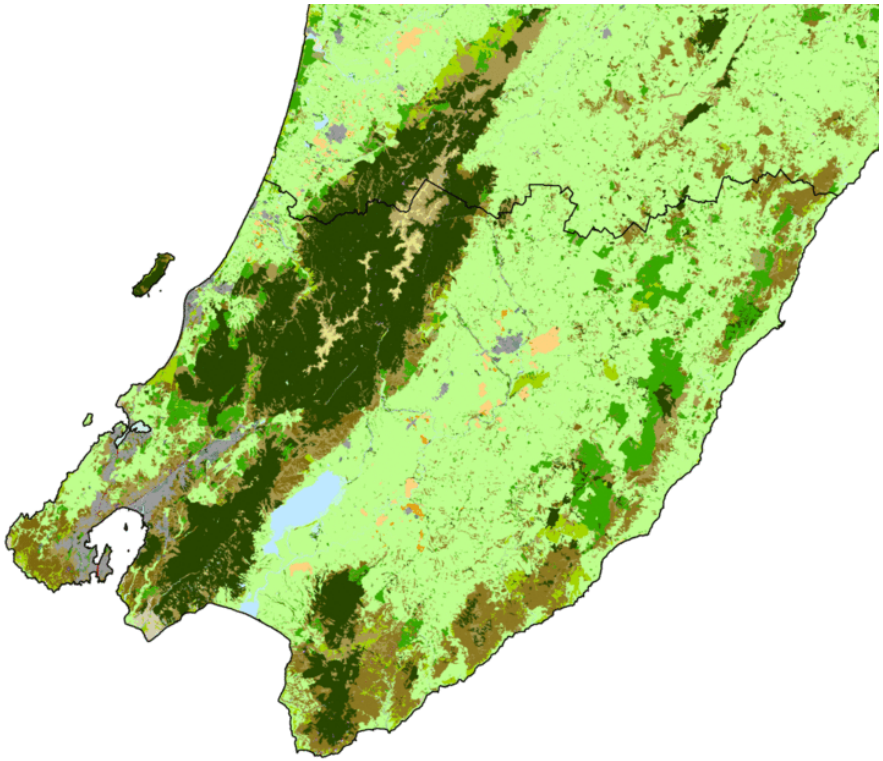
Landcare Research
Manaaki Whenua

Trends in Landscape Dynamics



Daniel Rutledge, Robbie Price and Alexander Herzig

Landcare Research
LINK Policy Seminar Series
Ministry for the Environment
Wellington, 18 Nov 2017

Outline

- Motivation and Need
- New Zealand Landscape Database
- Approach
- Trends
- Future Research

Motivation and Needs

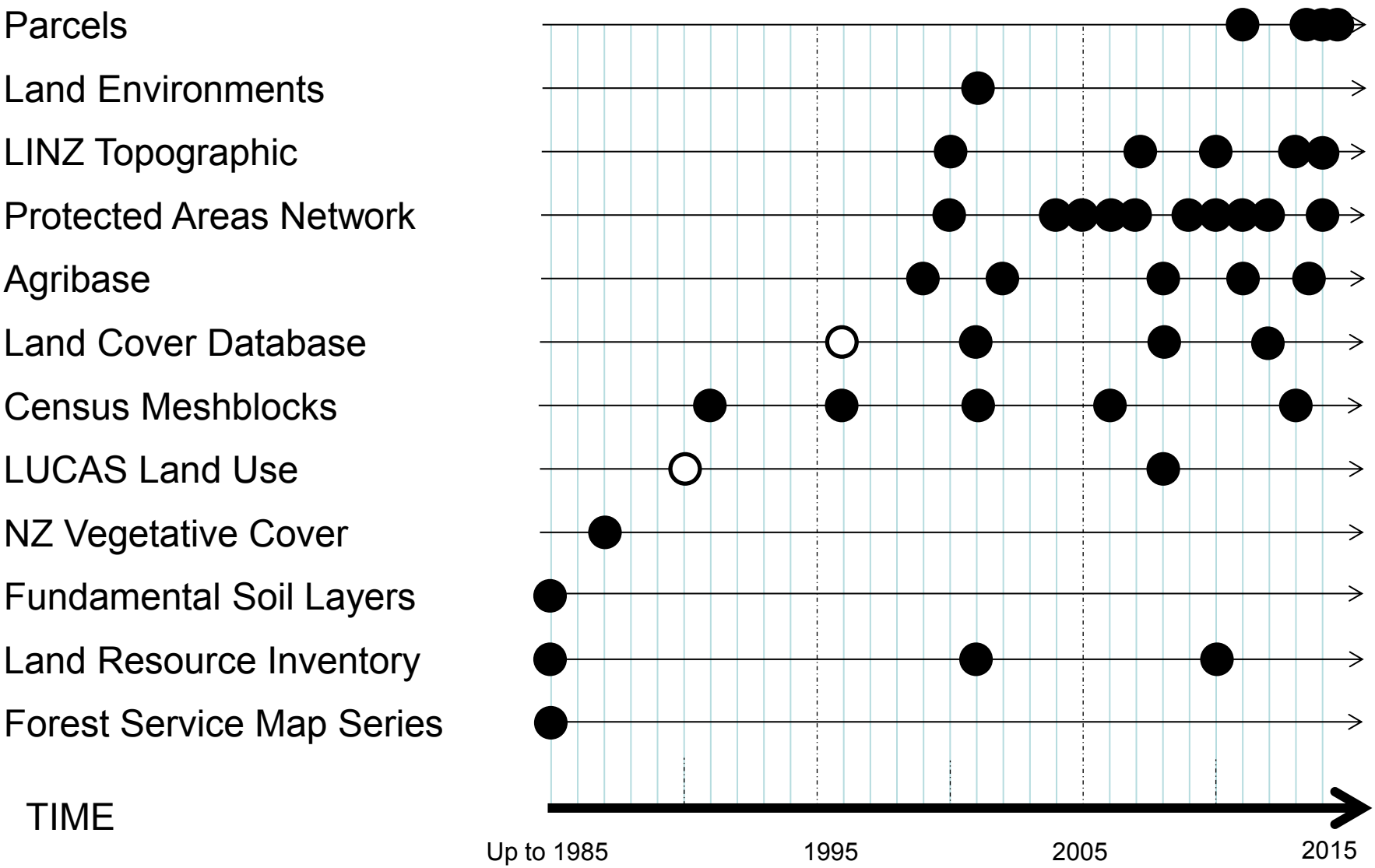
- Motivation
  To better understand trends and help determine drivers of landscape change across scales

- Needs
  - Foster better knowledge of landscape dynamics
  - Support a range of research especially modelling to explore possible future landscape dynamics (Climate Change, Ecosystem Services, Land Fragmentation)
  - Expand and solidify the evidence base for policy, planning and resource management
  - Support State of Environment reporting across a range of scales

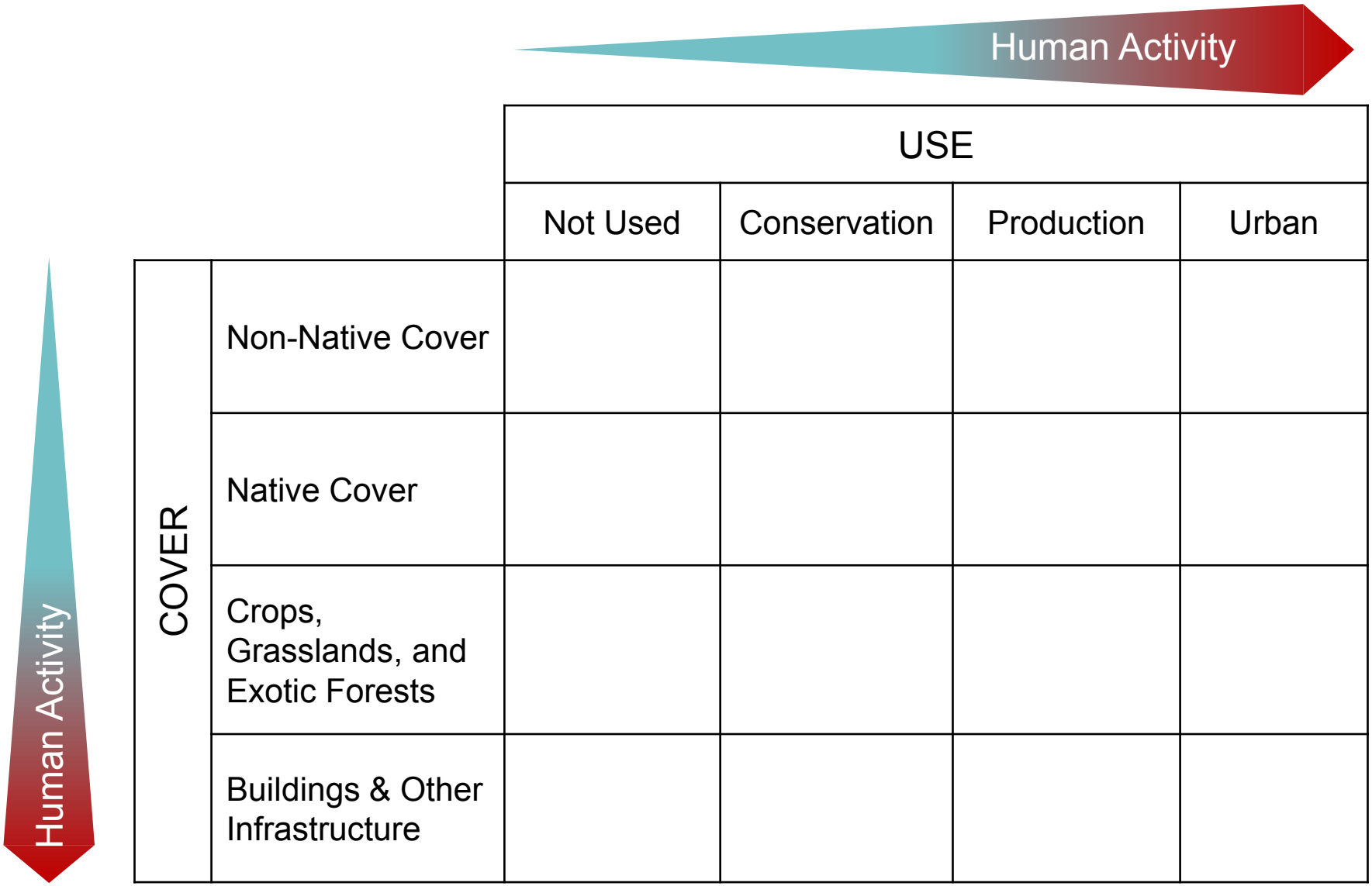
New Zealand Landscape Database (NZLD)

