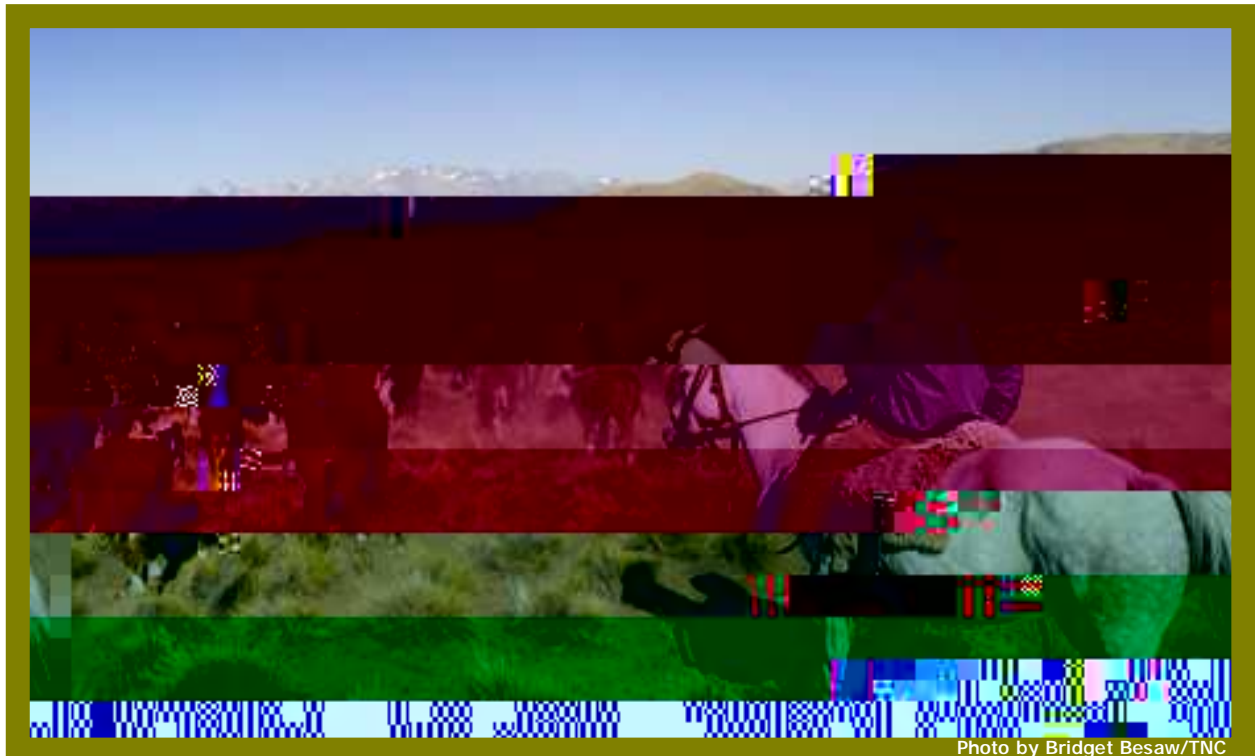


WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION

A Review of Current Research on
their Total Economic Value



Prepared for
The World Temperate Grasslands Conservation Initiative

By
Barbara Heidenreich
July 2009



Temperate Grasslands Conservation Initiative

Suite 300 – 300 West Georgia Street, Vancouver, BC V6B 6B4
CANADA

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	I
EXECUTIVE SUMMARY.....	II
1. INTRODUCTION.....	1
1.1 Background.....	1
1.2 Markets and Values - Background Information.....	2
1.3 Purpose and Methodology.....	4
2. TEMPERATE GRASSLANDS AS A SUSTAINABLE ECONOMIC RESOURCE.....	5

EXECUTIVE SUMMARY

Indigenous temperate grasslands are the most altered ecosystem on earth, with less than half remaining in an intact, natural condition. Intensive agriculture has replaced 41 percent of the world's temperate grasslands and another 13.5 percent have been converted to urban, industrial and other uses. Much of the remainder, although still under grassland vegetation, is degraded and vulnerable to desertification. The fundamental purpose of the Temperate Grasslands Conservation Initiative (TGCI) is to reverse this trend and increase the level of conservation and protection of temperate grasslands through establishing additional formally protected areas and encouraging ecologically sustainable land use practices throughout the biome.

