RECENT PROGRESS WITH THE CONSERVATION AND PROTECTION OF TEMPERATE INDIGENOUS GRASSLANDS IN NEW ZEALAND

Alan F. Mark[1]

[1]Deputy Project Director, Temperate Grasslands Conservation Initiative; Department of Botany, University of Otago, PO Box 56, Dunedin, New Zealand. alan.mark@otago.ac.nz

ABSTRACT

Progress with conservation of New Zealand's temperate indigenous grasslands, and particularly the rangelands of the South Island rain-shadow region, is described from the first modest reserve in the late 1960s. Early debates centred on serious degradation of many rangeland areas under the pastoral farming practices of periodic burning and associated sheep grazing, but later involved the need for baseline research areas and the protection of indigenous biodiversity and ecosystems. A Government-initiated tenure review process since the mid-1990s is described, whereby farmers volunteer to relinquish the more vulnerable, usually higher elevation and biodiverse, areas of their lease-hold properties in return for free-hold arrangements for the more productive areas. Reviews are ongoing. To date, 82 completed reviews of the 303 properties has resulted in 49 per cent of their 441,188 hectares being formally protected, and an additional 125,792 hectares from five properties purchased by the Government, being designated as conservation land. The current conservation status of the country's four major indigenous grassland types, totaling 15.4 per cent protected, is described in relation to the grassland types and their altitudinal distribution in relation to their baseline areas at the time of European settlement in the early 1840s.

INTRODUCTION

Temperate indigenous grasslands are one of the world's great biomes but are also the most altered, most threatened, and least protected of the earth's major terrestrial biomes (Henwood, 2010). Occupying approximately 8 per cent of the world's terrestrial surface (Figure 1 overleaf), just 5 per cent of this biome is currently within the global system of formally protected areas. Although this has increased from only 0.69 per cent in 2008, it remains the least-protected, major terrestrial biome as reported in the 1993 UN List of Protected Areas (IUCN – WCPA), a fact which led to the creation of IUCN WCPA's Grasslands Protected Areas Task Force (now Specialist Group) in 1996 (IUCN, 1994; Henwood, 1998). Following a decade of slow but steady progress to achieve a reported level of 5 per cent by 2007 (UNEP-WCMC, 2008), the Specialist Group launched the Temperate Grasslands Conservation Initiative (TGCI) in 2008, specifically to address this shortfall in the level of protection for this biome and, as well, to encourage the sustainable use of all temperate indigenous grasslands whether in protected areas or not. The TGCI promotes the many values of these grasslands: cultural, social, economic, environmental and ecological, placing particular emphasis on the valuable and varied ecosystem services they provide.

In preparation for a workshop during the World Parks Congress in Durban, South Africa in 2003, an informal TGCI undertook a global assessment of the status and conservation potential of the world's temperate indigenous grasslands (Henwood, 2004). This work was updated for the launch of the TGCI in 2008 in Hohhot, China and has formed the foundation for the ongoing pursuit of higher levels of protection for this biome (Peart, 2008a; 2008b). This assessment identified four temperate indigenous grassland regions in the world where the potential still exists to conserve extensive grasslands on a landscape scale: the Patagonian steppe, the Kazakh steppe, the Daurian steppe and North America's Northern Great Plains. In addition, the assessment recognized the many other temperate grassland regions that, while not necessarily offering potential at the landscape scale, still possess high conservation values worthy of protection. These included the indigenous grasslands of New Zealand.

