ANALYSIS OF NEW ZEALAND'S VEGETATION COVER USING LAND RESOURCE INVENTORY DATA

P. M. BLASCHKE[1*], G. G. HUNTER[2], G. O. EYLES[1] and P. R. VAN BERKEL[2]

SUMMARY: An analysis of New Zealand's vegetation cover is presented, based on vegetation information from the New Zealand Land Resource Inventory. This survey, undertaken between 1973 and 1979, recorded vegetation in homogeneous land inventory map units as part of a physical resource inventory, using a classification of 45 vegetation components covering indigenous and introduced vegetation cover.

The analysis is presented within the framework of a classification of New Zealand's vegetation cover, which is a functional grouping of the most common combinations of vegetation mapped. The classification emphasises the number of significant components of vegetation cover within map units rather than their importance or dominance. The total of 6863 different combinations of vegetation cover recorded in 89875 map units have been aggregated into 232 primary units of vegetation cover, termed vegetation cover categories. These were grouped into 88 vegetation cover classes and II vegetation cover groups. The latter, identifying the components of New Zealand's vegetation cover at the broadest level were as follows: grassland (22.5% of the New Zealand land area), grassland-cropland (8.2 %), scrubland and fernland (2.2%), forest (18.3%), forest-scrub (7.7%), grassland-scrub (26%), grassland with forest (3% forest with grassland (0.7%), grassland-scrub-forest (5.3%), miscellaneous (2.2%), no vegetation (3.9%).

The analysis is briefly discussed and compared with other available information. The comparatively detailed analysis of grassland and scrubland vegetation has revealed the large extent of mixed vegetation cover, especially grassland-scrub mixtures. It is concluded that the analysis confirms the dynamic and complex nature of New Zealand's present vegetation cover.

INTRODUCTION

Although New Zealand ecologists are now beginning to synthesise the literature on New Zealand plant community description (e.g. Armstrong, Park and Molloy, 1981) they are restricted by a Jack of inventory data on the vegetation cover of the country as a whole. Attempts to provide such data have had to be based largely on the New Zealand Yearbook land use statistics (based on census returns), which group land uses into only seven types, one of which includes all "land in fern, scrub and second growth, standing bush, barren and unproductive land, native timber" (New Zealand Department of Statistics, 1979).

Our paper aims to help fill this information gap by analysing the New Zealand Land Resource Inventory, which, although not having vegetation inventory as a primary function, has the advantage of complete and relatively recent national coverage. The vegetation classification used in the primary survey is a simple one employing 45 components covering indigenous and introduced vegetation, and is orientated towards land management for water and soil conservation requirements. In our paper, this primary classification is used to derive a vegetation cover classification which, although lacking in floristic detail, does provide an adequate framework for an analysis of the broad national pattern of vegetation cover.

[1] Land Resources Group. Aokautere Science Centre, Ministry of Works and Development, Private Bag, Palmerston North.

[2] Land Resources Group, Christchurch Science Centre, Ministry of Works and Development, P.O. Box 1479. Christchurch.

[*] Present address: C/- South Asia Institute, Department of Geography, University of Heidelberg, P.O. Box 103066, 6900 Heidelberg, West Germany.

METHODS

Description of inventory

The New Zealand Land Resource Inventory (NZLRI) is a major survey of New Zealand's physical land resources, which has been undertaken, since 1973, by the Water and Soil Division, Ministry of Works and Development, on behalf of the National Water and Soil .conservation Organisation. The NZLRI is published as a series of Land Resource Inventory Worksheets and accompanying extended legends (NWASCO, 1975-9). The information presented on the worksheets includes a compilation of five key physical factors—rock type, soil, slope, erosion; and vegetation—at a

scale of 1: 63360 (one inch to one mile), in accordance with standards set out in the Land Use Capability Survey Handbook (Soil Conservation and Rivers Control Council, 1971). Further information on general aspects and interpretation of the NZLRI is available in Howard and Eyles (1979) and NWASCO (1979).

In the homogeneous map unit method of recording data used in the NZLRI (Eyles, 1977), the five factors are mapped simultaneously within the limitations of scale. The minimum map unit area is approximately 60 ha. Vegetation is a secondary inventory factor and is thus usually recorded within a map unit boundary predetermined by the primary inventory factors, i.e. rock type, soil and slope. Often, therefore, more than one component of vegetation is recorded. within a map unit. This has had an important effect on the present analysis which shows significant areas of mixed vegetation cover comprising two or more components of vegetation mapped in the NZLRI.

The completion of national coverage of the NZLRI in September 1979, and its subsequent computer storage (van Berkel and Eyles, 1981) has enabled the compilation and analysis of New Zealand land resource information at a level of detail not previously available.

Vegetation information in the NZLRI

Information recorded on the NZLRI worksheets was obtained between 1973 and 1979 by a combination of stereoscopic aerial photograph interpretation, extensive fieldwork, and use of existing information. (In the case of vegetation, this latter included New Zealand Forest Service 1: 250 000 and 1: 63 360 Ecological Survey maps of indigenous forests (see, for example New Zealand Forest Service, 1973; Nicholls, 1966), unpublished NZFS forest compilation sheets, and catchment authority soil conservation and water management plans).

On each of the approximately 90 000 map units delineated on the NZLRI worksheets, vegetation cover was assessed using a classification of 45 components arranged into five groupings: grassland, cropland, scrub and fernland, forest, and miscellaneous. The classification, and method of recording, is set out in NW ASCO (1979). Definitions and notes on this vegetation classification, and criteria for the selection of vegetation units, will be published in a NWASCO technical publication.

Analysis of vegetation information

A computer listing was made of all combinations of vegetation recorded, together with the total area of each combination. This list totalled 2 568 combinations for the North Island and 4295 for the South Island.

Subsequent analysis consisted of grouping these combinations. Several methods for making this grouping were possible. The most straightforward would have been to group the combinations according to the first vegetation, i.e. the "dominant" vegetation, recorded within each map unit. This method was rejected because it would have underestimated many types of vegetation that usually appear as a secondary cover element at the NZLRI scale of mapping, and it would also have deleted much of the detail about areas of mixed vegetation. For example, areas recorded as grassland with minor scrub would have been listed as pure grassland, and consequently the area of scrub would have been underestimated. It was considered important to retain as much as possible of the detail about mixed vegetation, which is shown to comprise a very

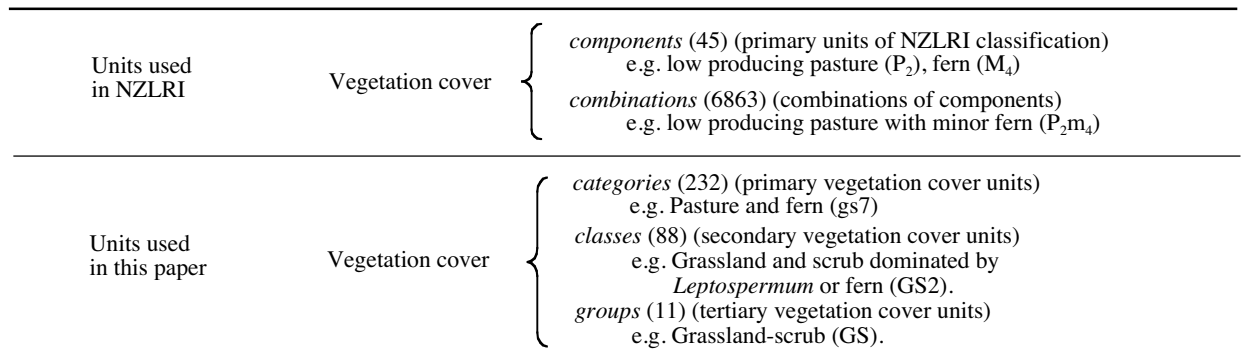

FIGURE 1. *Schematic representation of the levels of vegetation cover classification used in this paper. Figures in brackets denote the number of each of the units. See Tables I and* 2 *and NWASCO* (1979) *for legend to codes used in the examples.*

significant proportion of New Zealand's vegetation cover.

