Back to the Future – Pastoral Land Use in a Forest Land – Sustainability Challenges for the 21st Century

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Introduction

To contribute meaningfully to a session entitled "Deforestation" with a proposed paper title of "Trees in Pastoral Zones; Landuse Standards in the 21st Century" necessitates I carefully define the scope of my contribution. My paper will draw on my experiences as an ecologist working in the pastoral lands of New Zealand in roles that have led me to delve increasingly into what constitutes sustainability (of people, land and economy) for a tiny multicultural nation maturing amidst the remnants of a unique Gondwanaland ecosystem. As New Zealand's Parliamentary Commissioner for the Environment (PCE) I now examine a very wide range of issues associated with the New Zealand environment and its management. I will therefore approach the topic of deforestation by focusing almost exclusively on the New Zealand story; a story of a forested land that has had the most rapid conversion to pasture of any such land on this planet so the focus will be not on trees in a pastoral zone but on pasture in a formerly forested land. I will draw on some of my current work as PCE, with a focus on our history, tends and emerging themes.

It is not a definitive review of "the science" of sustainable land use in New Zealand but an attempt to reflect on the ecological, economic and social realities for a food, fibre and forest products producing nation of converting a forested landscape to predominantly grass. The realities revolve around changing societal expectations about the way, as a nation, we utilise our natural resources and in particular the values we put on our indigenous biodiversity. In New Zealand, as in many other parts of the world, forest/pasture tensions are very much on political agendas, as other contributors to past International Grassland Congresses have highlighted. (Foran 1993) Environmental concerns are increasingly influencing land use futures, particularly in developed nations. In New Zealand, this concern is one of where trees and our entire indigenous flora fit into our 21st century land use futures; not just as plantations or indigenous forest reserves, but as an integrated part of our production landscapes.

This paper will outline our ecological history, the current land use situation and then explore the dilemma we face as a nation; deciding what the place is for our indigenous flora (our indigenous biodiversity) in our production landscapes – our predominantly exotic grasslands' landscapes. This story is primarily about the maturing processes of an agricultural nation grappling with its ecological imperatives. Institutions and people will dominate rather than the data of hard sciences. The magnitude of the sustainability issues we face in a land formerly 80% forested is embellished with commentary, reflection and data to illuminate. I will conclude with some reflections on the key challenges for New Zealand's pastoral lands and possible portents for similar lands worldwide.

Context

Origins and Evolutions

New Zealand is home to 3.8 million citizens of Polynesian, European and increasingly Asian descent, occupying a land that has been peopled less than a thousand years. New Zealand's North and South Islands were the last big habitable islands on the face of our planet to be discovered by humans. Ours is a landscape, a unique remnant of Gondwanaland, whose indigenous plants and animals have not co-evolved with people. In less than a millennium humans and their occupying animals, plants, pest species and weeds have radically modified original ecosystems eliminating the majority of lowland forest and wetland habitats, and around one third of the indigenous birds that depended on these environments. Three quarters of our remaining bird species are now threatened. Indigenous biodiversity is therefore a particularly urgent environmental challenge for New Zealand – across our whole landscape. We have a duty to protect the Gondwanan survivors – wonderful eccentricities such as the kakapo, a flightless nocturnal parrot, or the tuatara, the closest thing remaining on the planet to the dinosaurs – but this involves the recognition that the future can only be secured within the wider and more complex ecological and economic realities of New Zealand's contemporary landscapes. The challenge is to integrate protection of our unique natural heritage with the ongoing practical business of achieving sustainability – particularly in terms of land uses. (See Box 1.)

The direction and content of sustainable development efforts are inextricably part of any country's political and economic system. New Zealand's political system is now a mixed member proportional (MMP) single house Parliamentary system. The rights of Mâori (the indigenous people of New Zealand/Aotearoa) are recognised under the 1840 Treaty of Waitangi and through current processes for the settlement of Mâori claims against the Crown for breaches of the Treaty. In the last 15 years we have undertaken, as a nation, a major series of economic and institutional reforms that have impacted on practically every facet of New Zealand life and activity. We now have one of the most open and unregulated economies in the world. The overall goal was to improve productivity through increased competition, reduced market rigidity and lower inflation. The reforms began in the financial sector and then moved to the labour and goods' markets and to the public sector, commencing with environmental administration (Brash 1996).

The environmental challenges facing New Zealand are, not surprisingly given its human colonisation history, different from most other developed countries. Our main challenges are ones of depletion, particularly destruction of forest habitats (and the species that once lived within them) but also of other ecosystems such as wetlands, high country and coastal lands. As a result we now grapple with an enormous loss of biodiversity, soil losses, degradation of water quality, and ongoing invasion by pests, diseases and weeds. These are in part the results of our past land development efforts, but increasingly are also due to New Zealand being an open trading economy and susceptible to new threats. New Zealand's economy is still largely based on the natural resources of the land and the oceans, thus major depletion and increasing pollution challenges (particularly in the form of pest species) are ongoing. In common with the rest of the western world, our rate of urbanisation and intensification of agricultural land uses has expanded dramatically in recent decades. There has been a 78% increase in urban land area between 1980 and 1995 (PCE 1998), with all the attendant pressures on land, water resources and air quality that this entails. New Zealand enters the 21st century with the daunting challenge of continuing to deliver the qualities of life expected by our citizens, and over a million international visitors each year, while at the same time endeavouring to halt the degradation of an ancient Gondwanan treasure chest of unique species that is still adjusting to the very recent arrival of homo sapiens and associated alien flora and fauna.

Box 1 - January 1999; New Zealand's Biodiversity Strategy Launch – reflections by the Minister of the Environment, Hon Simon Upton – now chair of the OECD Round Table on Sustainability in Paris.

"For most developed countries, on-going industrial pollution and the need to clean up a legacy of toxic and hazardous waste are at the top of the agenda.

By contrast, we are only lightly industrialised. It is, rather, the destruction of habitat and the species that once lived there that is our developmental legacy.

It would be easy for me, a descendant of colonising nineteenth century farmers, to utter an anguished mea culpa on behalf of the settlers who changed the face of this land. They didn't know then that they were walking into a spectacularly separate and ancient land. They came from a boring part of the earth – the last ice age had left Britain with only two endemic species. They had no emotional or practical experience of living amidst abundant and different life forms.

But they weren't the first to blunder onto these shores. Only a split second earlier in geological terms, Polynesians had arrived and created the same sort of havoc through fire and the hunting of prized bird species. New Zealand's North and South islands were the last big islands on the face of our planet to be discovered by humans and it was awful bad luck for the indigenous species that (save for two species of bat) we were the first terrestrial mammals.

I have for some time considered that the fundamental bond that Mâori and pakeha share in this country is our truly brief residence here. Unlike so many continental landmasses in which people like us have lived for thousands and thousands of years, the islands of Aotearoa/New Zealand have only known people with all their ingenuity and destructiveness for a few hundred years. Ours is a landscape whose plants and animals have not co-evolved with people. It is a landscape that is still in the throes of a traumatic response to our arrival.