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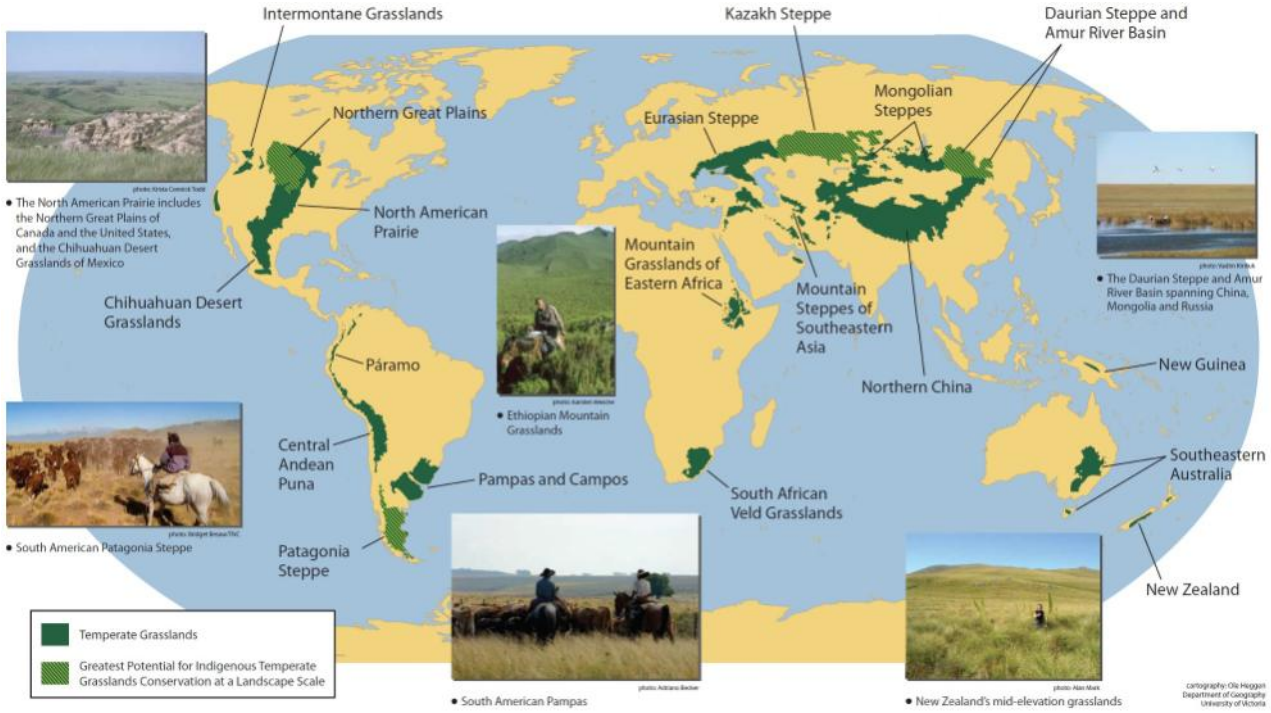

Figure 1. Map of the World's temperate indigenous grasslands; Temperate Grasslands Conservation Initiative (TGCI). Reprinted from TGCI Newsletter No 6, November 2011.

Apart from the low-alpine snow tussock grasslands above the treeline, indigenous grasslands in New Zealand were extensive in the South Island rain-shadow region to the east of the Southern Alps at the time of European settlement in the 1840s (Mark, 1993). In this rain-shadow region, the eastern lower-altitude areas were soon mostly developed for agriculture while the extensive, interior, more mountainous regions, with a semi-continental climate, were largely retained under Government ownership and leased in relatively large units for extensive sheep grazing, with pastoral farming. These extensively grazed indigenous grasslands are generally referred to, here and elsewhere, as rangeland. Subjected to periodic burning and a new phenomenon, mammalian grazing, land degradation was soon recognized as a serious threat to the sustainable management of these grasslands. This issue has been addressed in various ways, mostly with limited success, up to the present (Mark, 1994). The more remote indigenous tussock grasslands, along and west of the Southern Alps and on the North Island volcanic and other high mountains, were largely protected as conservation lands but were subjected to grazing, often severe, by a range of feral animals, mostly red deer (*Cervus elaphus*), introduced for recreational hunting (Mark, 1993; Mark & Dickinson, 1997).

Having initiated the protection of indigenous tussock grasslands within the New Zealand rangelands in the mid 1960s, for both baseline research and their heritage values, in 2003 the author was requested by the TGCI to make an assessment of the conservation status of New Zealand's indigenous grasslands. This was undertaken with the assistance of several colleagues and two Government departments. The Ministry of Agriculture made available their recently compiled Land Cover Data Base 1, while the Department of Conservation provided the records and maps of the country's formally protected areas.

METHODOLOGY

Using a baseline of 1840, the time of European settlement in New Zealand, four colleagues assisted with assessment of the areal extent throughout New Zealand of the five major types of indigenous grassland: lowland sward grassland, montane-subalpine short tussock (*Festuca novae-zelandiae*) grassland, montane-subalpine tall snow tussock (*Chionochloa rigida*) grassland, montane-subalpine tall red/copper (*C. rubra*) tussock grassland and low-alpine tall snow tussock (C. spp.) grassland (Mark, 1993; Mark & Dickinson, 1997), as well as high-alpine (non-grassland) communities and permanent ice and snow of the nival zone.

