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ANALYSIS OF DRIVERS AND BARRIERS TO LAND USE CHANGE

A Report prepared for the Ministry for Primary Industries

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1.0 EXECUTIVE SUMMARY

Land use change has been a significant feature of the New Zealand landscape since European settlement, largely driven by economic factors, and has been a strength of our primary land systems. Over the last 25 years, the most significant land use change has been a switch out of sheep and beef farming, with an increase in dairying and forestry.

This report discusses the drivers and barriers to land use change as they currently exist, as well as potential drivers/barriers starting to emerge. Within the report, "land use change" is defined as a change from one specific use to another, rather than intensification within a similar system.

There are a wide range of factors that can act as both drivers and barriers to land use change, grouped as follows:

- Biophysical
  - Soil type and soil characteristics
  - Topography, particularly slope
  - Climate
  - Water – availability for irrigation, impact of land use system on water quality

- Economic
  - Relative profitability of the land use
  - Access to capital
  - Infrastructure
  - Markets
  - Access to information
  - Access to skilled labour
  - Land tenure

- Technological change, which often impacts via improving profitability.

- Societal pressures and "license to farm". This is usually manifest in regulations affecting the sector, e.g. around animal welfare, food safety, human welfare, and environmental impacts.

- Personal factors. This covers the wide range of difference in individuals which may affect their thinking around land use change. It would include aspects such as age, education and experience, family circumstances, attitude to risk, access to capital, access to information, and attitude to change.

All of these factors interact as an amalgam as drivers and/or barriers for land use; they all interact in different ways and usually never in the same combination. The literature review discusses these factors, emphasising that it is often economic factors which are the most powerful in driving land use change decisions.

Within New Zealand, land use, and factors affecting land use change, are largely governed by the Resource Management Act (1991) and the implementation of this via council plans.

Territorial Authorities have a more direct regulatory effect, via regulations across a variety of activities, for example:

- Amenity effects, including landscapes and special ecological areas
- Building controls
- Controls on intensive farming
- Rules on zoning, particularly in the peri-urban areas
- Rules around rural subdivision

Broadly, Territorial Authorities have a relatively permissive attitude to land use [in the sense that land use is permitted relative to various standards; it does not infer a "do as you like" approach], apart from rural subdivision. This is often tightly controlled, in an endeavour to maintain land parcels as "economic units" and/or prevent the loss of high quality soils. Often, though, subdivision is a prerequisite for land use change, particularly for horticultural development, and there are strong economic drivers for this. Similarly, subdivision of rural land for urban development is driven by extremely high economic (and often political) factors.

Regional Council regulation influences land use, and land use change, via more indirect factors, particularly environmental regulation around water management, under the auspices of the National Policy Statement for Freshwater Management (2014). This process is underway, and has a high potential to drive land use change. The two main aspects involved are:

- Consents to take water for irrigation. The provision of water (or not) will have a major impact on whether land use change will occur; and

- Management of water quality, via control on discharge of contaminants (nitrogen, phosphorus, sediment, microbes) into water bodies. These controls, often involving capping of discharges, particularly for nitrogen, will also be a driver/barrier to land use change by either requiring a de-intensification of land use, or preventing land use change to a more intensive (i.e. higher discharge/loss) use.

In a similar vein, imposing a cost on biological greenhouse gas emissions (via central Government regulation) from agricultural systems would also act as a driver/barrier to land use change.

If restrictions are put in place due to environmental concerns, then an obvious measure, in order to ensure some degree of efficiency of use, and land use flexibility, would be to have trading systems in place for water and nutrients. Similarly, regulation and policy settings also need to allow for flexibility to allow for new/novel approaches to mitigating environmental effects.

There is an increasing interest in ecosystem services relative to land use, where ecosystem services are the benefits people derive from ecosystems. Basically, land use drives ecosystem services, not the other way around. Nevertheless, the thought is that restrictions could be placed on land uses so as not to (seriously) diminish the ecosystem services provided. Which in turn raises the issue of how ecosystem services are valued.

The report shows a wide variation in returns between pastoral farming (dairy, sheep & beef) and various horticultural enterprises (pipfruit, viticulture, kiwifruit).

This indicates the potential economic benefits of land use change, and conversely the opportunity cost if land use change cannot occur. Within this, often the capital cost of changing land use is significant, coupled with a delay in achieving a return on that investment, which can often act as a barrier to change, and needs to be incorporated in any risk assessment around land use change.

Discussion of land use often leads to the concept of land use optimisation, often with the definition that this means "highest and best" use, i.e. highest economic return, and/or endeavouring that the land use undertaken is best suited to the soil. Given the myriad of drivers and barriers in play, this concept is/will be very difficult to achieve, particularly given different interpretations that people can place on it. While government can influence this, there are too many factors involved to directly achieve this.

Land use and land use change is complex, strongly driven by economics, and a wide range of other factors which are usually inter-linked. Land use in New Zealand in recent decades has largely been driven by relatively free-market economics, while prior to the 1980's was driven by government subsidies in conjunction with other historical influences such as war. Currently, there is no real evidence of "market failure" per se, relating to land use change. There are a number of environmental externalities which are starting to be internalised via regulatory moves. As this progresses, the impact will be largely manifest via an economic cost, which in turn will see the "market" adjust accordingly, as will the incentives for land use change.

Options that are available to government to directly influence land use/land use change would involve:

- Use of incentives (e.g. subsidies) to influence land use change
- Use of regulatory mechanisms to price in externalities

There are a wide range of options which could influence land use change:

- Continuation/expansion of research into options, including farm system change, which landowners can use to mitigate adverse impacts
- Provision of information and advice to again assist landowners to improve their land use/mitigate adverse effects
- Investigate allocation mechanisms for nutrients (where on-farm limits are being imposed) to assess the best or most equitable means of achieving such allocations
- Development of market mechanisms (i.e. trading systems) for water and nutrients to ensure a degree of flexibility and efficiency of use within the limits
- Provision of information on current land use (as opposed to land cover) within New Zealand
- Provision of information on soil types
- Provision of information around different land uses, particularly economic and environmental
- Investigation into the development of urban infrastructure and the influence this has on peri-urban development/spread of housing onto agricultural land

2.0 PURPOSE

The purpose of this report is to discuss the drivers and barriers to land use change in New Zealand in order to help understand whether/where there are any gaps in the tools available to encourage the best use of high value soils.

3.0 METHODOLOGY

The project was essentially a desktop exercise to review current research and knowledge, drawing on existing data sources. This involved:

1. A literature review on both published and "grey" material on land use change drivers and impediments within New Zealand and internationally.

2. Analysis of District/Regional Council plans from four key regions: Auckland, Hawke's Bay, Horizon's, and Canterbury, relating to any regulatory controls (or implications) on land use.

3. An analysis of current land cover, matched to land use capability (LUC), producing a table showing area (in hectares) of current land cover category by LUC by region. The tables include eight LUC categories by five land covers (outlined below) within each region.

   A map has been produced for each of the 16 regions overlaying land cover by LUC. The land covers include:

   - Exotic forestry
   - Grassland
   - Cropland
   - Horticulture
   - Urban

4. A discussion on factors which drive, and/or impede land use change including:

   - Economic
   - Appetite for risk
   - Location/industry infrastructure
   - Market aspects
   - Access to expert advice/climate and soil information
   - Land owner psychology

5. A discussion on the environmental impact of land uses, the relationship with ecosystem services, and the implications of land use change.

6. An economic analysis as to the value of land use change/opportunity cost of barriers preventing it.

7. The above was pulled together in two case studies/examples, to assess whether market failure is occurring.

8. A workshop with MPI to discuss the results prior to the report being finalised.

4.0 DISCUSSION ON LAND USE IN NEW ZEALAND

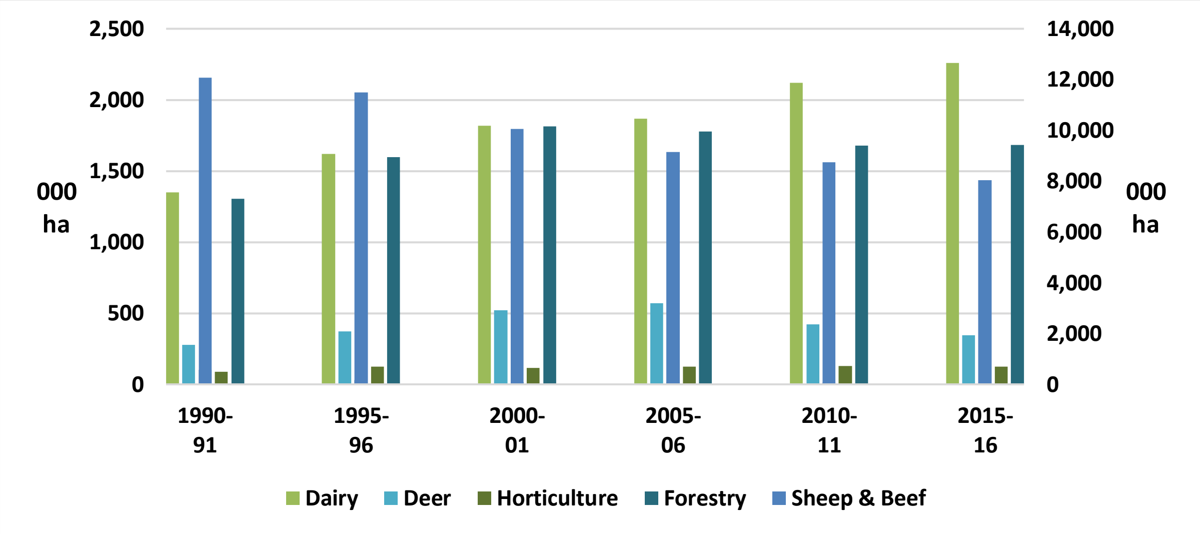
New Zealand consists of 26.8 million hectares, inclusive of off-shore islands. Of this, agriculture covers 13.8 million hectares (53.4%), exotic forestry 2.1 million hectares (8.1%), native forest 7.6 million hectares (29.6%), and "other" land (e.g. mountains, urban) 3.0 million hectares (11.2%). (refer Table 2). A breakdown of the change in land use areas in New Zealand from 1990/91 through to 2015/16 is shown in Table 1 and Figure 1 below.

Table 1: Land use areas in New Zealand over time

Land Use Areas - 000 ha	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16	1990 to 2015	000 ha Change
New Zealand								
Sheep & Beef	12,085	11,497	10,046	9,148	8,749	8,035	-34%	-4,051
Dairy	1,349	1,620	1,816	1,868	2,122	2,258	67%	909
Deer	276	374	523	569	420	344	24%	68
Other	103	29	15	14	11	9	-	-94
Grazing-Arable Total	**13,814**	**13,520**	**12,400**	**11,599**	**11,302**	**10,646**	-23%	**-3,168**
Horticulture	88	124	114	124	127	126	43.8%	38
Forestry	1,304	1,599	1,814	1,776	1,679	1,681	28.9%	377
North Island								
Sheep & Beef	4,819	4,487	3,876	3,573	3,527	3,369	-30%	-1,451
Dairy	1,208	1,370	1,429	1,377	1,402	1,368	13%	160
Deer	110	110	115	110	74	68	-38%	-42
Other	50	12	7	7	5	4	-	-46
Grazing-Arable Total	**6,187**	**5,979**	**5,427**	**5,068**	**5,009**	**4,810**	-22%	**-1,378**
Horticulture	63	85	77	76	74	71	12.7%	8
Forestry	928	1,150	1,315	1,278	1,206	1,212	30.5%	283
South Island								
Sheep & Beef	7,266	7,010	6,170	5,574	5,222	4,666	-36%	-2,600
Dairy	141	250	387	491	720	890	532%	749
Deer	167	264	408	459	345	276	66%	109
Other	53	17	8	7	6	5	-	-48
Grazing-Arable Total	**7,626**	**7,541**	**6,973**	**6,531**	**6,294**	**5,836**	-23%	**-1,790**
Horticulture	24	39	37	48	53	55	124.1%	30
Forestry	376	448	499	499	473	469	24.8%	93

Source: Statistics NZ, Beef + Lamb NZ Economic Service

Figure 1: Land use areas in New Zealand over time



Note: Sheep and beef area relates to the right-hand axis

Figure 2: Changes in land use from 1990-2016

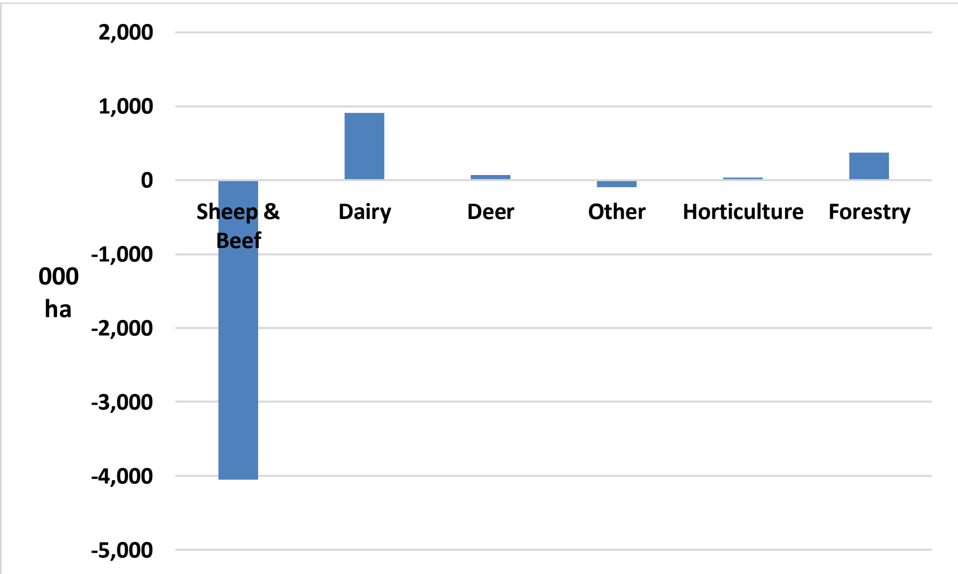


Figure 2 indicates that (mostly) dairy and forestry have expanded at the cost of sheep and beef land. It also indicates an issue with the data, as, assuming the area in sheep and beef has shrunk by 4 million hectares, and dairy plus forestry have increased by 1.3 million hectares, there appears to be 2.7 million hectares missing. The most likely fate for this land is a myriad of uses: incorporation of land (particularly South Island High Country) into the Conservation estate, reversion of pastoral land into scrub, farmers closing land to QEII covenants, and subdivision to lifestyle blocks/urban use.

A recent report (Clothier *et al*, 2017) indicates there is potential for a total of 2.1 million hectares of horticulture (apples, kiwifruit and wine grapes) in New Zealand, based on LUC analysis coupled with growing degree days, slope and frost-free period.

This is basically on LUC Classes 1 - 3, although it does include LUC Class 4 - 7 for viticulture. Similarly, they estimate a total area of 3.76 million hectares is available for arable cropping (forage, maize, cereal, potatoes and seed crops) on LUC Class 1 - 3 land.

A review of land cover relative to LUC classification for all of New Zealand[1] is shown in Table 2 below.

Table 2: New Zealand Land Cover by LUC Classification (hectares)

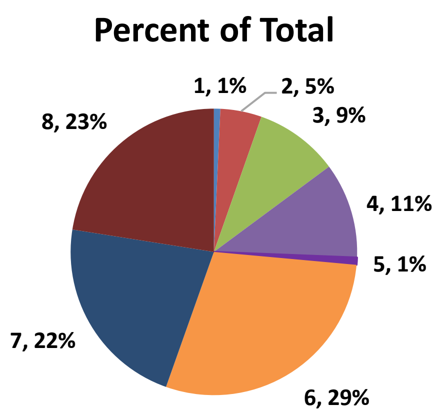
Land cover	1	2	3	4	5	6	7	8	Total
[no land use data]*	62	1,321	1,623	2,479	509	7,274	7,016	8,503	28,786
Cropland	25,378	148,406	143,916	39,858	735	9,924	1,752	167	370,136
Exotic forest	1,621	11,625	92,865	302,476	14,231	987,482	635,234	34,845	2,080,379
Grass and scrub	3,054	21,279	57,791	78,269	8,300	375,173	272,280	408,757	1,224,903
Grassland	136,816	947,837	2,000,541	1,988,679	160,323	4,305,897	2,152,720	1,504,129	13,196,943
Horticulture	12,365	27,547	40,028	13,297	173	7,437	2,600	243	103,691
Natural forest	1,328	12,679	56,966	287,962	19,128	1,704,582	2,521,526	3,035,210	7,639,380
Other**	1,093	8,323	23,276	47,169	6,229	66,334	97,262	814,494	1,064,180
Urban	5,454	23,793	27,033	18,768	760	14,373	4,608	966	95,756
Total	187,171	1,202,811	2,444,038	2,778,956	210,389	7,478,476	5,694,999	5,807,314	25,804,153

Source: LUCAS NZ Land Use Map 1990, 2008, 2012 (v016), NZLRI Land Use Capability, Statistics NZ.
*[no land use data] this area is not covered by the LUCAS land cover data
**Other. This includes areas of ice and rock, plus any other land cover not categorised in LUCAS

The total land area of New Zealand is 26,802,100 hectares[2]. The NZ Land Resource Inventory (LRI) database also includes a number of classifications outside of LUC, namely: Lake, Estuary, Urban, Quarry, and River, which also have LUCAS (Land use and carbon analysis system) land cover data. (Refer to Appendix 1). The total area included in this, for New Zealand, is 719,527 hectares, giving an overall area covered by the databases of 26,523,681 hectares.

The percentage of land by LUC classification and by land cover is outlined in Figure 3 and Figure 4 respectively.

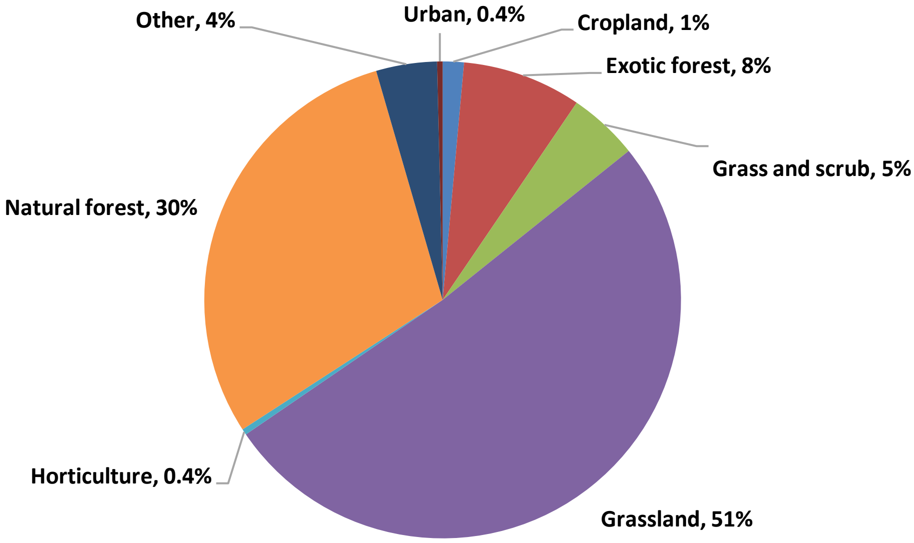
Figure 3: Percentage of land by LUC classification (NZ)



Note: The legend shows LUC category, followed by the percentage in that category

[1] For regional breakdowns, refer to Appendix 1
[2] Stats NZ

Figure 4: Percentage of land by land cover (NZ)



The proportion of land, by LUC, within each region, is illustrated below in Table 3.

Table 3: Proportion of land by LUC, within each region

	1	2	3	4	5	6	7	8
Northland	0.2%	3.0%	3.7%	10.9%	4.0%	8.2%	2.7%	0.5%
Auckland	2.3%	4.6%	2.7%	2.9%	0.0%	2.3%	0.9%	0.2%
Waikato	24.8%	21.0%	11.5%	12.2%	4.9%	12.3%	7.0%	2.1%
Bay of Plenty	1.5%	4.4%	3.1%	6.6%	0.3%	3.8%	6.9%	3.5%
Gisborne	3.0%	1.3%	2.0%	0.9%	0.0%	3.6%	6.9%	1.3%
Hawke's Bay	9.4%	2.2%	5.6%	3.6%	11.3%	7.7%	5.5%	3.5%
Horizons	18.1%	14.3%	7.6%	5.7%	1.9%	11.0%	10.7%	3.8%
Taranaki	19.4%	4.6%	3.8%	2.5%	18.1%	2.0%	4.0%	0.9%
Wellington	2.8%	2.5%	3.6%	1.5%	4.0%	3.7%	4.1%	1.8%
Marlborough	1.3%	0.9%	2.0%	1.1%	0.3%	3.9%	6.4%	4.9%
Nelson	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.4%	0.1%
Tasman	2.5%	0.4%	1.9%	1.9%	0.5%	1.5%	4.7%	8.1%
West Coast	0.0%	0.0%	0.6%	5.5%	5.8%	3.9%	7.0%	24.2%
Canterbury	12.4%	22.5%	22.3%	18.6%	11.6%	15.6%	12.5%	17.8%
Otago	1.6%	3.9%	14.0%	15.5%	21.2%	13.5%	13.6%	7.5%
Southland	0.6%	14.3%	15.5%	10.6%	16.2%	6.8%	6.5%	20.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

This shows that the greatest proportion of high quality land (LUC 1, 2, 3) is in the North Island, and the highest proportion of lower quality land (LUC 6, 7, 8) is in the South Island.

5.0 FACTORS WHICH DRIVE LAND USE CHANGE

The human race has always used and modified land to meet its material, social, and cultural needs (Briassoulis, 2009). Within this, it is important to differentiate between land use and land cover. Land cover reflects the physical or biological categorisation of land, for example, grassland, forest, or concrete. Land use however refers to purposes relating to land cover; for example, pastoral farming, horticulture, urban (Meyer and Turner, 1994). While these two terms are often used interchangeably, this report concentrates on land use change, with the definition being that the land in question changes completely from one land use to another, for example from pastoral farming to horticulture, or from sheep and beef farming to dairy.