The method chosen was to devise a list of primary units of vegetation cover summarising all the 6 863 vegetation combinations mapped in the NZLRI, at a level of detail appropriate to the survey scale. These units were termed *vegetation cover categories* and defined as "the primary vegetation cover units, containing one or more components of vegetation, which are nationally significant and which can be distinguished within the framework of the NZLRI vegetation classification and mapping system." The word "components" is used in the sense of the units of vegetation recognised in the NZLRI classification. 232 vegetation cover categories were recognised.

These were grouped into 88 *vegetation cover classes* and further grouped into II *vegetation cover groups*. Vegetation cover classes were defined as "units of one or more vegetation cover categories which share common physiognomic, ecological, or cultural characteristics". Vegetation cover groups were defined as "aggregations of vegetation cover classes which, identify the vegetation cover of New Zealand at the broadest level." The relationship of the units of classification used in the NZLRI and in this paper is shown in Figure 1.

When the list of vegetation cover categories had been finalised, each recorded combination was assigned to a category. This assignation was subjective, based on knowledge of what a mapped combination represented on the ground. The list was then computer sorted by category and the areas of each category totalled.

RESULTS AND DISCUSSION

Evaluation of method

The classification shown in Tables 1 and 2 is a very general one which essentially identifies the nature and number of recognised components of vegetation within map units in the NZLRI. However many minor variations could not be included; in particular all categories may include minor scrub components other than those mentioned, and minor areas of miscellaneous vegetation, for example swamp associations, sedges, or rushes. The classification does not attempt to give any detail about the composition of the plant communities that are recognised within vegetation cover categories, not even to the extent of utilising all the detail available in the NZLRI on dominance of vegetation cover components. To do so would have grossly complicated the analysis. It has not been possible to achieve complete consistency nor to avoid some arbitrary separations at the category level. However we have attempted to make separation at the class level definitive within the constraints of the mapping system. These constraints include some variation in the vegetation mapping techniques; for example some areas of grassland in Canterbury and

Marlborough were recorded as unspecified and in some cases misidentified. (These two regions, the earliest mapped during the NZLRI, contain a relatively greater proportion of unspecified vegetation than later work). Ongoing worksheet revision will rectify-these inadequacies.

Our approach to grouping vegetation combina-

TABLE 1. *Analysis of New Zealand Vegetation Cover by Vegetation Cover Groups**.

Vegetation cover group	North Island Area (ha)	North Island percentage	South Island area (ha)	South Island percentage	NZ Total area (ha)	NZ Total percentage
Grassland	2,939,100	25.7	3,014,800	20.1	5,953,900	22.5
Grassland-cropland	612,700	5.4	1,551,200	10.3	2,163,900	8.2
Scrubland and fernland	333,300	2.9	243,200	1.6	576,500	2.2
Forest	2,082,400	18.2	2,748,500	18.3	4,830,900	18.3
Forest-scrub	937,000	8.2	1,110,700	7.4	2,047,700	7.7
Grassland-scrub	2,535,900	22.2	4,336,700	28.9	6,872,600	26.0
Grassland with forest	546,200	4.8	240,000	1.6	786,200	3.0
Forest with grassland	96,800	0.8	100,200	0.7	197,000	0.7
Grassland-scrub-forest	846,500	7.4	553,800	3.7	1,400,300	5.3
Miscellaneous	183,900	1.6	397,500	2.6	581,400	2.2
No vegetation	299,600	2.6	725,300	4.8	1,024,900	3.9
Total	11,413,400		15,021,900		26,435,300	

* All areas are rounded to the nearest 100 hectares.
Percentages are rounded to the nearest 0.1 %, and are expressed in terms of total area for each island, which differ from New Zealand Yearbook areas by <1 %.

tions, summarised in Figure 1, represents a pragmatic approach to New Zealand vegetation classification, compared with recent work on a more comprehensive classification of New Zealand vegetation and landscape (Armstrong *et al.,* 1981). It is not intended to be a formal classification *per se,* but rather, a functional framework that is tailored to the vegetation information available from one primary source. It deliberately uses pseudotaxonomic terms such as category and class to emphasise its synthetic nature, does not allude to classical ecological terms such as association or type, and for the most part retains the mixture of vegetation and land use terms used in the NZLRI classification.

As a consequence of the compilation technique used in NZLRI, our analysis recognises a large number of 'mixed' vegetation categories (i.e. containing more than one component). In these situations, other mapping systems might delineate the components of vegetation separately or record only the dominant ones, depending on scale (Fig. 2). Furthermore, within mapping units it was not possible to distinguish between:

(a) 'homogeneus' mixtures, where one component is scattered more or less evenly among a second component, and
(b) discrete blocks of vegetation that cannot be separated because of limitations of scale.

Both these situations are classified into mixed vegetation cover categories (Figs. 3a and 3b).

These factors have the effect of exaggerating the area of mixed vegetation cover categories and classes. However the vegetation cover groups that would be considered to contain the most 'unnatural' mixtures (i.e. forest with grassland, grassland with forest, grassland-scrub-forest mixtures and some miscellaneous categories) cover only 9% of the New Zealand land surface in our analysis. Of this, more than one third comprises mixed pasture, indigenous forest and scrub in highly disturbed habitats. If the method adopted had been unduly distorting, one would have expected that the South Island analysis would contain greater areas Of 'unnatural' mixed vegetation cover categories than the North Island, owing to a difference in the method of recording vegetation which enabled a greater number of components of vegetation to be recorded within South Island map units. However this is not so: of the area of 'unnatural' mixtures listed above, 62 % occurs in the North Island, probably reflecting the greater area of heavily disturbed ecosystems.

FIGURE 2. *Inclusion of minor podocarp-hardwood-beech forest remnant within a predominantly low-producing pasture map unit. Represented in NZLRI as* $P_2n_{3d}n_{4a}$*; in this analysis as gf4. (Location N121:* 754464).

FIGURE 3a. *Scattered manuka* (Leptospermum scoparium) *within low-producing pasture. (Location NI21:595425).*

FIGURE 3b. *Discrete components of manuka and low-producing pasture. This situation and that shown in Fig. 3a are both represented in NZLRI as* P_2m_1*; in this analysis as gs4. (Location N149:163640).*

TABLE 2. *Analysis of New Zealand vegetation by vegetation cover categories and classes. (Rounding of areas and percentages as in Table 1.)*

