent of even 50 years ago, and increasingly fragmented. The plan acknowledges the reality of the close relationship between grassland conservation and agricultural policies in Europe and calls for better integration of approaches. On-farm case studies carried out by IUCN in Russia and Ukraine suggest that such integration is not only possible, but in marginal lands it is probably the only feasible economic approach. Harnessing financial investment from ethical funds may be a useful mechanism for encouraging the integration of grassland conservation and ecologically sustainable agriculture, provided that government farm policies adopt appropriate incentives.

IN MAY 1990, the UN Economic Commission for Europe (UNECE) convened a conference of European environment ministers (including Canada and the USA as honorary Europeans) in Bergen (Norway) to discuss a document entitled Action for a Common Future. They issued a Ministerial Declaration on Sustainable Management that set in train the Environment for Europe series of ministerial meetings on the environment, which now take place every two years. The first of these was held in June 1991 at Dobříš Castle (in former Czechoslovakia) where the Dobříš Assessment of Europe's Environment was commissioned. IUCN played a major role in contributing material on European ecosystems (including scrub/dry grasslands) to the eventual report, produced by the European Environment Agency (Stanners and Bourdeau 1995).

The second ministerial meeting at Lucerne (Switzerland) in April 1993 launched the Environment Action Plan for Central and Eastern Europe. As a consequence, the Council for Europe took the initiative for preparing a draft Pan-European Biological and Landscape Diversity Strategy (PEBLDS). The European Centre for Nature Conservation (ECNC) was requested to lead a team to assist an ad hoc group of national government experts in drafting the document. Other members of the team included IUCN, the World Conservation Monitoring Centre and the Institute for European Environmental Policy.

In October 1995, European environment ministers met in Sofia (Bulgaria) for the third pan-European conference. There they endorsed PEBLDS as a framework for strengthening and building on existing initiatives and programmes, including the Bern Convention, the European Conservation Strategy, and the Dobříš and Lucerne

Ministerial Conferences. It covers all UNECE countries from Iceland to Uzbekistan (Council of Europe *et al.* 1996).

The fourth ministerial conference on Environment for Europe took place in June 1998 at Aarhus (Denmark). The conference endorsed a number of initiatives, among others a special resolution on biodiversity and landscape and further endorsement of PEBLDS expressed in the Aarhus Declaration (see web-site http://www.mem.dk). The Declaration points out that land use has a strong impact on biological and landscape diversity in Europe and that the process of enlarging the EU gives wide opportunities to take initiatives to integrate biodiversity considerations into agricultural policy. The Declaration also calls on all the participating States, international organisations, NGOs and the private sector to increase their support for the implementation of the Convention on Biological Diversity, including through the PEBLDS, by exploring new and innovative financing means. In the resolution, the ministers underlined that the agricultural sector deserves special attention and should be considered a priority, as should a joint conference of agricultural and environmental ministers.

PEBLDS aims and action plan 1996–2000

The PEBLDS emphasises cross-sectoral participation, specifying mechanisms for communication, learning and exchanging experience. It does not aim to introduce any new legislation, but to facilitate and promote partnerships and to identify areas where further work is needed, such as agriculture, forestry, transport and tourism. The implementation mechanism, established in 1996, comprises a Council for the Strategy, an Executive Bureau and a joint CoE/UNEP Secretariat. The Council of Europe (CoE) publishes a strategy bulletin every two months (and maintains a web-site at http://www.coe.fr).

The aims of PEBLDS are to:

- Reduce threats to Europe's biological and landscape diversity.
- Increase the resilience of Europe's biological and landscape diversity.
- Strengthen ecological coherence of Europe as a whole.
- Ensure full public involvement in conservation of biological and landscape diversity.

PEBLDS encompasses a 20-year period, divided into four five-year action plans so it can respond to changing circumstances. The first action plan is divided into the following eleven Action Themes. In the context of this paper, Themes 2, 8 and 11 are the most relevant:

0. Pan-European action to set up the Strategy Process (led by UNEP), with the subsidiary tasks (0.1) to develop a pan-European task force for coordinating action and (0.2) to assist the introduction of national biodiversity strategies in all countries of Europe by 2000 (led by UNEP and IUCN).
1. Establishment of the Pan-European Ecological Network (led by CoE and ECNC).
2. Integration of biological and landscape diversity considerations into sectors (led by IUCN, Norway and Switzerland).
3. Raising awareness and support with policy makers and the public (led by CoE, IUCN and ECNC).
4. Conservation of Landscapes (led by the Netherlands and Switzerland).
5. Coastal and Marine Ecosystems (led by UNEP).

6/7. River Ecosystems and Inland Wetlands (led by Ramsar Convention Bureau).

8. Grassland Ecosystems (led by IUCN, ECNC).
9. Forest Ecosystems (led by UNEP).
10. Mountain Ecosystems (led by IUCN).
11. Action for Threatened Species (led by CoE – Berne Convention Secretariat).

Dry grasslands in Europe and north Eurasia

The discussion in this paper is confined to the lowland dry grasslands of the region as there is not enough space here to give proper treatment to wet and montane grasslands. Most of the dry grasslands in Western Europe result from forest clearance for agricultural purposes (especially grazing) over the last 10,000 years or more, and the associated biodiversity closely follows human land-use history (Goriup 1988). More extensive and natural dry grassland (or steppe) ecosystems persisted in eastern Europe and the former USSR until fairly recently, but between 1954 and 1960, the virgin lands programme in the former USSR converted some 41 million ha of steppe to arable farmland. This proved a disastrous economic failure due to insufficient attention being paid to soil and climate conditions, as well as there being overgrazing and over-cultivation in the prime black soil agricultural belt. In the Ukraine, for example, steppes once covered over half of the country. Today, arable land in the steppe zone is between 72 and 88% of the land surface, with only 3–5% of the remaining steppe area existing in a relatively natural condition.

Today, the relationship between dry grassland and agricultural land-use in Europe and north Eurasia is so intimate that they cannot easily be treated separately. Indeed, steppes are a particularly good example of a land-use where agriculture can co-exist with high natural and scenic values. In the absence of wild herbivores, for example, extensive grazing systems may actually serve as indispensable management substitutes. Even cereal crops (or 'pseudosteppes') can be attractive for a range of steppe wildlife because of the availability of food and cover. Where low intensity of cultivation has persisted in the region, it has supported reservoirs of species that are capable of rapid expansion. Not surprisingly, Birdlife International treats the two ecosystems together in their recent analysis of bird habitats in Europe (Tucker and Evans 1997). They found that 173 priority bird species were dependent on agriculture/grassland habitats, more than in any other major habitat type. Of these, 70% had an unfavourable conservation status in Europe.