In only 700-800 years humans and their accompanying animals have eliminated 32 percent of the endemic land and freshwater birds. Three quarters of those remaining are now threatened.

So when I say that biodiversity is the environmental issue for New Zealand, I mean that in a profound sense that does not apply to any other country. I believe we have a responsibility to care for this Gondwanan treasure chest not just for ourselves but for the world. The strategy we launch today is a way to nail our colours to the mast."

For the European colonists forests were seen as both an obstacle to the development of agriculture and an inexhaustible source of timber. From the 1860s onwards forest area declined rapidly. Between 1890 and 1900, 27 percent of the existing forest, or 13 percent of the total land area was cleared.

It was not until 1919, when all the useable land had been occupied, that a government agency, a forest service, was formed to manage what remained of the potentially harvestable public forests and to protect four to five million hectares of steep land forests for erosion and flood control. It is these protection forests which form the bulk of today's remaining indigenous forests and why lowland forest ecosystems are underrepresented in the conservation estate. In the knowledge that timber supplies from the sustainable management of the remaining indigenous forests would always be limited the Forest Service set about establishing an exotic estate based on Pinus radiata. The demands for indigenous timber

resulted in extensive clear felling of forest until the 1960s by which time exotic supplies began to take over. While some indigenous clearfelling has continued to the end of the 1990s, by 1996 indigenous timber constituted only 5% of the national supply; exotic timbers now dominate.

At a rough approximation we have perhaps 0.2 million ha potentially accessible to sustainable logging, or 0.5% of the area of indigenous forest covering New Zealand when Polynesians first arrived. To gain some perspective on the scale of what we now regard as 'available' for the sustained yield of timber, between 1890 and 1900, 3.5 million ha of indigenous forest was converted to farms. This was a rate four times that estimated to be now occurring in Asian Tropical Forests.

The indigenous forests have provided a focus for debate over sustainability from the time of human settlement, but more particularly since the early 1900s. Sustained cultural harvest, sustained timber yields, sustained biodiversity and ecosystems have each assumed increasing significance as the resource has declined in both quantity and in quality. We have failed to use our indigenous forests sustainably. We must now accept that the sustainability of most of our indigenous forests, under pressure from exotic pests and weeds and which are predominantly on public land, will require large inputs of resources from elsewhere; their management can no longer be funded from revenue generated internally.

Current land uses and trends

As is well documented New Zealand's climate is ideal for growing pasture grasses. However, the soils that nurture these plants are often less than ideal. Having evolved under forests most of our soils tend to be thin, acidic and usually have low levels of nitrogen, phosphorus and sulphur. Thus they need sustained input of particularly phosphorus and sulphur.

New Zealand embraces approximately 27.1 million hectares that are predominantly mountainous or hill country. Over two thirds (18.5 million hectares) has slopes over 12 degrees and nearly half greater than 28 degrees. Sixty percent (16 million hectares) is over 300 metres above sea level and 20% over 900 metres. Before human arrival 78% of the total area (24 million hectares) was under forest cover, 14% alpine zone and the balance was dry lands, lakes and swamps. Today the land use patterns are as detailed in Table 1.

Table 1- Land uses in New Zealand in 1993.

Land use	land area hectares (millions)	percent
Built-upon land (roads, railways, buildings etc)	**0.89**	**3**
Urban areas (residential, industrial/commercial, roads & railways)	0.73	3
Rural roads and railways	0.16	<1
Domesticated land (farm)	**14.42**	**56**
Pasture: improved grassland including lucerne	9.60	36
Pasture: tussock including danthonia	3.92	14
Arable crops (eg. grains, peas)	0.18	<1
Fodder crops (eg. turnips)	0.14	<1
Horticulture (eg. fruit, vegetables, vineyards)	0.09	<1
Other farmland including retired land (eg. fern, scrub, tussock & barren land)	0.42	2
Fallow land	0.07	<1
Domesticated land (forests)	**2.88**	**8**
Exotic forests (90% Pinus radiata)	1.40	5
Privately owned indigenous forests	1.32	2
State indigenous production forest	0.16	<1
Conservation land (national parks, reserves, protected sites)	**8.10**	**30**
Indigenous forest	4.80	18
Tussock and sub-alpine scrub	0.70	2
Other (eg. mountain tops, coastal areas, islands)	2.60	10
Other land	**0.76**	**2**
Lakes and river beds	0.54	2
Land not classified elsewhere	0.22	<1
Total New Zealand land area	**27.05**	**100**

Source : The State of New Zealand's Environment, 1997.

The two dominant land uses are improved and tussock pasture (50%) and conservation (30%). Only 30% of the land in pastures on improved tussock grasslands can be sustained without a significant risk of erosion. A further 28% can support limited livestock grazing but this must be accompanied by erosion management measures such as farm/forestry, erosion tree plantings, and of importance for our indigenous biodiversity, enhancing regrowth of indigenous vegetation for protection and production purposes.

The last 15 years of New Zealand's government reforms coupled with world commodity trading trends have resulted in some marked changes in pastoral land uses – the most notable being the decline in sheep numbers from 70.3 million in June 1982 to 48.1 million at June 1995. In contrast, cattle numbers have had modest fluctuations totalling 5.11 million in 1981, 4.67 million in 1991 and 5.18 million in 1995. Dairy livestock have increased from 2.92 million in 1981 to 4.09 million in 1995 with numbers still rising. Other land uses (small in terms of area used, but potentially very important in sustainability terms) that have increased significantly in recent years are horticulture (0.124 million hectares in 1995) exotic plantations (1.6 million hectares in 1995), and urban land (0.73 million hectares and a 78% increase 1980-1996).

Imbedded in these changes, particularly in the 1980s and 90s has been clear competition for land, a relatively new phenomenon. The pastoral sector lost about 820,000 hectares over the decade to 1993 and is projected to lose at least another 520,000 hectares to 2003. Even within this shrinking pastoral sector there is, as indicated above, a redistribution of traditional sheep, cattle, goat and crop usage into dairying, deer and "lifestyle blocks"; small recreational or semi recreational farms. This has taken 470,000 hectares from sheep and cattle farming up to 1993, and will claim another 260,000 by 2003.

The Context – in summary

Developing a sustainable future for pastoral systems in New Zealand necessitates an appreciation of our very recent forest origins, the consequent fragility of the land and biodiversity (see below) and the increasing environmental management demands being placed on all land users by New Zealand society and our fussy global consumers. The long-term land use trends appear to be to more intensive uses, agricultural and peri-urban, and towards systems embracing more trees, more woody species for production and biodiversity reasons. This is being driven by both ecological and economic imperatives. New Zealand's land and climate is forest friendly. Ecologically, that is where the vegetation of our landscapes will always head unless diverted by mans efforts. Pasture systems have to constantly stave off the drift to woody species. Increasingly economics and societal sympathies are favouring that drift for a number of reasons. This is resulting in the need to rethink New Zealand tree/pasture relationships, ecologically and in terms of the land-based business we create. This rethinking and recrafting has only just begun.