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	CLASS AREA S.I.	CLASS AREA N.Z.	CLASS %(NZ)	CATEGORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	CATEGORY AREA S.I.	CATEGORY AREA N.Z.
							Group 1 : GRASSLAND			
G1	Pasture	2 809 400	741 900	3 551 300	13.4	g1	Improved pasture	2 000 300	411 600	2 411 900
						g2	Unimproved pasture	679 100	89 300	768 400
						g3	Mixed improved and unimproved pasture	130 000	241 000	371 000
G2	Grassland with minor swamp associations	37 800	40 200	78 000	0.3	g4	Pasture with minor swamp associations	37 300	11 300	48 600
						g5	Tussock with minor swamp associations	500	21 500	22 000
						g6	Tussock and pasture with minor swamp associations	-	7 400	7 400
G3	Tussock associations with short tussock	5 800	883 700	889 500	3.4	g7	Short tussock	1 900	133 100	135 000
						g8	Short and snow tussock	600	724 700	725 300
						g9	Short and red tussock	3 300	18 700	22 000
						g10	Mixed short, snow, and red tussock	-	7 200	7 200
G4	Other tussock associations	43 200	798 900	842 100	3.2	g11	Snow tussock	11 300	388 700	400 000
						g12	Red tussock	26 700	1 700	28 400
						g13	Red and snow tussock	700	3 200	3 900
						g14	Sparse tussock	4 500	405 300	409 800
G5	Mixed short tussock and pasture associations	3 500	411 100	414 600	1.6	g15	Short tussock and improved pasture	400	29 900	30 300
						g16	Short tussock and umimproved pasture	3 100	315 500	318 600
						g17	Short and snow tussock and pasture	-	37 600	37 600
						g18	Short tussock and mixed improved and unimproved pasture	-	28 100	28 100
G6	Other mixed tussock and pasture associations	6 800	78 700	85 500	0.3	g19	Red tussock and improved pasture	4 000	6 700	10 700
						g20	Other tussock associations and unimproved pasture	2 800	56 200	59 000
						q21	Red or snow tussock and mixed improved and unimproved pasture	-	15 800	15 800
G7	Pasture with sand-dune associations	28 700	4 200	32 900	0.1	g22	Pasture with sand-dune associations	28 700	4 200	32 900
G8	Pasture with salt-tolerant associations	3 900	6 100	10 000	0.0	g23	Pasture with salt-tolerant associations	3 900	6 100	10 000
G9	Grassland and semi-arid herbfield associations	-	45 500	45 500	0.2	g24	Grassland and semi-arid herbfield associations	-	45 500	45 500
G10	Unspecified grassland	-	4 500	4 500	0.0	g25	Unspecified grassland	-	4 500	4 500
GROUP TOTAL:		2 939 100	3 014 800	5 953 900	22.5					
							Group 2 : GRASSLAND-CROPLAND			
C1	Cereal cropping/grassland systems	299 300	118 300	417 600	1.6	c1	Cereal cropping, or cereal cropping and pasture	299 300	113 400	412 700
						c2	Cereal croppind and mixed tussock and pasture	-	4 900	4 900
C2	Orchards or vineyards/ grassland systems	29 500	16 400	45 900	0.2	c3	Orchards or vineyards and pasture	29 500	16 400	45 900

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C3	Winter fodder cropping/ grassland systems	167 100	314 300	481 400	1.8	c4	Winter fodder cropping and pasture	167 100	248 300	415 400
						c5	Winter fodder cropping and tussock or mixed tussock and pasture	-	66 000	66 000
C4	Horticulture/grassland systems	36 300	11 200	47 500	0.2	c6	Horticulture, or horticulture and pasture	36 300	11 200	47 500
C5	Mixed cereal and winter fodder cropping/grassland systems	30 800	553 500	584 300	2.2	c7	Mixed cereal and winter fodder cropping and pasture	30 800	551 600	582 400
						c8	Mixed cereal and winter fodder cropping and mixed tussock and pasture	-	1 900	1 900
C6	Other cropping mixture/ grassland systems	48 500	34 200	82 700	0.3	c9	Other cropping mixtures, or other cropping mixtures and pasture	48 500	34 200	82 700
C7	Unspecified grassland/ cropland systems	1 200	503 300	504 500	1.9	c10	Unspecified cropping and pasture	1 200	498 400	499 600
						c11	Unspecified cropping and mixed tussock and pasture	-	1 600	1 600
						c12	Cropping and unspecified grassland	-	3 300	3 300
GROUP TOTAL:		612 700	1 551 200	2 163 900	8.2					
				Group 3 : SCRUBLAND AND FERNLAND						
S1	Mixed indigenous scrub	187 500	37 100	224 600	0.9	s1	Mixed indigenous scrub	187 500	37 100	224 600
S2	Scrub dominated by *Leptospermum* or fern	106 300	48 800	155 100	0.6	s2	*Leptospermum* and *Leptospermum* - dominated scrub not included below	92 600	12 800	105 400
						s3	Fern and fern-dominated vegetation not included below	2 200	22 200	24 400
						s4	*Leptospermum* and fern	11 500	13 800	25 300
S3	Scrub containing *Cassinia*	4 000	3 100	7 100	0.0	s5	*Cassinia* and *Leptospermum*	2 900	1 200	4 100
						s6	Other *Cassinia*-dominated scrub	1 100	1 900	3 000
S4	Broom-dominated scrub	800	1 900	2 700	0.0	s7	Broom and broom-dominated scrub	800	1 900	2 700
S5	Scrub containing gorse	18 500	34 500	53 000	0.2	s8	Gorse and mixed indigenous scrub	3 300	2 800	6 100
						s9	Gorse and *Leptospermum*	11 200	4 500	15 700
						s10	Gorse and fern	1 500	10 000	11 500
						s11	Gorse, fern and *Leptospermum*	1 400	13 900	15 300
						s12	Other gorse-dominated scrub	1 100	3 300	4 400
S6	Scrub dominated by sweet briar or matagouri	-	800	800	0.0	s13	Scrub dominated by sweet briar or matagouri	-	800	800
S7	Heathland scrub	1 400	-	1 400	0.0	s14	Heathland scrub	1 400	-	1 400
S8	Subalpine scrub	10 700	114 100	124 800	0.5	s15	Subalpine scrub	4 200	82 600	86 800
						s16	Subalpine and other scrub	2 800	2 500	5 300
						s17	Sparse subalpine scrub	3 700	29 000	32 700
S9	Scrub with sand-dune associations	4 100	400	4 500	0.0	s18	Scrub with sand-dune associations	4 100	400	4 500
S10	Unspecified scrub	-	2 500	2 500	0.0	s19	Unspecified scrub	-	2 500	2 500
GROUP TOTAL:		333 300	243 200	576 500	2.2					

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	CLASS AREA S.I.	CLASS AREA N.Z.	CLASS %(NZ)	CATEGORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	CATEGORY AREA S.I.	CATEGORY AREA N.Z.
							Group 4 : FOREST			
F1	Forests containing kauri	69 400	-	69 400	0.3	f1	Forests containing kauri	69 400	-	69 400
F2	Podocarp and podocarp-hardwood forest	523 100	339 200	862 300	3.3	f2	Podocarp forest	3 400	31 500	34 900
						f3	Lowland podocarp - hardwood forest	485 800	277 200	763 000
						f4	Highland podocarp - hardwood forest	15 400	20 000	35 400
						f5	Unspecified podocarp - hardwood forest	18 500	10 500	29 000
F3	Beech and beech-hardwood forest	304 000	1 468 600	1 772 600	6.7	f6	Lowland beech forest (North Island)	139 200	-	139 200
						f7	Highland beech forest (North Island)	66 100	-	66 100
						f8	Unspecified beech forest (North Island)	72 400	-	72 400
						f9	Beech forest (South Island)	-	1 434 700	1 434 700
						f10	Beech-hardwood forest	26 300	33 900	60 200
F4	Podocarp-hardwood-beech forest	627 300	745 200	1 372 500	5.2	f11	Lowland podocarp-hardwood-beech forest	598 900	588 800	1 187 700
						f12	Highland podocarp-hardwood-beech forest	3 700	123 000	126 700
						f13	Unspecified podocarp-hardwood-beech forest	24 700	33 400	58 100
F5	Beech-podocarp forest	2 200	14 600	16 800	0.1	f14	Beech-podocarp forest	2 200	14 600	16 800
F6	Hardwood forest	112 500	102 600	215 100	0.8	f15	Hardwood forest	112 500	102 600	215 100
F7	Exotic forest	417 000	66 300	483 300	1.8	f16	Exotic forest	417 000	66 300	483 300
F8	Mixed exotic and indigenous forest	26 900	12 000	38 900	0.1	f17	Mixed exotic and indigenous forest	26 900	12 000	38 900
GROUP TOTAL:		2 082 400	2 748 500	4 830 900	18.3					
							Group 5 : FOREST-SCRUB			
FS1	Kauri forest and scrub	62 500	-	62 500	0.2	fs1	Forests containing kauri and *Leptospermum*	55 100	-	55 100
						fs2	Forests containing kauri, and mixed indigenous scrub	7 400	-	7 400
FS2	Podocarp-hardwood forest and scrub	300 500	146 500	447 000	1.7	fs3	Podocarp-hardwood forest and *Leptospermum* or fern	93 400	10 500	103 900
						fs4	Podocarp-hardwood forest and mixed indigenous scrub	193 100	109 800	302 900
						fs5	Podocarp-hardwood forest and other lowland scrub	1 200	1 900	3 100
						fs6	Podocarp-hardwood forest and sub-alpine scrub	12 800	24 300	37 100
FS3	Podocarp-hardwood-beech forest and scrub	84 400	200 900	285 300	1.1	fs7	Podocarp-hardwood-beech forest and *Leptospermum* or fern	16 200	45 000	61 200
						fs8	Podocarp-hardwood-beech forest and mixed indigenous scrub	58 100	137 200	195 300
						fs9	Podocarp-hardwood-beech forest and other lowland scrub	200	1 300	1 500
						fs10	Podocarp-hardwood-beech forest and subalpine scrub	9 900	17 400	27 300

