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

A Review of Current Research on their Total Economic Value



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

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Barbara Heidenreich has held Associate Professor positions at both Trent University and Boston University (through its School for Field Studies, British Columbia) where she developed and taught courses in environment and economy linkages. Specializing in land use planning, her academic qualifications include degrees in economic geography: B.A. (York), M.A. (McMaster); and international business and public policy: M.I.A. (Columbia).

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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 by temperate grasslands with a focus on those 'use' and 'non-use' benefits that tend not to be priced in our market economy:

- Direct use value without grassland conversion (for example - rangeland for subsistence pastoral use, bio-medical, genetic, harvesting by-products, outdoor recreation).
- Indirect use values without grassland conversion provided by ecosystem functions that correspond with keeping the landscape intact (soil conservation/retention, water supply and retention, nutrient recycling, waste treatment, pollination, wildlife habitat, air quality, ozone protection and climate regulation).
- Non-use values of socio-cultural goods and services that contribute to human well-being whether the grassland landscape is converted or not (health, aesthetics, spiritual, cultural, traditional knowledge, education).

Site specific and eco-region landscape level case study research not only contribute to understanding the value of an intact natural area within a specific cultural context, but the results, when applied can move the conservation agenda forward. While there have been few such case studies completed for temperate grasslands this paper highlights some work by the United States, Canadian, South American and Australian governments, as well as a few more specific studies, that provide policy direction for conservation and templates for methodology transfer. In turn the effort to develop and apply conservation tools to grasslands is more recent and becoming extensive. This work is encouraging and is deserved of its own research review.

This report reaches a number of other supporting conclusions:

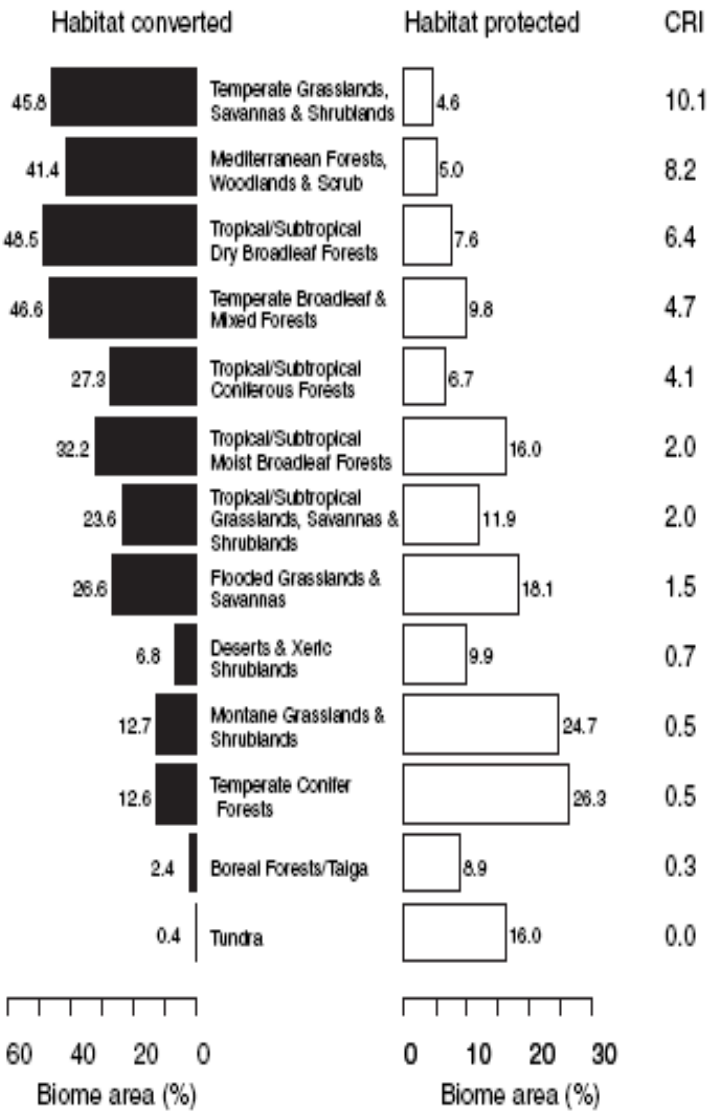
- No empirical valuation research was found by this review that specifically addressed the value of intact temperate grasslands. Empirical research fully identifying, quantifying and assigning value to such uses in temperate grasslands around the world has not yet been a focus of the research community and is needed.
- The research gaps in understanding these values are significant, expensive and daunting. Researchers may have to weigh these factors and instead focus on geographic, place-based, multi-disciplinary case studies. This approach is particularly true for socio-cultural valuation, which has proven difficult to transfer from one geographic area to another, or from one biome to another. As most decisions on land use and environmental management are made at the local level, research to be effective, needs to keep this end in focus and reflect the socio-economic context in which and for whom decisions will be made.
- No public governance system can afford to pay landowners the full value of ecosystem services and functions in order to maintain them. However, decision-makers should know what those values are, for they place into perspective any regulatory or market based compensation and allow for the determination of a comparative value of not converting the land or even having unsustainable projects modified or cancelled.
- The global profile of the temperate grasslands biome must be raised, both for the effect on direct protection and to provide the leverage needed to raise the necessary funds to continue this type of research work.
- While the role of ecosystem goods and services from temperate grasslands has long been identified as important, and social and cultural non-use values have also been identified and recognized as having value, the quantitative valuation of such services has not received the degree of attention that less imperiled biomes have received.

Temperate grasslands have value that encompass more than the goods and services traditionally bought and sold as a result of landscape conversion. The incorporation of these values into land use decision-making should aid in improved management, conservation and protection. When such values are not fully considered an accurate picture of the net benefit to human well-being of the choice of either converting temperate grasslands or maintaining them intact cannot be made. The resulting poor land-use and investment decisions made on temperate grasslands, by individuals and society is clearly evident around the world.

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 bio-geographic affinities occur. [1] Natural grasslands are variously known as prairies, steppes, pampas and rangelands.



Biomes are ordered by their Conservation Risk Index (CRI). CRI was calculated as the ration of per cent area converted to per cent area protected as an index of relative risk of biome-wide biodiversity loss.

Source: Hoekstra 2005

Temperate grasslands are the most altered ecosystem on earth, and the most endangered habitat in most countries where they occur (Figure 1). Of this biome which once covered 8% of the earth's surface, less than half remains. Intensive agriculture has replaced 41 percent of the world's temperate grasslands and 13.5 percent have been urbanized, industrialized and degraded.[2]

The Temperate Grasslands Conservation Initiative (TGCI) was established in 2005 to assist in addressing this biome loss and facilitating cooperation globally on its sustainable use and conservation. A TGCI workshop in Hohhot China in June 2008 (Peart 2008) identified the importance of understanding the full contribution that grasslands provide in terms of human social and cultural well-being (Peart 2008 – Figure 7 p. 15). This research review outlines current research regarding the economic value of goods and services provided by temperate grasslands. The review also highlights research gaps and research priorities.

Figure 1:
Habitat Conversion and Protection in the World's 13 Terrestrial Biomes

1.2 Markets and Values – Background Information

Our market system centres on the buying and selling of goods and services in the market place using money as a medium for exchange. However this system is inadequate for recognizing the full range of goods and services that grasslands provide. Historically the conversion of grasslands into housing or farms has been considered to give the highest economic return for the use of grassland. When grasslands are turned into a commodity in this way (i.e. a Direct Use Value is provided by converting the grassland) and sold in the market place, the economic value of the biome is considered to be reflected in the dollar amount exchanged. The full economic value of grasslands, however, needs to take into consideration other uses provided by grasslands; uses that do not require converting and the subsequent destruction of the biome. Grasslands, as a 'working landscape' (i.e. providing Direct Use Value without requiring conversion of the grasslands), provide goods and services that do not destroy (but may degrade) the biome: grazing, bio-medical use, providing genetic resources, harvesting by-products and active recreation use. Grasslands also provide social and cultural goods and services (i.e. Non-Use Values that neither convert nor consume grasslands) that have aesthetic, spiritual, and passive recreational value to human wellbeing. Grassland ecosystem functions which include water and climate regulation (i.e. Indirect Use Values that neither convert nor consume grasslands) provide life-sustaining services, which are increasingly being recognized and quantified.

Collectively, all these values contribute to what is known conceptually as the "Total Economic Value" (TEV)[3] of the biome (Table 1). To capture the monetary value of non-consumptive uses is not an easy task when only a few of these uses have cash flows associated with them. Some methods for valuing grassland services are relatively easy to calculate, for example the cost of protecting biodiversity on farmland is the income foregone ("opportunity cost") to the private landowner by not farming the land. Some goods and services are less easy to place an economic value on, such as valuing the aesthetics of a vista. As a result, economists have developed a variety of different methodologies (Appendix A) for assigning a monetary value to "non- consumptive" goods and services. While the methodologies have limitations, they do attempt to quantify and monetize goods and services not actively traded in our current market system. For example, ecosystem services such as carbon sequestration can be quantified as the amount of carbon stored per hectare to which society then can attach a monetary value. Even a simple qualitative listing of temperate grassland goods and services in studies to support decision-making raises awareness of their importance. Monetizing adds authority and credibility and provides a common (monetary) unit of understanding.

