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TEMPERATE GRASSLANDS

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TOWARD A STRATEGY FOR THE CONSERVATION AND PROTECTION OF THE WORLD'S TEMPERATE GRASSLANDS

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ABSTRACT—Temperate grasslands are one of the world's great biomes and were once home to some of the largest assemblages of wildlife the earth has ever known. Today these grasslands are considered the most altered terrestrial ecosystem on the planet and are recognized as the most endangered ecosystem on most continents. While species and habitat declines continue, temperate grasslands have the lowest level of protection of the world's 14 biomes. With only 4% of the biome under protected status, considerable effort will be required to increase this level of protection. Several international bodies have suggested that achieving at least a 10% level of protection should be considered a minimum, yet this is a monumental challenge in an ecosystem now so vastly altered. This paper presents a global overview of the status of protected areas in the context of the health and extent of the world's temperate grasslands and identifies the scope of remaining opportunities and regional priorities for increasing the level of protection. The Temperate Grasslands Conservation Initiative will facilitate international collaboration for, and develop a strategy to achieve, meaningful protection and sustainable use. The Northern Great Plains ecoregion is of international significance and can make a valuable contribution to the global restoration of the temperate grasslands biome.

Key Words: biodiversity, conservation, grasslands, protection, sustainable use, temperate

INTRODUCTION

Temperate grasslands are one of the world's great biomes, occupying about 9 million km², or 8% of Earth's terrestrial surface, and occur on every continent except Antarctica (White et al. 2000; See insert map, Plate 2). However, after cradling the needs of humankind for countless centuries, the temperate grassland ecosystem is now considered the most altered on the planet (McDougall and Kirkpatrick 1994; Samson and Knopf 1996; White et al. 2000; Gauthier et al. 2003). In fact, it is currently the most endangered ecosystem on most continents, especially in the prairie or plains of North America, the pampas of South America, the lowland grasslands of southeast Australia and New Zealand, the steppes of eastern Europe, and the grasslands of southern Africa (Henwood 2004, 2006). While not necessarily endangered, significant signs of stress are also appearing

in the more healthy and intact temperate grasslands in parts of South America and the vast steppes spanning the breadth of Asia (Henwood 2006; Peart 2008b).

Historically, grasslands at all latitudes have presented one of the most amenable environments for human settlement and have provided for human needs since early evolutionary times (Food and Agriculture Organization 2005). Indeed, grassland landscapes and many species of grasses, including corn, wheat, rice, oats, and sugarcane, continue to be a foundation of the world's food supply. From a conservation perspective, however, this productivity has come at a significant cost. Grasslands in temperate latitudes have now been modified by human activity to such a degree that little remains today in a natural state, and substantially less than other biomes in some form of long-term protection (White et al. 2000; Henwood 2006; UNEP-WCMC 2008). Once home to some of the world's greatest assemblages of wildlife, most temperate grasslands now support only remnant populations of this

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former abundance (Schaller 1992, 2001; Benedict et al. 1996; Minarro and Bilenca 2007).

Generally speaking, grassland ecosystems exhibit considerable diversity and abundance of flora and fauna, and appear prominently in the world's centers of plant diversity and areas important for endemic birds and large herbivores (White et al. 2000). Today, however, grassland birds that nest in temperate grasslands are the most rapidly declining group of birds in North America (NABCI 2009) and the world (White et al. 2000; Blancher 2003). North American bison (*Bison bison*) once numbered in the tens of millions and almost became extinct, along with many of their coinhabitants on the prairie, such as elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), grizzly bear (*Ursus arctos*), and wolf (*Canis lupus*) (Manning 1995; Geist 1996; Forrest et al. 2004). Similar trends in European and Asian grasslands have placed many of the large ungulate populations, such as European bison (*Bison bonasus*), Mongolian gazelle (*Procapra gutturosa*), Saiga antelope (*Saiga tatarica*), and Takhi (*Equus ferus przewalskii*; Przewalski's horse), and such predators as wolf and snow leopard (*Uncia uncia*), in serious jeopardy (Schaller 1992, 2001).

In addition to terrestrial flora and fauna, there are also many species that rely on aquatic environments and their riparian margins nestled within natural grasslands. North American prairie rivers and streams, for example, support an extremely diverse population of fishes, many of which have been significantly impacted over the past 150 years through water diversions for irrigation, modification of flow regimes and interruption of migration patterns by dam construction, decline in water quality by increased turbidity, and reductions in riparian vegetation (Rabeni 1996). Similarly, North America's prairie wetlands and potholes have historically supported one of the world's largest populations of waterfowl. Considerable habitat losses have occurred, primarily through the drainage and subsequent destruction by 1985 of over 50% of wetlands in the United States with similar levels of alteration in Canada (Batt 1996; NABCI 2009).