- Repository for any landscape data over space and time
- Contains primary and derived data
- Constantly evolving and growing as new data becomes available or is (re)discovered
- “Big Data” benefits and challenges

NZLD: Major Components



Approach


Human Activity
USE
Not Used
Conservation
Production
Urban
COVER
Non-Native Cover
Native Cover
Crops, Grasslands, and Exotic Forests
Buildings & Other Infrastructure
Human Activity

Cover Trends

Human Activity

COVER	USE			
	Not Used	Conservation	Production	Urban
Non-Native Cover				
Native Cover				
Crops, Grasslands, and Exotic Forests				
Buildings & Other Infrastructure				

Human Activity

Use Trends

Human Activity

Human Activity

COVER	USE			
	Not Used	Conservation	Production	Urban
Non-Native Cover				
Native Cover				
Crops, Grasslands, and Forests				
Buildings & Other Infrastructure				

Cover-Use Trends

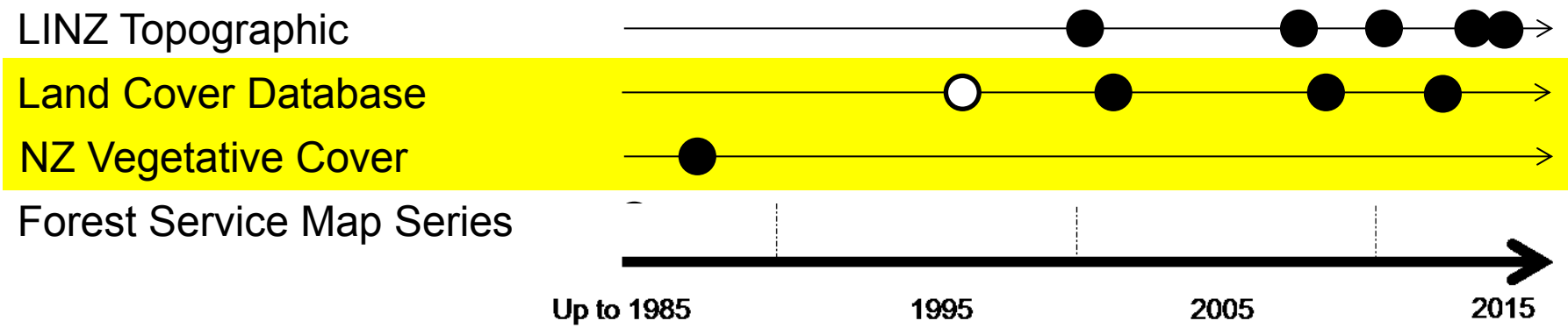
Human Activity

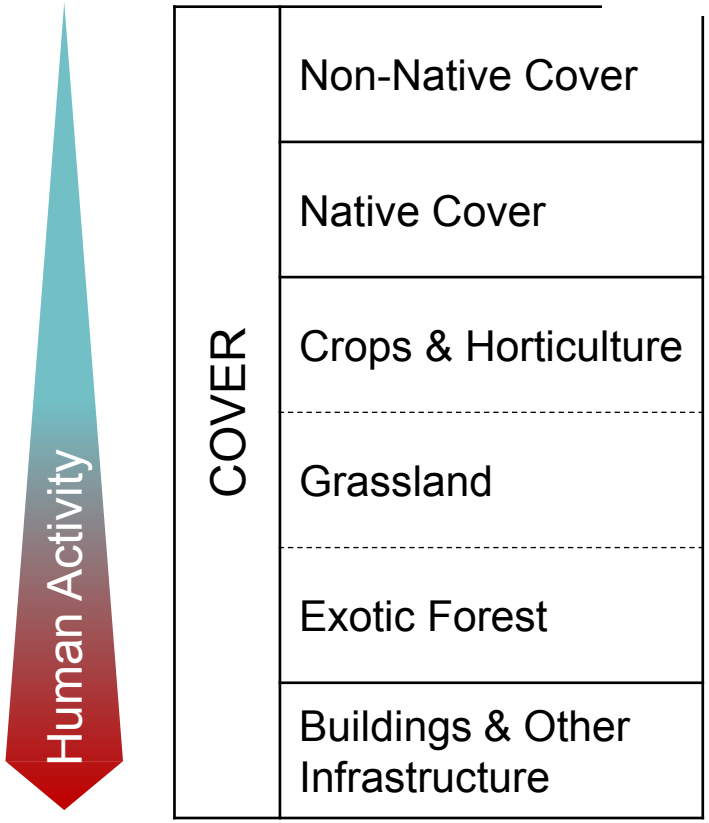
Human Activity

COVER	USE			
	Not Used	Conservation	Production	Urban
Non-Native Cover				
Native Cover				
Crops, Grasslands, and Exotic Forests				
Buildings & Other Infrastructure				

