

# Ecosystem services assessment in New Zealand

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## Ecosystem services research

Spatially explicit models of ES indicators

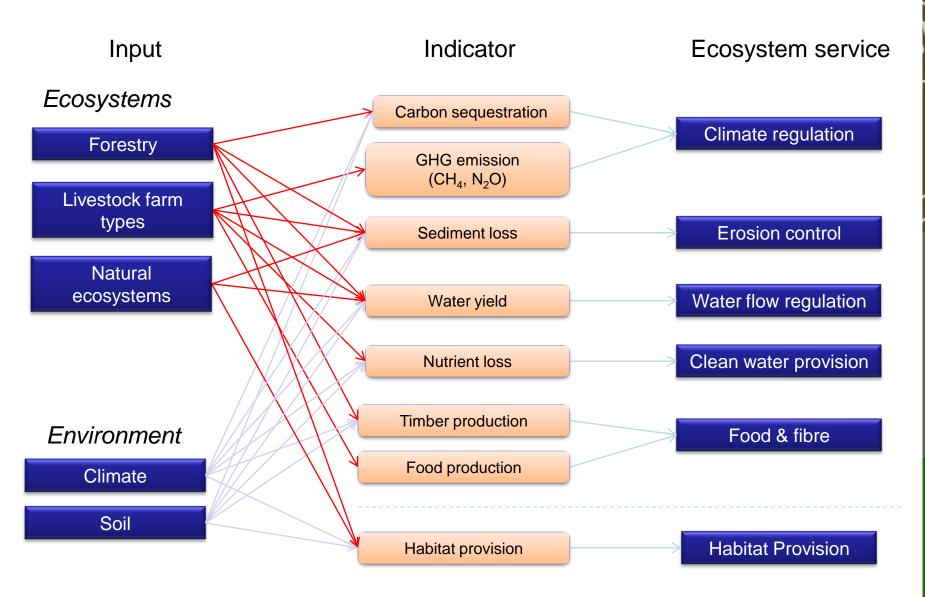
 Decision-making tools for better matching of land use with soil capability

 Build biodiversity into an ecosystem service-based approach for resource management

## **Ecosystem Services Classification**

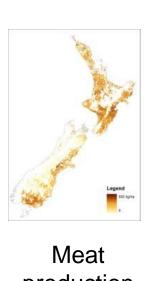
Tier 1	Tier 2	Tier 3				
Qualitative measure (narrative statement)	Quantitative measure per ecosystem	Spatial variation within ecosystem				
Food: capture fisheries, aquaculture, Wild food, honey Genetic resources, biochemicals Minerals Disease\pest regulation Pollination Cultural: Aesthetic values, recreation, tourism, sense of belonging	Food: crops Water purification Natural hazard regulation Nutrient cycling Soil formation and maintenance Primary production	Food: livestocks, crops Fibre: timber, sheep wool Freshwater: quality (nutrient) Physical support for dwellings Climate regulation Water-flow regulation Erosion control Water cycling Natural habitat provision				

## GIS framework



Ausseil et al (2013)

