Auckland
Regional Council
TE RAUHĪTANGA TAIAO

Vegetation Associated with Land Uses in the Auckland Region 2007

February TR 2009/013

Auckland Regional Council
Technical Report No.013 February 2009
ISSN 1179-0504 (Print)
ISSN 1179-0512 (Online)
ISBN 978-1-877528-20-0

Reviewed by:

Name: Amy Taylor

Position: Project Leader Land

Organisation: Auckland Regional Council

Date: 27 February 2009

Approved for ARC Publication by:

Name: Grant Barnes

Position: Group Manager Monitoring and Research

Organisation: Auckland Regional Council

Date: 27 February 2009

Recommended Citation:

Thompson, A. J.; Hicks, D. L. (2009). Vegetation Associated with Land Uses in the Auckland Region 2007. Prepared for Auckland Regional Council. Auckland Regional Council Document Type TR 2009/013.

Vegetation Associated with Land Uses in the Auckland Region 2007.

A. J. Thompson
D. L. Hicks

Prepared for
Auckland Regional Council

A. J. Thompson
Thelton Environmental Limited
McNicol Road, Clevedon, RD5, Papakura

D. L. Hicks
P O Box 170, Orewa

Contents

1 Introduction

This document summarises data and discusses results relevant to land use and vegetation, for a point sample survey of soil state (intactness and disturbance) from 2007 region-wide aerial photography. The survey has been carried out in accordance with the National Land Monitoring Forum's procedure for point sampling (NLMF, in prep.), and is similar to surveys carried out in the Manawatu-Wanganui, Auckland, Gisborne, Waikato, Wellington, Tasman and Bay of Plenty regions between 1997 and 2005.

Auckland's survey has been carried out primarily to provide information about soil state (intactness and disturbance) for state of environment reporting. Survey data are also expected to be useful for other purposes, such as providing detail about the region's land use; assessing the extent of vegetative soil conservation measures; and as a source of facts and figures for the Council's policy documents and publications.

The document is the third of four reports:

- Methods Used to Survey Soil State in the Auckland Region 2007,
- Soil State in the Auckland Region 2007,
- Vegetation Associated with Land Uses in the Auckland Region 2007, and
- Vegetative Soil Conservation Cover in the Auckland Region 2007.

2 Report Structure

Vegetation is not by itself an indicator of soil state, though extent to which it has been modified becomes relevant as an indicator of pressure on soil, from either land use or natural disturbance. Table 3.1 contains summary data about land use and associated vegetation in the Auckland region, specifically:

- Percentage of sample points in each of nine broad rural land uses (intensive, dairy, drystock, forest plantation, natural forest, natural scrub, exotic scrub, coastal grass and scrub, wetlands and mangrove swamps),
- Percentage of sample points not in rural use (buildings and yards, urban areas, water bodies and coastal features, points unclassified or lacking aerial photo cover).

Tables 3.2 to 3.10 split Table 3.1 up, summarising the nature of primary vegetation cover for each land use, and the extent of secondary vegetation cover associated with it.

Primary cover is the main vegetation, present on more than half of the one-hectare square surrounding a sample point. It may be herbaceous ground cover e.g. crop, pasture, tussock, wetland plants; or shrubby ground cover e.g. blackberry, gorse, tree fern, manuka; or tree cover e.g. pines, willows, podocarps, and kauri.

Secondary cover is associated vegetation, present on less than half of the one-hectare square. It may be intermingled with primary cover; for instance scattered scrub in pasture, or rank grass understory in tree plantations, or exotic scrub interspersed with wetland plants. Equally it may occur as discrete patches; for instance willows and poplars planted in grazed pasture, regenerating scrub occupying canopy gaps within natural forest, or wetland remnants surrounded by shelterbelts.

In each table, "miscellaneous" includes a small number of points that do not fit standard secondary vegetation categories. Examples are points where an urban use or a coastal landform is recorded in lieu of secondary cover.

The NLMF point sampling handbook (NLMF, in prep.), defines terms used in each table e.g. rural land use, non-rural land use, and primary vegetation cover, secondary vegetation cover, sparse, dense, scattered, and extensive. A glossary is appended to the first report (Methods used to survey soil state in the Auckland region).

3 Land Uses Region-Wide

Summary data are presented in this table to set the scene for discussions of vegetation associated with each land use, which follow Tables 3.2 to 3.10.

Table 3.1

Land uses throughout the Auckland region, 2007

Land uses	Composition	Points	Points as % of sample[1]	95% conf. lim.[2]
Rural uses:		**2883**	**54.6**	**1.3**
Intensive cultivation	vineyards incl. kiwifruit	26	0.5	0.2
	orchards incl. avocado	33	0.6	0.2
	market gardens	66	1.3	0.3
	grain crops	34	0.6	0.2
	greenfeed crops	12	0.2	0.1
	sub-total	171	3.2	0.5
Permanent pasture	dairy, improved	591	11.2	0.9
	drystock, improved	1496	28.3	1.2
	drystock, unimproved	146	2.8	0.4
	sub-total	2233	42.3	1.3
Forest plantations	coniferous trees	475	9.0	0.8
	broadleaved trees	4	0.1	0.1
	sub-total	479	9.1	0.8

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.

Cont. Table 3.1

Land uses throughout the Auckland region, 2007

Land uses	Composition	Points	Points as % of sample[1]	95% conf. lim.[2]
Conservation uses:		**1406**	**26.6**	**1.2**
Bush	natural forest	383	7.3	0.7
	natural scrub	758	14.4	0.9
	exotic scrub	122	2.3	0.4
	sub-total	1263	23.9	1.2
Coastal and wetland plants	coastal grass and scrub	29	0.5	0.2
	freshwater wetland	25	0.5	0.2
	saline wetland	89	1.7	0.3
	sub-total	143	2.7	0.4
Other uses:		**939**	**17.8**	**1.0**
Urban areas	residential	309	5.9	0.6
	industrial/commercial	99	1.9	0.4
	roads, railways, airfields	18	0.3	0.2
	open space	152	2.9	0.5
	sub-total	578	11.0	0.8
Rural areas	farm buildings and yards	123	2.3	0.4
	industrial buildings and quarries	34	0.6	0.2
	roads, railways, airfields	5	0.1	0.1
	sub-total	162	3.1	0.5

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.