The role of pre-European Maori settlers from about the mid-13th century in extending the grasslands through burning, particularly in the South Island rain-shadow region east of the Southern Alps, was accepted as part of the baseline since the species involved were indigenous. Moreover, the situation in New Zealand differed from

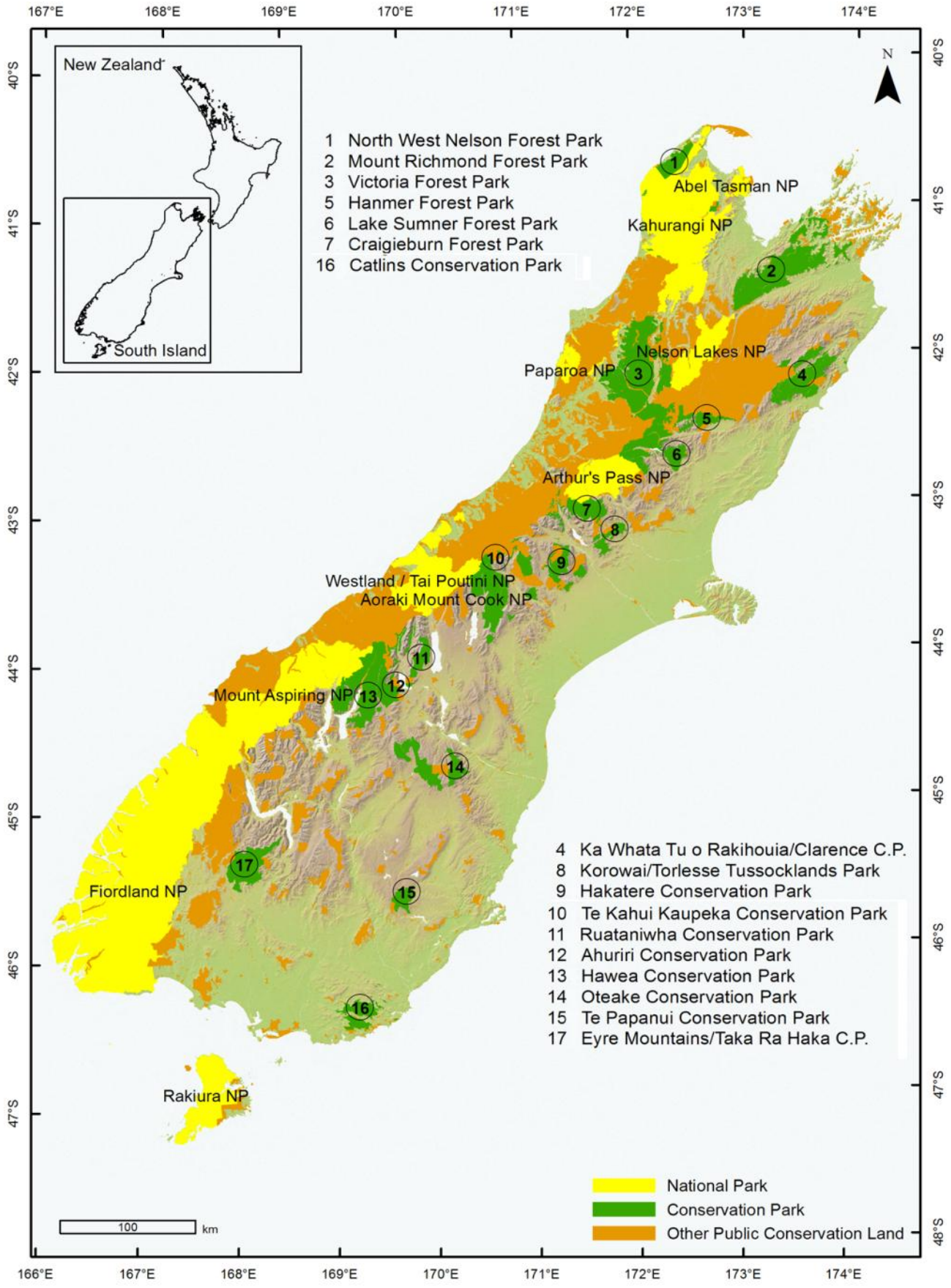

Figure 2. Map of New Zealand's South Island, showing the ten tussockland conservation parks in the rain-shadow region of the Southern Alps (key in lower right), as well as the seven largely forested parks (key in upper left), the eight national parks (named) and other conservation lands. Map supplied by the Department of Conservation.

View south-east across the crest of the Hawkdun Range, 1600-1870 m, northern Central Otago on greywacke parent material, showing low-alpine slim snow tussock (*Chionochloa macra*) grassland in good condition (foreground), eroding grassland beyond (mid-distance) and high-alpine fellfield and snowbanks on the highest slopes (distant) © Alan Mark, January, 2007

other countries only in the recent nature of its human occupation. The methods used are described in detail in Mark and McLennan (2005). The 1:50,000 scale paper maps we produced were digitized and the boundaries computed with ArcGIS, using elevation data obtained from the New Zealand topographic database. The 'tussock' category included in the Land Cover Data Base Version One (LCDB 1), derived from 1996-7 satellite imagery, was extracted to a separate ArcGIS layer, which was used to 'clip' to a copy of the baseline layer, to provide the current extent of the five major grassland types.