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FS4	Beech forest and scrub	131 100	463 900	595 000	2.2	fs11	Beech forest and *Leptospermum* or fern	55 500	82 700	138 200
						fs12	Beech forest and mixed indigenous scrub	48 100	317 100	365 200
						fs13	Beech forest and other lowland scrub	500	7 300	7 800
						fs14	Beech forest and subalpine scrub	27 000	56 800	83 800
FS5	Hardwood forest and scrub	200 600	40 300	240 900	0.9	fs15	Hardwood forest and *Leptospermum* or fern	77 400	22 500	99 900
						fs16	Hardwood forest and mixed indigenous scrub	113 700	14 100	127 800
						fs17	Hardwood forest and other lowland scrub	9 500	2 200	11 700
						fs18	Hardwood forest and subalpine scrub	-	1 500	1 500
FS6	Beech-hardwood forest and scrub	29 000	66 300	95 300	0.4	fs19	Beech-hardwood forest and *Leptospermum* or fern	8 900	21 300	30 200
						fs20	Beech-hardwood forest and mixed indigenous scrub	20 100	36 900	57 000
						fs21	Beech-hardwood forest and other lowland scrub	-	1 200	1 200
						fs22	Beech-hardwood forest and subalpine scrub	-	6 900	6 900
FS7	Podocarp forest and scrub	2 600	33 500	36 100	0.1	fs23	Podocarp forest and mixed indigenous scrub	2 400	25 500	27 900
						fs24	Podocarp forest and other scrub	200	8 000	8 200
FS8	Indigenous forest and pakihi associations	-	35 600	35 600	0.1	fs25	Podocarp forest with pakihi associations	-	2 600	2 600
						fs26	Podocarp forest, scrub, and pakihi associations	-	9 900	9 900
						fs27	Other indigenous forest with pakihi association	-	17 400	17 400
						fs28	Other indigenous forest, scrub and pakihi associations	-	5 700	5 700
FS9	Exotic forest and scrub	101 600	86 300	187 900	0.7	fs29	Exotic forest and *Leptospermum*-dominated scrub	38 900	1 900	40 800
						fs30	Exotic forest and mixed indigenous scrub	31 600	9 800	41 400
						fs31	Exotic forest and fern or gorse-dominated scrub	26 500	72 300	98 800
						fs32	Exotic forest and other scrub	1 300	2 300	3 600
						fs33	Conservation trees and scrub	3 300	-	3 300
FS10	Mixed indigenous and exotic forest and scrub	24 700	16 700	41 400	0.2	fs34	Mixed indigenous and exotic forest and scrub	24 700	16 700	41 400
FS11	Unspecified forest/scrub mixtures	-	20 700	20 700	0.1	fs35	Unspecified forest/scrub mixtures	-	20 700	20 700
GROUP TOTAL:		937 000	1 110 700	2 047 700	7.7					
							Group 6 : GRASSLAND-SCRUB			
GS1	Grassland and mixed indigenous scrub	641 100	310 400	951 500	3.6	gs1	Pasture and mixed indigenous scrub	637 800	135 200	773 000
						gs2	Tussock and mixed indigenous scrub	3 000	101 000	104 000
						gs3	Short tussock, pasture, and mixed indigenous scrub	300	74 200	74 500

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GS2	Grassland and scrub dominated by *Leptospermum* or fern	1 467 200	690 800	2 158 000	8.2	gs4	Pasture and *Leptospermum*	1 163 500	79 600	1 243 100
						gs5	Tussock and *Leptospermum*	37 300	116 700	154 000
						gs6	Tussock, pasture and *Leptospermum*	5 400	75 000	80 400
						gs7	Pasture and fern	126 900	73 500	200 400
						gs8	Tussock and fern	300	90 400	90 700
						gs9	Tussock, pasture and fern	-	48 800	48 800
						gs10	Pasture, or short tussock and pasture, *Leptospermum* and fern	133 500	116 200	249 700
						gs11	Tussock, *Leptospermum* and fern	300	90 600	90 900
GS3	Grassland and scrub containing *Cassinia*	60 400	49 100	109 500	0.4	gs12	Grassland, *Cassinia*, and *Leptospermum*	31 300	21 300	52 600
						gs13	Grassland and other *Cassinia*-dominated scrub	29 100	27 800	56 900
GS4	Grassland and scrub containing gorse	201 600	455 000	656 600	2.5	gs14	Pasture and gorse	62 800	135 800	198 600
						gs15	Tussock and gorse	-	3 500	3 500
						gs16	Tussock, pasture and gorse	-	36 700	36 700
						gs17	Pasture, or short tussock and pasture, gorse and mixed indigenous scrub	31 400	54 900	86 300
						gs18	Short tussock, gorse, and mixed indigenous scrub	-	9 500	9 500
						gs19	Pasture, or short tussock and pasture, gorse and *Leptospermum*	88 200	72 400	160 600
						gs20	Tussock, gorse and *Leptospermum*	200	4 600	4 800
						gs21	Pasture, or short tussock and pasture gorse and fern	11 700	71 400	83 100
						gs22	Short tussock, gorse and fern	-	7 200	7 200
						gs23	Grassland, gorse and broom	500	48 800	49 300
						gs24	Pasture, or tussock and pasture, gorse and other scrub	6 800	6 600	13 400
						gs25	Short tussock, gorse, and other scrub	-	3 600	3 600
GS5	Grassland and broom-dominated scrub	4 600	31 000	35 600	0.1	gs26	Grassland and broom-dominated scrub	4 600	31 000	35 600
GS6	Grassland and blackberry-dominated scrub	23 300	1 300	24 600	0.1	gs27	Pasture and blackberry-dominated scrub	23 300	1 300	24 600
GS7	Grassland and scrub dominated by sweet briar or matagouri	-	1 111 500	1 111 500	4.2	gs28	Pasture and sweet briar	-	27 100	27 100
						gs29	Tussock and sweet briar	-	43 400	43 400
						gs30	Short tussock, pasture and sweet briar	-	69 800	69 800
						gs31	Pasture and matagouri	-	60 100	60 100
						gs32	Tussock and matagouri	-	196 500	196 500
						gs33	Tussock, pasture and matagouri	-	409 800	409 800
						gs34	Pasture, sweet briar and matagouri	-	17 200	17 200
						gs35	Tussock, sweet briar and matagouri	-	77 900	77 900
						gs36	Short tussock, pasture, sweet briar and matagouri	-	74 500	74 500
						gs37	Pasture or short tussock and pasture, sweet briar and other scrub	-	5 000	5 000