As an effort to make a stronger case for conservation and protection, the TGCI identified the need to better understand the total economic value (TEV) of temperate grasslands to human social and cultural well-being. This review summarizes the current literature regarding the TEV of goods and services provided by indigenous temperate grasslands, highlights research gaps and identifies future priorities.

The central conclusion is both surprising and disturbing. No empirical valuation research was found by this review that addressed intact temperate grasslands specifically. In a biome with the highest Conservation Risk Index globally, our understanding of the TEV of the goods and services provided by indigenous temperate grasslands is therefore virtually non-existent. As a result, temperate grasslands are one of the least understood global biomes in terms of their value to sustainable economic uses, and the provision of socio-cultural and ecosystem goods and services that contribute to human well-being. If not corrected, this lack of understanding will continue to threaten the long-term ecological viability of those indigenous grasslands that remain.

This report documents the current and limited understanding of the TEV of the goods and services provided by temperate grasslands. The need to place a value on the ecosystem goods and services and the social and cultural non-use values of natural areas has been identified as important since the 1990's, and techniques have been developed to help 'monetize' these values. This analysis documents the full range of goods and services provided bycom

1. INTRODUCTION

1.1 Background

Temperate Grasslands are areas of grass and graminoid-dominated indigenous ecosystems. These ecosystems occur mainly in the middle latitudes and also in areas of tropical and temperate high mountains above the regional tree line where generally similar environments and temperate biogeographic affinities occur.¹ Natural grasslands are variously known as prairies, steppes, pampas and rangelands.

Temperate grasslands are the most altered ecosystem on earth, and the most endangered habitat in most countries where they occur (Figure 1).

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Economic Value of Indigenous Temperate Grasslands

Table 1: Temperate Grasslands Contribution to Human Well-Being (Total Economic Value - TEV)

Direct Use Value: consumption requiring grassland conversion	Direct Use Value: consumption without grassland conversion (the "Working Landscape")	Non-Use Value & Indirect Use Value: human benefits that neither convert nor consume temperate grasslands	
Grassland as an economic resource (economic goods and services) that have Direct Use Value and result in conversion of the biome	Grassland as a sustainable economic resource with Direct Use Value, involving some consumption (degradation) of the biome but not total conversion (adapted from Maczko & Hidinger 2008)	Social, cultural goods and services with Non-use Value that contribute to human well being (adapted from Chiesura & de Groot 2003; Maczko & Hidinger 2008)	Ecosystem Functions and corresponding goods and services that have Indirect Use Value (adapted from Costanza,R., D'Arge R., De Groot R., Farber _____)

1.3 Purpose and Methodology

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Econom

2.1.3 Bio-medical, Genetic Resources, Grass and Grass B

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Economic Value of Indigenous Temperate Grasslands



WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Economic Value of Indigenous Temperate Grasslands

5.0 RESEARCH PRIORITIES FOR VALUING TEMPERATE GRASSLANDS

The research gaps in understanding values associated with intact temperate grasslands are significant and will be time-consuming and expensive to remedy. While the magnitude of the research effort required seems daunting, the time and costs associated with such valuation studies have to be weighed. Full information is not always needed to provide relevant information for decision making. Researchers will need to evaluate costs and benefits of having reliable monetary values for all or key ecosystem services or whether, in comparing alternatives, the recognition of value and quasi-quantitative relative values provide enough information for decision making. The approach should depend on the purpose of the study and can be part of a scoping process where the required level of detail can also be defined.