Knowing that there are values that encompass more than goods and services bought and sold in the market assists in making sustainable, fair and transparent decisions. Valuation also is the basis for damage assessment and compensation systems. Quantifying these values aids in environmental management as regulatory frameworks and markets using taxes and charges can be developed. If our economy is not fully able through its current pricing systems to provide an accurate picture of the net benefit to human well-being of choosing between converting temperate grasslands or maintaining an intact biome, poor land-use and investment decisions by individuals and by society as a whole will result.

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

Direct Use Value: consumption requiring grassland conversion	**or**	**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 S., et al. 1997; Sala O.E. and Paruelo, J.M.. 1997; De Groot, R.S.. 2002; Maczko & Hidinger 2008)*
Agriculture for food, fibre, fuel crops, plantation forestry **Mining,** particularly coal, uranium **Urban development**: residential, commercial industrial development; rail & road transport; infrastructure land uses;		**Rangeland** commercial grassland use as forage/rangeland for domestic ruminants producing livestock, meat, milk, wool, leather. Unsustainable use will result in ecosystem degradation; **Subsistence pastoral** (indigenous) agricultural systems & grazing, hunting and gathering; **Bio-medical use** of vegetation (edible & pharmaceutical uses) **Genetic resources** through biodiversity for new and wild relatives of existing crop and pasture plants; **Harvesting grass and grassland by-products** for the production of commercial-industrial products: thatch grass, building material, rope, wild hay, seed and thatch harvesting for restoration purposes **Recreation (active):** motorized (ATV etc) use; hunting	**Health** **Aesthetic** value **Spiritual** **Inspirational** **Social-Psychological** values **Cultural heritage** **Scientific – educational; TEK** **Recreation (passive):** eco-tourism; hiking trails; birding; photography	**Gas regulation**:– CO_2/ O_2 balance; UVb protection by ozone; maintenance of air quality; **Climate regulation**:- carbon regulation/sequestration, cloud formation; **Disturbance prevention**:– storm protection, drought recovery, flood control; **Water regulation and water supply:**– run-off control, filtering, water retention and storage; **Soil retention and soil formation:**- weathering of rock and decomposition of organic matter; **Nutrient cycling:-**storage, internal cycling, processing and acquisition of nutrients (e.g. nitrogen fixation); **Waste treatment:-**role of vegetation and biota in removal or breakdown of xenic and excess nutrients; **Pollination:**-role of biota in movement of floral gametes in wild species and crops; **Biological control:-**population and pest control by predator-prey dynamics; **Habitat/Refugia:**- suitable living and reproductive space for resident and migrating species

1.3 Purpose and Methodology

This review documents (a) our current understanding of the full range of goods and services provided by temperate grasslands with a focus on those "use" and "non-use" benefits that tend not to be priced in our market economy, and (b) the research that has attempted to assign a dollar value to these goods and services. The Institute for Scientific Information (ISI) Web of Knowledge, an online academic database provided by Thomson Scientific, and other library-based bibliographic search engines were used to identify research papers that contributed to an understanding of all goods and services contributed by biomes in general and temperate grasslands in particular.[4] The sections that follow highlight the most significant studies from the over 2,000 publications reviewed. Ecosystem services and their value were not a focus, but are included for completeness. Research results from other biomes have been included when applicability to temperate grasslands was identified either in highlighting a research gap, providing directions for future research and / or adding insights on methodological approaches.

2. TEMPERATE GRASSLANDS AS A SUSTAINABLE ECONOMIC RESOURCE

2.1 "Working Landscapes" – Direct Use Values Without Grassland Conversion

Working landscapes provide economic benefits to human well-being without conversion of the biome. Uses include commercial grazing of native and domestic herbivores on native vegetation (rangelands) to produce meat, milk, wool, and leather, subsistence pastoral (indigenous) agricultural systems, non-cultivated food gathering for human consumption such as honey and berries, the bio-medical use of vegetation, provision of genetic resources for new or wild relatives of crop and pasture plants and other purposes, harvesting grasslands for products such as thatch grass (for building material and rope), wild hay, harvesting seed and thatch for restoration purposes, and active recreational uses, which potentially may impact but do not destroy the ecosystem (may include motorized - ATV, dirt-bike use, hunting and fishing). Although there may in some cases be considerable degradation to grasslands from these activities, total destruction of the grassland would generally not result.

2.1.1 Rangelands

The most significant economic analysis of rangelands reviewed is the 2005 United States Government Accountability Office Report *Livestock Grazing*. The report describes rangeland grazing returns in the 2004 fiscal year for the federal agencies responsible for managing 235 million acres of lands. Grazing fees generated $21 million, which represents a monetary (market) value for the use of 235 million acres of natural grasslands. The study provides a budgetary analysis of management costs ($ 144 million) and the grazing fees received ($ 21 million) but did not consider economic, environmental, or the societal costs and benefits of grasslands. The authors recommended periodically re-examining the grazing programs, including how much of the program's financing should be paid for by those who benefit most directly. Given the size of the land base, most of it being prairie grasslands, it would be useful to undertake a more extensive analysis of the economics of these rangelands, their management and the other societal, cultural and ecosystem values provided. Such research should include the value trade off, if any, on degraded ecosystem services from what appear to be grazing fees maintained at (subsidized) artificially low levels.

2.1.2 Subsistence Pastoral

Pastoralism, the extensive herding of livestock in grasslands, is considered to be in some cases the most sustainable production system, as well as one of the few agrarian production systems compatible with nature conservation (Rass 2008). Globally there are more than 120 million pastoralists who are custodians of more than 5000 M ha. of rangelands (White *et. al.* 2000). This grassland use has become the research focus of the World Initiative for Sustainable Pastoralism (WISP), a joint programme of the World Conservation Union (IUCN) and the UN Development Programme (UNDP).Two significant research documents recently released that focus on the economics of pastoralism, Hatfield and Davies (2006) *Global Review of the Economics of Pastoralism* and Rodriguez (2008) *A Global Perspective on the Global Economic Value of Pastoralism*. Both provide an excellent qualitative overview of the direct values of pastoralism as well as other diverse values, and both reports emphasize the need to assign real monetary values to direct use and non-use values to fully understand the role of pastoral cultures to society and the environment.

Using the unit of measurement established by Costanza, the Hatfield and Davies report provides sufficient data existed for the development of direct value of rangelands based on carrying capacity of the Afar region of Ethiopia (Section 6 - Table 2). Rodriguez provides a macro-economic approach to valuation using an estimation of the contribution to national accounts of marketed goods and services from pastoralism such as: animal sales and consumption; milk sales and consumption; hides and skin sales and consumption; wool sales and consumption. The difficulties of determining the value of non-marketed good and services such as transportation by livestock, the contribution of traction to agriculture, manure trading and soil fertility and even the contribution of the pastoralism to the tourist industry are all noted. There is an absence of valuation studies for these services. In addition there remain the challenges of valuing the role of pastoralism on ecosystem services without double counting. Grazing grasslands contributes to maintaining healthy vegetation, which captures carbon, reduces erosion, maintains soils and facilitates water-holding capacity. Biophysical inventories necessary to assign value to this contribution need to be completed. WISP's approach relies on the collection and interpretation of secondary data rather than generating primary data. In addition to the difficulties in the quantity and quality of the data on pastoral societies, the lack of homogeneity among pastoral groups makes the transfer of values and the aggregation of values to obtain a broader picture of the contribution of pastoralists very difficult. Using such data, much of it being locally based and anecdotal, in different locations and at different scales to obtain the type of biome values developed by the field of ecological economics for ecosystem goods and service flows is a challenge. A few studies simply indicating the diversity of the values being considered are listed below:

- A study by Wang (2008) located in the Inner Mongolia Plateau and the Song Nen Plain of north-eastern China applied a new quantitative method for grassland resource evaluation. The method provides a value for management practices, but not to overall valuation in monetary terms of the resource. This type of empirical data is the first step in understanding pastoral value of a grassland resource.
- The concept of using financial incentive systems to reward pastoral management that improves carbon sequestration has been suggested by Tennigkeit & Wilkes (2008). The study adds a new dimension to valuing pastoralism and an impetus to further biophysical studies as the concept would enable support of pastoral sustainable resource use by examining the feasibility of tying this livelihood into the development of carbon markets.
- A simple quantitative index for calculating the "eco-pastoral value" of grasslands in the Spanish Pyrenees has been developed by Gómez-García *et al*. (2002). The index ranks the ecological values and pastoral values of areas using a numerical index that can be used to compare different sites for land management and conservation purposes. The transferability and usefulness of this index to temperate grasslands needs to be evaluated.
- A recognition that there is increased consumer interest in locally grown and origin-labeled grassland products, which can be marketed as such. There is growing scientific evidence of the role of local temperate grassland flora on various sensory characteristics of both meat and dairy products, such as colour and flavour. These benefits of biodiversity have been identified and marketed for cheese (Coulon *et al*. 2004) and meat (Priolo *et al*. 2001). At this point, market differentiation specific to grasslands has been recognized, but not quantified nor developed commercially to its full market potential.

2.1.3 Bio-medical, Genetic Resources, Grass and Grass By-products Harvest

Products sustainably harvested from temperate grasslands that contribute to human well-being but do not require the destruction of the ecosystem, need to be systematically identified at the landscape, region and site level, then quantified and assigned a monetary value. A few grassland by-products that have been identified include wild hay, honey, medicinal plants, and herbs and grass for roof thatching (Hatfield & Davies 2006) (Rodriguez 2008). However, almost all empirical research quantifying these products has been conducted in tropical biomes (Brown 1994, 1997; Letšela 2003; Yadav 2000; Lehmkuhl 1988).