Cover Trends

Cover Trends



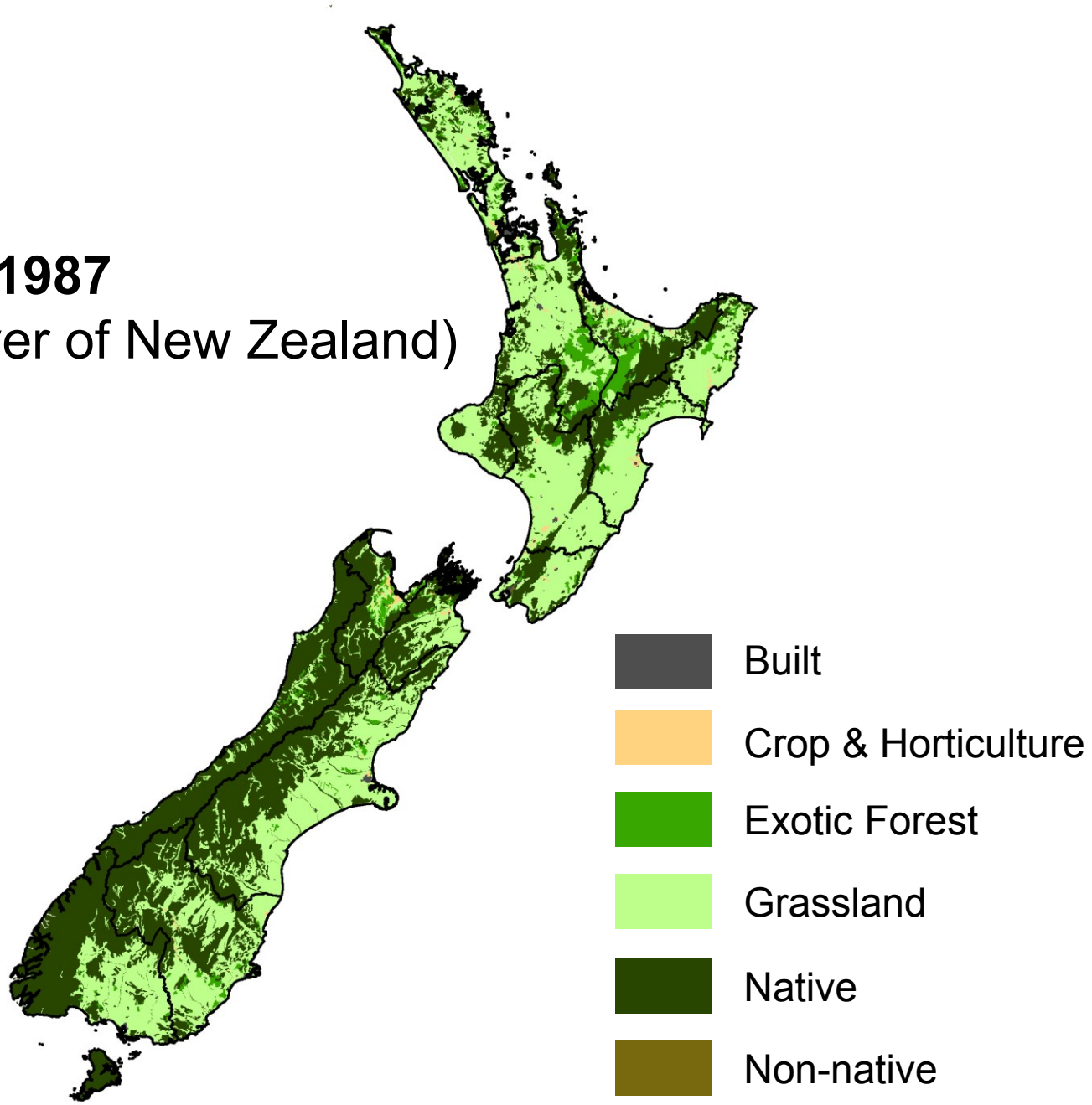


Cover Data

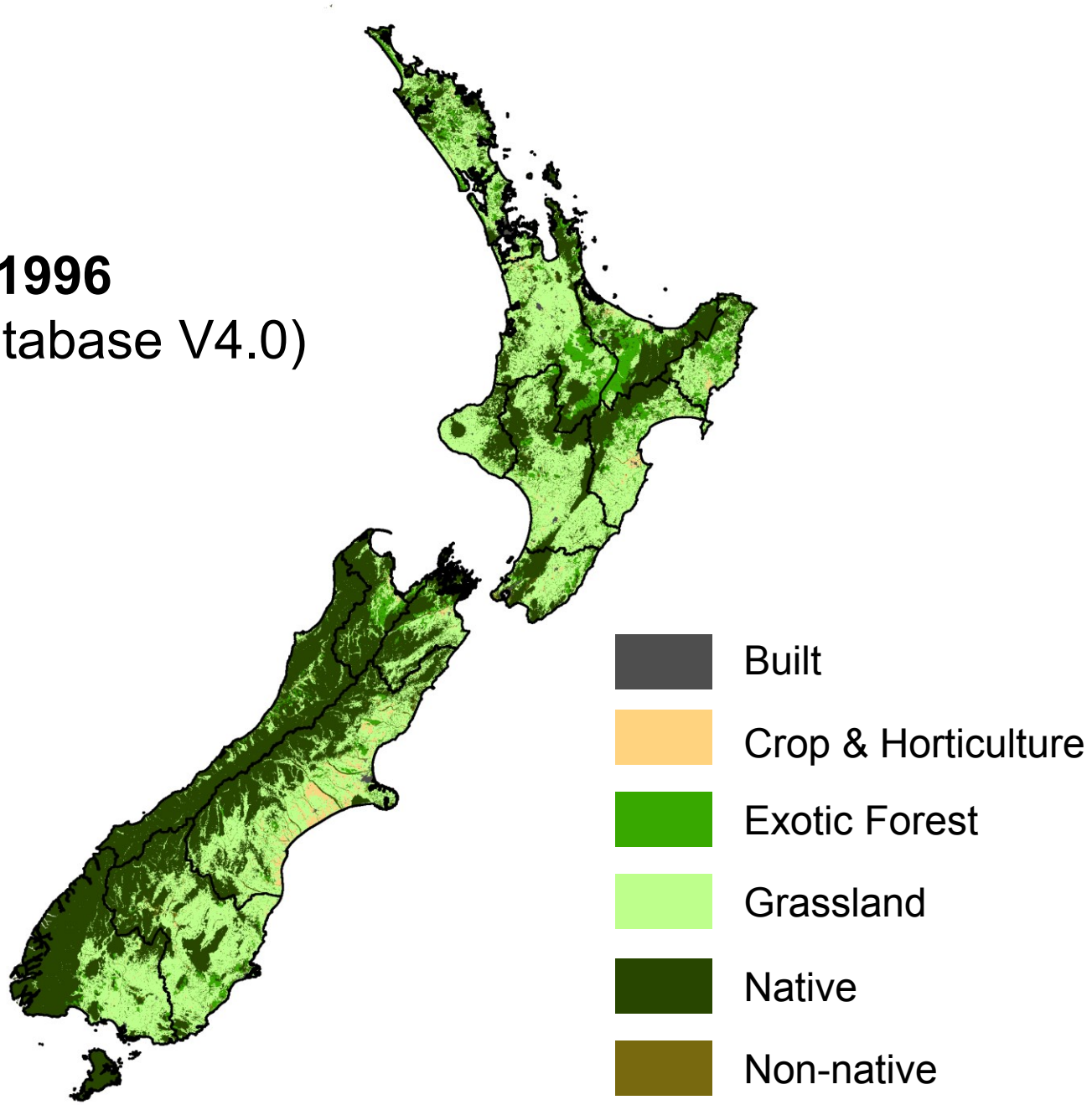
	Vegetative Cover of NZ Edition 1	Land Cover Database V4.0
Total Area	26,733,449 ha	26,842,404 ha
# of Classes	51	33
Number of Features	7,425	479,353
Scale	1:1,000,000	~1 Ha Minimum Mapping Unit*

*79,806 polygons < 1 ha in LCDB 4.0; smallest is 0.08892 ha = 889 m^2

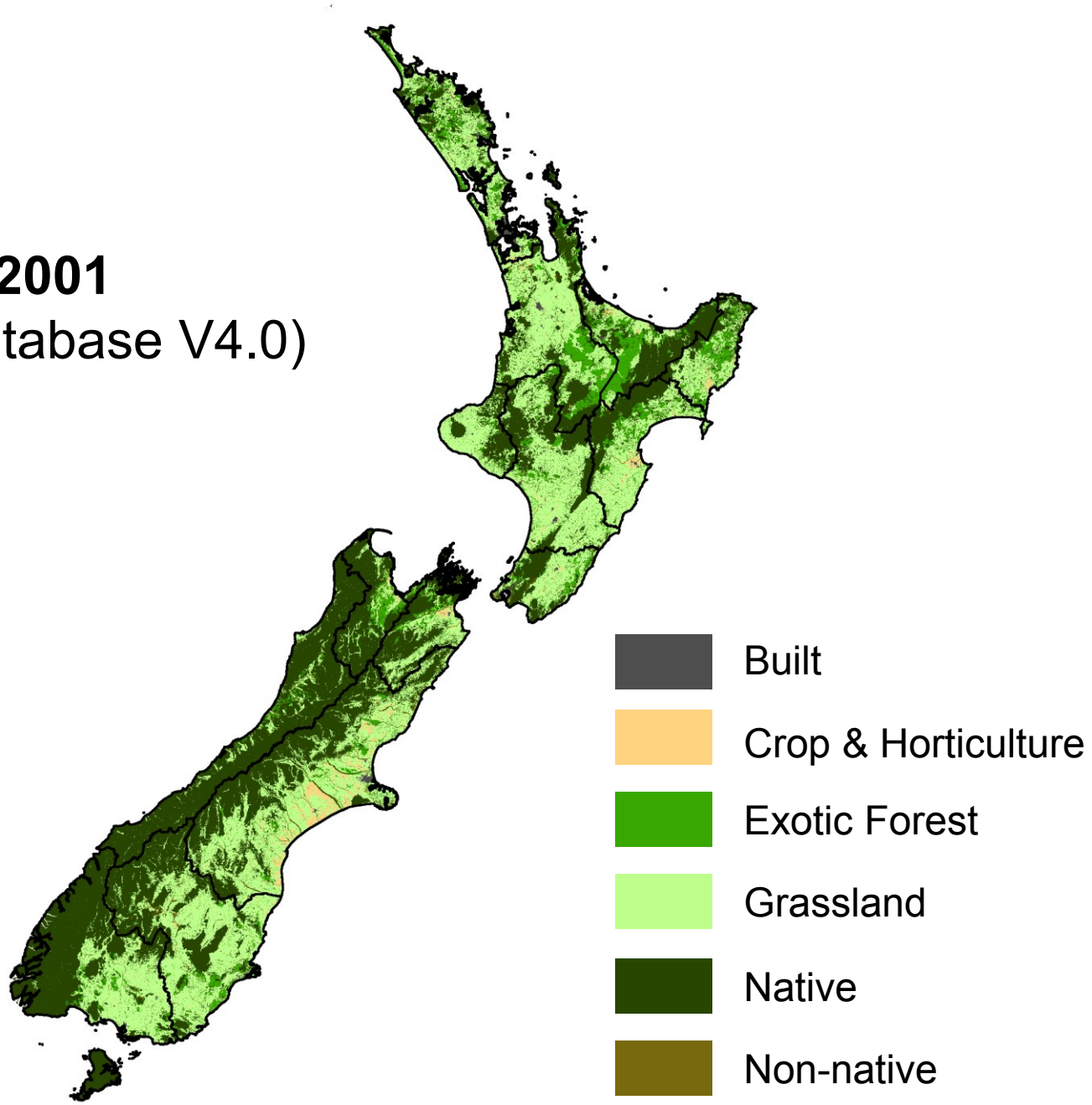
LAND COVER 1987
(Vegetative Cover of New Zealand)



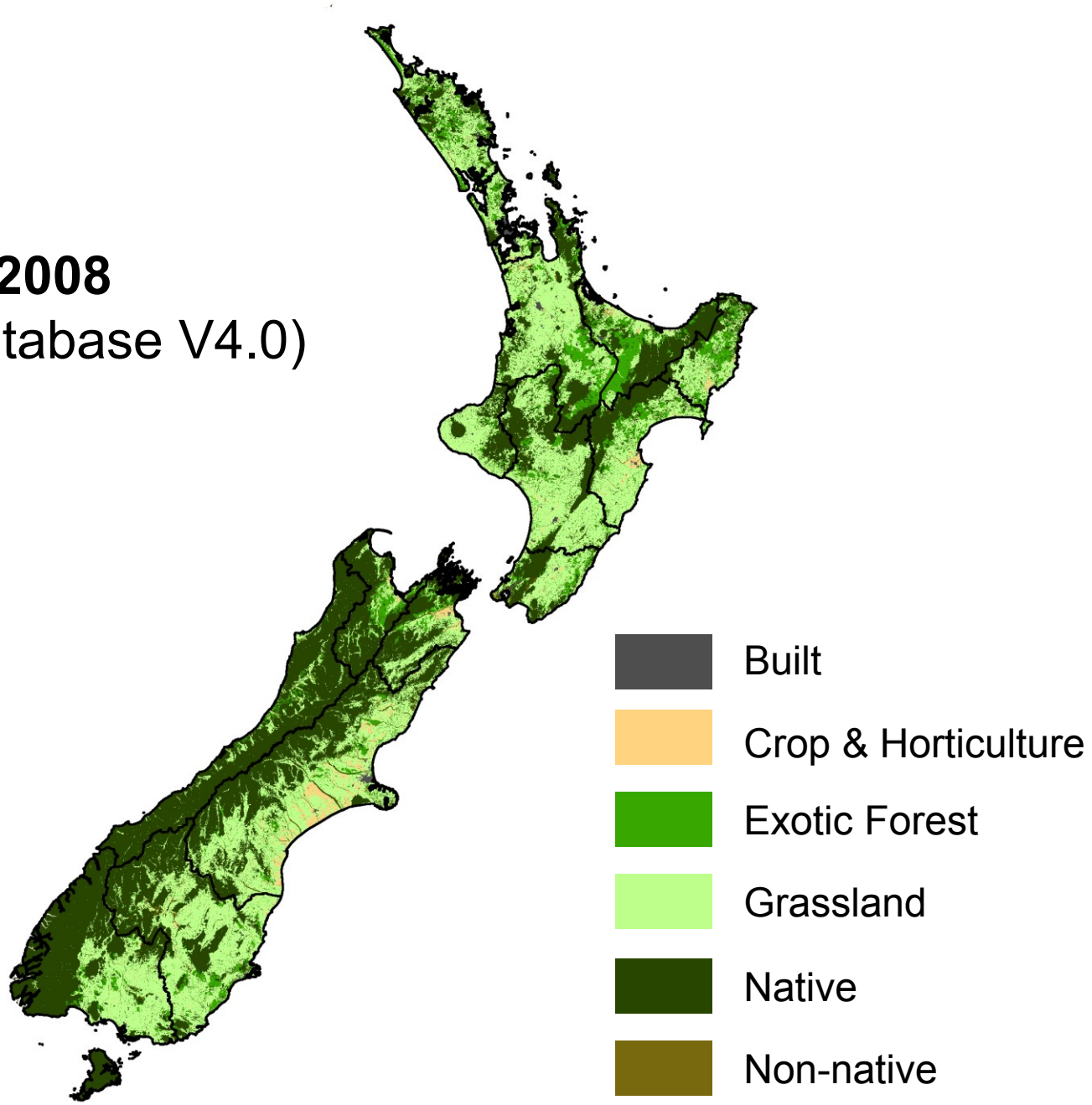
LAND COVER 1996
(Land Cover Database V4.0)