Research must be undertaken in a focused way that leads to meeting geographic grassland conservation goals and objectives. Any research responding to the issue of adapting to climate change should have regard to the literature review by Heller and Zavaleta (2009), which synthesizes the potential solutions that have been identified, and the consensus and direction provided as ways to cope with climate change. The temperate grassland research of Gibons (2005) and Maczko & Hidinger (2008) outlines a multidisciplinary approach linking grassland stewardship and conservation into a complex agro-ecosystem to be managed at a variety of scales: from pasture management and livestock farming

5.4 Conservation Tools

Tools recognized as effective in changing social behaviour include:

- regulatory instruments (laws, regulations and policies),
- market-based (economic) instruments (MBIs)⁹ that affect the costs and benefits of different behavioural options and these include subsidies, taxes and charges, and the creation of markets such as emissions trading systems and carbon markets.
- suasive instruments (education, training, providing information, and social recognition) which capitalize on the importance of unwritten rules of social conduct to change behaviour.

These approaches are seldom alternative options. Suasive tools have been extremely effective in promoting the use of conservation easement agreements, donations and bequests of land to conservation organizations in order to protect sensitive natural areas. However enabling legislation is required that provides registered charitable lands trusts the ability to provide tax relief in exchange. MBIs and suasive instruments focus on providing incentives and disincentives to consumers, investors and producers to enable them to make informed decisions about the environmental consequences of their actions or purchases. The use of regulation to create economic instruments to promote the conservation of temperate grasslands is a direct route to avoid further habitat loss; although not as direct as outright land securement by acquisition or conservation easement agreements for conservation purposes by government and non-government organizations. An analysis of recent experience with incentive based instruments (Jack, Kousky, Sims 2008) in terms of their design, outcomes, effectiveness, cost effectiveness and lessons learned, emphasizes the importance of context and improved collaborations between economists and ecologists to better specify the production function for ecosystem services as a key in achieving policy goals.

The effort in developing and applying conservation tools to grasslands is recent and extensive. It deserves its own research review. Some useful references include: Curran (n.d.), Danielson (1995), De Civita (n.d.), Dutilly-Diane (2007), Ferraro (2002)

6.0 CONCLUSIONS

Temperate grasslands are recognized as the most imperiled ecosystem in most countries where they occur. Yet this biome clearly remains one of the least understood in terms of the value of its sustainable economic uses, social-cultural services, as well as the many ecosystem goods and services that it contributes to human well-being. In a biome with the highest Conservation Risk Index (Figure 1) globally, our understanding of the full monetary value of the goods and services provided by natural temperate grasslands is virtually nonexistent. This has fundamental implications to the wise use of the remaining undisturbed biome.

What do we know about the total economic value of natural temperate grasslands?

There is a good overall qualitative understanding of the elements that together make up the concept of the total economic value of the biome (Section 1 - Table 1). The role of ecosystem goods and services has been identified as important since the 1990s, and social and cultural non-use values of natural areas have also been identified and recognized as having value although there is little qualitative research in this field that is temperate grasslands specific. Techniques have been developed to help monetize these values. Quantitative valuation of sustainable economic use, social and cultural non-use values and ecosystem goods and services has occurred in many biomes. However, no empirical valuation research was found by this review that addressed intact temperate grasslands specifically.

Quantitative data specific to natural temperate grasslands that would allow a comprehensive total economic valuation of this biome is simply not available.

The figures that have been developed and used in valuing “grasslands” (Table 2) are not based on temperate grassland data, but extrapolated from global grassland data and value transfer from other biomes. This needs to be remedied as the total economic value of intact biomes appears to be highly location specific.

Table 2 summarizes the research review results for natural temperate grasslands. It also provides an overview of the research gaps.