Globally, about 41% of temperate grasslands have been converted to agricultural use, another 6% to urbanization, and an additional 7.5% to commercial forestry and other disturbances (White et al. 2000). With this level of conversion, an analysis in 2005 confirmed that temperate grasslands represent the biome most at risk in the world (Hoekstra et al. 2005). Using the "Conservation Risk Index," a measure of the ratio of total area converted to the area protected within a biome, the index

for temperate grasslands is the highest of all biomes at 10 to 1 (Hoekstra et al. 2005). In such a scenario, whether formally protected or not, remaining natural areas of indigenous temperate grasslands take on a heightened importance for the ongoing ability to provide a range of essential ecological services, including the yield of water, the maintenance of biodiversity through the protection of habitat, the conservation of genetic diversity, recreation and tourism, areas of religious or spiritual significance, and as sources of natural foods and medicines (Food and Agriculture Organization 2005).

In this age of rising concern over climate change, one of the more significant benefits of natural grasslands is their ability to store large amounts of carbon (Food and Agriculture Organization 2005). As grasslands grow, they absorb carbon from the atmosphere. At a global level, natural grasslands represent a very large carbon sink, playing almost as important a role as forests in recycling greenhouse gases (Minahi et al. 1993). Of further significance, natural grasslands store considerably more carbon in the soil than in the vegetation itself (White et al. 2000). So when natural grasslands are converted to other uses, particularly intensive agriculture, carbon is released, becoming a major source of greenhouse gas emissions (White et al. 2000; Worldwatch Institute 2009). In fact, land use and land-use change, especially from agriculture, deforestation, burning, and irrigation, are responsible for more than 30% of greenhouse gas emissions (Worldwatch Institute 2009).

Modern technologies for carbon capture and sequestration are at least a decade away, and can therefore only promise to assist with capturing greenhouse gases that have yet to be released (Worldwatch Institute 2009). The only method immediately available for sequestering greenhouse gases already in the atmosphere is managing land-use change, primarily agricultural (Worldwatch Institute 2009). Recently, five major strategies have been suggested to increase carbon capture and storage through managing agricultural land use and land-use change; among them are protecting natural habitats, restoring grasslands, and minimizing tillage to enhance the ability of soils to sequester more carbon through producing and storing organic matter (Scherr and Sthapit 2009).

Despite the essential role grasslands have played and will continue to play for both humans and nature, temperate grasslands have not until quite recently been visible on the global conservation agenda (Henwood 2004, 2006). Opportunities to protect significant representative and ecologically viable examples of this biome have been largely overlooked. This is particularly evident in those

TABLE 1
STATUS OF THE CONSERVATION AND PROTECTION OF THE WORLD'S TEMPERATE GRASSLANDS

Grassland region	Area of original extent (km ²)	10% conservation target (km ²)	Percentage remaining in native cover (%)	Current percentage protected (%)	Remaining area (km ²) and percentage required to meet target
EURASIA					
Eastern Europe	440,000	44,000	3-5	0.2	43,120 (9.8%)
Black Sea–Kazakh steppe	760,000	76,000	76	0.5-2.1	64,600 (8.5%)
Russian steppe	500,000	50,000	15	0.1	49,500 (9.9%)
EAST ASIA					
Mongolia	822,760	82,270	90	10.3	Undetermined
China	3,386,000	338,600	53	35	Undetermined
Russia's Amur Basin	100,000	10,000	5-20	5	5,000 (5%)
AUSTRALIA, NEW ZEALAND, AND SOUTH AFRICA					
Southeast Australia	60,000	6,000	0.5-2.0	2.0	4,800 (8%)
New Zealand	82,430	8,240	44	15.4	Undetermined
South Africa	360,590	36,100	65	2	28,900 (8%)
NORTH AMERICA (NA) AND SOUTH AMERICA (SA)					
NA Tallgrass	600,000	60,000	1-3	0.5	57,000 (9.5%)
NA Mixed grass	835,700	83,600	36-40	1.5-2.6	62,000 (7.4%)
NA Shortgrass	1,190,900	120,000	40-48	8.0	24,000 (2.0%)
NA Intermontane shrub steppe	53,300	5,300	46-70	5.9	2,200 (4.1%)
NA Chihuahuan	573,600	57,400	15	2.5	43,000 (7.5%)
SA Northern Paramo	35,700	3,600	60	43.4	Undetermined
SA Central Paramo and Puna	740,000	74,000	Unknown	9.3	Undetermined
SA Pampas	540,000	54,000	30	1.05	49,100 (9.1%)
SA Campos	210,000	21,000	65-80	0.2	20,500 (98.8%)
SA Patagonian steppe	800,000	80,000	95	5.0	40,000 (5.0%)

Note: For the sources of data contained in this table, refer to the text for the references to each country or region.

temperate grasslands offering relatively high productivity, such as North America's tallgrass prairie, Argentina's pampas, and southeast Australia's tussock grasslands. Here, and in other grassland regions, levels of protection often range from 1% to 3% (Table 1). The level of communication and international cooperation within the conservation community that is so often evident in other biomes such as tropical rainforests, mountains, or coral reefs has been missing for temperate grasslands. Quite to the contrary, there has been a pervasive reluctance to

recognize this ecosystem as being worthy of protection, which has essentially precluded conservation and protection from being considered legitimate land uses.