Cont. Table 3.1

Land uses throughout the Auckland region, 2007

Land uses	Composition	Points	Points as % of sample[1]	95% conf. lim.[2]
Water bodies and coastal features	lake or pond	16	0.3	0.1
	inter-tidal estuary	101	1.9	0.4
	beach	31	0.6	0.2
	rock platform or cliff	51	1.0	0.3
	sub-total	199	3.8	0.5
Unclassifiable land :		**49**	**0.9**	**0.3**
Other	unclassified points in 2007	0	0.0	0.0
	points with no photos in 2007	49	0.9	0.3
	sub-total	49	0.9	0.3
All land in region :	**total**	**5277**	**100.0**	**0.0**

Note 1: "% of sample" sub-totals/totals may differ by 0.1% due to rounding.
Note 2: "% of area" sub-totals/totals may differ by 0.01% due to rounding.

54.6% of the region was in rural uses of a commercial nature:

- 3.2% of Auckland's land was intensively cultivated i.e. fruit, vegetable, grain and fodder crops.
- 42.3% was in permanent pasture, with a balance of 11.2% in dairy pasture to 31.1% in drystock pasture.
- 9.1% was occupied by forest plantations, overwhelmingly pines.

26.7% of the region was in conservation use. By "conservation use" is meant land deliberately kept in a natural or semi-natural state. The percentage includes not just DOC reserves, but a cumulatively greater area of regional parkland and private land:

- 7.3% of Auckland's land was in standing natural forest; either bush remnants that have never been cleared, or regeneration.

- 16.7% was in scrub, with a balance of 14.4% in natural scrub to 2.3% in exotic scrub.
- Just 0.5% was occupied by coastal plant communities. These were a mix of grass and scrub, comprising intermingled natural and exotic species.
- Another 2.2% was occupied by wetland plant communities, with a balance of 0.5% freshwater to 1.7% saline wetlands.

14.1% of the region was in uses that entail partial displacement of vegetation by buildings and paved surfaces:

- 11.0% of Auckland's land was urbanised (the figure includes 2.9% urban open space).
- Another 3.1% was occupied by rural buildings and yards.

3.8% of the region was land substantially devegetated by natural processes:

- 0.3% was lakes and ponds.
- 1.9% was inter-tidal estuaries.
- 0.6% was beaches.
- 1.0% was coastal rock platforms and cliffs.

A final 0.9% of the region was unclassifiable due to absence of cloud-free aerial photographic cover.

4 Vegetation Associated with Land Uses

4.1 Vegetation associated with intensive land uses

(3.2% of the region) (Table 3.2)

The sub-sample size (n = 171) for intensive land uses is small relative to the regional total (n=5277). It provides good estimates of areas under each intensive use, as percentages of the region (see Table 3.1). However it results in large error margins when primary and secondary vegetation are expressed as percentages of the sub-sample. These percentages should therefore be regarded as indicative.

4.1.1 Primary cover

Amongst intensive uses, 39% of primary cover is vegetable crops (market gardens/outdoor vegetable production), 20% is grain crops, 7% fodder crops, 19% orchard fruit trees, and 15% vineyards (9% grapes plus 6% kiwifruit).

30% of the land under intensive use has sparse primary cover i.e. freshly cultivated soil or emergent crop. 59% has dense primary cover (growing crop, close orchard or vineyard canopy). 11% has primary cover removed or truncated by harvest.

Vegetable crops (market gardens/outdoor vegetable production) remain widespread in the Franklin district, with smaller concentrations on the west Auckland rural fringe, and south-west Rodney between Waimauku and Helensville. Freshly cultivated vegetable fields account for most of the land with sparse primary cover.

Grain crops, predominantly maize, are dispersed on lowlands throughout Rodney district as well as Franklin; as are fodder crops (mainly brassicas). The collective proportion of fodder crops and grain crops is explained by the seasonal timing of aerial image acquisition (late summer-early autumn). These land uses would largely revert to pasture at other times of the year. Seasonal timing also explains why grain crops account for two thirds the harvested land.

Apart from the long-established orchard concentration on west Auckland's urban-rural fringe (running from Henderson through Kumeu to Huapai), other orchards are dispersed throughout Rodney and Franklin districts. Almost all have dense primary cover; exceptions being old orchards with gaps between trees (possibly abandoned).

Table 3.2

Vegetation associated with intensive land uses

Primary cover:	Kiwifruit	Vineyards	Orchards	Market gardens	Grain crops	Green feed crops	Total points	as % of points in use	95% conf. lim.
Sparse	0	2	6	36	4	3	51	29.8	6.9
Dense	10	13	27	25	18	8	101	59.1	7.4
Harvested	1	0	0	5	12	1	19	11.1	4.7
Total points	11	15	33	66	34	12	171	100	0.0
as % points in land use	6.4	8.8	19.3	38.6	19.9	7.0	100		
95% confidence limits	3.7	4.2	5.9	7.3	6.0	3.8			

Secondary cover	None	Hedgerow	Shelter belt	Mown grass	Grazed grass	Rank grass or wetland	Exotic scrub	Natural scrub	Exotic trees	Natural trees	Amenity trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	37												37	21.6	6.2
Scattered				7	2	4	1		6	2		1	23	13.5	5.1
Extensive		7	36	12	11	2	8	2		1	27	4	110	64.3	7.2
Total points	37	7	36	19	13	6	9	2	6	3	27	6	171	100.0	0.0
as % points in land use	21.6	4.1	21.1	11.1	7.6	3.5	5.3	1.2	3.5	1.8	15.8	3.5	100		
95% confidence limits	6.2	3.0	6.1	4.7	4.0	2.8	3.3	1.6	2.8	2.0	5.5	2.8			

Vineyards and kiwifruit are interspersed throughout the lowland areas of the region. They also have dense primary cover, apart from a few that are recently planted or uprooted.

4.1.2 Secondary cover

22% of land in intensive agriculture has no secondary vegetation cover. These are cultivated fields associated with outdoor vegetable production and grain cropping.

25% has shelterbelts and hedgerows as secondary vegetation. Most are interspersed with orchards and vineyards.

8% of intensively farmed land has grazed grass as secondary cover, adjacent to cultivated fields or orchards.

11% has areas of mown grass. These appear within orchards and vineyards, as ground cover.

Rank grass, together with pockets of wetland are present on 3% of land under intensive use. These secondary covers are found on uncultivated rough ground e.g. drainage hollows or streambanks.

Exotic scrub is found as secondary cover on another 6% of land under intensive use, at similar sites.

Just 5% of land has exotic trees planted as woodlots, adjacent to cultivated fields. A larger proportion - 16% - has amenity tree plantings. These are associated with buildings and yards.

Remnant natural trees and scrub, collectively present on just 3% of land, do not account for much secondary cover. Typically they remain at the edge of cultivated fields or on watercourse banks.

3% of intensively used land has miscellaneous secondary cover, not able to be classified as a vegetation category. These are rural buildings and yards - houses, packing sheds, barns - or in a few instances, adjacent urban buildings.