Detailed research was undertaken of the indigenous use of the phanta[5] grasslands in south-west Nepal (Brown, 1994, 1997). Here the extraction of grass (for roofing material) and other by-products from phantas inside the Royal Bardia National Park by local people living in adjacent villages was identified, quantified and valued in monetary terms. The flowering plant and indigenous grass use in Nepal described in Brown's research has also been studied by Yadav (2000), Lehmkuhl *et al*. (1988) and Sah *et al*. (2003) and by Letšela *et al*. (2003) in Lesotho. All these studies, while of methodological interest, involve tropical grassland harvest and do not provide transferable values to temperate regions where the by products may not exist. They do, however, indicate the quantitative significance of such grassland by products to local residents. In general there is a low economic value in absolute dollars; but such by products have a high cultural value and there are high costs associated with replacement products such as using tile roofing material to replace thatch grass for roofing.

Similarly, the type of comprehensive contingent valuation research and economic valuation using shadow pricing undertaken in terms of use and non-use values by P.O. Okwi and D. Kaija (1999) in the tropical grassland areas of North Eastern Uganda (Karamoja) provides a template for a type of research that may be useful for temperate areas. This analysis of the agricultural products, fuel wood, honey, pastoral grazing, livestock sales and other use and indirect use values provided by the Karamoja grasslands indicated that these benefits are substantial on all fronts, benefits in the magnitude of Uganda shillings 200,000,000 per month (Exchange rate at the time is 1US$= Uganda shillings 1500).

Only one case was found for temperate grasslands that valued grassland by- products. Estimates were established for various grassland products and by-products in Hungary by using costs of production, or using market price for demanded products, or replacement value if grass supplements or forage substitutes are used (Nábrádi 2007, 2008). However, the analysis was not built on natural grasslands (described in the report as "botanical curiosities") but planted pasture grasses valued as a cost of production, which are the sum costs of soil preparation, seed, fertilizer, sowing, weed control. While this production cost provides an estimate of the value of natural grass on a replacement cost basis, Nábrádi points out that natural grass is a far superior product in terms of its nutritional content. This anecdotal enhanced quality of natural grass forage adds to value by contributing supplements that maintain animal health and life performance, another interesting factor that needs to be measured and valued.

While grasses have provided the hereditary material for the principal human food crops: rice, wheat, corn, and other grains, and this has been recognized as an important use value (Sala & Paruelo in Ch. 13 and Myers in Ch.14 of Daily (ed) 1997; Daily *et al*. 2003) (Pimentel *et al*. 1997) (Suttie *et al*. 2005) (Silvertown *et al*. 2006), no research was found documenting the dollar value of this contribution historically. Nor was any research found estimating future use values of genetic diversity for temperate grasslands although the value of "biodiversity prospecting" for the pharmaceutical industry has been reviewed in Simpson *et al*. (1996) and the underexploited potential economic value of plant material (principally in the tropics) has been the subject of considerable research and promotion by Vietmeyer (2008). Interest in the forage value of different species (Nelson & Burns 2006) as a rangeland management tool has had some focus in terms of temperate grassland genetic research.

2.1.4 Recreation (active)

The contribution of recreational activities to local, regional and national economies has received considerable research attention (Eubanks 1999) (DuWors *et al*. 1999)(Rudzitis & Johnson 2000) (U.S. Fish and Wildlife Service) (Fleischer & Tsur 2003) (Simpson *et al*. 2008). Many reports provide statewide statistics and expenditures and do not allow for the partitioning of the recreational activities related to grasslands from other biomes. In such research it would be useful to distinguish in temperate grassland areas, between active use (motorized ATV use, trail-bike) that potentially results in ecosystem degradation, and passive uses as photography, bird listing, canoeing and hiking trails[6]. The hypothesis that the net benefit of passive recreation may be greater than active recreation when the cost of environmental impacts are considered would be useful to test in temperate grasslands where motorized recreation can be an issue. Considerable empirical research is required to provide accurate figures for temperate grasslands and have them reflect the reality of changing global economics, type of recreational activity and take into consideration any negative externalities (such as damage to ecosystem functions) associated with active recreational use. No such temperate grassland specific studies were found although some estimates have been provided in Section 6 – Table 2 based on state tourism figures.

2.2 Summary

Important qualitative studies recognizing and listing the contribution of intact grasslands, principally tropical are available. Some grassland case studies (Rodriguez 2008) indicate their role in ranching and pastoral systems and the provision of by-products that have many economic, social and cultural uses. However, empirical studies fully identifying, quantifying and assigning value to such uses in temperate grasslands around the world has not as yet been a focus of the research community.

3. SOCIAL AND CULTURAL GOODS AND SERVICES WITH NON-USE VALUE

3.1 Non-use Values

Temperate grasslands provide a range of non-use social and cultural values that contribute to human well-being without consuming or degrading the ecosystem. These services include health benefits, aesthetic value, spiritual, inspirational, social-psychological values, cultural heritage, scientific, educational and traditional ecological knowledge (TEK) values. Many of these values are not accounted for in our market system as they are not traded in the open competitive market for money, or are traded only in the "informal economy"[7]. The difficulty of "pricing what is priceless" has long been recognized (Smith 1996).

Monetary valuation techniques often used to quantify non-use values of our biomes are conceptually and methodologically ill suited to address the socio-cultural values of biomes. Social- psychological and cultural heritage values are primarily interpreted in terms of significance, meanings, perceptions and qualitative associations (using methods from the sociological and psychological sciences), rather than in dollar figures.

3.1.1 Health (physical and mental)

In some areas, such as human health, quantification of benefits of natural systems has progressed by calculating those benefits in terms of reduced public expenditures for the health care system, or in better efficiency at work and increased productivity. Various studies have looked at the positive impact that nature has on health and wellbeing: Ulrich (1984), Kaplan (1995), Wells & Evans (2003), Maller *et al*. (2005), Louv (2006), Berman (2008). There is no research on impacts on physical and mental health specifically related to temperate grasslands but the studies referenced have applicable methodologies.

3.1.2 Aesthetic Value

Hedonic pricing, a "revealed preference" valuation methodology (see Appendix A) has been used extensively to assign dollar values to natural areas and trees in urban settings. Price differences related to identical houses located near different amenities (parks, trees) are seen as reflecting the aesthetic value of nature (Nowak 2002) (Wolf 2004) (Costanza 2006). Such studies are used in advocating for the preservation of trees, natural areas within urban areas and parks. For in addition to contributing to a range of social and ecosystem values, the increase in property values attributed to the amenity also becomes reflected in increased property taxes, a reality that is appreciated, but not always fully understood by local government.

The growing popularity of low-density ("ranchette") development in a prairie setting, as described in Comartie (1998), Conner *et al*. (2002) can be seen as a consumer response to a certain aesthetic. The real estate value of this type of housing (Appendix A – Hedonic pricing) and the costs related to the travel associated with such a lifestyle choice (Appendix A - Travel Cost) together reflect the economic value of this aesthetic preference vis-à-vis other lifestyle choices. This type of development has its own economic impacts locally in stimulating the rural economy. The economic impact of this movement has been addressed by Rudzitis and Johnson (2000), but has not specifically been addressed as a temperate grassland research topic.

Several studies have attempted to place a value on landscape aesthetics using survey techniques (Arriaza *et al*. 2004, Burel & Baudry 1995). These types of stated preference valuation methods and pricing systems for measuring aesthetic preferences are being developed (Bienabe & Hearne 2006). There is an extensive body of research developing in the valuation of amenity benefits (Defenders of Wildlife: Conservation Economics Program Bibliography of Economic Valuation Literature, 2008), however the research has not been applied directly to temperate grasslands as an amenity.

3.1.3 Spiritual, Inspirational, Social-psychological ("a sense of place")

Grasslands have always served as a form of inspiration for artistic expression in music, painting, and poetry (Berman 2008) and provide spiritual, inspirational and social-psychological values related to a 'sense of place'. Research by Newell (1997) found that 61% of participants identified some part of the natural environment as their favourite place. While the survey was not specifically related to temperate grasslands, the results indicate the importance that a biome may have to the regional psyche, a fact to be capitalized on in conservation initiatives. Donations and memberships to environmental organizations and conservation agencies, or the time people are willing to invest in voluntary nature-related jobs are often used as an indication of the importance of the geography of place to individuals (Chiesura & de Groot 2003), however this method of valuation has not been undertaken specifically for grasslands.

3.1.4 Cultural Heritage Values

Cultural heritage values include local lifestyles, practices and traditions, cultural landscapes, and personal and collective history which are all a part of cultural identity (Brown 1994, 1997) (Loomis 2000) (McIntyre *et al*. 2002) (Suttie & Reynolds 2003) (Suttie *et al*. 2005) (Mokany *et al*. 2006) (Cruz *et al*. 2007) (Curtin 2008). As early as 1967 Krutilla observed that many people value natural wonders simply for their existence and have a positive "willingness to pay" (Appendix A - WTP) government to exercise good stewardship of the land even though their enjoyment is vicarious. Other valuation methods, including travel cost and contingent valuation, were developed to monetize this type of cultural non-use value. Despite this early recognition, insufficient attention has been paid to the cultural heritage value of natural areas and their importance to social well-being (Chiesura & de Groot.2003).