To build a strong case for conserving and protecting temperate grasslands, it is essential to understand and document their total economic value and true contribution to human social and cultural well-being. Recent research assessed the current state of knowledge about the total value of goods and services provided by indigenous temperate grasslands (Heidenreich 2009). While the

total economic value of other biomes appears relatively well understood, this study found no empirical valuation research that addressed intact temperate grasslands. As a result, temperate grasslands likely represent the least understood biome in the world in terms of their true value to sustainable economic uses and provision of sociocultural and ecosystem goods and services that contribute to human health and well-being (Heidenreich 2009).

This lack of understanding about the true value of temperate grasslands puts them at a serious disadvantage and, if not corrected, could continue to threaten the long-term ecological viability of remaining indigenous grasslands. If our economy is not fully able to recognize through the market pricing system the net benefits of temperate grasslands, then inappropriate land use and investment decisions will result and the total value of these grasslands will be lost to society.

GRASSLANDS PROTECTED AREAS SPECIALIST GROUP

In response to the conservation dilemma for temperate grasslands, the World Commission on Protected Areas (WCPA) of the International Union for Conservation of Nature (IUCN) created the Grasslands Protected Areas Task Force, now a Specialist Group, in 1996. The aim of the Specialist Group is to promote and facilitate the establishment of new protected areas throughout the tropical, subtropical, and temperate grassland biomes. Because 16% of subtropical and tropical grasslands are already protected, the Specialist Group adopted increasing the level of protection of temperate grasslands as an immediate priority (UNEP-WCMC 2008). Its goal is to protect 10% of the biome by the year 2014, the year of the next World Parks Congress, and to provide for the protection, restoration, and wise use of grassland protected areas through developing best practices, in particular for managing grazing, exotic species, fire, and water (Henwood 2006; Peart 2008b).

In this paper, the definition of “protection” is consistent with that of the IUCN, where a protected area is “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecological services and cultural values” (Dudley 2008:8). The term “effective” in this definition refers to nonlegal means, such as traditional rules practiced in areas conserved by local indigenous communities or policies of established nongovernment organizations in managing private protected areas (Dudley 2008). This

definition, and the six IUCN management categories of protected areas that flow from it, are “neutral” on ownership and management authority of protected areas, and they equally recognize governance by governments, private entities, indigenous peoples, and local communities (Dudley 2008). The common denominator is that, regardless of the governance model, protected areas are managed in accordance with the central objective—the long-term conservation of nature. I do not know the extent to which all forms of governance, in particular private protected areas, have been recognized and included in the figures quoted in this paper, nor the relative comparability of management regimes from one country to another. This is a necessary area of research.

With this priority on temperate grasslands, the Specialist Group focuses on North and South America, Europe, Asia, southern Africa, Australia, and New Zealand. These include the Great Plains and intermontane grasslands of North America, as well as the Chihuahuan desert grasslands in Mexico. In South America, the diversity of temperate grasslands includes the pampas and campos, the paramos and puna along the spine of the Andes, and the steppes of Patagonia. The infamous steppes of Eurasia stretch from eastern Europe, through Kazakhstan and western Russia, the high elevations of the Himalaya–Hindu Kush and Tibetan Plateau, to Mongolia, northern China, and Siberian Russia. The Specialist Group also works with the grasslands in the temperate latitudes of southeast Australia, New Zealand, and southern Africa.

In the decade since creation of the Specialist Group, the level of conservation and protection of grasslands has risen significantly. The amount of the world’s temperate grasslands in protected areas has increased from 0.69% in 1996 to 4.1% in 2009 (IUCN 1994, 1998; Chape et al. 2003; UNEP-WCMC 2008; Coad et al. 2009). While this increase of almost 600% represents considerable progress, only 9 of the 43 ecoregions found within the global temperate grassland biome have achieved the 10% level of protection being sought for all of the world’s ecological regions by the United Nations’ Convention on Biological Diversity (Coad et al. 2009). While some of this increase is attributable to better inventories and data management on protected areas, there have been many new protected areas established with a commensurate rise in the level of awareness of the plight of temperate grasslands, leading to the development of programs designed to improve conservation and protection throughout the biome (Henwood 2004, 2006).