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	S.I.	N.Z.	CLASS %(NZ)	CATEGORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	S.I.	N.Z.
GS7	Grassland and scrub dominated by sweet briar or matagouri (continued)	-	1 111 500	1 111 500	4.2	gs38	Short tussock, sweet briar and other scrub	-	12 000	12 000
						gs39	Pasture or tussock and pasture, matagouri and other lowland/montane scrub	-	67 600	67 600
						gs40	Tussock, matagouri and other lowland/montane scrub	-	50 600	50 600
GS8	Grassland and *Dracophyllum* or *Calluna* dominated heathland scrub	38 900	-	38 900	0.2	gs41	Grassland and *Dracophyllum* or *Calluna*-dominated heathland scrub	38 900	-	38 900
GS9	Grassland and subalpine scrub	57 900	1 289 700	1 347 600	5.1	gs42	Tussock and subalpine scrub	49 300	1 233 000	1 282 300
						gs43	Mixed tussock and pasture and subalpine scrub	2 800	16 500	19 300
						gs44	Tussock, subalpine scrub, and other scrub	5 800	40 200	46 000
GS10	Grassland including crops and scrub	32 800	198 900	231 700	0.9	gs45	Pasture, gorse, and crops	3 200	124 000	127 200
						gs46	Other grasslands, crops and scrub	29 600	74 900	104 500
GS11	Grassland, scrub and semi-arid herbs	-	73 000	73 000	0.3	gs47	Pasture, matagouri or sweet briar and semi-arid herbs	-	13 000	13 000
						gs48	Short tussock, matagouri or sweet briar and semi-arid herbs	-	11 600	11 600
						gs49	Short tussock, pasture, scrub and semi-arid herbs	-	48 400	48 400
GS12	Grassland, scrub and sand-dune associations	7 100	2 800	9 900	0.0	gs50	Pasture, scrub and sand-dune associations	7 100	2 800	9 900
GS13	Unspecified grassland/scrub, mixtures	1 000	123 200	124 200	0.5	gs51	Pasture and unspecified scrub	1 000	62 400	63 400
						gs52	Tussock and unspecified scrub	-	34 900	34 900
						gs53	Pasture, tussock and unspecified scrub	-	12 700	12 700
						gs54	Unspecified grassland and scrub	-	13 200	13 200
GROUP TOTAL:		2 535 900	4 336 700	6 872 600	26.0					
							Group 7 : GRASSLAND WITH FOREST			
GF1	Pasture with indigenous forest	356 300	47 800	404 100	1.5	gf1	Pasture with kauri forest	1 600	-	1 600
						gf2	Pasture with podocarp forest	23 000	18 800	41 800
						gf3	Pasture with podocarp-hardwood forest	217 400	11 700	229 100
						gf4	Pasture with podocarp-hardwood-beech forest	3 600	4 500	8 100
						gf5	Pasture with hardwood forest	100 800	1 200	102 000
						gf6	Pasture with beech forest	8 500	11 600	20 100
						gf7	Pasture with beech-hardwood forest	1 400	-	1 400
GF2	Pasture with exotic forest	120 900	41 600	162 500	0.6	gf8	Pasture with exotic production forest	70 300	41 600	111 900
						gf9	Pasture with conservation trees	50 600	-	50 600
GF3	Tussock with indigenous forest	8 800	49 200	58 000	0.2	gf10	Tussock with beech forest	7 400	44 700	52 100
						gf11	Tussock with other indigenous forest	1 400	4 500	5 900
GF4	Tussock with exotic forest	600	2 500	3 100	0.0	gf12	Tussock with exotic forest	600	2 500	3 100

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	S.I.	N.Z.	CLASS %(NZ)	CATE-GORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	S.I.	N.Z.
GF5	Grassland with mixed indigenous and exotic forest	17 300	2 200	19 500	0.1	gf13	Pasture with mixed indigenous and exotic forest	17 300	2 200	19 500
GF6	Mixed tussock and pasture with forest	900	33 700	34 600	0.1	gf14	Tussock and pasture with indigenous forest	100	21 300	21 400
						gf15	Tussock and pasture with exotic forest	800	12 400	13 200
GF7	Grassland including crops with forest	41 400	60 800	102 200	0.4	gf16	Pasture and crops with indigenous forest	23 300	16 300	39 600
						gf17	Pasture and crops with exotic forest	18 100	44 500	62 600
GF8	Unspecified grassland with forest	-	2 200	2 200	0.0	gf18	Unspecified grassland with forest	-	2 200	2 200
GROUP TOTAL:		546 200	240 000	786 200	3.0					
						Group 8 : FOREST WITH GRASSLAND				
FG1	Indigenous forest with pasture	51 300	36 300	87 600	0.3	fg1	Kauri forest with pasture	2 800	-	2 800
						fg2	Podocarp forest with pasture	300	400	700
						fg3	Podocarp-hardwood forest with pasture	22 300	13 700	36 000
						fg4	Podocarp-hardwood-beech forest with pasture	6 200	7 700	13 900
						fg5	Hardwood and coastal forest with pasture	17 700	100	17 800
						fg6	Beech forest with pasture	800	13 400	14 200
						fg7	Beech-hardwood forest with pasture	1 200	1 000	2 200
FG2	Exotic forest with pasture	24 100	7 900	32 000	0.1	fg8	Exotic production forest with pasture	22 900	7 900	30 800
						fg9	Conservation trees with pasture	1 200	-	1 200
FG3	Indigenous forest with tussock	11 500	49 000	60 500	0.2	fg10	Podocarp-hardwood forest with tussock	200	3 800	4 000
						fg11	Podocarp-hardwood-beech forest with tussock	4 400	10 400	14 800
						fg12	Beech forest with tussock	6 800	34 400	41 200
						fg13	Other indigenous forest with tussock	100	400	500
FG4	Exotic forest with tussock	1 000	2 300	3 300	0.0	fg14	Exotic forest with tussock	1 000	2 300	3 300
FG5	Exotic forest with sand-dune associations	4 100	600	4 700	0.0	fg15	Exotic forest with sand-dune associations	4 100	600	4 700
FG6	Mixed indigenous and exotic forest with pasture	4 800	4 100	8 900	0.0	fg16	Mixed indigenous and exotic forest	4 800	4 100	8 900
GROUP TOTAL:		96 800	100 200	197 000	0.7					
						Group 9 : GRASSLAND-SCRUB-FOREST MIXTURES				
GSF1	Mixtures of pasture, scrub and indigenous forest	707 300	148 100	855 400	3.2	gsf1	Mixed pasture, indigenous forest and scrub	707 300	148 100	855 400
GSF2	Mixtures of pasture, scrub and exotic forest	111 900	84 600	196 500	0.7	gsf2	Mixtures of pasture, scrub and exotic forest	111 900	84 600	196 500

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	S.I.	N.Z.	CLASS %(NZ)	CATE-GORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	S.I.	N.Z.
GSF3	Mixtures of tussock, scrub and indigenous forest	20 400	188 700	209 100	0.8	gsf3	Mixed tussock, indigenous forest and lowland scrub	7 900	123 300	131 200
						gsf4	Mixed tussock, indigenous forest and subalpine scrub	12 500	65 400	77 900
GSF4	Mixtures of tussock exotic forest and scrub	6 900	10 800	17 700	0.1	gsf5	Mixed tussock, exotic forest and scrub	6 900	10 800	17 700
GSF5	Mixtures of sand-dune associations forest and scrub	-	1 700	1 700	0.0	gsf6	Mixtures of sand-dune associations forest and scrub	-	1 700	1 700
GSF6	Mixtures of pasture and tussock, forest and scrub	-	90 900	90 900	0.3	gsf7	Mixed pasture and tussock, indigenous forest and scrub	-	62 600	62 600
						gsf8	Mixed pasture and tussock, exotic forest and scrub	-	28 300	28 300
GSF7	Mixtures of indigenous and exotic forest, grassland and scrub	-	3 900	3 900	0.0	gsf9	Mixed indigenous and exotic forest, grassland and scrub	-	3 900	3 900
GSF8	Unspecified and miscellaneous grassland, forest and scrub mixtures	-	25 100	25 100	0.1	gsf10	Unspecified and miscellaneous grassland scrub and forest mixtures	-	25 100	25 100
GROUP TOTAL:		846 500	553 800	1 400 300	5.3					
						Group 10 : MISCELLANEOUS				
M1	Subalpine or alpine herbs	33 000	248 100	281 100	1.1	m1	Subalpine or alpine herbs	33 000	248 100	281 100
M2	Vegetation dominated by swamp associations or rushes	72 300	72 700	145 000	0.5	m2	Swamp associations or rushes	15 700	10 300	26 000
						m3	Swamp associations or rushes and *Leptospermum*	26 500	26 200	52 700
						m4	Swamp associations or rushes and podocarp or podocarp-hardwood forest	1 100	6 700	7 800
						m5	Swamp associations or rushes with other minor scrub or forest	16 400	10 600	27 000
						m6	Swamp associations or rushes with minor pasture	7 600	6 800	14 400
						m7	Swamp associations or rushes with minor grassland and scrub	1 700	8 200	9 900
						m8	Swamp associations or rushes with grassland and forest	3 300	3 900	7 200
M3	Salt-tolerant associations	5 300	3 500	8 800	0.1	m9	Salt tolerant associations	3 900	2 700	6 600
						m10	Salt tolerant associations with minor pasture	1 400	800	2 200
M4	Vegetation dominated by sand-dune associations	73 300	14 000	87 300	0.3	m11	Sand dune associations	28 700	2 700	31 400
						m12	Sparse sand-dune associations	21 500	1 600	23 100
						m13	Sand dune associations with minor pasture	11 900	4 200	16 100