Ecosystem functions and corresponding goods and services that have Indirect Use Value		
Water Filtration	n.a.	
Water Supply – storage & retention	n.a.	
Erosion Control; Sediment Retention	\$ 50.	(global)Wilson (2008) Table 12: based on Costanza (2006)
Soil Formation	H: \$ 10. L: \$ 7.4	H:(global) Wilson (2008) Table 12: based on Costanza (2006) L:(global/New Jersey)Costanza (2006);Pimentel (1998)
Nutrient Cycling	n.a.	
Waste Treatment	H:\$ 146.00 L:\$ 108.73	H:(global) Wilson (2008) Table 12: based on Costanza (2006) L:(global)Costanza (2006)
Pollination -	H:1,190.00 L: \$ 32.00	H: (global) Wilson (2008): services provided by grasslands was estimated at \$ 1,109 per ha. per year based on the global average of crop production that is dependent on pollination (30%) multiplied by the total value of farm crop production for the region. L: (global/New Jersey) Costanza (2006) needs to be updated with Morandin (2006), Losey

Some additional observations emerge from this review:

- One issue that needs immediate attention is the need to raise the profile of the temperate grassland biome, publicize its Conservation Risk Index and ensure that this biome is recognized as a research priority. Directed research funds are urgently needed. The awareness initiated by the TGCI 2008 Hohhot Workshop within the grasslands research community must expand beyond the temperate grassland community to the broader environmental and ecological economics community and TGCI needs to advocate for a focused research agenda on this imperiled biome ¹⁰.
- In addition to the gaps in the *qualitative* recognition of the direct use, non-use and indirect goods and services as provided by natural temperate grasslands (Section 1 - Table 1), there is almost a complete absence of *quantitative* empirical data on natural temperate grasslands to feed into accepted valuation methodologies i.e. survey data on the type of good or service provided, the quantity provided, or the change in quantity provided. Research is needed that would enable estimates of total economic value data using specific temperate grassland data by geographic area.
- These research gaps in the recognition, quantification and valuation of natural temperate grasslands goods and services that have direct use and non-use value are significant and will be time-consuming and expensive to remedy. However, such work must be undertaken as understanding and quantifying value assists in the identification of stakeholders and supports more sustainable decision making by providing better information on the consequences on new policies or planned developments. Clear research priorities for immediate action are needed in order to focus scarce resources. Potential areas have been highlighted in Section 5.
- Absolute valuation figures are not always needed to provide relevant information for decision making; relative values are often sufficient to evaluate alternatives. However, the quantification and monetization of total economic value which includes ecosystem services, social-cultural non-use values *plus* the type of fiscal analysis provided by cost of community studies (COCS) does offer a higher degree of leverage in having unsustainable projects modified or cancelled.
- It has been argued that the cultural context and natural diversity among biomes and between temperate grassland geographic regions limits the applicability of transferring research results (“value/benefits transfer” technique) from one area to another, e.g. tropical grasslands to temperate grasslands, and between geographic regions of the same biome e.g. temperate grasslands in Australia to temperate grasslands in China. Pragmatically, these estimates are better than the alternative of

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Economic Value of Indigenous Temperate Grasslands