Why is the 10% target important? If one accepts the premise that in a highly developed world there exists a

need to set aside areas for maintaining biodiversity and ecological processes to survive in the long term, one of the key questions to emerge is “how much?” The debate has rested for now on a target of protecting 10% of each of the world's 14 biomes, of which temperate grasslands is one (Coad et al. 2009; Schmitt et al. 2009). This target has become a fundamental tenet of the United Nations' Convention on Biological Diversity and the United Nations' Millennium Development Goals (UNEP-WCMC 2008).

The debate continues, however, with new research indicating that the numbers of individuals in a population required to ensure long-term persistence of a particular species greatly exceeds targets typically proposed for conservation management (Traill et al. 2009). This thinking could have implications for the 10% target for protected areas, suggesting that this target may be too small, especially in grasslands where many species are migratory at regional or continental scales.

Creating protected areas alone will not be sufficient to guarantee the long-term survival of grassland species. In addition, the fragmentation of grassland habitats and loss of connectivity between them presents an even greater challenge to species persistence (Merola-Zwartjes 2004; Peart 2008b). Whether the fragments are protected or not, restoring or maintaining corridors to provide connectivity and enable movement between them is a fundamental principle of applied conservation biology (Merola-Zwartjes 2004). A case in point is the recent initiative to protect the migration corridor for pronghorn antelope in northwestern Wyoming in the western United States, linking the animal's summering grounds in Grand Teton National Park with their winter habitats in the Upper Green River Valley (ENS 2008). Berger et al. (2006) speculated that this population would become extirpated if the corridor were not maintained.

TEMPERATE GRASSLANDS CONSERVATION INITIATIVE

In an effort to increase the rate of progress in conserving and protecting temperate grasslands, the Specialist Group launched the Temperate Grasslands Conservation Initiative (TGCI) in June 2008 at a two-day workshop held in Hohhot, China, in conjunction with the joint International Grasslands Congress and International Rangelands Congress. The Initiative hopes to focus the work of the Specialist Group on fostering greater communication and cooperation at the global level for conserving and protecting the world's temperate grasslands (Henwood

2006; Peart 2008b). The Hohhot workshop brought together 35 experts from 14 countries representing the global temperate grasslands biome to determine how best to proceed. Through considerable discussion, they agreed to work together to reverse the trend of biodiversity loss and degradation of temperate grasslands biome by promoting the designation and special management of representative protected areas and the widespread use of sustainable management practices throughout the biome.

The Conservation Initiative goals were informed by a common understanding of threats and challenges to future conservation and protection of the world's remaining temperate grasslands, including widespread livestock grazing, the introduction of exotic species, fire suppression, conversion to other land uses, and the overarching but still poorly understood implications of global climate change. The central message is that temperate grasslands must be better managed throughout the biome to sustain the many valuable ecological services they deliver and to reverse ongoing trends of habitat and biodiversity loss, fragmentation, ecosystem degradation, and desertification (Peart 2008b).

The Conservation Initiative also positions the conservation and protection of temperate grasslands in the context of other social and economic goals, as expressed through a number of international programs, such as the UN's Millennium Development Goals to promote sustainable development, alleviate hunger, increase food production, and ensure access to safe water. In addition, conserving and protecting grasslands can lend valuable support for initiatives to sustain the lifestyles and livelihoods of indigenous and traditional peoples and their communities.

The principal outcome of the Hohhot workshop was agreement to develop a global strategy to achieve these goals and inspire the production of region-specific action plans worldwide. The first regional action plans will be prepared for East Asia and South America. Individual workshops have been held for these two regions, and the report for the South American workshop held in Argentina in 2008 is now available (Michelson 2009). The report of the Hohhot workshop is entitled *Life in a Working Landscape: Towards a Conservation Strategy for the World's Temperate Grasslands* (Peart 2008b). An accompanying compendium describes the various temperate grassland regions of the world, their current condition, levels of protection, and potential for increased protection (Peart 2008a).

The workshop culminated in the adoption of “The Hohhot Declaration.” This declaration is a consensus

statement prepared by workshop participants and endorsed by the International Grasslands Congress and International Rangelands Congress (see Appendix 1). The declaration represents a call to action to protect and conserve the world's remaining temperate grasslands. The Hohhot Declaration has been translated into several languages spoken in the biome and is a primary tool of the Conservation Initiative to encourage all parties involved in using and managing temperate grasslands to take action accordingly.

GLOBAL ASSESSMENT OF THE CONSERVATION STATUS OF TEMPERATE GRASSLANDS

The work of the Conservation Initiative and implementation of the Hohhot Declaration is guided by an assessment of the status and conservation potential of the world's temperate grasslands. A preliminary assessment was undertaken by the Specialist Group in 2003 in preparation for the World Parks Congress held in South Africa (Henwood 2004) and was updated for the Hohhot workshop into a compendium by Specialist Group members (Peart 2008a). The national or regional reports in the compendium were prepared by local experts and capture the status and trends in each area. They provide a foundation for determining conservation priorities regionally and globally. Table 1 provides a numerical summary of the findings of this assessment and enables a quick comparison of one temperate grassland region to another.