Empirical qualitative studies such as the work of Barrow *et al* (2007) and Stenseke (2006) in Sweden, illustrate the importance of understanding and recognizing how local knowledge and farming practices are instrumental in maintaining and enhancing semi-natural grasslands. This type of descriptive study is the first step into developing a policy and landscape management system that could be based on quantitative values associated with the ecosystem services and aesthetic values provided by the rural farm sector. An initiative capitalizing on this value, the protection of the Culm Grassland in Devon and Cornwall in the UK (known as Rhos Pasture in Wales and Purple Moor Grass a Biodiversity Action Plan habitat), relies on the recognition of local stewardship and cultural values as the base for grassland conservation (Leach n.d.). Linking such initiatives to farm tourism (Section 3.1.6.) provides a return to the rural community for ecosystem preservation. Sustainable rural development maintained through rural tourism or through market based subsidy systems can preserve a region's cultural heritage and its associated landscapes.

Such potential is recognized in The Grassland Foundation Study of Nebraska by Sutton *et al*. (2005). Systematic studies, such as those sponsored by The National Trust (UK) have also attempted to capture the economic value of maintaining cultural heritage landscapes in terms of full time job equivalents (Tourism Associates 1999). This type of quantitative empirical research valuing the cultural heritage aspects of temperate grassland areas is required. Ultimately there needs to be greater recognition that from grasslands come humans, our agricultural systems, the domestication of horses, cattle, sheep, lamas and most cereal crops. Understanding grassland ecology helps us understand ourselves. Some grassland areas retain archaeological sites of great knowledge that are not yet fully valued even for their tourism potential.

3.1.5 Scientific-educational and Traditional Ecological Knowledge (TEK)

Natural systems and anthropogenic impacts all provide study-material for educational purposes. Globally, government research and educational institutions, non-government/charitable organizations and advocacy groups are in themselves a source of economic stimulus in rural and remote areas and it would be useful to evaluate their economic and social impact locally, regionally and globally.

Indigenous peoples with an historical continuity of resource use often possess a broad knowledge base of the behaviour of complex ecological systems in their own localities. The importance of preserving the value of the knowledge-practice-belief complex of indigenous peoples needs to be fully recognized if ecosystems and biodiversity are to be managed sustainably (Gadgil *et al*. 1993)(Millar & Curtis 1999) (Barrow 2007). However, methodologies for assigning value have not been fully developed or applied in temperate grasslands. This is a value that can be easily and irretrievably lost if it is not fully recognized and documented. Web based opportunities such as *Trees for Life Journal* (www.tfljournal.org) can assist in bringing traditional knowledge of beneficial plants to the attention of those interested. Exposure of grassland species in this type of public forum may have benefits in stimulating research into valuing traditional knowledge.

3.1.6 Recreation (passive)

Intact ecosystems provide space for recreation and escape from urban stress. While the economic impact of tourism has been studied extensively (DuWors 1999)(U.S. Fish and Wildlife Service Survey Results) and eco-tourism more recently (Simpson 2008) there has been no quantitative research specific to natural grasslands or temperate grasslands or pastoral-cultural tourism (Hatfield & Davies 2006) (Rodriguez 2008). In the absence of this type of biome specific empirical data Sutton (2005) uses the results of a 2004 federal survey that calculates that the money spent on wildlife recreation in the U.S.A. is more than the total amount of cash receipts received by the U.S. livestock industry. Eubanks (1999) studying area encompassing the middle section of the Platte River in Nebraska, estimated annual gross economic value of wildlife watching alone ranged between $27.9 million to $ 57.5 million which, when combined with hunting and fishing raised the annual gross economic value to between $70.6 to $115.8 million. Again, in the absence of site specific grassland data, Sutton transfers visitor spending in the Badlands National Park in South Dakota ($ 19 million annually in a 60 mile radius), to Nebraska; a figure which he accepts as indicative of the potential inherent in a hypothetical world class native prairie preserve.

Some of the research being undertaken on passive recreational uses in road-less areas and cultural landscapes (Rudzitis & Johnson 2000) (Crist *et al*. 2005) (Lindborg & Bengtsson *et al*. 2008) and the local economic impact of trails (PriceWaterhouseCoopers 2004) (Rivers, Trails & Conservation Assistance Program 1995) have important implications for rural economies as they indicate that passive recreational uses make a significant economic impact without conversion or degradation of the biome.

3.2 Summary

The identification of the many non-use values that relate to nature has come from disciplines such as the health sector, sociology, psychology, geography and others. This field of empirical research is emerging. The process of quantifying and assigning dollar values is hampered by survey costs and the poor fit of most valuation techniques. While compelling data is emerging in terms of the importance of nature to health, and the monetary value of cultural heritage landscapes, also known as working landscapes, the application of these approaches to temperate grasslands is still required.

4. ECOSYSTEM FUNCTIONS PROVIDING INDIRECT USE VALUE

4.1 Indirect Values

When ecosystem functions are destroyed as grasslands are converted, there is a loss of numerous life sustaining ecosystem services. While not a part of the terms of reference for this particular research review, such a review would not be complete if the indirect value provided by ecosystem services was not mentioned.

The first comprehensive attempt to synthesize the global research on valuing ecosystem services in monetary terms was released in 1997 by Robert Costanza et al. A dollar value was assigned to the seventeen ecosystem functions of sixteen biomes. Global grasslands (which included chaparral, steppe, rangeland) ecosystem functions in this landmark study were estimated to be $906 billion US dollars ($906 x 10^9) worth of services per year. While the Costanza team and the data produced received considerable criticism for the absolute numbers and the methodologies used as well as the subsequent application of the data using dollar values per acre for the seventeen ecosystem functions of each biome (Section 6 - Table 2), pragmatically, the values are better than the alternative of assuming that non-use benefits and indirect services have zero value. This seminal work, well described and defended in the New Jersey application of the methodology (Costanza et al. 2006) still remains the accepted basis for assigning a dollar value to ecosystem functions. The dollar figure estimated for the annual value of grassland ecosystem goods and services was known at that that time to be substantially undervalued. It was not complete, nor did it reflect temperate grasslands alone. Due to a lack of available information, no value was assigned to this biome's role in climate regulation, disturbance regulation, water supply, carbon sequestration, nutrient cycling, habitat/refugia, raw materials, genetic resources, or any of the social-cultural values identified in Section 3.0.

With the release in 2004 of The Nature Conservancy and IUCN Assessing the Value of Ecosystem Functions (Pagiola et al.) and in 2005 the Millennium Ecosystem Assessment (MES), the importance of ecosystem functions was fully recognized. The MES reflected the work of over 1,300 scientists worldwide over four years and focused on the concept of ecosystem services and their contribution to human well-being. The MES however, did not generate any new primary knowledge; it added value to existing information by summarizing, interpreting, collating and disseminating. As with the work of Costanza in 1997, temperate grasslands are aggregated within a generic "grasslands" biome that includes savannas and shrubland, tropical and sub-tropical grasslands, and the methodology for estimating value relies heavily on benefits transfer, also known as value transfer, where results from studies conducted in specific regions and other biomes are adapted and assumed to provide valid "best estimates" for grasslands.

While important but incomplete work in valuing ecosystem functions and goods and services in grasslands (but not specifically temperate grasslands) was started by Sala and Paruelo in 1997 and is a part of the climate regulation and gas regulation service valuation for grasslands in the Costanza (1997) and MES data base, it appears that primary research been focused in other biomes (forest, wetlands) not temperate grasslands. The empirical data and valuation gaps identified in Costanza's 1997 compilation have not been refined or remedied. While there has been a rapid and exponential growth in ecosystem valuation research in the past ten years, it is striking to review a listing of research by land cover (Costanza et. al. 2006 - Appendix C) (Kroeger & Manalo 2006 – Table 5.1) and economic valuation literature (Defenders of Wildlife Conservation Economics Program October 2008) and see how little research has been conducted for grasslands in relation to other biomes, let alone temperate grasslands.

Assigning value to temperate grassland ecosystem functions still uses some manipulation of the Costanza (1997) meta-data and on value transfers. Hundreds of ecosystem service projects are underway around the world (Yuan-Ferrell & Kareiva 2006) using some adaptation of this methodology. Scaled to a dollar per acre (hectare), it forms the basis for calculating annual ecosystem value (ESV) flows for New Jersey USA (Costanza 2006), Poyang Lake Basin China (Yang 2008) and Southern Ontario Canada (Wilson 2008). The work of Costanza in New Jersey (2006) provides an annual ESV flows from grasslands/ rangelands of $12[8] - $ 77 per acre (in 2004 US$/acre/yr). These values were the lowest annual ESV flow values for the twelve marine and terrestrial land covers studied. For comparative purposes, ESV flows from freshwater wetlands ESV flows were $ 8,695- $ 11,568. In updating the 1997 data base for this study, Costanza identified research data gaps (Type A peer reviewed studies) for grasslands as: disturbance regulation, water regulation, water supply, nutrient cycling, waste treatment, pollination, biological control, habitat-refugia, and cultural-spiritual. The range of values for economic use, non-use and indirect use values as developed by Costanza and used or modified by Wilson are provided in Section 6 - Table 2.