4.2 Vegetation associated with dairy pasture

(11.2% of the region) (Table 3.3)

The sub-sample size (n = 591) provides a good estimate of the area in dairy pasture, as a percentage of the region (see Table 3.1). It supplies reasonable indications of primary and secondary vegetation, expressed as percentages of the sub-sample, with error margins that are fairly small.

4.2.1 Primary cover

Despite recent contraction of dairying due to lifestyle block subdivision on Auckland's urban fringe, many dairy farms remain at a greater distance. They are dotted throughout the lowlands of Franklin and Rodney districts.

Composition of dairy pasture is 100% improved, dominated by high-fertility species e.g. ryegrass and clover. Other species are a secondary component of the sward e.g. cocksfoot, lotus, kikuyu.

76% of dairy pasture is dense (spelled or lightly grazed), 22% is sparse (heavily grazed), and 2% harvested for hay or silage.

Extent of sparse pasture is consistent with the summer season during which aerial photography was acquired. Nonetheless, three quarters of dairy pasture still has dense ground cover. The percentage harvested is surprisingly low. This may reflect timing of photography in late summer-early autumn, well after hay and silage had been cut.

4.2.2 Secondary cover

37% of dairy pasture either has no secondary vegetation, and another 16% just has shelterbelts or hedgerows along paddock edges.

6% has wetland plants or mangroves occur along streams, around ponds or on estuarine margins within dairy land.

Secondary scrub (both exotic and natural) is adjacent to 7% of dairy paddocks. The low percentage of scrub, as well as the low ratio of exotic (2%) to natural scrub (5%), indicate the intensity of dairy farming, and reflect that dairying occurs chiefly on stable, well-drained and fertile land.

Table 3.3

Vegetation associated with dairy pasture

Primary cover:	Improved pasture	Total points	as % of points in use	95% conf. lim.
Sparse	133	133	22.5	3.4
Dense	448	448	75.8	3.5
Harvested	10	10	1.7	1.0
Total points	591	591	100.0	0.0
as % points in land use	100.0	100		
95% confidence limits	0.0			

Secondary cover	None	Hedgerow	Shelterbelt	Intensive use	Wetland	Exotic scrub	Natural scrub	Exotic trees	Natural trees	Amenity trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	220											220	37.2	3.9
Scattered						7	18	73	23			121	20.5	3.3
Extensive		34	60	15	33	7	13	36	22	30	1	251	42.5	4.0
Total points	220	34	60	14	33	14	31	109	45	30	1	591	100.0	0.0
as % points in land use	37.2	5.8	10.2	2.4	5.6	2.4	5.2	18.4	7.6	5.1	0.2	100		
95% confidence limits	3.9	1.9	2.4	1.2	1.9	1.2	1.8	3.1	2.1	1.8	0.3			

Natural trees as secondary cover are present in 8% of dairy pasture. They are equally divided between remnant bush-lots and scattered trees in paddocks.

The 18% of dairy pasture with exotic trees as secondary cover is made up by eucalypt or conifer woodlots adjacent to paddocks; and spaced poplars or willows planted for shade or soil conservation.

Another 5 % of dairy pasture is adjacent to amenity tree plantings, in the vicinity of yards and buildings.

2% has intensive uses as secondary cover. This category mainly comprises maize paddocks for grain harvest, and fodder crops used for seasonal supplementary feed. A much smaller component represents adjacent orchards and vineyards.

4.3 Vegetation associated with drystock pasture

(31.1% of the region) (Table 3.4)

The sub-sample size (n = 1642) provides a good estimate of the area in drystock pasture, as a percentage of the region (see Table 3.1). It also supplies good estimates of primary and secondary vegetation, expressed as percentages of the sub-sample, with small error margins.

4.3.1 Primary cover

Drystock pasture includes the farming of beef cattle, sheep, deer, goats and horses. The majority of drystock pasture is improved (91%), comprising well established productive grass species. 9% is unimproved, dominated by lower fertility grasses such as browntop and fescue, interspersed with broadleaf weeds, rush and sedge. 72% of drystock pasture is dense i.e. spelled or lightly grazed. 27% is sparse i.e. heavily grazed. 1% is harvested for hay or silage.

The percentage of improved pasture is very high, reflecting that Auckland's drystock farms are mainly on terrain of easy to moderate contour, with a long history of cultivation for pasture renewal. Despite a perception that drystock farming is restricted to hill country, the point sample indicates that much of it is interspersed with dairy farms or intensive agricultural uses, on the flats and downlands of Franklin and Rodney districts. Unimproved pasture in contrast is restricted to steeper hill country, of lower fertility and excessive drainage, in the Kaipara Hills, Dome Hills, and Hunua Ranges. Even here, it occurs as individual paddocks at the back of farms; not as entire properties.

Table 3.4

Vegetation associated with drystock pasture

Primary cover:	Improved pasture	Unimproved pasture	Total points	as % of points in use	95% conf. lim.
Sparse	422	16	438	26.7	2.1
Dense	1054	130	1184	72.1	2.2
Harvested	20		20	1.2	0.5
Total points	1496	146	1642	100.0	0.0
as % points in land use	91.1	8.9	100		
95% confidence limits	1.4	1.4			

Secondary cover	None	Hedgerow	Shelterbelt	Intensive use	Wetland	Exotic scrub	Natural scrub	Exotic trees	Natural trees	Amenity trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	323											323	19.7	1.9
Scattered					56	91	104	147	105			503	30.6	2.2
Extensive		49	108	28	49	73	163	102	112	126	6	816	49.7	2.4
Total points	323	49	108	28	105	164	267	249	217	126	6	1642	100.0	0.0
as % points in land use	19.7	3.0	6.6	1.7	6.4	10.0	16.3	15.2	13.2	7.7	0.4	100		
95% confidence limits	1.9	0.8	1.2	0.6	1.2	1.5	1.8	1.7	1.6	1.3	0.3			

The proportion of drystock pasture that has been heavily grazed or depleted is consistent with seasonal dry conditions at the time of aerial photography. Nevertheless the majority still has good ground cover. A small proportion harvested, again reflects timing (most of the region was photographed between mid-summer and early autumn, after paddocks had been cut for hay or silage).

4.3.2 Secondary cover

Extent of secondary vegetation cover (80% of the sub-sample) reflects less intense pasture management on drystock farms and is perhaps a recognition that secondary vegetation is worth retaining on sites that are unstable or not economical for clearing.

Secondary vegetation cover is absent from 20% of all drystock pasture land. Another 10% just has hedgerows (3%) or shelterbelts (7%) at the edge of open paddocks. The open drystock pasture predominates on land of easier contour, including downlands and foothills.

Wetland plants or mangroves occur along streams, around ponds or on estuarine margins within drystock farms; but present at 6.4% of drystock pasture, they are not an extensive secondary cover.