CLASS CODE	VEGETATION COVER CLASS	CLASS AREA N.I.	CLASS AREA S.I.	CLASS AREA N.Z.	CLASS %(NZ)	CATEGORY CODE	VEGETATION COVER CATEGORY	CATEGORY AREA N.I.	CATEGORY AREA S.I.	CATEGORY AREA N.Z.
M4	Vegetation dominated by sand-dune associations (continued)	73 300	14 000	87 300	0.3	m14	Sand dune associations with minor scrub	4 100	3 300	7 400
						m15	Sand dune associations with minor indigenous forest	1 500	600	2 100
						m16	Sand dune associations with minor exotic forest	5 600	1 600	7 200
M5	Pakihi associations	-	43 900	43 900	0.2	m17	Pakihi associations	-	10 800	10 800
						m18	Pakihi associations with minor pasture	-	12 800	12 800
						m19	Pakihi associations with minor forest	-	2 500	2 500
						m20	Pakihi associations and scrub or forest and scrub	-	17 800	17 800
M6	Semi-arid herbfield associations	-	15 300	15 300	0.1	m21	Semi arid herbfield associations	-	15 300	15 300
GROUP TOTAL		183 900	397 500	581 400	2.2					
					Group 11 : NO VEGETATION					
N1	No vegetation	299 600	725 300	1 024 900	3.9	n1	Areas of land with very sparse or no vegetation	25 500	219 400	244 900
						n2	Urban areas	99 400	30 600	130 000
						n3	Lakes	112 100	227 700	339 800
						n4	Rivers	60 300	234 300	294 600
						n5	Other unmapped areas	2 300	13 300	15 600

The analysis does recognise dominance in some of the 'unnatural' mixtures, so that the minor component of vegetation can be ignored if desired. These situations are:

(1) forest/ grassland mixtures which are separated according to whether forest or grassland is dominant (groups 7 and 8),
(2) mixtures containing "miscellaneous" vegetation classes. These are listed in group 10 only if the miscellaneous component is dominant, otherwise they are listed according to the dominant grassland, scrub or forest element of the mixture.

The other mixed cover categories are mainly homogeneous mixtures and in our opinion are correctly retained. The convention followed for mixtures in Table 2 is that the word "and" implies no dominance whereas "with" implies dominance.

Comparisons with other data

There is very little information with which to compare Tables 1 and 2. The only surveys similar to the NZLRI are land inventory and land use capability surveys carried out for the National Water and Soil Conservation Organisation. These are undertaken on an individual farm property, mountain range or river catchment basis, to standards set out in the Land Use Capability Survey Handbook (Soil Conservation and Rivers Control Council, 1971). Most are unpublished reports. For examples of published work containing some information on vegetation cover see Otago Catchment Board (1966), and Prickett and Williams (1971). Data from these surveys are included in a standardised form in the NZLRI.

National statistics are available for forested areas (New Zealand Forest Service, 1978) but the classification used in published data is very broad and gives no indication of forest disturbance. Agricultural statistics (New Zealand Department of Statistics, 1980) give a comparatively detailed picture of land use, especially of arable land, but do not give any detail of the actual vegetation cover within land uses. The Ministry of Agriculture and Fisheries and others are now undertaking regional surveys of scrub weeds, based on farmer surveys (A.A. Sheppard, MAF, Palmerston North, pers. comm.), a combination of postal survey and quantitative sampling (Bascand and Jowett, 1979), or semi-intensive field mapping (Stevens and Hughes, 1973). Comparisons between NZLRI figures and other scrub weed surveys may only be made when the latter are fully published, and when NZLRI figures have been comparably subdivided by region.

A comparison can be made with the broad analysis provided by Kelly (1980), using New Zealand Year Book statistics, weighted measurements from Wards (1976) and other sources. Kelly's analysis seems at first sight very different from that shown in Table 1. However his total for "improved grassland, other grazing land and cropping land" (14.4 million ha) is similar to the total for the cropland, grassland, and grassland-scrub groups of this analysis (15 million ha). Much of the difference would be contained in Kelly's "alpine zone" which contains a substantial area of snow tussock grazing land, the balance of the latter group being contained in the "miscellaneous" and "no vegetation" groups of this analysis. Another interesting comparison is that the area of Kelly's forest groups (7 million ha) equals the total of both forest and forest-scrub groups of this analysis (6.9 million ha).

Concluding discussion

A full discussion of the information presented in Tables 1 and 2 is not possible in this paper. However the comparisons mentioned above do indicate the significance of the data, particularly the wide incidence of the mixed grassland-scrub group, usually hidden in land use statistics under such terms as 'unimproved grazing land', but showing up in this analysis as the largest single vegetation cover group. For example, in the North Island, mixtures of grassland and indigenous lowland scrub (gs 1-13) occupy nearly 2.2 million ha or 19% of the island's land surface; while in the South Island, matagouri *(Discaria toumatou)* or sweet briar *(Rosa rubiginosa),* rarely mapped as "pure" scrub in the NZLRI, occur in grassland-scrub mixtures (gs 28-40) on over 1.1 million ha or nearly 8 % of the island's land surface.

Table 1 shows that the NZLRI vegetation classification has permitted relatively detailed information about vegetation cover categories containing scrub, especially for agriculturally important weeds such as gorse *(Ulex europaeus)* (s8-12, gs 14-25). The emphasis of the classification towards agriculturally orientated land management also reveals significant features in the analysis of the grassland and grassland/cropland groups, notably the widespread occurrence of 'short tussock associations' oversown with or invaded by pasture species in the South Island (g 15-18), and the extent of the grassland-cropland group in the South Island. The area of this latter group gives a measure not of arable land as such, but of the area in grassland/ cropland systems, much of which would be cropped at least occasionally. This is approximately four times the actual area under crops (excluding grasses for hay and seed, and lucerne) (New Zealand Department of Statistics, 1979) and represents over

one third of all South Island scrub-free grassland including all types of tussock.

The analysis provides limited detail about the forest and other indigenous vegetation cover. However it does show that of the 7 million ha shown by Kelly (1980) as forest, more than 2 million ha, or nearly 30%, comprises forest-scrub mixtures. Not all these mixtures, however, result from forest logging or other human disturbance.

Our analysis does not distinguish between these man induced and naturally occurring features. On the other hand, our analysis reveals a significant area of small forest remnants within grassland, particularly of podocarp-hardwood or hardwood forest within pasture (gf 3, 5) in the North Island, and of small exotic forest stands within pasture (gf 8) in both islands. Similarly it shows a large area of grassland-scrub-forest mixtures, particularly of mixed pasture, indigenous forest and lowland scrub (gsf 1) in the North Island.