The statistical compendium that accompanied the Dobříš Assessment provided data on 186 'representative' scrub/grassland sites across Western Europe, extending as far as the Caspian Sea (Figure 1). These sites comprise about 14 million ha of land, most of which is in the Mediterranean region. Indeed, over half is in Spain, and it is no coincidence that Spain now holds the largest single population of the threatened great bustard *Otis tarda* anywhere (about 16,000 birds out of a world population of about 30,000). By contrast, in Austria, once famous for its Pannonic plains, native dry grassland now amounts to a pathetic 30 ha. In any case, much of the 14 million ha is highly fragmented, and less than half of that area enjoys any semblance of conservation protection.

Figure 1 also clearly indicates the dearth of information from the former USSR at that time. In the former USSR, steppe reserves were created mainly in central Asia; hardly any exist in the western part and only Askania Nova (Ukraine) and the Central Black Soil Reserve (Russia) exceed 2,000 ha in extent. To help address this problem, between 1996 and 1998 the IUCN European Programme carried out a project on

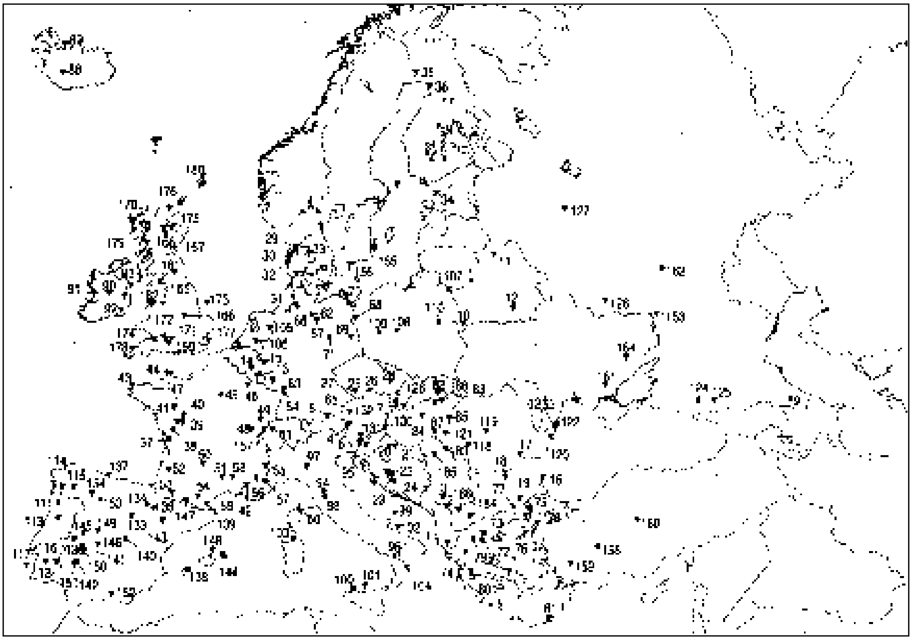

Figure 1. *Location of representative scrub and grassland sites across Europe (from Europe's Environment: Statistical Compendium).*

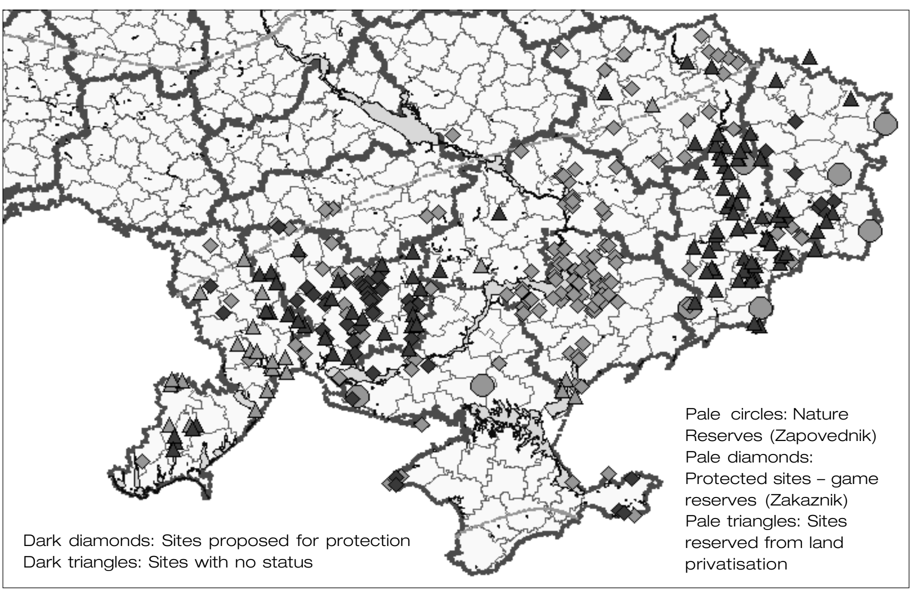

Figure 2. *Important steppe areas in Ukraine, derived from IUCN project on steppe biodiversity and sustainable agriculture.*

Sustainable Agriculture and Steppe Biodiversity in Russia and Ukraine. Funded by the Dutch Ministry for Agriculture and Nature Conservation, the principal aim was to investigate the feasibility of a rural development model integrating sustainable use practices with the maintenance and restoration of biodiversity in steppe zones. One of the main tasks was compiling preliminary inventories of important steppe sites. The inventories yielded information on over 600 sites in the two countries. In the Ukraine (Figure 2), the sites were mostly small and highly fragmented, except for some former military training areas in Crimea. In Russia (Figure 3), relatively large sites still occurred

in the south-western oblasts around the Caspian and Black Seas. However, site protection levels were poor or non-existent in both countries.

Figure 3. *Location of important steppe areas in south-western oblasts, Russia, derived from IUCN project on steppe biodiversity and sustainable agriculture.*

Maintaining the ecological quality of agricultural and grassland habitats, including protection of key sites, is the main conservation priority. In Western and central Europe, the quality of these habitats is declining due to increasing intensity of land use (e.g. crop improvement and specialisation, application of chemicals, loss of marginal habitats and field rotations, and higher levels of livestock grazing). The planned extension of the European Union, its single market and its Common Agricultural Policy eastwards is already exacerbating these problems in Hungary and Poland as investors move in to buy land cheaply and claim EU subsidies for 'improving' it. However, government support for agriculture in Ukraine, Russia and Kazakhstan has almost collapsed, especially in the less productive regions. Here there are great opportunities for restoring steppe habitats. There is a window of opportunity over the next few years to show how future agricultural development in eastern Europe can integrate sustainable production with biodiversity conservation in the steppe zone. There could also be significant lessons for landscape management and reform of the Common Agricultural Policy in the European Union itself. However, this paper now returns to a discussion of PEBLDS as the best available platform to pursue these opportunities for conservation and integration.

