BEFORE COMMISSIONERS APPOINTED BY QUEENSTOWN LAKES DISTRICT COUNCIL

IN THE MATTER	of Resource Management Act 1991
AND	
IN THE MATTER	of submission of Jeremy Bell Investments Limited and Submission 782/784 and FS1030/1091

BRIEF OF EVIDENCE OF PETER ROSS ESPIE

GALLAWAY COOK ALLAN
LAWYERS
DUNEDIN

Solicitor on record: Phil Page / Bridget Irving
P O Box 143, Dunedin 9054
Ph: (03) 477 7312
Fax: (03) 477 5564
Email:phil.page@gallawaycookallan.co.nz
Email: bridget.irving@gallawaycookallan.co.nzz

1. Qualifications

1.1 My full name is Peter Ross Espie. I am a research scientist who has specialised in the ecology and agronomy of South Island high country grassland systems.

1.2 I hold a B. Ag. Science degree (First Class Honours) from Lincoln College (1976) and was a University of Canterbury Senior Scholar. After post–graduate study at the University of British Columbia (Dip. CS), I completed a PhD in soil-plant relationships, examining fertilizer development of high country grasslands, as a Hellaby Fellow at the Centre for Resource Management, Lincoln College/University of Canterbury in 1987.

1.3 I have been awarded a Stapledon Fellowship, a Hellaby Fellowship, University Grants Scholarship, University Senior Scholarship, Nelson Golden Bays Scholarship, and a Sewell Scholarship.

1.3 I am a Director of AgScience Limited, an agricultural research and consultancy company.

1.4 I am a former Director of The Queen Elizabeth the Second National Trust, and was an Honorary Research Fellow in the Department of Botany at the University of Otago. I am the Chairman of the Balmoral Biodiversity Benchmark Trust, responsible for protecting and managing extensive grassland, shrubland and wetland systems near Lake Tekapo, Mackenzie Basin.

1.5 I worked as a Technical Officer, Range Management, Department of Lands & Survey in Canterbury until 1978 when I undertook post -graduate studies at the University of British Columbia, working on forest soils. I was the field team leader for the Mackenzie Protected Natural Areas Programme leading conservation assessments for five ecological districts in the Mackenzie Ecological Region 1983/84. From 1985-1992 I was a scientist at the Forest Research Institute, Christchurch, working in forest and grassland ecology, and from 1992-2004 a scientist at AgResearch, Dunedin, researching grassland agronomy and management, and was the team leader of AgResearch’s Grow Otago soils and climate modelling group.

1.6 I have published over 50 scientific papers, research reports and articles and one book. I am invited internationally as a keynote conference speaker and guest lecturer. I undertake applied and University research and graduate supervision (Honours to PhD).

1.7 I have provided scientific assessments for District and Regional Councils and New Zealand and Australian Government departments. I have been called as an expert witness for Water Allocation, Environment Court and Land Valuation tribunal hearings.

1.8 I have read, and agree to comply with, the code of conduct for expert witnesses [1].

2. Scope of Evidence

2.1 I have been engaged by Jeremy Bell Investments Limited to provide advice in relation to the vegetation clearance rules in the Proposed Queenstown Lakes District Council Plan (QLDC).

2.2 I am familiar the vegetation and environments Queenstown Lakes ("QLD") through the GrowOtago climate and soil modelling project plus my involvement with many ecological studies and assessments in the district.

3. Evidence

3.1 Central to the discussion regarding indigenous vegetation clearance is the QLDC's statutory requirement to manage the tension between biodiversity protection and production land uses.

3.2 The Environment court ruling in *Royal Forest and Bird Society of New Zealand v. Dougal Innes* [2014] NZEnvC 72 strongly suggest revision of the QLDC vegetation clearance rules for greater simplicity, clarity and practical application for ordinary residents.

[1] Schedule 4 Code of conduct for Expert Witnesses, High Court Rules.

3.3 Definition of what constitutes significant indigenous vegetation lies at the heart of this issue and the conflicts regarding permissible land use.

3.4 Definition of indigenous is straightforward and unambiguous.

3.5 But what constitutes indigenous vegetation and the threshold for 'significance' is contested.

3.5 I illustrate this in Figure 1. Vegetation is an assembly of plant species and similar assemblies are ecologically termed 'communities'.

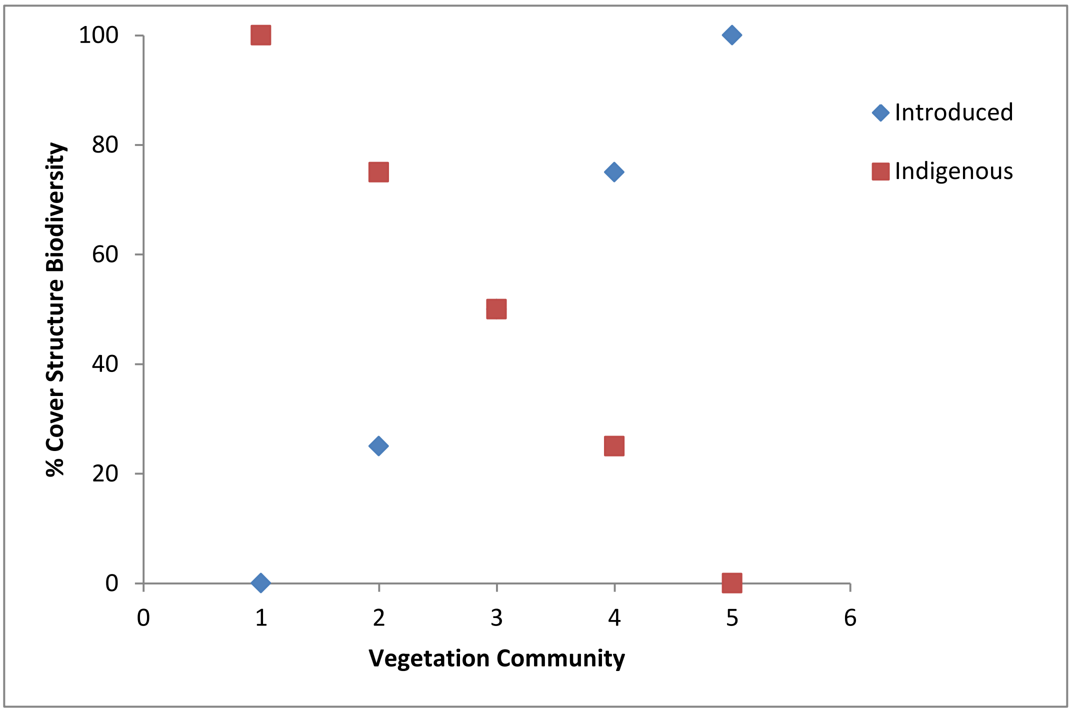


Figure 1. Vegetation Community composition.