Doubters and Renegades - early worries about the sustainability of pastoral uses

As pastoralism was transforming New Zealand in the late 19th and early 20th century there were those who sought to conserve something of the unique forests and those who sought to shape the new pasture lands or existing tussock lands with exotic trees and shrubs which had arrived as part of the new settlers' cargo. (We now have perhaps 6,000 exotic plants, 2,000 of which are now 'in the wild'). Building plant collections had become extremely fashionable in Europe during the 18th and 19th centuries. Moving plants around had become common with colonisation, both out to the new colonies as well as back to the mother country, Great Britain. One of many early settlers to have a particular interest in exotic trees and shrubs and to set about the re-creation of Britain on the other side of the world was Thomas William Adams.

Adams took up virgin tussock grassland at Greendale, Canterbury in 1865 to become the first farmer in the district. He planted trees all his life, for shelter, fuel, timber and amenity. By 1910 his plantings covered 60 ha and he was a major influence in the planting of county reserves and in the choices of species on neighbours' properties. By 1908 he had over 800 species of trees and shrubs in an arboretum, including indigenous species. Adam's species trials included radiata pine and his work influenced the choice of species in the large-scale plantings of the 1920s.

Adams became a member of the Forestry Commission appointed in 1913 to develop long-term forest policy.

Forests reborn – emergence of sustainability issues

The planting of trees in the pastoral landscape was generally extremely constrained until the 1960s. Trees and shrubs were planted for amenity purposes around homesteads, small areas were planted for firewood where indigenous trees were not available, and trees were planted for shelter. The National Land Cover Data Base picks up over 7000 km of shelterbelts in each of the North and South Islands, and there are suspected to be more, which can't be seen on satellite images. (Steve Thompson pers.comm)

Forests have always been an essential part of the pastoral landscape of New Zealand. The 'protection forest' lands, now part of the conservation estate, were considered to be an integral part of their farmed catchments. There is a long history of catchment retirement for soil and water purposes as well as planting by central government (on crown land) or catchment authorities, (now part of local government units called regional councils) on private and leasehold land. Most such plantings were to protect soil and thus sustain pastoral farming rather than diversifying land use into timber or other non-pastoral production. The establishment of plantations for timber production purposes has been, until relatively recently, an activity set apart from pastoralism and focused on lands considered unsuitable for that purpose. The state and large private companies have frequently been in conflict with farmers, and their local government district councils, in posing threats from land encroachment and in bringing new people and new values into rural communities. Tensions were particularly high in the 1960s and 70s when pastoral farmers were feeling economic pressures and the faceless state or corporate began to impose on the relatively powerless but heart of pastoralism, "the family farm".

Production plantation forestry, 90% dominated by radiata pine, now (2000) occupies some 1.7 million ha. The exotic plantings of the early 1900s were intended to eventually replace the use of indigenous timbers on the domestic market. Forest planting assumed a major social role during the depression of the 1930s when large-scale exotic plantings were undertaken in the central North Island. This employment role continued up until the mid 80s. Exotic afforestation was so successful, and tree growth so spectacular by world standards, that by the 1960s there was wide support for a major expansion of planting for the purpose of regional development and to build a resource for wood processing and/or export.

Prior to the government stepping back from direct involvement in plantation forestry in 1987 and selling all but 6% of the resource to the private sector, the public owned over half of the resource. Although the larger proportion of the resource is now owned by larger private companies, some 30% is managed by, or for, small forest owners. Many of these are farm foresters. In recent years new planting on farms has made an increasing contribution to the national totals. Of the annual new plantings of some 50-60,000 ha per annum, 60% is now predominantly planted on farms.

Forestry now ranks third in terms of commodity exports, earning New Zealand $2.5 billion to the year to June 1999, and accounting for 3.9% of GDP. The industry employs 21,000 people and this will rapidly increase as the level of harvestable timber doubles over the next few years as the expanded plantings of the 1960s start to come on stream. Forestry activities are now significant in the pastoral landscape, and more importantly, pastoral farmers are beginning to see the financial benefits and become increasingly involved. The farm forestry sector has always been extremely innovative, more so than the managers of the large plantations. The leaders in the sector have maintained close relations with the forest research scientists around New Zealand and overseas. 'Experimental plantings' of alternative exotic timber species, as well as plantations of indigenous species such as Kauri and Totara, are woven through the pastoral landscape. Radiata pine is not alone in its outstanding growth rates. There are many other species New Zealand is able to grow well if sites are carefully

chosen. Farm foresters are increasingly showing the way with the sustainable management of indigenous forests, particularly for New Zealand beech species.

Box 2 - Pastoral Idyll

In 1991 when farming was in the doldrums, driven by a desire to plant and manage some trees and probably inspired at least partly by Aldo Leopold's 1949 classic 'A Sand County Almanac', we bought a run-down dairy run-off at Pongakawa in the plateau country between the northern shore of Lake Rotoiti and the central Bay of Plenty coast. Apart from a tiny remnant of a couple of hectares of the original semi-coastal forest that formerly characterised the vicinity, it was essentially 50 hectares of what I would call pastoral desert.

This has become the second of my personal places.

After an effort that has consumed most weekends for the past decade, 40 hectares is now in well-managed radiata pine, with 5 hectares of cypresses and eucalypts and the remaining 5 hectares retained in grass for grazing that pays the rates and, I am bound to admit, for the purely amenity values of 'the long meadow'. Obviously through the exercise I have got thoroughly to grips with forest management. But through the long hours alone in that particular landscape I have also observed the magical reappearance of a plethora of native flora and fauna. Orchids and ferns have very quickly lined the tracks, and the semi-coastal forest trees including mangeao, rewarewa and nikau that formerly characterised this landscape are re-appearing. Kereru[1] that were previously very occasional visitors to the native forest remnant are now resident all year round, and their increasing numbers suggest that, with possum and mustelid control in place, they may be breeding. The remnant itself, released from grazing below and browsing in the canopy, shows much renewed vigour and, with some extra help around the margins, is pushing outwards again after decades of contraction - the ranks of regenerating rewarewa look quite prepared to challenge the radiata that shelter them for the time being. Bellbirds and tui, never seen before afforestation, now entertain me as I prune my way through the weekends, and the whole landscape is a-chatter with grey warblers, fantails and waxeyes. If I stay late, the ruru/moreporks that were raised last summer in a cavity high in an ancient pukatea call across the gathering gloom and flit as silently as moths through cypress and pine. I don't even mind the raucous rosellas and sulphur-crested cockatoos that have an instinctive penchant for the eucalypt plantation – none of the natives seem to be disturbed by their presence.