Scrub collectively (natural plus exotic) accounts for 26% of secondary vegetation cover. Scrub is the predominant secondary vegetation in pasture on hill country slopes, steepland faces, or incised gullies, where access for clearance and weed control are limited. Natural scrub (16%) is more extensive than exotic scrub (10%) on this country, which is explained partly by natural incidence, though also by weed control, and perhaps some landowners' sympathies for preserving natural vegetation.

Natural trees are present as secondary vegetation in 13% of drystock pasture. Areas of natural trees are equally divided between contiguous blocks of bush and scattered trees in paddocks.

Exotic trees planted within 15% of drystock pasture, are slightly more extensive. Greater proportions are space-planted in paddocks for shelter or soil conservation, than as woodlots.

8% of drystock pasture has amenity trees planted around farmhouses, sheds and yards. The category also includes a number of intensive agricultural/horticultural buildings, such as poultry sheds and glasshouses sited on or next to drystock farms; but these larger buildings do not have much associated vegetation.

Intensive uses as secondary cover (2%) include fodder crops used for seasonal supplementary feed, as well as vegetable fields, orchards or vineyards adjacent to drystock pasture on lowlands.

4.4 Vegetation associated with forest plantations

(9.1% of the region) (Table 3.5)

The sub-sample size (n = 479) provides a good estimate of plantation area, as a percentage of the region (see Table 3.1). It also supplies reasonably good estimates for primary and secondary vegetation within plantations, though error margins for some categories are rather wide when expressed as percentages of the sub-sample.

4.4.1 Primary cover

Large forest plantations are concentrated in three areas - South Kaipara Peninsula (Woodhill Forest), the Dome Hills (Mahurangi Forest) and Hunua Ranges (ARC water catchments plus private forests). Many small woodlots on farms, scattered throughout the region, are also classed as plantations.

99% is conifer plantation, mainly radiata pine. Less than 1 % is broadleaved plantation (gum or wattle).

53% of plantations are maturing trees with dense closed canopy. Another 11% are maturing trees with open canopy (planted at wide spacing's or thinned). Harvested plantations are 8% by area, while 28% are young trees (re-planted or first-rotation) that have not closed canopy yet.

The high ratio of open canopy to closed canopy is a consequence of forest management in the years preceding photography. A large proportion of Auckland's plantations have been felled and replanted within recent years. Just six of the harvested sample points (2% of plantation area) have not been replanted in pines. Most are steep sites reverting to scrub; just one appears to be in process of conversion to pasture.

Table 3.5

Vegetation associated with forest plantations

Primary cover:	Conifer	Broad-leaved	Total points	as % of points in use	95% conf. lim.
Sparse - young trees	132		132	27.6	4.0
Dense - mature open canopy	51	1	52	10.9	2.8
Dense - mature close canopy	253	3	256	53.4	4.5
Harvested	39		39	8.1	2.4
Total points	475	4	479	100.0	0.0
as % points in land use	99.2	0.8	100		
95% confidence limits	0.8	0.8			

Secondary cover	None	Intensive uses	Improved pasture	Unimproved pasture	Wetlands	Coastal vegetation	Exotic scrub	Natural scrub	Exotic trees	Natural trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	131											131	27.3	4.0
Scattered			7			3	7	5		1		23	4.8	1.9
Extensive		1	32	83	4	12	121	58	3	9	2	325	67.8	4.2
Total points	131	1	39	83	4	15	128	63	3	10	2	479	100.0	0.0
as % points in land use	27.3	0.2	8.1	17.3	0.8	3.1	26.7	13.2	0.6	2.1	0.4	100		
95% confidence limits	4.0	0.4	2.4	3.4	0.8	1.6	4.0	3.0	0.7	1.3	0.6			

4.4.2 Secondary cover

Just 27% of plantation sites have no secondary cover. This figure indicates that although 53% of plantations in the region are closed canopy, only half are completely free of canopy gaps. The other half are mature stands with occasional canopy gaps in the midst of otherwise closed canopy. These have either emergent secondary vegetation on sites that have been cleared but not planted (typically exotic scrub), or more commonly, retained secondary vegetation on uncleared sites. Its composition is:

- natural scrub, present in canopy gaps at 13% of plantations,
- bush remnants, present at 2%,
- coastal grass and scrub, present at 3%, and
- wetlands, present at 1%.

Coastal grass and scrub (in particular marram grass, spinifex and sedge), together with wetlands, are recorded in canopy gaps at sample points on coastal dunes and coastal flats which have been afforested in the sand country of South Kaipara peninsula.

Much secondary vegetation in pine plantations is diffuse, as ground cover amongst young trees that have not yet closed canopy, or amongst maturing trees that retain an open canopy because of wide initial spacing (or heavy thinning). The components are:

- 17% rank grass, at harvest sites over-sown with a grass-legume mix prior to planting young pine seedlings, and
- 27% exotic scrub associated with post-harvest re-growth, access roads and forest-edge vegetation. It quickly takes over from grass-legume mix for a few years, until itself suppressed by young pines closing canopy.

The balance of secondary vegetation is accounted for by forest edges adjacent to farmland:

- improved pasture in grazed fields (8%), and
- a single sample point where an intensive use is recorded next to forest, and two miscellaneous points where houses and associated amenity plantings are recorded.

4.5 Vegetation associated with natural forest

(7.3% of the region) (Table 3.6)

The sub-sample size (n = 383) provides a good estimate of area in natural forest, as a percentage of the region (see Table 3.1). It also supplies reasonably good estimates

for primary and secondary cover on forested land (expressed as percentages of the sub-sample), apart from two categories where error margins are rather wide.

4.5.1 Primary cover

Sample points in natural forest include a few intact kauri forest remnants, widespread regenerating kauri-podocarp-broadleaf forest, forest at an early stage of regeneration dominated by kanuka, and coastal broadleaf forest dominated by pohutukawa. Forest canopies are diverse and species composition cannot be ascertained with any certainty from aerial photography, so differentiation of primary vegetation cover has not been attempted.

Unlike some other regions where forest has been cut over for timber within recent decades, none of Auckland's forest has been recorded as sparse. Much of it has been milled for timber between 170 and 60 years back, but is now regenerating well. All forested sample points were recorded as dense primary cover; though this somewhat masks a pattern of large forest trees interspersed with smaller regenerating trees or scrub.

Just 38% has forest trees as dense primary cover, without canopy gaps. These equate to areas of bush that have never been logged, or logged bush now at an advanced stage of regeneration.

44% has an open canopy of forest trees remaining in, or emerging through, successional scrub. These are areas of bush that have been logged in past years, but where regeneration is not yet advanced.