3.6 There is consensus that vegetation where indigenous species constitute the predominant components of cover, structure and species composition, (Community 1) are indigenous vegetation. Examples in QLD are western beech forests and alpine snow tussock grasslands.

3.7 There is also consensus that vegetation where introduced species constitute the predominant components (Community 5) is introduced or exotic. Examples are high producing pasture and forest plantations.

3.8 Due to anthropic action, Polynesian burning and European pastoralism, indigenous vegetation has been modified to varying degrees, containing both indigenous and introduced species (Communities 2-4).

3.9 Broadly there are three categories of vegetation: e.g. indigenous, modified, exotic; (or using a four class scale, indigenous, semi-natural, modified, exotic).

3.10 Problems arise in determining where the boundary of indigenous vegetation lies. One view, regarding naturalness as an important criterion, restricts it to only relatively unmodified communities e.g. those with 100 – 75% or 100 – 66% indigenous characteristics. These are universally regarded as having higher value than more modified examples derived from the same community.

3.11 Others consider even highly modified communities that have been derived from indigenous communities and retain some indigenous elements, as indigenous vegetation e.g. those ranging from 100 - to say 5%.

3.12 These distinctions result in ambiguity in interpretation of district plan requirements. If communities with a high degree of indigenous integrity are taken to constitute indigenous vegetation, then following the extensive PNA and Department of Conservation tenure review surveys, identification and protection of representative indigenous communities in the QLD is well advanced and the best examples of communities are identified and most are protected . Provisions regarding indigenous vegetation clearance should apply only to these communities.

3.13 Conversely, the alternative view holds that protection of even highly modified communities is incomplete, and application of indigenous vegetation clearance rules to these intermediate communities is required to halt biodiversity loss.

3.14 My opinion is that classification of vegetation into three categories would considerably assist QLDC with implementation of indigenous vegetation management.

3.15 Significance is allocating value to vegetation communities. Two fundamentally different approaches are possible.

3.16 The first uses direct measurements of community attributes, e.g. indigenous species composition, naturalness, % cover, structure, and uses these to determine conservation value in an district against criteria such as original communities, rarity, connectivity etc.

3.17 The second uses indirect or secondary surrogate criteria to allocate significance, e.g. the % of indigenous cover in a modelled environment (Land Environments of New Zealand (LENZ) and the derived Threatened Environment Classification (TEC).

3.18 Direct assessment of vegetation is superior to the use of indirect estimated indices to determine significance.

3.19 There is considerable scientific uncertainty regarding how accurately fine scale level 4 LENZ modelling corresponds with observed floristic and faunal differences in tussock grassland systems.

3.20 LENZ was designed in 2004 as an environment classification system on a national scale. Critical problems are present when it is used at a local scale, as is proposed in the QLDC Plan.

3.21 The principle criticisms relate to data adequacy and model construction. Climatic information was obtained from Meterological Service stations (now NIWA data) which were always located close to human habitation for manual recoding by observers, leading to a low altitude bias. Furthermore there is a nationally uneven distribution of professionally operated stations, being mainly based in urban centers, with few located in the high country. There is variable quality of the information in the datasets.

3.22 While rainfall records were frequently collected (>2,000 stations), solar radiation, a key driver of ecological processes, was not (`~20 stations). Yet the environmental factors used to paramatise the model were all given even weighting.

3.23 Advances in understanding of meteorological processes, for example the effect of el Nino and the Pacific Decadal Oscillation, are not incorporated in the LENZ model but affect the data combined from stations at different periods.

3.24 There are further problems with extrapolation of information. Soil parameters used were originally collected from the 1968 National Soil survey and mapped at a broad general scale of 1: to four miles. This results in considerable inaccuracy as later soil surveys demonstrate. This still continues in the latest version of soils extrapolated to 1:50,000 scale.

3.25 Different models use different assumptions and parameterisation and give different results. For a parallel example, different models have been constructed to estimate critically important primary production drivers (e.g. pasture productivity and energy content) from environmental inputs but there were discrepancies in output depending on the scientific equations and assumptions used[2].

3.26 Validation of equations and assumptions is critical for model accuracy. Though widely adopted, LENZ has never been nationally or regionally validated against the actual variation in vegetation communities within level 4 environments.

3.27 Local environmental gradients which critically affect vegetation communities, for example the differences in different soil phases with different moisture holding capacity which results in two entirely different dryland communities within a scale of meters, are not shown in LENZ environments.

[2] Frater et al 2015., NZ Grasslands association journal 77; 19 – 22.

3.28 These deficiencies are carried over into the Threatened Environment Classification (TEC) which uses LENZ Level IV as its scale of reference.

3.29 The TEC introduces further data extrapolation and interpretation problems. Indigenous cover is taken from the Land Cover Database of New Zealand, which is a national scale classification that maps broad habitat types across New Zealand. The land cover database has a number of deficiencies, including low vegetation resolution and low thematic resolution, which means only broad types of habitat are mapped. In addition, there are difficulties in mapping mixed indigenous and exotic shrubland and grassland.

3.30 I consider that while LENZ and TEC have value as broad scale planning tools, they are inappropriate to be used as fine scale vegetation determinants of significance in district plans.

3.31 I illustrate this with a recent disputed vegetation clearance case in the upper Hawea[3].

3.32 The case concerned clearance of approximately 4 hectares of scattered kanuka (*Kunzea ericioides*) shrubland and degraded fescue tussock (*Festuca novae-zelandiae*) grassland for development of centre pivot irrigated pasture 2.5 km south east of Lake Hawea, (Figures 2,3).

---

[3] Application by P Phiskie – RM140465 Decision of D Whitney dated 23 June 2015.