Both the baseline and current cover maps were analyzed on the basis of a map of biogeographically-based ecological regions (ERs), of which 60 of the 79 ERs for the three main islands were presumed to have contained indigenous grassland at the time of European settlement. The ecological region data were also grouped into four major geographic regions on the basis of the general pattern of land use and indigenous grassland exploitation. The North Island (114,740 km^2) was treated as one unit of 19 ecological regions because of the relatively small extent of indigenous grasslands. The South Island (151,120 km^2), however, was split three ways: the extensive rangelands in the central rain-shadow region, east of the Southern Alps (19 ERs) which occupies about 10 per cent of the country's land area, the western generally wet mountainous region (10 ERs) which had been largely protected as national parks and other conservation lands, and the eastern lowlands and lower hills which had been mostly developed for agriculture, plus Stewart Island (12 ERs) (see Figure 2).

The South Island rangelands had long caused concern because of the serious degradation under the pastoral farming practices of periodic burning, which the indigenous grasslands clearly tolerated, and associated sheep grazing. These grasslands showed an obvious intolerance to mammalian, mostly sheep, grazing, particularly in the post-fire recovery period. This was attributed to such grazing, combined with burning, being a new phenomenon in a land without indigenous terrestrial mammals, apart from two species of bat (Mark, 1993; 1994). The need for baseline research areas and protection of the indigenous biodiversity and ecosystems was also promoted (Mark, 1985) and, following later research, also the value of upland tall snow tussock grasslands, for maximizing water production (Mark & Dickinson, 2008).

Table 1. Assumed baseline (1840) extent of the four major indigenous tussock grassland types in New Zealand at 1840 (the fifth, sward grassland was minor, ~2%, and is not included here), based on each of the 60 mainland ecological regions (out of the 79 total ERs) (T), which are assumed to have contained indigenous grassland (G) at the time of European settlement in 1840. These have been grouped into four major geographic regions. The percentage of each type remaining in 2002 (%R), and the percentages of the latter which were formally protected in September 2002 (%P '02) and in December 2007 (%P '07), are also shown.

Geographic Region	Km²	ERs (G/T)	GRASSLAND TYPE: Low-alpine tall snow tussock				Montane-subalpine tall snow tussock			
			Area (ha)	%R	%P '02	%P '07	Area (ha)	%R	%P '02	%P '07
North Island total	57,141	19/38	4,292	100	82	82	32,598	100	72	73
South Island western non-rangeland total	57,925	10/10	391,127	100	95	96	278,219	100	94	95
South Island eastern non-rangeland total	28,502	12/12	443	100	64	64	11,717	29	49	49
South Island rangeland total	66,499	19/19	697,352	96	27	40	1,197,842	81	12	21
TOTAL	**210,068**	**60/79**	**1,093,214**	**98**	**52**	**61**	**1,520,376**	**84**	**31**	**39**

Geographic Region	GRASSLAND TYPE: Montane-subalpine tall red/copper tussock				Montane-subalpine short tussock			
	Area (ha)	%R	%P '02	%P '07	Area (ha)	%R	%P '02	%P '07
North Island total	231,446	45	27	27	419,177	1	65	65
South Island western non-rangeland total	60,673	19	88	93	7,253	100	7	7
South Island eastern non-rangeland total	696,672	1	18	24	1,210,354	4	1	2
South Island rangeland total	883,066	28	8	15	1,950,338	42	3	5
TOTAL	**1,871,856**	**20**	**16**	**21**	**3,587,121**	**25**	**3**	**5**

Separate summaries were derived for each of the four major regions, with the rangeland region being of particular interest since, up until the late 1960s, no areas had been formally protected. The indigenous grasslands of this region had been entirely allocated to extensive pastoral farming as rangeland.

RESULTS

Apart from the first reserve, a modest 660 ha area protected in 1969, which involved a relinquished leasehold property plus contributions from two neighbouring farmers, there was considerable farmer and political opposition to the formal protection of rangeland. This was despite the need for baseline research areas to assess the cause(s) of widespread degradation, which had been of general concern to the Government as land owners and the overseeing regional authorities, as well as the farmers, for many decades (Mark, 1993; 1994). Support, however, gradually came from several quarters, notably the Government's Ombudsman, who was prevailed upon to investigate a bid by nine grassland ecologists for a 1000 ha baseline research area, which had been rejected by the Lands Department. This rejection followed an environmental impact assessment that had recognized the conservation values and research potential of the Nardoo catchment which the Ombudsman's report recognized (Mark, 1982). This report had recommended that: "*the area should be retained as a reserve for a limited period ... and subject to review in 15 years time.*" It also stated that: "*persuasive arguments have been advanced for designating ... a scientific reserve. The proposal has received a great deal of support from scientists of all the relevant disciplines. .... I am aware that tussock grasslands are seriously under-represented in the reserves system.*" (Mark, 1982).