## Mapping ecosystem services









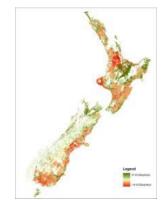
Provisioning services

production

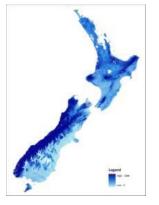
Milk solids production

Wood production

Wool production



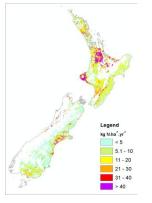
Greenhouse gas fluxes



Water yield



Soil retained

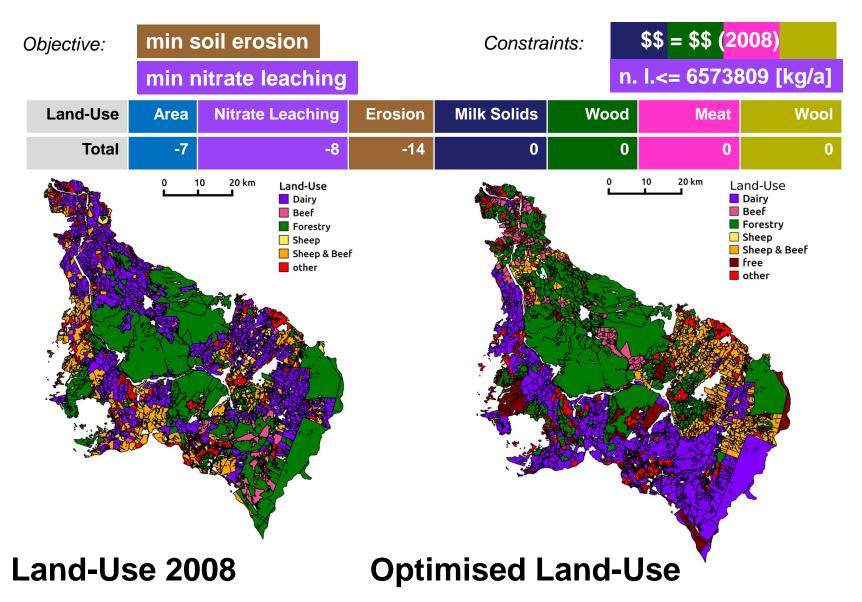


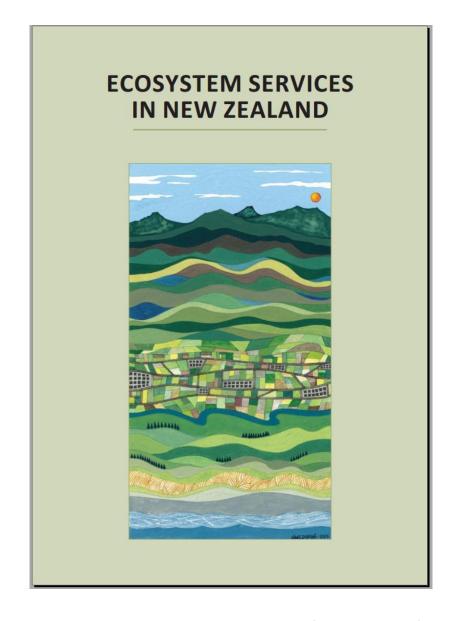
**Nutrient loss** 

Regulating services

Ausseil et al (2013)

## Spatial optimisation of ES





www.nationwidebooks.co.nz (book order)

http://www.landcareresearch.co.nz/publications/books/ecosystem-services-in-new-zealand (pdfs)

### What's in the book

- Part 1: Natural and managed ecosystems
- Part 2: Ecosystem services
- Part 3: Analysis

### ECOSYSTEM SERVICES IN NEW ZEALAND'S INDIGENOUS TUSSOCK GRASSLANDS: CONDITIONS AND TRENDS

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ABSTRACT: Indigenous vegetation such as grassland provides a range of services of varying values to humanity, depending on grass-land type and degree of intactness. Understanding this complex relationship in a particular ecosystem or related ecosystems is most important and should be an integral component of environmental planning. To set the scene, some historical aspects of the origins important and instruction to an image to component or currentinents in parameter. For example, the second and except on the development, management and research in New Zealand's indigenous grasslands are described, and changes in land tenure are outlined to provide a background against which the ecosystem services that grasslands have to offer can be better understood. The ecosystem services that different grassland types are able to provide are described according to the Millennium Ecosystem Assessment categories especially those of provisioning (biodiversity values): regulating water production, polination, biological control), cultural (educational, scientific, recreational and tourism values); and supporting (soil conservation values, carried to storage and sequestration). The threats to these services are then described with emphasis on land use (gazzing and intentification, mining), traview weeds and invertibed to the production of the control of the contr tebrates, and climate change. We conclude by pointing out that indigenous grassland ecosystems deliver a wide range of importan ecosystem services that provide many tangible benefits to human well-being, which are best protected in public ownership and managed

Key words: biodiversity, ecosystem services, grasslands, invasive species, soil, water.