18% has canopy gaps or edge gaps occupied by vegetation other than natural scrub. These are mostly areas where forest adjoins other land uses, and will be discussed under the heading "secondary cover".

No points in natural forest were recorded as having been recently harvested or cleared, anywhere in the region.

Table 3.6

Vegetation associated with natural forest

Primary cover:	Forest	Total points	as % of points in use	95% conf. lim.
Sparse (canopy gaps)	69	69	18.0	3.8
Dense (open canopy)	167	167	43.6	5.0
Dense (close canopy)	147	147	38.4	4.9
Harvested	0	0	0.0	0.0
Total points	383	383	100.0	0.0
as % points in land use	100.0	100		
95% confidence limits	0.0			

Secondary cover	None	Intensive uses	Improved pasture	Unimproved pasture	Coastal vegetation	Exotic scrub	Natural scrub	Exotic trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	147									147	38.4	4.9
Scattered			4							4	1.0	1.0
Extensive		1	36	5	1	4	167	8	10	232	60.6	4.9
Total points	147	1	40	5	1	4	167	8	10	383	100.0	0.0
as % points in land use	38.4	0.3	10.4	1.3	0.3	1.0	43.6	2.1	2.5	100		
95% confidence limits	4.9	0.5	3.1	1.1	0.5	1.0	5.0	1.4	1.6			

4.5.2 Secondary cover

38% of natural forest has a close canopy with no secondary cover. The 38% indicates extent of closed canopy maturing natural forest in the region. Much of this area is on Great Barrier Island, Little Barrier Island, the Hunua ranges, and the Waitakere ranges. On the downlands, coastal terraces, floodplains and foothills of the Auckland region, undisturbed or closed-canopy regenerating natural forest only occurs as fragments.

Another 44% has an open canopy of trees interspersed with natural scrub under-storey. The strong association between natural forest primary cover and natural scrub secondary cover, is an artefact of the regeneration in Auckland's forests following extensive cut-over and logging over the last two centuries.

Just 18% has other secondary vegetation in distinct canopy gaps or at forest edges.

10% has improved pasture on forest edges. This is explained by the fragmentation of contiguous areas of natural forest in lowland areas and foothills where forest has been historically converted to pastoral farming. These areas are particularly prevalent in the Rodney district, Hunua district, Awhitu Peninsula and West Auckland. There is no evidence of recent conversion of natural forest to pasture land along these edges.

A much smaller percentage (1%) has unimproved pasture on forest edges. These are rank, ungrazed or lightly grazed land associated with the forest-agriculture interface on steepland areas like the Hunua Ranges, Dome Hills and Kaipara Hills. Exotic scrub is also recorded as secondary vegetation at a similar percentage of these sites (1%).

Exotic trees are a measureable component of secondary vegetation (2%) in natural forest. These are mainly radiata pine plantation stands bordering natural forest in the Hunua Ranges, Dome Hills and Kaipara Hills.

A single sample point with coastal vegetation, and another with an intensive use next to a natural forest stand, indicate that these secondary covers are present but uncommon.

For a small number of sample points (3%), buildings and yards are recorded in lieu of secondary vegetation in forest clearings. These are houses. There are two concentrations - in the Waitakere Ranges and on Great Barrier - though others dispersed widely through the region in small forest remnants on lifestyle blocks (bush subdivision covenants and similar).

4.6 Vegetation associated with natural scrub

(14.4% of the region) (Table 3.7)

The sub-sample size (n = 758) provides a good estimate of area in natural scrub, as a percentage of the region (see Table 3.1). It also supplies good estimates for primary and secondary cover on scrubland (expressed as percentages of the sub-sample), apart from two categories where error margins are rather wide.

4.6.1 Primary cover

In the Auckland region, primary scrub cover is dominated by regenerating manuka and kanuka on dry or infertile sites, broadleaf scrub species (matipo, karamu, hangehange) on sites of intermediate fertility, and tree-ferns on damp sites. Canopy composition is often mixed, so differentiation of primary cover has not been attempted.

28% of sample points are closed canopy scrub i.e. at an intermediate stage of regeneration. Another 38% have scattered forest trees emerging through an otherwise closed canopy. Here regeneration is more advanced, but the trees are not yet dense enough to displace scrub as primary cover. 34% have canopy gaps occupied by other secondary vegetation, indicating disturbance by land use or natural processes.

Some of the scrub has been induced by recent land use change; however the majority has prevailed for some time, particularly in steeply incised gullies, unstable areas and other harsh sites. Natural scrub has always been an important element in Auckland's primary vegetation cover. It reflects a long history of vegetation clearance by tangata whenua as well as European settlers. Though scrub declined from the 1920s through the 1980s as farming intensified, and land unsuitable for farming was afforested, there has actually been a slight expansion in area of natural scrub since the 1990s. This is a consequence of landowners intentionally retiring parts of their properties, after recognising that pasture cannot be sustained long-term on steep, erosion-prone or infertile land.

4.6.2 Secondary cover

28% of natural scrub is closed canopy i.e. mature. Another 38% has small forest trees starting to emerge. There is a strong association between natural scrub primary cover and natural forest secondary cover. It is an artefact of cut-over for logs and bush clearance for farming over the last two centuries. Steep and/or infertile sites were

never successfully farmed, were abandoned early, and are now at an advanced stage of regeneration, with tree species particularly kauri and tanekaha emerging through scrub canopy. Such sites are concentrated in the Waitakere and Hunua Ranges, plus Great Barrier Island.

34% of sample points have secondary vegetation other than scrub. These are either canopy gaps caused by natural disturbance (wind throw, landslides), or scrub edges adjacent to various land uses:

- 13% of scrubland has improved pasture as secondary vegetation. These are scrub edges and their frequency is explained by sample points falling on patchy scrub regeneration at steep or infertile sites where forest has been historically converted to pastoral farming. Such areas are particularly prevalent in the Rodney district, Hunua district, Awhitu Peninsula and West Auckland. At these sample points there is no evidence e.g. cutting or spraying, of recent conversion from natural scrub into improved pasture.

- Unimproved pasture associated with natural scrub is surprisingly low, at just 2% of sample points. It occurs in regenerating scrub patches at steep or infertile sites.

- Exotic scrub as secondary vegetation within natural scrub is more widespread, at 9% of sample points. It occurs on small patches of rough or infertile ground within farms. If ungrazed, these rapidly revert to gorse and other exotic weeds (tobacco tree, brush wattle, pampas grass and giant reed). Indigenous scrub species eventually emerge through the exotics, so a proportion of reverting sites are in transition between the two.

- Exotic trees as secondary vegetation (5% of sample points in scrub) are partly radiata pine plantation forests bordering areas of natural scrub (northern Hunua ranges and central Rodney district). The balance is farm woodlots which are often planted around the edge of gullies or steep faces.