The global assessment found high variation among the various temperate grassland regions of the world, both in the extent to which indigenous grasslands remain and the degree to which they are protected. Criteria for creating new protected areas prioritize the presence of relatively large and natural expanses of grasslands with healthy populations of indigenous wildlife. Knowledge of the locations of these areas can help identify where the greatest potential lies for significant improvements in conservation and protection. In Eurasia, for example, we find that for the grasslands of eastern Europe, primarily in portions of Romania, Bulgaria, Hungary, Moldova, and Ukraine, only 3% to 5% remain in a natural or near-natural state, with a mere 0.2% protected (IUCN 1991; Anonymous 2002). With so little remaining in a relatively natural state, opportunities for increasing levels of protection in this region are limited.

In contrast, the eastward extension of steppe into Kazakhstan and Russia reveal much lower levels of disturbance (Anonymous 2002; Smelansky and Simonov 2008). Although current levels of protection in this region

are also extremely low (0.1%-2.1%), the vast steppes of the region have the potential to offer significant opportunities for increased protection (Anonymous 2002; Klebelsberg 2008). Of particular importance are the steppes of Kazakhstan, which support about 80% of the remaining numbers of and habitat for the endangered Saiga antelope; the conservation and protection of these steppes is essential for the long-term survival of the Eurasian population of this species (Lushchekina and Struchkov 2001). A major project is now underway, under the auspices of the United Nations Development Program (UNDP) and the Global Environment Facility, to expand the protected area system of Kazakhstan to ensure an improved coverage of steppe ecosystems (Global Environment Facility 2007). The intent is to expand the protected-area system in Kazakhstan's steppes by 3.5 million hectares by 2030 (Global Environment Facility 2007).

Farther east, as one follows the large expanse of grasslands into northern China, Mongolia, and Siberian Russia, we again find more extensive areas of relatively natural grasslands (Peng et al. 2008; Tumurbaatar 2008). Levels of protection here are quite high, with Mongolia boasting over 10% protection and China an impressive 35% (Peng et al. 2008; Tumurbaatar 2008). In Mongolia, grasslands occupy over 70% of the country. While much of the grasslands is considered to be in a natural or semi-natural state, degradation is increasing from overgrazing, mining operations, and infrastructure development (Sneath 1998; Tumurbaatar 2008). With a strong conservation policy seeking to protect 30% of its territory, there is considerable opportunity for further conservation gains in Mongolia (Myagmarsuren 2000; Tumurbaatar 2008; Reading et al., this volume). In China, while about 53% of its grasslands remain in natural vegetation cover, as much as 90% of all its grasslands are suffering from degradation (up from 27.5% in the 1980s), primarily due to overgrazing and the effects of desertification (Food and Agriculture Organization 2005). Continued commitments by the Chinese government to further grasslands conservation and restoration, such as the Natural Grassland Protection Programme, should lead to continued improvements in the conservation and sustainable use of these grasslands (Peng et al. 2008).

The region where Mongolia, China, and Russia converge is known as the Daurian steppe. This region is outstanding for the breadth of natural habitats and connectivity it provides for migrating species of wildlife, including millions of birds and large populations of Mongolian gazelle. This iconic species has lost more than 50% of its range over the past century and is now concentrated

in Mongolia's eastern steppes (Schaller 2001). In 1994 the three countries created contiguous nature reserves to form the Dauria International Protected Area of 1.7 million hectares to better coordinate conservation efforts (Tkachuk 2008). This international effort will hopefully serve as a foundation for additional transboundary conservation programs among these three countries (Tkachuk 2008).

In Australia and New Zealand, we find a common pattern where high-elevation grasslands have received high levels of protection, whereas low-elevation grasslands almost cease to exist. In southeastern Australia, less than 2% of the lowland grasslands remain, while more than 90% of the high-elevation grasslands remain in relatively natural condition (Gilfedder et al. 2008). In New Zealand, the figures for remaining natural grasslands and for protected areas are similarly skewed by disproportionately high levels of protection in the high-elevation areas (Mark et al. 2008). New Zealand has recently undergone a review of ownership and management of its publicly held grasslands, resulting in an increase of 2.6% in lands managed for conservation to a total of 15.4% (Mark et al. 2009). In contrast, most southeastern Australia grasslands are privately owned (Gilfedder et al. 2008). Opportunities for increased conservation and protection are limited and focused on developing innovative programs aimed at conserving biodiversity in privately owned, production-oriented landscapes (Gilfedder et al. 2008).