One other temperate grassland ecosystem services valuation study (Bean 2004) for a prairie reserve in Merrimac, Wisconsin based the value of annual ESV flows on value transfer from wetland information and carbon sequestration dollar values offered at the Chicago Climate Exchange. The Merrimac WI annual grassland ecosystem value was estimated to be $142.5 per hectare ($ 57.69/acre), which is within the range of grassland values estimated by Costanza.

The use of NPP (Net Primary Productivity) data, which measures the total amount of plant growth and is considered indicative of the health of existing vegetation has been considered a proxy for total ecosystem value. The work of Scurlock (2002) in 31 grassland sites (half being temperate) could contribute to this understanding if monetized. Recent temperate grassland specific research advances have been made in carbon sequestration (Soussana et al. 2004; Rees et al 2005; Jones et al. 2006). Clearly this new research has been driven by the urgency of climate change. Given its importance, a listing of recent research on grasslands water regulation and climate change has been listed in Appendix C and D.

4.2 Summary

There continues to be a reliance on monetary figures estimated from value transfer of global data sets. Projects around the world have applied these global figures into values of regional ecosystem goods and services using adaptations of Costanza's 1997 ESV flows or by using other methodologies such as open-ended contingent valuation (Alvarez-Farizo 1999). In the absence of more refined data, these values or versions of them (Chan 2006) are still useful. They have been used extensively in land use and policy decisions as well as in designing conservation incentive and restoration projects (Slootweg & vanBeurkering 2008); however the refining of data sets for temperate grasslands should be a priority as the economic value of many ecosystem functions is highly location specific (Salzman & Ruhl 2000) (Kroeger & Casey 2007).

While the role of ecosystem goods and services from temperate grasslands has long been identified as important, and social and cultural non-use values have also been identified and recognized as having value, quantitative valuation of such services has not received the degree of attention that less imperiled biomes have received.

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 practices at the farm unit, to managing for amenity and cultural heritage values at the landscape level. This comprehensive geographic view and multi value approach should be followed. Lemaire (2005) and Herrick *et al*. (2007) provide useful perspectives on grassland research.

Methodologies such as developed by Stephens *et al*. (2008) that use satellite imagery and logistic regression models to predict temperate grassland conversion and degree of threat to the most biologically valuable grassland areas will be useful for assisting in prioritizing geographically. The need to meet the challenges of climate change and water regulation and supply will be a future research imperative (Appendix C, D). A number of research opportunities that have been identified through this review process that appear to have a high potential for aiding in the biome's conservation have been highlighted below.

5.1 Ecoregion-Landscape Level Research – A Case Study Approach

Site specific and ecoregion landscape level case by case research not only helps contribute to understanding the value of a intact natural area within a specific cultural context, but the results, if applied, move the conservation agenda forward. While there are many case studies globally that should be evaluated, several potential case studies have been identified in this review that could provide policy direction for conservation initiatives and templates for methodology transfer.

5.1.1 The Arthur County Conservation Trust (Nebraska)

A potentially useful proposed multidisciplinary research project has been sketched out by Sutton *et al*. (2005) in *The Economic Benefits of Grassland Protected Areas*. Described but not fully valued is a hypothetical Arthur Conservation Trust (Nebraska) outlined in "Buying Arthur County". This proposal would transform, over time, 400,000 acres of the county from working ranches into a prairie reserve. Sketching out the costs and benefits, a compelling case is made in terms of the residents of Arthur County being better off economically with the acquisition of this land and its gradual transformation from a grazing landscape into a world class prairie wildlife and recreation area. A detailed business case is required that fully values all net economic social and cultural aspects of such a proposal, assesses value to improved ecosystem services, uses biome specific visitor spending, and fully assesses the fiscal implications to the county. Such a case study would provide a much needed template for this type of conservation approach.

5.1.2 Understanding the Public Subsidy System of Grassland Grazing (USA)

The United States Department of the Interior's Bureau of Land Management and the U.S. Department of Agriculture's Forest Service manage livestock grazing on almost 235 million acres. The United States Government Accountability Office in *Livestock Grazing* (2005) indicated extensive subsidization of rangeland grazing. Broadening the scope of this budgetary analysis as suggested by the report and including as well the impact on ecosystem services of current grazing systems vis-à-vis sustainable landscape management that protects biodiversity would provide an important perspective on temperate grassland working landscapes. Such an approach would benefit from the research of Wuerthner and Matteson (2002) and the conceptual frameworks of Maczko & Hidinger L. (eds) (2008) *Sustainable Rangelands Ecosystem Goods and Services,* but should provide the quantitative and monetary data missing in the Maczko & Hidinger (2008) report.

5.1.3 One Earth Farms Corporation (Canada)

On March 26, 2009 a partnership between a corporate investor (Sprott Resources) and seventeen First Nations groups from the Canadian prairies was announced that would affect one million acres in the Great Plains. Under the plan, the First Nations will lease their land at market value to One Earth Farms Corporation for agricultural uses, principally cattle ranching, grain and oilseed cultivation. A potential research opportunity exists by proposing an expansion of the corporate Business Plan to include an analysis of the return on investment using full cost accounting of agricultural operations vis-à-vis natural grassland retention/restoration with native ruminants, or varying combinations of agricultural conversion and natural grasslands. A full cost analysis may confirm the analysis of Balmford (2002) and potentially provide different land management options for the partners.

5.1.4 "Cost of Community Studies"

The fragmentation and sale of rangelands and grasslands for residential uses in the United States has been documented by Conner *et al*. (2002) and Stephens *et al*.(2008). A growing consumer interest in rural "ranchette" development has widespread implications on maintaining natural prairie grasslands in North America. Cost of Community Services (COCS) studies by such organizations as the American Farmland Trust (2001) and Paul Anton (2005) show large lot rural residential development requires more expenditure for services than it generates in revenue for county governments. On average, farms use 37 cents worth of services for every dollar of revenue contributed; while rural residential development receives $1.15 in government services for every tax dollar contributed. In one service alone, firefighting, the U.S. Government has calculated that this type of development in rural wild lands has caused firefighting costs to triple since 2000 (Maczko & Hidinger (2008), now costing in the U.S.A. over $ 3 billion annually. Such public finance full cost accounting provides the information that planners and decision makers need in order to understand the costs inherent in converting grasslands to housing. COCS research can provide a strong argument for the conservation of working landscapes and natural grasslands without the need for any further detailed valuation efforts.

5.2 Social, Cultural Heritage Valuation Research

Given the difficulty in transferring from one geographic area to another, social, cultural heritage valuation research, regional empirical studies are required at a regional geographic level. Empirical data is required for grassland goods and services including the harvest value of indigenous animals and plants, genetic resources, pharmaceutical and future medicinal uses of grasslands, natural grassland-based tourism and the value of grazing of native ruminants and subsistence livestock grazing. The reports of the World Initiative on Sustainable Pastoralism (Hatfield & Davies 2006; Rodriguez 2008) identify numerous by-products from grasslands and highlight the lack of data required for valuation of these products. The absence of use value for such products is then implicated in decisions taken about land use that result in loss or degradation of the ecosystem and way of life. An extensive research agenda is provided by the WISP reports, much of which is related to obtaining empirical quantitative data to enable

a total economic value to be developed for pastoral societies. When something has a known value, it is more likely to be respected and cared for or compensated for. Research methodologies have been developed and applied in other biomes, but not to natural temperate grassland regions.

5.3 Ecosystem Goods and Services Research

The collection of primary biophysical data about ecosystem functions, status and processes at the ecoregion and site level is time-consuming and costly. This may reflect why the broad range of ecosystem functions and services identified as research gaps in the Costanza *et al*.1997 review, still remain and the monetary values of ecosystem goods and services established by Costanza depending as they do on meta-data, or value transfer from other areas have not been refined.

Land-use decision-making, national accounting and a growing reliance on market based incentives (MBI) to encourage private landowners to supply ecosystem services from their working lands makes it necessary to complete our understanding of the value of temperate grassland service benefits. Research data gaps in the quantification and valuing of ecosystem services continue in the areas of disturbance regulation, water regulation, water supply, nutrient cycling, waste treatment, pollination, biological control, habitat-refugia (Section 6 - Table 2).

Data collection that is specific to temperate grasslands ecosystem services is urgently needed. However the time and costs associated with such valuation studies also have to be weighed. Full information is not always needed to provide relevant information for decision making. Many conservation tools and market based incentives (MBI) are more effectively based, not on empirical quantified units of measurement of non-use and indirect use ecosystem service value flows, but on business valuation techniques (Appendix A) such as discounted net income streams, FMV and other options such as willingness to pay, replacement costs, avoided costs.

Conservation programs based on primary research that quantifies the real value of ecosystem services being conserved is an ideal and many projects attempt to take this approach (Yuan-Farrell & Kareiva 2006); recognizing that such values exist and using valuation methodologies whether they are based on transfer value analysis, willingness to accept payments or willingness to pay are useful in that understanding the economics is the basis for making the case for conservation in today's market driven society (de Brun 2007). Confidence in such an approach to conservation can stem from the results of Balmford's (2002) review of case research valuing four remaining intact ecosystems for which there was full valuation data (which did not include temperate grassland ecosystems due to research gaps): in every case, the loss of non-marketed services outweighs the marketed benefits of conversion, often by at least 100:1. Across the four biomes for which there was useable data, total economic value after conversion was half the value of those estimated for the relatively intact system. The implication of this observation in conservation policy work is that no public governance system can afford to pay landowners the full value of ecosystem functions in order to maintain them, but they should know what those values are for they place into perspective any regulatory or market based compensation program to landowners for not converting the biome. Income foregone becomes a valid and relatively inexpensive alternative. It also is easier to calculate.