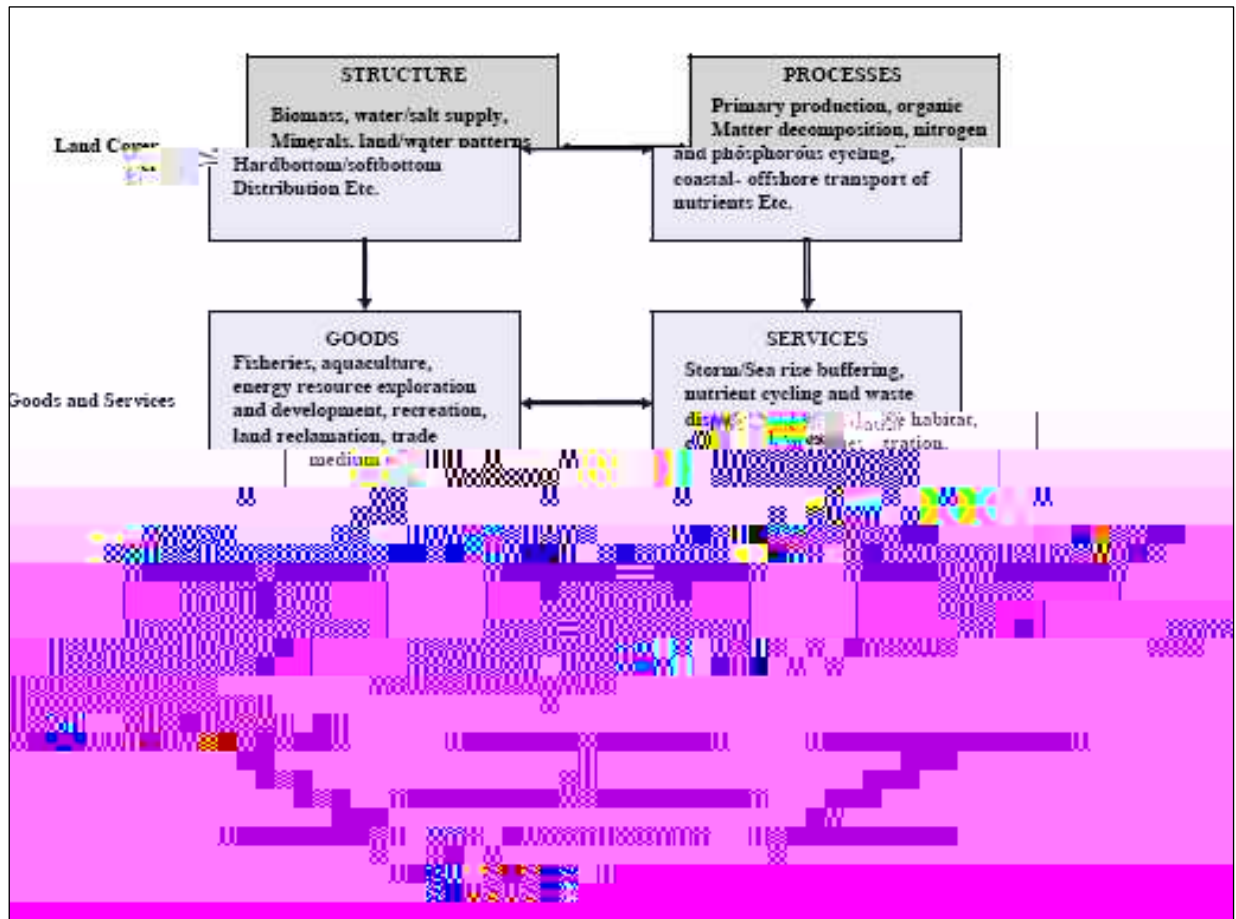


Figure 2: Total Economic Value of Ecosystem Functions, Goods and Services

Source: Costanza, Wilson, Troy et. al. 2006. *The Value of New Jersey's Ecosystem Services and Natural Capital*. Appendix A, Figure 2, p. 63.

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Econom

- **New Zealand** (Mark & McLennan 2005; Mark & Dickinson 2008; Mark et al. 2009). The South Island government-leased high country of extensively grazed rangeland, occupies 2.6 million ha (10% of the total land area). It is currently undergoing tenure review whereby lessees can apply to freehold (privatize) the more productive, generally lower-altitude lands while the less modified, generally higher-altitude areas, valuable for soil, water and nature conservation and recreation revert to full government control, are destocked and managed by the Department of Conservation in the public interest. To date (March 2009) 59 of the 303 leasehold properties have completed tenure review, with 179,132 ha (56%) being privatized and 138,110 ha (44%) reverting to conservation management, together with an additional 125,792 ha through government purchase of five whole properties. Another 105 properties are at various stages of review. Nine conservation parks totalling more than 480,000 ha. of mainly indigenous grasslands, have been created in the South Island high country since 2000. There has thus been a major increase in the area of formally protected indigenous grasslands within the last decade, now amounting to 15.4% of the original baseline (1840: pre-European) grassland area.