None of this burgeoning biodiversity was in evidence as we bent over our first radiata seedlings back in 1991. It is almost as though the landscape remembers, as the American environmental writer Wendell Berry has suggested. You cannot act well in a place, he says, until you have understood what nature intended for it:

'...in country originally forested, the farmer must study the forest, because to be healthy, the field must be an analogue of the forest; in analogy its nature is remembered. The nature of the original forest is, so to speak, "the genius of the place", which one is obliged to consult, not by human prescription, but by natural law'.

In short, I have learnt that whatever the aesthetic and amenity values associated with pastoral landscapes, they are biologically impoverished by contrast with forested ones, in the central Bay of Plenty hills at least. And that buried just beneath the surface of all of those impoverished landscapes is a treasure of indigenous ecological potential.

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[1] Native wood pigeon

The increasing focus on the sustainable management of natural resources through the 1970s and 80s culminated in the enactment of New Zealand's most far-reaching piece of environmental legislation, the Resource Management Act 1991 (RMA). (See Appendix 1). This innovative extraordinarily demanding legislation administered by local government (regional and district councils) requires all users of natural resources to manage them sustainably and to mitigate any adverse effects of their use. The Act is intended to be enabling, with the focus being on the mitigation or avoidance of adverse effects rather than on prescribing what land can be used for. The presumption in the Act is that land can be used for any purpose unless there is an express constraint. There are a number of matters in the Act, which can severely constrain the use of land and resources in the interest of sustainability outcomes. In particular, *'significant indigenous vegetation and significant habitats of indigenous fauna'* must, along with a number of related matters, be recognised and provided for as *matters of national importance*. It is this requirement that has been applied in a manner that brings marginal and scattered remnants into coherent ecological frameworks; but threatens the property rights of landowners. *The New Zealand Biodiversity Strategy- Our Chance To Turn The Tide (2000)* has recently been released and adds weight to the case for affording remnants greater attention. It must also be noted that the *Forest Amendment Act (1992)* requires the sustainable management of privately owned indigenous forest.

The legislative and policy changes in New Zealand have resulted in a major devolution of responsibilities to local government, the business sector, farm families and community. There is a view, widely held, that we are at an impasse. In spite of the visionary nature of our legislation and the huge amount of effort which has gone into developing policies and plans, there is only limited evidence to support the view that we have moved, or are moving, onto a more ecologically sustainable pathway with our land uses. The comment of the Commissioner for the Environment, Canberra, Australia may hold a chilling ring of truth; 'New Zealand leadership is in the development of environmental management processes, not in the management of the environment.'(Joe Baker pers.comm)

Sustaining what?

At its simplest in a grasslands context "sustainability" is about the ecological health and the capacity of any given pasture or grassland system to remain healthy in the longer term. It's also about dependence on inputs and the outputs achieved from inputs. That is, is the system ecologically efficient over the longer term? The more intensive the grassland system, the higher the inputs and usually, the lower the ecological efficiency. This is certainly the case with New Zealand dairy pasture systems. Energy inputs to dairying on farm (direct and via nitrogenous fertilizers) have increased significantly over the last 20 years. In 1977 such inputs were 1GJ/ha compared with 8GJ/ha by 1998 (Wells 1998). The overall result is that there has been a decrease in the conversion efficiency of energy to food. Currently it takes about three units of energy input to produce a calorie of milk protein energy output. The long-term sustainability in ecological and economic terms is questionable particularly given the ground and surface water pollution challenges arising from the on average 2.5 cows per hectare and increased fertilizer inputs. These ecological externalities are increasingly putting pressure on the current dairy pasture model and leading to fierce debates about where new dairy farms can be developed (see Box 3).

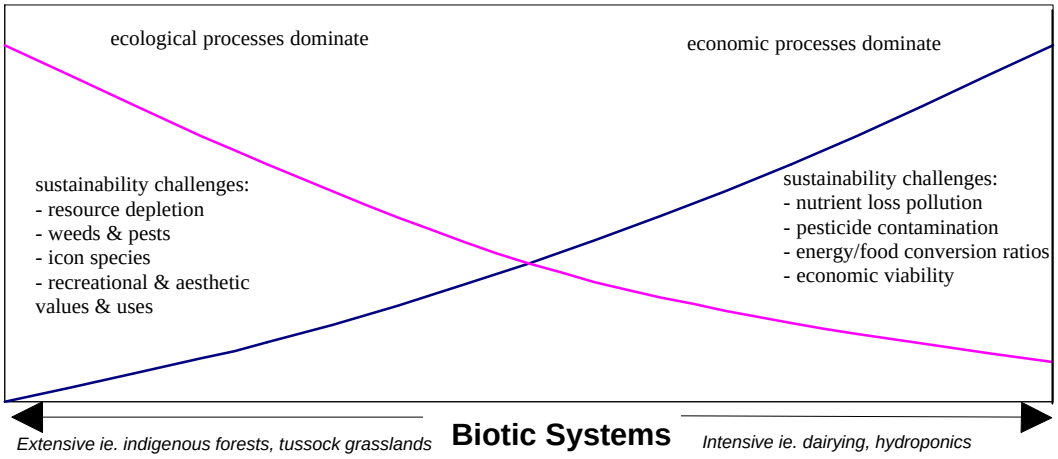
Box 3 - The Lake Taupo Story

A defining debate is emerging in relation to the future maintenance of water quality in Lake Taupo. Located in the centre of the North Island, this is New Zealand's largest and one of its most beautiful lakes – with very high water quality and clarity. The lake is set within a large basin originally clothed in mixed patterns of tussock and forest. Over the last 100 years the basin was settled, the original vegetation mostly removed, and the basin transformed into plantation forests and pasture. The lake is internationally recognised as an outstanding trout fishery and the whole basin is a major focus for recreation and tourism. Since farming began there has been a gradual decline in the quality of the lake water, largely due to leached nutrients from farming. The porous soil, of volcanic origin, allows for a very free movement of nutrients from land to water. The slow nutrification of the lake is leading the regional and district councils towards imposing, via the Resource Management Act 1991 if necessary, limitations on future land uses of the basin. It is now recognised that any expansion of dairying within the basin (there are already 2000 cows) could rapidly turn the lake from a brilliant blue to a murky green. Dairy interests have estimated that there is sufficient suitable land in the basin to carry 25,000 cows which, on the strength of current knowledge, would ensure the death of the lake.

They are also a critical factor in New Zealand's natural grasslands. (see Box 4)

This necessitates recognition that that the ecological sustainability of our pastoral systems is being challenged by different forces of the two ends of the developmental spectrum. This is illustrated in Figure 1 and further discussed in Williams 1999, "Sustainable Development of Landuses in New Zealand; Utopian Vision or Realistic Goal?"