Recent advances in web accessible GIS value-transfer modeling such as the EcoValue Project, which estimates economic value of ecosystem services (M.A. Wilson *et al*. 2004, 2005) appears a promising tool for decision makers. However, it still functions in the absence of temperate grassland specific data. A recently announced cooperative initiative between The Research Ranch Foundation and the Sonoran Institute (Oesterkamp & Marlow 2008) dedicated to the study of the value of native grasslands ecosystem services may provide some important new data. Meanwhile, in using the ESV flows in conservation initiatives, the benefits and costs of having more refined monetary values of temperate grassland ecosystem services will need to be weighed. It may be that in comparing land use alternatives, simply the recognition of value and relative values, or using global estimates by biome provides enough information for decision making.

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), Frame (2002), Gauthier (2003), Goldman (2007), Henwood (2006, 2008), Hodgson (2005), Hopkins (2006), Kirkman (2006), Kroeger & Casey(2007), Mark (2003), Sutton (2005), Swinton (2007). Agencies such as the United States Department of Agriculture Economic Research Service, the United States Environmental Protection Agency's National Centre for Environmental Research, groups such as The Grassland Foundation, Trust for Public Land, the Conservation Economics Program of the Defenders of Wildlife and web based sites such as the Katoomba Group and their www.ecosystemmarketplace.com have focused on such research and compiling databases in the field. The development and application of distinct conservation tools has to reflect the social and cultural reality of the geographically diverse temperate grassland systems. A few examples of such regulatory and MBI conservation tools include:

- **Australia** - the National Action Plan for Salinity and Water Quality National MBI Pilot Programme www.napswq.gov.au/mbi; the Plains Tender MBI & Bush Tender MBI (Stoneham et al. 2003)
- **Germany** (Lower Saxony) agri-environmental subsidies paid to preserve species rich grassland sites (Wittig 2006)
- **Canada** - The Alternative Land Use Services (ALUS) is an ecological goods and services government subsidy program in Canada that pays farmers for conserving and restoring ecosystem functions. http://www.deltawaterfowl.org/alus/index.php

The implementation of such conservation tools relies heavily on the public (and private landowner) recognition, understanding and acceptance of the economic value of intact biomes from a qualitative perspective rather than in quantitative terms. It is now well recognized that conservation programs could benefit from a more solid foundation in empirical valuation research (Jack, Kousky & Sims 2008).

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.

Table 2: Summary Table of Total Economic Values for Intact Temperate Grasslands

Temperate Grassland as a sustainable economic resource with Direct Use Value	**$ / ha. /year ***	***Location / Source of data*** **L: lowest value estimates** **M: medium** **H: highest value estimates**
Rangelands	$ 00.22	(*U.S.A.*) US.GAO (2005) based on 2004 animal fees only
pastoralism	$ 19.50	(*Afar, Ethiopia*) Hatfield & Davies (2006) livestock only (tropical grassland example)
bio-medical; genetic resources	n.a	
grass, grassland by-products	n.a.	(*Nebraska* 2001) U.S.Fish & Wildlife Service (state av.)
recreation (hunting & fishing)	$ 17.22	
Social, cultural goods and services with Non-use Value		
Health	n.a.	
Aesthetic / Recreation	H: $ 3.00 L: $ 0.40	H:(*global / Ontario, Canada*)Wilson (2008) Table 12:based on Costanza (2006) L: *(global/New Jersey, USA*) Costanza (2006); Boxall(1995); Alvarez-Fariza(1999)
Spiritual	n.a.	
Inspirational	n.a.	
Social-Psychological values	n.a.	
Cultural heritage	n.a.	
Scientific – educational; TEK	n.a.	
Recreation (wildlife watching)	L:$ 6.50 M:$ 22.22 H:$117.	L:(*Nebraska* 2001) U.S.Fish &Wildlife Service (state av.) M:(*Colorado* 2001) U.S.Fish & Wildlife Service (state av.) H: (*S.Dakota* 1999) Dennis Propst*, et. al.*(2000) Economic Impacts of Badlands National Park Visitor Spending in Local Economy from Sutton (2005)
Ecosystem functions and corresponding goods and services that have Indirect Use Value		
Air Quality-Atmospheric Stabilization	$ 12.00	(*global*)Wilson (2008) Table 12: based on a global average from Costanza (1997)
Climate Regulation (stored carbon)	$ 213.00	(*Canada*)Wilson (2008) Table 12: carbon storage is estimated at 105 tonnes/ha. based on Smith, Desjardins, Grant, (2001). Carbon value is calculated using the average damage cost of carbon emissions reported by the Intergovernmental Panel on Climate Change ($52/tC) with the total value of $5,460 /ha. being converted to an annual value using a 20-year annuity investment formula; Sala & Paruelo (1997)
Climate Regulation (annual carbon uptake)	$ 28.46	(*Canada*)Wilson (2008) Table 12: based on Smith, Desjardins, Grant (2001) "Estimated changes in soil carbon associated with agricultural practices in Canada." *Canadian Journal of Soil Science*. 81:221-227;
Disturbance Avoidance	n.a.	
Water Regulation (Runoff Control)	H: $ 7. L: $ 4.90	H: (*global*)Wilson (2008) Table 12: based on Costanza (2006) L:(global/*New Jersey*)Costanza (2006)

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 (2006)
Natural Regeneration	n.a.	
Biological Control	H: $ 40. L:$ 29.65	H: (*global*)Wilson (2008) Table 12: based on Costanza (2006) L: (*global/New Jersey*)Costanza (2006)
Habitat/Refugia	n.a.	
Total per ha. in $/ha./yr ***** Costanza (2006)–US Dollars (2004) ***** Wilson (2008) - Canadian Dollars (2005)	H:$1,618. L:$ 190.27	H:Wilson (2008) L:Costanza (2006)

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 assuming that non-use benefits and indirect services have zero value. In the absence of regionally specific research this methodology is used extensively. However, as many decisions on environmental policy and land use are made at the local level, research to be effective, needs to keep this end in focus and reflect the socio-economic context in which and for whom decisions will be made.
- The work of experts from separate disciplines is too one-dimensional to be useful in solving today's issues. The complexity in understanding all use and non-use values, quantifying the goods and services provide by an intact biome or working landscape, requires an inter-disciplinary research approach. The problem being studied needs to determine the appropriate tools and research expertise.

The imperative that should drive all research and focus priorities is the extent to which the research directly advances the protection of those temperate grasslands identified as most under threat.

APPENDICES

APPENDIX A: VALUATION METHODOLOGIES AND DEFINITION OF TERMS

Understanding the role and value of temperate grasslands in our society requires a far more comprehensive analysis than this biome has received to date. Consideration must be given not just to the full benefits and costs associated with our individual "consumptive uses" that require the conversion of the biome and thus its destruction or degradation, but also to the broader individual and societal costs related to losing the values inherent in an intact ecosystem. Use values are derived from the welfare that a particular commodity provides through its service, now or in the future. Non-use values are derived from the benefits present generations may obtain and also because they know that future generations will also enjoy the goods or service (known in the lexicon as "bequest value"). Benefit often is obtained by people from the knowledge of the very existence of the commodity ("existence value"). Existence values are difficult to fit into the utilitarian framework of human well-being, but there does need to be recognition that some consider the intrinsic worth of something to have value irrespective of what other human beings, perhaps the majority, think[11]. The history of valuation techniques for assessing goods and services that do not pass through the market place (use and non-use values) and the emergence in our understanding of Total Economic Valued is well summarized by Costanza, Wilson, Troy *et al*.(2006 Appendix A).

All valuations are based in part on one of the following traditional approaches:

- Cost Approaches e.g. historical cost or replacement cost
- Market Approach e.g. comparable market value or comparable royalty value
- Income Approach e.g. net earnings/cash flow, brand contribution or royalty

When the purpose of valuation is clearly set, the first step of the procedure is choosing an appropriate analysis tool. The techniques developed to assign monetary value to goods and services not priced in our current economic system are as follows:

- **Avoided Cost (AC):** Value based on the cost of services that do not need to be provided because the alternative was avoided. For example, riparian set-back requirements can avoid the costs of bank stabilization and barriers that would be needed as a flood control measure to reduce property damage along a river.

- **Business valuation approach**: Understanding the concept of **Opportunity Cost** is critical in understanding "value" in decision making. The opportunity cost to a property-business owner is income foregone by not using their investment (land) in an alternative way. This concept only has meaning if we are able to understand and calculate those alternate income opportunities and a variety of business valuation methodologies and land appraisal methodologies have been developed to quantify value. The most useful include calculating the potential **discounted net income streams** possible from the property, using a **capitalization of income** method, and undertaking **FMV ("Fair Market Value") land appraisal** as established by comparable real estate sales or business sales. Thus the value of natural ecosystem protection expressed as the opportunity cost to the landowner, can be calculated by quantifying in today's values, the expected future net income streams foregone by the landowner not using his property in that alternative "highest and best" consumptive use permitted by the current regulatory (planning) regime (agricultural, subdivision).