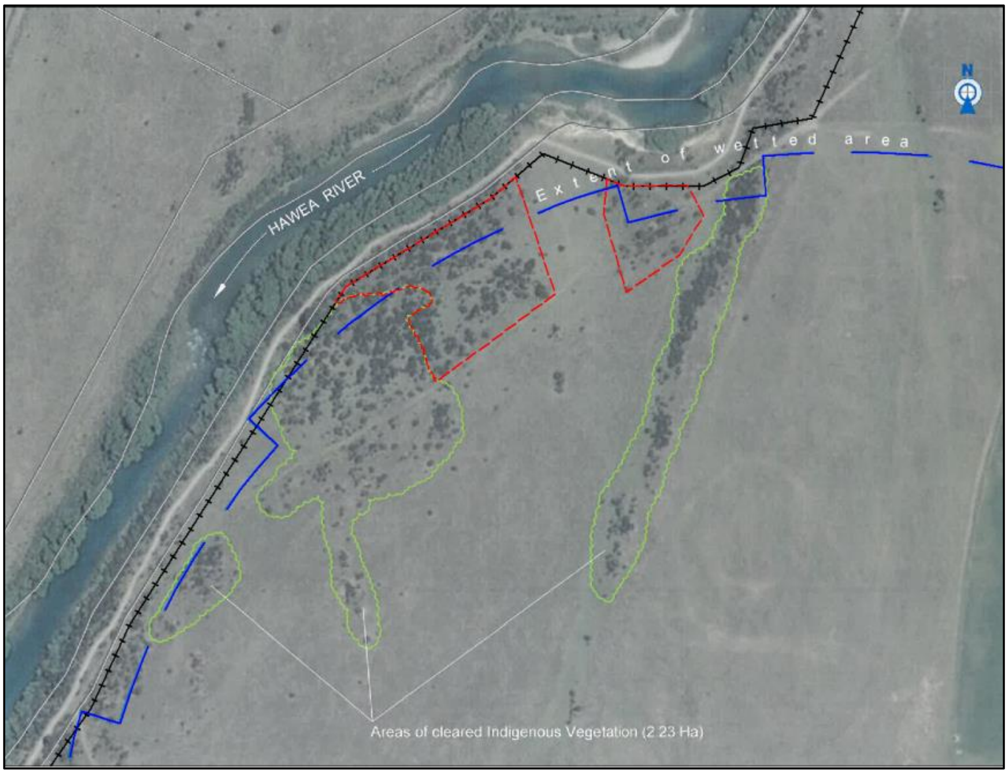


Figure 2. Phiskie site vegetation on site before clearance. Cleared Kanuka association (green outline) remaining Kanuka association inside development area (red outline) and approximate extent of irrigation (blue outline). New Fence line (black line). The western riparian area between fence line and river has been given by the Phiskie's for conservation/ recreation.

Figure 3. Phiskie site vegetation. Open kanuka shrubs with inter-shrub vegetation almost entirely comprising exotic grasses browntop (*Agrostis capillaris*) and sweet vernal (*Anthoxantum odoratum*) and the introduced herb mouse-ear hawkweed (*Hieracium pilosella*) grassland ground cover.

Phiskie Site Vegetation and Species Assessment

3.33 Views differed as to the ecological and conservation value of the vegetation communities as discussed in paragraphs 3.10 and 3.11. The loss of biodiversity in the TEC classification in an ‘Acutely Threatened’ environment was considered a major factor for retention. Conversely, the non threatened status of the principle indigenous species, the degree of modification and the adequacy of local conservation in less modified communities (Figures 4, 5, Table 3), plus the QLD plan recognition of farming as a land use, were considered as major factors for allowing clearance.

Figure 4. Kanuka shrubland and dryland grassland, Reko's Point Conservation Area, 73.5 ha, 9 km south east of the Phiskie site.

Figure 5. Fescue tussock grassland, Devon Dairies Queen Elizabeth the II National Trust Conservation, 66.45 ha, 8 km south east of the Phiskie site.

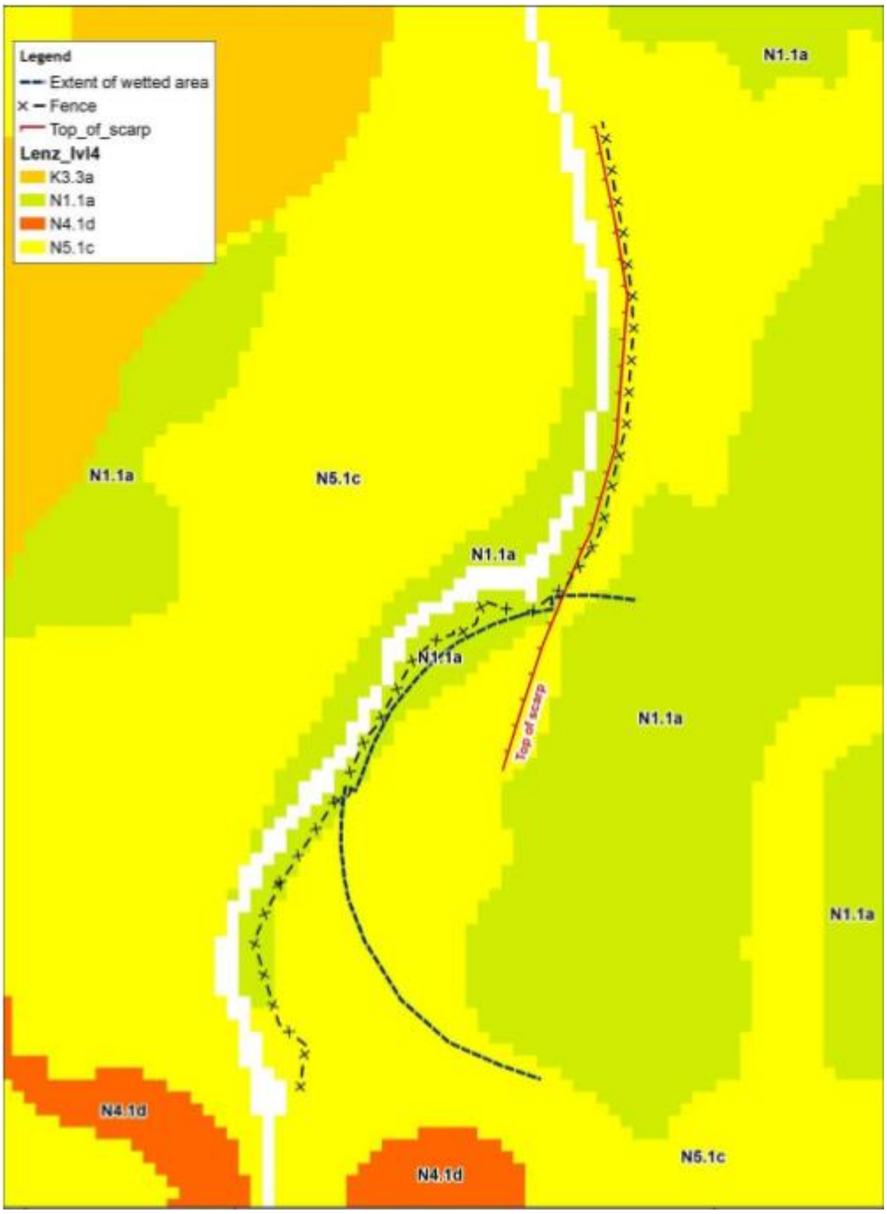
Figure 6. Department of Conservation land adjacent to the Phiskie site. Note; Devon Daries's QEII covenant is adjacent to (east) of Campbell's Reserve is not shown.