References cited:

Mark A., Dickinson K..2008. "Maximizing water yield with indigenous non-forest vegetation: a New Zealand perspective". *Frontiers in Ecology and the Environment* 6: 25-34.

Mark AF, McLennan B. 22005. The conservation status of New Zealand's indigenous grasslands. *New Zealand Journal of Botany* 43: 245-270.

Mark AF, Michel P, Dickinson KJM, McLennan B. 2009. The conservation (protected area) status of New Zealand's indigenous grasslands: an update. *New Zealand Journal of Botany*

APPENDIX C: REFERENCES – WATER SERVICES RESEARCH

Baldocchi D.D., Xu L.K., Kiang N.. 2004. “How plant

Poulenard J., Michel J.C., Bartoli F., Portal M., Podwojewski P.. 2004. "Water repellency of volcanic ash soils from Ecuadorian páramo: effect of water content and characteristics of hydrophobic organic matter."

a ,am671(o)-0.981R57(a)559(.)e.61124()-0.491788(o)-01124()-5.64154(s)-7.61124()-r63517.(a4(p250.9810

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Econom

IPCC. 2007. *Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon S., Qin D., Manning M., Chen M., Marquis K.B., Averyt M., Tignor M., and Miller H.M.(Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

Jackson R.B., Banner J.L., Jobbágy E.G., Pockman W.T., Wall D.H..2002. "Ecosystem carbon loss with woody plant invasion of grasslands." *Nature*. 418:623–626.

Jones M.B., and Donnelly A.. 2004. "Carbon sequestration in temperate grassland ecosystems and the influence of management, climate and elevated CO₂." *New Phytologist*. 164 (3):423-439.

Jones S. K., Rees R. M., Kosmas D., Ball B. C., and Skiba U.M.. 2006. "Carbon sequestration in a temperate grassland; management and climatic controls" *Soil Use and Management*. 22:132–142.

Kirkbride M and R Grahn. a

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Economic Value of Indigenous Temperate Grasslands

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Econom

Gauthier D.A., Lafon A., Toombs T., Hoth J., Wiken E..2003. *Grasslands: Towards a North American Conservation Strategy*. Co-published by the Commission for Environmental Cooperation (Montreal) and the Canadian Plains Research Center (Regina). ISBN 2-922305-90-2. Montreal Quebec H2Y 1N9. 99 pgs.

Gintzburger G., Toderich K.N., Mardonov B.K., Mahmudov M.M..2003. *Rangelands of the Arid and Semi-Arid Zones of Uzbekistan*. Published jointly by International Centre for Agricultural Research in the Dry Areas CIRAD, France, and ICARDA, Syria. 426 p.

Gintzburger G..2004. "Agriculture and Rangelands in Middle Asian Countries." in Ryan, Vlek & Paroda, 2004, q.v.

Gibon A..2005. "Managing grassland for production, the environment and the landscape. Challenges at the farm and the landscape level." *Livestock Production Science*. 96:11-31.

Giuliani V..2002. "Theory of attachment and place attachment." in M. Bonnes, T. Lee, & M. Bonaiuto (eds.), *Psychological theories for environmental issues*. Ashgate, Aldershot.

Gómez-García D., García-González R., Marinas A., Aldezabal A..2002. "An eco-pastoral index for evaluating Pyrenean mountain grasslands." 19th General Meeting of the European Grassland Federation La Rochelle. <http://www.ipe.csic.es/conservacion/Tools/GOMEZ-588.ppt>

Greenway G., Sanders S..2006. "The Fiscal Implications of Land Use: A "Cost of Community Services" Study for Red Deer County". Calgary: Miistakis Institute, April 2006 (available as 4 .pdf reports from the Miistakis web site: www.rockies.ca/)

Goldman, R. 2000. *The Impacts of Horse and Dairy Cattle on the Ecology of the Prairie*. 200

Hoekstra J.M., Boucher T.M., Ricketts T.H., Roberts C..2005. "Confronting a biome crisis: global disparities of habitat loss and protection." *Ecology Letters*.8:23 - 29.