- **Contingent Valuation (CV):** A method used to estimate the value of a good or service by simply asking people about it. The method rests on the hypothetical market behaviour of people. Hypothetical land use scenarios are posed in surveys using alternatives that may potentially affect those surveyed. This method is often used for valuing less tangible services like wildlife habitat or biodiversity.

- **Hedonic Pricing (HP):** The difference in value reflected in the prices people will pay for similar properties that may have different environmental amenities. For example, property values abutting a natural area tend to exceed the prices of identical homes located within the plan of subdivision.

- **Replacement Cost (RC):** This approach estimates the cost of replacing a good or service. The method may estimate cost of restoring the ecosystem so that it again provides the service; an approach that may be limited by what people are willing to spend to restore the environment to the pre-damaged state (Cole 2005). Value can be assigned as well by calculating the cost of obtaining the same service in another way. Often only after the ecosystem has been destroyed or damaged and the effects have to be mitigated by public expenditures through costly engineering solutions does a full understanding of "replacement value" as a valuation methodology emerge. The courts have been more receptive to evidence based on restoration costs than evidence based on other types of valuation studies (Thompson 2002). Valuation methodologies that tend to focus on "replacement value" however, need to be adapted to the specifics of an ecosystem. Different services require different approaches and the geographic transferability of values derived in one specific location to another may have severe limitations. In some situations the value of an ecosystem service is calculated by using the cost of replacing it with human-made (engineering) systems: for example, the cost of hand pollinating crops in the absence of biotic pollinators, or the cost of engineered water purification in lieu of natural filtering systems. Field research of grassland ecosystem restoration work is only now beginning to give insights into site specific replacement value data (Sutherland 2002; Van Dyke 2004; Prober & Thiele 2005).

- **Travel Cost (TC):** A method to estimate value which is based on the observed time and money people are willing to spend to travel to a site.

- **Value (or benefits) transfer:** Is a simple and accepted economic methodology where values are adapted from other study areas. An estimate for the economic value of non-market goods or services through the analysis of a single study, or group of studies, that have been previously carried out is used to value similar goods or services in other study areas. The 'transfer' itself, refers to the application of economic values and other information from the original 'study site' (i.e. tropical grasslands) to an alternate, but potentially comparable site (i.e. temperate grasslands). Does the application of global averages for the value of grassland ecosystem functions developed by Costanza *et al*. (1997)(2006) to temperate grasslands in Ontario (Wilson 2008) provide defensible figures for that region? Can an estimate of the benefits of ecotourism in one park be used to estimate the benefit of a different park in a different location? The methodology is inexpensive and relatively valid under certain conditions: the obvious being that the commodity or service being valued should be similar at the site where the original research was undertaken to the site where the research results are being applied, and the population characteristics in both locales are similar[12].

- **Willingness to Accept (WTA):** Willingness to accept compensation, or how much an individual is willing to pay to compensate a welfare loss or forgo a welfare increase. This value, which may be based on the individual producer's perceived opportunity costs, is important in subsidized conservation and restoration programs of ecosystems. The method has been used to stop biodiversity losses in agricultural landscapes (Abensperg-Traun & Wrbka 2004).

- **Willingness to Pay (WTP):** How much individuals are willing to pay to secure an increase in their welfare, or to prevent its loss (Stoneham 2005). People tend to over-perceive the value of losses and under-perceive the value of gains, which is why there is often a great disparity between WTA and WTP[13]

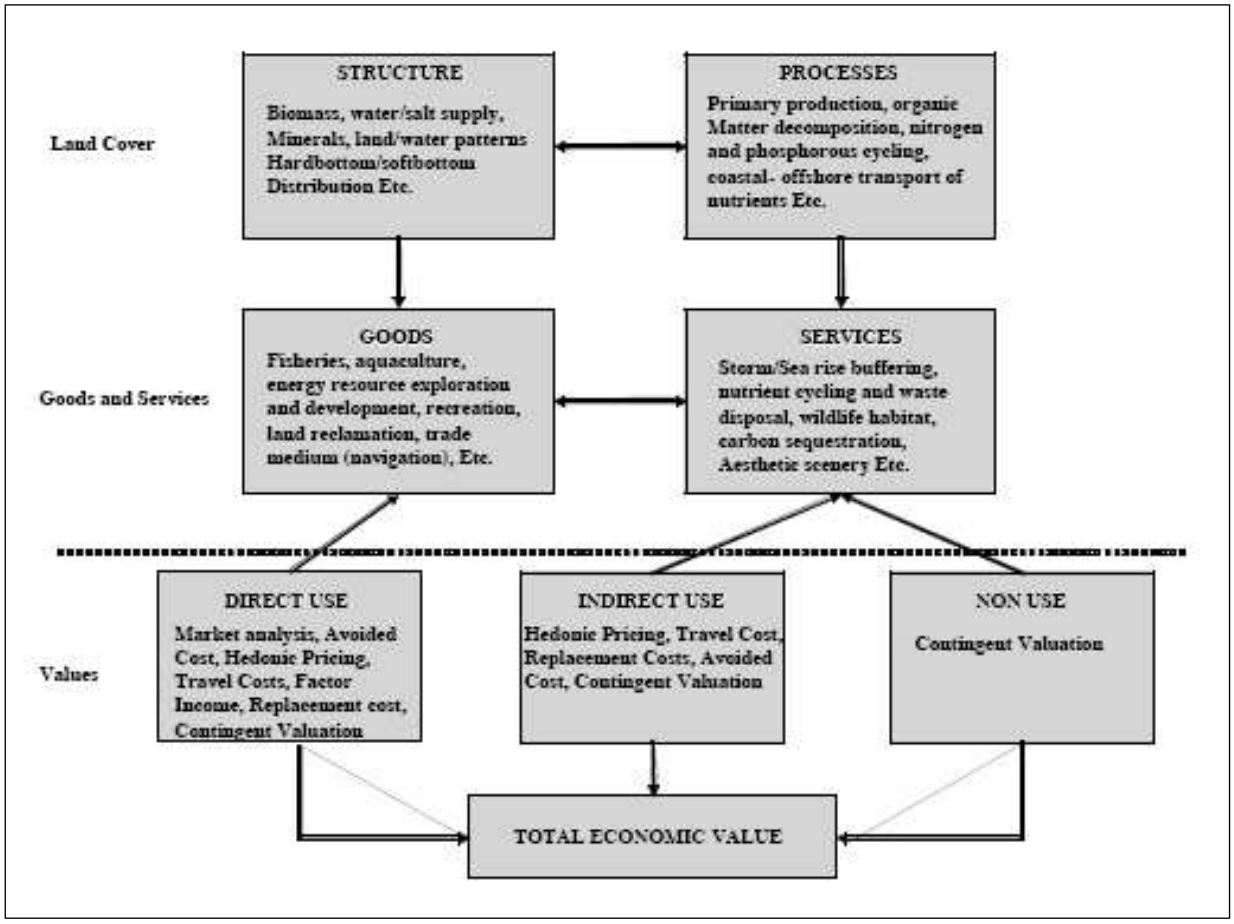


Figure 2: Total Economic Value of Ecosystem Functions, Goods and Services

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

APPENDIX B: GLOBAL CASE STUDIES

- **China**: Dong S. *et al*. (2007). "Economic Benefits of local Grasslands"; Nan (2005), Guo *et al*. (2006) *The Rangeland Journal* 28(2):97-104 (Grassland degradation and resources in China and the arid Aletai Region in Northern China)

- **Mongolia** (Northern): Zhang *et al*. (2007) A description of Mongolian nomadic culture and its advantages over agrarian culture in terms of ecology and environmental care, sustainable utilization of grasslands and social economic development in the region. See also Kris Havstad 2008 with Herrick and Tseelei, www.frontiersinecology.org (The Ecological Society of America)

- **North America,** U.S.A. Chariton Valley, Iowa has through its Conservation Reserve Program attempted to establish a sustainable regional agricultural economy based upon grassland and forages. Research funding was important in supporting activities to develop energy and fibre crop production capabilities and conversion technologies, and market-based incentives and adjustments that recognize the environmental value of grasslands (Sellers 1999).

- **North America,** U.S.A. Nebraska (Sutton T., Ochsner., Lierman S., and Shahan A.. 2005) Conservation objective: to create a system of protected grassland natural areas on the Northern Great Plains based on conservation biology principles.

- **South America** (Contributed by Andrea Michelson)
  The level of understanding and recognition of the socio-economic value of temperate grasslands differs in each of the four South American eco-regions, due to the different services provided, the socio-economic relevance acknowledged by each society and the local and regional research capability. In spite of the growing development of local and national studies in this regard, an integral piece of research that assesses the total value of each eco-region is still lacking. Some studies performed at a broader scale include South American biomes but are not specific of temperate grasslands. For example, t'Mannetje et al. 2008 developed carbon sequestration studies of managed grasslands in Latin America (1).