### INTRODUCTION

Indigenous vegetation provides a range of services of varying values to humanity. These are associated with the normal functioning of components in integrated ecological systems. The type and level of service inevitably varies among ecosys-tems but New Zealand's indigenous grasslands can contribute multiple services depending on grassland type and their degree of intactness. As the human population and associated land-use pressures increase in New Zealand, many ecosystem services provided by indigenous ecosystems are reduced and threatened. Understanding this complex relationship in a particular ecosystem component of environmental planning.

The normal functioning of most ecosystems provides many tangible benefits to human well-being that are usually taken for granted by the general public unless they become obvious by a sudden disruption or threatened failure. Most ecosystem servi cannot be privately owned, so are appropriately treated as 'public good', which adds to their risk of being ignored or inadvertently threatened. In addition, disturbing an ecosystem in a particular ation often causes effects elsewhere.

The Millennium Ecosystem Assessment (2005) pro

a framework for considering ecosystem services derived from indigenous grasslands, categorising ecosystem services as: provi-sioning (food, fibre, water, fuel, genetic resources); regulating (air quality, climate, water flow, pollination, erosion control, pest and disease control); cultural (spiritual, aesthetic, recreational, educa-tional) and supporting (photosynthesis, soil formation, nutrient cycling). In this chapter we address some of these categories and outline the role of tussock grasslands in the major types of New Zealand's indigenous grasslands.

### NEW 7EALAND'S INDIGENOUS GRASSI ANDS

It has been well established that indigenous grasslands prob-

ably reached their greatest extent just before European settlement

in the 1840s (Holloway 1959; Mark 1993; Mark and McLennan 2005) and this is frequently used as a conservation baseline. Although debated, this baseline is somewhat easier to establish than a prehuman one of for example AD 1100. However, the biota of these grasslands before European settlement essentially comprised only indigenous biota. Moreover, the pattern is consistent with overseas situations where, unlike New Zealand, humans had been present much longer yet had similar impacts on the indigenous vegetation; thus, early human activities generally favoured non-woody, particularly grassland, vegetation because of its generally greater adaptation to fire than the indigenous woody flora (Ogden et al. 1998).

However, the extent of grassland in this rain-shadow region before Polynesian settlement continues to be the subject of debate, much of it based on the Central Otago region. A widely held view considers that areas of low- to mid-altitude tussock grassland, below the climatic treeline in the South Island rain shadow region, were derived from a woody, mostly forest cover that was removed by not-infrequent burning during the period following Polynesian settlement about 750 years ago (McGlone 2001; Wilmshurst et al. 2008; McWethy et al. 2010). McGlone (2001) considered that in pre-settlement times grassland was mostly patchy within the woody ecosystems, occurring in limited areas of droughty or low-nutrient soils and wetlands, or temporarily after infrequent fire or other disturbance'. However, the environmental tolerance of residual populations of a suite of woody taxa led Walker et al. (2003, 2004a, b) to assume forest while 'shrublands may have dominated above the regional treeline', Walker et al. (2003, p. 58) considered tussock grasses relevant only in the 'alpine tussock-shrubland zone [which] is restricted to the highest elevations in Central Otago ... [as on] the summits of the Old Man Old Woman and Pica Ranges and the grassland was probably confined to floodplains and local areas of shallow or permanently moist soils'. Extensive grasslands below

In the late 1990s, the Department of Conservation initiated study of the impact of burning in tussock grassland as part of a larger study investigating impacts of fire on the grassland vegeta-tion (Payton and Pearce 2009), and examining the characteristics of fire in tall tussock grassland. This provided an opportunity for more intensive invertebrate sampling, with some baseline infor at the two sites selected for this study (Barratt et al. 2005, 2006). and examination of the extent to which introduced biocontro agents have expanded their range from lower altitude pasture to natural grassland ecosystems (Figure 5). Comparative invertebrate work was carried out at two other native grassland sites, at Cass and near the Tukino Skiffeld, Mt Ruapehu. These sites were used in conjunction with the Otago sites to investigate impacts on the invertebrate fauna from agricultural development (over-sowing with exotic pasture species) and cultivation (Barratt et al.