The grasslands biome in southern Africa (including South Africa, Lesotho, and Swaziland) occupies the region's high central plateau and presents a very different scenario to that in New Zealand and Australia. Here, the levels of disturbance and protection are more evenly distributed among the four major types of grasslands (Carbutt et al. 2008). In total, 34% have been irreversibly transformed by a variety of land uses, primarily agriculture, and 65% remain under native cover used for grazing livestock and wildlife (Carbutt et al. 2008). The current level of protection for these grasslands is 2%, which, combined with the 65% remaining in native cover, suggests that good opportunities exist for increasing protection (Carbutt et al. 2008). The grasslands biome is also, however, the economic heartland of South Africa, generating 34% of its gross domestic product, and as much as 80% of the land lies in private ownership (Carbutt et al. 2008). Ongoing initiatives include the National Grassland Biodiversity Programme to conserve biodiversity throughout the biome, the National Stewardship Programme to encourage conservation on private land, and special initiatives like the Ekwangala Grasslands Project in which nongovernment organizations and stakeholder groups are

collaborating in implementing a long-term conservation strategy on a landscape scale involving 1.6 million hectares (Carbutt et al. 2008).

In North America, the tallgrass prairie is virtually gone, with only about 3% remaining, and only 0.5% of its original extent protected (Steinauer and Collins 1996; Packard and Mutel 1997). The situation improves as one moves west, with as much as 40% of mixed-grass prairie remaining and up to 2.6% protected, and 48% of the shortgrass prairie remaining with 8% protected (Samson and Knopf 1994, 1996; Bragg and Steuter, 1996; Weaver et al. 1996; Forrest et al. 2004). Recent ecoregional planning processes have identified the most ecologically significant grassland areas remaining on the continent that could form the basis for a network of grassland conservation areas and promote the ecologically sustainable use of grasslands to prevent further biodiversity and habitat loss (Nature Conservancy 2000; Forrest et al. 2004; CEC/TNC 2005). In the Northern Great Plains of Canada and the United States, for example, 10 areas ranging in size from 2 to 4 million acres of largely untilled prairie have been identified to form the core of a network of grassland protected areas designed to help restore the Great Plains and its ecological processes on a landscape scale. Such a strategy would involve linking public lands, tribal lands, and privately held ranch lands into large, cooperatively managed units. The strategy would be implemented over decades to provide the necessary ecological conditions to support native species, many of which are migratory on a continental basis (Forrest et al. 2004). Within the Northern Great Plains, more site-specific planning has also occurred through the Northern Mixed-Grass Transboundary Conservation Initiative in the mixed-grass prairie in Alberta, Saskatchewan, and Montana to arrive at specific management actions to maintain and restore the remaining intact grassland ecosystems of this transboundary region (Smith Fargey 2004).

In Mexico, a strategy was developed to conserve the biodiversity and functional integrity of the grasslands of the Chihuahuan desert (ECOPAD 2007). Having deteriorated since the mid-1800s due to harmful agricultural practices, fragmentation, and other land uses, only about 15% of the steppes of the Chihuahuan desert remain in relatively natural condition, with only 2.8% protected (CEC/TNC 2005; ECOPAD 2007). The ECOPAD strategy provides a conservation framework to address the many challenges to restoring the ecological integrity of these grasslands and recovering species and habitats by focusing on developing sustainable land use and production systems (ECOPAD 2007).

Temperate grasslands in South America include the high-elevation paramo of the northern Andes (Venezuela, Columbia, Ecuador, Peru); the paramo and puna in the central Andes (Peru, Bolivia, Chile, Argentina); the pampas and campos of the Rio de la Plata grasslands (Argentina, Uruguay, Brazil); and the Patagonian steppes (Argentina, Chile) (Peart 2008a). In the high-elevation grasslands of the central Andes, conservation efforts have been limited, with levels of protection below 3% in most grassland types (Halloy et al. 2008). Overgrazing and desertification are common threats to the integrity of these areas (Halloy et al. 2008). The northern Andes, however, tops the world's list of hotspots for endemism and for species/area ratio, and up to 60% of these grasslands remain in natural condition and 43% have been formally protected (Cuesta 2008). The pampas and campos of the Rio de la Plata grasslands are the largest complexes of grasslands in South America and have been extensively studied to identify remaining areas of ecological significance (Bilenca and Minarro 2004; Minarro and Bilenca 2007). About 30% of the pampas remain in Argentina, but only 1.05% has been protected (Minarro et al. 2008). Although much more of the campos remains under native cover, as much as 81% in Uruguay and southern Brazil, the levels of protection are extremely low, averaging about 0.25% for Argentina, Uruguay, and Brazil (Minarro et al. 2008).