  The Paramos ecosystem plays a key role in water storage, regulation and provision, and sustains the lives of millions of people in northern South America (2). Governments and societies, at a local and international level, are increasingly recognizing this important function(3). During the last decade much progress has been achieved in assessing economic indirect use values at a local level. For example, a study developed in the Binational Watershed of Catamayo-Chira of Ecuador and Peru, where one of the predominant vegetation types is typical of the paramos; determined an economic value for water services in the range of USD 0,509-0,623/m3 (4). In other areas of lower water retention such as the bofedales of Jimbura in southern Ecuador, an evaluation established a value of hydrological production of USD 0,006 /m3 (5). On the other hand, local governments with support from NGOs have established payment-for-service mechanisms in some important areas or cities such as the Cauca valley in Colombia, and Quito the capital city in Ecuador (6, 7). Another market-based approach recently launched by Ecuador Environmental Ministry at the national level is an incentive-led conservation program that will pay a maximum US 30/ha/year to private owners for the preservation of paramos in their properties (8). Several new projects of compensation, payment-for-service and incentives for paramos conservation are now being launched (9-11).

  High andean wetlands from Bolivia and Peruvian Puna also provide countless services to local communities. For instance Cordillera de Sama in southern Bolivia provides water to Tarija and nearby cities. An evaluation revealed that the total economic and social benefit provided by this service is USD 484,134/year (12).

In Pampas and Campos and in the Patagonia steppe, ecosystem services and functions have been long recognized, especially by the scientific and conservation community (13-17). However, it is not until recently that the economic and social value of this goods and services and the ecological costs of land use transformation are being controversially discussed - especially referring to hydrological functions, carbon storage, nutrient balance, soil protection, agricultural and husbandry management, primary production (18-24). No market-based mechanisms for conservation of grasslands have been applied yet in these two ecoregions.

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- **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.

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APPENDIX F: ENDNOTES

[1] Temperate grasslands definition as provided by the Temperate Grasslands Conservation Initiative: see Peart B.. 2008. *Life in a Working Landscape: Towards a conservation strategy for the World's Temperate Grasslands*. IUCN. Temperate Grasslands Conservation Initiative (IGIC): A Record of The World Temperate Grasslands Conservation Initiative Workshop Hohhot, China, June 28-29, 2008. (Section 2.4 p.8)

[2] Sutton T., Ochsner., Lierman S., and Shahan A.. 2005. "Economic Benefits of Grassland Protected Areas". Grassland Foundation.

[3] Total Economic Value (TEV): Total Economic Value is reported as the sum of use value and non-use values or passive values. Use values can be direct when goods and services are exchanged on the market which reveals their value. Use values that are indirect, refer to the life support services role of the natural environment, which are 'indirectly used'. Option values reflect the value placed on a future ability to use the environment, and thus the potential future benefits of goods and services. Quasi-option value reflects the willingness to avoid irreversible commitment to development now, given the expectation of future growth with knowledge relevant to the implications of development. Non-use values include: existence values, where the benefit results from knowledge that goods and service exist and will continue to exist, independently of any actual or prospective use by the individual; and bequest value, where the benefit is in ensuring that future generations will be able to inherit the same goods and services of the present generation.

[4] The methodology used for this draft report was internet based using the University Library - electronic services – ISI Web of Knowledge under the search words: Grassland + grasses + savannah + prairie + pampas + steppe + rangelands + temperate + nature + biome + dryland + ecosystem + economic + ecological + social + cultural + value + evaluation + service + climate change + carbon + water + pastoral + peoples + region + biodiversity + conservation + well-being + health + benefit + costs. More than two thousand relevant or related general publications, scientific articles, websites and books were accessed which are concerned with valuing nature and temperate grassland goods and services (economic, ecological, social-cultural, intrinsic). General "valuation" publications and grassland-rangeland specific peer-reviewed scientific publications have also been reviewed for empirical data and valuation methodologies.

[5] In the lowland Terai of Nepal, two types of grassland are found, riparian tall-grass floodplains, and wooded grasslands/phantas. The floodplain grasslands, which consist of tall, perennial grasses, are established and maintained by fluvial action and flooding; the wooded grasslands and phantas consist of shorter perennial grass and originated following human intervention (forest clearing, burning, grazing of domestic stock, and cultivation). Parks such as the Royal Bardai National Park, and Royal Shukla Phanta Wildlife Reserve contain many small to moderate-sized grasslands, some interconnected and others scattered throughout the tropical forest.

[6] Reports by Southwick Associates, Inc. in some states provide this type of differentiation:
2003 – Economic Impact Analysis of non-consumptive wildlife-related recreation in Arizona. Report prepared for the Arizona Game and Fish Department, May 2003. 18pp.

2003 – The 2001 Economic Benefits of Watchable Wildlife Recreation in Florida. Report prepared for the Florida Fish and Wildlife Conservation Commission, February 10, 2003. 22pp.

2006 – The economic contribution of active outdoor recreation – technical report on methods and findings. Report prepared for the Outdoor Industry Foundation, July 9, 2006. Fernandina Beach, FL. 85pp.

2007 – Sport fishing in America: An Economic Engine and Conservation Powerhouse. Produced for the American Sport fishing Association, 2007. 11pp; Hunting in America: An Economic Engine and Conservation Powerhouse.

[7] Informal economy: economic activity that is neither taxed nor monitored by a government; and is not included in that government's Gross National Product (GNP). It tends to be diverse, small scale and can include barter and exchange that may or may not involve monetary compensation.

[8] Costanza (2006) a "Type A" figure based on value transfer analysis using only peer-reviewed studies that used conventional environmental economic methods; the second ("Type A-C") monetary result added to this, non-peer reviewed studies, raw data, technical reports as well as secondary (meta) analysis of peer reviewed and non peer reviewed studies-analyses of ecosystem service values that were readily accessible.

[9] MBIs work by providing a framework for a market exchange between buyers of environmental services (such as government agencies, regional NRM bodies or licensed polluters), and willing sellers of these services (such as farmers). Under an MBI framework, 'buyers' of environmental services are provided with a marketplace in which to choose the best value outcomes; land managers (and others) are given a business incentive to become suppliers, or 'sellers' of innovative environmental services.

In this way, MBIs entail the creation, introduction or facilitation of markets where none existed before, or modify the function or use of existing markets to achieve enhanced environmental outcomes. MBIs have been successfully used to: improve existing incentive processes, target intervention by engaging specific land managers, engaging land managers in specific management activities to improve the management of natural resources, gain greater results for less funding.

MBIs can be used to: alter market prices, set caps on the use of resources, improve the way a market works, create a market where one previously did not exist. Examples of MBIs include: conservation tenders or auctions, environmental offsets, cap-and-trade mechanisms MBI principles can also be used with: conservation agreements, tax incentives, grants, subsidies, stewardship payments. For a good survey of MBIs see Kroeger & Casey, 2007

[10] Projects such as the EcoValue Project http://ecovalue.uvm.edu/evp/modules/nz/evp_lulc_definitions.asp#lulc_past run from the University of Vermont, need to be re-configured to recognise *natural* temperate grasslands as a land use cover type. The EcoValue Project currently defines "pasture" as a land use-land cover (LULC) type as "land used for pasture, both permanent and rotated; grass". TGCI should network with national research centres around the globe, including the US. Environmental Protection Agency's National Centre for Environmental Research, The Grassland Foundation, National Audubon Society & Appleton-Whittell Research Ranch (AWRR), Chinese Grassland Society , Canadian Great Plains Research Centre (Regina), CSIRO Division of Wildlife and Rangelands Research, European Grassland Federation, US.Agricultural Research Service (ARS), the Global Change Impacts on Pastures and Rangelands Network, IUCN-WISP, Inner Mongolia Grassland Research Station, the Research Ranch Foundation, the Sonoran Institute, the Gund Institute for Ecological Economics at the University of Vermont, The Nature Conservancy (see listing of global contacts involved ion empirical ESV in Yuan-Farrell & Kareiva 2006), etc. The purpose would be to advocate for elevating natural temperate grasslands as a research priority. Such open access web sites such as the Katoomba Group's Ecosystem Marketplace http://www.ecosystemmarketplace.com/ and the *Trees For Life Journal* http://www.tfljournal.org/ need to be browser friendly for temperate grassland specific information, projects and research.

[11] Callicott, J. Baird. "Intrinsic Value in Nature: a Meta-ethical Analysis." *The Electronic Journal of Analytic Philosophy*. 3 (Spring 1995) provides a perspective on this; while Edward W.Younkins (2004) "The Flawed Doctrine of Nature's Intrinsic Value." *Capitalism & Commerce*. 2(147) (Montreal) argues that environmentalists fail to realize that value means having value to someone who values. To be a value some aspect of nature must be a value to some human being and only people have the capacity to assign and to create value with respect to nonhuman existents.

[12] Environment Canada introduced the 'Environmental Valuation Reference Inventory' (EVRI) in 1993 -1994 as a powerful internet-based tool in the application of the Benefit Transfers approach to environmental decision-making. EVRI is a comprehensive online database of environmental valuation studies. The database is expressly designed to be a facilitating tool for benefit transfers (BT), and is therefore structured according to the steps and procedures involved in the BT method. These are identified as: (a) definition of value to be estimated; (b) literature search; (c) assessment of literature for transfer suitability; (d) assessment of literature for quality and credibility; (e) transfer of benefit estimates. It is asserted that EVRI can help with some of the key challenges of benefit transfers, enhancing the accessibility and accuracy of the method to estimate the value of environmental goods or services without the expense and time required for primary valuation research.

[13] Coursey, D.L. *et al*.1992. "The Disparity Between Willingness to Accept and Willingness to Pay Measures of Value" in Markanda and Richardson. Ch. 7 pp.92-100