Figure 1. Sustainability of Biotic Systems: Ecological Vs. Economic Dominance



The tensions right across this land use spectrum are generating a focus on New Zealand's international obligations such as under the Agenda 21 agreement of the United National Conference on Environment and Development in 1992, which requires promotion of sustainable development and conservation enhancement. This focus, in conjunction with market demands for quality products from a quality production environment is stimulating considerable effort to produce soil quality measures (Beare et al 1997) and measures of the sustainability of farming in New Zealand (Wratten et al 1997).

Box 4:

In many areas well maintained pasture with a dense grass covering and fertiliser application has increased the organic carbon content of the soils, leading to improved water retention and nutrient cycling capacity. Without ongoing replenishment however, soils deteriorate and become acid again. In a submission to a Parliamentary Select Committee, Dr Peter McIntosh, a scientist with Landcare Research, had this to say in relation to the high country;

"Theoretical considerations suggest that without topdressing and grazing, in a semi-arid environment as Central Otago, soil carbon may take 48 years to increase from 1.9% (indicative of degraded soils) to 3.0% (indicative of undegraded soils.) That these figures are approximately correct is indicated by a 1995 examination of two enclosure plots established by Leonard Cockayne in 1920, on semi-arid soils in Central Otago, which has shown that exclusion of sheep has not only resulted in a complete vegetation cover of native and oversown species, but has raised soil c from 2.3 to 3.1% (a 35% increase).

In the conclusion to his submission he said:

Providing that commodity prices continue to be sufficiently high to support maintenance topdressing, and provided that it is economic to apply lime to hilly and steep country if required, it appears that oversowing and topdressing of the moister high country below about 1000m to 1200m altitude (for example the ranges of the western Mackenzie) is sustainable; however, as with "development" of the lowlands, this results in a substantial loss of biodiversity. Above this altitude the oversowing and topdressing option is uneconomic because of the short growing season. These pasture lands must be very sparingly grazed (if at all) to prevent nutrient decline.

Sustainability in a wider societal context – the one that is building up concerns about pasture and grassland "futures" has wider connotations. It involves bringing together in a common, holistic framework the sustaining of human centred values with the sustaining of nature's intrinsic values. Such a concept is embodied in the stated purpose of New Zealand's Resource Management Act where activities must address human needs in both the short and long-term, while safeguarding the life-supporting capacity of nature in its own right. This places a constraint on human activities; they must secure the integrity and continuity of natural systems over time.

Sustainability is about, for example, ensuring the self-cleansing capacity of waters is not overwhelmed; the health and regenerative capacities of soils, fisheries, forests and other renewable systems is maintained; the stability of the climate system is not disrupted; the risks

arising from natural or man made hazards or hazardous substances are kept at a low level; and the biodiversity of an area is not diminished. The bottom line is that sustainability is not just about sustaining the capacity of humans to dominate and manipulate the environment for their unique benefit and survival. That is the sharp reality that New Zealanders have to grapple with – particularly in terms of how we sustain our unique animals and plants in a deforested land; in a land being constantly invaded by pests and weeds from foreign lands and in world markets where our fussy consumers are increasingly expecting us to be able to demonstrate that our land based production systems are not mining New Zealand's ecologies.

This requires major shifts in our land use policies, legislation and not least the sciences. This need has certainly been well recognised at an intellectual level but I perceive progress towards more sustainable states is, and will remain, slow. Barney Foran in drawing together the themes of IGC XVII in 1993 (Foran 1993) noted that "while this congress marked the passing of one era in grassland science and heralded the beginning of another more broadly integrated science there are still many fondly held beliefs which are anachronistic for today's markets and environmental attitudes". He went on, under a heading "Can't see the grass for the trees!" to highlight papers that detailed the societal cost of clearing Amazon Rainforest (US$5000/ha) and focused on tree clearance. He contended they were all aimed at enhancing production of "commodity products probably of moderate quality for which we expect prices to be pretty flat for the next decade". His unstated question was "why are we at the end of the 20th century continuing to clear forests or woodlands in the face of so much ecological evidence that this is not sustainable ecologically or economically". He in part answered it by noting that "Conservation and recreation take place throughout our grassland production systems almost without the scientist in us noticing: those sort of things are supposed to happen in national parks and at weekends". This led onto the question, "In the future might grassland science find itself squeezed between cropping and conservation?" (Foran 1993). If current New Zealand evidence were any guide, I would say yes! I sincerely trust that many more pastoral scientists in 2001 are looking well beyond their traditional sciences in their quest to develop more sustainable heritage systems; ones that deliver a much wider range of attributes to society than have past pasture monocultures. I will be looking for evidence at IGC XIX that the issues Foran highlighted in 1993 are being seriously debated and addressed.

Sustaining New Zealand's bio-diversity; what species, where and for what purpose?

As highlighted early in this paper (Box 1) biodiversity is the environmental/ sustainability issue for New Zealand. Our endowment of indigenous flora and fauna is unique. Any resolution of the sustainability of pastoralism must address our biodiversity challenges. If we as a society choose to nurture our indigenous biodiversity we must be prepared to actively manage all our land to sustain all our biodiversity, be it on reserve, residential or farmlands.

The New Zealand Biodiversity Strategy

As a signatory to the International Convention on Biological Diversity, New Zealand is obliged to develop a Biodiversity Strategy. The need to do so was highlighted in 1997 in New Zealand's first state of the environment report". Indigenous biodiversity was described as our "most pervasive environmental issue" (Ministry for the Environment 1997). The purpose of New Zealand's strategy is to establish a strategic framework for action to conserve

and sustainably manage New Zealand's biodiversity. The primary focus is on indigenous biodiversity, though the maintenance of exotic biodiversity is acknowledged and addressed.

The process of developing the New Zealand Biodiversity Strategy has been a protracted one. We ratified the Convention in 1993; Government approved the preparation of a strategy in 1995; it began in 1996; a consultation draft was produced by December 1998 (Department of Conservation/Ministry for the Environment 1998) and a final strategy was launched early in 2000. The lead agencies developing the strategy have been the Department of Conservation and the Ministry for the Environment. The 1999 consultation phase was extensive, with over 50 meetings and 7800 submissions. The draft strategy was described as "receiving a broad level of support" although my community monitoring indicates ongoing concerns about the adequacies of consultation with tangata whenua (the indigenous Mâori people of New Zealand). The final strategy has been refined and revised to sharpen the focus on community action and education. It identifies 147 actions for implementation over 20 years; a daunting task that will necessitate substantive shifts in land use and land management.

Valuing biodiversity

The biggest single challenge to halting the decline in biological diversity in New Zealand is achieving widespread understanding, and dare I say agreement, as to what it is and why it is important. The 1992 Convention on Biological Diversity defines it as:

> "the variability among living organisms from all sources, inter alia, terrestrial, marine and aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and ecosystems."