- Wetlands are present as secondary vegetation at 1% of sample points in scrub. Most of these are swampy valley bottoms, though a few are mangrove swamps where scrub adjoins estuaries.

- Just three sample points with coastal vegetation, and two with intensive uses, indicate that these are uncommon secondary covers in scrubland.

- Points with miscellaneous secondary cover (3%) are rural and urban houses in scrub. Similar to houses in forest, there are two concentrations - the Waitakere Ranges and Great Barrier Island - with many additional houses dispersed on lifestyle lots where scrub has been subdivided from farms throughout rural Auckland.

Table 3.7

Vegetation associated with natural scrub

Primary cover:	Scrub	Total points	as % of points in use	95% conf. lim.
Sparse (canopy gaps)	257	257	33.9	3.4
Dense (open canopy)	286	286	37.7	3.5
Dense (close canopy)	215	215	28.4	3.2
Harvested	0	0	0.0	0.0
Total points	758	758	100.0	0.0
as % points in land use	100.0	100		
95% confidence limits	0.0			

Secondary cover	None	Intensive uses	Improved pasture	Unimproved pasture	Wetlands	Coastal vegetation	Exotic scrub	Exotic trees	Natural forest	Misc.	Total points	as % of points in use	95% conf. lim.
None	215										215	28.4	3.2
Scattered			26	1	1	2	3	22	167		222	29.3	3.2
Extensive		2	72	16	7	1	65	17	119	22	299	39.4	3.5
Total points	215	2	98	17	8	3	68	39	286	22	736	97.1	1.2
as % points in land use	28.4	0.3	12.9	2.2	1.1	0.4	9.0	5.1	37.7	2.9	97		
95% confidence limits	3.2	0.4	2.4	1.1	0.7	0.4	2.0	1.6	3.5	1.2			

4.7 Vegetation associated with exotic scrub

(2.3% of the region) (Table 3.8)

The sub-sample size for exotic scrub is n = 122, so while it gives a good indication of the true regional figure for this land cover (see Table 3.1), error margins for primary cover, and for associated secondary vegetation, are rather large when expressed as a percentage of the sub-sample.

4.7.1 Primary cover

Exotic scrub was formerly more extensive in the Auckland region It used to be prevalent on infertile lowland soils - "gumland" - but declined greatly due to land improvement between the 1920s and 1980s. The total area is now only a sixth that of natural scrub.

It now forms primary cover on limited areas of steep land in Rodney and Franklin districts, where reversion has occurred within marginal land that is still on the whole utilised for plantation forestry or drystock farming.

Exotic scrubland is usually dominated by gorse, but also includes blackberry, tobacco tree and other woody invasive species. Canopy composition is so mixed, that differentiation of primary cover has not been attempted.

Just 10% of exotic scrub has a closed canopy without secondary vegetation. 30% has a closed canopy interspersed with natural scrub. Another 20% has trees (exotic or natural) emerging through closed-canopy scrub. These categories - collectively 60% of exotic scrubland - are classed as dense primary cover in Table 3.8.

The balance - some 40% - is exotic scrub with canopy gaps or scrub edges occupied by other vegetation. These are collectively classed as sparse primary cover in Table 3.8, on the grounds that canopy gaps and edges indicate site disturbance.

Pockets of exotic scrub also remain on patches of rough ground within better farmland, but here they are generally recorded as secondary vegetation within pasture (see Tables 3.3 and 3.4).

Table 3.8

Vegetation associated with exotic scrub

Primary cover:	Scrub	Total points	as % of points in use	95% conf. lim.
Sparse (canopy gaps)	49	49	40.2	8.7
Dense (open canopy)	61	61	50.0	8.9
Dense (close canopy)	12	12	9.8	5.3
Harvested	0	0	0.0	0.0
Total points	122	122	100.0	0.0
as % points in land use	100.0	100		
95% confidence limits	0.0			

Secondary cover	None	Improved pasture	Unimproved pasture	Wetlands	Natural scrub	Exotic trees	Natural forest	Misc.	Total points	as % of points in use	95% conf. lim.
None	12								12	9.8	5.3
Scattered		8	2	1	5	16	3		35	28.7	8.0
Extensive		5	26	1	32	3	2	6	75	61.5	8.6
Total points	12	13	28	2	37	19	5	6	122	100.0	0.0
as % points in land use	9.8	10.7	23.0	1.6	30.3	15.6	4.1	4.9	100		
95% confidence limits	5.3	5.5	7.5	2.3	8.2	6.4	3.5	3.8			

4.7.2 Secondary cover

Just 10% of exotic scrubland has no secondary cover. This low figure indicates that at the disturbed sites on which it grows, it is typically invading - or being displaced by - other plant species.

Natural scrub is the most widespread secondary cover within exotic scrub, present at 30% of sample points. These are sites initially colonised by exotic weeds after abandonment. They have now remained undisturbed for long enough, that indigenous successional species are appearing through the exotic cover.

Natural trees, emerging through just 4% of exotic scrub, are nowhere near as common. They are outweighed by faster-growing exotic trees (16%). Typically these are sparse open-canopy pines, wattles or willows - self-sown "wildlings" that have sprung up on abandoned land.

On sites where reversion is less advanced, unimproved pasture is the most widespread secondary cover, at 23% of sample points. It occurs in gaps not yet taken over by exotic scrub, on rough farmland where grazing pressure has diminished due to steep terrain, erosion or infertile soil. There are also many sites where improved pasture is recorded as a secondary cover (11%). These are generally clean paddocks adjacent to the edge of scrub.

Wetlands appear at just two sample points and an intensive land use at just one. These are uncommon secondary covers in scrubland.

Miscellaneous secondary cover, recorded at 5% of sample points, is where house sites have been located in exotic scrub on lifestyle blocks.

4.8 Vegetation associated with coastal grass and scrub

(0.6% of the region) (Table 3.9)

The sub-sample size for coastal grass and scrub is very small (n = 29). It may indicate the true regional figure for this land cover (see Table 3.1), but percentages are too small and confidence limits too wide to provide a good indication of its primary and secondary cover components.