Further studies by Otago University students have added to knowledge of tussock grassland invertebrates (Figure 4), such as information on invertebrate biodiversity of tussock shrubland (Derraik et al. 2001, 2002, 2003); biodiversity of insects along a gradient of tussock grassland modification (Dixon 2004), Coleoptera biodiversity (Goodman 2002); Curculionidae and associations with plants (Murray 2001: Murray et al. 2003. 2006): plant-invertebrate relationships (Rate 2005): invertebrate of alpine patterned ground (Scott 2007); and spiders in tussock grassland (Malumbres-Olarte 2010).

### THE GRASSLAND PATTERN AT THE TIME OF EUROPEAN

Mark and McLennan (2005) attempted to deduce the general pattern of the major indigenous grassland types in immediately pre-European time (1840 baseline); this was a model exercise for the World Conservation Union of IUCN plan to assess the The New Zealand grassland nattern was assessed on the basis

of five major grassland types established in the ecological litera-ture by Cockayne (1928) and Wardle (1991). These patterns are described in Mark (1993). Mark and Dickinson (1997), and Mark and McLennan (2005). Three broad types of wide extent were recognised: lowland to montane short tussock grassland, lowland to montane tall tussock grassland, and subalpine to low-alpine tall tussock grassland. Only the low-alpine grasslands were considered to be strictly natural or primary Figures 3c, 6a, b). In the North Island, the short tussock grassland, generally <50 cm tall, pied some drier inland areas, and in the South Island, shor tussock grassland occupied the lower slopes of the subhumid ne basins of Marlborough, inland South Canterbury (Figure 3a), and Central Otago (Figure 3b) below c. 800 metres and where annual rainfall was also less than 700 mm (Figure 3c). The dominant grasses in recent time have been Festuca novae zelandiae. Poa cita and locally Elymus apricus, but their role in the early post-European grasslands and details of the plant cover at this time remain uncertain, although shrubs and palatable herbs were probably more common (Wardle 1991). Festuca novae-zelandiae and Poa cita are relatively unpalatable so, as a result of pastoral farming, both have increased and displaced more palatable species (Connor 1964; Mark 1993), Fescue tussock (F. novae-zelandiae) is only rarely mentioned in early accounts.

Montane to subalpine tall tassock grassland in many areas was dominated by forms of the red tussock. Chionochlog rubra, which

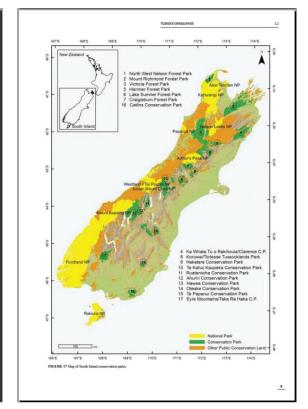


alpine snow tusseck-herbfield, Gertrude Valley, Fiordland National Park, with large-leaved Colminia, Bullvinella, Ram



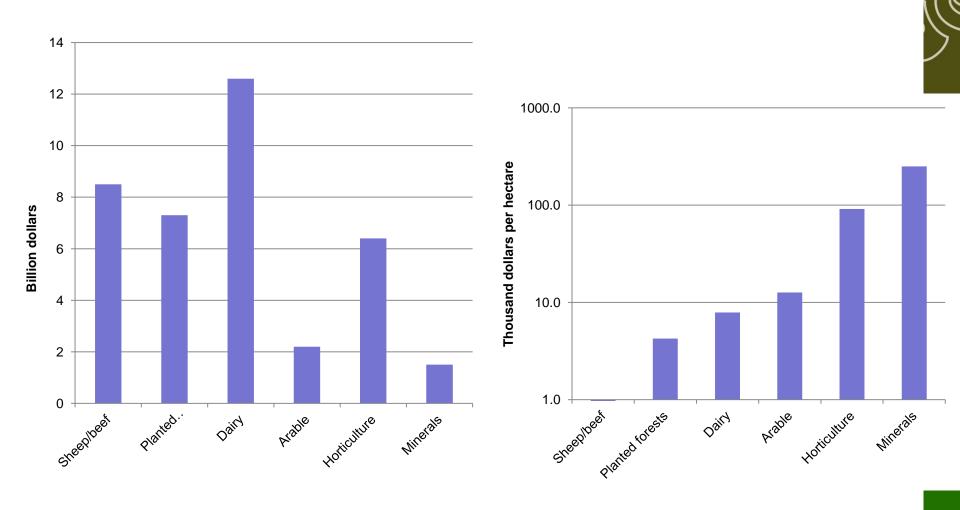
o National Park, 1450 m. AFM photo, January 1970