Table 1. Department of Conservation land closely adjacent to the Phiskie site.

Land Unit	Area (ha)
Reko's Point Conservation Area	73.5
Campbell's Reserve	17.8
Clutha River / North Side	46.0
Clutha River Marginal Strip	217.9
Butterfields Wildlife Management Reserve	33.3
Albert Town Conservation Area	165.2
Hawea River Marginal Strip	59.2
Dublin Bay Outlet - Albert Town Recreational Reserve	143.4
Hikuwai Conservation Area	61.2
Mt Iron	52.2
Total	**869.7**

3.34 The Phiskie's provision of some 6 ha of the same vegetation associations for conservation immediately adjacent to the pivot area, plus the protection in two extensive adjacent conservation areas, the same habitat and environment as well as in the 870 ha of adjacent Crown Conservation land (Figure 6, Table 1) adequately protects the communities and species present on the Phiskie site.

3.35 The two LENZ level 4 classifications for the Phiskie site and their national distribution are shown in Figure 7.



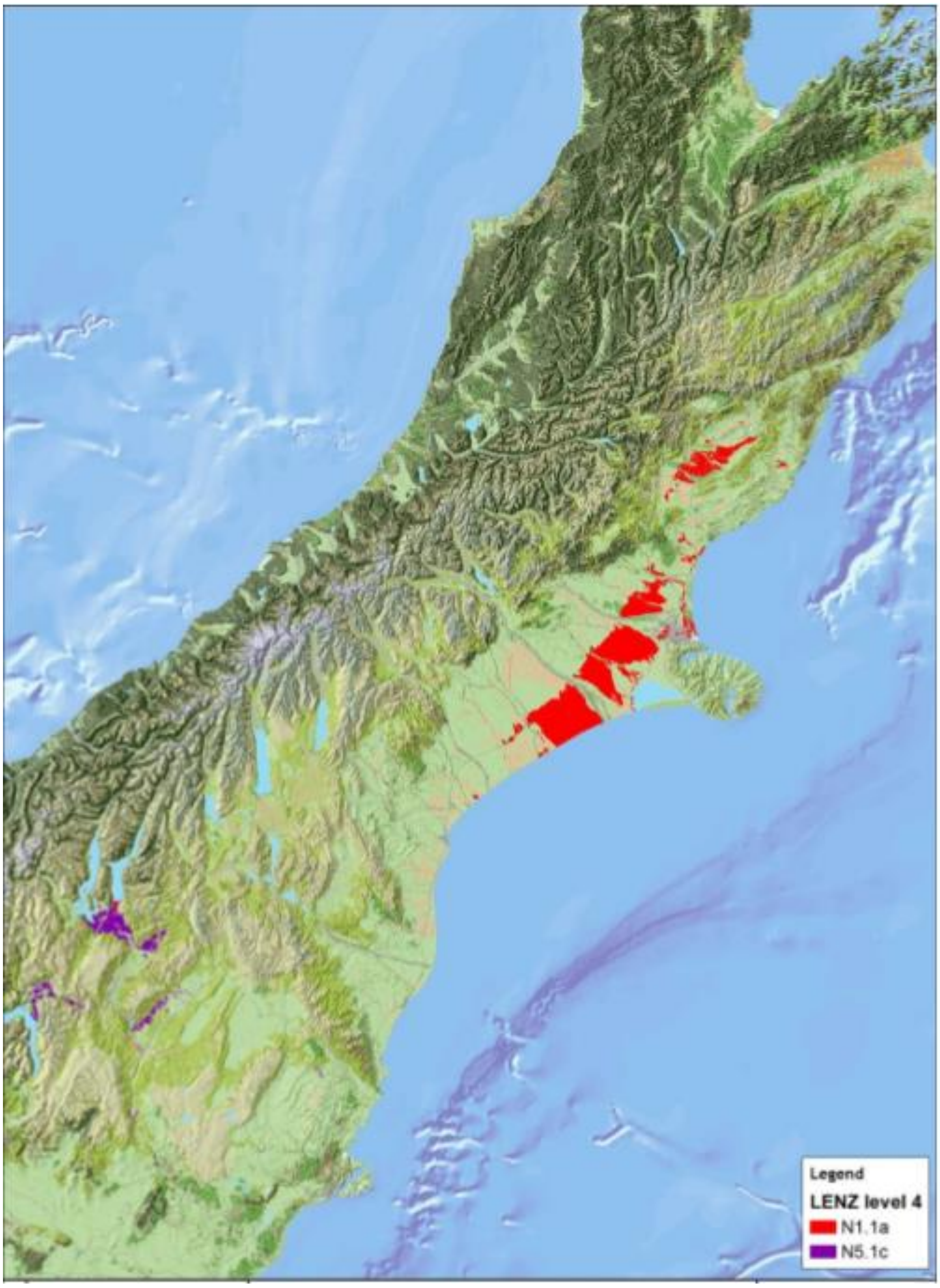


Figure 7. LENZ environments n5.1a and N 5.1c on the Phiskie site and national distribution.

3.35 The local vegetation communities, either Kanuka or grassland, did not differ between the LENZ environments. The inclusion of the upper Hawea with predominantly Canterbury environments in N5.1a, appears anomalous.

Irrigation as Clearance of Vegetation

3.37 Competitive exclusion following irrigation, fertilisation and introduction of pasture species is considered to constitute vegetation clearance in dryland environments. This form of 'clearance' has been included within the definition of 'Clearance of Vegetation' in the Proposed District Plan.