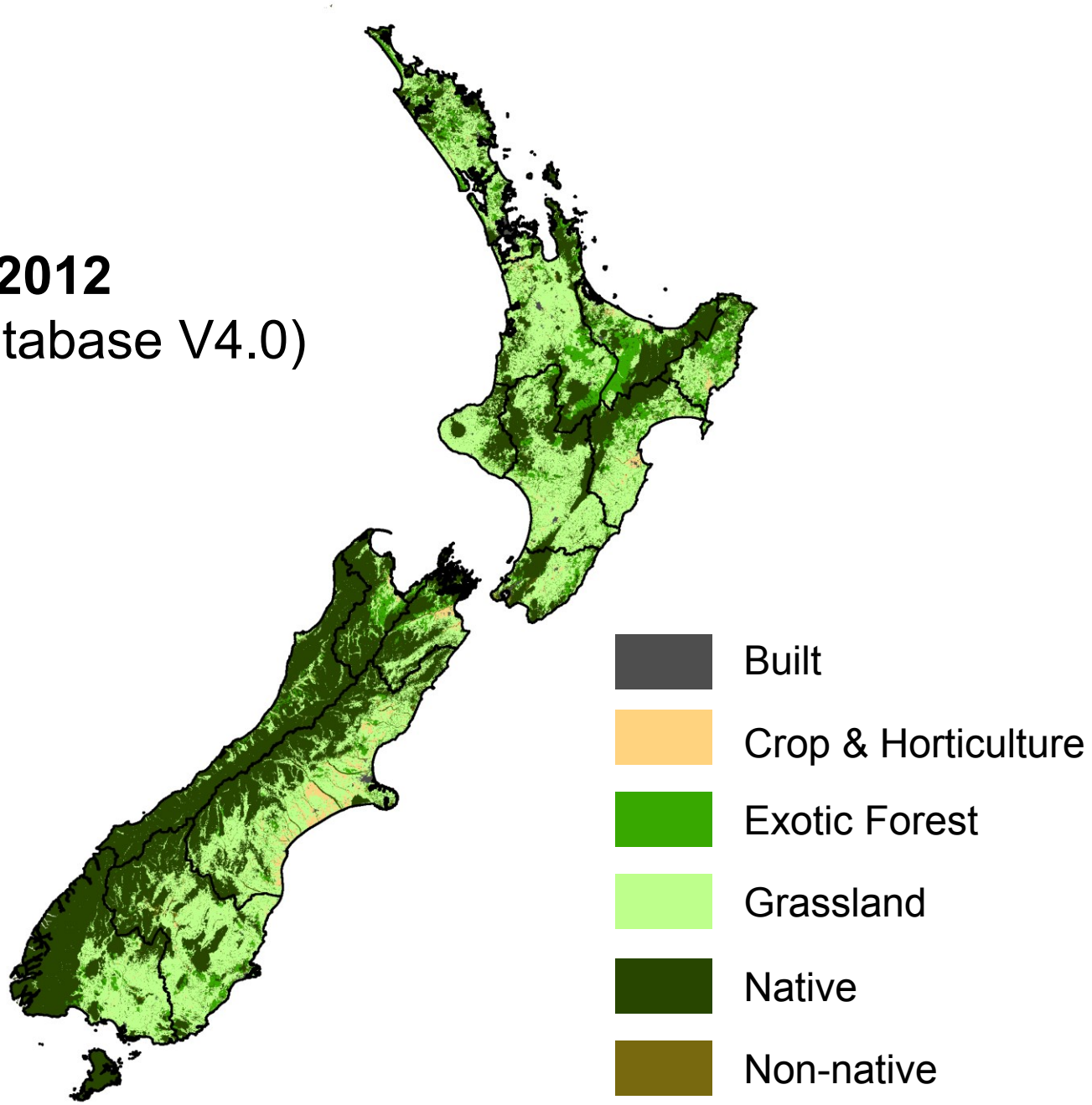
LAND COVER 2001
(Land Cover Database V4.0)



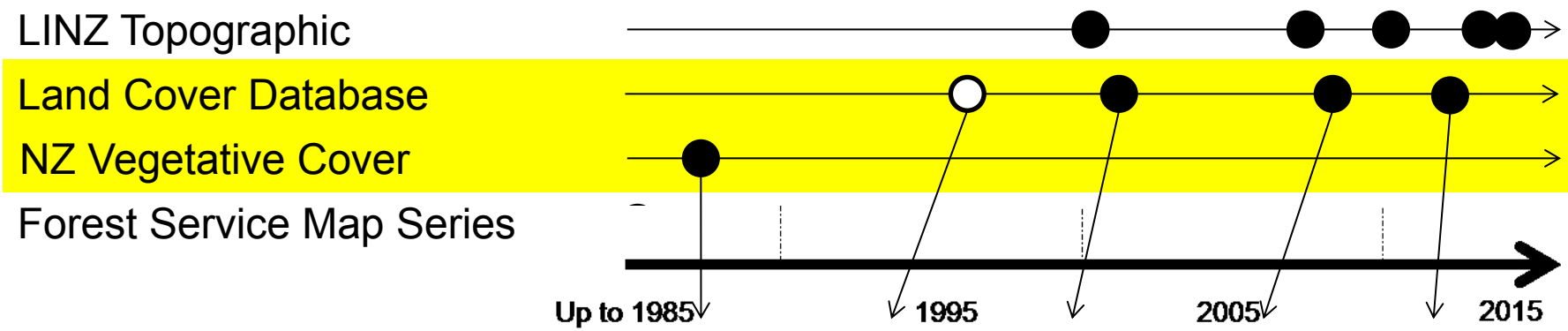
LAND COVER 2008
(Land Cover Database V4.0)



LAND COVER 2012
(Land Cover Database V4.0)



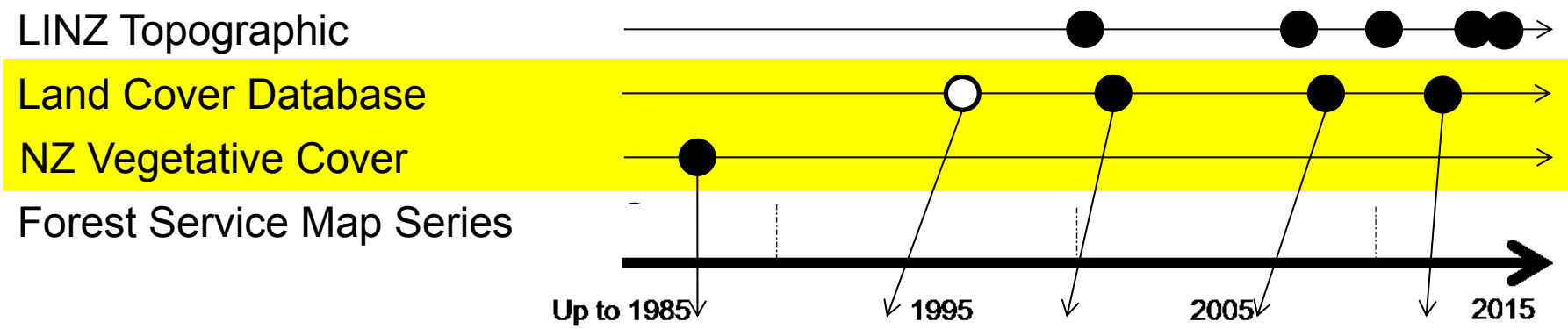
Cover Trends



Human Activity

COVER	1987	1996	2001	2008	2012
Non-Native Cover	20,211	370,038	362,520	354,623	344,333
Native Cover	13,021,045	13,159,228	13,138,753	13,108,615	13,084,661
Crops & Horticulture	164,898	431,791	445,005	472,161	473,221
Grassland	12,165,902	10,848,649	10,663,561	10,619,339	10,675,261
Exotic Forests	1,220,217	1,811,369	2,003,966	2,045,552	2,019,515
Buildings & Other Infrastructure	140,489	221,330	228,598	242,113	245,412

Cover Trends



Human Activity

COVER	1987	1996	2001	2008	2012
Non-Native Cover		+349,826 +38,870	-7,517 -1,503	-7,897 -1,128	-10,290 -2,573
Native Cover		+138,183 +15,354	-20,475 -4,027	-30,138 -4,216	-23,954 -5,926
Crops & Horticulture		+266,893 +29,655	+13,214 +2,643	+27,156 +3,879	+1,060 +265
Grassland		-1,317,753 -146,361	-185,597 -37,018	-44,222 -6,317	+55,922 +13,981
Exotic Forests		+591,152 +65,684	+192,597 +38,516	+41,586 +5941	-26,037 -3,299
Buildings & Other Infrastructure		+80,841 +8,982	+7,269 +1,454	+13,515 +1,931	+3,299 +825

Did we really “lose” 1.3M hectares of grassland from 1987 to 1996?