While land use within a farm can change, for example, intensify as a result of a higher stocking rate on a pastoral farm, or increasing the proportion of beef animals relative to sheep on a sheep and beef farm, or change from cropping potatoes to onions, the overall nature of the farm has not discernibly changed. While acknowledging this, again this report focuses more on significant land use change as noted above.

There are a range of factors which drive land use change, all of which tend to interact and influence each other.

5.1 Biophysical Factors

These include the range of biophysical influences which can affect land used decisions:

- Soil type - whether free-draining or not, whether suitable for horticulture compared with pastoral agriculture, how deep the topsoil, how fertile it is.
- Topography - how flat or steep the land is, the aspect of the land, how suitable for mechanised farming, how prone to erosion.
- Climate - how much rainfall, how windy, sunshine hours, degree of seasonal variation, how hot or cold it is at different times of the year.
- Availability of water - for example, for irrigation or domestic/industrial consumption, and the quality of that water.

5.2 Economic Factors

These include a range of factors which are somewhat loosely defined around “economic”, and include:

- Profit - what are the costs and returns from particular land uses, particularly on a comparative basis?
- Capital - access to capital for both investment, development and seasonal finance. This can vary; at an aggregate level New Zealand is not short of capital, but at an individual level it varies widely.
- Markets - is there a market for whatever land use is envisioned, what is the proximity to the market
- Infrastructure - whether there is infrastructure available to support the proposed land use – be it servicing firms, processing firms, marketing firms. If no infrastructure currently exists, what is the likelihood/speed of development? Infrastructure also relates to access to road transport and other transport infrastructure, e.g. airports, ports. Infrastructure can also involve “landesque” factors such as availability/accessibility of irrigation and/or land drainage systems, and water supply networks.

- Access to information - availability of information/technical advice around the proposed land use change.
- Access to (skilled) labour necessary to run the proposed new land use activity.
- Land tenure - if the land owner has secure property rights to the land, then the incentive to consider long-term land use decisions is enhanced. If land tenure is uncertain, then the incentive is to concentrate on short-term farming activities, and forgo any longer-term options.

5.3 Technological Factors

This relates to understanding the current technology around a particular land use, and/or understanding how technology or farm system management knowledge is changing, which may allow for a land use change previously not thought possible. For example, the development of aerial top-dressing enabled significant fertility improvements on steep hill country, and significant increases in stock numbers on this land generating more economic hill country farms, which previously could only carry a low number of stock of particular classes.

Another example is the advent of artificial drainage and frost protection systems. Implementing these can mean improving the quality of the soil and/or combating a climatic condition such that crops can be grown in what was originally a less than ideal situation.

It also relates in part to having access to information or specialised advice, as noted above.

5.4 Societal/Regulatory Factors

Agriculture has always operated within a “societal licence to farm”, which is becoming more prevalent and defined as societal pressures are increasing, as evidenced by concerns around animal welfare and environmental impacts of land use. This is being reflected in regulation, which has a direct potential to affect both land use and land use change.

This potential can act in one of two ways: regulations around discharges (e.g. particulates, smell, agri-chemicals, nutrients, greenhouse gases) could restrict or promote land use change, and other regulatory/incentive frameworks (i.e. taxation, subsidies) can also influence land use change.

Societal factors also include wider driving forces such as population change and the demand for land for urban settlement, changes in food preferences which may result in demand for a “new” food, or a decline in demand for an existing food product.

5.5 Individual Factors

This covers the wide range of difference in individuals which may affect their thinking around land use change. It would include aspects such as age, education and experience, family circumstances, attitude to risk, access to capital, access to information, and attitude to change. This comes down to personal preference; a farmer running livestock on land suited to horticulture will (often) not necessarily change land use – they prefer livestock over plants, for a variety of personal reasons.

This can be illustrated by the response to the 2015 Survey of Rural Decision Makers (Landcare Research 2015) via the response to a question on land use change:

Table 4: Primary reason for not changing land use/intensifying/increasing size of farm

	Frequency	Percentage
Lack of financing	48	10.2%
Lifestyle decision	252	53.6%
Environmental decision	42	8.9%
Anticipate retiring soon	59	12.6%
Other	69	14.7%
	470	**100.0%**

The "other" category covered a range of aspects:

- Age
- Already retired
- Change is not necessarily a way to optimise performance
- Current land use is very sustainable with minimal environmental impacts and high security of fenced native bush
- Don't want to change
- Emissions Trading Scheme
- Environmental Regulation
- Everything works fine as is, "If it ain't broke, don't fix it"
- Farm is already set up - no change necessary
- Forest in place and growing
- Forest not ready for harvesting
- Fully utilised
- Happy as I am

Further results from the 2015 survey are shown in Appendix 2.

Perhaps the key thing is that land use change is usually very much driven by individual decisions; land use change is driven by peoples' responses to economic opportunities, as mediated by institutional factors. For example, the prevalence of the kiwifruit industry in the Bay of Plenty or wine grapes in Marlborough did not happen because New Zealand Inc. thought it was a good idea; it happened because individuals saw an opportunity and acted on it.

5.6 Aggregation of Factors

A further key aspect to consider is that the driving force for land use change is an amalgam of all of the above factors; they all interact in different ways and usually never in the same combination. As Briassoulis (2009) noted:

> "*The establishment of unambiguous causal relationships among the particular biophysical and societal factors that act as driving and mitigating forces of land use and land cover change is not straightforward because their relative influence and importance, as well as their interactions, depend on the spatial and temporal level of analysis and the geographical and historical context of study, their intricate spatial and temporal interplay, their changes over time and the difficulties to observe and describe many of them, as well as the processes through which they influence land use change*."

In essence therefore there are a wide range of factors interacting to drive or counter land use change, and which can be difficult to influence in its entirety.

6.0 LITERATURE REVIEW

6.1 Introduction

To understand the drivers and barriers to land use change, it is important to understand some of the recent New Zealand history with regard to land development. Of particular relevance to this review are the Livestock Incentive Scheme 1976, and the Land Development Encouragement Loans. These schemes are relevant to current farming practices because many of today's farmers also farmed under these regimes, and were therefore influenced by them in terms of their land use decisions.

During the 1960's, as an offset to domestic industry protection, Government became increasingly concerned with sheltering the traditional pastoral industries from the reality of the overseas marketplace. Instead of allowing the market to drive behaviour, a suite of assistance measures and subsidies were put in place (Rayner, 1990). In 1976 the government introduced the Livestock Incentive Scheme (LIS). It was administered by the Rural Bank and offered a combination of low interest loans, and/or reductions of loan principal and tax rebates if certain livestock expansion targets were met (Tyler & Lattimore, 1990). In 1978 the Land Development Encouragement Loan (LDEL) Scheme was introduced. This scheme was also funded through the Rural Bank and included interest free loans and reductions in principal for farmers if certain land development targets were met. The aim was to increase production, particularly on marginal land (Tyler & Lattimore, 1990).

The schemes were colloquially known as the skinny sheep schemes, and there was a sharp increase in sheep numbers recorded following the introduction of the Livestock Incentive Scheme (Reynolds & SriRmaratnam, 1990). Numbers peaked at 70.3 million in 1982 (Statistics New Zealand, 2011). The numbers have been falling ever since, although production per animal has improved substantially. Total sheep numbers have fallen 51% (from 58 million to 28.3 million) since 1990 with total lamb meat exported only dropping 6% (Beef + Lamb New Zealand, 2016).

The change in land use was also dramatic with the introduction of the schemes causing a similar impact on vegetation clearance as the wool boom during the Korean War in the 1950's as highlighted by the quote below (Taylor *et al.* 1997).

> *"Agricultural pressures on the land are driven largely by economics and have fluctuated with export prices and past government subsidies. High market prices caused farmers to convert forest to pasture during the 1950's wool boom, and government subsidies for pastoral farming had the same effect in the 1970's and early 1980's. Since the incentives ended in the mid-1980's, sheep numbers have declined and several thousand hectares of pasture has been converted to exotic pine forests. An even larger area of marginal pasture on steep erodible slopes has been left to regenerate in scrub and native forest." – State of the Environment Report, 1997.*

The suite of government interventions were also a driving force behind land use change to horticulture; the development of the kiwifruit industry in the Bay of Plenty for example was driven by a range of factors, including the biophysical aspects of soils and climate in the Bay of Plenty, the high financial returns from kiwifruit, coupled with marketing and input subsidies from Government.

A particular driver was the high marginal tax rates existing at the time, which could be offset by investing in such activities as kiwifruit development (Sandrey and Reynolds,1990).

The removal of subsidies in 1985 was one of the defining characteristics of the current farming generation who went from being incentivised to have excessively high stock numbers and a 'slash and burn' mentality to maximise production output on-farm, to a whole new-look industry where productivity gains were required to meet growing on-farm costs. This highlights the level of influence Government policy has on land use. It is also important to understand this context when developing new policies that are likely to result in land use change.

Rural land use change in a broad sense can be classified into (Britton and Fenton, 2007):

- Forestry to pastoral use
- Current dairying to intensive dairying
- Pastoral use to cropping/horticulture
- Any land to renewable energy
- Pasture to forestry
- Any land to urban/rural residential/infrastructure

Land use and land use change data is limited, as is any forecasting data (Britton and Fenton, 2007). Land cover in New Zealand has seen relatively little change over the past two decades (Dorner and Hyslop, 2014), while land use change has occurred within existing land cover (e.g. pastoral) (Kerr and Olssen, 2012).

A range of literature has been produced in New Zealand around land use change, with most relating to documenting land use change, or modelling work around various factors impacting, or likely to impact, on land use change. This literature review will cover the New Zealand papers, as well as outlining a range of overseas research.

6.2 Drivers of land use change

Thorrold (2010) noted that land use is a visual, often emotive and economically critical part of New Zealand life, and that land use change is always occurring, often not in a broad pattern across the whole country but regionally specific as new opportunities to use land, sunshine and water attract the attention of farmers and investors. He noted that land use changes can be explained by differences in the profitability and capital values of different land uses, influenced by resource limits including slope, soil types and irrigation availability, and that these changes reinforce the basic land valuation concept that land use will over time move to its best use. Briassoulis (2009) also highlights the importance of climate, weather, topography, bedrock and soil type, surface water and groundwater in driving land use decisions.

Land use is driven by land quality including factors such as climate, soil types, topography and water. Land quality determines productivity, and therefore has a significant influence on profitability (Anastasiadis *et al,* 2014; Thorrold, 2010). On this basis, landowners looking to maximise their returns, or profit, will select land use according the quality of their land, with the best quality land being used for the most intensive, profit generating use, and the poorest quality land being less productive (Anastasiadis *et al*, 2014, Dorner and Hyslop, 2014).

Valuation is based on the concept that land use will shift over time to its best use (i.e. highest economic return) (Matthews, 2010). The key here, is that land use change is primarily influenced by the landowner (Britton and Fenton, 2007).

The importance of economic drivers and land quality is reinforced by Lubowski *et al* (2008) who investigated the drivers of land use change in the United States over the period 1982 to 1997. They found that private land use decisions depended critically on land quality and were also influenced by anticipated economic returns to alternative uses, which in some cases have been affected significantly by public policies, sometimes intentionally and sometimes unintentionally. Key aspects of their findings were:

- There was strong evidence that the declining area in cropland over the period was due to falling crop net returns and the existence of the Conservation Reserve Programme (CRP).
- Other federal agricultural support payments raised the profitability of cropping (which increased plantings), which meant the government directly competed with itself in providing incentives for landowners to retire environmentally-sensitive cropland under the CRP. Any increase in cropland came at the expense of land in pasture.
- Because cropping is a more intensive land use, typically involving greater application of agricultural chemicals, government payments were likely to have had unintended environmental impact, either positive (if cropland declined) or negative (if cropland expanded).
- For forestry, they identified the rise in timber net returns as the most important factor driving the increase in forest areas between 1982 and 1997. They also identified declining crop net returns as a major factor affecting forest area during this period, which is consistent with other reports that forest areas had increased due to passive regrowth on abandoned agricultural lands. In addition, they suggest that policies targeting forest net returns, such as payments for carbon sequestration, are likely to be particularly effective at encouraging the retention of existing forests, rather than new forest establishment.
- Urban net returns appear as the only significant driver of urban land increases, supporting the notion that the dramatic increase in urban land observed subsequent to 1982 was largely a response to increased housing demand driven by demographic changes and economic growth. They suggest that efforts to protect open space by increasing net returns to agricultural uses are likely to have only limited impacts. Once urban development becomes feasible, development returns are so much greater than returns to other land uses that observed changes in non-urban returns are of insufficient magnitude to make a significant difference.

Britton and Fenton (2007), identified a range of external drivers influencing the decision-making process around land use and suggest that understanding how landowners respond to external drivers can be valuable in influencing their behaviour. External drivers identified were commodity prices, both in New Zealand and internationally; market demands which are influenced by economic and population growth as well as government policy; regional and territorial government policy, primarily driven by the Resource Management Act in New Zealand; community preferences; technological changes; land value; and climate change (identified as a future driver).

Table 5 outlines the influence of these external drivers (as well as individual preferences) on specific land use change. This table is extracted directly from Britton and Fenton (2007) and aims to identify the primary drivers, but the authors acknowledge that all drivers will influence land use change in some way.

Table 5: Land use change by key driver (not accounting for a catastrophic event such as a volcanic eruption or significant biosecurity threat).

Land use change	International commodity prices	NZ commodity prices	Market demands (global and local)	NZ govt policy	Regional council policy	Territorial authority policy	Individual preferences	Community preferences	Technological changes	Land value	Climate change
Forestry to dairy/pasture	▲	▲	▲	▲	▲				▲	▲	
Current dairy to intensified dairy	▲	▲	▲	▲					▲	▲	▲
Any land to renewable energy (cropping biofuels/ wind)	▲	▲	▲	▲					▲	▲	▲
Pasture to forestry	▲	▲	▲	▲						▲	▲
Any land to urban/ rural residential/ infrastructure		▲	▲	▲		▲	▲	▲		▲	
Any land to mining/ extractions/ flooding for dams	▲	▲	▲	▲	▲				▲	▲	
Any land to "extensification"	▲	▲	▲				▲			▲	▲
Any land to protected areas							▲	▲		▲	
Pasture to horticulture	▲	▲	▲						▲	▲	▲
Pasture to vege cropping	▲	▲	▲							▲	▲
Any land to indoor crops	▲	▲	▲		▲	▲	▲	▲	▲	▲	▲
Any land to factory farming	▲	▲	▲			▲		▲	▲	▲	▲
Any land to abandonment/ retirement		▲		▲			▲	▲		▲	▲

Land use change is slow (Kerr and Olssen, 2012; Stavins and Jaffe, 1990), and often landowners will value the option to convert to an alternative land use at a later stage (Schatzki, 2003). Thus, decisions around the purchase of land can be determined not only by its current use, but by future potential use. Slope of land has a strong influence on this, with the most profitable use on flat land, and the least profitable use on steeper land, and these uses are at their most profitable on their relevant land use (e.g. dairy, arable and horticulture on flat land, forestry on steep land, and sheep and beef on intermediate land) (Todd and Kerr, 2009).

Using MAF Farm Monitoring Data from 2010, Thorrold (2010) demonstrated that economic pressures in the previous decade had driven the conversions to dairy in Canterbury and Southland where the appropriate land type was available for use (i.e. relatively flat). An assessment of return on equity showed a threefold advantage over arable land in Canterbury, and a twelvefold advantage over sheep farming in Southland (the predominant land uses prior to the dairy conversions). Kerr *et al* (2007) support the finding that land use change is consistent with economic theory. Thus, increases in the dairy payout led to an increase in the share of total land used for dairy, while an increase in forestry price led to a decrease in the share of land left in scrub. These authors acknowledged they had a small number of data points and variables to model.

Briassoulis (2009) explored the factors influencing land use and land cover change, as outlined in Section 5 above. She noted that land use and land cover change is influenced by a variety of biophysical and societal factors operating on several spatial and temporal levels, and acting in intricate webs of place- and time-specific relationships.

The choice of land use and decisions to change it are influenced by the size of the household, age, gender, education, employment, attitudes, values, and personal traits of household members, site-specific conditions - accessibility, landesque capital (e.g. water supply system), regional land use structure - as well as by transportation cost, profits, parcel size, competition, costs of production, product prices, public and private financial support, land-management practices, land tenure, and ownership.

Enforcing that view, Lambin *et al* (2001) hypothesised that the causes of land use and land cover change was dominated by simplifications which, in turn, underlie many environment-development policies. They concluded that neither population nor poverty alone constitute the sole and major underlying causes of land cover change worldwide. Rather, peoples' responses to economic opportunities, as mediated by institutional factors, drive land cover changes. Opportunities and constraints for new land uses are created by local as well as national markets and policies, and that global forces often become the main determinants of land use change, as they amplify or attenuate local factors.

At the Environmental Defence Society Conference in 2008, Rutledge identifies seven key drivers of rural land use looking towards 2100. These drivers include culture, values, beliefs and world views; population increasing, ageing, culturally diverse, more urban, loss of production land; climate change, shifting production some positive and some negative; energy, impact on costs; markets, increasing demand for food; consumers, local, natural; and technology, increasing efficiencies. These factors are considered in a model which considers transfers between conservation, production, urban and unmanaged land uses. Rutledge *et al* (2011) suggests this model supports the notion that global land supply is finite and that it "highlights the need to monitor and anticipate irreversible changes that limit future land use options".

The literature suggests that economics, natural resources of soil type, slope and climate, as well as social preferences and the interaction of these is what will drive land use change. Factors that influence these, such as the impact of regulations on economic returns of a particular land use, will therefore contribute to land use change.

6.3 Barriers to land use change

If, as is referenced by Anastasiadis *et al* (2014), land quality is a key driver of productivity and profitability, it stands to reason, that land quality is a barrier to land use change. As in, the poorer the quality of land, the more limited the land use options. A study by Todd and Kerr (2009) looked at how land cover and land use relate to slope and land use capability. They found that slope was both a barrier and a driver to land use change, with land considered 'non-productive' from an economic perspective such as native forest and scrub located on steeper land with more variable slope. Conversely, land uses requiring 'high-quality' land such as arable and horticulture were found on the flattest land with little variability.

In their study, Todd and Kerr (2009) found that pastoral land use was located on land with an average slope of 7 degrees, while land with forest cover had an average slope of 11 degrees. The authors went on to suggest that slope may be a helpful predictor of land use change to dairy. Other factors they suggested as predictors for land use and land use change were current land use for dairy, sheep and beef; proximity to urban area or processing plant; potential profitability of the land use and property size – to distinguish between commercial agriculture and lifestyle properties. However, Dorner and Hyslop (2014), found that profitability data is not a useful predictor of aggregate rural land use change in New Zealand using their modelled approach.

The relative economics of a particular land use are also a key barrier to a change in land use. Even when large changes in economic profits occur, land use responses can be delayed and can be gradual (Kerr and Olssen, 2012). Dorner and Hyslop (2014), suggest a range of detail in terms of the decision-making process regarding the economics. Considerations of the expected costs of conversion (to an alternative land use) against the expected benefits; the value of delaying a decision given the costs and risks of the decision; and the economic implications of the risk of conversion not paying off. Schatzki (2003) supports this finding and goes on to suggest policy makers consider the sunk costs of participation in particular policies promoting shifts in behaviour, alternative options for participants, and uncertainty over outcomes on participation decisions.

A report by The Catalyst Group (2014) exploring barriers to alternate land uses and crops identified barriers in the producer-to-market supply chain including knowledge on how to grow, store, process and transport new products was lacking. Additionally, a key challenge highlighted was in developing and accessing markets for alternative produce/products with the land use decision-maker not necessarily being able to influence this, or having the skills to do so. Dorner and Hyslop (2014) also identified distance to ports and supermarkets as a potential barrier.

As highlighted in Section 6.2, societal and human factors are key influencers in land use decisions, and thus there are also social barriers to land use change which have been identified in the literature. Parks (1995) suggests that a barrier to land use change is in the human capital of the land management decision-maker, in that they may not have the skills to run a new type of farm. Land management decision-makers may have preferences which drive the current use (Dorner and Hyslop, 2014; Thorrold, 2010; Britton and Fenton, 2007). Along with this, there may be a status quo bias to keep the land in its current use (Dorner and Hyslop, 2014). Timàr (2011) found that land in Māori tenure is managed less intensively than other privately-owned land, which may suggest a cultural barrier to, or driver of land use change. Overcoming these social barriers requires either a change in land management decision-making (e.g. via extension or education), or a change of the land management decision-maker (e.g. through succession, or sale of the land).

Thorrold (2010) suggests that a cost on greenhouse gas emissions, nutrient loss limits and visual impacts are possible constraints to land use change in the Canterbury and Southland Regions with nutrient loss limits suggested to be the most significant. As land use intensifies, the nutrient losses tend to increase. Thus, driving for greater economic returns within or between land use may be constrained by nutrient loss limits in some parts of New Zealand.

A study on the East Coast by Tomlinson *et al* (2000) investigated the attitudes to land use change relating to the impediments to forestry development in the region. They found multiple impediments to the developing forestry industry in Gisborne and the East Coast, with specific issues relating to:

- Infrastructure, particularly the need to upgrade roads and the development of processing facilities within the region;
- Social cohesion, with differing parts of the community either supporting or not supporting forestry development;
- Economic impacts on agriculture and local and regional businesses;
- Environmental impacts; and
- Tensions within the industry and with communities, especially around pay rates and working conditions.

As with drivers of land use and land use change, the literature exploring the barriers to land use and land use change highlight the complex and interactive nature of many factors including economic, social and environmental.

6.4 Sustainable land use

The literature review has focused on land use change from one land use to another. However, increasingly in New Zealand, there are pressures to improve the sustainability of land use within an existing system. While this may lead to a land use change, it may also lead to changes of use within an existing major land use (e.g. planting areas of a sheep and beef farm in trees, while still predominantly being a sheep and beef farm). A range of factors have been identified as barriers to sustainable land use.