There are obviously many regional differences in this analysis; however beyond North Island/South Island comparisons further analyses will have to await subdivision of the data by region. Such subdivision could be profitably made on the basis of ecological districts.

In the meantime, this brief discussion of the analysis has concentrated on the features that emphasise, in our view, the dynamic and complex nature of New Zealand's present vegetation cover. That such a complex pattern should have resulted from a comparatively short period of human intervention shows the overwhelming influence that land use has had on the vegetation cover. O'Connor (1973) introduced the concepts of ecological and cultural stability in the New Zealand landscape; the analysis presented in our paper may go some way towards quantifying these concepts.

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APPENDIX 1

NOTES ON CATEGORIES IN TABLE 2

Abbreviations used: assn (association); NI (North Island), SI (South Island).

1. GRASSLAND

All categories: The term pasture denotes non-tussock grassland, usually dominated by introduced species.

gl-3: Includes significant areas with minor rushes and sedges, but areas with minor swamp assns are included in g4-6.

g4-6: Includes minor areas where swamp assns, rushes, or sedges, and grassland both occupy >40% cover.

g4: Includes 1600 ha (SI) with minor pakihi assns.

g7-9,11,13,14,16,17,19,20: Include areas with minor subalpine or alpine herb assns.

g14: Generally mapped where total grassland cover <40%. Probably underestimated, especially in eroded areas. Mostly snow tussock or snow and short tussock assns in SI, red or snow tussock in NI.

g17: Mainly with unimproved pasture.

g18: Mainly with red tussock *(Chionochloa rubra)* in NI; various tussock assns in SI.

g22: Includes minor areas where sand-dune assns and pasture both >40% cover.

g23 : Includes minor areas where salt tolerant assns and pasture both >40% cover.

g24: Considerable underestimate. Semi-arid herbfield assns only mapped in Otago, but occur elsewhere in SI with unimproved pasture and / or short tussock assns, especially in Marlborough and Waitaki Valley, where they have been included in 81, 3, 7, 16 and appropriate grassland-scrub categories. Grassland and semi-arid herbfield assns both >40% cover in approx. half of area quoted.

2. GRASSLAND-CROPLAND

All categories: Contain grassland as well as crops in most map units. Areas shown are therefore "areas of cropping systems" rather than actual cropped areas (see text).

c2,5,8,11: Tussock component varied, but usually minor.

c5 : Mainly with mixed tussock and pasture.

c9: Usually horticulture with other cropping, or rchards/vineyards with cereal cropping. 2S00 ha (NI) is in pure cropping mixtures.

cl0: In Canterbury and Marlborough, mapped in the early stage of the survey, crop types were frequently unspecified. Most cropping in these regions is cereal/pasture, winter fodder cropping/ pasture or mixed systems.

3. SCRUBLAND

All categories: The terms "scrub" and "scrubland", when used in a general sense, include fernland. Tree ferns *(Cyathea* spp., *Dicksonia* spp.) are included in mixed indigenous scrub.

sl: Includes scrub mixtures dominated by *Lepto-spermum* or fern but containing other indigenous scrub spedes. GeneraUy occurs In lowland and montane habitats below lOOO m asl but may occasionally extend into subalpine zone up to 1200 m with a *Leptospermum* component. Includes 700 ha (NI) mixed indigenous scrub and blackberry.

s2 : Excludes areas of *Leptospermum* and swamp assns (included in m5). Excludes areas of *Leptospermum-dominated* heathland vegetation in NI (included in sI4).

s14: Mapped in NI only. Includes heathland scrub dominated by *Dracophyllum* spp., *Leptospermum scoparium* and *Calluna vulgaris*.

s 15-17 : Include *Dracophyllum-dominated* subalpine scrub not included in s14.

s15,17: Include areas with minor alpine or subalpine herb assns.

s16: Usually with *Leptospermum* in NI; varied in SI.

s17: Generally mapped where total scrub cover <40%.

s18: Mapped in NI only.

4. FOREST

All categories: The term "forest" includes cutover (logged) forest where a forest structure with significant canopy trees is retained after logging. Cutover forest has been indicated with a separate symbol in some areas during the survey, principally in central and southern NI and western southland. All categories containing forest may include areas in SI of stunted forest, for example of beech forest < 6 m high growing at or near the timber-line or on exposed coastal sit/".~

fl: Mainly podocarp-hardwood-kauri forest

f5 : Occurs mainly where map units fall across altitudinal boundary between lowland and high-land podocarp-hardwood forest (taken as the limit of rimu, *(Dacrydium cupressinium»,* and both were mapped.

f6-9: Totals presented in different categories for NI and SI as beech forest were not subdivided into highland/lowland in SI.

f8 : Occurs mainly where map units fall across altitudinal boundary between lowland and high-land beech forest (approx. 1100 m).

f13: See note *to f5*.

fl5 : Includes 2900 ha (NI) coastal forest. Coastal forest has been undermapped and therefore not separated from hardwood forest. Includes areas

of heavily logged podocarp-hardwood forest where no significant podocarp component remains.

fl6 : Includes small areas of exotic trees planted for catchment protection or erosion control with no production potential. Area underestimated as exotic forest expansion has occurred since field mapping in many areas. Many plantings too small to map.

fl7 : Mainly exotic forest with cutover podocarp-hardwood forest in NI; varied in SI.

5. FOREST-SCRUB

All categories: Includes areas with minor scrub other than those mentioned.

fs2,4,8,12,16,20: See note to sl.

fs3,7,11,15,19: *Leptospermum* and fern have not been separated as they often occur together in forest-scrub mixtures. In most categories *Leptosperrmum* is dominant and occurs in >80% of the toal area. The exceptions are fs11 and 15 in SI where fern occurs on 34900 ha (42%) and 13900 (62%) respectively of the total area.

fs5 : Mainly with gorse or *Cassinia* in SI.

fs6,10,14,18,22: Includes small areas with minor alpine or subalpine herb assns. Includes small areas with lowland as well as subalpine scrub where map units cross altitudinal boundaries.

fs7: Includes 1000 ha (NI) beech-podocarp forest and *Leptospermum*.

fs8 : Includes 400 ha (NI) beech-podocarp forest and mixed indigenous scrub.
fsll: With gorse or broom in SI.
fsl3: Mainly with *Cassinia* in NI, with gorse or *Cassinia* in SI.

fs15-18: Includes small areas with coastal forest, especially fs20, 21 in NI.

fs17: Includes 1600 ha (SI), 3800 ha (NI) with *Cassinia*. Balance mainly with gorse.

fs23: Includes 7200 ha (SI) with minor swamp assns

fs24: Mainly with gorse, or with *Leptospermum* and minor swamp assns.

fs25-28: Pakihi dominated assns are included in m27. However totals include small areas where both pakihi assns and forest or scrub >40% cover.

fs26,28: Mainly with mixed indigenous scrub or gorse.

fs29: Exotic forest >40% cover on 31600 ha (NI); 1100 ha (SI).

fs30: Exotic forest >40 % cover on 17700 ha (NI); 8300 ha (SI).

fs31: Exotic forest >40% cover on 23100 ha (NI); 49600 ha (SI).

fs32: Mainly with broom in SI; varied in NI.

fs33: Mapped in NI only.

fs35: Exotic forest >40% cover on 7600 ha (NI); 2000 ha (SI).