3.38 However competitive exclusion by vegetation competition also occurs on dry land environments.

3.39 I illustrate this by accurate long-term scientific monitoring of dryland vegetation in the Mackenzie basin fluvioglacial outwash plains.

3.37 Protected Natural Areas (PNA) survey of the Mackenzie Ecological Region [4] identified an area of undeveloped fescue tussock grasslands on the Pukaki Flat, at Simons Hill and Ben Ohau Stations. These existed on the fluvioglacial outwash within these properties. A long-term grazing experiment was started in 1989 to investigate the effects of grazing on undeveloped fescue tussock grasslands.

3.38 There were three grazing treatments using large 75 x 75 m fenced exclosure plots:

a) excluded rabbits and stock (nil grazing, coded –R-S);
b) no stock but allowing rabbit grazing (coded +R-S).
c) grazing by rabbits and stock (no exclosure, coded +R+S).

Every plant species present in eight randomly located quadrats in a 20 x 20 m area was carefully recorded using 10 x 10 cm grid squares and their percentage cover scored. Plots were re assessed eleven times between 1990 and November 2010[5].

[4] Espie, P.R. et al, 1984. Mackenzie Ecological Region, NZ Protected Natural Areas Programme, Department of Lands & Survey, Wellington.
[5] Espie, P.R. 2008. Simons Pass Station Tenure Review Botanical Assessment. AgScience Contract Report.

3.39 Both native and introduced species biodiversity decreased after 1990 (Figure 8). Fescue tussock, indigenous scabweed and exotic herb cover decreased, with a simultaneous rise in mouse-ear hawkweed (*Hieracium pilosella*) cover (Figure 9).

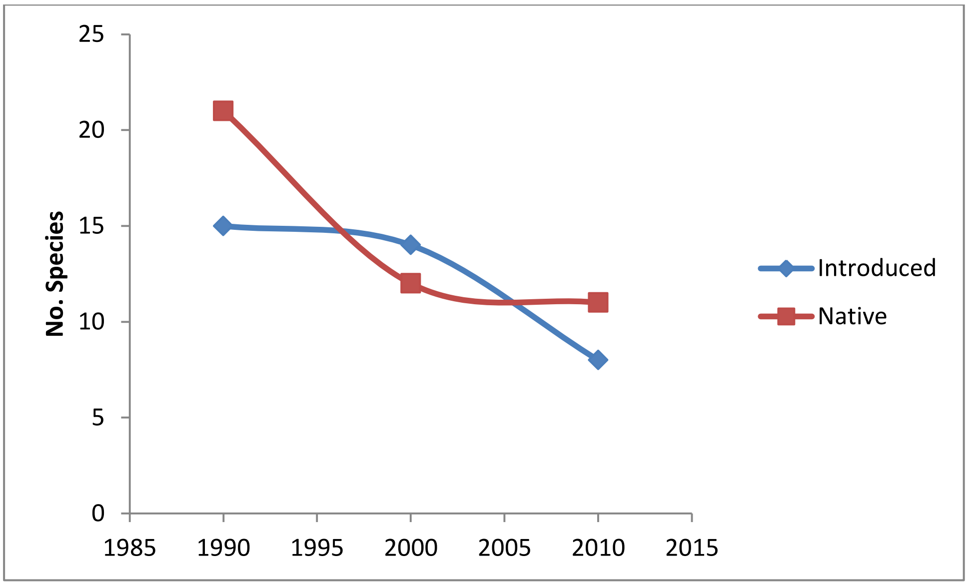


Figure 8. Long term changes in number of species biodiversity.

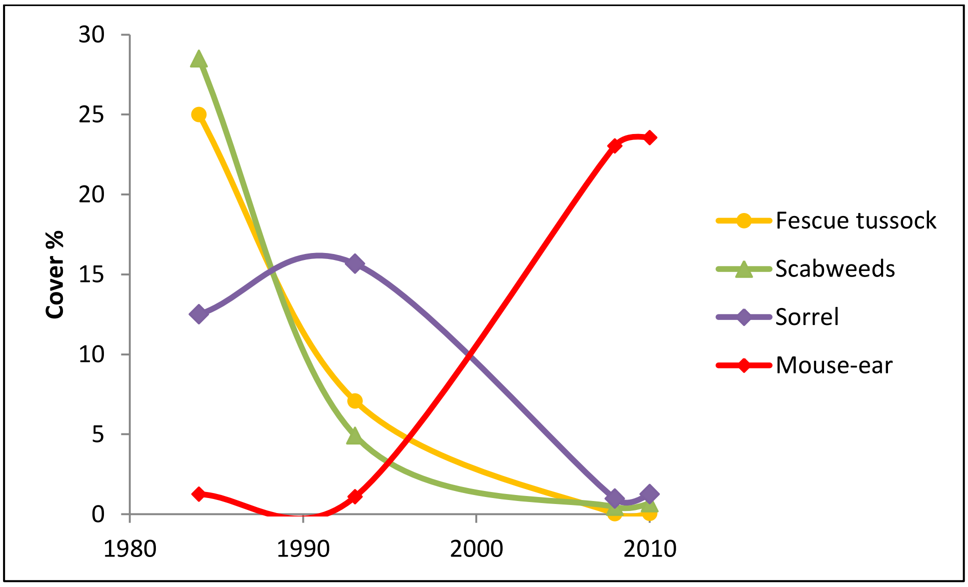


Figure 9. Change in major ground cover components 1984 – 2010. .