grows to 1.5 metres tall and has distinctive reddish to copper hues t was extensive on the North Island volcanic mor as a prominent feature on Mt Egmont (Clarkson 1986) and the central Volcanic Plateau (Atkinson 1981; see Figure 7), Here, in have invaded (Rogers and Leathwick 1994)



Mark AF, Barratt BFP, Weeks E 2013. Ecosystem services in New Zealand's indigenous tussock grasslands: conditions and trends. Jo Dymond JR ed. Ecosystem

### Value of some provisioning ecosystem services



## Synopsis of the book

Service Group Service	Urban	Urban Production					Natural										
Provisioning	Urban	Pasture	Cropland	Orchard	Exotic forest	Forest	Shrubland	Grassland	Alpine	Rare	Wetland	Estuary	Lake	River	Marine		
Crops	7	7	7	7													
Livestock		±						<b>↔</b>									
Capture fisheries											\ \	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		
Aquaculture														7	7		
Wild foods		$\leftrightarrow$			↔	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		±	±	±	±			
Timber					1	<b>\</b>											
Fiber		× .				7		<b>↔</b>			`\						
Biomass fuel		↔					<b>↔</b>										
Thermal energy																	
Freshwater		±	$\leftrightarrow$	↔	↔	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		<b>↔</b>		$\leftrightarrow$	±			
Genetic resources		<b>↔</b>	7	7	<b>↔</b>	$\leftrightarrow$	$\leftrightarrow$	±	±	<b>&gt;</b>	<b>\sqrt</b>	$\leftrightarrow$	$\leftrightarrow$	<b>S</b>	<b>↔</b>		
Biochemicals, natural medications, and pharmaceuticals							7										
Minerals						7	7	7	7								
Physical support for dwellings	1	<b>↔</b>	<b>↔</b>	↔				<b>↔</b>									
Regulating	Urban	Pasture	Cropland	Orchard	Exotic forest	Forest	Shrubland	Grassland	Alpine	Rare	Wetland	Estuary	Lake	River	Marin		
Air quality regulation	7																
Climate regulation	<b>\sqrt</b>	×	<b>↔</b>	↔	1	$\leftrightarrow$	1	$\leftrightarrow$	$\leftrightarrow$		$\leftrightarrow$	<b>↔</b>	<b>↔</b>	<b>↔</b>	×		
Water regulation		$\leftrightarrow$			±	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		$\leftrightarrow$			<b>\sqrt</b>			
Erosion regulation		7	<b>↔</b>		7	$\leftrightarrow$	7	<b>\Sigma</b>	↔								
Water purification and waste treatment	7	7									>			× .			
Disease regulation	7																
Pest regulation	7	<b>↔</b>	<b>&gt;</b>	<b>&gt;</b>	<b>↔</b>	7	<b>↔</b>	<b>\S</b>	<b>&gt;</b>		<b>&gt;</b>	<b>↔</b>	<b>S</b>	<b>&gt;</b>	↔		
Pollination	1	1	Ţ	1		<b>↔</b>	<b>↔</b>	<b>↔</b>	$\leftrightarrow$								
Natural hazard mitigation					$\leftrightarrow$	$\leftrightarrow$	↔				$\leftrightarrow$						
Cultural	Urban	Pasture	Cropland	Orchard	Exotic forest	Forest	Shrubland	Grassland	Alpine	Rare	Wetland	Estuary	Lake	River	Marine		
Amenity value	<b>&gt;</b>	<b>↔</b>	<b>↔</b>	7	<b>↔</b>	$\leftrightarrow$	<b>↔</b>	$\leftrightarrow$	$\leftrightarrow$	↔	>	<b>&gt;</b>	<b>&gt;</b>	±	$\leftrightarrow$		
Recreation	$\leftrightarrow$	<b>↔</b>			$\leftrightarrow$	$\leftrightarrow$	<b>↔</b>	$\leftrightarrow$	$\leftrightarrow$		<b>↔</b>	$\leftrightarrow$	<b>&gt;</b>	$\leftrightarrow$	$\leftrightarrow$		
Tourism	↔	<b>↔</b>			↔	<b>↔</b>	<b>↔</b>	$\leftrightarrow$	$\leftrightarrow$	↔	↔	↔	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		
Sense of belonging	$\leftrightarrow$	<b>\sqrt</b>	<b>&gt;</b>	↔	↔	$\leftrightarrow$		$\leftrightarrow$	$\leftrightarrow$			$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$	$\leftrightarrow$		
Supporting	Urban	Pasture	Cropland	Orchard	Exotic forest	Forest	Shrubland	Grassland	Alpine	Rare	Wetland	Estuary	Lake	River	Marin		
Soil formation and maintenance	<b>\sqrt</b>	<b>\S</b>	$\leftrightarrow$	7	$\leftrightarrow$	$\leftrightarrow$	<b>↔</b>	<b>Y</b>	<b>&gt;</b>								
Provision of natural habitat free of weeds and pests	7	<b>↔</b>	<b>↔</b>	<b>↔</b>	<b>↔</b>	±	↔	<b>×</b>	$\leftrightarrow$	<b>&gt;</b>	<b>S</b>	<b>S</b>	$\leftrightarrow$	× .	×		