The situation subsequently improved, particularly through a tenure review process initiated by the Government in the mid 1990s, as a means of addressing

*Montane short tussock (***Festuca novae-zelandiae***) grassland at the ~1000 ha Tekapo Scientific Reserve, Mackenzie Basin, inland South Canterbury. This reserve, on an extensive fluvio-glacial outwash plain, has had sheep removed and rabbits controlled for 20 years and is showing clear signs of restoration. October, 2011 © Alan Mark, January, 2007*

environmental degradation of the rangelands, as well as saving on its costs of administering the 303 rangeland leases (which exceeded its income from the rentals). Initiated by a lessee farmer, the tenure review process involves a renegotiation of the lease to separate the more productive, usually highly modified, lower altitude areas from the more vulnerable, usually less modified, higher elevation lands. These latter areas usually had significant inherent (landscape, indigenous biodiversity, soil and water conservation, recreational, etc.) values. These lands would revert to full Crown (i.e. Government) control and management (by the Department of Conservation), while the more productive lands could be made free-hold. In addition to tenure review, the Government also purchased the lease-hold interests of five high country rangeland properties, amounting to 125,792 ha, to be managed for their conservation values.

The situation as at Sept. 2002 was analyzed (for the Durban TGCI workshop) and indicated that some 12.3 per cent of the original country-wide indigenous grassland baseline (1840) area was formally protected but only 9.1 per cent of the rangeland portion (Mark and McLennan, 2005; see Table 1). Within the rangelands, the four major grassland types varied considerably (the fifth type, sward grassland, not a rangeland type, had been minor, ~2 per cent overall), both in the proportion still remaining and also in the degree of protection. For the low-alpine tall snow tussock grassland, some 96 per cent of the baseline area remained, inevitably modified to varying degrees through 150 years of pastoralism, and 27 per cent of this remaining area was formally protected in 2002. By contrast, only 42 per cent of the montane-subalpine short tussock grassland (see picture above) remained, inevitably modified, but only 3 per cent of this remaining area was formally protected at this time. Of the other two grassland types, the montane-subalpine tall snow tussock type (see photos above), with 12 per cent of the baseline area protected, had fared better than the tall red/copper tussock type, which occupies more gentle slopes, often able to be cultivated (8 per cent). The same pattern prevailed for the country as a whole (Mark & McLennan, 2005; see Table 1).

The situation was updated to December, 2007 for presentation at the TGCI Hohhot workshop (Mark et al., 2009), by which time the formally protected area of indigenous grasslands had increased from 12.3 to 15.4 per cent of the original baseline area of 82,436 km^2. This increase was essentially the result of continuing tenure review of the South Island rangelands. Here protection involved mostly the higher altitude types: low-alpine tall