PEBLDS action plan for grasslands

Action Theme 8 of PEBLDS sets out the main challenges and opportunities to be addressed and considered in implementing an Action Plan for European grasslands. Three Pan-European objectives and five regional level activities are set out in Action Theme 8, which can be summarised as:

Pan-European objectives

1. Encourage the development of action plans for natural and semi-natural grasslands (especially the most important and threatened), ensuring that they contribute to the Pan-European Ecological Network.
2. Develop grassland agricultural management schemes supported by concrete financial and legal measures, case studies and information exchange that maximise land manager participation to ensure maintenance and expansion of landscape and grassland diversity.
3. Encourage the incorporation of grassland and agricultural zone monitoring into the data gathering programmes of environmental management authorities and research agencies.

Regional focus

1. Prioritise the conservation of grasslands of high biological and landscape diversity in different types of grassland habitats and biogeographical zones.
2. Request the development of an outline action plan for semi-natural grasslands, linked to Natura 2000, which could be the basis for future options on reform of the Common Agricultural Policy; and further to request the development of a policy on land use in the EU taking account of agricultural surpluses and changing afforestation needs.
3. Apply successful mechanisms for maintaining extensively managed grasslands in the wider landscape.
4. Consider how to make cross-compliance in the framework of Common Agricultural Policy reform support biological and landscape values.
5. Develop public and private participation schemes for the sell-off of agricultural land in central and eastern European countries and promote them as case studies.

The IUCN convened an expert meeting in Newbury (UK) in October 1996 to consider the implications of the activities described in Action Theme 8. The participants recommended that four main project groups were needed to construct an Action Plan that met pan-European and regional objectives. The PEBLDS Executive Bureau examined these proposals the following November and, after making some amendments, approved the schedule set out in Table 1. A corridor approach is being adopted to better focus in situ project efforts, especially in the east of Europe and north Eurasia where the largest tracts of intact grassland and steppe remain. The corridor extends from the judet of Tulcea in Romania, across Moldova and the southern oblasts of Ukraine and Russia, to western Kazakhstan and central Uzbekistan (Figure 4). It includes about 30 more or less autonomous local government regions where site-specific measures will be concentrated. Outside the corridor, attention will be paid mainly to communication and information exchange between steppe reserve managers, and to promote public awareness and policy development. As increased resources are mobilised in future, the corridor will be expanded to adjacent regions, eventually

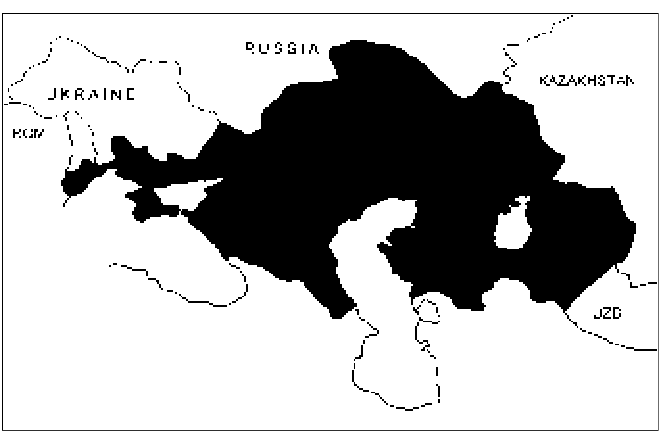

Figure 4. *Grassland corridor (black) from eastern Romania, across Moldova, southern oblasts of Ukraine and Russia, through to western Kazakhstan and central Uzbekistan.*

Table 1. PEBLDS Grassland Action Plan Project Groups.

	Project Group	region / countries	duration
1.	National and European Forums for grassland management	pan-Europe; Hungary, Kazakhstan, Russia, Ukraine, UK	1997–2000
1.1	Demonstration Centres for grassland management, training and public awareness	pan-Europe	1998–1999
1.2	Electronic network for grassland managers	grassland protected areas in central and eastern Europe	1997–1998
1.3	Partnerships for local authorities in grassland zones	pan-Europe	1997–2000
1.4	Strengthen NGOs involved in grassland conservation	central and eastern Europe	1997–2000
2.	Guidelines for model chapters on grassland ecosystems for National Biodiversity Action Plans	pan-Europe; sub-sets for EU members, EU accession states and eastern Europe/CIS	1997–1998
2.1	Guidelines for grassland ecological networks	pan-Europe; sub-sets for EU members, EU accession states and eastern Europe/CIS	1997–1999
3.	Technical preparation for the creation of grassland Biosphere Reserves (especially in former military areas)	Turkey, eastern Europe, Kazakhstan	1997–2000
3.1	Handbook for grassland managers based on case studies of land privatisation programmes	central and eastern Europe	1998–1999
4.	National inventories of grasslands and associated low-intensity farmland to identify important areas (SAC, IBA, IPA)	pan-Europe	1997–2000
4.1	Identification and evaluation of PSR indicators for grasslands	pan-Europe	1997–1998
4.2	Study of grassland ecotones and implications for conservation	pan-Europe	1998–1999
4.3	Study of livestock grazing and other management techniques at key sites for biodiversity	Spain	1998–2000

forming a steppe ecosystem network across the whole of Europe that is integrated into the lowland farming landscape.

Ecological farming and grassland conservation

The PEBLDS Action Plan for Grasslands recognises the close relationship between grassland conservation and agriculture, which also relates to Action Theme 2 on integration of biodiversity into the main economic sectors. The IUCN project on Sustainable Agriculture and Steppe Biodiversity in Russia and Ukraine has already laid some groundwork in this regard by developing an economic model for encouraging ecologically sustainable agriculture. This model includes arable reversion to steppe through farm-level management plans. The specific objectives of this component of the project were:

1. To prepare a plan for the management of a real farm in a steppe ecosystem to find out whether ecologically sustainable agriculture and conservation of biodiversity in

Russia can work at the present time. The plan would focus on (i) products, (ii) local (community-based) services and (iii) means.

2. To involve local farming communities, local authorities and other stakeholders in preparing the management plan by inviting them to two workshops to discuss the issues concerned.

A case study from Russia

The IUCN farm management studies from both Russia and Ukraine provide many insights for the future restoration and sustainable management of steppe landscapes. The farms operate within similar political, legal, economic and social contexts, but their ecological circumstances differ and so the proposed strategies are also different. There is only space here to deal with one study, and the Russian one has been selected since the farm, which covered 17,800 ha, was large enough to constitute a grassland landscape in its own right.

The farm is called Druzhba ("friendship") and is located on the central left (eastern) bank of the Volga River in Rovno raion, Saratov oblast (Figure 5). It was constituted as a Limited Company in 1992 by the reformation of a state collective farm of the same name, and directly employs 433 people. The founders of the enterprise were 593 owners of property and land shares.