Arguably, adjusting land use within an existing system is easier than changing land use so these factors could apply to overall land use change. The following summarises work from a number of Australian studies (Ahnstrom *et al*, 2008; Barr and Cary, 2000; Cary *et al*, 2001; and Pannell *et al*, 2006) which identified barriers to landowners of considering sustainable land use patterns.

- Age and education level of the farmer or landowner
- Shifting farmer perception from what is 'normal'
- Perceived loss of productive land and associated productivity
- Lack of evidence that a change will work within existing farming operations
- Lack of understanding on how to monitor new land use practices
- Regulatory barriers
- Concern around the cost of implementation and lack of long-term financial security once new land use embedded
- Concern about increased labour requirements to implement
- Uncertainty regarding long-term viability of land use
- Concern around impact on neighbours
- Change to lifestyle
- Lack of clear guidelines as to what determines sustainable land use
- Lack of skills, knowledge, technology and experience to implement changes

Conversely, increased uptake of sustainable land use can be demonstrated through (Ahnstrom *et al,* 2008; Barr and Cary, 2000; Cary *et al,* 2001; Pannell *et al,* 2006):

- An awareness of the problem to be managed
- Having a sense of control
- Having a farm plan
- Affordable new practices/approaches to management
- Making a public commitment
- Receiving a financial benefit or attracting a financial incentive
- Implementing practices which don't impact current productivity or profitability
- Practices which work in seamlessly with other farm tasks
- Being able to share the approach with other farmers
- Cost-saving benefits

These findings support the earlier analysis from Anastasiadis *et al, (*2014) on the link between land use and an economic return, regardless of the extent of the land use change.

Ledgard (2013) looked at land use change in Southland. The analysis showed that in the past 20 years the net stocking rate in the region remained unchanged, but the change in land use from the sheep-dominated farming systems to dairy-dominated farming systems has resulted in increased net nutrient losses with the associated risks to waterways. As identified earlier, the land use change has been driven by economics, with the increased environmental risk, an (unintended) consequence of this.

Given that many environmental practices instigated as a result of a policy intervention result in an economic cost to land users (e.g. through capped or reduced production as is the case in Taupo, or capital investment to implement such as investment in a feed-pad), policies targeting a shift in land use change will need to be grounded in economics, and address the complexity of land use management decisions within a regional context to achieve actual environmentally sustainable outcomes.

6.5 Ecosystem services in relation to land use

There is growing interest in academia around the use of ecosystem services. Rutledge *et al* (2011) consider that this growing interest could result in thresholds aimed at sustaining their condition and function, thereby influencing future land use dynamics. Depending on how the ecosystem services are accounted for, the extent and intensity of land uses could be fixed in time. Rutledge *et al* go on to identify ecosystem services as functions provided by ecosystems that are beneficial and useful to humans. The Millennium Ecosystem Assessment was the first attempt to classify ecosystem services globally, and identified 24 services divided into four categories of supporting, provisioning, regulating and cultural. The Rutledge paper identified four of these key ecosystem services for New Zealand including:

1. Eutrophication/nitrogen enrichment of water ways, attributed to agricultural intensification (provisioning service).
2. Pollination decline attributed to increased urbanisation, lack of foraging areas, pesticide use and emerging diseases impacting on reproductive success of planted crops and native plants (regulating service).
3. Air quality (regulating service).
4. Soil erosion (supporting service).

In a US study, Lawler *et al* (2014) modelled land use change from 2001 to 2051 under two scenarios. Firstly, a continuation of the 1990's land use trends, and secondly, a high crop demand more reflective of the recent past. The modelling looked at different policy interventions to impact on these trends in a way that provided incentives for maintaining and expanding forest cover, conserving natural habitats, and limiting urban sprawl. In other words, protecting ecosystem services. They concluded that policy intervention would need to be aggressive to significantly alter underlying land use trends, such as those drivers mentioned in the previous section, and shift the course of ecosystem service provision.

The literature surrounding ecosystem services indicates that changing land use will change the ability of an ecosystem to provide beneficial functions, sometimes positively and sometimes negatively (Arunyawat and Shrestha, 2016; de Freitas, 2017; Hoonchong *et al,* 2017; Kandziora *et al*, 2014; Keller *et al,* 2015; Lawler *et al,* 2014; Li *et al,* 2017; Tarekul Islam *et al,* 2015; Xiaowei *et al,* 2016; Zhou *et al,* 2017). These papers are assessing the impacts of land use change on ecosystem services, rather than using ecosystem services as a mechanism to drive land use change. The literature was not clear on whether policies directly targeted at enhancing ecosystem services would result in land use change per se, although Rutledge *et al* (2011) uses the example of nitrogen limits for land owners in Lake Taupo to manage water quality (as an ecosystem service) driving land use change. There is limited literature on the impact of ecosystem services in a New Zealand context.

7.0 COUNCIL ANALYSIS

Land use, and factors affecting land use change, are largely governed by the Resource Management Act (1991) and the implementation of this via Council Plans. For the purpose of this report, four regions were investigated as to their regulatory framework, and likely impact of this on land use change: Auckland, Hawke's Bay, Horizons, and Canterbury, as all have been subject to some degree of land use change in recent decades[3].

Broadly, regional council regulation tends to influence land use and land use change via "indirect" environmental issues, such as water takes, odour, and especially, via regulation of the discharge of contaminants to water as governed by the National Policy on Freshwater Management (MfE 2014).

District or city councils can more directly influence land use and land use change via control of activities, for example subdivision, earthworks, infrastructural development, and zoning. Within this, there is some restriction via Section 10 RMA existing use rights. This restricts the ability of district councils to require land use change on an existing lawful activity, i.e. a land use can continue in contravention of a rule in a district plan if that land use existed prior to the rule coming into existence and continues in the same scale and intensity.

7.1 General Factors

There are a number of regulatory factors which can influence land use change[4]:

- Controls on amenity effects, e.g. dust, noise, odour, are generally more onerous the closer to the rural urban interface. So, districts that are closer to an urban population and/or have a perceived rural landscape tend to have stricter controls. Amenity controls tend to have a requirement of internalising effects within the property boundary, but can, in an attempt to providing certainty, often set a distance an activity can occur, from either the boundary or often a dwelling on neighbouring property, e.g. buildings housing animals.
- Intensive farming, e.g. poultry/pigs, generally have stricter rules when closer to the rural urban boundary due to potential and actual reverse sensitivity effects (noise, odour, dust etc.). Land uses like this come under increasing pressure especially where there is rapid urban expansion, and the technologies required to mitigate effects related cost of compliance can have a significant impact.
- Building controls, e.g. size/scale/footprint/colour/reflectivity - territorial authorities that have such controls are often attempting to preserve a presumed rural landscape and a presumed pastoral and non-industrial type use. Clusters of wintering barns, implement sheds, feed-pads etc. will often have stricter controls, sometimes under the guise of protecting soil versatility.
- The influence of zoning rule changes, e.g. where previously rural land becomes rural residential/urban, can create boundary issues which can become land use change by creep. This is especially in relation to nuisance effects such as noise, dust, agrichemicals and odour. While generally managed by district councils, there is some overlap in that discharge of agrichemicals, fertiliser, and effluent are regional council matters.

[3] Refer to Appendix 4 for an outline of the respective regional rules

[4] Note: these all relate to Territorial Authority matters

- Opportunities for expanding a land use, or creating a new land use may be limited by controls over things such as wetlands, indigenous biodiversity, and landscapes. The controls in such instances may not prevent land use change, but the application for consent and conditions that may be imposed on a granted consent could make the proposal uneconomic along with the risk/uncertainty of whether consent would be granted.
- Subdivision controls in rural areas are generally an attempt to protect rural land uses and prevent the "carving up" of land. While this tends not to be an issue in preventing land use change, there could be a consideration for a farming/horticulture land use that does not require a large land area but needs to be in a rural area, and suitable land of a suitable size is not available. An example here is that the kiwifruit industry in the Bay of Plenty would not exist if the subdivision of existing farms had not been permitted.
- There can be overlays relating to such issues as landscape or special ecological areas, which can influence land use decisions, e.g. outstanding landscapes often have restrictions around forestry specifically as a monoculture, and regulations around building height, size, colour etc.

Overall, apart from the rural/urban interface, or peri-urban area, where the regulatory framework can be relatively strict, most district councils have a relatively relaxed attitude specifically to land use change, to the extent that all rural land uses are allowed in rural areas subject to meeting prescribed standards. An exception to this is the South Waikato District[5], where they are regulating conversion of land change use from forestry to pasture as a controlled activity.

The main regulatory controls which can/will affect land use change, particularly agricultural, into the future on a broader scale, relate to water; water takes (particularly where the catchment is deemed to be over-allocated) and contaminant discharges to water. Both of which are regulated by regional councils.

7.2 Auckland

Auckland Council is a Unitary Authority, and therefore has the functions of both a regional and territorial authority.

At the regional level, existing farming/rural activities in Auckland can continue unimpeded so long as they meet basic good management practice.

At a territorial level, Auckland has relatively restrictive rules including non-complying for subdivision at the urban interface areas (mainly as an approach to protect rural land/high quality soils from urban encroachment). In the rural zones however, activities such as intensive farming/forestry are generally permitted with standards.

The most restrictive standard outside of Council defined Good Management Practice is restrictions on the distance activities can occur from dwellings, e.g. 250 metres for a poultry farm.

[5] Refer to Appendix 3

Auckland is yet to develop regional rules under the National Policy on Freshwater Management, which is likely to restrict discharge of contaminants to water bodies, which in turn is likely to impact on land use and land use change, as discussed later in the report.

7.3 Hawke's Bay

Similar to Auckland, the Hawke's Bay territorial authorities have some restrictions around subdivision of rural land, but are also relatively permissive regarding land use activities.

Hawke's Bay Regional Council has restrictions around the application of nitrogen related to the discharge of (dairy) effluent:

- No direct discharge to water
- Does not result in surface ponding for more than 3 hours
- Must not exceed 150 kgN/ha/yr and 30 kgN/ha/31 days onto grazed pasture underlain by sandy or volcanic soils, or 200 kgN/ha/yr and 50 kg/ha/31 days for all other soils.

The council has recently imposed nutrient discharge rules within the Tukituki catchment. In particular, imposing a nitrogen leaching cap relative to Land Use Capability (applies to properties over 4 ha[6]) as shown below:

Table 6: Hawke's Bay Regional Council Nitrogen Leaching Allocation (Tukituki Catchment)

LUC Class	I	II	III	IV	V	VI	VII	VIII
(kg/N/ha/yr	30.1	27.1	24.8	20.7	20	17	11.6	3

This has potential to drive land use change if existing farming systems cannot comply with these limits (discussed further in the next section), particularly if (presumably) they are extended to the rest of the region.

Hawke's Bay also has rules/regulations around water takes for irrigation purposes[7] which has the potential to influence land use assuming water availability is constrained, particularly for the intensive cropping and permanent horticulture within the region. This issue is complicated with respect to the construction or otherwise of the proposed Ruataniwha dam; if the dam does not proceed and landowners are restricted to current allocable flows, then possible expansion of horticulture and cropping is unlikely to occur. Conversely, if the dam does proceed, then intensification of land use and land use change is very likely, at least within the bounds of the nitrogen allocation.

7.4 Horizons

Again, territorial authorities have some restrictions around subdivision of rural land, but are relatively permissive regarding land use activities.
At the regional level, Horizons "One Plan" has a number of regulations that have the potential to affect land use and land use change:

[6] Properties between 4 ha and 10 ha with less than 8 SU/ha, and not growing vegetables, dairying or grazed forage crops are also exempt.
[7] Refer to Appendix 4

- Restrictions on nitrogen discharge to water. Maximum nitrogen leaching limits have been mandated relative to Land Use Capability classification, with the expectation that these are reduced over a 20-year time-period. This is discussed further in the next section, but has direct potential to restrict current land use activities, and force land use change if these limits cannot be met.

- Limits on water takes. Limits are placed on water extraction, particularly relating to low flow limits. Again, this has potential to impact on land use and land use change if/when water bodies reach their maximum allocation levels.

- Restrictions on vegetation clearance, land disturbance, or cultivation in a Hill Country Erosion Management Area. The latter is defined as any area of land with a pre-existing slope of 20 degrees or greater. Land disturbance is where an area of more than 100 m^2 is disturbed, and cultivation restrictions relate to vegetation clearance of 1 hectare or greater. These are restricted discretionary rules, requiring a consent to proceed. These all combine to restrict land clearance on steep hill country [Most other regional councils have similar such rules].

- Agrichemicals and burning. This involves permitted activity standards which are based around good practice/codes of practice. While they could influence land use practices it is likely this would be on a case by case basis.

The implementation of the One Plan is currently being reviewed as a result of the recent Environment Court decision[8] as discussed in the next section.

7.5 Canterbury

The Canterbury Regional Plan differentiates the region into different catchments (e.g. Kaikoura, Hurunui–Waiau, Waimakariri, Selwyn Te Waihora, etc., as well as "zones" within these, e.g. red, orange, green, light blue). Each catchment and zone have specific rules relating to water quality, particularly limiting discharges of nitrogen, and water takes, predominantly for irrigation. Individual farms will have specific nitrogen loss limits which they cannot exceed.

While not specifically aimed at land use change, the rules are very likely to influence both intensity of land use, and potential land use change.

The decisions around Plan Change 5 have recently been released, which include amendments to district-wide rules around Nutrient Allocation Zones, which are still subject to appeal. The plan also has used the words "avoid" and "not exceed" particularly in relation to nitrogen losses. The recent Supreme Court decision on King Salmon[9] directly infers that consents cannot be granted in cases where the conditions cannot be met, in the sense that the Court found that "avoid" means "not allow" or "prevent occurrence".

7.6 Rural Land Subdivision

As noted, most territorial authorities have a relatively permissive attitude to land use [in the sense that land use is permitted relative to various standards. It does not infer a "do as you like" approach], apart from the subdivision of rural land for lifestyle or urban expansion.

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[8] *Wellington Fish and Game Council v Manawatu-Wanganui Regional Council [2017] NZEnvc 37*

[9] *Environmental Defense Society Inc. v The New Zealand King Salmon Co Ltd [2014] NZSC 38.* Refer Appendix 5.

This is mostly aimed at preventing disaggregation of land parcels (i.e. endeavouring to maintain land parcels as "economic units") or preventing the loss of high quality soils to urban development.

A study in the western Bay of Plenty (WBoPDC, 2005) investigating the productivity changes following subdivision showed a number of differing impacts:

- The original report in 1996 showed a decrease in the gross margin from the land in the survey, as a result of subdivision, of 6%, that there was no strong relationship between property size and primary production land use, and that properties subdivided into titles of less than 2 hectares were more often removed from primary production.
- The 2000 update showed that for properties subdivided between January 1995 and January 2000, there was a decrease (-17%) in total gross margin from the area in the survey, there was again little relationship between property size and land use category except that, again, the smaller properties were commonly removed from primary production. 59% of properties less than 4 hectares in size were removed totally from primary production following subdivision.
- The 2005 update found for properties subdivided since 2000 there was an increase in average gross margin (29%) after subdivision despite 27% of the land area being removed from primary production. The highest gross margins after subdivision were generally in the title size range of 3 - 8 hectares. The gross margin generally decreased after subdivision on title sizes under 1.5 hectares due to the high proportion of the land (82%) being removed from primary production. For titles smaller than 4 hectares, 65% of the titles were removed from primary production.

The increases/decreases in land use from this study were:

Table 7: Changes in Primary Industry Land Uses after Subdivision

Study	2004 New Titles	2004 Old Titles	2000	1996/97
Increases in:	Kiwifruit, avocados, forestry	Sheep and beef, deer, avocados, forestry, flowers	Deer, other pastoral, avocado, forestry, nursery, other horticulture, flowers.	Sheep and beef, citrus, avocado, other horticulture, flowers, forestry.
Decreases in:	Dairy, sheep and beef, deer, other pastoral, other horticulture, citrus	Dairy, other pastoral, kiwifruit, nursery, other horticulture.	Sheep and beef, dairy, kiwifruit, citrus.	Dairy, kiwifruit.

Source: WBoPDC 2005

This perhaps illustrates the dilemma for rural land subdivision; often it is a prerequisite for more intensive land use (with higher economic return), particularly horticulture, but accompanied by a reduction in other land uses, especially pastoral, and with some of that land also taken out of productive (agricultural) use.

Caution is needed when talking about "taking land out of production" for housing. Housing has a very high utility factor, which drives a high economic value; rural land around urban centres can be worth anything from $10,000 - $100,000 per hectare, depending on use. In houses, particularly in a city context, the land is worth anything from $1 million per hectare or more, which means there is an extremely powerful economic driver (often in conjunction with a political driver) to subdivide land for urban purposes [As noted in the literature review - in Lubowksi *et al* 2008].

Notwithstanding the controls that councils endeavour to apply to subdivision, there are a significant number of "paper titles" that exist on many farming units, which allow the owners to subdivide the title as of right.

The Productivity Commission report (2017)[10] indicates the need to continue to allow land availability for housing as a factor in reducing housing costs. Many urban areas are situated on relatively higher value soils, which was often one of the factors in determining the original settlement. This means that any housing expansion is likely to be onto high quality soils. But housing doesn't require high quality soils, and therefore there is a good argument to steer housing development towards lower quality soils.

Part of this "steering" is a factor which is often overlooked as a driver (or controller) of rural subdivision, particularly peri-urban/urban development, is infrastructure, particularly transport routes. Potentially, the provision of urban infrastructure could be used to better "direct" urban development onto areas with poorer soils. A case in point is Auckland; as a generalisation the soils to the south of the city tend to be of high quality, especially the Class 1-3 soils around Pukekohe/Pukekawa, whereas the soils to the north (Albany-Orewa) are of lesser quality. The provision of better transport infrastructure (i.e. second harbour bridge/tunnel?) may well attract development in the north rather than the south.

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10 http://www.productivity.govt.nz/sites/default/files/MASTER%20COMPILED%20Better%20urban%20planning%20with%20corrections%20May%202017.pdf

8.0 ENVIRONMENTAL IMPACT OF LAND USE CHANGE

One of the concerns around land use change is that it is often accompanied by a greater degree of environmental impact, as often the change involves shifting to a more intensive use as noted in the literature review. In noting this, however, actual impacts can vary significantly, and there are numerous examples of land use changes with lower environmental impacts.

As discussed in the section on council rules, within New Zealand there are two major drivers around environmental factors which have a high potential to affect land use change.

8.1 Water Management

This is primarily governed by the Resource Management Act (1991), coupled with the National Policy Statement on Freshwater Management (Ministry for the Environment, 2014). The RMA is New Zealand's principal legislation for environmental management, and promotes the sustainable management of natural and physical resources such as land, air and water. The National Policy Statement on Freshwater Management sets out the objectives and policies for freshwater management under the RMA.

Under these two pieces of legislation, Regional Councils are required to develop regional plans which provide rules and regulations around water management, particularly the abstraction of water (e.g. for domestic and industrial use, for stock drinking water, and water for irrigation) and the maintenance/enhancement of water quality via control on the discharge of contaminants into water bodies.

8.1.1 Water Takes

The availability or otherwise of water for irrigation can be a major driver for land use change. This can be evidenced within New Zealand where the advent of irrigation has promoted major land use change, usually out of dry-land livestock farming, into more intensive uses such as dairying, arable cropping, and horticulture.

In a number of regions (e.g. Waikato) the council is indicating that some catchments are currently fully allocated; the absence of the availability of more water is restricting both land use intensification, and land use change, and making water storage a more viable alternative. In other regions (e.g. Canterbury) large-scale irrigation schemes are being implemented or mooted, which is driving land use change.

Availability of water therefore drives decisions on potential land use and will contribute to decisions around land use change.

8.1.2 Water Quality

Most regional plans are now imposing restrictions on contaminant discharges into water bodies; while this started with the advent of the RMA, the more recent National Policy Statement on Freshwater Management has given it a further impetus.

For agriculture (which is the dominant land user in New Zealand) the contaminants in question are: nitrogen (mainly leaching as nitrate into ground water), phosphorus, sediment, and microbes (all of which mostly enter waterways via overland flow).

Of these, many councils are placing a numerical limit on nitrogen discharges from agricultural land, as modelled by OVERSEER® [11].

This has direct implications for land use in that, in the absence of applying mitigation strategies, intensification of land use, and land use change, will become problematic. In some cases, there is potential that nitrogen limits will generate land use change to less intensive farming systems as was the case in most of the Lake Taupo Catchment following the introduction of nitrogen limits.

Table 8: Indicative nitrogen leaching figures from different land uses (various sources)*

Farming System	N leaching (Range) kgN/ha/yr
Dairy	20 - 150
Sheep & Beef	6 - 50
Kiwifruit	10 - 40
Viticulture	5 - 10
Pipfruit	5 - 20
Arable Cropping	20 - 40
Intensive Vegetable Cropping	20 - 150
Forestry	2.5 - 4

*Actual leaching figures can vary widely, depending on individual characteristics of the land, climate, and land management system.

As can be seen from Table 8, the (generally) higher leaching land uses are dairying and intensive vegetable production, which means that tight controls on nitrogen leaching has the potential to drive land use away from these current uses depending on how nutrient allocations are distributed between land uses.

An example of this is the current Horizon's regional plan, which has mandated nitrogen leaching limits relative to Land Use Classification (Table 9).

Table 9: *Cumulative nitrogen leaching maximum by Land Use Capability Class (Table 14.2, Horizons Regional Plan) kgN/ha/year*

PERIOD (from the year that the rule has legal effect)								
LUC	I	II	III	IV	V	VI	VII	VIII
Year 1	30	27	24	18	16	15	8	2
Year 5	27	25	21	16	13	10	6	2
Year 10	26	22	19	14	13	10	6	2
Year 20	25	21	18	13	12	10	6	2

This poses a number of issues for land use change:

- LUC has no direct correlation with nitrogen leaching, so it is difficult to see the rationale in using it to determine nitrogen leaching limits.