		LAND COVER 1996					
		Built	Crop	Exotic Forest	Grassland	Native	Non-native
LAND COVER 1987	Built	111,204	601	1,793	13,512	10,083	1,764
	Crop	11,412	51,198	4,832	87,113	7,675	2,446
	Exotic Forest	3,697	1,453	937,569	77,698	187,947	10,031
	Grassland	81,381	372,493	624,160	9,004,496	1,814,170	244,948
	Native	9,082	5,318	236,139	1,637,769	10,996,006	106,474
	Non-native	250	2	4,671	3,846	8,676	2,753

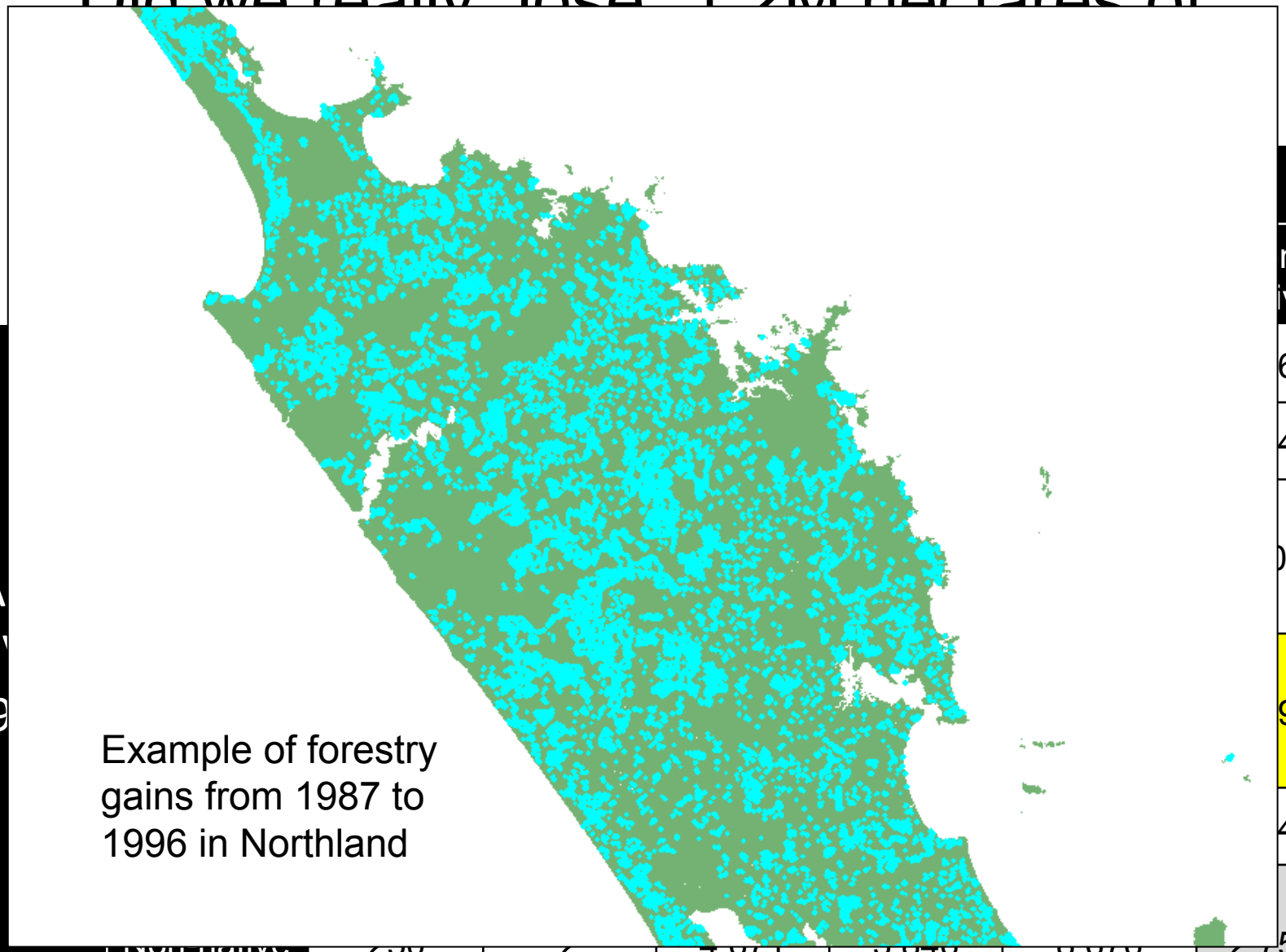
Did we really “lose” 1.2M hectares of grassland from 1987 to 1996?

	LAND COVER 1996					
LAND COVER 1987						n-ve
						64
						46
						031
						948
						474
Non-native	250	2	4,671	3,846	8,676	2,753

OBSERVATIONS

1. Large amount of confusion due to the mixed nature of cover classes from the 1987 Vegetative Cover
   1. Largest confusion between Grassland and Native (e.g. “Pasture and podocarp-broadleaved forest’)
   2. No specific Crop cover class in 1987
2. Net gain in Exotic Forest likely correct, although estimating the actual magnitude would require further investigation. Many of the “new” exotic forest polygons are <10 ha and possibly small farm forestry stands that were not mapped explicitly.
3. Built areas net gains correct but magnitude is overestimated, again due to a resolution issue where small towns not mapped.

Did we really "lose" 1.2M hectares of



Example of forestry gains from 1987 to 1996 in Northland

LA CO 19							
							n-ive
							64
							46
							031
							948
							474
	Non-native	290	2	4,074	5,846	8,076	2,753

LCDB 4.0 Change Overview

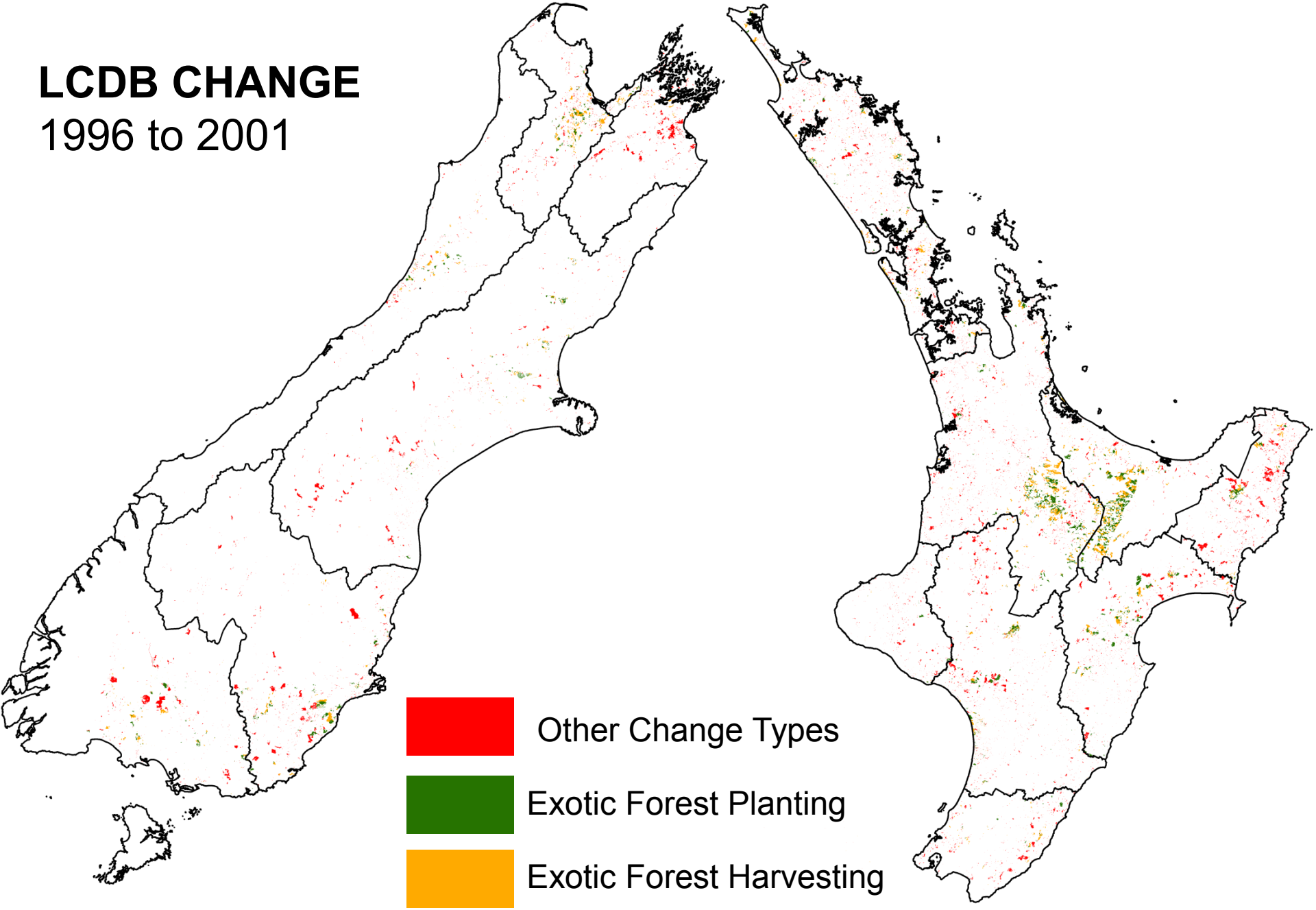
	Total Change	Excluding Forest Rotations	Forest Rotations
Area (ha)	1,290,349	683,193	607,200
Area per Year (ha)	80,649	42,700	37,950
National Annual Rate of Change (%)	0.30%	0.16%	0.14%
Biggest Change Polygon	4,894 (Exotic Forest 2001 to Forest – Harvested 2008)	3,486 (Low Producing Exotic Grassland to Exotic Forest)	4,894 (Exotic Forest 2001 to Forest – Harvested 2008)