The region where Druzhba is located is characterised by an arid, moderate to hot climate, with large annual fluctuations in temperature (annual mean of 6°C from 1961 to 1977, and range of 3.6 to 7.9°C) and rainfall (annual precipitation between 230 and 470 mm from 1961 to 1982). The territory occupied by Druzhba is on light chestnut soils, which often form complexes with alkaline (salty) soils. It lies in a transition zone between dry feather-grass (*Stipa*) steppes and arid to semi-arid wormwood (*Artemisia*) shrub steppes in which areas of grass and shrub steppe are distributed in a mosaic. It is tentatively estimated that Druzhba supports about 300 species of vascular plants, about 2,500 species of invertebrates, 180 species of birds (including migrants) and 50 species of mammals. Several species, including the great bustard (*Otis tarda*), the mantis *Bolivaria brachyptera* and the tulip *Tulipa gesneriana* are listed as globally threatened.

The gross output of crops in recent years has undergone significant annual fluctuations, partly caused by climatic and soil conditions, and partly by management problems. Thus, the average gross yield for the period 1992 to 1996 was 5,785 tonnes, but it was 10,430 tonnes in 1993 and only 2,132 tonnes in 1995. The production statistics for the farm livestock operations between 1992 and 1996 clearly indicate a declining trend of about 40% for milk and 72% for meat, as a consequence of the reduction in numbers of cows and pigs on the farm, and the lack of adequate forage (in terms of both quantity and quality). The poor results from agricultural production, combined with rapidly growing costs, have led to a very difficult financial position in the company. In 1995, production costs amounted to about US$802,000, but in 1996 grew by 60% to US$1.2 million, with

Figure 5. *The location of Druzhba farm in Saratov oblast, Russia, a site for ecologically-sustainable agriculture.*

steep increases in the prices of seeds, oil and fuel, spare parts and electricity. In the same period, the value of gross agricultural production from crops and livestock remained constant at about US$456,000.

In 1996, the farm had a commodity debt with the Saratov food corporation amounting to about US$242,000. Accordingly, almost the entire marketable cereal and other crop production had to be handed over to the food corporation in repayment of the previous year's debt. The credit arrangement was not economically beneficial for the farm, as the food corporation bought agricultural produce at the lowest market prices and sold industrial items at the highest market prices. It was impossible to change this situation since the farm operations were unprofitable and there were no alternative sources of financing. Thus, the farm has been forced to accept the commodity credit from the food corporation each year. The farm has barely survived only because of additional income from its facilities for processing cereals to flour and groats that can be used to make barter deals for raw materials.

Steppe area at Druzhba farm heavily grazed by cattle. Reduced grazing pressure would improve habitat and pasture quality. Photo: Paul Goriup.

Against this rather discouraging background, the IUCN study nevertheless revealed that there was significant potential for developing ecologically sustainable agricultural at Druzhba, combining higher levels of income while at the same time enhancing the conservation of steppe ecosystems. In fact, the introduction of ecologically sustainable agriculture at Druzhba is probably the best economic strategy for this farm given its geographic location and economic circumstances in Saratov region. It also possesses sufficient land, material and labour resources, as well as a satisfactory level of administrative and management capacity.

As a first step towards improving the ecological conditions and conserving scarce species, it is proposed that some 300 ha of arable land and 800 ha of steppe pasture be retired from use, and that 160 ha of new shelter belts be planted. These conservation measures can be compensated for by introducing new systems of land use based on modern organic production methods on the rest of the farm, and by better use of existing processing facilities. This would generate more income, some of which could be needed to meet the costs of conservation management in the short term. In due course, it is anticipated that the conservation measures would provide new sources of income from sustainable harvesting of medicinal and ornamental plants, bee-keeping and even farm-based tourism (e.g. camping, riding, angling, hiking).

Conclusion

Grasslands in Europe and north Eurasia have generally been neglected as a conservation issue until fairly recently. Most people regarded them as either pastures or potential arable land, and did not appreciate their considerable biodiversity. The fact that the majority of the world's staple food crops (e.g. wheat, oats, maize, rice and sorghum) are grasses has hardly been noticed. There are very few substantial grassland protected areas in Europe and north Eurasia and the management of the remainder is dependent more on agricultural policies than conservation strategies. Apart from some military training areas, grassland conservation in Europe and north Eurasia will mean the reversion of surplus arable land. There is little if any likelihood of recreating the vast steppes found fifty years ago, let alone those of two centuries past.

On the other hand, grassland conservation will be an ideal testing and proving ground for some of the new approaches for protected area management in the wider environment, including bioregions, ecological corridors and networks, ecologically sustainable development and landscape-scale management. Moreover, relatively small changes in the financing of agriculture, for example through promoting an ecological approach on marginal lands, would enable more suitable private investment and really bring the PEBLDS Action Plan for Grasslands to life. Hopefully such matters will be on the agenda for any future agriculture/environment forums including the inter-ministerial meeting in the Environment for Europe process.

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Conservation of pampas and campos grasslands in Argentina

SANTIAGO KRAPOVICKAS AND ADRIÁN S. DI GIACOMO

The pampas and campos grassland ecosystems in the southern part of the plains in north-eastern Argentina are described. Details of the vegetation and fauna are given and agricultural land use is evaluated. The effects of human activities on soil erosion and nutrient impoverishment are mentioned, along with the implications of agrochemical usage. The biodiversity loss attributed to these activities is assessed, with examples given of several large mammals lost from the area. Internationally-funded conservation efforts in the region are described, as well as the Pampas Argentina Project which examines bird-life. It is concluded that the survival of pampas and campos biodiversity will rely on public education of the environmental and socioeconomic benefits of grasslands.

THE MAIN grassland ecosystems in Argentina are the pampas and campos, covering the southern part of the chaco-pampas plains in the north-eastern region of the country (Figure 1). The surface area of this biome in Argentina has been estimated at 468,000 km^2 (APN 1998). Soriano (1991) estimated the total area of pampas and campos in the Río de la Plata grasslands at over 700,000 km^2, but this incorporates parts of Uruguay and southern Brazil.

Relief is almost completely flat, with a very slight slope towards the Atlantic Ocean, and a few hills and rocky outcrops in isolated sites. Soils develop over a variety of materials in these grasslands, but in the temperate pampas, loess, silt and sand are the most important. Black or brown prairie soils occur in the eastern and central pampas, and are mainly mollisols (Cabrera 1976, Lavado 1991). Towards the west, the sandy soils are classified as entisols. In the temperate portion, mean annual temperature is about 15°C, and there are warm summers and cool winters, with a possibility of frost in some six months per year, dependent on latitude. Rainfall decreases from 1,000 mm in the north and east to 400 mm in the south and west (Cabrera 1976, Soriano 1991). Rains occur throughout the year. In the pampas, these are more frequent in spring and autumn, scarce in winter and very rare in summer (Cabrera 1976). In the campos rains increase markedly in winter (Lemcoff 1991).