Table 3.9

Vegetation associated with coastal grass and scrub

Primary cover:	Marram grass, other coastal grasses	Total points	as % of points in use	95% conf. lim.
Sparse	19	19	65.5	17.3
Dense	10	10	34.5	17.3
Total points	29	29	100.0	0.0
as % points in land use	100.0	100		
95% confidence limits	0.0			

Secondary cover	None	Wetland	Exotic scrub	Exotic trees	Natural trees	Total points	as % of points in use	95% conf. lim.
None	21					21	72.4	16.3
Scattered			1		1	2	6.9	9.2
Extensive		1	1	4		6	20.7	14.7
Total points	21	1	2	4	1	29	100.0	0.0
as % points in land use	72.4	3.4	6.9	13.8	3.4	100		
95% confidence limits	16.3	6.6	9.2	12.6	6.6			

4.8.1 Primary cover

Coastal grass and scrub has been recorded on foredunes and fixed dunes close to the coast; also on a few particularly exposed coastal cliffs. Primary cover is low-habit and sparsely-occurring sand-binding grasses such as marram, matihetihe (spinifex), and pingao. They are interspersed with native coastal shrubs e.g. pohuehue, toitoi, flax, or exotic invaders e.g. pampas, boxthorn, gorse.

65% of coastal vegetation occurs as sparse primary cover, interspersed with bare sand, soil or rock. Some of the sample points on dune terrain have more bare sand than vegetation. The 35% balance is dense. Most is marram grass.

4.8.2 Secondary cover

Little coastal vegetation - just 28% - has secondary cover. It comprises:

- 14% exotic trees,
- 7% exotic scrub,
- 3% natural trees, and
- 3% wetlands.

Radiata pine forest plantations bound some of the sand and coastal vegetation areas, chiefly on the South Kaipara peninsula. Here and elsewhere e.g. on dunes behind Mangawhai, Te Arai and Pakiri, exotic scrub colonises disturbed sites.

Coastal forest (pohutukawa) and wetland vegetation (raupo and wiwi) are also present as secondary vegetation at undisturbed sites. However each instance is just recorded at a single sample point; not enough to provide a true indication of their extent.

4.9 Vegetation associated with wetlands and mangroves

(2.2% of the region) (Table 3.10)

The sub-sample size for wetlands and mangroves is small (n = 114), enough to indicate true regional extent of the land cover (see Table 3.1); but not enough to be confident about the extent of component primary or secondary cover.

Table 3.10

Vegetation associated with wetlands and mangrove swamps

Primary cover:	Wetland	Mangroves	Total points	as % of points in use	95% conf. lim.
Sparse	9	22	31	27.2	8.2
Dense	16	67	83	72.8	8.2
Total points	25	89	114	100.0	0.0
as % points in land use	21.9	78.1	100		
95% confidence limits	7.6	7.6			

Secondary cover	None	Improved pasture	Unimproved pasture	Exotic scrub	Natural scrub	Exotic trees	Natural trees	Misc.	Total points	as % of points in use	95% conf. lim.
None	67								67	58.8	9.0
Scattered		6	1	1	1	3	1		13	11.4	5.8
Extensive		16	1	2	4	2	3	6	34	29.8	8.4
Total points	67	22	2	3	5	5	4	6	114	100.0	0.0
as % points in land use	58.8	19.3	1.8	2.6	4.4	4.4	3.5	5.3	100		
95% confidence limits	9.0	7.2	2.4	2.9	3.8	3.8	3.4	4.1			

4.9.1 Primary cover

22% of wetland vegetation is freshwater (rush, sedge, raupo, flax). 78% is saline (mangrove and salt marsh; mainly the former).

27% of primary cover is sparse. Most of the sparse primary cover is mangrove swamp where mudflat is visible through patchy canopy. 73% of primary cover is dense - again dominated by mangrove swamp.

Mangroves are now four times as common as freshwater wetland plants. This reflects ongoing drainage and clearance of freshwater swamps. They were never particularly widespread in Auckland's landscape; typically confined to narrow floodways along streams; and most have disappeared in course of farm development over the past 170 years.

The mangroves in contrast grow on estuarine sites that are difficult to drain. While a few mangrove swamps have been reclaimed around margins of the Kaipara and Manukau harbours, most survive to the present day. Landowners adjacent to estuaries consider that the area of mangroves is actually expanding.

4.9.2 Secondary cover

Secondary vegetation cover is present at just 41% of sample points in wetlands and mangrove swamps. It comprises:

- 4% exotic trees,
- 3% exotic scrub,
- 4% natural trees,
- 4% natural scrub,
- 19% improved pasture,
- 2% unimproved pasture, and
- 5% miscellaneous.

The 59% of sites without secondary cover are entirely mangrove swamps. The few mangrove swamps where any secondary vegetation has been recorded are estuary shores where mangroves abut improved pasture on well-drained estuarine flats.

Residual freshwater wetlands account for the balance of points where improved pasture is recorded, plus points with other secondary vegetation. Rather than in the wetlands, it is typically along their margin as a narrow band of retained (natural) or planted (exotic) vegetation that separates the wetland from an adjacent land use.

The miscellaneous figure (5%) is where houses are recorded in lieu of secondary vegetation, at a few sample points in urban Auckland adjacent to the Waitemata or Manukau harbours.

5 Summary

This section summarises key points from the preceding results. The conclusions apply to Auckland's vegetation in 2007, the year of aerial photographic coverage. They are based on a sample of one-hectare areas at 5277 points, taken from the coverage at one kilometre spacing's throughout the region.

5.1 Pressure on vegetation - impacts of land use and natural processes on primary cover

5.1.1 Primary cover on land in rural use

(Table 3.11, summarising Tables 3.2 to 3.5)

Table 3.11

Impacts of land use on primary cover

	Area where primary cover is :			
	dense as % of area in use	sparse as % of area in use	harvested/absent as % of area in use	totals as % of area in use
Rural uses :				
Intensive uses	59.1	29.8	11.1	100.0
Dairy pasture	75.8	22.5	1.7	100.0
Drystock pasture	72.1	26.7	1.2	100.0
Forest plantation	64.3	27.6	8.1	100.0
Conservation uses :				
Natural forest	82.0	18.0	0.0	100.0
Natural scrub	66.1	33.9	0.0	100.0
Exotic scrub	59.8	40.2	0.0	100.0
Coastal grass & scrub	34.5	65.5	0.0	100.0
Wetlands & mangroves	72.8	27.2	0.0	100.0

Under rural uses, primary cover is entirely planted - fruit trees, vines, vegetable, grain or greenfeed crops, improved or unimproved pasture, coniferous or broadleaved trees.

- Most land under rural use has a dense primary cover; highest for dairy pasture (76%), next-highest for drystock pasture (72%), somewhat lower for forest plantations (64%) and intensive uses (59%).
- The proportion of sparse primary cover is similar for all rural uses, at between 20 and 30%. The higher percentages are to be expected for intensive uses (30%, where some primary cover is always disturbed by soil cultivation) and forest plantations (28%, where some cover is always young trees that have not yet closed canopy).
- The percentages for dairy (23%) and drystock pasture (27%) may seem higher than expected. They are attributed to drought stress and heavy grazing at the time of aerial photography, which was midsummer to autumn 2007.
- A substantial part of primary cover is harvested, only amongst intensive uses (outdoor vegetable production and grain crops, 11%), and forest plantations (8%). Again, this is to be expected. In dairy and drystock pasture, vegetation harvest is minimal (1% to 2%), and is accounted for by hay or silage paddocks.