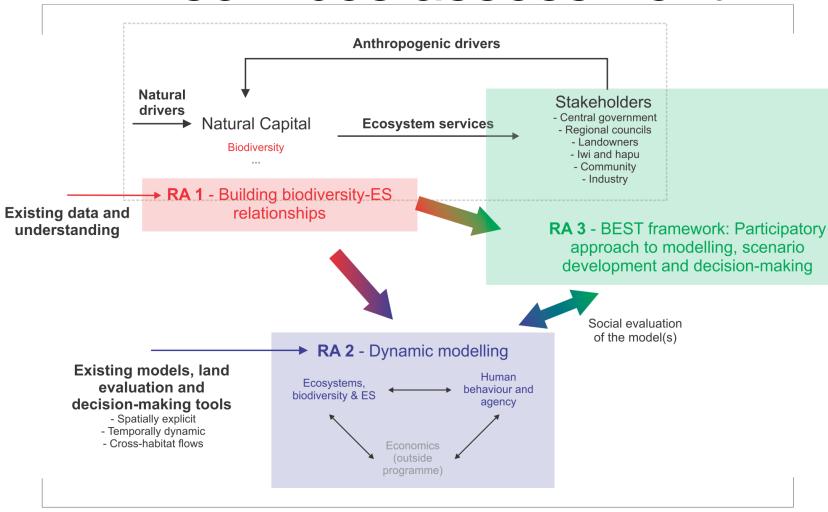
## What have we learned?

Improve riparian management

Match land use with soil capacity

 Evaluate trade-offs between invasive species and native biodiversity

# BEST: Biodiversity and ecosystem services assessment



## Linkages with decision-makers

Piloted ES approach with regional councils

Piloted ES review with 5 NZ companies

 Science advice to the New Zealand Natural Capital Assessment

Involvement at international level to IPBES and ITPS

## Innovative data analysis



- improve harmonisation of spatial databases (soil, land use, biodiversity) for reporting
- Model indicators of biodiversity and ecosystem services
- Support environmental reporting and future
   ES assessment

## Thank you