Figure 1. Location of Argentine portion of Rio de la Plata grasslands (campos in dark shade, pampas in light shade).

Vegetation

Vegetation in the pampas and campos is dominated by grasses (Poaceae). The flora of the pampas subregion comprises about 1,000 species of vascular plants, mostly native (León 1991). Most of the plant taxa are shared with the Chaco biome, although there are several of Andean origin (Cabrera 1976). Endemic species are scarce and the total number of grass species present in the pampas is 230, of which 190 are native and 40 introduced. The native grasslands have often been described as 'flechillar', due to the dominance of "flechillas" (little darts) of the genera *Stipa*, *Piptochaetium* and *Aristida*. Important non-grass plant families are the Asteraceae and Fabaceae. In wet locations and years the vegetation structure is prairie-like, and in drier conditions it is steppe-like. Some internal heterogeneity is distinguishable within the pampas, varying with natural gradients and landscape features.

The campos is a subtropical savanna that constitutes the northern expression of the pampas, with which it shares many plant taxa. Characteristic grass genera include *Andropogon*, *Aristida*, *Briza*, *Erianthus*, *Piptochaetium*, *Poa*, *Stipa*, *Paspalum* and *Panicum* (León 1991). Trees appear in isolated patches or as riparian forests. *Syagrus yatay*, a palm, forms open woodland in several places, and in other sites dwarfish palm species (*Alagoptera*, *Syagrus*, *Diplothemium*) grow mixed with grasses (Cabrera 1976, León 1991).

Fauna

Fauna in Argentina's temperate grasslands has recently been impoverished by human colonisation and other factors. This brief review concentrates on mammals and birds, as there is no complete review on the situation for other groups. Several naturalists and foreign travellers visiting the pampas in the 1800s wrote about the abundance of pampas deer or "venado de las pampas" (*Ozotoceros bezoarticus*), greater rhea or "ñandú" (*Rhea americana*) and tinamous or "perdices" (*Rynchotus rufescens*, *Nothura* sp., *Eudromia elegans*), which were the most conspicuous animals, often hunted for food, leather or feathers (Haene 1994). Two top predators, the puma (*Felis concolor*) and the jaguar (*Leo onca*) were present, according to many reports from the last century (Chebez 1994). The total number of bird species inhabiting the pampas area is estimated at 300, of which some 60 species are strict grassland dwellers (Reboreda and Rabuffetti in prep.). Buenos Aires Province, which was originally almost entirely grassland, has a list of 403 recently recorded species (Narosky and Di Giacomo 1993). These include some forest species inhabiting relic woodlands in the north-east and south of the province. A partial list of birds of the campos in the south of Misiones province has almost 300 species (Krauczuk 1996).

*Grassland relicts in San Luis Province, Argentina, are the strongholds for pampas deer (*Ozotoceros bezoarticus celer*). Photo: Santiago Krapovickas.*

Land-use

Large numbers of feral cattle and horses have been reported in the pampas since the early 1600s. These animals, brought from Europe by Spaniards, had no predators or competitors, and rapidly colonised almost all of the grassland area. The effects of wild livestock and fires, set to herd the animals, undoubtedly caused important changes in the grasslands (Soriano and Deregibus 1991). Nevertheless, in the words of Soriano and Lavado (1991), "the principal means by which the grasslands of this region have been changed has been through agricultural activities". The livestock industry and arable agriculture developed strongly in the pampas during this century. The area of cropland in Argentina increased from an average of 6 million ha at the beginning of the 1900s to 26 million ha in 1984 (Soriano 1991). The main crops are wheat, maize, soybean and sorghum.

At a regional scale, the agricultural zones of temperate Argentina are concentrated almost completely in the pampas (Guerschman 1998). This biome provides about 90% of the country's total agricultural production (Di Pace 1992). In the pampas, the isohyet of 600 mm of mean annual precipitation follows the western boundary of cultivated land. Inside the high precipitation area, the lowest proportion of agricultural land is found in the flooding pampa and in the Mesopotamic pampa of Entre Ríos Province (Guerschman 1998).

There has been an increasing trend in total sown area since the 1970s (Guerschman 1998). Pampas soils still allow high production levels with very low fertiliser input (Deregibus and Soriano 1991, Di Pace 1992). Traditional rural practices included rotation of agriculture with perennial pasture crops for cattle, allowing for a partial recovery in soil structure and nutrients. During recent years, low profitability of beef production and higher prices for agricultural products has encouraged farmers to abandon this kind of rotation in the best soil of the pampas, and simultaneously, summer crops such as soybean increased in area by means of a two-harvest system that allowed growing wheat in winter and a second crop in summer. Both processes are part of an intensification that now seems to be turning the whole pampas over to continuous agriculture (Deregibus and Soriano 1991, Di Pace 1992).

Like almost all grasslands in Argentina, the campos has been used for cattle, horse and sheep grazing for the last three centuries but at present there is a strong trend towards other use. Forestry is growing, backed by government support in the east of Corrientes Province, the campos' stronghold in Argentina. Exotic eucalyptus and conifers are the preferred species. In 1994, commercial plantations occupied 151,254 ha in the province, mostly in the campos area, an increase by 6% from the previous year. The government intends to further increase the area devoted to this activity through promotion policies, including long term loans. In 1995, 13,607 ha of campos land was earmarked for forestry, representing 40% of the area to be forested for the whole of Argentina (SAGPyA 1996).

As high-intensity agriculture spreads, so pesticide use substantially increases in pampas and neighbouring areas (Di Pace 1992). Herbicides contribute 69% of total Argentine agrochemical sales, whilst other pesticides contribute 28%. Some of the widely-used substances are highly toxic for man and wildlife. These include aldicarb, methil azimphos, carbofuran, chlorpiriphos, dimethoate, metamidophos and monocrotophos. Soybeans require the greatest level of pesticide use. Although herbicides are not as toxic as other pesticides, they can cause extensive microhabitat change, potentially deleterious for wildlife living in the agro-ecosystem (Iolster in prep.).

Effects of human activities on the ecosystem

Agricultural practices have had a major impact on ecosystem function in the pampas. For instance, it has been shown that the peak of maximum photosynthetic activity is being moved regionally earlier or later in the season, according to the kind of crops being cultivated in different zones (Guerschman 1998). This gives an example of the scale of the changes involved, but does not explain what is going on with other ecosystem processes, such as biogeochemical cycles.

The history of land use in the grasslands of Argentina is responsible for some disastrous effects on the environment. Soil erosion in the rolling and inland pampa is perhaps the worst. In the rolling pampa, at least 1.3 million ha are losing more than 20 tons/ha of soil each year. Nutrient impoverishment is another negative trend. It has been estimated that continuous agriculture could decrease nutrients to a level where even the best soils will need massive fertilisation in several decades (Di Pace 1992).