[11] OVERSEER is a computer nutrient budget model, which estimates nutrient balances, including nitrogen discharges from the farm system.

- Intensive vegetable production, mostly occurring on LUC Classes 1 - 3, has on average, a nitrogen leaching level well above anything outlined in the above table, and is unlikely to meet the limits without significant developments in mitigation options. This then has the potential to:

    - Result in land use change to lower nitrogen leaching activities such as pastoral farming or permanent horticulture (thereby significantly reducing the production of vegetables), or
    - Result in growers having a large area of high quality land, with only a small proportion in vegetable production and the rest in a relatively low nitrogen leaching activity, for example fattening lambs (meaning large areas of high quality soils could be producing very little).

- Systems which currently have high levels of leaching and are on poorer land classes are likely to need to change land use to either lower nitrogen leaching horticultural crops (dependent on irrigation water availability) or to a more extensive pastoral system.

- The nitrogen leaching limits will also prevent (in all likelihood) land use changes into more intensive systems, e.g. conversion of drystock or forestry land into dairying (which is occurring in a number of regions).

The recent Environment Court decision on Horizon's One Plan has resulted in a need for the Council to change the way they have been implementing the plan until now. Previously, the Council were granting consents to farmers who were not meeting the table, but could demonstrate a reduction in nitrogen leaching over a period of time. However, the court decision suggests the Council can now only grant a consent to land owners who can meet the table, or demonstrate they are not having a detrimental effect on the environment. The Council are currently reviewing their processes and are yet to report on the new process to land owners who are yet to get consent. This demonstrates that nitrogen limits in this instance are likely to be a significant driver of land use decisions.

8.2 Climate Change and Greenhouse Gas Emissions

In 2016 New Zealand ratified the Paris Agreement on climate change. This commits New Zealand to reduce national GHG emissions to 30% below 2005 levels by 2030. As agriculture makes up 49% of New Zealand's emission profile it is very likely agriculture will be involved to some extent.

Recent modelling work (Reisinger *et al* 2017) indicates limited opportunity to change systems on-farm to reduce greenhouse gas (GHG) emissions. This then raises the likelihood of land use change to some extent into forestry and potentially horticulture as a mitigation strategy, particularly where nutrient limits are also imposed.

Table 10: Indicative Biological GHG emissions from different land uses*

	T CO_2e/ha/yr
Dairy	12.5
Sheep and Beef	3.0
Kiwifruit	0.17
Viticulture	1.03
Apples	0.71
Arable cropping	0.95

*Individual farms can vary significantly from these figures
Source: Reisinger *et al* (2017), Clothier *et al* (2017)

Forestry sequesters carbon and hence acts as a carbon sink.

From a GHG mitigation viewpoint, the table above indicates a significant reduction if land use changes from pastoral to either horticultural or to forestry. The extent to which this happens would depend to a large degree on the magnitude of any cost on greenhouse gas emissions imposed, acting as an economic driver. Currently under the Emissions Trading Scheme (ETS) the point of obligation for the pastoral industry lies with the processors. This means any incentive to change at an individual farm level would be significantly reduced.

The advent of the ETS in 2007 placing a value on carbon sequestration provided an incentive for land use change into forestry. The value, however, tended to be quite low, and while there has been some new planting of forestry post 2007, it (a) was much less than in previous years, and (b) the net areas of the production forestry estate actually decreased[12]. But with the value of carbon rising in recent years, this incentive may well come into play.

8.3 Summary

Overall therefore, there are a number of environmental drivers, acting largely through regulation, which have the potential to drive land use change within New Zealand. This is just starting to be manifest, and will develop as councils promulgate plans developed under the NPS-FM. While the underlying action is environmental impact mitigation, the driver will be manifest as an economic cost of applying the mitigation strategies.

Currently, only one Regional Council has a (proposed) rule which directly affects land use change. This is the proposed Waikato Regional Councils' Healthy Rivers Plan Change 1[13], which makes land use change to a more intensive use (i.e. greater level of contaminant discharge) a non-complying activity. Thus, a consent is possible, but not highly probable given the strict conditions likely to be imposed. This rule is interim, in that there is a sunset clause (10 years), on the basis that a more effects-based approach can be developed (such as a nitrogen allocation system).

[12] https://www.nzfoa.org.nz/images/stories/pdfs/2016-NEFD-report_web.pdf
[13] Refer Appendix 3

8.4 Ecosystem Services

Ecosystem services are the benefits people derive from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on earth[14].

An expanded explanation of the various components is:

- **Provisioning services**: The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and fresh water.
- **Regulating services**: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
- **Cultural services**: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g. knowledge systems, social relations, and aesthetic values.
- **Supporting services**: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Ecosystem services are usually measured by Total Economic Value (TEV), where TEV = Use Value (UV) plus Passive Value (PV) (Patterson & Cloe, 2013), as illustrated below.

Use Value as outlined above. Passive Values involve three component parts:

- **Option value.** This is the willingness to pay for the preservation of an ecosystem against some probability that an individual will make use of the ecosystem at a later date.
- **Existence value.** This is how much an individual is willing to pay to preserve an ecosystem, even though that individual may never intend to use that ecosystem. For example, an individual may wish to preserve tuatara on an offshore island of New Zealand, but have no intention or inclination of ever visiting such an island because of its isolation.
- **Bequest value.** This is the willingness to pay to preserve an ecosystem so that future generations can gain the benefit from that ecosystem.

Ecosystem services are important relative to land use, in that intensification of land use tends to impact more on the services that ecosystems provide. Similarly, land use change can have major implications for ecosystem services; think tropical forest to palm oil trees, or pasture land to urban centres.

In the authors' experience, ecosystem services are seldom a factor taken onto account by land owners contemplating a land use change. While biophysical factors are often a crucial aspect (e.g. soil type, soil drainage, local climate) in land use change decisions, e.g. for pastoral use into horticulture, these are considered more in a productive sense rather than ecosystem services.

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[14] Millennium Ecosystem Assessment, 2005.
http://millenniumassessment.org/documents/document.300.aspx.pdf

To some extent this is changing, slightly, in that environmental constraints are being considered by farmers, along the lines of "*the land use change/intensification I am considering will have environmental consequences, therefore I need to find a farm which has the physical characteristics, which will help ameliorate these impacts*". In noting this, technology also affects such decisions, in that if the land selected is not quite suitable, there may well be technological or management systems that can also be used to mitigate impacts.

Ecosystem services are very much driven by land use, rather than the inherent biophysical characteristics of the land. Forestry has a higher intrinsic ecosystem service value relative to (say) dairying, given the differing impact each has. This can be illustrated by the different ecosystem service values ascribed (van den Belt *et al*, 2009):

- Dairy: indirect value $404/ha (2006 value inflated to 2016 using the CPI = $493/ha)
- Forestry: indirect value $1,791/ha (2006 value inflated to 2016 using the CPI = $2,184/ha)

"Indirect" values are indicative of the ecosystem service values. To this the "direct" values (those associated with tangible uses, i.e. economic rents) need to be added.

- Dairy: $2,419/ha (5-year average)[15]
- Forestry: $267/ha[16]

Adding the indirect and direct values gives the following:

- Dairy: $2,912/ha
- Forestry: $2,451/ha

Care needs to be taken in using these values, particularly given the issues involved in determining the indirect ecosystem service values, usually achieved via choice modelling, or "willingness to pay" studies.

Perhaps the main point regarding ecosystem services and land use, is that the value of ecosystem services is determined by the land use, not by the biophysical features of the land. Wetlands, for example, have a high ecosystem service value (Patterson & Cloe, 2013). This is regardless of whether they are on LUC 1 or LUC 5 land.

This can be illustrated via a New Zealand example, where forestry has been planted on some west coast beach areas (e.g. Northland, Manawatu) to stabilise sand dunes. In their natural state, the dunes were prone to erosion; the trees were planted to prevent this and stabilise the dunes. So, in effect, a land use change has enhanced the ecosystem services from that ecosystem.

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[15] DairyNZ

[16] Estimate based on Journeaux et al 2016, + NEFD (Class 5-7 land, 5% discount rate).

9.0 ECONOMIC ANALYSIS ON THE VALUE OF LAND USE CHANGE

The value of differing land use can be illustrated via the returns obtained from different uses.

Table 11: EBIT per hectare from differing land uses

	2013	2014	2015	2016	Average
Pipfruit	$13,973	$14,850	$18,530	$21,160	$17,128
Viticulture	$10,440	$13,360	$7,513	$16,015	$11,832
Kiwifruit	$28,859	$27,058	$29,222	$36,347	$30,372
Dairy	$2,661	$4,007	$2,483	$957	$2,527
Sheep and Beef	$126	$181	$175	$138	$155

Source: MPI 2017, DairyNZ 2017, Beef + Lamb NZ 2017

Note:
(i) Pipfruit EBIT based on Hawke's Bay
(ii) Viticulture EBIT based on Marlborough
(iii) Kiwifruit EBIT based on Bay of Plenty
(iv) Dairy and Sheep and Beef EBIT national average

This table shows the economic benefits obtained from land use change, or conversely, the opportunity cost if land use change cannot occur due to some limiting factor or barrier to change.

This can be illustrated by some hypothetical examples.

1. **Conversion of a sheep and beef farm to dairying**
   Assuming a 100 hectare farm, from the above table the difference in EBIT from having the farm in dairying is $237,200.

   Which is not quite true, as assuming the farm was suitable for dairying, the average EBIT as a sheep and beef farm is more likely to be $300/ha[17], giving a difference of $222,700.

2. **Conversion of a dairy farm to pipfruit**
   Again, assuming a 100 hectare farm, the difference in EBIT from the above table from having the farm in pipfruit is $1,460,100.

On the face of it, the above two examples would indicate there are strong economic reasons for land use change. The reason why such land use change occurs depends on the range of factors as discussed in Section 5.0. A key driver is economic, namely the capital required for land use change, and access to this at an individual level.

For the sheep and beef to dairy conversion, the capital required is in the order of $20,000 per hectare (including livestock, but excluding irrigation). Income would be received in the following year, although it could take three to four years for the farm to fully perform.

For the pipfruit conversion, capital required is in the order of $100,000 per hectare, plus potentially a further $20,000 - $30,000/ha for hail covering. Returns depend very much on

[17] Beef + Lamb NZ North Island Class 5 Intensive Finishing

varieties planted, but some production would be expected in year two, with full production expected by year six[18].

For kiwifruit, capital requirement would be $250,000/ha for a gold license (if it could be procured), plus $200,000/ha for capital development. Some returns would be expected in year three, with full returns achieved in year five[19].

So, for the horticultural options, there is also a degree of risk in waiting for returns following the capital expenditure. Notwithstanding the increased risk from growing a single crop.

If there were barriers to the land use change, then obviously there would be an opportunity cost of not changing. For example:

(i) If the sheep and beef farm could not be converted to dairying because of (say) nitrogen discharge limits, then the opportunity cost or "loss" would be circa $2,200 per hectare.

(ii) If the dairy farm could not be converted to pipfruit because of a lack of water for irrigation, then the opportunity cost or "loss" would be $14,600 per hectare.

9.1 Market Failure

Part of the purpose of this study was to determine if there was any "market failure" with regard to land use change in New Zealand. This study has found no evidence of this, with land use change relatively free to happen, with some barriers imposed such as rural subdivision rules. Beyond this, though, land owners are able to readily change land use, dependant on their individual circumstances.

It depends to some extent on the definition of "market", as land use change can impose a range of externalities, particularly in relation to environmental impacts. Given a definition of externality as *an activity which affects other parties without this being reflected in market prices*, this study assumes they are not part of the current land use change "market".

As outlined in this report, however, externalities around water, and potentially greenhouse gas emissions, are starting to be addressed via government/council regulations, and are likely to be rapidly priced into land use decisions, and hence would become part of the overall "market" factors determining land use change.

9.2 Optimisation of Land Use

There is some thought that land use needs to be "optimised" such that the best soils are producing at their "highest and best use", which usually means at the highest economic return.

This poses a range of issues, particularly as to the definition of "optimisation" and who is doing the defining – often it is a matter of personal perspective. Another definition is to have a mixed land use rather than the mono-cultural production systems predominant in the New Zealand primary sector (which optimise economic returns).

[18] Jonathan Brookes, Horticultural Consultant, AgFirst, personal communication
[19] Sandy Scarrow, Horticultural Consultant, Fruition, personal communication

Optimisation or best use can also change dependent on changing circumstances and/or the use of technology. Examples here would include:

- The use of drainage and/or frost protection, thereby allowing a crop to be grown that would not necessarily be possible in the natural state.
- The recognition that some land use (or crop) is possible on what was previously considered poor soil. The classic example here is viticulture on the Gimblett Gravels near Hastings.

In this respect therefore, optimisation also requires recognition that it involves a degree of capability of being transformed, dependant on new technologies.

Table 2 shows that there is 106,000 hectares of production forestry on LUC Class 1-3 soils. With due respect to forestry, the economic returns from those soils is likely to be much higher in another land use, such as cropping or horticulture. Similarly, there is 3,000,000 hectares of grassland on LUC Class 1-3 soils, and again a higher economic return under horticulture is very probable.

At the extreme, as this report has indicated, the highest return from land is under housing, so is that the “highest and best” use of land? Not necessarily, but does mean that towns and cities will continue to expand as population increases.

The question therefore is why do landowners persist in a land use that has a lower relative economic return compared to alternatives. As outlined in this report, the two key drivers of land use change are biophysical and economic, and yet this has not resulted in optimisation of land use in in the eyes of some people. The answer relates back to the myriad of drivers and barriers discussed earlier in this report, all interacting in different ways, and not the least of which are personal factors and values – landowners like what they are doing and have no desire (or need) to change.

The end result of all these interactions is the land use pattern New Zealand currently has, along with any perceived anomalies of under-optimisation.

Part of this equation comes back to externalities, and whether they are priced into the market, which, by definition, they aren’t. But, again as outlined in this report, regulatory moves around water takes and water quality, plus (potentially) greenhouse gas emissions, are in the process of being priced into the market, which will definitely affect land use and land use change. The extent to which, and whether this results in a higher degree of “optimisation”, will unfold over the next decade or two.

Care also needs to be taken when assessing eco-system services and endeavouring to price them into the equation as well. Two (simplistic) examples:

(i) As noted in this report, wetlands have a high ecosystem service value; often put at $40,000- $50,000/hectare. This is well in excess of any pastoral farming system, and most horticultural systems. So, does this mean we should convert land into wetlands?

(ii) Again, as noted, forestry has a higher passive ecosystem service value compared with dairying. But when productive returns are added in, the returns from dairying are higher. So, which is the most optimal land use? Often this depends on the situation and location.

Another definition of optimisation is having a land use that best (or better) suits the soil. So, in this definition horticulture should be on the high-quality soils (i.e. LUC 1-3), pastoral agriculture on the lesser quality soils, and forestry on even lesser quality soils. As Table 2 indicates, this is not the case, given the range of drivers involved. Personal preference is a big part, and technology also comes into play; the advent of artificial drainage and frost protection systems means that crops can be grown on less than ideal soils/climatic conditions. Similarly, for intensive pastoral farming (e.g. dairying), the combination of technology and relative economics means it has spread into areas which are not necessarily ideal in their natural state. Part of this argument is (for example) "farmers should not be running heavy cattle on heavy soils on hill country in winter." Which indeed they shouldn't. The answer to this though is not land use controls, which would have to be relatively strict and comprehensive to have any chance of success, but in farmer education.

The point of the discussion above is to show that the question of optimisation is very complex, and often means different things to different people. And that there is no ready means of achieving optimisation.

While government can influence land use and land use change via incentives and subsidies, or via regulatory controls, these will not necessarily result in optimisation (whatever that may mean) because land use is affected by a wide range of other drivers and barriers, which are largely beyond government influence, and will change over time.

10.0 DISCUSSION/CONCLUSION

Land use change has been a significant factor of the New Zealand primary sector for well over 100 years[20], and arguably one of the strengths of the sector, whereby land use can readily change to a more profitable/sustainable use.

As discussed in Section 5 and the literature, there are a large number of factors which act as either drivers or barriers to land use change.

The initial factors relate to biophysical aspects, particularly soil type, slope, and climate. Increasingly, access to water, for irrigation, is also a key aspect. Once these factors are satisfied, a whole myriad of factors then come into play. Perhaps the most significant of these could be loosely termed "economic", with the relative profitability of the differing land uses being of paramount importance. This is reinforced by the literature review, with several researchers indicating profitability as a key land use change driver. Recent examples in New Zealand would be the development of land out of forestry into dairying (South Waikato), and out of drystock farming into dairying (Canterbury, Southland); all essentially driven by the higher relative profitability of dairying.

This "economic" tag could also include access to capital, especially at an individual level, access to markets, the infrastructure necessary to support the land use change, regulations, and access to information and advice. At an aggregate level, there is no indication of a shortage of capital available in New Zealand; the issue is mainly around accessing this and the risk assessment banks would place on both the individual and the proposed land use change.

Infrastructure[21] and marketing capability tend to develop over time. In the initial stages of a new land use change, limited infrastructure and marketing may be a barrier. Conversely, having well established infrastructure and marketing can act as a driver to land use change (e.g the dairy industry in New Zealand). But often the development and marketing go hand-in-hand with land use change; as the land use change becomes more significant, thereby demanding a greater level of infrastructure and marketing, they develop accordingly. Examples would be the kiwifruit industry and the viticulture industry, both of which developed over time with the infrastructure required. Canterbury currently has 1,197 dairy farms, milking 930,000 cows, and covering 55,700 hectares. If Canterbury had (hypothetically) gone from zero dairy to the current level, in one year, then the lack of infrastructure would have been a serious barrier. But the land use change occurred over time, and the infrastructure developed alongside this, to the point where it is now a driver; farmers can convert to dairying knowing the servicing and processing sectors can support them.

Information and advice is also broadly available, courtesy of a range of organisations; the industry good bodies (e.g. DairyNZ, Beef+Lamb NZ, Horticulture NZ, Deer Industry NZ, Wine NZ), private consultants, and research organisations (e.g. CRI's, universities). Even information on relatively unknown crops can often be sourced via the World Wide Web.

[20] Government was intervening in the land market in the 1890's to encourage more intensive land use, ref https://teara.govt.nz/en/1966/land-settlement/page-6

[21] Infrastructure being defined as including; servicing firms, processing capacity, and transport networks.

A key driver and/or barrier to land use change are personal factors, including aspects such as age, experience, education, and family circumstances. All of which combine to motivate, or not, a desire for land use change. Often it is personal preference; as an example, there are areas in New Zealand of sheep and beef farms surrounded by dairy farms - the land is quite suitable for dairy, but the personal preference of the farmer is to stay in sheep and beef. Appetite for risk is also an important personal factor, and often a key aspect when contemplating capital requirements and pay-back periods for land use change.

The literature review also reinforces the concept that economic factors are the key drivers of land use change, assuming the biophysical factors allow this. It is important to note that many of the modelling studies assume profitability to be the key driver, and often ignore other factors.

Economic factors are a very significant factor in driving land use change in the sense of conversion of agricultural land into urban land. As outlined in the report and literature review, the economics of primary land use pale in comparison to urban value and demand, hence the ongoing conversion of land around urban centres. Of particular (side) note is that land use change to urban is effectively a permanent removal of the land from primary production; an issue in a country based on exports of primary products.

This study has indicated there are a wide range of factors which affect land use and land use change decision making. All of which interact with each other in many variable ways. So, while economic factors are indicated as key (again assuming favourable biophysical factors), there remain a wide range of other factors which interact in the land use change decision.

Perhaps the main drivers and barriers to land use change that are arising in New Zealand relate to societal acceptance, via regulation. This is manifest in the development of regulations under the Resource Management Act and its subsidiary, the National Policy Statement for Freshwater Management.

Within New Zealand the RMA is administered by Regional Councils and Territorial Authorities, with the latter having much more direct control on land based activities. Generally, Territorial Authorities are relatively permissive in their approach to land use [in the sense that land use is permitted relative to various standards] apart from rural subdivision/urban development.

The main potential drivers and barriers to land use in a regulatory sense come from the Regional Councils, and the controls they are placing on water takes (for irrigation, frost control) and discharges on contaminants to water (e.g. nitrogen, phosphorus, sediment, bacteria). Under the National Policy Statement for Freshwater Management, Regional Councils must have plans fully implemented by the end of 2025 detailing regulations with respect to water takes and water quality. This process is underway, with councils around the country at various stages of implementing the National Policy Statement for Freshwater Management. A number of Councils have plans (or proposed plans) in place, although many are currently subject to legal appeal.

The controls the plans are seeking to put in place are likely to directly affect land use and land use change by restricting water takes and discharges of contaminants to waterbodies, notwithstanding there may be good environmental reasons for this. This process is still very much to play-out, but is likely to restrict land use changes to more intensive uses that either require water for irrigation, or discharge greater amounts of contaminants to water.

A corollary to this is that if restrictions are put in place due to environmental concerns, then an obvious measure, in order to ensure some degree of efficiency of use, and land use flexibility, would be to have trading systems in place for water and nutrients. Similarly, regulation also needs to allow for flexibility to allow for new/novel approaches to mitigating environmental effects.

The impact of regulatory impost is also likely to be seen if a greenhouse gas emission charge is imposed on agriculture as part of New Zealand’s climate change policy. Again this is likely to act as both a driver and a barrier of land use change.

There is an increasing interest in ecosystem services relative to land use, where ecosystem services are the benefits people derive from ecosystems. Perhaps the key thing to remember is that land use drives ecosystem services, not the other way around. Nevertheless, the thought is that restrictions could be placed on land uses so as not to (seriously) diminish the ecosystem services provided. Which in turn raises the issue of how ecosystem services are valued.