3.40 These changes were not due to grazing (Figure 10).

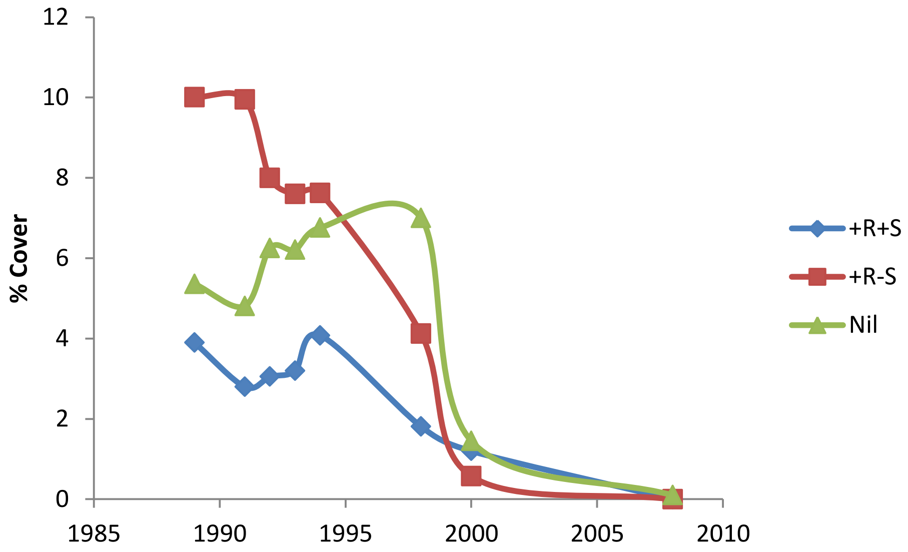


Figure 10. Changes in fescue tussock cover, Pukaki Flat 1990 -2010.

3.40 The magnitude of this change is shown in Figures 11 and 12 and changes in hieracium cover at Simons Hill, refer Figure 13.

Figure 11. Figure 30. Pukaki Flat in 1995, fescue tussock grassland.

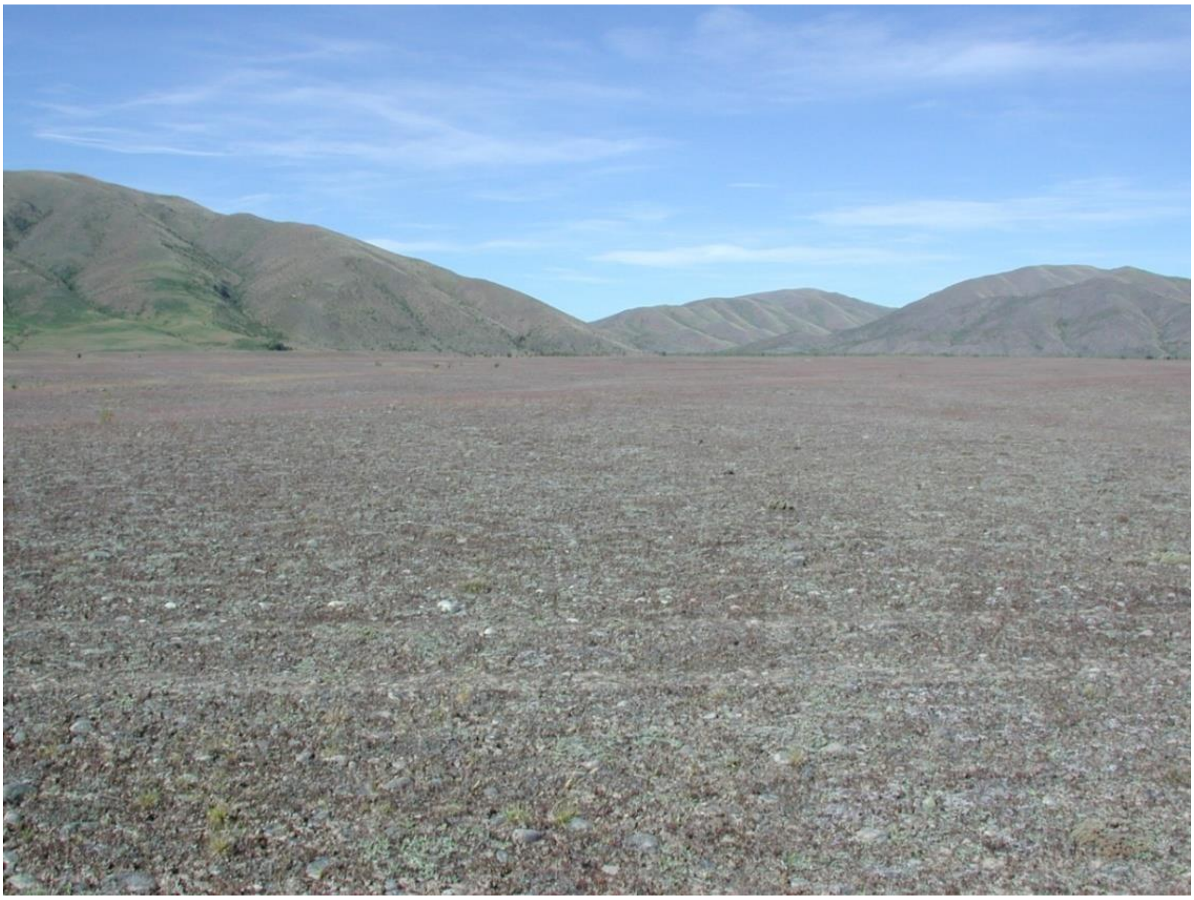


Figure 12. Pukaki Flat in 2009, transformed to *Hieracium* herbfield and bare ground.

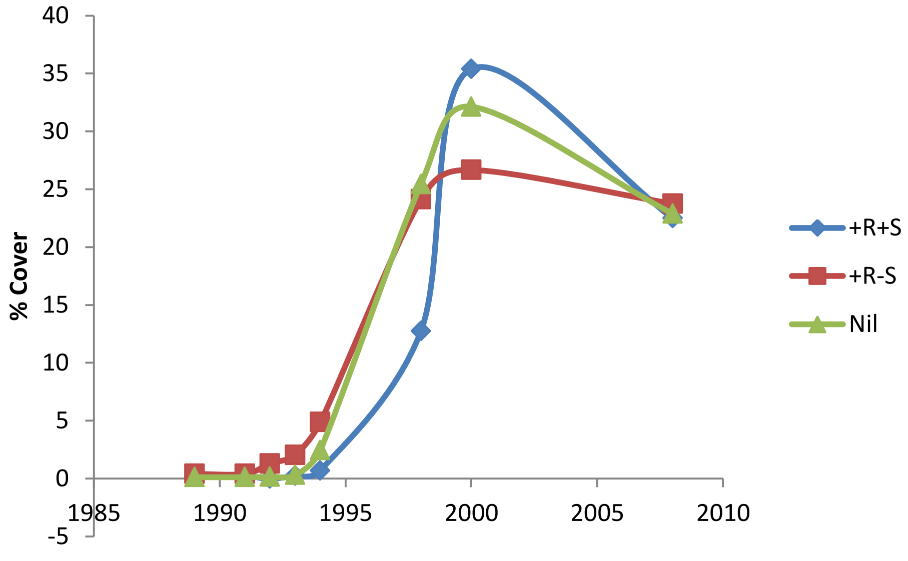


Figure 13. Changes in *Hieracium pilosella* cover, Pukaki Flat 1990 -2010.