The pampas have been famous as cattle grazing lands since colonial times. Nevertheless, the flooding pampa only has a "short evolutionary history of grazing", which combined with the subhumid climate makes it highly vulnerable. The tall grasses that live in these communities recover slowly and lack flexibility in their modes of regrowth. This results in a high susceptibility to invasion by exotics following grazing. This increase in exotics produces large increases in diversity with moderate grazing pressures, while native perennial tall grasses disappear (Milchunas *et al.* 1988).

Effects on biodiversity

Habitat conversion and increased human disturbance after settlement are responsible for a reduction in biodiversty in the pampas and campos. Buenos Aires Province is the most developed part of the country, and holds the highest human population density. Birds in Buenos Aires, probably the best studied group of wildlife in the biome, suffered four grassland species extinctions according to Narosky and Di Giacomo (1993). Of these, eskimo curlew (*Numenius borealis*), a medium sized, migratory shorebird that nested in the North American tundra, is the only globally extinct species (Collar *et al.* 1992). This bird once visited the pampas in flocks, but the last sightings in Argentina were in 1939 (Narosky and Di Giacomo 1993). Although the causes of its extinction are not clear, habitat transformation and heavy hunting in its nesting and wintering areas are at least partly responsible (Chebez 1994). After 1985, there are no records in the province for the saffron-cowled blackbird (*Xanthopsar flavus*), a medium-sized songbird with bright yellow underparts that lives in humid grasslands and marsh borders. Although the species can coexist with cattle and agriculture to some extent, it does not seem to tolerate major disturbances such as marsh drainage (Fraga *et al.* 1998). This blackbird still subsists in the campos. The strange-tailed tyrant (*Alectrurus risora*), a small but conspicuous flycatcher, was scarce in Buenos Aires Province in the last century, but there was a nesting population. The last sightings are dated 1895 (Narosky and Di Giacomo 1993). Antarctic rail (*Rallus antarcticus*) is an enigmatic waterbird that was probably very scarce and scattered in pre-settlement times, but disappeared entirely soon after the establishment of the modern ranches (Narosky and Di Giacomo 1993).

Other megafauna have suffered dramatic contractions, both to their distribution areas and population numbers. The best known case is the southern race of the above mentioned pampas deer (*Ozotoceros bezoarticus celer*). There are reports of two million hides being exported from Buenos Aires between 1860 and 1870. Now only several hundred remain from two isolated populations within marginal habitats. One is in the semi-arid inland pampa of San Luis Province, and the other in the coastal flooding pampa of Buenos Aires Province (Chebez 1994). The northern subspecies of this cervid (*O. b. leucogaster*), although present in Uruguay and southern Brazil, is also threatened in Argentina, with a small population remaining in the campos of Corrientes Province (Parera pers. comm.).

The jaguar has been completely extinct in the pampas and campos of Argentina since the first half of this century. Besides the undoubted effect of habitat conversion and hunting (Chebez 1994), it has been hypothesised that Holocene climatic changes could have contibuted to this species' retreat (Ringuelet 1978).

The long-term use of several agrochemicals has potential negative impacts on biodiversity. Monocrotophos misuse has caused severe mortality incidents of Swainson's hawks (*Buteo swainsoni*), a migratory raptor, as well as of other fauna in the pampas (Canavelli and Zaccagnini 1996, Krapovickas and Lyons 1997).

Conservation efforts

Unfortunately, pampas and campos biodiversity is not preserved in the protected areas. Less than 150,000 ha are formally included in reserves, representing some 0.3% of the biome's surface area (APN 1998). Existing protected areas are located mainly in the flooding pampa (Samborombón Bay, with salty *Spartina* grasslands), the austral pampa (Sierra de la Ventana) and several scattered wetlands. No significant areas of the typical flechillar grassland (which grows on fertile, well-drained soils) have been protected and this has now practically disappeared. In addition, reserves in the flooding and austral pampas, although important for their biodiversity, are poorly protected.

The situation described above reflects both the fact that the grasslands are the most valuable ecosystem for human activities, and the fact that their conservation importance has been neglected. Recently, federal authorities have realised the need to make conservation of the pampas a high priority. The biome was included in an ambitious project to establish several newly-protected areas in the country. This project receives support from the Global Environmental Facility through the World Bank (APN 1998). An area of about 30,000 ha in the western inland pampas of San Luis province was conserved as the Parque Nacional Los Venados (Pampas Deer National Park). The present extensive cattle grazing in the area has allowed the survival of important native grassland patches (León and Anderson 1983) in which puma, pampas deer, greater rhea and other megafauna subsist. Conservation plans include the establishment of a large buffer zone in which to experiment with sustainable land-use technology, through cooperation among federal and provincial governments. Although the intentions are excellent, the project is taking too long to achieve conservation outcomes. While the bureaucrats dither, a humid climate cycle is encouraging local farmers to plow up the land and sow exotic pastures and grains. This is despite the fact that agriculture in this semi-arid environment is clearly unsustainable because of the fragile sandy soils (Maceira pers. comm.).

Recent wildlife deaths caused by pesticides have encouraged cooperative efforts to monitor and prevent such incidents. An inter-agency committee was established, comprising members of federal and provincial governments, and NGOs. This group is achieving important goals in research and public awareness, so helping to minimise the impact of pesticides (Krapovickas and Lyons 1997).

The Asociación Ornitológica del Plata (AOP) recently launched the Pampas Argentinas Project, comprising basic research and education to convey the message that the temperate and subtropical grasslands are valuable environments for humans and wildlife. The project is inspired by the fact that birds seem to be good indicators of an ecosystem's health and the risks for man. The popularity of Swainson's hawk is being used to promote habitat conservation and sustainable use in this species' key areas.

Recent development projects

Public concern over the social value of nature is slowly growing in Argentina. This is reflected by the growing importance assigned to environmental impact assessments for development projects. There are at least two projects that could have serious impact on grassland relics in Argentina, for which the probable consequences and alternatives should be carefully studied.

Besides federal government plans to encourage tree plantations in the campos, provincial agencies are promoting a plan to build several dams along the Aguapey River in Corrientes. This would allow the enlargement of the area devoted to rice, but will have a dramatic impact on important grasslands and riparian forests.

On a broader scale, the government of Buenos Aires Province is preparing the Salado River Basin Master Plan to improve agricultural conditions in a large area of semi-natural grasslands in the flooding pampa. Since the Salado Basin is the last big semi-natural area of the province, this could have important effects on terrestrial and aquatic biodiversity on a regional scale (Di Giacomo and Krapovickas 1998).

Conclusions

Long-term survival of pampas and campos biodiversity depends on public education about the value of grasslands. Particularly, it is essential to convey a good understanding of the services provided by the ecosystem (maintenance of the composition of the atmosphere, genetic library, amelioration of weather, conservation of soil, etc.) in the sense suggested by Sala and Paruelo (1997).