Hopkins A., Holz B..(2005). "Grassland for agriculture and nature conservation: production, quality and multifunctionality." *Grassland Science in Europe*. 10:15–29.

Hopkins A., Wilkins R.J.. 2006. "Temperate grassland: key developments in the last century and future perspectives." *Journal of Agricultural Science*. 144:503–523.

International Union for Conservation of Nature (2008) B. Peart (Ed.) *Temperate Grasslands Conservation Initiative Workshop. Life in a Working Landscape: Towards a Conservation Strategy for the World's Temperate Grasslands*. Hohhot, China.

http://cms.iucn.org/about/union/commissions/wcpa/wcpa_puball/wcpa_pubsubject/wcpa_grasslandspub/index.cfm?uNewsID=2545

Jack B.K., Kousky C., Sims K.R.E..2008. "Designing Payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms."

Lemaire G., Wilkins R., and Hodgson J.. 2005. "Challenges for grassland science: managing research priorities." *Agriculture Ecosystems & Environment*. 108(2):99-108.

Lehmann B., Hediger W..2004. "The contribution of grassland to social benefits of agriculture - an economic analysis". In (Editors): Lüscher A., Jeangros B., Kessler W., Huguenin O., Lobsiger M., Millar N., Suter D. *Land use systems in grassland dominated regions*. Proceedings of the 20th General Meeting of the European Grassland Federation, Luzern, Switzerland, 21-24 June 2004.

Lehmkuhl J.F., Upreti R.K., Sharma U.R..(1988). "National parks and local development: grasses and people in Royal Chitwan National Park, Nepal." *Environmental Conservation*, 15(2):143-8.

Letšela T., Witkowski E. T. F., Balkwill K..2003. "Plant resources used for subsistence in Tsehlanyane and Bokong in Lesotho." *Economic Botany*. 57(4):619-639.

Lindborg R., Bengtsson J., Berg Å., Cousins S.A.O., Eriksson O., Gustafsson T., *et al.*2008. "A landscape perspective on conservation of semi-natural grasslands." *Agriculture, Ecosystems and Environment*. 125:213–222.

Loomis J., Rameker V., Seidl A..2000. "Potential Non-Market Benefits of Colorado's Agricultural Lands: A Review of the Literature." Colorado State University Department of Agricultural and Resource Economics, *Agricultural Resource Policy Report APR 00-02*.

Losey J.E., Vaughn M..2006. "The Economic Value of the ecological Services Provided by Insects." *Bioscience*. 56(4): 311- 323.

Louv R..2006. *Last Child in the woods. Saving our children from Nature Deficit Disorder*. Chapel Hill, NC: Algonquin Books.

Maczko K., Hiding L.. (eds). 2008. *Sustainable Rangelands Ecosystem Goods and Services*. Sustainable Rangelands Roundtable. SRR Monograph No. 3. <http://sustainableangelands.warnercnr.colostate.edu/>

Maller C., Townsend M., Pryor A., Brown P., St. Leger L..2005. "Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations." *Health Promotion International*. 21(1):45-54.

Mark A., Dickinson K., Patrick B.. 2003. "Indigenous grassland protection in New Zealand."

Milne J.A.. 2003. *Book Review: Grice, A.C., Hodgkinson, K.C. (Eds.), "Global Rangelands: Progress and Prospects."* *Grass Forage Science*. 58:99.

Morandin L.A., Winston M.L..2006. Pollinators provide economic incentive to preserve natural land in ecosystems." *Agriculture, Ecosystems and Environment*. 116(3-4):289-292.

Nábrádi A..2007. "The Economic Value of Grassland Products." *Applied Studies in Agribusiness and Commerce*. 1(1):19-28.

Nábrádi A..2008. "Marketable Value of Grassland Products." *Cereal Research Communications*. 36(3S):2027-2030.

Nan Z.. 2004. "The Grassland Farming System and sustainable agricultural development in China." *Grassland Science*. 51:15–19.