As noted earlier, economics is a major driving force in land use change. The analysis within the report shows a wide variation in returns between pastoral farming (dairy, sheep and beef) and various horticultural enterprises (pipfruit, viticulture, kiwifruit). This indicates the potential economic benefits of land use change, and conversely the opportunity cost if land use change cannot occur. It also outlined the potentially very high capital costs involved and delay in achieving a return on that investment, which can often act as a barrier to change, and needs to be incorporated in any risk assessment around land use change.

The concept of land use optimisation often arises, often with the definition that this means “highest and best” use, i.e. highest economic return, and/or the land use is best suited to the soil. Given the myriad of drivers and barriers in play, this concept is/will be very difficult to achieve, particularly given different interpretations that people can place on it.

Land use and land use change is complex, strongly driven by economics, and a wide range of other factors which are often interlinked. Land use in New Zealand in recent decades has largely been driven by relatively free-market economics, while prior to the 1980’s was driven by government subsidies, in conjunction with other historical influences such as war. Currently, there is no real evidence of “market failure” per se, relating to land use change. There are a number of environmental externalities which are starting to be internalised via regulatory moves. As this progresses, the impact will be largely manifest via an economic cost, which in turn will see the “market” adjust accordingly, as will the incentives for land use change.

11.0 WHERE TO NEXT?

Part of the purpose of this study was to consider whether there are any "tools" available, particularly for central government, to influence land use change/encourage the best use of high quality soils.

As the report had discussed, there are two key actions whereby government can directly influence land use, and land use change:

(i) Via incentives such as subsidies (be-it cash or other actions such as tax concessions), which was the favoured mode of action for much of the 20th century. There are still some subsidies in this arena, i.e. the Afforestation Grant Scheme, which provides a cash subsidy for planting areas into forestry for erosion control purposes and/or carbon sequestration.

(ii) Via regulatory controls. As discussed in this report, this process is underway via controls on water takes and contaminant discharges to water, plus potentially pricing of greenhouse gas emissions. Which is essentially pricing in externalities, and will very likely affect land use change.

Regulatory controls would also include other aspects of the RMA, particularly the NPS on Urban Development Capacity which directs local authorities to provide sufficient development capacity in their resource management plans for housing and business growth to meet demand, which will directly affect peri-urban land use.

There are a wide range of other options which could influence land use change. These include:

(i) Continuation/expansion of research funding. Government is the major funder of research in New Zealand; with the advent of regulatory controls, there is a need for a continuation of research into options, including farm system change, which farmers can use to mitigate adverse impacts.

(ii) Reducing environmental impacts has a large component of public good. This gives a rationale for government involvement; particularly around the provision of information and advice. Many environmental mitigations requiring farm system change are relatively complex, requiring a high level of information on options and how to adopt them.

Within this is the identification and provision of information as to the impacts of land use change.

Currently within New Zealand there are a range of organisations involved in environmental extension, particularly the Industry Good Bodies and Regional Councils. And while there is a public good rationale for government involvement, there is also a rationale for industry (as an agent of farmers) to address the negative externality involved in environmental impacts. Any extension programme could therefore be a partnership between government, industry and regional councils.

An example of how this could be arranged is outlined in Appendix 6.

(iii) A current component of reducing contaminant discharges to water, is the allocation of farm-level limits on such discharges. This is currently confined to nitrogen allocations, but potentially could include phosphorus and other contaminants.

The allocation is in effect an allocation or distribution of wealth. Research and analysis is required to assess the best or most equitable means of achieving such allocations (which in most cases is more likely to be the "least worst").

(iv) Placing restrictions or limits around the taking of water or discharges of contaminants often leads to a degree of inefficiency, both in the use of the resource, and in land use. To address this, in order to ensure some degree of efficiency of resource use, and land use flexibility, requires market mechanisms (i.e. trading). Work is required to determine mechanisms that will facilitate water and nutrient trading.

The above are largely focused at improving the mitigation of environmental impacts, which will have flow-on effects on land use change. Other measures which would directly help land use change decisions could include:

(v) Provision of information on current land use (as opposed to land cover) within New Zealand at an appropriate scale. Statistics on this are largely restricted to a regional level, and usually well out of date. Information at a district level or especially at a block level is mostly non-existent.

(vi) Provision of information on soil type at an appropriate scale. Similarly, information of soil types is difficult to obtain, and usually at a relatively high level (e.g. 1: 56,000 scale). Soil type is often a key aspect (or precursor) in determining whether to change land use.

(vii) Provision of information around different land uses, particularly economic and environmental. This would involve collaboration between government and CRIs and Industry Good bodies, and should be part of the extension component discussed above. It could also include research into alternative crops.

(viii) Investigation into the development of urban infrastructure and the influence this has on peri-urban development/spread of housing onto agricultural land.

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APPENDIX ONE: LAND COVER BY LUC CLASSIFICATION

The following tables are based on analysis of:

LUCAS NZ Land Use Map 1990 2008 2012 (v016) - https://data.mfe.govt.nz/layer/2375-lucas-nz-land use-map-1990-2008-2012-v016/

NZLRI Land Use Capability - https://lris.scinfo.org.nz/layer/48076-nzlri-land use-capability/

Stats NZ regional boundaries - http://www3.stats.govt.nz/digitalboundaries/annual/ESRI_Shapefile_2017_Digital_Boundaries_High_Def_Clipped.zip

Northland (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	16	129	624	25	872	311	622	0	12,918	40	0	3,127	18,684
Cropland	46	2,291	1,177	463	11	24	2	0	0	2	3	0	3	4,022
Exotic forest	2	388	2,734	20,659	309	119,254	44,936	2,455	15	48	59	0	3	190,862
Grass and scrub	15	663	3,314	10,566	142	32,419	5,374	1,623	11	37	27	0	4	54,194
Grassland	230	28,845	71,283	222,363	5,479	221,277	19,763	7,079	60	384	650	3	149	577,564
Horticulture	78	1,707	2,237	889	14	392	10	0	1	0	3	26	0	5,355
Natural forest	19	1,207	7,337	38,640	2,271	235,773	74,650	11,973	25	287	285	3	15	372,486
Other	0	168	1,787	6,569	19	5,436	9,097	7,595	2,592	230	60	80	2,116	35,749
Urban	46	858	1,309	1,810	50	908	143	40	0	5	4,440	0	0	9,609
Total	435	36,143	91,307	302,583	8,320	616,354	154,287	31,388	2,702	13,911	5,567	112	5,417	1,268,526

Northland (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.01%	0.05%	0.00%	0.07%	0.02%	0.05%	0.00%	1.02%	0.00%	0.00%	0.25%	1.5%
Cropland	0.00%	0.18%	0.09%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.3%
Exotic forest	0.00%	0.03%	0.22%	1.63%	0.02%	9.40%	3.54%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	15.0%
Grass and scrub	0.00%	0.05%	0.26%	0.83%	0.01%	2.56%	0.42%	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	4.3%
Grassland	0.02%	2.27%	5.62%	17.53%	0.43%	17.44%	1.56%	0.56%	0.00%	0.03%	0.05%	0.00%	0.01%	45.5%
Horticulture	0.01%	0.13%	0.18%	0.07%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.4%
Natural forest	0.00%	0.10%	0.58%	3.05%	0.18%	18.59%	5.88%	0.94%	0.00%	0.02%	0.02%	0.00%	0.00%	29.4%
Other	0.00%	0.01%	0.14%	0.52%	0.00%	0.43%	0.72%	0.60%	0.20%	0.02%	0.00%	0.01%	0.17%	2.8%
Urban	0.00%	0.07%	0.10%	0.14%	0.00%	0.07%	0.01%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.8%
Total	0.03%	2.85%	7.20%	23.85%	0.66%	48.59%	12.16%	2.47%	0.21%	1.10%	0.44%	0.01%	0.43%	100.00%

Auckland (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	12	486	455	307	0	954	694	662	0	6,530	640	1	1,167	11,908
Cropland	2,359	4,694	1,637	430	0	263	46	0	0	6	30	12	0	9,477
Exotic forest	24	618	2,201	4,175	0	33,814	10,794	700	33	24	192	7	8	52,589
Grass and scrub	89	1,736	1,817	2,508	0	3,844	752	385	1	29	316	2	1	11,479
Grassland	1,418	38,212	49,474	55,116	0	66,080	7,832	1,607	16	414	636	38	7	220,852
Horticulture	120	1,745	738	344	0	208	3	0	0	1	11	0	0	3,169
Natural forest	55	1,279	4,891	13,767	0	66,479	32,375	8,283	146	270	2,259	24	23	129,852
Other	8	360	632	853	0	1,126	579	1,072	653	395	862	0	33	6,574
Urban	311	6,249	3,096	2,353	0	809	254	26	13	47	40,210	107	0	53,474
Total	4,396	55,379	64,941	79,854	0	173,575	53,329	12,736	863	7,716	45,156	191	1,239	499,374

Auckland (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.10%	0.09%	0.06%	0.00%	0.19%	0.14%	0.13%	0.00%	1.31%	0.13%	0.00%	0.23%	2.4%
Cropland	0.47%	0.94%	0.33%	0.09%	0.00%	0.05%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	1.9%
Exotic forest	0.00%	0.12%	0.44%	0.84%	0.00%	6.77%	2.16%	0.14%	0.01%	0.00%	0.04%	0.00%	0.00%	10.5%
Grass and scrub	0.02%	0.35%	0.36%	0.50%	0.00%	0.77%	0.15%	0.08%	0.00%	0.01%	0.06%	0.00%	0.00%	2.3%
Grassland	0.28%	7.65%	9.91%	11.04%	0.00%	13.23%	1.57%	0.32%	0.00%	0.08%	0.13%	0.01%	0.00%	44.2%
Horticulture	0.02%	0.35%	0.15%	0.07%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.6%
Natural forest	0.01%	0.26%	0.98%	2.76%	0.00%	13.31%	6.48%	1.66%	0.03%	0.05%	0.45%	0.00%	0.00%	26.0%
Other	0.00%	0.07%	0.13%	0.17%	0.00%	0.23%	0.12%	0.21%	0.13%	0.08%	0.17%	0.00%	0.01%	1.3%
Urban	0.06%	1.25%	0.62%	0.47%	0.00%	0.16%	0.05%	0.01%	0.00%	0.01%	8.05%	0.02%	0.00%	10.7%
Total	0.88%	11.09%	13.00%	15.99%	0.00%	34.76%	10.68%	2.55%	0.17%	1.55%	9.04%	0.04%	0.25%	100.00%

Waikato (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	105	53	162	0	1,168	1,309	427	0	0	48	0	220	3,492
Cropland	2,927	6,514	3,064	2,374	0	844	731	18	1	0	2	0	4	16,480
Exotic forest	160	1,516	21,787	65,978	302	159,118	60,927	5,510	113	0	46	88	118	315,665
Grass and scrub	289	1,673	2,790	5,712	85	18,404	9,144	8,970	96	0	53	51	96	47,363
Grassland	40,306	231,476	235,778	219,394	8,010	487,078	72,560	19,379	476	0	1,113	328	371	1,316,270
Horticulture	280	1,196	541	192	0	199	13	5	0	0	1	0	0	2,428
Natural forest	561	3,444	8,716	38,249	1,855	247,658	237,667	74,158	518	0	245	48	183	613,303
Other	165	2,049	2,843	4,619	40	4,732	14,395	12,021	70,773	0	230	174	2,425	114,466
Urban	1,645	4,613	4,283	2,892	13	2,138	624	137	57	0	10,635	16	19	27,073
Total	46,333	252,587	279,856	339,572	10,305	921,339	397,371	120,626	72,034	0	12,374	706	3,437	2,456,539

Waikato (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.01%	0.00%	0.05%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.01%	0.1%
Cropland	0.12%	0.27%	0.12%	0.10%	0.00%	0.03%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.7%
Exotic forest	0.01%	0.06%	0.89%	2.69%	0.01%	6.48%	2.48%	0.22%	0.00%	0.00%	0.00%	0.00%	0.00%	12.8%
Grass and scrub	0.01%	0.07%	0.11%	0.23%	0.00%	0.75%	0.37%	0.37%	0.00%	0.00%	0.00%	0.00%	0.00%	1.9%
Grassland	1.64%	9.42%	9.60%	8.93%	0.33%	19.83%	2.95%	0.79%	0.02%	0.00%	0.05%	0.01%	0.02%	53.6%
Horticulture	0.01%	0.05%	0.02%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.1%
Natural forest	0.02%	0.14%	0.35%	1.56%	0.08%	10.08%	9.67%	3.02%	0.02%	0.00%	0.01%	0.00%	0.01%	25.0%
Other	0.01%	0.08%	0.12%	0.19%	0.00%	0.19%	0.59%	0.49%	2.88%	0.00%	0.01%	0.01%	0.10%	4.7%
Urban	0.07%	0.19%	0.17%	0.12%	0.00%	0.09%	0.03%	0.01%	0.00%	0.00%	0.43%	0.00%	0.00%	1.1%
Total	1.89%	10.28%	11.39%	13.82%	0.42%	37.51%	16.18%	4.91%	2.93%	0.00%	0.50%	0.03%	0.14%	100.00%

Bay of Plenty (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	137	124	181	0	370	64	234	0	311	95	0	103	1,618
Cropland	297	4,550	1,738	2,142	0	984	41	57	0	0	21	0	32	9,863
Exotic forest	0	396	9,178	96,090	29	94,023	74,782	7,386	49	0	70	0	6	282,008
Grass and scrub	25	1,232	3,475	4,301	18	10,772	8,026	2,077	97	4	204	0	73	30,303
Grassland	2,258	36,229	48,449	54,864	555	85,308	23,114	5,494	115	31	533	0	404	257,356
Horticulture	125	8,009	5,542	3,718	54	2,071	606	208	0	0	14	0	4	20,349
Natural forest	5	871	3,133	16,751	3	87,442	285,045	185,237	224	0	66	0	6	578,782
Other	88	639	888	2,714	0	1,349	1,215	1,576	20,777	44	94	0	317	29,701
Urban	42	1,326	2,390	2,408	0	1,077	263	504	61	9	6,998	0	39	15,117
Total	2,840	53,388	74,917	183,170	659	283,397	393,157	202,771	21,323	399	8,095	0	983	1,225,097

Bay of Plenty (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.01%	0.01%	0.01%	0.00%	0.03%	0.01%	0.02%	0.00%	0.03%	0.01%	0.00%	0.01%	0.1%
Cropland	0.02%	0.37%	0.14%	0.17%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.8%
Exotic forest	0.00%	0.03%	0.75%	7.84%	0.00%	7.67%	6.10%	0.60%	0.00%	0.00%	0.01%	0.00%	0.00%	23.0%
Grass and scrub	0.00%	0.10%	0.28%	0.35%	0.00%	0.88%	0.66%	0.17%	0.01%	0.00%	0.02%	0.00%	0.01%	2.5%
Grassland	0.18%	2.96%	3.95%	4.48%	0.05%	6.96%	1.89%	0.45%	0.01%	0.00%	0.04%	0.00%	0.03%	21.0%
Horticulture	0.01%	0.65%	0.45%	0.30%	0.00%	0.17%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	1.7%
Natural forest	0.00%	0.07%	0.26%	1.37%	0.00%	7.14%	23.27%	15.12%	0.02%	0.00%	0.01%	0.00%	0.00%	47.2%
Other	0.01%	0.05%	0.07%	0.22%	0.00%	0.11%	0.10%	0.13%	1.70%	0.00%	0.01%	0.00%	0.03%	2.4%
Urban	0.00%	0.11%	0.20%	0.20%	0.00%	0.09%	0.02%	0.04%	0.00%	0.00%	0.57%	0.00%	0.00%	1.2%
Total	0.23%	4.36%	6.12%	14.95%	0.05%	23.13%	32.09%	16.55%	1.74%	0.03%	0.66%	0.00%	0.08%	100.00%

Gisborne (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	0	5	0	0	19	50	112	0	0	6	0	0	192
Cropland	2,119	2,834	5,963	176	0	308	42	52	0	0	1	0	0	11,494
Exotic forest	26	325	2,628	2,309	0	54,762	125,593	2,381	0	0	21	5	0	188,051
Grass and scrub	152	501	1,931	943	0	13,073	25,275	2,021	5	0	54	7	0	43,961
Grassland	1,305	9,589	31,763	15,917	0	150,835	134,036	6,854	2	0	133	8	0	350,442
Horticulture	1,871	696	2,477	5	0	57	12	2	0	0	0	0	0	5,121
Natural forest	14	1,173	3,849	5,327	0	52,980	108,594	57,152	1	0	26	0	0	229,115
Other	40	174	822	440	0	528	1,059	4,025	123	0	40	14	0	7,266
Urban	125	103	512	124	0	107	11	26	0	0	1,835	0	0	2,841
Total	5,653	15,395	49,950	25,241	0	272,669	394,672	72,623	130	0	2,116	34	0	838,483

Gisborne (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Cropland	0.25%	0.34%	0.71%	0.02%	0.00%	0.04%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	1.4%
Exotic forest	0.00%	0.04%	0.31%	0.28%	0.00%	6.53%	14.98%	0.28%	0.00%	0.00%	0.00%	0.00%	0.00%	22.4%
Grass and scrub	0.02%	0.06%	0.23%	0.11%	0.00%	1.56%	3.01%	0.24%	0.00%	0.00%	0.01%	0.00%	0.00%	5.2%
Grassland	0.16%	1.14%	3.79%	1.90%	0.00%	17.99%	15.99%	0.82%	0.00%	0.00%	0.02%	0.00%	0.00%	41.8%
Horticulture	0.22%	0.08%	0.30%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.6%
Natural forest	0.00%	0.14%	0.46%	0.64%	0.00%	6.32%	12.95%	6.82%	0.00%	0.00%	0.00%	0.00%	0.00%	27.3%
Other	0.00%	0.02%	0.10%	0.05%	0.00%	0.06%	0.13%	0.48%	0.01%	0.00%	0.00%	0.00%	0.00%	0.9%
Urban	0.01%	0.01%	0.06%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.22%	0.00%	0.00%	0.3%
Total	0.67%	1.84%	5.96%	3.01%	0.00%	32.52%	47.07%	8.66%	0.02%	0.00%	0.25%	0.00%	0.00%	100.00%

Hawke's Bay (ha)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	4	68	17	0	94	145	226	0	0	32	0	17	603
Cropland	3,195	3,871	8,535	1,953	9	672	379	10	3	0	58	0	99	18,785
Exotic forest	242	566	5,441	9,963	438	101,835	44,089	4,889	37	0	51	0	1,534	169,085
Grass and scrub	180	580	2,480	2,358	304	19,402	13,762	12,136	21	0	13	0	492	51,728
Grassland	8,049	16,128	111,641	79,592	22,916	367,143	91,763	18,651	108	0	187	0	5,723	721,899
Horticulture	5,007	4,295	5,018	224	67	133	1,129	2	353	0	10	0	172	16,409
Natural forest	1	133	1,838	5,089	9	80,346	161,594	165,957	0	0	0	0	28	414,996
Other	177	215	1,620	1,089	57	2,755	1,609	1,487	6,291	0	37	0	2,377	17,714
Urban	672	693	1,202	276	18	147	810	0	0	0	4,357	0	62	8,238
Total	17,523	26,485	137,844	100,560	23,817	572,528	315,279	203,358	6,813	0	4,746	0	10,503	1,419,456

Hawke's Bay (%)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Cropland	0.23%	0.27%	0.60%	0.14%	0.00%	0.05%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	1.3%
Exotic forest	0.02%	0.04%	0.38%	0.70%	0.03%	7.17%	3.11%	0.34%	0.00%	0.00%	0.00%	0.00%	0.11%	11.9%
Grass and scrub	0.01%	0.04%	0.17%	0.17%	0.02%	1.37%	0.97%	0.85%	0.00%	0.00%	0.00%	0.00%	0.03%	3.6%
Grassland	0.57%	1.14%	7.87%	5.61%	1.61%	25.87%	6.46%	1.31%	0.01%	0.00%	0.01%	0.00%	0.40%	50.9%
Horticulture	0.35%	0.30%	0.35%	0.02%	0.00%	0.01%	0.08%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	1.2%
Natural forest	0.00%	0.01%	0.13%	0.36%	0.00%	5.66%	11.38%	11.69%	0.00%	0.00%	0.00%	0.00%	0.00%	29.2%
Other	0.01%	0.02%	0.11%	0.08%	0.00%	0.19%	0.11%	0.10%	0.44%	0.00%	0.00%	0.00%	0.17%	1.2%
Urban	0.05%	0.05%	0.08%	0.02%	0.00%	0.01%	0.06%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.6%
Total	1.23%	1.87%	9.71%	7.08%	1.68%	40.33%	22.21%	14.33%	0.48%	0.00%	0.33%	0.00%	0.74%	100.00%

Horizons (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	5	0	0	0	0	17	157	388	0	0	0	0	8	574
Cropland	3,191	9,254	2,903	827	0	832	157	11	0	0	19	0	28	17,222
Exotic forest	290	1,214	6,832	11,469	102	72,840	63,178	2,696	9	0	33	0	167	158,830
Grass and scrub	1,119	5,125	7,929	6,767	115	35,583	31,131	40,309	32	0	264	0	595	128,968
Grassland	28,446	150,954	156,198	107,699	3,591	566,014	247,886	43,640	46	0	1,256	0	1,419	1,307,149
Horticulture	106	280	109	23	0	9	1	0	0	0	4	0	4	537
Natural forest	238	1,940	8,380	29,254	64	142,273	264,205	119,205	8	0	142	0	230	565,940
Other	263	1,155	1,668	3,228	25	4,122	2,009	13,273	487	0	138	0	1,357	27,725
Urban	282	1,608	1,403	413	5	511	191	79	1	0	9,725	0	32	14,249
Total	33,940	171,531	185,422	159,681	3,901	822,202	608,914	219,600	583	0	11,581	0	3,840	2,221,195