However, since 1992, biological diversity – usually simply biodiversity – has been used to describe a myriad of ecological, biological and conservation concepts – but mostly to refer to the variety of species. Clearly it is much more than this but I suspect most people do not really understand this. Over the last 20 years the public face of our conservation efforts in New Zealand has been dominated by stories of saving icon species on the brink; black robins, kokako, kakapo and now kiwi. It will be a tough job to shift this perception to where the real values of biological diversity lie – as part of the planet's natural capital. Tough also because New Zealanders are <u>very</u> concerned about the loss of any of our unique species. There <u>is</u> a recognition we have a duty to ensure they are not lost forever for intrinsic value reasons, if no other.

It is the services of healthy ecosystems, clean water, stable climate, fertile soils and the assimilation of wastes (natural and industrial), that are the most valuable components of natural capital. Diversity of species is essential to the maintenance of that capital. How do we know this? A good piece of evidence of the innate value of ecosystem services is provided by the US$200 million Biosphere II experiment. In 1991, eight people entered a sealed, glass-enclosed 3-acre living system, where they expected to remain alive and healthy for two years. Instead, air quality plummeted, carbon dioxide levels rose, and oxygen had to be pumped in from the outside to keep the inhabitants healthy. Nitrous oxide levels inhibited brain function. Cockroaches flourished while insect pollinators died, vines choked out crops and trees, and nutrients polluted the water so much that the residents had to filter it by hand before they could drink it. Of the original 25 small animal species in Biosphere II, 19 became extinct.

At the end of 17 months, the humans showed signs of oxygen starvation equivalent to living at an altitude of 17,500 feet. Of course, design flaws are inherent in any prototype, but the fact remains that $200 million could not maintain a functioning ecosystem for eight people for 17 months.

The lesson of Biosphere II is that there are no man-made substitutes for essential natural services. We have not come up with an economical way to manufacture watersheds, gene pools, topsoil, wetlands, river systems, pollinators, or fisheries. Technological fixes cannot solve all problems with soil fertility or guarantee clean air, biological diversity, pure water, and climatic stability; nor can they increase the capacity of the environment to absorb unlimited quantities of wastes.

Communicating the message to New Zealanders that biodiversity is much more than simply protecting our icon species, requires more substantive research on ecosystem values and functioning, education on the importance of the whole system, and incentive/tax systems that will lead to our societal consumption patterns making less demand on all ecosystems.

The New Zealand Biodiversity Strategy cites the one study that has attempted to value New Zealand's indigenous biodiversity in monetary terms. This estimated land in 1994 at NZ$46 billion (Patterson and Cole 1999). The need to press on with identifying just what species we have is acknowledged, but taxonomy has been the Cinderella of the science world in New Zealand in recent years. We currently have about 30,000 described indigenous terrestrial species in New Zealand, but it is estimated the total number may be closer to 80,000. The backlog in species identification is substantial, particularly for marine life (PCE 1999), while a recently identified plant (*Celmisia sp*) collected 20 years ago now appears to be extinct (David Given pers comm).

So valuing biodiversity means knowing what we have got, and achieving widespread understanding that "halting the decline" is about much more than declines in individual species or indigenous community remnants. It is ultimately about declines in the capacity to deliver essential ecosystem services but (and this is a big but), there is little focus in New Zealand's strategy on the need to greatly improve our valuation of ecosystem services, inclusive of any production values, which particular indigenous species may have. Until this changes it is going to be very difficult to get the level of investment needed from governments or landowners. We will constantly undervalue the services and hence under-invest in their maintenance.

Turning the tide – making indigenous species part of our production landscape futures and recognising their contribution to enhancing ecological sustainability.

The marked decline in sheep numbers has resulted in a reversion of considerable areas of marginal hill lands to scrub cover (mostly indigenous species) or conversion to exotic *Pinus sp* plantations. This trend continues with major impacts on some rural communities and rural/regional ecosystems e.g. the impacts of *Pinus radiata* on Northland rivers and streams, and the wildlife and mahinga kai[2] values of those waterways. In some pastoral areas (e.g. the South Island tussock grasslands) there has been a major effort to diversify and focus on "niche" livestock farming to better suit land and markets (e.g. deer and super fine merino). But the major trend in agricultural land uses is towards intensification and specialisation (monocultures) on the limited areas of better soils, with the notable exception of a fledgling organic farming industry, which four years ago exported only $6 million of produce and this year will reach $60 million.

While New Zealand's biodiversity strategy recognises the need to maintain and enhance the biodiversity/genetic variability of exotic species, its focus is primarily on

[2] places where food and other resources are traditionally gathered.

indigenous biodiversity. In a land use context this generates two major challenges: the first is how to maintain biodiversity while current land uses involve fewer than 50 exotic species, and the second, the place of indigenous species, and associated ecosystems, on our non public lands. The strategy highlights the need for action by private landowners as noted above. However, gains on these two fronts will be hard. Enhancing biodiversity on private farmlands is always going to be dependent on the impact it has on the economic viability of the farm business. The general decline in farm returns (Alexander 1999), excepting the 25-30% of really profitable farms, makes it difficult to promote investments for biodiversity gains, unless they can also enhance profitability. The growing number of organic farms and increasing realisation of how overall ecological health can improve productivity in other farm systems (Wratten et al 1997), is providing the substrate for enhancing biodiversity on at least some farmland.

The area of potentially greatest biodiversity gain is returning land to indigenous vegetation – ultimately forests. As noted above, some natural reversion is occurring, as is some restoration of remnant forest/scrub areas. Ultimately, however, the greatest biodiversity gains on private land lie with the re-establishment of indigenous forests, scrublands or wetlands for sustainable harvesting and other profitable uses. While these will have different ecological characteristics to our old growth forests or original wetlands, our Gondwanan remnants, they will greatly increase the habitats for many of our unique flora and fauna and provide pathways for fauna to travel between the remnants.

While such forest developments seem logical, they are strongly opposed by some environmental non-government organisations because they perceive any commercial values attached to indigenous forests will stimulate demand for their products and hence all indigenous forests. In addition there is a widespread belief in rural New Zealand that regrowth of indigenous vegetation will only lead to such areas being appropriated by district plans which require, per the RMA, that "significant indigenous vegetation and significant habitats in indigenous fauna" be recognised and provided for as "matters of national significance", i.e. set aside in reserves. Therein lies a core paradigm clash. Much of our conservation thinking in New Zealand still focuses on reservation as the only option for nature conservation. This is, in part, a product of the Conservation Act (1987) which effectively partitions New Zealand into protected lands and production lands. However, as discussed above, the RMA that governs production lands also requires the protection of indigenous species and habitats. Nowhere, except in the 1993 Forest Amendment Act is there a focus on the sustainable use of indigenous forests and this mechanism is seen as inflexible and bureaucratic encouraging avoidance. The extreme tension between protection and use has been highlighted in the last 18 months by an acrimonious debate about trying to sustainably harvest timber from old growth New Zealand beech forests (*Nothofagus sp*) on the West Coast of the South Island. Such debates about land use and utilisation of indigenous species will have to be resolved if substantive gains in biodiversity in New Zealand are ultimately to be achieved and pastoral lands are going to have the scope to develop new business models that ultimately make greater sustainable use of indigenous species and forest ecologies.