LCDB4 Change by Region

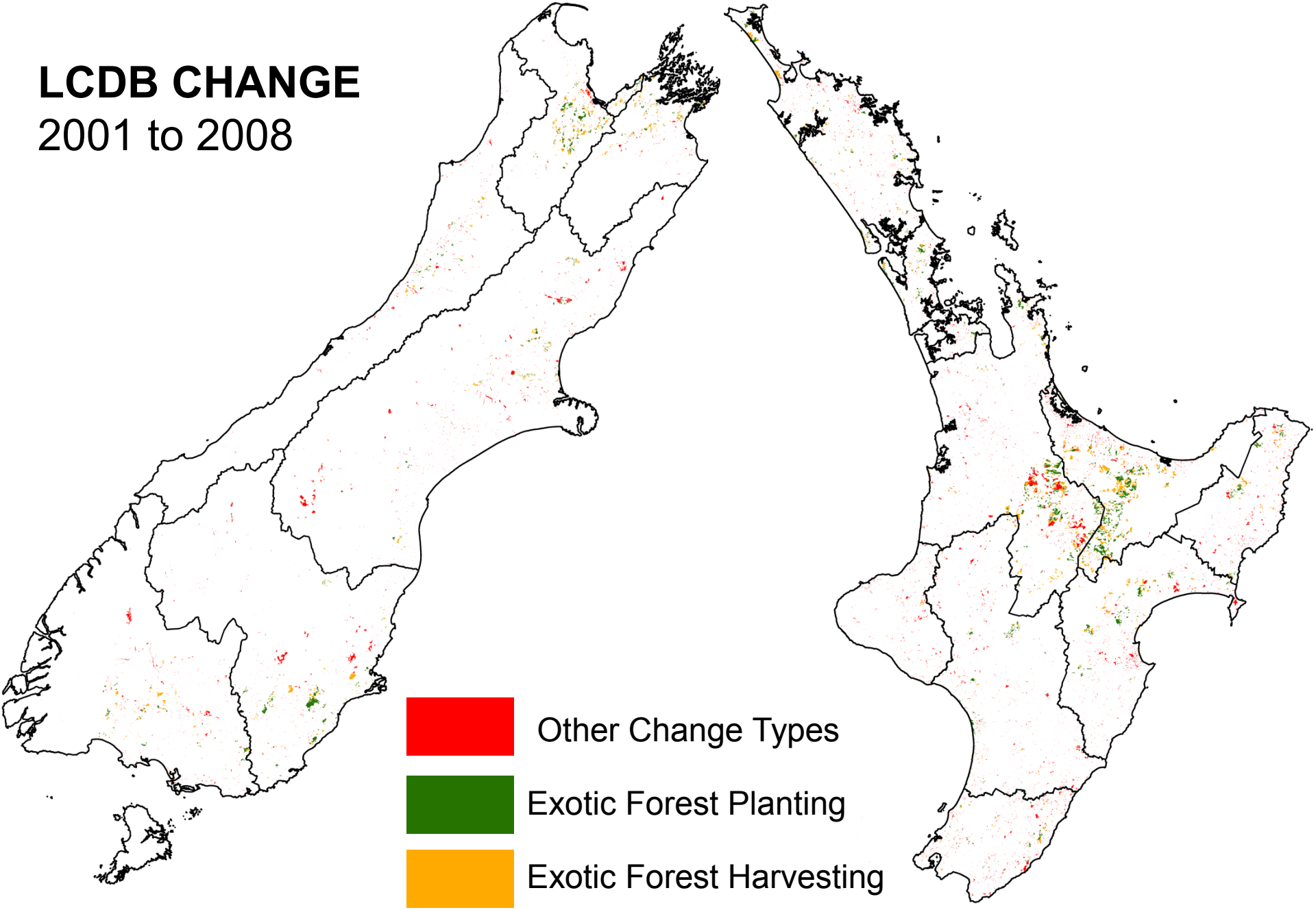
REGION	Total Area 1996-2012 (ha)	% Region Area 1996-2012	% Annual Change
Bay of Plenty Region	171,982	14.00%	0.88%
Nelson Region	5,916	13.94%	0.87%
Gisborne Region	72,222	8.61%	0.54%
Waikato Region	203,849	8.29%	0.52%
Northland Region	84,543	6.76%	0.42%
Tasman Region	65,014	6.74%	0.42%
Hawke's Bay Region	94,089	6.63%	0.41%
Auckland Region	29,464	5.97%	0.37%
Marlborough Region	62,057	5.93%	0.37%
Wellington Region	41,444	5.10%	0.32%
Manawatu-Wanganui Region	86,890	3.91%	0.24%
Otago Region	110,601	3.47%	0.22%
Taranaki Region	22,261	3.07%	0.19%
Canterbury Region	128,107	2.83%	0.18%
Southland Region	72,892	2.29%	0.14%
West Coast Region	38,634	1.66%	0.10%

LCDB CHANGE

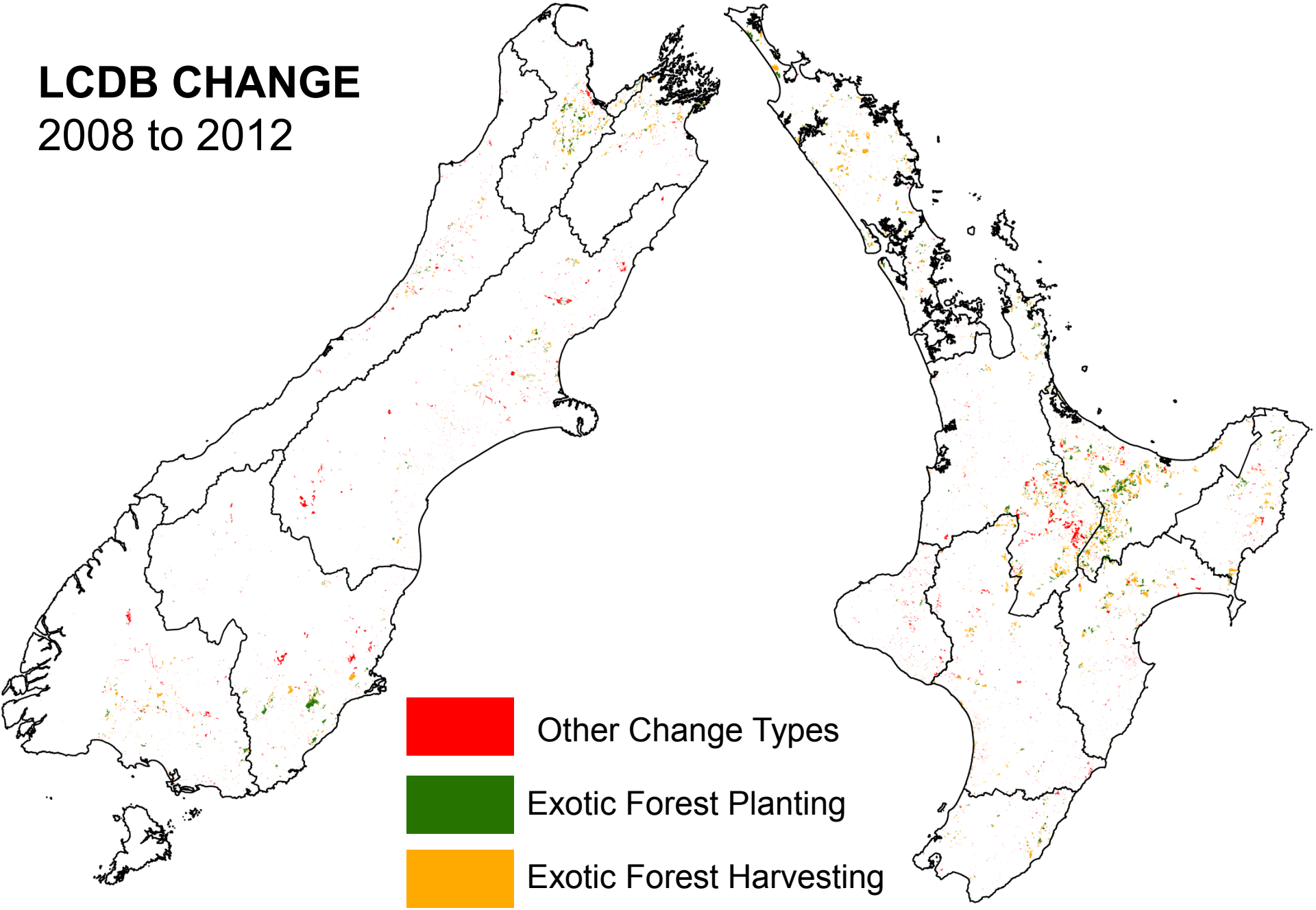
1996 to 2001



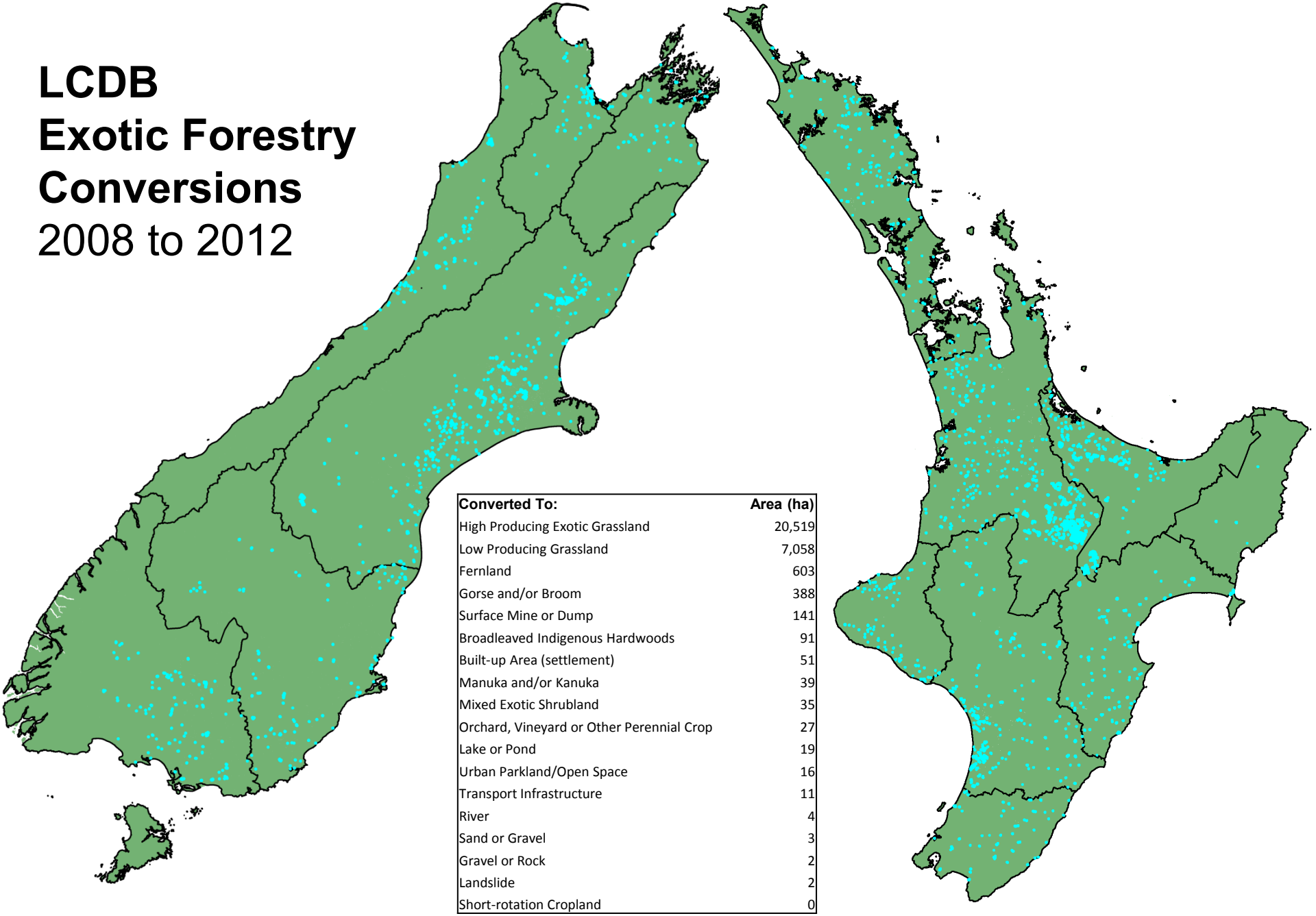
LCDB CHANGE
2001 to 2008



LCDB CHANGE
2008 to 2012



LCDB
Exotic Forestry
Conversions
2008 to 2012



Converted To:	Area (ha)
High Producing Exotic Grassland	20,519
Low Producing Grassland	7,058
Fernland	603
Gorse and/or Broom	388
Surface Mine or Dump	141
Broadleaved Indigenous Hardwoods	91
Built-up Area (settlement)	51
Manuka and/or Kanuka	39
Mixed Exotic Shrubland	35
Orchard, Vineyard or Other Perennial Crop	27
Lake or Pond	19
Urban Parkland/Open Space	16
Transport Infrastructure	11
River	4
Sand or Gravel	3
Gravel or Rock	2
Landslide	2
Short-rotation Cropland	0