There are some urgent actions that could help in this educational goal, whilst providing solutions for short-term problems. One of these is to encourage sustainable use of the grasslands through all possible means. Perhaps a combination of integrated pest management, no tillage cropping, crop and cattle rotations, cattle grazing in natural grasslands and habitat protection could have the desired result. Much research, as well as governmental and private support, is needed.

Protected natural areas also need a strong boost in support in the pampas and campos. The important Parque Nacional Los Venados project could fail if it does not receive clear political and financial support. Existing reserves also need to be implemented properly. This could be partially achieved through increased cooperation between federal and provincial agencies, an issue often neglected in the past.

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Resumenes

Estudio general de las áreas protegidas en el bioma de las praderas templadas

WILLIAM D. HENWOOD

Se realiza una evaluación del estado actual de las áreas protegidas en el bioma de las praderas templadas, así como se examinan los impedimentos para mejorar el nivel de protección. Se sugieren entonces las prioridades de las estrategias para el desarrollo de una red de áreas protegidas en el bioma de las praderas templadas, con vista a la conservación de la biodiversidad. Se dan recomendaciones para que el próximo Plan de Acción de UICN de praderas identifique sucesos históricos y tipos de impacto que han alterado el incentivo de la conservación de las praderas. Se recomienda también la identificación de los factores socioculturales que influyen en el uso y gestión de este bioma. Se piensa necesaria la construcción de una conciencia para así cambiar las percepciones que tienen usuarios y políticos respecto a las praderas.

Las Grandes Planicies de Norteamérica

DAVID A. GAUTHIER Y ED WIKEN

Mediante la utilización de un sistema de clasificación del ecosistema para Norteamérica y el sistema de clasificación de UICN para áreas protegidas, se presentan los datos que resumen la distribución y extensión de las áreas protegidas para las Grandes Planicies de Norteamérica. Las Grandes Planicies constan de cinco grandes subdivisiones ecológicas, tres federales y 24 jurisdicciones provinciales o estatales. Los Estados Unidos cuentan con el 80% de las Grandes Planicies, mientras que Canadá el 16% y Méjico el 4%. Aproximadamente, un 6% de las Grandes Planicies se concentra en áreas administradas con fines de conservación. Los Estados Unidos cuentan con un 74% de las áreas protegidas mayores de 1,000 ha de tamaño, mientras que Canadá cuenta con el 24% restante. El noventa y nueve por ciento del área protegida se presenta en tres de las cinco regiones ecológicas que comprenden las Grandes Planicies. De estas tres regiones ecológicas, la mayoría de las áreas protegidas se dan en la Llanura Semiárida Centro-Occidental. El ochenta por ciento de las áreas protegidas están clasificadas bajo la categoria V de la UICN, mientras que el 5% se encuentra en las categorias I a III de la UICN.

Praderas nativas de tierras bajas en el Sudeste templado de Australia: niveles de protección e impedimentos para su conservación

STEVE C. TAYLOR

Las praderas nativas de tierras bajas en el Sudeste templado de Australia son los ecosistemas más amenazados de Australia. Desde el asentamiento europeo en 1788, Australia ha perdido más del 99.5% de estas praderas. Algunas de las causas de estas pérdidas son la limpieza y conversión a cultivos, invasión de plantas exóticas, alteración de los regímenes de incendio y el sobre-pastoreo producido por herbívoros introducidos tales como el ganado ovino y vacuno. En los últimos años se ha llegado a un acuerdo por parte de los gobiernos para financiar los prados protegidos que quedan mediante ayudas coordinadas nacionalmente y programas tales como 'Bushcare', 'Landcare', 'Grasslands Ecology Program' y 'Save the Bush'. Además, se han planeado nuevas reservas, lo cual refleja la creciente conciencia de la importancia de nuestras praderas nativas. Los principales impedimentos para la conservación de las praderas que quedan incluyen la falta de recursos para combatir el sobre-pastoreo y la invasión de malas hierbas, así como la inadecuada gestión de los incendios y la pequeña extensión de los restos de praderas que hacen que sean más propensos a la degradación.

Praderas templadas y alpinas del Himalaya: ecologia y conservación

G. S. RAWAT

Se presenta una revisión de la ecología y conservación de los prados en la región del Himalaya. Se definen y describen cinco tipos de praderas: praderas de temperatura cálida; frías pendientes cubiertas de hierba; praderas subalpinas; praderas alpinas; y formaciones de estepas del transhimalaya. Se examinan la estructura de la flora, las tendencias estacionales en las praderas y regiones forestales y la productividad de la biomasa. Las especies de aves y mamíferos se consideran como indicadores de biodiversidad. Se describen entonces los efectos humanos de pastoreo, recogida de hierbas medicinales y recogida de leña. El artículo concluye analizando los aspectos de conservación y gestión, planteando el sostenimiento de diferentes usos del suelo.

La Estrategia Biológica y de Diversidad del Paisaje Paneuropea: integración de la agricultura ecológica y conservación de praderas

PAUL GORIUP

Siguiendo la adopción de la Estrategia Biológica y de Diversidad del Paisaje Pan-Europeo (PEBLDS) por los ministros del Medio Ambiente europeos en 1995, la UICN ha sido el líder en el desarrollo del Plan de Acción de Praderas Europeas. Las praderas en Europa y Noreuroasia han visto reducida su extensión desde hace incluso cincuenta años, incrementando también su fragmentación. El plan toma en cuenta la interacción real entre la conservación de las praderas y las políticas agrarias en Europa, llamando a una mejor integración de los planteamientos. Estudios en granjas llevados a cabo por IUCN en Rusia y Ucrania sugieren que esta integración no es tan solo posible sino que en tierras marginales es probablemente el único planteamiento rentable económicamente. El aprovechar inversiones financieras de fondos éticos podría ser un mecanismo útil para fomentar la integración de la conservación de las praderas y la agricultura ecológicamente sostenible, siempre que las políticas gubernamentales de granjas adopten los incentivos adecuados.

Conservación de los campos y pampas en Argentina

SANTIAGO KRAPOVICKAS Y ADRIAN S. DI GIACOMO

Se describen los ecosistemas de campos y pampas al sur de las planicies del Noreste de Argentina. Se dan detalles de la vegetación y fauna así como se evalúa el uso agrícola. Se mencionan los efectos de las actividades humanas en la erosión de la tierra y empobrecimiento de nutrientes a la vez que se estudian las implicaciones del uso de la agroquímica. Se evalúa la perdida de la biodiversidad atribuida a estas actividades, y se dan ejemplos de perdidas de grandes mamíferos en el área. Se describen los esfuerzos de conservación financiados internacionalmente en la región, así como el Proyecto Pampas de Argentina en el que se examina la vida de las especies de aves. Se concluye que la supervivencia de la biodiversidad en campos y pampas depende de la educación publica en cuanto a temas de medio ambiente y beneficios socioeconómicos de las praderas.