New Zealand will have real difficulty breaking out of the partitioned landscape model; production on private lands with pasture dominating and conservation of public lands. Conservationists do not trust landowners to manage indigenous species in a sustainable fashion while landowners do not trust conservationists who try and appropriate their private property rights.

Sustaining biodiversity on private land has received particular focus during the strategy's development. Government agencies accept that New Zealand's aggregate biodiversity continues to be significantly affected by private land management. A Ministerial

advisory committee has prepared a report on biodiversity on private land (Ministry for the Environment (MFE) 2000).

The committee was asked to develop an "agreed set of proposals that will lead to effective sustainable management of biodiversity outside the conservation estate" (MFE 2000 p3). The committee consulted the length and breadth of New Zealand and developed 17 recommendations. More importantly it began a process of encouraging many New Zealanders to ask hard questions about what our land use futures should look like and what we must do to achieve them. The committee chairman, in an overview was prepared to comment frankly about the largely socio-political hurdles we face. He noted:

> *"One hundred years of a culture that encouraged land clearance as a virtue transformed our indigenous landscape. Those 100-odd years also created mindsets in both praise and condemnation of the industrialisation of our land. Remnants of both mindsets still remain, even though the economic and cultural reversal began 30 years ago. In the 1970s intensive livestock feed lots and synthetic fibre began their adverse impact on our pastoral industry.*
>
> *Intervention failed to stem the tide, and plantation forestry and reversion follow the retreat of farm animals from our less productive lands, not all of which are in remote locations. Thousands of new dwellings now share landscapes with animals and plantations. These dynamic land use changes, combined with growing resource depletion, triggered the gestation of the Resource Management Act, and the empowerment of local communities to manage their resources in a more integrated fashion.*
>
> *Our consultation confirmed that these significant economic and cultural changes are now entrenched despite protestations to the contrary. It is now widely acknowledged that plants and animals are in serious competition with humans for space and sustenance, and that they have a legitimate claim and entitlements".*

The role of the RMA, a piece of legislation as unique as some of our species, was also put into sharp focus in terms of its impact on private property rights – a flashpoint in any debate about the needing to change land uses – particularly when they impact on economic viability.

> "*The RMA facilitates and enables the public to intrude across that "private threshold". In this new world of the RMA, every intruder is confident that the morality and virtue of the cause justify the heresy of the violation. Those intruded upon rarely share that view. There is a special responsibility and burden on those administering the RMA process, at all stages, to recognise and be aware of these sensitivities, which are deeply entrenched and go to the very soul and origins of security, community and democracy. We ignore such sensitivities at our peril. They should not, and need not, be compromised in the drive to halt the decline in indigenous biodiversity."* (MFE 2000 p6)

While the report is an important milestone in our thinking about land use futures in New Zealand and where our indigenous species fit, it did not address a major dimension; the sustainable use of indigenous species. Until this is addressed we will have scant chance of achieving our current biodiversity goals let alone the sustainability demands of our fussy markets and the economic viability challenges of our landowners. This is a matter that I believe is at the heart of grassland futures in New Zealand, and I suspect many other countries. I discuss it below.

Back to the future

There are many barriers to the blending of indigenous vegetation back into the deforested pastoral lands of New Zealand. They are largely social, institutional and economic. The biggest immediate barrier is the desire by some sections of society to seek de-commercialisation of all indigenous species with the only harvesting to be for cultural purposed by New Zealand's first arrivals, Mâori. The problem is this "goal" has not been openly debated by New Zealanders. It has arisen by stealth via a series of pieces of legislation (principally the Conservation Act 1987 and RMA 1991) and intensive lobbying for all old growth forced logging to cease. The goal of protecting old growth forests is valid; that it has flowed over into the goal of protecting all indigenous vegetation is creating an unsustainable position for land use futures.

So what is a way forward? As PCE I have instigated, in October 2000, an investigation into the future role of indigenous flora on non-public lands. The goal of the project is to discuss whether it is possible to link the utilization of indigenous flora on non-public lands to the enhancement of New Zealand's ecologically sustainable development and specifically terrestrial indigenous bio-diversity. The intent of the investigation, which will involve an issues paper followed by a more detailed investigation of an aspect or aspects, is to stimulate a much wider and searching debate about land use pathways for New Zealand in the 21st century. In ecological terms current agricultural systems, pastoral and others, are not suitable. They are all mining resources to a greater or lesser extent. Forest systems tend to have the lowest input needs. Therefore should such systems, using species that have spent 80 million years adapting to New Zealand's unique climate and geologies, form a greater part of our futures? I believe they should and must.

Some clues as to what that future might look like, drawing on what is happening now in New Zealand and Australian examples are outlined in Boxes 5 and 6. Grassland scientists worldwide must embrace the realities portrayed.

Box 5: A window on the future?

Taranaki Regional Council is generally regarded as one of the more forward thinking units of local government in the country and has developed a reputation for its success in getting its rural community onside. Bill Bayfield, the director of resource planning with the council, believes that for them 'the tide has turned!' Their council has been monitoring changes in vegetation cover from aerial photographs, which they have going back to the 1950s. They are satisfied that their region is on the path to a more sustainable future with significant areas of retirement from grazing, allowing reversion to an indigenous cover, and/or the planting of exotic plantations for longer term timber production. The council has a history of dealing with riparian management (strips of vegetation along streams) and can see major improvements in water quality. The 'Taranaki Tree Trust' facilitates the management of indigenous remnants, focusing on significant areas and organising covenants where appropriate. Perhaps the most worthwhile initiative is the council's support for the development of 'whole farm plans'. These plans enable the development of a more integrated approach to retirement, afforestation, and riparian re-vegetation. An optimistic view would see all farms in the region having whole farm plans within ten years. There needs to be an element of realism. Farmers will fence vegetation but they won't undertake active management unless their financial circumstances allow. (Bill Bayfield – pers.comm)

Box 6: Future farm outputs – ecological services

Markets for environmental services are beginning to emerge. The first carbon and salinity trades have recently been negotiated by State Forests of NSW in partnership with the Sydney Futures Exchange (carbon) and Macquarie Food and Fibre (salinity). Markets for biodiversity can also be imagined. For example, the Goulbourne – Broken Hill Catchment in Victoria is contemplating marketing investment in conservation shares in Melbourne. Further opportunities lie in other areas such as water purification. In one celebrated case the services of water filtration and purification provided by ecosystems in the catchment for New York City was estimated to be worth at least US$6 billion, which was the difference between the cost of repairing the ecosystems and building artificial filtration facilities to replace the degraded capacity of the ecosystem services (Chichilnisky, G. and G. Heal 1998. Economic returns from the biosphere. Nature 391, pp 629-630.) In rural landscapes a particular challenge is how to bundle or package services associated with re-establishing areas of indigenous vegetation. Table 2 projects the potential by speculating on what a diversified farm might look like in 20 years time. Traditional agricultural business output accounts for 55% of the total. Areas of land rehabilitated provide benefits through timber, carbon credits, salinity mitigation, water filtration and biodiversity. These benefits are sold to different clients in a mature market place that has defined and quantified the flows of valued services from the farm.