LCDB 1996-2012 Change Matrix

		LAND COVER					
		Built	Crop	Exotic Forest	Grassland	Native	Non-native
LAND COVER	Built	220,509		274	291	192	64
	Crop	1,670	424,611	355	5,025	111	17
	Exotic Forest	1,419	673	1,720,820	79,473	4,981	4,004
	Grassland	19,711	47,429	224,818	10,504,971	37,568	14,153
	Native	1,524	181	52,128	62,727	13,040,677	1,992
	Non-native	580	327	21,121	22,774	1,132	324,103

LCDB 1996-2012 Change Matrix

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	Grassland	19,711	47,429	224,818	10,504,971	37,568	14,153
	Native	~~1,624~~	~~181~~	~~52,~~	~~727~~	~~13,040,677~~	~~1,992~~
	Non-native	580	327	21,121	22,774	1,132	324,103

+43,984

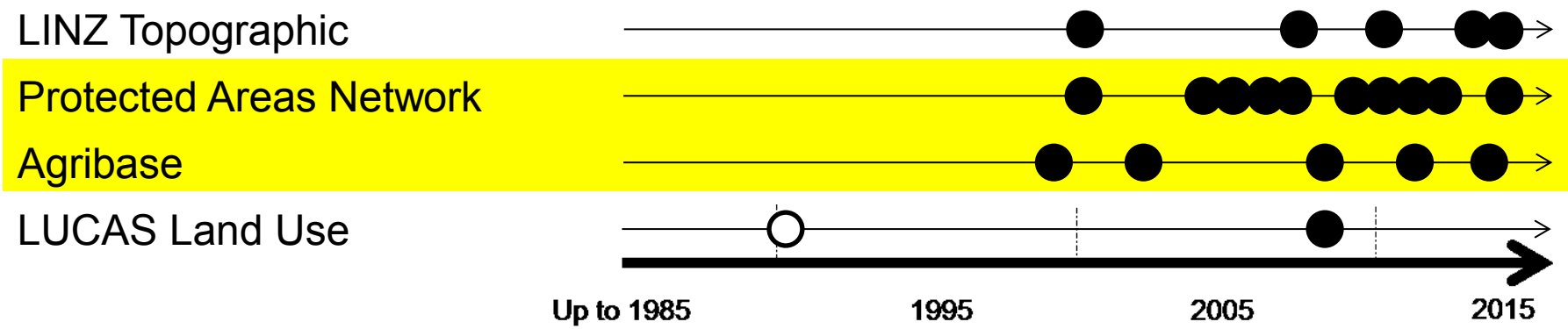
-118,551

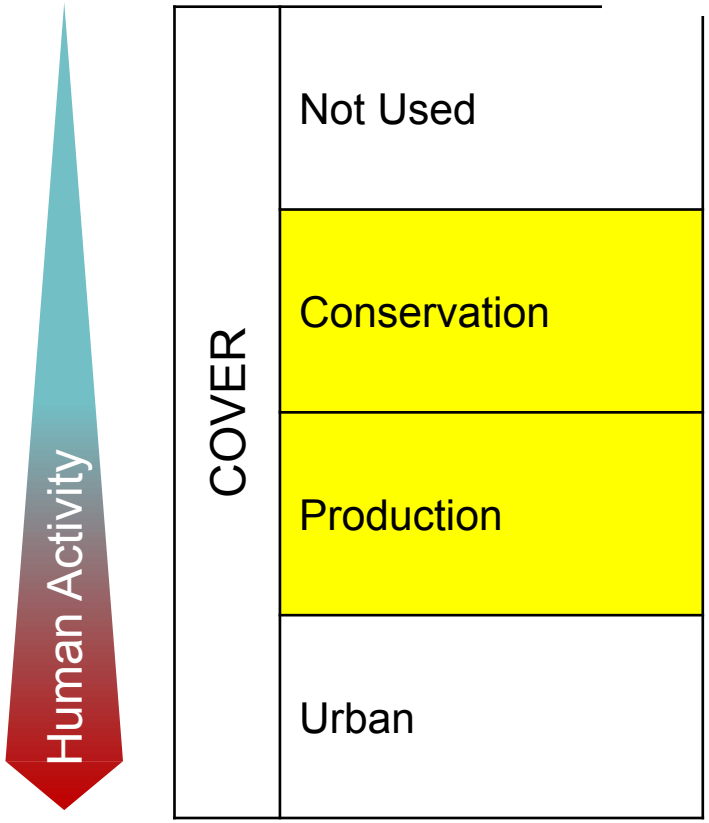
Cover Trends Summary

- Long-term net losses (-)
  - Native cover (-74,567 ha)
  - Non-native cover (i.e. “weeds”) (-25,705 ha)
  - Most losses to production crops, grasslands, and exotic forests
- Long-term net gains (+)
  - Production (+76,189 ha)
    - Continual increased in exotic forest until 2008-2012
    - 2008-2012 showed reversal with gains in grasslands and losses in forestry
    - Crop + Hort also increasing over time
  - Built area increasing (+24,082 ha)
    - Remains <1% of total area according to LCDB
    - Gains slowed during the most recent measurement period (2008-2012)
- Change generally slow on average
  - 0.30% nationally annually
  - 0.16% nationally annually if forest rotations excluded
  - Spatially heterogeneous (0.10 to 0.88%)
- More complex dynamics underpin trends with most types of cover experiencing some gains and losses, which are spatially heterogeneous

Use Trends

Use Trends

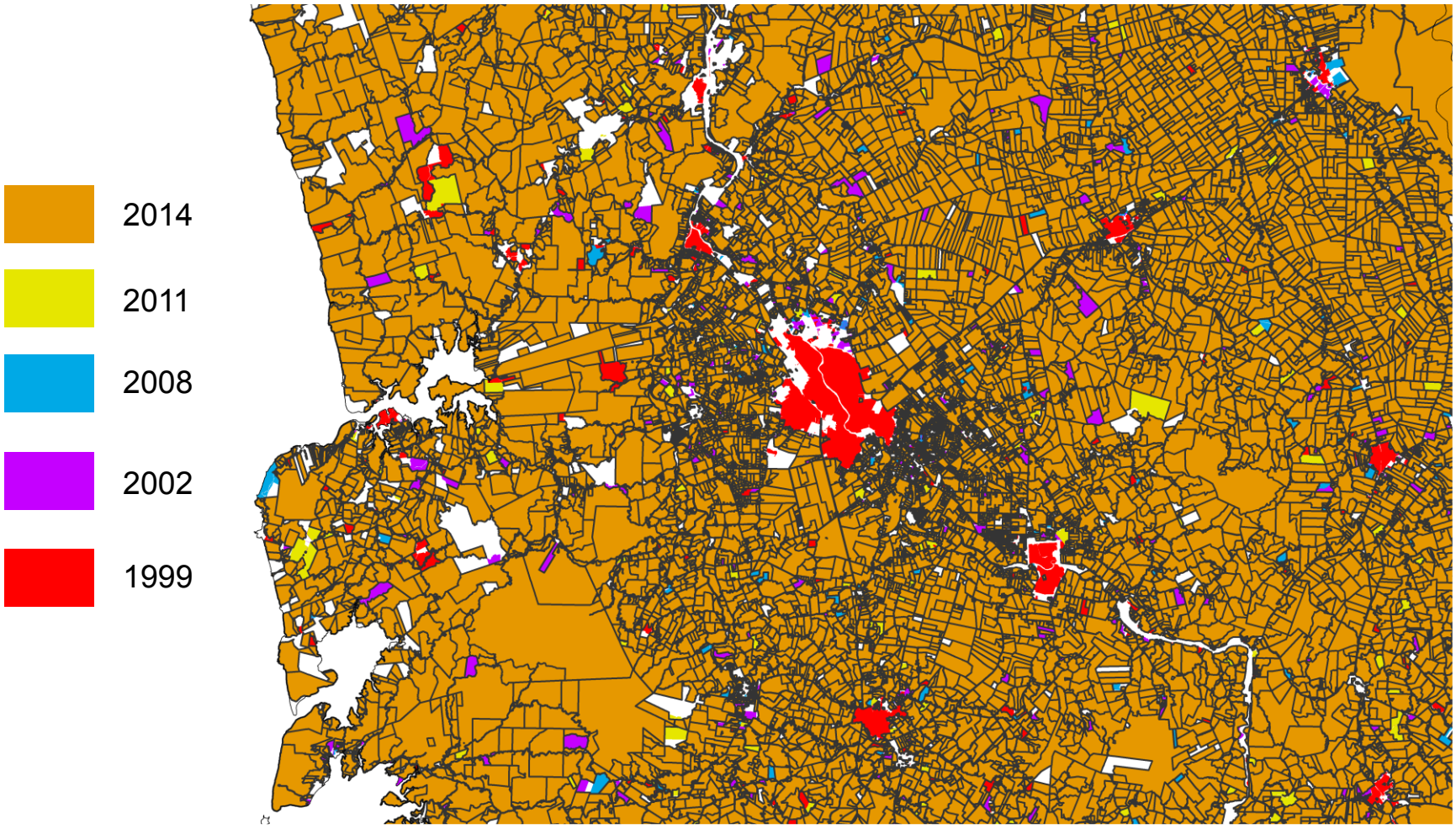

LINZ Topographic
Protected Areas Network
Agribase
LUCAS Land Use
Up to 1985
1995
2005
2015