6. GRASSLAND-SCRUB

All categories: Have been subdivided by scrub component. Subdivisions by grassland component, where significant, are given below.

gsl-3,17,18: See note for s1.

gs2: Mainly with short tussock, but SI total includes 26000 ha with minor snow tussock (13400 ha with snow tussock >40% cover).

gs3 : Includes 6600 ha (SI) with red or snow tussock present, and 3100 ha (SI) where red tussock is the most important tussock.

gs4-11: Excludes areas with gorse. See gsl9, 20.

gs5 : Mostly with short tussock in SI but includes 20300 ha with snow tussock present and 8800 ha with red tussock present. Mainly with red or short tussock in NI.

gs6: Mostly with short tussock in SI, but includes 7900 ha with snow tussock present (6500 ha with snow tussock >40% cover) and 17600 ha with minor red tussock. 1900 ha with short tussock in NI; remainder with red tussock. Includes 19000 ha (SI) with minor sweet briar or matagouri.

gs8: Mainly with short tussock, but includes 15300 ha with snow tussock present and 4300 ha with red tussock present.

gs9: Mainly with short tussock but includes 9500 ha with snow tussock present (5700 ha with snow tussock >40 % cover) and 4600 ha with minor red tussock).

gs 10: All with pasture in NI; 49600 ha with mixed pasture (mainly unimproved) and short tussock in SI; small areas with minor snow or red tussock.

gsll: Mainly with short tussock but includes 5800 ha with minor snow tussock present and 24000 ha with red tussock present (6400 ha with red tussock >40% cover).

gsl2; All with pasture in NI. 3200 ha with short tussock in SI; 5000 ha with snow tussock; remainder mainly with unimproved pasture.

gsl3: All with pasture in NI; varied grassland component in SI.

gsl5: 3100 ha with short tussock; remainder with red tussock (SI).

gsl6: 9200 ha with red tussock; 2000 ha with minor snow tussock, remainder with short tussock (SI).

gsl7: All with pasture in NI; 5600 ha in SI with pasture and short tussock, also small areas with minor red tussock.

gsl9: All with pasture in NI; 19000 ha with pasture and short tussock (usually minor); also 1000 ha with minor red tussock.

gs20: 1600 ha '(SI) with snow tussock; remainder with short tussock.

gs21: 11000 ha (SI) with short tussock and pasture; remainder with pasture.

gs23: 13700 ha (SI) with short tussock and pasture; 500 ha (SI), 200 (NI) with short tussock; remainder with pasture.

gs24: Mainly with pasture. Mainly with *Cassinia* or blackberry (NI); or matagouri (SI).

gs25: Mainly with matagouri (SI).
gs26: Excludes areas with gorse. See gs23. All with pasture in NI. 13600 ha in SI with short tussock and pasture, remainder mainly with pasture.

gs29: Mainly with short or short and snow tussock.

gs30: Includes 1100 ha with minor snow tussock.

gs32: Mainly short or short and snow tussock. Includes 21200 ha with minor red tussock.
gs33: 350000 ha with short tussock and unimproved pasture, with other minor tussock. Remainder with various grassland mixtures.
gs35: 16100 ha with snow tussock present; remainder with short tussock.
gs36: Includes 800 ha with red tussock and pasture and 700 ha with snow tussock and pasture.
gs37: 1900 ha with pasture; remainder with short tussock and pasture. Mainly with minor *Leptospermum*.
gs38: Mainly with minor *Leptospermum*.
gs39: 38200 ha with short tussock and unimproved pasture; remainder with various grassland mixtures. Various minor scrub.
gs40: Mainly with short, short and snow, or short and red tussock. Various minor scrub.
gs41: Mapped NI only; excludes 8800 ha grassland and *Leptospermum* with minor heathland vegetation mapped in gs4, 5.
gs42: Includes sparse tussock and subalpine scrub mixtures. In SI mainly with snow or snow and short tussock; in NI with various tussock mixtures.
gs42-44: Includes areas with minor alpine or subalpine herb assns. Includes areas of *Dracophyllum*-dominated subalpine scrub (SI).
gs43: Mainly snow tussock with minor unimproved pasture and subalpine scrub.
gs44: Mainly with snow or snow and short tussock.
gs47-49: See note to g24. Includes small areas where semi-arid herb assns and grassland or scrub both >40% cover.
gs47: Includes 200 lia with gorse.
gs48: Includes 7900 ha with unspecified scrub; remainder with sweet briar or matagouri.

7. GRASSLAND WITH FOREST

gf2: Most areas contain minor swamp assn, rush or sedge components.
gf4: Includes 1600 ha (SI) pasture with beech-podocarp forest.
gf5 : Includes 7700 ha (NI) with coastal forest (underestimated).
gf9: Mapped in NI only (underestimated)
gfl0: Mainly short or short and snow tussock in SI; mainly short or red tussock in NI.
gf11: Short or snow tussock in SI; snow or red tussock in NJ. 500 ha (NI) with podocarp-hardwood-beech forest; 400 ha (SI) with hardwood forest; remainder with podocarp-hardwood forest.
gfl2: Short or snow tussock in SI; red tussock in NJ.
gfl3: Includes 600 ha (SI) with short tussock.
gfl4: 100 ha (NI) with red tussock; 300 ha (SI) with snow tussock; remainder with short tussock.
gfl5: Various grassland mixtures.
gfl6: In SI, 2200 ha with beech forest, 1000 ha with podocarp forest, remainder with podocarp-hardwood forest.
In NI, 800 ha with hardwood forest; remainder with podocarp or podocarp-hardwood forest.

8.FOREST WITH GRASSLAND

fg4: Includes 400 ha (N!) with beech-podocarp forest.
fg5: Includes 200 ha (NI) with minor sand-dune assns
Includes 800 ha (NI) with coastal forest.
fg6: Includes 1100 ha (SI) with minor snow tussock.
fg8: Includes 300 ha (SI) with minor snow tussock.
fg9: Mapped in NI only (underestimated).
fgl0-13: Totals include areas of minor alpine or sub-alpine herb assns.
fgl0: Mainly short tussock. Small areas of red and snow tussock in SI. Includes 1000 ha (SI) with minor pasture.
fg11: Mainly snow tussock. Small areas with short tussock. Includes 2200 ha (SI) with minor pakihi assns.
fg12: Mainly snow tussock. Small areas with short or red tussock.
fgl3: Hardwood forest in NI; hardwood and beech-hardwood forest in SI.
fgl4: Mainly with short tussock. Small areas with red tussock.

9. GRASSLAND-SCRUB-FOREST MIXTURES

gsf1: Various combinations. Much of the area involves mixtures of pasture, mixed indigenous scrub or *Leptospermum,* and logged podocarp-hardwood or hardwood forest, especially in NI; more varied in SI. Includes 2900 ha (SI) with subalpine scrub. Includes minor cropland.
gsf2: Includes 5500 ha (NI) with conservation trees. Includes minor cropland.
gsf3: Various combinations. Mainly with short tussock (SI); short or red tussock (NI). Mainly with *Leptospermum* or heathland scrub in NI.
gsf4: Various combinations. Much of the area involves mixtures with snow tussock and beech forest in SI; various tussocks in NI.
gsf6-9: Mapped in SI only
gsf7,8: Various scrub and forest components. Mostly with short tussock and pasture.
gsf8: Includes grassland-scrub mixtures with minor exotic forest.

10. MISCELLANEOUS

m1 : Only mapped where alpine or subalpine herb assns were dominant vegetation mapped. Includes areas of minor short or snow tussock or sub-alpine scrub. Includes 198000 ha (SI); 15000 ha (NI) where total cover <40%.
m2: Includes areas of swamp associations with minor red tussock. Includes 400 ha (NI), 300 ha (SI) of coastal swamp and salt-tolerant assns.
m3: Includes 22300 ha (NI), 3800 ha (51) where *Leptospermum* >40%. Most of this area also has swamp assns >40% cover.
m4: Includes areas where forest and swamp assns both >40% cover.
m6-8: See comment to g4.
m6: Includes 500 ha (SI) with minor tussock.

m7: Includes 900 ha (NI) where *Leptospermum* >40%. m 13: See comment for g22.

m13: Includes areas where both pasture and pakihi assns >40% cover.

m19: Includes areas where both scrub and pakihi assns >40% cover.

m21: Mainly with minor unimproved pasture and/or short tussock. 1400 ha with minor matagouri or sweet briar.

NO VEGETATION

nl: Snow and ice fields, gravel beds, shifting sand etc.

n5: Some estuaries, some mines; not mapped consistently.