Table 2: Potential farm products in the year 2020

Commodity	Share of farm business (Net Present Value)	Client
Wheat	40%	World Market
Wool	15%	World Market
Timber	10%	Pulp Wood Specialty Timber Merchants
Carbon Credits	7.5%	Japanese Steel Company
Salinity Credit	7.5%	Catchment Management Authority – cost sharing fund
Water Filtration Credit	15%	Water Board
Biodiversity Credit	5%	Philanthropic Trust

To achieve this vision, methods that can account for the various environmental services flowing from on-ground works are required.

From: Conserving Biodiversity, Institutions, Policies and Incentives. Final Report Carl Binning CSIRO Wildlife and Ecology. Nov 2000, 81pp: For the New Zealand Treasury, Ministry for the Environment and Department of Conservation.

Concluding views

In this story of pastures rapidly carved out of a forested land I have endeavoured to highlight that the uniqueness of New Zealand's ecology, our greening urban values, the demands of our fussy global food and fibre markets and international visitors are the 21st century "shapers" of our grassland futures. The 20th century industrial agricultural model will not take us far into this century. Yes, we have a proud record as a developer of pastoral systems based on introduced grasses and legumes and dependant on phosphorus and sulphur. However, as the sciences of sustainability have begun to mature and the ecological/environmental impacts of our systems become quantified and absorbed by the public and political consciousness, expectations of land stewards have changed drastically. This is being expressed as a general movement towards a diversification of activities in the rural environment with people, Mâori and pakeha[3] moving out of urban areas to develop new enterprises. The rural population, particularly peri-urban, is on the rise again.

Facets of the New Zealand story are repeated around the world today. The challenge of maintaining biodiversity, a fundamental requirement for good land use stewards in the 21st century, is being faced, to a greater or lesser extent, by all nations. The way New Zealand is approaching the challenge may well provide lessons for others. So what are those challenges and what is needed?

- Protecting and enhancing New Zealand's unique biodiversity is the single biggest long-term driver for the redesign of our land use systems. Market demands are the short to medium term drivers. We will not achieve the biodiversity goals we have set ourselves, and are expected of us by communities worldwide, unless there is an expansion of indigenous vegetation on private farmlands. This has to be within legislative and property rights frameworks that are acceptable to current landowners given they will bear a large proportion of the costs associated with the redesign.
- Indigenous biodiversity must assume greater value, intrinsic and economic. This has been fully accepted in conservation terms but we are only just beginning the debate about whether we should, or how we might, assign conservation an economic value. A wide range of markets for potential "products", as illustrated in Table 2, must be developed. Some of those products will be extractions from the expanded indigenous ecosystems.
- Current policies, legislation and investment practices are continuing to favour a partitioned landscape in New Zealand. One where the use is exclusively conservation, plantation forestry or intensive pastoral crop or horticulture. This sharp demarcation is starting to break down at the interfaces between extensive pastoral lands, conservation and forest lands, but the pace is slow except where there are dedicated farm forestry or conservation orientated farming families and sympathetic local government policies and practices. Extensive effort is needed to identify, and remedy the myriad of barriers to land use and farm business changes. Many of the barriers are not because we don't have the required information. It is more frequently a matter of who's got the information, how it is disseminated and attitudes and behaviours of land users and public agencies.
- The "land" sciences of pastoral agriculture in New Zealand face big challenges. Over the last 50 years they have dramatically increased production of animal products per hectare. However, this has increasingly been at the expense of ecological efficiencies and environmental impacts. Resolving these challenges now requires a much wider suite of "sciences" and much greater involvement of wider society, particularly land users. The values of ecological capital and economic capital have to be intertwined. The ecological health of pastoral systems will have to be the dominant focus with economic realities being shaped by ecological necessities, not the reverse.

[3] Non Mâori New Zealanders

- Over the rest of the 21st century the viability of New Zealand farms will increasingly be dependent on woody species. Many of these will be our indigenous species. The ecological cost of their removal has been high. We cannot carry that cost for another century. New Zealand will remain in the business of pampering the palates and passions of the world's more prosperous peoples. These 'palates' will increasingly focus on ecological sustainability matters. To deliver on the expectations will require us to continue to enhance our biodiversity in ways that can contribute to the returns from the farm business.

Grassland scientists in New Zealand are already part of the teams that will design more integrated land use systems – ones where grass and trees blend more and which are ultimately more ecologically sustainable. The other key players in the team are the land users and our units of local government. Because land users, the farm families which characterise New Zealand agriculture are the ones that carry most of the risks and costs associated with land use changes, they are the key players. In many ways they may already be ahead of the science community in recognising what is needed; what the realities are. However they are, whether Mâori or pakeha, proudly independent and fiercely protective of their property rights. Therefore for grassland sciences to make a substantive contribution in New Zealand or elsewhere in the world, to 21st century pastoral systems that embrace biodiversity and other ecological imperatives, they must fully integrate their effort with land users. It will take such collective effort and combined wisdom to meet grassland challenges. I look forward to observing progress over the next decade.

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Appendix 1

Resource Management Act 1991

By bringing together laws governing land, air and water resources, the Resource Management Act (RMA) introduces a totally new approach to environmental management. The Act's 'eco-system' approach recognises that elements of the environment do not stand alone, and that effects of human activities on the environment are not discrete.

Sustainable management

The Resource Management Act has a single, overarching purpose: to promote the sustainable management of natural and physical resources. In the Act, 'sustainable management' means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well0-being and for their health and safety while:

- sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;

- safeguarding the life-supporting capacity of air, water, soil and ecosystems; and

- aiding, remedying, or mitigating any adverse effects on the environment.

This recognises that people need to use resources for their welfare, but that in doing so we must not, either singly or cumulatively, compromise the ability of the environment to continue to provide those resources, or other indirect services (such as erosion control) to the community.

The concept of sustainable management is derived from that of sustainable development. Sustainable development was coined in 1987 by the World Commission on Environment and Development (World Commission on Environment and Development, 1987), and developed at the 1992 Rio 'Earth Summit'. It is a widely embracing concept, requiring environmental sustainability as well as economic viability and social justice.

In comparison, the concept of sustainable management in the Resource Management Act leaves the pursuit of economic and social goals to other mechanism available to government and the community, e.g. our taxation and welfare systems. While recognising that there are social and economic consequences from the use of resources, the Act attempts to ensure that the environment's sustainability is not compromised by the pursuit of those concerns.

Source: The State of New Zealand's Environment 1997, Ministry for the Environment.