3.41 Therefore the use of competitive exclusion as an indigenous vegetation clearance factor cannot be restricted to centre pivots and should not be selectively used within the Plan.

Single Species Management.

3.42 The combination of indigenous vegetation communities and threatened indigenous species in the QLDC plan combines two completely different ecological categories. Identification and management requirements are different.

3.43 Identification of threatened species, particularly small or cryptic species, is often only possible by qualified professionals, and is not easily implementable by ordinary landholders. This was one of the key issues in *Royal Forest and Bird Society of New Zealand v. Dougal Innes*.[6]

3.44 Inclusion of this criterion as proposed is problematic to implement. Unlike vegetation communities which are generally recognisable, the presence, or possible presence, of threatened species is not easy to determine for landholders and may only be possible in a narrow seasonal timeframe (e.g. spring annuals). Thorough assessments can be time consuming and costly.

3.45 Rare indigenous species naturally may have very low occurrences and dispersed populations which also makes identification difficult.

3.46 Management of rare species should focus on viable populations rather than vegetation clearance rules being triggered by the occurrence of an individual plant.

3.47 Assessment of rarity value also need to take in consideration the adequacy of protection in protected areas in similar habitats. Many of these have not been adequately assessed for all the species recommended for inclusion in the Threatened Plant List at 33.7 of the Propose Plan..

3.48 Only after a comprehensive assessment of the adequacy of protection has been completed can a meaningful value be attributed to significance.

[6] [2014] NZEnvC 72

3.49 Furthermore rare species management may require active intervention, e.g.by establishing populations of rare and threatened plants in protected areas. Active rather than passive management through ecological restoration could be an important strategy for maintaining such species.

Benefits of Irrigation

3.50 The effect of irrigation development may also confer environmental benefits which are important for sustainability.

3.51 Vegetation communities differed after irrigation in the Mackenzie Basin. Non-irrigated soils had a ground cover largely comprised of bare soil, stones and Hieracium (Figures 14, 15; Table 2). Irrigated soils have an almost complete cover of pasture species with minimal bare ground
(Figure 15, Table 2).

3.52 This has enormous ecological significance. Wind erosion on dryland vegetation in the Mackenzie basin since 1953 averaged 2.2 cm soil loss per year[7]. Loss on bare ground sites averaged 3.9 cm whereas vegetated sites showed no soil loss.

---

[7] Basher L.R. Webb, T.H 1997. Wind erosion rates on treeaces in the Mackenzie basin. Journal of the Royal Sociedty of New Zealand 27: 499-512.

Figure 14. Contrast between irrigated and non-irrigated Mackenzie soils, Simons Hill Station.

Figure 15. Left: Typical ground cover of non-irrigated Mackenzie soils, fluvio-glacial outwash, 20 m from the margin of irrigated centre pivot in Fig. 14, with bare soil, stones and Hieracium.
Right: Ryegrass clover pasture under pivot irrigation.

Table 2. Dryland and Irrigated vegetation ground cover composition (%)

Ground Cover Class	**Dryland** Flat Outwash Plain (a)	**Dryland** Flat Outwash Plain (b)	**Dryland** Flat Outwash Plain (c)	**Mean**	**Irrigated** Flat Outwash Plain
No. sites	6	7	7		1
Rock & Stone	**1**	**1**	**1**	**2**	
Bare soil	**29**	**53**	**65**	**25**	
	3				
Hieracium	**36**	**29**	**17**	**27**	
Introduced grasses	**10**	**5**	**1**	**26**	**65**
Introduced herbs	**3**	**0**	**2**	**1**	**35**
Introduced shrubs				**0**	
Fescue tussock	**5**	**0.3**		**8**	
Native grasses				**1**	
Native herbs			**0.0**	**4**	
Native shrubs	**14**	**1**		**2**	
Moss & Lichen		**11**	**14**	**3**	
Total Rock & soil	30	54	66	**26**	
Total Introduced	48	34	20	**56**	**100**
Total Native	19	12	14	**19**	
Total	**100**	**100**	**100**	**100**	**100**

3.53 Irrigation also significantly improved beneficial soil properties such as water holding capacity (WHC). Unimproved dryland soils in the Mackenzie had water holding capacity of 20.7% in the upper topsoil 0- 7.5 cm and 22.6% in the lower topsoil 7.5 – 15 cm. In contrast, the water holding capacity of irrigated topsoils were 47.6% and 34.7% respectively[8]. Other benefits such as soil carbon levels, micro biological biodiversity and increased nutrient levels also occur under irrigation.

3.54 It is evident that irrigation development has the capacity to improve and safeguard the life supporting capacity of soils by substantially increasing vegetation cover, reducing the extent of exposed bare ground and the consequent major environmental loss of upper topsoil which contains the

[8] Webb, T..H 2016. Brief of evidence in Carr and Brookside Farms Trust Ltd. vs. Galloway Cook Allan before the High Court of New Zealand, 29th February 2016.

highest soil fertility. It improves present and future environmental sustainability of dryland farming systems.

3.55 In conclusion I consider that direct assessment, differentiation between indigenous and modified vegetation and their assessment criteria, and consideration of the adequacy of protection are absolutely fundamental to achieving a socially acceptable balance between indigenous biodiversity protection and productive use of natural resources.

Rules 33.3.3.2 and 33.3.3.3

3.56 The above rules in the Proposed Plan determine when the clearance thresholds apply. Rule 33.3.3.2 and 33.3.3.3 contain two alternate criteria for the application of the standards in Rule 33.5. Those criteria are the percentage of indigenous vegetation in the total area to be cleared (20 or 30%), or the total number of species present in the total area to be cleared.

3.57 I have a difficulty with the use of the diversity criteria. The following example demonstrates the issue:

Figure 6. Shady aspect Douglas fir forest above Londonderry Terrace and approximate location of plot L1. Management: nil clearance of conifers.

3.58 The first conifers were planted in the 1880's to provide shelter and firewood in the gold mining areas of the Shotover River. Little natural regeneration, or wilding spread, occurred until the middle 1900s, presumably due to pressure from grazing animals. Pastoral grazing ceased in 1983 when Mt Aurum Station completed tenure review and the Department of Lands & Survey, and subsequently its successor, the Department of Conservation, assumed responsibility for management of the land as the Mt. Aurum Recreational Reserve.