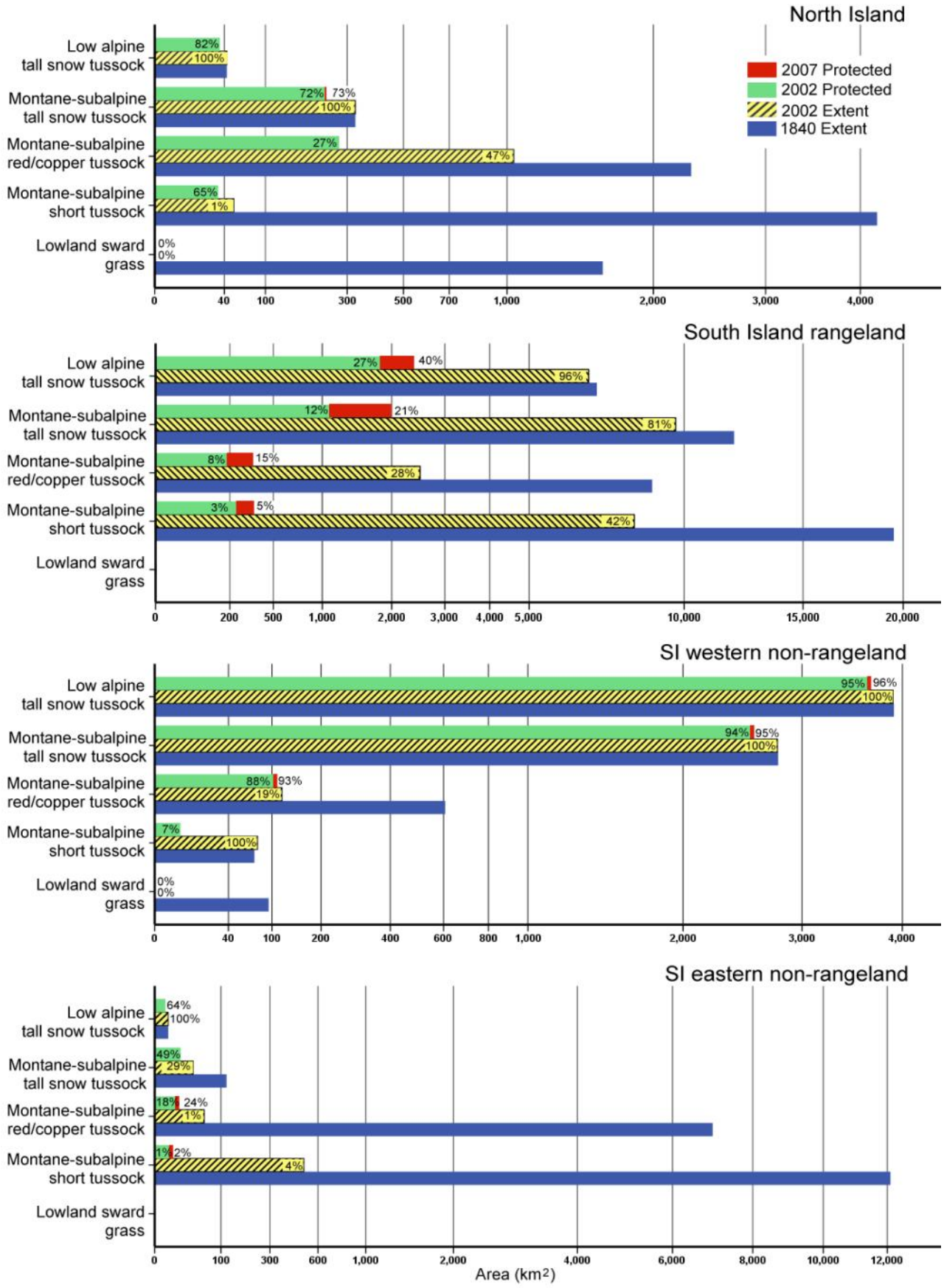

Figure 3: Areal extent of the five major indigenous grassland types in each of the four main geographic regions of New Zealand, with values for the baseline (1840), and current (2007) extents, as well as that formally protected in Sept. 2002 and Dec. 2007. Reprinted, with permission, from Mark, et al., 2009.

Above: ***Montane-subalpine tall snow tussock (*****Chionochloa rigida*****) grassland in Te Papanui Conservation Park, or 'Waterlands Park' in relation to its importance for high water yields recorded nearby, on rolling uplands of the Lammerlaw Range, eastern Otago uplands at 800-1000 m © Gilbert van Reenen.***

Left: ***Montane-subalpine tall snow tussock (*****C. rigida*****) grassland and an extensive wetland, Teviot Swamp, at 800-1000 m, on gentle western slopes of the Lammerlaw Range, eastern Otago uplands, on schist parent material. Part of Beaumont Pastoral Lease, this property is currently going through the tenure review process. February, 2010 © Alan Mark.***

snow tussock grassland increased by 13 per cent to 40 per cent, the montane-subalpine tall snow tussock grassland by 9 per cent to 21 per cent of the baseline value, and the montane-subalpine tall red/copper tussock grassland by 7 per cent to 15 per cent, while the lowest elevation, short tussock grassland increased by only 2 per cent to 5 per cent (Table 1; Figure 3). This latter grassland type continues to be poorly represented and moreover, is currently undergoing rapid land use transformation.

The tenure review process is still on-going and, as at April, 2012, reviews have been completed on 83 of the 303 properties, five have been purchased by the Government, 42 were in various stages of the formal process, while applications had been made for another 68, and 105 were not in the review process. Of the 83 completed reviews, totaling 441,188 hectares, 51 per cent of the land has been taken out under free-hold agreement while the remaining 49 per cent, including the five Government-purchased properties, has reverted to full Government ownership and control, and are managed by the Department of Conservation. This is close to the 50 per cent value indicated by the Government when the special legislation, the Crown Pastoral Land Act, 1998, was being debated in the mid 1990s.