In the Patagonian steppe in southern Argentina and Chile, most of the region remains under native grass cover, notwithstanding overgrazing, and much is privately owned (Michelson 2008). About 5% of the region currently lies within protected areas, although only 1% is considered effectively managed (Paruelo et al. 2006; Michelson 2008). The Nature Conservancy has initiated a program to protect 10% of the steppes of Patagonia through additional protected areas, nature reserves on private land, and promoting sustainable land-use practices (Michelson 2008). Following a continent-wide workshop in 2008, a comprehensive strategy is being developed for conserving and protecting South America's grasslands (Michelson 2009).

IDENTIFYING GLOBAL PRIORITIES FOR CONSERVATION AND PROTECTION

The regional summaries provide a basis to begin to identify priorities for conserving and protecting temperate grasslands on a global basis. It is possible to distinguish three general categories of grassland landscapes according to current levels of protection and disturbance,

remaining area under native grassland cover, current ecological condition and potential for restoration, and prospects for increased protection. These landscape categories are (1) Highly Modified and Fragmented Landscapes; (2) Moderately Modified and Fragmented Landscapes; and (3) Large, Relatively Intact Landscapes.

The Highly Modified and Fragmented Landscapes include the steppes of eastern Europe, the tallgrass prairie of North America, and the lowland grasslands of New Zealand and southeastern Australia. In these landscapes, grasslands remain only as isolated fragments with little or no potential for connectivity. Due to the very high degree of conversion and well-established land-use patterns, even with concerted restoration efforts it is unlikely we could achieve levels of protection greater than 5%. In the Moderately Modified and Fragmented Landscapes, the degree of retention of natural grassland landscapes and patterns of land use may render it possible to achieve levels of up to 10% protection, as the fragments are larger and have greater potential for connectivity. Examples of these landscapes remain in the pampas and campos in South America, the grasslands in southern Africa, and the steppes of northern China.

The greatest potential for significant conservation gains lies in the Large, Relatively Intact Landscapes found in the Daurian steppe, the shared grasslands of eastern Mongolia, northern China, and southern Russia; the Kazakh steppe; the Patagonian steppe; and in portions of the Northern Great Plains of North America. It is in these four grassland landscapes where potential exists to conserve and protect large, ecologically viable grasslands on a landscape scale. With restoration and reintroduction efforts, it may be possible to reestablish indigenous wildlife populations and functional predator-prey relationships. All of these landscapes except for the Kazakh steppe have been included in the Global 200 identified by the World Wildlife Fund (2009).

While these four regions may share potential for improved conservation, that is where their similarities end. Each region is defined by its own social, economic, cultural, and political circumstances, creating diverse challenges that demand equally diverse approaches to conservation and protection. The steppes of Kazakhstan and the Dauria region, for example, are mostly state-owned, whereas Patagonia and the Northern Great Plains are 90% and 98% owned by private interests, respectively. The steppes of eastern Mongolia, part of the Dauria region, remain in relatively good condition, whereas about 35% of the Patagonian steppe has already been transformed into desert conditions through overgrazing. The vast Dauria

region is still an outstanding, intact grassland, but it faces increasing threats from mining and energy development, new irrigation projects, and border-related security issues. In contrast, the Northern Great Plains is highly fragmented and there is a strong reliance on both intensive and extensive agriculture that has not been amenable to conserving biodiversity and ecological processes. The intent of the Temperate Grasslands Conservation Initiative is to prioritize these four regions and to facilitate discussion, communication, and collaboration toward finding regionally appropriate solutions to their conservation and protection.

CONSERVATION FUTURE FOR THE NORTHERN GREAT PLAINS

The Northern Great Plains constitute about 225,000 km² in the northern portion of North America's Great Plains, of which about 48% remain under relatively natural vegetation cover (Forrest et al. 2004). Within these remaining natural areas, potential exists to conserve and protect several grassland landscapes millions of acres in size that can recapture the lost magnificence of the North American prairie. A recent conservation assessment of this region, in a landmark study called *Ocean of Grass*, confirmed that the Northern Great Plains, while not a naturally functioning ecosystem, retains some of the largest blocks of untilled prairie remaining in North America and harbors considerable potential for restoring grassland ecosystems on a landscape scale (Forrest et al. 2004). This assessment recommends increasing the level of protection of the Northern Great Plains in areas managed primarily for biodiversity conservation from its current level of 1.5% to 10%-15% by 2020 (Forrest et al. 2004). Such restoration efforts could provide habitat to once again support ecologically viable populations of a suite of prairie wildlife, including free-roaming herds of bison, and reestablish large-scale ecological processes (Forrest et al. 2004).