5.1.2 Primary cover on land in conservation use

(Table 3.11, summarising Tables 3.6 to 3.10)

Under conservation uses, primary cover is natural except for exotic scrub and coastal grass (dominated by marram grass which has been planted to control sandblows).

- Most land in conservation uses has dense primary cover i.e. close canopy, or open canopy with emerging regeneration. The 82% of primary cover assessed as dense for natural forest, reflects the length of time that has now elapsed since previous site disturbance on such land in the Auckland region. Lower percentages for natural (66%) and exotic scrub (60%), indicate that here, site disturbance has been more widespread, though not necessarily recent (see next bullet point). A much lower percentage (35%) in dense primary cover for coastal grass and scrub indicates recent site disturbance either by attempts at land use, or by natural processes (see third bullet point). The proportion of dense primary cover is high (73%) for wetlands and mangrove swamps, because this category is four-fifths mangrove.
- Forest has a low percentage of sites (18%) assessed as sparse primary cover i.e. with canopy gaps occupied by other vegetation. Scrubland has higher percentages of sparse cover; 34% for natural and 40% for exotic. The prevalence of canopy gaps here indicates widespread historical disturbance. Much is attributed to past land use (timber-cutting agricultural clearance, burning and gum-digging); though some is caused by recent natural processes (erosion on slopes, deposition along valley bottoms, wind throw or climatic exposure on ridges). Today, most canopy gaps are now occupied by extensive herbaceous ground cover or scrubby successional vegetation.

- Coastal grass and scrub have 66% sparse primary cover; while freshwater wetlands and saline mangrove swamps have 27% sparse. These two conservation uses suffer repeated natural disturbance (sandblows or rockfalls in coastal vegetation, inundation of wetlands and estuarine sedimentation amongst mangroves). A few of the sites also show the impact of attempts at rural use (grazing of coastal vegetation, part-drainage of wetlands, reclamation of mangroves)

5.2 Pressure on vegetation - impacts of land use and natural processes on secondary cover

5.2.1 Secondary cover on land in rural use

(Table 3.12, summarising Tables 3.2 to 3.5)

Table 3.12

Impacts of land use and natural processes on secondary cover

	Area with secondary cover	Area where secondary cover is :			
		planted	induced	natural	non-vegetative
	as % of area in use	as % of area in use	as % of area in use	as % of area in use	as % of area in use
Rural uses :					
Intensive uses	78.5	63.2	5.3	6.5	3.5
Dairy pasture	62.9	41.9	2.4	18.4	0.2
Drystock pasture	80.4	34.1	10.0	35.9	0.4
Forest plantation	72.6	26.2	26.7	19.3	0.4
Conservation uses :					
Natural forest	61.6	11.7	3.1	43.9	2.9
Natural scrub	71.6	15.1	14.1	39.2	3.2
Exotic scrub	90.2	34.5	15.6	36.0	4.1
Coastal grass & scrub	27.5	13.8	6.9	6.8	0.0
Wetlands & mangroves	41.3	21.1	7.0	7.9	5.3

Secondary cover is present on 79% of land under intensive uses. It is as extensive in drystock pasture (80%), but less in dairy pasture (63%). Secondary cover is present in 73% of forest plantations.

Types of secondary cover are a function of land use:

- The planted proportion is 63% under intensive use, 42% and 34% for dairy and drystock pasture respectively, and 26% amongst forest plantations.
- The proportion of induced cover (exotic scrub) is 5% for intensive uses and 2% for dairy pasture. It rises to 10% for drystock pasture (where grazing pressure is low on parts that are steep or infertile), and peaks at 27% in forest plantations (where exotic scrub comes away amongst young trees on re-planted sites).
- Natural secondary cover is 7% amongst intensive uses, 18% in dairy pasture, and 36% for drystock pasture (uncleared patches or reversion on rough land). It drops back to 19% amongst forest plantations (where bush, scrub or wetland are just retained on parts that are unsuitable for planting or difficult to harvest).
- Non-vegetative secondary cover is rural buildings and yards. They are present on 4% of the area under intensive use, though drop to less than 1% of the areas in dairy pasture, drystock pasture and forest plantation.

5.2.2 Secondary cover on land in conservation use

(Table 3.12, summarising Tables 3.6 to 3.10)

Secondary cover is widespread on all land in conservation use, except for wetlands and mangrove swamps.

- Just a small proportion of the secondary cover is planted - grazed pasture on bush edges or rank grass remaining on abandoned farmland. It rises from 12% in forest, through 15% in natural scrub, to 34% in exotic scrub. The figure falls to 14% in coastal grass and scrub (tree windbreaks planted in the coastal zone to protect plantations farther inland), and is 26% in wetlands and mangroves (pasture bordering swamps or estuaries).
- Induced secondary cover (exotic scrub and wildling trees) rises from 3% in forest through 14% in natural scrub, to 16% in exotic scrub. It falls to 7% amongst coastal vegetation (gorse, boxthorn, pampas grass infestations); and remains at 7% in wetlands and mangroves (scrub invading dry margins). Most of the induced secondary cover indicates past land clearance during attempts at farming, though some - particularly amongst exotic scrub - is invasion by wildling trees.
- Secondary natural scrub cover is present in 44% of forest. Conversely secondary forest cover is present in 39% of natural scrub. Secondary natural scrub and forest cover are also widespread (36%) in exotic scrub. Secondary natural cover falls to 7% amongst coastal vegetation, and 8% amongst wetlands and mangroves. The low levels here have different causes : bare sand or bare rock displace secondary cover at many coastal sites; remaining wetlands are small, with exotic vegetation around their margins; and mangrove swamps' saline environment precludes any secondary cover except along margins above the tidemark (generally developed into pasture).

- Even on land in conservation uses, much of the natural secondary cover is a consequence of past land use. Examples are emergence of forest trees through scrub (cut-over forest), and natural scrub regeneration through exotic scrub (abandoned farmland). Just some of the secondary cover - in steep hill country and ranges - is a response to natural disturbance; notably scrub patches in forest (plant succession on healed erosion scars or wind throw areas).

- Non-vegetative secondary cover (buildings and yards) are surprisingly widespread on land in conservation uses. They are present on 3% of the area in forest and natural scrub, and 4% of the area in exotic scrub. These figures indicate some Aucklanders' preference for building "lifestyle block" houses or "urban fringe" houses in the bush. Such buildings are absent from coastal grass and scrub (unstable sites), though adjacent to 5% of the area in wetlands and mangroves.