Resumés

Une revue des zones protégées dans le biome des prairies tempérées

WILLIAM D. HENWOOD

Les statuts actuels des zones protégées dans le biome des prairies tempérées sont évalués et on discute des contraintes pour améliorer leur niveau de protection. Des priorités stratégiques sont alors suggérées pour le dévelopement d'un réseau de zones protégées de prairies tempérées en travers du biome tout en considérant la préservation de la biodiversité. Des recommendations sont ensuite faites pour que le Plan d'Action de l'UICN sur les prairies qui va avoir lieu prochainement détermine les événements historiques et les types d'impacts qui ont provoqué un changement de motivation pour la préservation des prairies. Il est également conseillé d'évaluer les facteurs socio-économiques qui influencent l'utilisation et la gestion des prairies. Une prise de conscience semble s'avérer nécessaire pour modifier la manière dont les utilisateurs et les législateurs les perçoivent.

Les Grandes Plaines d'Amérique du Nord

DAVID A. GAUTHIER ET ED WIKEN

En utilisant un système de classification standardisé des écosystèmes pour l'Amérique du Nord et le système de classification de l'UICN pour les régions protégées, des données sont présentées qui résument la distribution et l'étendue des zones protégées pour les Grandes Plaines d'Amérique du Nord. Les Grandes Plaines sont constituées de cinq subdivisions écologiques principales, 3 juridictions fédérales et 24 juridictions provinciales ou d'état. Les Etats-Unis possèdent 80% des Grandes Plaines, le Canada 16% et le Mexique 4%. Approximativement 6% des Grandes Plaines sont comprises dans des zones gérées dans un but de conservation. Les Etats-Unis possedent 74% des zones protégées, >1 000 ha, tandis que le Canada en possède 24%. Quatre-vingt-dix-neuf pourcents des zones protégées se trouvent dans seulement trois des cinq régions écologiques que comprennent les Grandes Plaines. De ces trois régions écologiques, la majorité de la zone protégée se trouve dans les Prairies Semi-Arides du Centre-Ouest. Quatre-vingt pourcents des zones protégées sont codées UICN VI, tandis que 5% tombent dans les classes UICN I et III.

Les plaines herbagées tempérées originelles du sud-est australien : les niveaux de protection et les obstacles à leur conservation

Steve C. Taylor

Les plaines herbagées tempérées originelles sont les écosystemes les plus menacés en Australie. Depuis les colonies européennes en 1788, l'Australie a perdu plus de 99.5% de ses prairies. Cette perte a été causée entre autres par le défrichage et la conversion à la culture, l'invasion par les plantes exotiques, les systèmes de feux alternés et par l'excès de pâturage dû à l'introduction d'herbivores tels que le bétail et les moutons. Ces dernières années, un engagement a été pris par les gouvernements pour aider financièrement des projets concernant le restant des prairies grâce à des subventions coordonnées au niveau national et des programmes tels que 'Bushcare' (le soin des fourrés et taillis), 'Landcare' (le soin de la terre), le 'Grassland Ecology program' (le programme écologique pour les prairies), et 'Save the Bush' (Sauvons les fourrés et les taillis). De plus, de nouvelles réserves sont prévues, ce qui reflète la prise de conscience croissante de la communauté de l'importance des prairies originelles restantes. Les obstacles principaux à la conservation des terres restantes comprennent un manque de ressources pour faire face au pâturage excessif et à l'envahissement par les mauvaises herbes, la gestion inadéquate des feux et la petite taille de nombreux terrains restants ce qui les rend d'autant plus vulnérables à la dégradation.

Prairies alpines et tempérées de l'Hymalaya : écologie et conservation

G. S. Rawat

L'écologie et la conservation des prairies dans la région himalayenne sont passées en revue. Cinq types de prairies sont définis et décrits : prairies tempérées chaudes ; pentes herbeuses tempérées froides ; prairies subalpines; prairies alpines ; formations de steppes transhimalayiennes. La structure florale, les tendances successives dans les régions des prairies et forêts et la productivité de la biomasse sont examinées. Des espèces de mammifères et d'oiseaux sont repris sur des listes comme indicateurs de la biodiversité. Les répercussions de l'activités humaine comme l'élevage en prairies, la cueillette d'herbes médicinales, la collecte du bois de chauffage sont alors décrites. Le rapport conclut en portant le regard sur les aspects de conservation et de gestion qui touchent au développement durable de différentes affectations des sols.

La stratégie Pan européenne pour la diversité biologique et paysagère : intégration de l'agriculture écologique et de la conservation des prairies

Paul Goriup

Après l'adoption de la Stratégie Paneuropéenne de la Diversité Biologique et Paysagère (SPDBP) par les ministres de l'environnement en 1995, l'UICN a joué un rôle primordial dans le développement du Plan d'Action Paneuropéen pour la Protection des Prairies. L'étendue des prairies en Europe et en Eurasie du nord a fortement diminué même si on compare la situation à celle d'il y a seulement 50 ans et les prairies sont de plus en plus fragmentées. Le plan reconnaît la réalité de la relation étroite qui existe entre la conservation des prairies et la politique agricole et demande une meilleure intégration des démarches. Des études de cas à la ferme entreprises par l'UICN en Russie et en Ukraine suggèrent qu'une telle intégration est non seulement possible, mais que sur les terres marginales c'est la seule approche économique réalisable. Exploiter des investissements financiers à partir de fonds d'investissement éthiques peut constituer un mécanisme utile à l'encouragement de l'intégration de la conservation des prairies et une agriculture écologiquement durable, pourvu que la politique gouvernementale s'appliquant aux fermes incite à l'action de maniere appropriée.

Conservation des prairies pampas et campos en Argentine

Santiago Krapovickas et Adrian S. Di Giacomo

Les écosystèmes des prairies pampas er campos dans la partie méridionale des plaines du nord-est Argentin sont décrits. Des détails de la végétation et de la faune sont fournis et l'utilisation agricole de la terre est évaluée. Les effets de l'activité humaine sur l'érosion des sols et l'appauvrissement en substances nutritives sont mentionnés ainsi que les implications de l'usage des produits agrochimiques. La perte de la biodiversité attribuée à ces activités est évaluée et est accompagnée d'exemples de plusieurs grands mammifères disparus dans la région. Les entreprises de conservation de la région qui reçoivent des fonds internationaux sont décrits ainsi que le 'Pampas Argentina Project' qui examine la vie des oiseaux. En conclusion, la survie de la biodiversité des prairies pampas et campos dépend de l'éducation du public portant sur les avantages environnementaux et socio-économiques.

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Cover photo: Colony of black-tailed prairie dogs in Grasslands National Park, Saskatchewan, Canada. Photo: William Henwood.

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