3.59 The dominant conifers at Mt Aurum are European Larch (*Larix decidua*) and Douglas fir (*Pseudotsuga menziesii*). Both species grow exceptionally well in the South Island high country[9] and can be the source of vigorous wilding spread[10].

3.60 Conifer increase and spread in and around the Reserve (Fig. 1), was recognized as a problem, and management strategies were recommended to contain the conifers to designated areas[11] . Containment of wilding pines was formally adopted in the Mt Aurum Recreation Reserve conservation management plan[12].

3.61 In April 2005 an initial site inspection was made of vegetation and wildling spread in the Mt Aurum Recreational Reserve and Ben Lomond Station.

3.62 On the 8th and 9th March 2006, six 10 x 10 m grassland plots and one reconnaissance 4 x 4 m plot, one 20 x 20 m shrubland plot and three 10 x 10 m forest plots were assessed in Ben Lomond and Mt Aurum Recreational Reserve. Representative sites were chosen for areas under different managements, or aspects, and plot positions were then located by random number. Plot locations were measured by a

---

[9] Ledgard, N.J.; Belton, M.C. 1985. Exotic trees in the Canterbury high country. NZ Jl For. Sci. 15(3) 298-323.
[10] Ledgard, N.J. 1988. The spread of introduced trees in New Zealand's rangelands - South Island high country experience. Tussock Grasslands and Mountain Lands Institute Review 44: 1-7.
[11] Ledgard, N. 1990. The spread of introduced conifers at Mt Aurum station: background, present situation and management options. DOC Contract Report: 19 pp.
[12] Department of Conservation, 1991. Mt Aurum Recreation Reserve Conservation Management Plan.

Trimble Global Positioning System (GPS) to ± 4.5 - 6 m accuracy for subsequent Geographic Information System (GIS) mapping (Figs. 2, 3).

Table 1. Vascular plant diversity in forest and grassland communities

Area		**Mt Aurum**								**Ben Lomond**		
Vegetation		Forest			Grassland					Grassland		
Wilding Mgmt.		Nil			Hand			Spray		Grazed		
Plot		L1	L2	S1	P1	P2	P3	C1	C2†	BL1	BL2	BL3
Origin	Class											
Exotic	Grass			2	3	4	4	2	2	3	4	4
	Herb	1		3	4	2	2	2	5	5	4	7
	Shrub			1		3	2			1	1	2
	Tree	1	1	1	2	2	2	1			2	1
Exotic Total		**2**	**1**	**7**	**9**	**11**	**10**	**5**	**7**	**9**	**11**	**14**
Native	Fern	1		3	2	1	1	1		1		1
	Grass				1		1	1		1	2	1
	Herb				12	3	2	3	3	6	5	9
	Lichen				3		2			1		
	Tussock				3	1		2	2	3	2	1
Native Total		**1**	**0**	**3**	**21**	**5**	**6**	**7**	**5**	**12**	**9**	**12**
Grand Total		**3**	**1**	**10**	**30**	**16**	**16**	**12**	**12**	**21**	**20**	**26**

Note: only a small reconnaissance plot 13% the size of normal plots.

3.63 Conifer invasion significantly reduced plant diversity. The closed canopy Douglas fir communities (refer Table 3 and 4 L1, L2) had extremely low species diversity with only two other species present. Diversity rose in the deciduous Larch community (refer Table 3 and 4 - S1), but was still considerably less than in the directly comparable shady aspect grasslands (refer Table 3 and 4 P1 - 10 vs. 30 total species, 3 vs. 21 native species).

Table 4. Major components of site vegetation and ground cover (% cover).

Plot	L1	L2	S1	P1	P2	P3	C1	C2	BL1	BL2	BL3	Total
Rock					15					0.05	0.3	15.4
Bare soil	3	10			0.5							13.5
Litter	99	90	100	2								291.0
Browntop			0.1	51	35	30	93	80	85	75	65	514.1
Douglas fir	95	98		0.3	1	0.3						194.6
Chewings fescue				20	40	63				0.3	0.1	123.4
Larch			90	0.3	0.1	0.3	0.1			0.3		91.1
Fescue tussock				12			4	12	3	6	1	38.0
Sweet vernal			0.05	0.3	0.3	0.3	0.3	1	5	5	10	22.3
White clover										0.3	14	14.3
Wild marjoram									1	11		12.0
Forest hawkweed			8	3			0.3	0.3				11.6
Blue tussock				2.5				5	2	0.3		9.8
Sweet brier					3	0.5			0.05	0.3	1	4.9
Tutu											4	4.0
Glaucus bidibid				1.5			1	0.1	0.3	0.3		3.2
Cotoneaster					0.3	2.5						2.8
Snow tussock				1			0.3		1.5			2.8
Catsear				0.5	0.3	1		0.1	0.1	0.1	0.1	2.2
Wall lettuce			2									2.0
Pātōtara, Dwarf mingimingi				1							0.75	1.8
Bracken fern					1	0.5			0.05			1.6
Grey scrub, coprosma					1.5							1.5
A moss (*Polytrichum)*				0.05	1	0.3						1.4
Snowberry				1							0.2	1.2
Foxglove	0.1		1									1.1
Porcupine shrub					0.3				0.3	0.5		1.1
Mouse-ear hawkweed						0.05		1				1.1
A moss (*Hypnum*)				0.3				0.3	0.3	0.05	0.1	1.1
Red clover											1	1.0

3.64 The forest sites were dominated by either Douglas fir or Larch while the introduced grasses Browntop (*Agrostis capillaris*), Chewing's fescue (*Festuca rubra*) and Sweet Vernal (*Anthoxanthum odoratum*) were the main components of the grasslands. Fescue (*Festuca novae-zelandiae*) and blue tussocks (*Poa colensoi*) were the main native grasses, the introduced species white clover (*Trifolium repens*), wild marjoram (*Origanum vulgare*) and forest hawkweed (*Hieracium lepidulum*) comprised the major herb component.

3.65 This demonstrates the difficulty with using species diversity as a standalone threshold for triggering the indigenous vegetation clearance standards. My assessment is that in above example the clearance of the wilding pine species would have required a resource consent under the proposed indigenous vegetation rules.

Peter Ross Espie

21 April 2016