Horizons (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Cropland	0.14%	0.42%	0.13%	0.04%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.8%
Exotic forest	0.01%	0.05%	0.31%	0.52%	0.00%	3.28%	2.84%	0.12%	0.00%	0.00%	0.00%	0.00%	0.01%	7.2%
Grass and scrub	0.05%	0.23%	0.36%	0.30%	0.01%	1.60%	1.40%	1.81%	0.00%	0.00%	0.01%	0.00%	0.03%	5.8%
Grassland	1.28%	6.80%	7.03%	4.85%	0.16%	25.48%	11.16%	1.96%	0.00%	0.00%	0.06%	0.00%	0.06%	58.8%
Horticulture	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Natural forest	0.01%	0.09%	0.38%	1.32%	0.00%	6.41%	11.89%	5.37%	0.00%	0.00%	0.01%	0.00%	0.01%	25.5%
Other	0.01%	0.05%	0.08%	0.15%	0.00%	0.19%	0.09%	0.60%	0.02%	0.00%	0.01%	0.00%	0.06%	1.2%
Urban	0.01%	0.07%	0.06%	0.02%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%	0.44%	0.00%	0.00%	0.6%
Total	1.53%	7.72%	8.35%	7.19%	0.18%	37.02%	27.41%	9.89%	0.03%	0.00%	0.52%	0.00%	0.17%	100.00%

Taranaki (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	4	6	42	25	7	12	12	339	0	0	35	0	0	482
Cropland	623	387	219	159	54	89	4	0	0	0	3	0	2	1,540
Exotic forest	517	949	1,832	1,196	1,299	11,695	15,635	67	0	0	15	0	5	33,211
Grass and scrub	441	771	1,827	1,564	801	3,796	4,680	2,679	0	0	219	0	4	16,782
Grassland	33,584	51,562	85,471	55,979	32,782	80,913	37,725	3,064	7	0	738	0	173	381,999
Horticulture	146	31	40	19	15	13	0	1	0	0	1	0	0	266
Natural forest	352	964	2,113	9,917	2,741	49,317	170,414	43,477	3	0	97	0	167	279,561
Other	63	338	823	319	142	642	916	866	46	0	86	0	48	4,289
Urban	640	654	1,050	220	256	147	56	18	0	0	4,000	0	1	7,042
Total	36,370	55,661	93,417	69,399	38,097	146,622	229,443	50,513	57	0	5,194	0	400	725,173

Taranaki (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.1%
Cropland	0.09%	0.05%	0.03%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.2%
Exotic forest	0.07%	0.13%	0.25%	0.16%	0.18%	1.61%	2.16%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	4.6%
Grass and scrub	0.06%	0.11%	0.25%	0.22%	0.11%	0.52%	0.65%	0.37%	0.00%	0.00%	0.03%	0.00%	0.00%	2.3%
Grassland	4.63%	7.11%	11.79%	7.72%	4.52%	11.16%	5.20%	0.42%	0.00%	0.00%	0.10%	0.00%	0.02%	52.7%
Horticulture	0.02%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Natural forest	0.05%	0.13%	0.29%	1.37%	0.38%	6.80%	23.50%	6.00%	0.00%	0.00%	0.01%	0.00%	0.02%	38.6%
Other	0.01%	0.05%	0.11%	0.04%	0.02%	0.09%	0.13%	0.12%	0.01%	0.00%	0.01%	0.00%	0.01%	0.6%
Urban	0.09%	0.09%	0.14%	0.03%	0.04%	0.02%	0.01%	0.00%	0.00%	0.00%	0.55%	0.00%	0.00%	1.0%
Total	5.02%	7.68%	12.88%	9.57%	5.25%	20.22%	31.64%	6.97%	0.01%	0.00%	0.72%	0.00%	0.06%	100.00%

Wellington (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	0	17	24	0	126	143	255	0	0	80	0	10	655
Cropland	346	2,464	2,769	285	82	169	10	0	0	0	13	0	0	6,138
Exotic forest	18	334	2,060	2,497	145	39,063	38,431	553	9	0	264	0	55	83,429
Grass and scrub	227	1,613	5,594	1,954	205	14,944	10,367	7,031	26	0	279	0	183	42,422
Grassland	4,268	23,636	71,760	32,701	7,934	152,713	57,088	6,909	241	0	1,031	0	1,055	359,337
Horticulture	147	325	1,396	258	0	43	0	0	0	0	17	0	3	2,189
Natural forest	18	403	2,072	2,389	71	63,150	125,090	88,003	22	0	1,930	0	459	283,608
Other	67	621	1,011	511	22	1,848	560	472	8,542	0	521	0	559	14,735
Urban	104	266	971	392	0	1,408	147	11	6	0	16,722	0	0	20,027
Total	5,195	29,662	87,651	41,010	8,460	273,463	231,836	103,234	8,847	0	20,857	0	2,325	812,540

Wellington (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.02%	0.03%	0.00%	0.00%	0.01%	0.00%	0.00%	0.1%
Cropland	0.04%	0.30%	0.34%	0.04%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.8%
Exotic forest	0.00%	0.04%	0.25%	0.31%	0.02%	4.81%	4.73%	0.07%	0.00%	0.00%	0.03%	0.00%	0.01%	10.3%
Grass and scrub	0.03%	0.20%	0.69%	0.24%	0.03%	1.84%	1.28%	0.87%	0.00%	0.00%	0.03%	0.00%	0.02%	5.2%
Grassland	0.53%	2.91%	8.83%	4.02%	0.98%	18.79%	7.03%	0.85%	0.03%	0.00%	0.13%	0.00%	0.13%	44.2%
Horticulture	0.02%	0.04%	0.17%	0.03%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.3%
Natural forest	0.00%	0.05%	0.26%	0.29%	0.01%	7.77%	15.39%	10.83%	0.00%	0.00%	0.24%	0.00%	0.06%	34.9%
Other	0.01%	0.08%	0.12%	0.06%	0.00%	0.23%	0.07%	0.06%	1.05%	0.00%	0.06%	0.00%	0.07%	1.8%
Urban	0.01%	0.03%	0.12%	0.05%	0.00%	0.17%	0.02%	0.00%	0.00%	0.00%	2.06%	0.00%	0.00%	2.5%
Total	0.64%	3.65%	10.79%	5.05%	1.04%	33.66%	28.53%	12.71%	1.09%	0.00%	2.57%	0.00%	0.29%	100.00%

Marlborough (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	0	43	0	0	1,243	1,437	656	0	0	9	0	1,432	4,821
Cropland	264	2,280	1,077	569	0	205	103	11	4	0	1	0	39	4,553
Exotic forest	0	39	1,525	2,064	26	33,750	43,811	3,110	0	0	3	0	116	84,444
Grass and scrub	3	126	1,340	1,642	37	22,154	23,529	19,485	3	10	16	0	562	68,909
Grassland	114	2,225	28,739	17,686	448	188,863	126,303	118,286	16	0	180	9	4,437	487,307
Horticulture	2,061	6,527	13,391	5,029	0	3,096	332	10	0	0	45	0	47	30,536
Natural forest	0	3	1,517	2,362	46	41,516	166,593	99,328	3	4	15	0	207	311,594
Other	1	31	355	410	39	1,228	3,139	42,362	1,739	35	14	7	6,538	55,897
Urban	6	163	395	77	7	146	226	30	0	0	1,700	0	1	2,750
Total	2,449	11,394	48,380	29,840	604	292,202	365,472	283,277	1,765	49	1,982	16	13,380	1,050,811

Marlborough (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.00%	0.12%	0.14%	0.06%	0.00%	0.00%	0.00%	0.00%	0.14%	0.46%
Cropland	0.03%	0.22%	0.10%	0.05%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.43%
Exotic forest	0.00%	0.00%	0.15%	0.20%	0.00%	3.21%	4.17%	0.30%	0.00%	0.00%	0.00%	0.00%	0.01%	8.04%
Grass and scrub	0.00%	0.01%	0.13%	0.16%	0.00%	2.11%	2.24%	1.85%	0.00%	0.00%	0.00%	0.00%	0.05%	6.56%
Grassland	0.01%	0.21%	2.73%	1.68%	0.04%	17.97%	12.02%	11.26%	0.00%	0.00%	0.02%	0.00%	0.42%	46.37%
Horticulture	0.20%	0.62%	1.27%	0.48%	0.00%	0.29%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.91%
Natural forest	0.00%	0.00%	0.14%	0.22%	0.00%	3.95%	15.85%	9.45%	0.00%	0.00%	0.00%	0.00%	0.02%	29.65%
Other	0.00%	0.00%	0.03%	0.04%	0.00%	0.12%	0.30%	4.03%	0.17%	0.00%	0.00%	0.00%	0.62%	5.32%
Urban	0.00%	0.02%	0.04%	0.01%	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%	0.16%	0.00%	0.00%	0.26%
Total	0.23%	1.08%	4.60%	2.84%	0.06%	27.81%	34.78%	26.96%	0.17%	0.00%	0.19%	0.00%	1.27%	100.00%

Nelson (ha)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	20	50	15	0	15	19	17	0	28	0	0	0	164
Cropland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exotic forest	0	8	280	13	0	2,836	8,306	32	0	5	0	0	0	11,480
Grass and scrub	0	8	58	3	0	554	648	663	0	26	0	0	0	1,960
Grassland	0	328	769	178	0	2,165	1,155	851	0	8	0	0	0	5,454
Horticulture	0	16	2	0	0	5	0	0	0	0	0	0	0	23
Natural forest	0	15	270	27	0	4,229	13,315	2,163	0	20	0	0	0	20,038
Other	0	1	51	7	0	50	75	3	0	7	0	0	0	195
Urban	0	306	488	225	0	400	22	0	0	1,240	0	0	0	2,681
Total	0	702	1,969	468	0	10,253	23,539	3,729	0	1,335	0	0	0	41,995

Nelson (%)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.05%	0.12%	0.04%	0.00%	0.04%	0.05%	0.04%	0.00%	0.07%	0.00%	0.00%	0.00%	0.4%
Cropland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Exotic forest	0.00%	0.02%	0.67%	0.03%	0.00%	6.75%	19.78%	0.08%	0.00%	0.01%	0.00%	0.00%	0.00%	27.3%
Grass and scrub	0.00%	0.02%	0.14%	0.01%	0.00%	1.32%	1.54%	1.58%	0.00%	0.06%	0.00%	0.00%	0.00%	4.7%
Grassland	0.00%	0.78%	1.83%	0.42%	0.00%	5.16%	2.75%	2.03%	0.00%	0.02%	0.00%	0.00%	0.00%	13.0%
Horticulture	0.00%	0.04%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.1%
Natural forest	0.00%	0.03%	0.64%	0.06%	0.00%	10.07%	31.70%	5.15%	0.00%	0.05%	0.00%	0.00%	0.00%	47.7%
Other	0.00%	0.00%	0.12%	0.02%	0.00%	0.12%	0.18%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.5%
Urban	0.00%	0.73%	1.16%	0.54%	0.00%	0.95%	0.05%	0.00%	0.00%	2.95%	0.00%	0.00%	0.00%	6.4%
Total	0.00%	1.67%	4.69%	1.11%	0.00%	24.41%	56.05%	8.88%	0.00%	3.18%	0.00%	0.00%	0.00%	100.00%

Tasman (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	9	21	151	151	0	447	384	635	0	345	0	0	3	2,146
Cropland	411	188	622	34	0	18	0	1	0	0	0	0	1	1,276
Exotic forest	6	98	1,687	4,916	32	30,262	63,666	3,949	0	0	0	0	46	104,662
Grass and scrub	114	188	1,429	1,792	40	5,835	14,625	21,277	4	9	0	0	312	45,625
Grassland	1,448	2,911	33,892	31,689	704	36,257	17,536	62,857	16	82	0	0	1,088	188,481
Horticulture	2,173	1,213	4,249	423	0	234	11	11	0	0	0	0	18	8,333
Natural forest	33	105	2,582	11,107	274	36,719	169,684	364,396	79	0	0	0	257	585,236
Other	132	59	692	1,393	1	1,227	1,558	16,259	3,714	35	0	0	1,395	26,466
Urban	385	173	1,310	388	0	792	51	0	0	365	137	0	0	3,603
Total	4,712	4,956	46,613	51,895	1,051	111,792	267,515	469,386	3,814	836	137	0	3,122	965,829

Tasman (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.02%	0.02%	0.00%	0.05%	0.04%	0.07%	0.00%	0.04%	0.00%	0.00%	0.00%	0.2%
Cropland	0.04%	0.02%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.1%
Exotic forest	0.00%	0.01%	0.17%	0.51%	0.00%	3.13%	6.59%	0.41%	0.00%	0.00%	0.00%	0.00%	0.00%	10.8%
Grass and scrub	0.01%	0.02%	0.15%	0.19%	0.00%	0.60%	1.51%	2.20%	0.00%	0.00%	0.00%	0.00%	0.03%	4.7%
Grassland	0.15%	0.30%	3.51%	3.28%	0.07%	3.75%	1.82%	6.51%	0.00%	0.01%	0.00%	0.00%	0.11%	19.5%
Horticulture	0.22%	0.13%	0.44%	0.04%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.9%
Natural forest	0.00%	0.01%	0.27%	1.15%	0.03%	3.80%	17.57%	37.73%	0.01%	0.00%	0.00%	0.00%	0.03%	60.6%
Other	0.01%	0.01%	0.07%	0.14%	0.00%	0.13%	0.16%	1.68%	0.38%	0.00%	0.00%	0.00%	0.14%	2.7%
Urban	0.04%	0.02%	0.14%	0.04%	0.00%	0.08%	0.01%	0.00%	0.00%	0.04%	0.01%	0.00%	0.00%	0.4%
Total	0.49%	0.51%	4.83%	5.37%	0.11%	11.57%	27.70%	48.60%	0.39%	0.09%	0.01%	0.00%	0.32%	100.00%

West Coast (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	0	22	99	265	330	244	407	0	343	12	0	41	1,761
Cropland	0	0	4	30	0	0	1	0	0	0	0	0	0	36
Exotic forest	0	0	85	1,884	79	16,802	23,271	145	0	0	5	0	172	42,445
Grass and scrub	0	0	659	6,350	1,039	15,562	26,667	133,642	21	79	67	0	2,611	186,698
Grassland	0	0	12,066	81,727	6,834	40,133	26,949	238,019	96	157	142	0	11,955	418,078
Horticulture	0	0	4	11	0	0	0	0	0	0	0	0	0	14
Natural forest	0	0	1,203	54,035	2,591	210,187	312,112	875,900	249	71	83	0	2,759	1,459,191
Other	0	0	584	7,161	1,355	10,230	11,931	157,454	10,814	2,739	136	0	22,019	224,422
Urban	0	0	81	431	120	709	311	41	3	2	1,278	0	30	3,006
Total	0	0	14,708	151,728	12,283	293,952	401,485	1,405,609	11,183	3,391	1,724	0	39,587	2,335,650

West Coast (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.00%	0.01%	0.00%	0.00%	0.00%	0.1%
Cropland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Exotic forest	0.00%	0.00%	0.00%	0.08%	0.00%	0.72%	1.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	1.8%
Grass and scrub	0.00%	0.00%	0.03%	0.27%	0.04%	0.67%	1.14%	5.72%	0.00%	0.00%	0.00%	0.00%	0.11%	8.0%
Grassland	0.00%	0.00%	0.52%	3.50%	0.29%	1.72%	1.15%	10.19%	0.00%	0.01%	0.01%	0.00%	0.51%	17.9%
Horticulture	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.0%
Natural forest	0.00%	0.00%	0.05%	2.31%	0.11%	9.00%	13.36%	37.50%	0.01%	0.00%	0.00%	0.00%	0.12%	62.5%
Other	0.00%	0.00%	0.02%	0.31%	0.06%	0.44%	0.51%	6.74%	0.46%	0.12%	0.01%	0.00%	0.94%	9.6%
Urban	0.00%	0.00%	0.00%	0.02%	0.01%	0.03%	0.01%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.1%
Total	0.00%	0.00%	0.63%	6.50%	0.53%	12.59%	17.19%	60.18%	0.48%	0.15%	0.07%	0.00%	1.69%	100.00%

Canterbury (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	17	409	279	331	42	507	259	258	0	729	28	0	108	2,967
Cropland	9,564	103,374	102,337	27,120	422	4,655	117	0	1	0	18	0	1,060	248,668
Exotic forest	298	3,567	14,024	28,977	374	71,023	9,263	671	50	0	155	0	7,457	135,859
Grass and scrub	303	4,731	12,396	13,683	980	82,355	44,101	48,581	179	29	213	0	10,596	218,148
Grassland	11,811	150,882	404,716	431,563	18,376	896,193	524,481	440,509	3,042	122	850	0	56,636	2,939,181
Horticulture	182	1,410	1,907	588	23	136	3	0	0	0	0	0	25	4,274
Natural forest	0	560	1,519	5,567	363	93,885	121,188	179,393	114	0	3	0	2,464	405,056
Other	60	805	2,784	5,547	3,710	14,050	12,887	361,885	53,254	2,340	153	0	79,659	537,134
Urban	896	4,609	4,982	2,989	21	3,297	393	37	24	22	14,850	0	18	32,137
Total	23,132	270,348	544,945	516,365	24,310	1,166,102	712,692	1,031,334	56,665	3,241	16,269	0	158,023	4,523,424

Canterbury (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.01%	0.01%	0.01%	0.00%	0.01%	0.01%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.1%
Cropland	0.21%	2.29%	2.26%	0.60%	0.01%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	5.5%
Exotic forest	0.01%	0.08%	0.31%	0.64%	0.01%	1.57%	0.20%	0.01%	0.00%	0.00%	0.00%	0.00%	0.16%	3.0%
Grass and scrub	0.01%	0.10%	0.27%	0.30%	0.02%	1.82%	0.97%	1.07%	0.00%	0.00%	0.00%	0.00%	0.23%	4.8%
Grassland	0.26%	3.34%	8.95%	9.54%	0.41%	19.81%	11.59%	9.74%	0.07%	0.00%	0.02%	0.00%	1.25%	65.0%
Horticulture	0.00%	0.03%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.1%
Natural forest	0.00%	0.01%	0.03%	0.12%	0.01%	2.08%	2.68%	3.97%	0.00%	0.00%	0.00%	0.00%	0.05%	9.0%
Other	0.00%	0.02%	0.06%	0.12%	0.08%	0.31%	0.28%	8.00%	1.18%	0.05%	0.00%	0.00%	1.76%	11.9%
Urban	0.02%	0.10%	0.11%	0.07%	0.00%	0.07%	0.01%	0.00%	0.00%	0.00%	0.33%	0.00%	0.00%	0.7%
Total	0.51%	5.98%	12.05%	11.42%	0.54%	25.78%	15.76%	22.80%	1.25%	0.07%	0.36%	0.00%	3.49%	100.00%

Otago (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	85	105	213	30	556	152	4	0	191	87	0	16	1,440
Cropland	35	2,876	7,971	2,759	157	802	62	8	0	0	7	0	83	14,761
Exotic forest	27	741	8,136	32,201	6,242	94,061	4,995	193	0	0	44	0	1,005	147,645
Grass and scrub	87	758	5,486	8,636	3,428	66,530	40,194	34,256	0	16	124	0	873	160,389
Grassland	2,599	40,942	311,291	362,007	30,584	734,054	665,985	225,184	0	120	495	0	5,021	2,378,281
Horticulture	70	81	2,375	1,575	0	841	481	4	0	0	1	0	6	5,433
Natural forest	33	126	1,703	16,101	3,228	102,623	49,616	74,137	0	12	406	0	238	248,223
Other	18	620	4,002	5,652	593	10,020	14,033	103,764	0	237	62	0	11,018	150,019
Urban	212	1,086	2,248	2,489	251	1,419	957	14	0	1	5,413	0	30	14,121
Total	3,082	47,314	343,317	431,633	44,514	1,010,907	776,476	437,564	0	578	6,637	0	18,290	3,120,313

Otago (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.0%
Cropland	0.00%	0.09%	0.26%	0.09%	0.01%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.5%
Exotic forest	0.00%	0.02%	0.26%	1.03%	0.20%	3.01%	0.16%	0.01%	0.00%	0.00%	0.00%	0.00%	0.03%	4.7%
Grass and scrub	0.00%	0.02%	0.18%	0.28%	0.11%	2.13%	1.29%	1.10%	0.00%	0.00%	0.00%	0.00%	0.03%	5.1%
Grassland	0.08%	1.31%	9.98%	11.60%	0.98%	23.53%	21.34%	7.22%	0.00%	0.00%	0.02%	0.00%	0.16%	76.2%
Horticulture	0.00%	0.00%	0.08%	0.05%	0.00%	0.03%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.2%
Natural forest	0.00%	0.00%	0.05%	0.52%	0.10%	3.29%	1.59%	2.38%	0.00%	0.00%	0.01%	0.00%	0.01%	8.0%
Other	0.00%	0.02%	0.13%	0.18%	0.02%	0.32%	0.45%	3.33%	0.00%	0.01%	0.00%	0.00%	0.35%	4.8%
Urban	0.01%	0.03%	0.07%	0.08%	0.01%	0.05%	0.03%	0.00%	0.00%	0.00%	0.17%	0.00%	0.00%	0.5%
Total	0.10%	1.52%	11.00%	13.83%	1.43%	32.40%	24.88%	14.02%	0.00%	0.02%	0.21%	0.00%	0.59%	100.00%

Southland (ha)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0	2	34	269	66	454	1,531	3,141	0	1,212	23	0	9	6,741
Cropland	0	2,829	3,901	535	0	58	56	0	0	0	2	0	25	7,405
Exotic forest	10	867	12,435	18,084	4,853	52,344	3,556	108	3	0	30	0	779	93,069
Grass and scrub	10	1,575	5,267	9,490	1,105	29,947	14,007	73,621	157	41	23	0	696	135,938
Grassland	979	163,918	347,248	220,202	22,112	230,872	98,544	305,745	386	141	380	0	7,211	1,397,740
Horticulture	0	17	3	0	0	0	0	0	0	0	0	0	0	20
Natural forest	0	455	5,840	39,380	5,612	190,005	229,383	686,448	1,900	67	2	0	644	1,159,737
Other	10	1,088	2,714	6,657	225	6,991	22,199	90,379	74,350	2,093	50	0	4,004	210,759
Urban	87	1,085	1,312	1,280	20	359	151	3	2	28	2,969	0	27	7,324
Total	1,097	171,835	378,755	295,897	33,993	511,029	369,427	1,159,445	76,797	3,582	3,478	0	13,396	3,018,734