Rangeland areas that have now been formally protected are designated as conservation areas while, beginning in 2000, the larger areas, exceeding 20,000 ha, have been designated conservation parks, of which there are currently ten, amounting to 581,032 hectares (Figure 2; Table 2). These extend from northern to southern South Island and all contain a range of upland ecosystems, representative of much of their ecological region, while some, such as Ahuriri and Hakatere Conservation Parks, have important altitudinal corridors and sequences of ecosystems, and are more adequately representative of their ecological region (Figure 4).

Some additional conservation parks have been identified in conservation strategy documents for the four eastern South Island conservancy regions, which hopefully will be implemented with the completion of future tenure

Figure 4. Eastern slopes of the Old Man Range, Central Otago on schist substrate, showing the altitudinal sequence of vegetation, mostly grassland types and the estimated long-term mean annual precipitation and air temperature vales based on a short-term (6-yr) study in relation to the long-term record for the nearby town of Alexandra (141 m) on the valley floor.

reviews. Thus, over the last 50 years, the indigenous grasslands of the South Island rain-shadow region have greatly increased their proportion of New Zealand's total conservation lands which now cover some 34 per cent of the country's area.

VALUING THE ECOSYSTEM SERVICES OF UPLAND INDIGENOUS TALL TUSSOCK GRASSLANDS

Protected areas are becoming increasingly valued the world over, for their often irreplaceable role in providing a range of ecological goods and services, essential to the well-being of both ecosystems and humans. With this considerable expansion of protected areas in the indigenous grasslands of New Zealand, there has not only been an increased protection of native plants (Mark & Adams, 1995) and animals: birds, lizards and invertebrates (Mark et al., in press), but also an assurance of continuation of the important ecosystem services they provide in soil conservation, and particularly in maximizing the production of clean fresh water, as well as retention of their cultural, recreational and ecotourism values.

Several studies, using both paired catchments and non-weighing lysimeters, in and adjacent to the Te Papanui Conservation Park on the eastern Otago uplands, have shown that good condition, tall tussock grassland can maximise water yield relative to any alternative vegetation cover types, and even bare soil (Mark & Dickinson, 2008). These authors describe a long-term, mid-altitude (460-670 m), paired-catchment hydrological study which revealed increasingly reduced water yields over time, from an afforested catchment compared with an adjacent catchment of indigenous tall snow tussock (*Chionochloa rigida*) grassland. The reduction in water yielded annually, from the 310 ha catchment afforested in exotic *Pinus radiata*, reached 41 per cent after 22 years, relative to that from the adjacent indigenous grassland catchment. Moreover, water yield reached 80 per cent of the measured annual precipitation (and up to 86 per cent over the snow-free six months) from an upland fog-prone site in the same region, reflecting both the conservative water use by the tussock cover and the ability of its metre-long, fine foliage to intercept considerable amounts of water from the not-infrequent passing fog (Holdsworth & Mark, 1990; Mark & Dickinson, 2008). The 20,590 ha Te Papanui Conservation Park on this eastern Otago upland, is referred to as "The Waterlands Park" by the Department of Conservation, in recognition of its recorded value for high water production. This area provides more than 60 per cent of the water for Dunedin City's 120,000 population.

In addition to water production, research has also shown that intact indigenous grasslands have great potential for

Table 2. Area and date of establishment of ten conservation parks from the rangeland region of the South Island of New Zealand.

Conservation park	Area (ha)	Established
Korowai/Torlesse	20,328	2000
Te Papanui	20,590	2003
Eyre Mts/Taka Ra Haka	65,160	2003
Ahuriri	46,655	2004
Hakatere	39,138	2006
Clarence	88,066	2008
Ruataniwha	37,220	2008
Te Kahui Kaupeka	93,800	2009
Hawea	105,260	2009
Oteake	64,815	2010
TOTAL	**581,032**	

the sequestration of large amounts of carbon, perhaps almost as important as forests (Minahi et al., 1993; FAO, 2010). With most carbon stored in the soil rather than in the surface vegetation, this ability to store carbon is highly dependent on these grasslands remaining intact. The conversion of grasslands to other land uses, especially agriculture and also forestry, leads to release of much of this carbon. Conversely, indigenous grassland management practices, designed to maximize the sequestration of carbon, can actually increase productivity and enhance resilience (FAO, 2010).

Globally, land use change accounts for almost 20 per cent of greenhouse gas emissions and, with about 55 per cent of temperate indigenous grasslands already developed, their formal protection, coupled with sustainable use in non-protected areas and the restoration of degraded grasslands, would make a significant contribution to mitigating the effects of climate change (White et al., 2000; World Watch Institute, 2009). Protection of temperate indigenous grasslands lags far behind that of the world's other major biomes and, while many challenges remain to improving this situation, the recent progress made in New Zealand is a strong testament to what can be achieved and hopefully replicated in other parts of the world.