Nelson C.J., Burns J.C.. 2006. "Fifty Years of Grassland Science Leading to Change". *Crop Science*. 46:2204-2217.

Newell P.B..1997. "A Cross-Cultural Examination of Favorite Places." *Environment and Behavior*. 29(4):495-514.

Nowak D.J. *et al.*2002. "Compensatory value of urban trees in the United States." *Journal of Arboriculture*. 28(4):194-199.

O'Connor T. G., Kuyler P..2005. *National Grasslands Initiative: Identification of Compatible Land Uses for Maintaining Biodiversity Integrity*. Report for the South African National Biodiversity Institute's National Grasslands Biodiversity Programme.

Okwi P.O., Kaija D..1999. "Valuing Tropical Grasslands:The Case of Overstocking in Northeastern Uganda." Organization for Social Science Research in Eastern and Southern Africa
<http://www.ossrea.net/ssrr/no24/no24.htm>

Osterkamp W.R., Marlow

ce 981081027(.)-0.4905(s)-7.60997(l)6.63531(a)r7(l)6.635(d)-0.981027(i)6.63531

PriceWaterhouseCoopers LLP, Econometric Research Limited and EDA Collaborative Inc..2004. *Ecol !* "

Tennigkeit T., Wilkes A..2008. "Carbon Finance in Rangelands - An Assessment of Potential in Communal Rangelands." <http://www.iucn.org/wisp/resources/?2645/Report-CARBON-FINANCE-IN-RANGELANDS-An-Assessment-of-Potential-in-Communal-Rangelands>

Thompson D. B..2002. "Valuing the Environment: Courts' Struggles with Natural Resource Damages." *Environmental Law*. 32(1): 57-89 (Northwestern School of Law of Lewis & Clark College).

- Wilson S.J.. 2008 “Grassland Ecosystem Values” (Section 3.4) in *Ontario’s Wealth. Canada’s Future. Appreciating the Value of the Greenbelts’ Eco-services*. Vancouver, B.C.:David Suzuki Foundation. pp. 35-36.
- Wit P..2008.“Cultural awareness and nature conservation.” Extract from: *The nature of drylands. Diverse ecosystems, diverse solutions*. Barcelona: IUCN.
- Wittig B., Kemmerman A.R., Zacharias D..2006. “An indicator species approach for result-orientated subsidies of ecological services in grasslands – A study in Northwestern Germany.” *Biological Conservation*. 133:186–197.
- Wolf K.L..2004. “Public Value of Nature: Economics of Urban Trees, Parks and Open Space.” *Design with Spirit: Proceedings of the 35th Annual Conference of the Environmental Design Research Association*: 88-92.
- Wuerthner G., Matteson M..2002. *Welfare Ranching: The Subsidized Destruction of the American West*. Sausalito, CA: Foundation Ecology (343 pp.)
- Yadav R.P., Thaguna S.S., Sah J.P..2000. “Grasslands in Royal Shukla Phanta Wildlife Reserve: status, importance and management.” in *Grassland ecology and management in protected areas of Nepal*. Proceedings of a Workshop, Royal Bardia National Park, Thakurdwara, Bardia, Nepal 1999. Volume 2: Terai protected areas, pp.128-137.
- Yang H..2008. “An Ecosystem Service Value Assessment of Land Use Change on Poyang Lake Basin under GIS Technology, China.” *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. Vol. XXXVII. Part B8. Beijing 2008, pp.327-330.
- Yuan-Farrell C., Kareiva P..2006. *Ecosystem Services. Status and Summaries*. Washington, D.C.: The Nature Conservancy.
- Zhang M.A., Borjigin E., and Zhang H..2007. “Mongolian nomadic culture and ecological culture: On the ecological reconstruction in the agro-pastoral mosaic zone in Northern China.” *Ecological Economics*. 62:19-26.

WHAT ARE GLOBAL TEMPERATE GRASSLANDS WORTH? A CASE FOR THEIR PROTECTION
An Analysis of Current Research on the Total Econom