This is not as fanciful a notion as it may sound. For example, in the Missouri Breaks area of eastern Montana the American Prairie Foundation is working to protect 3.5 million acres of native prairie in the American Prairie Reserve (World Wildlife Fund 2008; American Prairie Foundation 2009; Manning 2009). The Grassland Foundation, in collaboration with the Northern Great Plains Program of the World Wildlife Fund, has implemented the Grasslands 2010 initiative, subscribing to the 10% protection target for the Northern Great Plains and aspiring to create a 1-million-acre Nebraska Prairie Reserve (Grassland Foundation 2005; Sutton et al. 2005). The

Conservation Alliance of the Great Plains has similar hopes for a large area of relatively natural grasslands centered on the Oglala, Little Missouri, Buffalo Gap, and Thunder Basin national grasslands in Nebraska, North Dakota, South Dakota, and Wyoming, respectively (Grassland Foundation 2004). Adjacent to the border with Canada, the bi-national Northern Mixed Grass Transboundary Conservation Initiative is working to achieve improved biodiversity conservation in the shared grasslands of Montana, Alberta, and Saskatchewan (Smith Fargey 2004).

The Northern Great Plains ecoregion has been identified as a global priority for conservation and protection as one of the World Wildlife Fund's Global 200, and as outlined above, the Temperate Grasslands Conservation Initiative shares this recognition (World Wildlife Fund 2009). However, with 98% of the Northern Great Plains in private ownership, strong public-private partnerships for biodiversity conservation will be required if significant progress is to be made. A recent analysis of evolving demographic and economic trends in the Northern Great Plains reveals continuing declines in rural populations and in the contribution of agriculture to the regional economy. In turn, these trends may lead to large-scale shifts in landownership and management priorities in the near future (Freese et al. 2009). The natural capital that remains in the Northern Great Plains presents opportunities for public-private partnerships in pursuit of nature-based economic activities to help diversify and strengthen the regional economy in a way that serves both agriculture and biodiversity conservation. These economic activities include capitalizing on the region's natural amenities, promoting products derived directly from ecosystem features, and marketing ecosystem services such as the provision of water and carbon sequestration (Freese et al. 2009). Expanding the system of conservation areas in the Northern Great Plains, on both public and private land, is only one of a dozen recommended actions directed toward building a nature-based economy to supplement and complement an agriculture-based economy (Freese et al. 2009).

This is likely where the future lies for conservation in the Northern Great Plains. With vision and leadership, the long-term conservation of this invaluable grassland ecosystem is a possibility, one that could make a significant contribution to the global restoration of the temperate grasslands biome. With sufficient progress in this and the other high-priority regions, as well as the many important initiatives in the more fragmented landscapes, temperate grasslands may well come to hold their rightful place in the world's protected area system.

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APPENDIX 1 THE HOHHOT DECLARATION

June, 2008

We, the participants of the Temperate Grasslands Conservation Initiative, recognize that:

Considering that temperate indigenous grasslands provide environmental services essential for life on earth as a source of food, fibre, human livelihoods and well-being, cultural and biological diversity, the recharge of aquifers and the sequestration of carbon, particularly in the face of global climate change;

Agreeing that temperate indigenous grasslands are terrestrial ecosystems dominated by herbaceous and shrub vegetation, maintained by grazing, fire, drought and/or low temperatures and that all of these processes are dynamic and display great variability in terms of time, extent, intensity and place;

Recognizing the opportunities that temperate indigenous grasslands provide in feeding people, it is imperative to maintain the genetic diversity of grassland systems;

Realizing the importance of temperate indigenous grasslands to the life and cultural survival of mobile indigenous peoples and the value of indigenous knowledge as well as the accumulated experience of traditional indigenous temperate grasslands users;

Acknowledging that temperate indigenous grasslands are currently considered among the most imperiled ecosystems on the planet, having been modified by human activity to such a degree that most grasslands have been transformed and very little remains in a natural state;

Recognizing that the remaining areas of natural grassland continue to be threatened by inappropriate policies that lead to loss of grassland, as well as unsustainable land use and management practices;

Acknowledging that success will require participatory management approaches and partnerships among all sectors to ensure the integration of production and biodiversity conservation outcomes for the continued provision of grassland ecological goods and services;

Recognizing the importance of strengthening indigenous territories, community conserved areas and the establishment of new protected areas;

Recognizing that one of the most important opportunities for collaboration is ensuring worldwide societal recognition of the enduring value of natural grasslands;

Developing and implementing incentives for good land stewardship, restoration and the sustainable management of indigenous temperate grasslands is essential to guarantee their sustainable use as healthy working environments.

Therefore, we the participants of the Hohhot World Temperate Grasslands Conservation Initiative Workshop from five continents and 17 countries, declare that temperate indigenous grasslands are critically endangered and urgent action is required to protect and maintain the services they provide to sustain human life. We call upon all sectors of society to collaborate towards this goal.

(The Declaration was signed by thirty-three scientists and representatives from China, Mongolia, Russia, South Africa, New Zealand, Australia, Iran, Germany, the United States, Canada, Ecuador, Argentina, and Uruguay.)