Southland (%)

	LUC													
Land cover	1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.05%	0.10%	0.00%	0.04%	0.00%	0.00%	0.00%	0.22%
Cropland	0.00%	0.09%	0.13%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.25%
Exotic forest	0.00%	0.03%	0.41%	0.60%	0.16%	1.73%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	3.08%
Grass and scrub	0.00%	0.05%	0.17%	0.31%	0.04%	0.99%	0.46%	2.44%	0.01%	0.00%	0.00%	0.00%	0.02%	4.50%
Grassland	0.03%	5.43%	11.50%	7.29%	0.73%	7.65%	3.26%	10.13%	0.01%	0.00%	0.01%	0.00%	0.24%	46.30%
Horticulture	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Natural forest	0.00%	0.02%	0.19%	1.30%	0.19%	6.29%	7.60%	22.74%	0.06%	0.00%	0.00%	0.00%	0.02%	38.42%
Other	0.00%	0.04%	0.09%	0.22%	0.01%	0.23%	0.74%	2.99%	2.46%	0.07%	0.00%	0.00%	0.13%	6.98%
Urban	0.00%	0.04%	0.04%	0.04%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.24%
Total	0.04%	5.69%	12.55%	9.80%	1.13%	16.93%	12.24%	38.41%	2.54%	0.12%	0.12%	0.00%	0.44%	100.00%

New Zealand (ha)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	62	1,321	1,623	2,479	509	7,274	7,016	8,503	0	22,606	1,136	1	6,260	58,789
Cropland	25,378	148,406	143,916	39,858	735	9,924	1,752	167	10	7	178	12	1,377	371,721
Exotic forest	1,621	11,625	92,865	302,476	14,231	987,482	635,234	34,845	318	77	988	100	11,471	2,093,333
Grass and scrub	3,054	21,279	57,791	78,269	8,300	375,173	272,280	408,757	653	281	1,872	61	17,098	1,244,867
Grassland	136,816	947,837	2,000,541	1,988,679	160,323	4,305,897	2,152,720	1,504,129	4,629	1,460	8,325	386	95,650	13,307,392
Horticulture	12,365	27,547	40,028	13,297	173	7,437	2,600	243	354	2	106	26	279	104,458
Natural forest	1,328	12,679	56,966	287,962	19,128	1,704,582	2,521,526	3,035,210	3,292	732	5,559	75	7,681	7,656,719
Other	1,093	8,323	23,276	47,169	6,229	66,334	97,262	814,494	254,155	8,154	2,482	275	133,866	1,463,112
Urban	5,454	23,793	27,033	18,768	760	14,373	4,608	966	166	1,718	125,268	123	260	223,290
Total	187,171	1,202,811	2,444,038	2,778,956	210,389	7,478,476	5,694,999	5,807,314	263,576	35,037	145,913	1,058	273,943	26,523,681

New Zealand (%)

Land cover	LUC 1	2	3	4	5	6	7	8	Lake	Estuary	Urban	Quarry	River	Total
[no land use data]	0.00%	0.00%	0.01%	0.01%	0.00%	0.03%	0.03%	0.03%	0.00%	0.09%	0.00%	0.00%	0.02%	0.2%
Cropland	0.10%	0.56%	0.54%	0.15%	0.00%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	1.4%
Exotic forest	0.01%	0.04%	0.35%	1.14%	0.05%	3.72%	2.39%	0.13%	0.00%	0.00%	0.00%	0.00%	0.04%	7.9%
Grass and scrub	0.01%	0.08%	0.22%	0.30%	0.03%	1.41%	1.03%	1.54%	0.00%	0.00%	0.01%	0.00%	0.06%	4.7%
Grassland	0.52%	3.57%	7.54%	7.50%	0.60%	16.23%	8.12%	5.67%	0.02%	0.01%	0.03%	0.00%	0.36%	50.2%
Horticulture	0.05%	0.10%	0.15%	0.05%	0.00%	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.4%
Natural forest	0.01%	0.05%	0.21%	1.09%	0.07%	6.43%	9.51%	11.44%	0.01%	0.00%	0.02%	0.00%	0.03%	28.9%
Other	0.00%	0.03%	0.09%	0.18%	0.02%	0.25%	0.37%	3.07%	0.96%	0.03%	0.01%	0.00%	0.50%	5.5%
Urban	0.02%	0.09%	0.10%	0.07%	0.00%	0.05%	0.02%	0.00%	0.00%	0.01%	0.47%	0.00%	0.00%	0.8%
Total	0.71%	4.53%	9.21%	10.48%	0.79%	28.20%	21.47%	21.89%	0.99%	0.13%	0.55%	0.00%	1.03%	100.00%

The following are extracts from the above survey:
http://www.landcareresearch.co.nz/science/portfolios/enhancing-policy-effectiveness/srdm/srdm2015

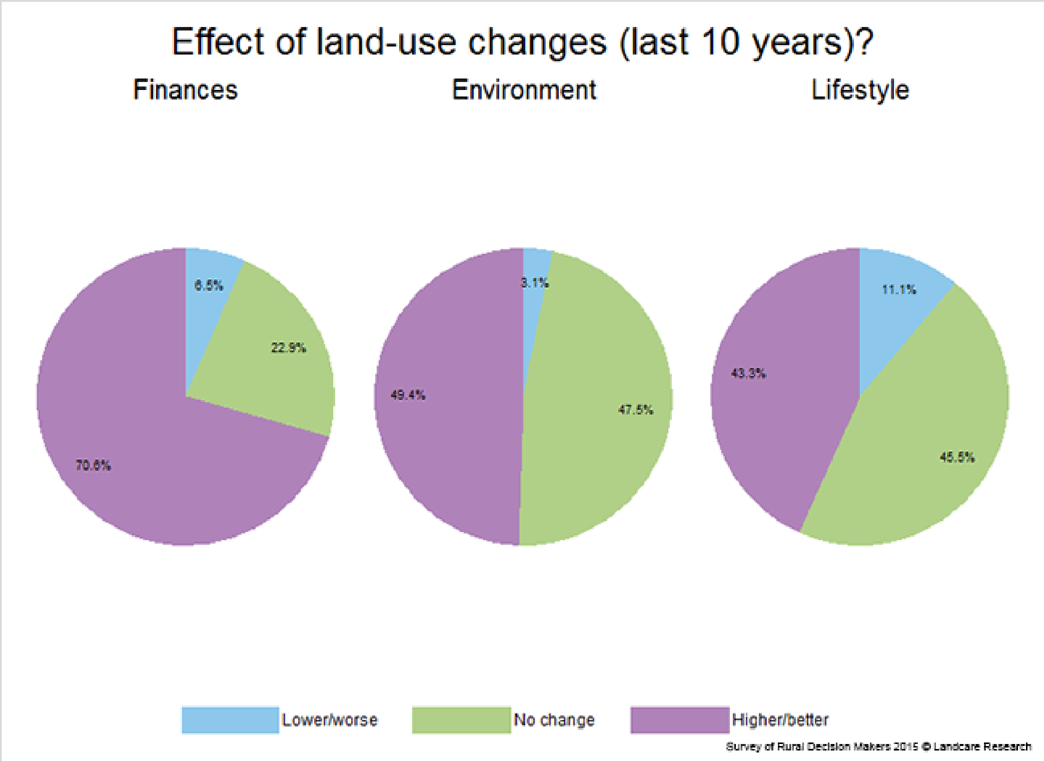


Figure 3.1(b): Effect of land use changes in the last 10 years

New Land Uses:

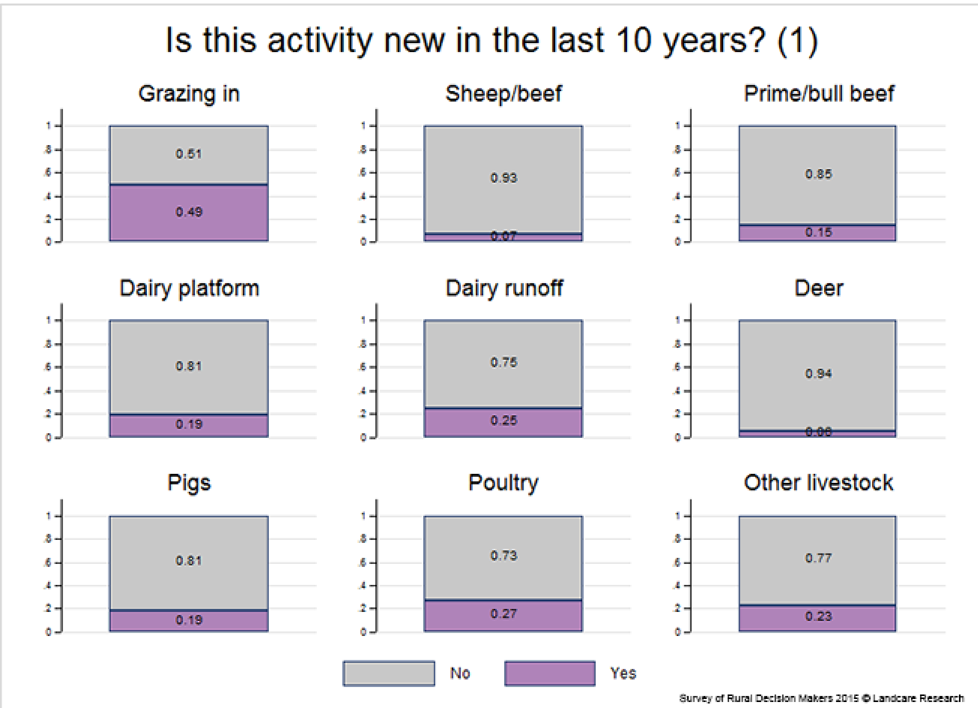


Figure 3.2(a): New activity in the last 10 years

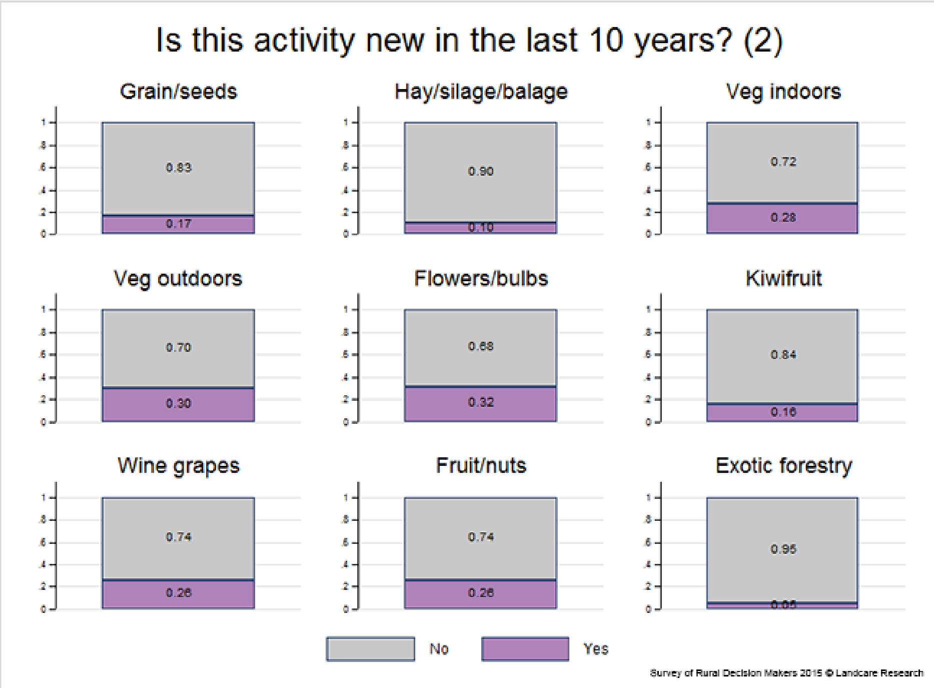


Figure 3.2(b): New activity in the last 10 years

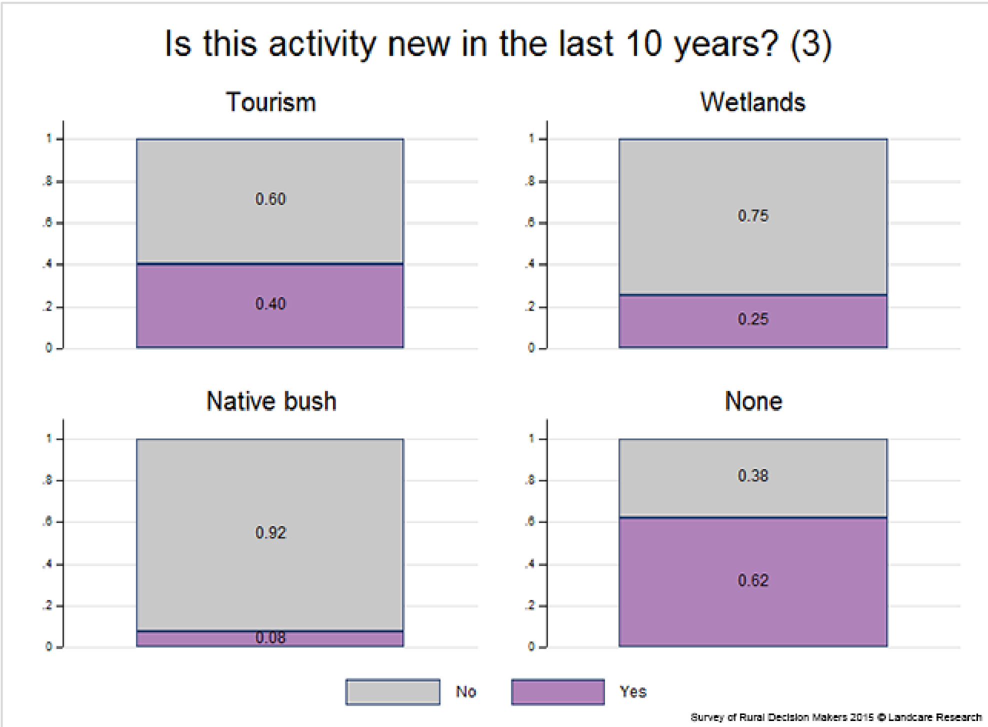


Figure 3.2(c): New activity in the last 10 years

Landowners likely to convert land to a new land use in the next 2 years:

	Frequency	Percentage
Not at all likely	1,275	64.1%
Possible	545	27.4%
Very Likely	169	8.5%
	1,989	**100.0%**

Examples of Rules where the specific intent is to control land use change

Waikato Regional Council – Healthy Rivers Plan Change 1

Policy 6: Restricting land use change/Te Kaupapa Here 6: Te here i te panonitanga ā-whakamahinga whenua
Except as provided for in Policy 16, land use change consent applications that demonstrate an increase in the diffuse discharge of nitrogen, phosphorus, sediment or microbial pathogens will generally not be granted. Land use change consent applications that demonstrate clear and enduring decreases in existing diffuse discharges of nitrogen, phosphorus, sediment or microbial pathogens will generally be granted.

3.11.5.7 Non-Complying Activity Rule – Land Use Change/Te Ture mō ngā mahi kāore e whai i ngā ture – Te Panonitanga ā-Whakamahinga Whenua

Rule 3.11.5.7 - Non-Complying Activity Rule – Land Use Change

Notwithstanding any other rule in this Plan, any of the following changes in the use of land from that which was occurring at 22 October 2016 within a property or enterprise located in the Waikato and Waipa catchments, where prior to 1 July 2026 the change exceeds a total of 4.1 hectares:

1. Woody vegetation to farming activities; or
2. Any livestock grazing other than dairy farming to dairy farming; or
3. Arable cropping to dairy farming; or
4. Any land use to commercial vegetable production except as provided for under standard and term g. of Rule 3.11.5.5 is a non-complying activity (requiring resource consent) until 1 July 2026.

Notification:
Consent applications will be considered without notification, and without the need to obtain written approval of affected persons, subject to the Council being satisfied that the loss of contaminants from the proposed land use will be lower than that from the existing land use.

South Waikato District Council

Chapter 28 Rural
28.3.2 Controlled Activities The following are controlled activities in the Rural Zone provided they comply with the Performance Standards set out in Rule 28.4 below:

(a) Marae development and papakāinga

(b) Modifications to a Built Heritage Feature identified as controlled in the relevant Heritage Inventory Record form in Appendix B

(c) Conversion of commercial forestry land for farming
ADVICE NOTE: the conversion process excludes the harvesting (felling and extraction) of timber from the site as provided for in the definition of Forestry

(d) Internal alterations on buildings with identified interiors in Appendix B: Built Heritage Inventory, necessary for the primary purpose of improving structural performance, fire safety or physical access.

(e) External alterations to buildings identified in Appendix B: Built Heritage Inventory, necessary for the primary purpose of improving structural performance, fire safety or physical access.

(f) Clearance of indigenous vegetation, land disturbance and drainage that is a controlled activity under Rule 14.4.2.

The specific matters where control is reserved are identified in Rules 8.3.1b) with regard to marae development and papakāinga, Rule 8.3.1c) with regard to Modifications to a Built Heritage Feature, Rule 8.3.1g) with regard to Conversion of commercial forestry land for farming, Rule 8.3.1h) with regard to removal of vegetation in a Significant Natural Area, and Rule 8.3.1 i) with regard to alterations to built heritage items to improve structural performance, fire safety or physical access, and shall be used when considering a resource consent application from a controlled activity in the Rural Zone.

Performance Standard 28.4.8(b)

(b) Farming which involves the conversion of land used for forestry to farming as per 28.3.2(c) shall also comply with the following standards:

i) In the following nominated catchments properties adjacent to or with boundaries to the rivers and streams listed in Table 1 below also shall comply with the following performance standards:

- Fencing shall be constructed no closer than the riparian setback to the banks of a nominated river or stream and should generally be permanent and effectively exclude all livestock present;
- Tracks, access ways and races shall not be constructed closer than the riparian setback to the banks of a nominated river or stream;

Table of streams/rivers with required riparian setback

8.3.1 Reservation of Control - Controlled Activity Land Use Applications

(g) Conversion of commercial forestry land for farming:

Measures to manage the effects on riparian margins including existing indigenous vegetation and stock access within these margins;

Conditions of consent that ensure performance standards in Rule 28.4 are implemented in an appropriate manner to minimise the actual and potential adverse effects including cumulative effects of the activity;

Measures to manage the actual and potential effects resulting from the extent of disturbance of natural character, access, amenity values and landscapes including cultural landscapes, cultural sites, and archaeological sites, and indigenous biodiversity;

Monitoring and/or review conditions.

Appendix Four: Summary of Regional Council Rules

This summary is not intended to be an exhaustive list of rules that may influence land use. Rather it is to be seen as indicative of the rules within each region that may (and how they may) influence land use decisions.

Auckland Council (Unitary)

Rule	Description	Classification	Land Use change influencers (key ones only)	Non compliance	Notes	Comments
Rural Production Discharges						
E35.6.1	Permitted activity standards: General standards to all permitted activities	Permitted	(1) No direct discharge to water or runoff to surface water, intermittent streams or artificial watercourses that connect to surface water; (2) Discharges must not result in surface ponding of more than 3 hours duration; (3) The application rate of nitrogen from any combination of diary effluent (excluding urine from grazing animals) nitrogenous fertiliser and other nitrogen discharges from other rural production activities must not: (a) exceed 150kgN/ha/yr and 30kgN/ha/31 days onto grazed pasture underlain by sandy or volcanic soils, or (b) exceed 200kg/ha/yr and 50kg/ha/31 days onto grazed pasture underlain by soils other than those listed above;	Discretionary	If defaulting to discretionary the policies of E1.3.(4) and E1.3(5) would apply which are direct from the NPS -i.e. The extent to which the discharge would avoid contamination that will have an effect on the life supporting capacity of freshwater, and health of people and communities	However, the Permitted activity standards means probably unlikely that farming activities would need to apply for consent?

Taking using damming and diversion of water and drilling						
E7.4.1(A6)	For surface water - more that 20m3/day and no more that 100m3/day of water from a Lake	Restricted discretionary; or discretionary if from a high use stream management overlay; or non-complying if from a wetland management area overlay	The assessment criteria includes E7.8.2(1)(b) the extent to which the proposal will be consistent with the management of allocation of freshwater within the guidelines provided by Appendix 2 River and stream minimum flow and availability and Appendix 3 Aquifer water availabilities and levels, and give priority to making fresh water available for the following uses (in descending order of priority): (i) existing and reasonably foreseeable domestic and municipal water supply and animal drinking water requirements; (ii) existing lawful established water users; (iii) uses of water for which alternative water sources are unavailable or unsuitable; (iv) all other uses	discretionary	The policies note that still needs to be brought into line with NPSFM	
E7.4.1(A26)	Take and use of ground water not meeting the permitted activity or bores	Discretionary	The permitted activity standards allow up to 20m3/day averaged over 5 day period and no more than 5000m3/year. Minimum flow guidelines in Appendix 3 must not be exceeded.			