ACKNOWLEDGEMENTS

I thank Andrew Lonie, Department of Conservation, Dunedin, for the preparation of the map of South Island conservation areas (Figure 2), and Matt Donnelley of Land Information New Zealand (LINZ) for updating process. Much of my grasslands research has been funded by the Hellaby Indigenous Grasslands Research Trust. I also wish I also wish to thank the two anonymous reviewers for their helpful comments.

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ABOUT THE AUTHOR

Alan Mark is an Emeritus Professor at the University of Otago. He has researched the pure and applied ecology of the upland snow tussock grasslands and associated mountain lands throughout New Zealand, aimed at their sustainable management and adequate conservation. He obtained a BSc and MSc from the University of New Zealand and a PhD with a Fulbright Travel Grant, from Duke University, North Carolina, U.S.A, in 1958.

Alan has been a member of the Temperate Grasslands Conservation Initiative since its inception in 2003. He has published some 190 peer-reviewed papers and also a popular book, '*New Zealand Alpine Plants*', with botanical artist Nancy Adams which is currently being revised, with the inclusion of the alpine fauna.

Alan has been a strong advocate for conservation of New Zealand's indigenous ecosystems and involved with several conservation organisations. His contributions to conservation and sustainable resource management have been recognised with various awards and honours, including a Fellowship of the Royal Society of New Zealand, the Society's Hutton Medal and Fleming Environmental Award, as well as a CBE (1989) and KNZM (2009), for contributions to scientifically-based conservation in New Zealand.

RESUMEN

El avance con respecto a la conservación de los pastizales templados de Nueva Zelanda, y en particular los pastizales de la sombra pluvial de la región al sur de la isla, se reseña desde la primera y modesta reserva de finales de 1960. Los primeros debates se centraron en la severa degradación de muchos pastizales sometidos a las prácticas agrícolas de quema periódica y el pastoreo de ovejas asociado a ellas, pero luego incluyeron la necesidad de áreas para la investigación de base y la protección de la biodiversidad y los ecosistemas autóctonos. Se detalla un proceso de análisis en materia de tenencia iniciado por el Gobierno desde mediados de la década de 1990, mediante el cual los agricultores renuncian voluntariamente a las zonas más vulnerables (que suelen ser las de mayor elevación y con mayor biodiversidad) de sus tierras bajo arrendamiento a cambio de acuerdos de plena propiedad para las tierras más productivas. Los análisis están en curso de realización. A la fecha, el análisis de 82 de las 303 propiedades ha mostrado que el 49 por ciento de sus 441.188 hectáreas está protegido formalmente, y otras 125.792 hectáreas de cinco propiedades adquiridas por el Gobierno están siendo destinadas a la conservación. El estado de conservación actual de los cuatro tipos más importantes de pastizales autóctonos del país, con un total de un 15,4 por ciento protegido, se describe en relación con los tipos de pastizales y su distribución altitudinal con respecto a sus áreas de referencia en el momento de la colonización europea en la década de 1840.

RÉSUMÉ

Les progrès réalisés dans la conservation des pâturages natifs tempérés de Nouvelle-Zélande, et notamment les pâturages de la région de pluviométrie du sud de l'île, sont décrits à partir de l'exemple de la première réserve, de taille modeste, créée à la fin des années 1960. Les premiers débats

tournaient autour de la grave dégradation de nombreuses zones de pâturages du fait des pratiques d'agriculture pastorale de l'époque (brûlage périodique et pâturage par les moutons). Par la suite, les acteurs ont senti le besoin d'établir des zones de recherche de référence et de protéger la diversité biologique et les écosystèmes natifs. Enfin, notons le processus d'évaluation du régime foncier initié par le gouvernement depuis le milieu des années 1990, où les agriculteurs se sont portés volontaires pour céder les zones les plus vulnérables (en général les plus élevées, et là où la diversité biologique est la plus riche) de leurs propriétés louées à bail, en échange d'accords de pleine propriété pour leurs zones les plus productives. Des études sont en cours. À l'heure actuelle et grâce à la conclusion de 82 études portant sur 303 propriétés, 49% des 441 188 hectares ont pu être officiellement protégés, et 125 792 hectares supplémentaires originaires de cinq propriétés ont été achetés par le gouvernement et désignés terres de conservation. Le statut de conservation actuel des quatre principaux types de pâturages natifs du pays, dont 15,4% sont protégés, est décrit en fonction du type de pâturage et de leur répartition en altitude, et par rapport à leurs zones de référence au moment de l'installation des européens, au début des années 1840.