Rule	Description	Classification	Land Use change influencers (key ones only)	Non-compliance	Notes	Comments
Takes						
55	The take and use of surface water or groundwater including takes and uses associated with, or ancillary to Community Irrigation Schemes, except as provided for by Rules 53, 54, TT3, TT3A, TT3B and TT4	Discretionary		Consent declined	Rules 53 and 54 are Permitted activity and limited to 20m3/day.	As below matters of discretion include whether the stream or river is fully allocated; and the influence the take has on other authorised takes
					Table 9 provides the minimum flow and allocable volumes that have been specified for some rivers in Table 9 pg102 Ch 5 for surface water takes.	
					Schedule 3 provides the environmental guidelines for surface water quality	
					Policy 73 - surface water quality - new allocations do not cause authorised takes being restricted or suspended for more than 5% of the time on average between Nov – April	
					Policy 74 new ground water takes do not disadvantage existing efficient ground water takes	

TT rules - Tukituki Takes						
TT3B	The replacement of an existing resource consent for the take and use of: (a) surface water, or (b) groundwater located within Groundwater Allocation Zones 1-10	Restricted discretionary	Does not result in any exceedance of the allocation limits in Table 5.9.4, 5.9.5 (tranche 1) or 5.9.6 (whichever is applicable; and the take complies with the relevant minimum flow regime.	Discretionary	The critical determinant is the allocable flow. The other matters primarily relate to the efficient use of water	
TT4	The take and use of surface or groundwater comprising; (a) new surface water takes (applied for after 4 May 2013); (b) new groundwater takes located within Groundwater Allocation Zones 1 to 3 (applied for after 4 May 2013); (c) ground water takes outside of Ground Water Allocation Zones 1 to 3; (d) new High Flow Takes; (e) Takes that do not comply with Rule TT3, TT3A, or TT3B; excluding takes associated with a Community Irrigation Scheme involving an in-stream dam or any other in-stream dam (in which case Rule 55 applies)	Discretionary	(a)The take does not result in any exceedance of allocation limits - as defined in Tables 5.9.4, 5.9.5 and 5.9.6; and (b)The take complies with relevant minimum flow regime. (c) No new ground water takes from Groundwater Allocation Zones 2 and 3 utilising Tranche 3 groundwater maybe exercised under this rule unless and until augmentation flows are discharge that are commensurate to the scale and effect of the proposed take, during the same irrigation season as the Tranche 2 groundwater takes are exercised, to each of the Waipawa River and the upper Tukituki River or one or more of their respective tributaries at a rate of up to 715l/s to each river catchment at the highest practicable elevation as required to maintain the relevant downstream minimum flows specified in Table 5.9.3	Non-Complying	key phrase - "does not result in any exceedance of allocation limits" infers over-allocated catchments will not get consent	

Discharges - Tukituki						
TT2	The use of production land on farm properties or farming enterprises pursuant to s9(2) RMA within the Tukituki River catchment that does not comply with TT1(permitted activity)	Restricted Discretionary	The nitrogen leached from the production land does not result in the Table 5.9.1D Tukituki LUC natural Capital; Nitrogen Leaching Rates on a whole of farm property or whole of farm enterprise basis being exceeded by more than 30 percent	Non Complying	The matters of discretion relate to actual or proposed loss including receiving water quality, the GMP actions undertaken etc.	Appears the condition of no increase of N loss in the Table 5.9.1D is an absolute. This which is the same requirement as for the permitted activity rule. This requirement is also estimated on a 4 year rolling average. If meeting the table is an absolute consent requirement will create an issue if based on an estimate? As per the recent Horizons case. However, OBJ TT1 seeks safe drinking water, food gathering, swimming in line with NPSFM and OBJ TT2 if not at that level due to human degradation it is to be achieved progressively by 2030. Therefore, this could infer that Table 5.9.1D is not an absolute requirement so long a progress can be shown? Again, the Horizons decision will likely influence interpretation.

Rule	Description	Classification	Land Use change influencers (key ones only)	Non compliance	Notes	Comments
Discharges to Land and Water: Chapter 14						
14-1	Existing intensive farming land use activities (intensive farming includes dairy farming, commercial vegetable growing, cropping, intensive sheep and beef farming (all defined in the plan))	Controlled	Matters of control include compliance with the cumulative nitrogen leaching maximum specified in table 14-2	Restricted discretionary	Table 14-2 provides the cumulative nitrogen leaching maximum by LUC - critical issue is the ability of the land use to be able meet these limits	Critical question is whether Table 14-2 is achievable over time noting that the maximum decreases over time (e.g. LUC1 30kg/N/yr in year 1 and 25kg/N/yr in year 20)
			The matters in Policy 14-9 applies to any new discharge or a change or increase in discharge		Policy relates to meeting the requirements of the NPSFM in regards to life supporting capacity, ecosystem health, health of people and their communities	
14-2	Existing intensive farming land use activities not complying with Rule 14-1	Restricted discretionary	Matters of discretion include the extent of noncompliance the cumulative nitrogen leaching maximum in Table 14-2		A restricted discretionary does allow for a consent to be declined. However also allows for a consent to be granted where there is noncompliance with the matters listed e.g. requirement for bridges, exclusion of stock from waterways and wetlands etc	Anecdotally appears that applying for a restricted discretionary consent is "safer" than a controlled. The recent case *Wellington Fish and Game & Ors v Manawatu-Wanganui Regional Council [2017] NZEnvC 37* will influence how decisions are to be made. The actual impact is currently uncertain
			The matters in Policy 14-9 applies to any new discharge or a change or increase in discharge		Policy relates to meeting the requirements of the NPSFM in regards to life supporting capacity, ecosystem health, health of people and their communities	
14-3 & 14-4	New intensive farming land use activities				These are in effect no different to Rules 14-1 & 14-2	

Takes, Uses and Diversions of Water and Bores: Chapter 16						
16-6	Existing essential takes and uses of surface water complying with core allocations taken at or below minimum flow	Discretionary	Limited to takes for domestic and stock drinking water takes below the minimum flow	Non-complying	Limited to domestic takes 250 litre/day per person and 70 litres/day for stock water	This rule applies when the required take occurs below minimum allocable flow. Note 16-1 is a permitted activity that allows 15m3/day/property up to 30m3/day for animal farming and has no mention whether compliance with minimum allocable flow is required
16-8	Takes and uses of surface water not complying with core allocations or takes and uses of water taken at or below minimum flow	Non-complying	For takes that are not already regulated in 16-1, 16-7 or 16-9 that are below minimum flow unless an essential take as per 16- 6		No complying requires that a consent needs to meet the objectives and policies of the Plan. A key objective appears to be the recognition and provision for the values and management in SchB	Ostensibly would influence land use change in overallocated catchments that require water for irrigation, dairyshed washdown etc. Significance of the issue is dependent on where and how often surface water falls below minimum flow - i.e. how many rivers/streams are fully allocated
Land Use Activities and Indigenous Biological Diversity: Chapter 13						
13-6	Specified vegetation clearance, land disturbance or cultivation in a Hill Country Erosion Management Area	Restricted Discretionary	Definition: Hill Country Erosion Management Area means any area of land with a pre-existing slope of 20degrees or greater. Land disturbance more than 100m2, cultivation, vegetation clearance of 1ha or greater		Matters of control focus on sediment run off, extent of noncompliance with water quality target	Could influence land use decisions, but possibly greater influence in the land management decisions -Areas with high risk of noncompliance possibly increased shift to forestry or retirement?

Rule	Description	Classification	Land Use change influencers (key ones only)	Non compliance	Notes	Comments
All Nutrient Allocation Zones						
5.41A - 5.41D	A range of rules	Permitted - Prohibited	For properties over 10 hectares the farming activity is a permitted activity if consent to discharge is managed by irrigation scheme or hold water consent for irrigation which had discharge limit as condition of that consent. The balance of the rules relates complying with processes to generating a nutrient loss rate either by using the Farm Portal or Overseer with complete noncompliance being prohibited.		These rules are more to do with the process of generating the loss rate number, compliance is still required with any limits that are identified in the various zones	These rules are Part of PC5 and are potentially still subject to appeal in the Environment Court
Selwyn Waihora						
11.5.6	The use of land for a farming activity in the Selwyn Te Waihora sub-region is a permitted activity provided the following conditions are met: (2) the property is less than 10 ha; and (3) The nitrogen loss calculation for the property does not exceed 15kg/ha/annum	Permitted	Note need to meet both 2 & 3	Discretionary Activity that requires a Farm Environment Plan to be prepared along with not exceeding the nitrogen loss limit for the property (being the maximum annual loss of nitrogen for a single year between 2009 and 2013)	Noncompliance will be treated like any other farming block. Question whether the cost of compliance be a disincentive for lifestyle block owners?	Lifestyle blocks tend to have issues on change of ownership that results in land use change - e.g. from running a few sheep to running a horse stud/racing stable
11.5.10 & 11.5.11	11.5.10 for land for a farming activity or 11.5.11 for parcels of land farmed as an enterprise	Discretionary	No increase in nitrogen of identified baseline	Prohibited		

Red Zone						
5.48	The use of land for farming activity that does not comply with condition 2 of Rule 5.43; or condition 2 of 5.44; or condition 2 of 5.46	Prohibited	Condition 2 in all cases essentially states: The nitrogen loss calculation for the part of the property within the Red Nutrient Allocation Zone does not increase above the nitrogen baseline		5.48 is the final rule in a cascade of rules - e.g. Permitted if under 20kg/N/ha; Restricted Discretionary if over 20kg/N/ha dependent on where in the catchment the property is and conditional on staying under the nitrogen baseline	Does not prevent land use change but holds the intensity level to the nitrogen baseline (presuming a linear correlation) unless the land use can better manage nutrient loss
5.48A	The use of land for a farming activity on a property greater than 10 ha in area that does not comply with condition 2 of Rule 5.45A, or the use of land for a farming activity as a part of a farming enterprise that does not comply with condition 2 of Rule 5.46A is a prohibited activity	Prohibited	Condition 2 in all cases essentially states: The nitrogen loss calculation for the part of the property within the Red Nutrient Allocation Zone does not increase above the nitrogen baseline and from July 2020 does not exceed the Baseline GMP		Condition 2 of 5.46A Until 30 June 2020 the nitrogen loss calculation for the farming enterprise does not exceed the nitrogen baseline and from 1 July 2020 the Baseline GMP Loss Rate	These rules are Part of PC5 and are potentially still subject to appeal in the Environment Court
Orange Zone						
5.56	From 1 January 2016, the use of land for a farming activity that does not comply with Rule 5.54 or condition 1 of Rule 5.55 is a discretionary activity	Discretionary	Condition 1 in all cases essentially states; the nitrogen loss calculation within the Zone does not increase above the baseline by more than 5kg/ha/year		In this Zone losses can be above the nutrient baseline if consent is granted	The likelihood of consent being granted is dependent on the matters of discretion to be considered in granting consent and the ability of the landowner to achieve them. (Quick scan these weren't obvious in the Plan)
5.56A	The use of land for a farming activity that does not comply with condition 2 of Rule 5.55 is a non- complying activity	Non complying	Condition 1 requires that a Farm Environment Plan has been prepared in accordance with Schedule 7 Part A			Consider this rule is a back stop rule where for whatever reason a Farm Environment Plan is not developed.

Green and Light Blue Zones						
5.59	The use of land for a farming activity that does not comply with Rule 5.58 is a non-complying activity	Non complying	5.58 requires that a Farm Environment Plan is prepared in accordance with Schedule 7 Part A that includes; Management practices to minimise losses of discharges; application shows the benefits of the activity to the community and environment; potential effects on water quality including drinking water		Essentially seeking GMP. This should not be fatal to land uses or land use change	Will influence land uses to those that can show positive benefits both for the environment as well as socially (jobs) and economically
Stock Exclusion						
5.70	Unless categorised as a prohibited activity under Rule 5.71 the use and disturbance of the bed (including banks) of a lake, a river that is greater than 1m wide or 100mm deep (under median flow conditions) or a wetland by intensively farmed stock and any associated discharge to water is a non-complying activity	Non complying			Not fatal to any pastoral land use, but, could influence land use decisions if the economic cost of stock exclusion is high e.g. deer?	
5.71	The use and disturbance of the bed (including banks) of a lake or river by any farmed cattle or farmed deer or farmed pigs and any associated discharge to water is a prohibited activity in the following areas; -	Prohibited	In a salmon spawning site (Schedule 17); within a Community Drinking Water Protection Zone (Schedule 1); within 100m upstream of a freshwater bathing site (Schedule 6); in the bed (including banks of a spring- fed plains river as shown on the Planning Maps		Should not be fatal, but could influence land use decisions if the cost of stock exclusion is high.	

Take and Use of Surface water						
5.124	The taking and use of surface water from a river or lake that does not meet condition 2 or 3 in Rule 5.123 is a non complying activity	Non complying	Condition 2 new consents if no limits set in sections 6 to 15 take must meet a flow regime with a minimum flow of 50% of the 7 day mean annual flow(7DMALF) and an allocation limit of 20% of the 7DMALF; condition 3 the take is not from a wetland, hapua or a high naturalness river or high naturalness lake. (abridged)		This is only for new takes not the reconsent of exiting takes. Section 6 - 15 the catchment specific limits	potential to influence land use if an overallocated catchment
5.125	The taking and use of surface water from a river or lake that does not meet condition 1 in Rule 5.123 is a prohibited activity	Prohibited	Condition 1 new consents the take does not result in any exceedance of any environmental flow or allocation limit or rate of take or seasonal or annual volume limits set in sections 6 - 15 for that waterbody			potential to influence land use if an overallocated catchment
Take and Use of Ground water						
5.129	The taking and use of groundwater that does not meet one or more of conditions 1 or 4 in Rule 5.128 is a non complying activity	Non complying	Condition 1 requires that the take is from within a Ground Water Allocation Zone on the Planning Maps; Condition 4 for new takes and the impact of bore interference effects on any groundwater abstraction other than an abstraction of the applicant (abridged)		This is only for new takes not the reconsent of exiting takes. Section 6 - 15 the catchment specific limits	Potential to influence land use if in an overallocated catchment
5.130	The taking and use of groundwater that does not meet one or more of conditions 2 or 3 in Rule 5.128 is a prohibited activity	Prohibited	Condition 2 requires for new consents the take does not result in any exceedance of any environmental flow or allocation limit or rate of take or seasonal or annual volume limits set in sections 6 - 15 for that waterbody; Condition 3 requires new consents as determined in Schedule 13 does not exceed the ground water allocation limits for the relevant Ground Water Allocation Zone in Sections 6 – 15		This is only for new takes not the reconsent of exiting takes. Section 6 - 15 the catchment specific limits	Potential to influence land use if an overallocated catchment

Transfer of Water permits						
5.133	The temporary or permanent transfer in whole or in part of a water permit to take or use surface or groundwater, is a restricted discretionary activity provided conditions are met	Restricted Discretionary	Volume same or less, same water body or for ground water same allocation zone,		Provides for flexibility of land use but could be worth checking the actual uptake and whether the cost of transfer is a deterrent?	Potential to allow land use change to more efficient uses of water

Appendix Five: Supreme Court King Salmon Decision

The following is an extract from an Atkins Holm Majurey newsletter (2015)[22].

King Salmon: A Year On...

In the last year, the RMA world has begun to see the ramifications of the decision of the Supreme Court in the land mark case *Environmental Defence Society Inc v The New Zealand King Salmon Co Ltd [2014] NZSC 38*.

The case concerned King Salmon's proposal to establish and operate additional salmon farms in the Marlborough Sounds.

After a lengthy saga of decisions and appeals, three questions were put to the Supreme Court: Whether the New Zealand Coastal Policy Statement (NZCPS) has standards or policies which must be complied with in relation to outstanding coastal landscape and natural character areas and, if so, did the Papatua Plan Change comply with s67(3)(b) RMA even though it did not give effect to NZCPS Policies 13 and 15;

Whether the Board of Inquiry gave effect to the NZCPS in coming to a balanced judgment; and Whether the Board was obliged to consider alternative sites because the plan change was located in an outstanding natural landscape or outstanding natural character area.

The Supreme Court overturned the decisions of the High Court and the Board of Inquiry, and declined to grant the consent. Its decision turned on the interpretation of section 5 of the RMA, the characterisation of the relationship between the RMA and the NZCPS and the relationship between policies and objectives within the NZCPS, and the definitions of "avoid", "inappropriate" and "give effect to" as used in the RMA and NZCPS.

King Salmon was a case the outcome of which was very much determined on its somewhat unusual combination of facts, but decisions in the past year have shown that the Supreme Court's decision will not be "confined to its facts".

KEY FINDINGS OF THE SUPREME COURT

Two findings in particular (which are detailed below) have stimulated considerable debate: the Supreme Court's interpretation of "avoid"; and its critique of the "overall broad judgement" approach.

MEANING OF "AVOID"

The Court found that "avoid" in Policies 13 and 15 of the NZCPS bears it's ordinary meaning of "not allow" or "prevent occurrence of". Policies 13 and 15 were therefore seen as being "bottom lines" and having a binding effect on decision makers.

This is a far stricter interpretation – giving authorities much less discretion than the prevailing "overall broad judgement" approach. However, the effect of this was softened somewhat by the Court's findings that:

[22] https://ahjmlaw.co.nz/uploads/other/King_Salmon_newsletter.pdf

In section 5 RMA, in the sequence of "avoiding, remedying or mitigating" – "remedying" and "mitigating" indicate that developments which might have adverse effects on particular sites can be permitted if those effects are mitigated and/or remedied.

"Avoid" must be considered against the background of the particular goals that the avoidance means to achieve. Similarly, what is "inappropriate" should also be assessed by what is being protected — the higher the value being protected, the more likely that the development will be inappropriate.

In discussing "avoid adverse effects" the Court appears to suggest that some activities with minor or transitory effects would not fall foul of the absolute requirement to avoid adverse effects in areas of outstanding natural value, where their avoidance is not necessary or relevant to preserve the natural character of the coastal environment, or protect natural features and landscapes.

THE "OVERALL BROAD JUDGEMENT" APPROACH

Section 5 of the RMA provides that the purpose of the RMA is to provide for sustainable management. From the enactment of the RMA up until this decision, courts had been developing and applying an "overall broad judgment" approach regarding the benefits of proposals because this was considered best to serve the purpose in section 5.

This approach was not taken by the Supreme Court in *King Salmon*.

The Board of Inquiry had ultimately decided the King Salmon applications by reference to section 66 RMA which provides:

66 Matters to be considered by regional council (plans)

(1) A regional council must prepare and change any regional plan in accordance with—

...

(b) the provisions of Part 2;

The Supreme Court held that the NZCPS is to be considered as complying with Part 2 of the Act, that Part 2 would be implemented if effect was given to the NZCPS, and that councils do not have to go beyond the NZCPS, back to the RMA when formulating or changing a regional or coastal plan that must give effect to the NZCPS.

The Court found that the prevailing "overall broad judgement" approach was inappropriate because the wording of policies 13(1)(a) and 15(a) of the NZCPS mean that they are essentially bottom lines. Such an approach would create uncertainty, be inconsistent with the coastal consent process, and would have the potential to undermine the strategic region wide approach that the NZCPS requires regional councils to take to planning.

The Supreme Court accepted that there were tensions between policies in the NZCPS, but read down the extent of that conflict. It said that tensions will be infrequent and that conflicts between policies dissolves when attention is paid to how the policies are expressed. Conflicts that remain should be kept as narrow as possible. Analysis of conflicts should be undertaken under the NZCPS and be informed by section 5 of the RMA. Section 5 should not be treated as the primary decision-making provision.

THE EFFECT OF THE DECISION

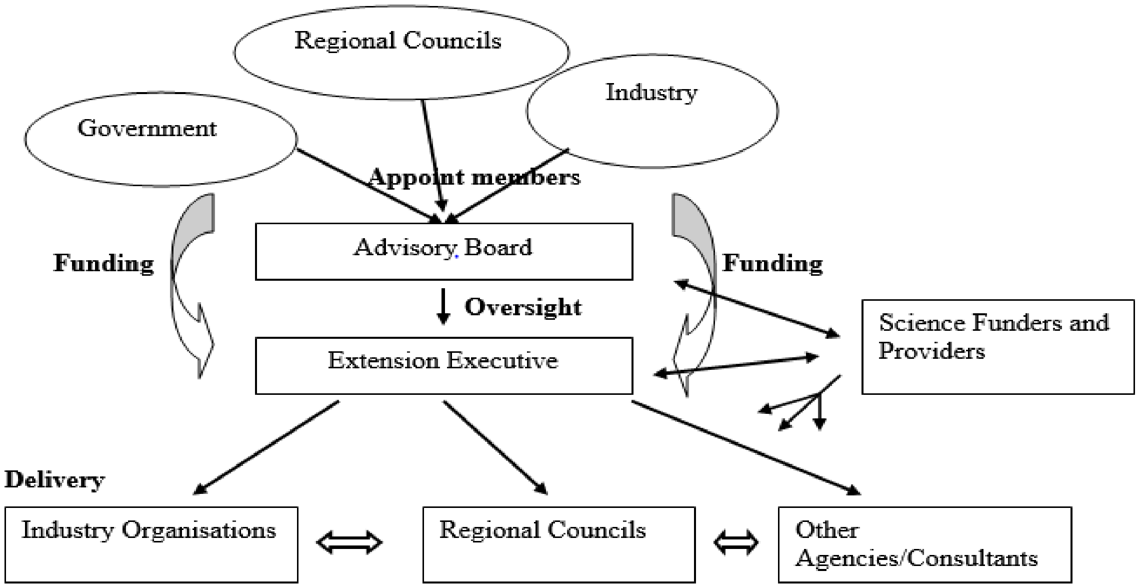
King Salmon has certainly altered the approach to plan change processes markedly, and to the interpretation and application of the NZCPS.

The “overall broad judgement approach” has so far been maintained in decisions made on resource consent applications, but weight has been given to the Supreme Court’s findings in a range of fora.

There is still contention over the extent of the effect of *King Salmon* on resource consent decisions. In deciding a resource consent application, a consenting authority must “have regard to” effects on the environment, national standards, policy statements the NZCPS etc – this wording is different to that under consideration by the Supreme Court. This gives rise to the opinion that it is a planning decision and its effect should therefore be confined to that arena. The attitude that appears to have emerged, however, is that *King Salmon* is not binding on authorities granting resource consents, but is given some weight.

Appendix Six: Possible Institutional Extension Model

A possible combined partnership approach to extension is illustrated below



Essentially the key funders are Government, Industry, and Regional Councils, with delivery largely via the Industry Good bodies, Regional Councils, and the Private Sector

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