Human Activity
COVER
Not Used
Conservation
Production
Urban

Use Data

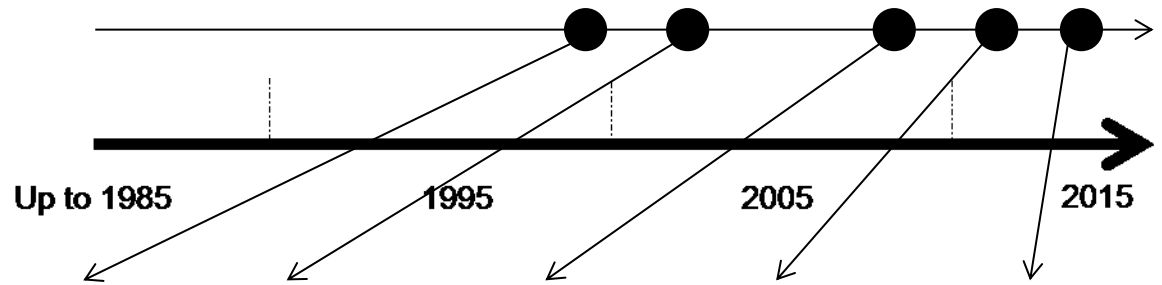
	Agribase					PAN-NZ
	1999	2002	2008	2011	2014	2014
Total Area (ha)	11,979,986	16,803,325	23,721,360	24,769,453	24,846,260	13,348,063
# of Classes	32	33	34	35	36	438
# of Features	81,947	94,867	102,490	133,094	134,310	85,704
Scale	Parcels	Parcels	Parcels	Parcels	Parcels	Varies – as small as parcels

Agribase



Agribase Trends

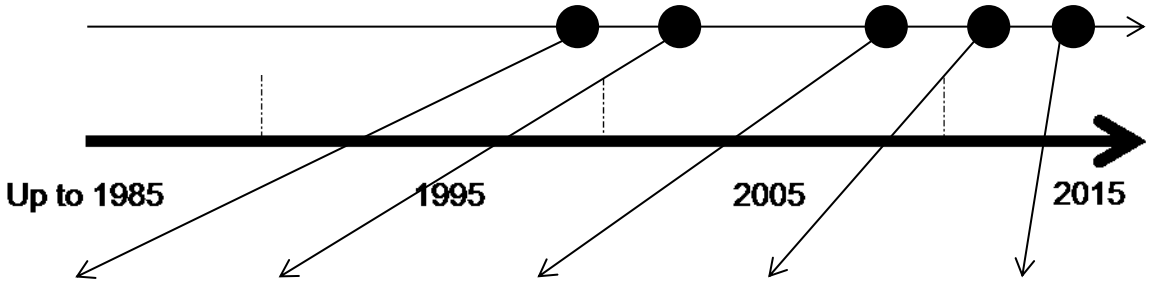
Agribase



Arable	121,290	177,102	191,512	200,541	193,107
Beef	1,563,074	1,756,732	1,674,305	1,583,392	1,579,940
Dairy	1,422,231	1,709,453	1,903,874	2,071,449	2,060,909
Deer	265,437	360,146	333,306	344,414	326,928
Forestry	712,317	1,348,483	1,621,465	1,558,212	1,609,640
Lifestyle	23,951	94,237	152,551	229,264	242,009
Sheep	2,930,192	2,938,366	2,299,708	2,031,187	1,992,300
Sheep & Beef	3,483,854	5,986,601	7,266,883	7,319,176	7,261,059
Vegetables	9,810	14,864	18,138	18,603	19,055
Viticulture	8,768	15,000	26,010	30,154	32,244
	1999	2002	2008	2011	2014

Agribase Trends

Agribase

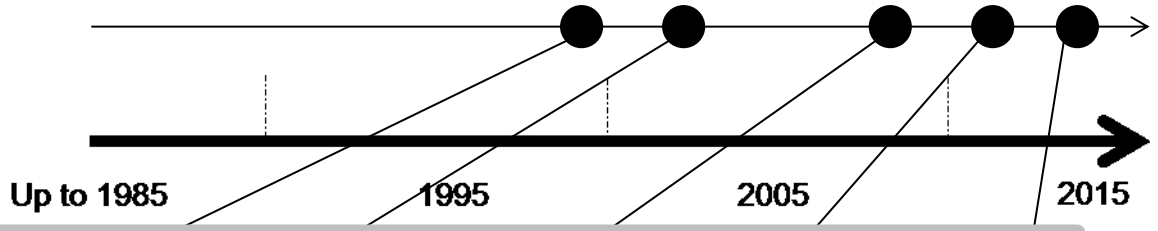


Arable		55,812	14,410	9,029	-7,434	)3,107
Beef	1,	193,658	-82,427	-90,913	-3,452	9,940
Dairy	1,	287,222	194,421	167,575	-10,540	0,909
Deer		94,709	-26,840	11,108	-17,486	6,928
Forestry		636,166	272,982	-63,253	51,428	9,640
Lifestyle		70,286	58,314	76,713	12,745	2,009
Sheep	2,	8,174	-638,658	-268,521	-38,887	2,300
Sheep & Beef	3,	2,502,747	1,280,282	52,293	-58,117	1,059
Vegetables		5,054	3,274	465	452	9,055
Viticulture		6,232	11,010	4,144	2,090	2,244

1999 2002 2008 2011 2014

Agribase Trends

Agribase



OBSERVATIONS

1. Gains in Dairy, Lifestyle, Vegetables, and Viticulture
2. Losses in Beef and Sheep
3. Fluctuations in Sheep & Beef, Deer, Forestry
4. Some changes will result from differences in coverage (e.g. gains resulting from increased coverage)

A						07
B						40
D						09
D						28
F						40
Li						09
S						00
S						59
V						55
Viticulture		6,232	11,010	4,144	2,090	2,244
		1999	2002	2008	2011	2014

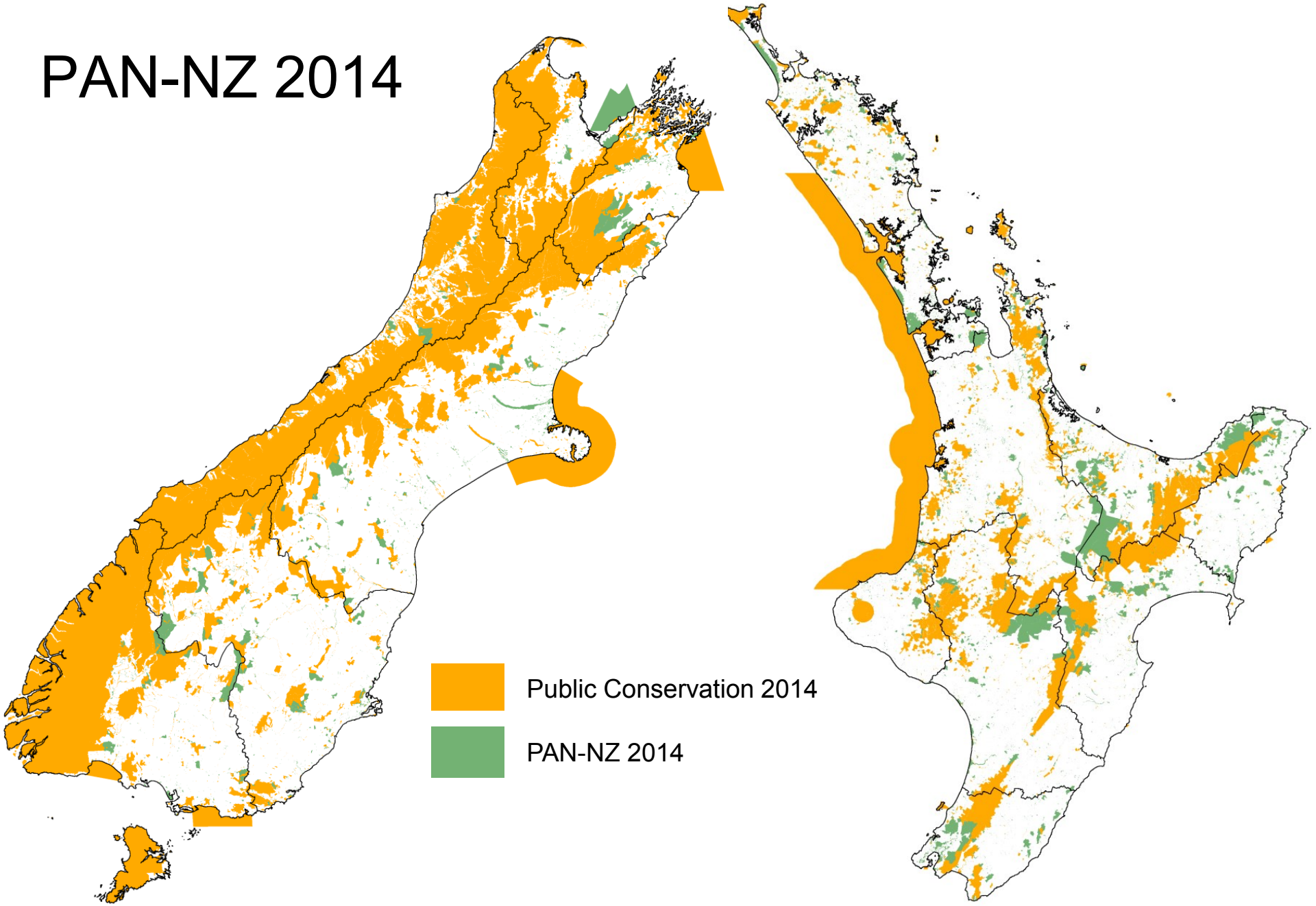
Dairy Farming Changes

Upper Waikato

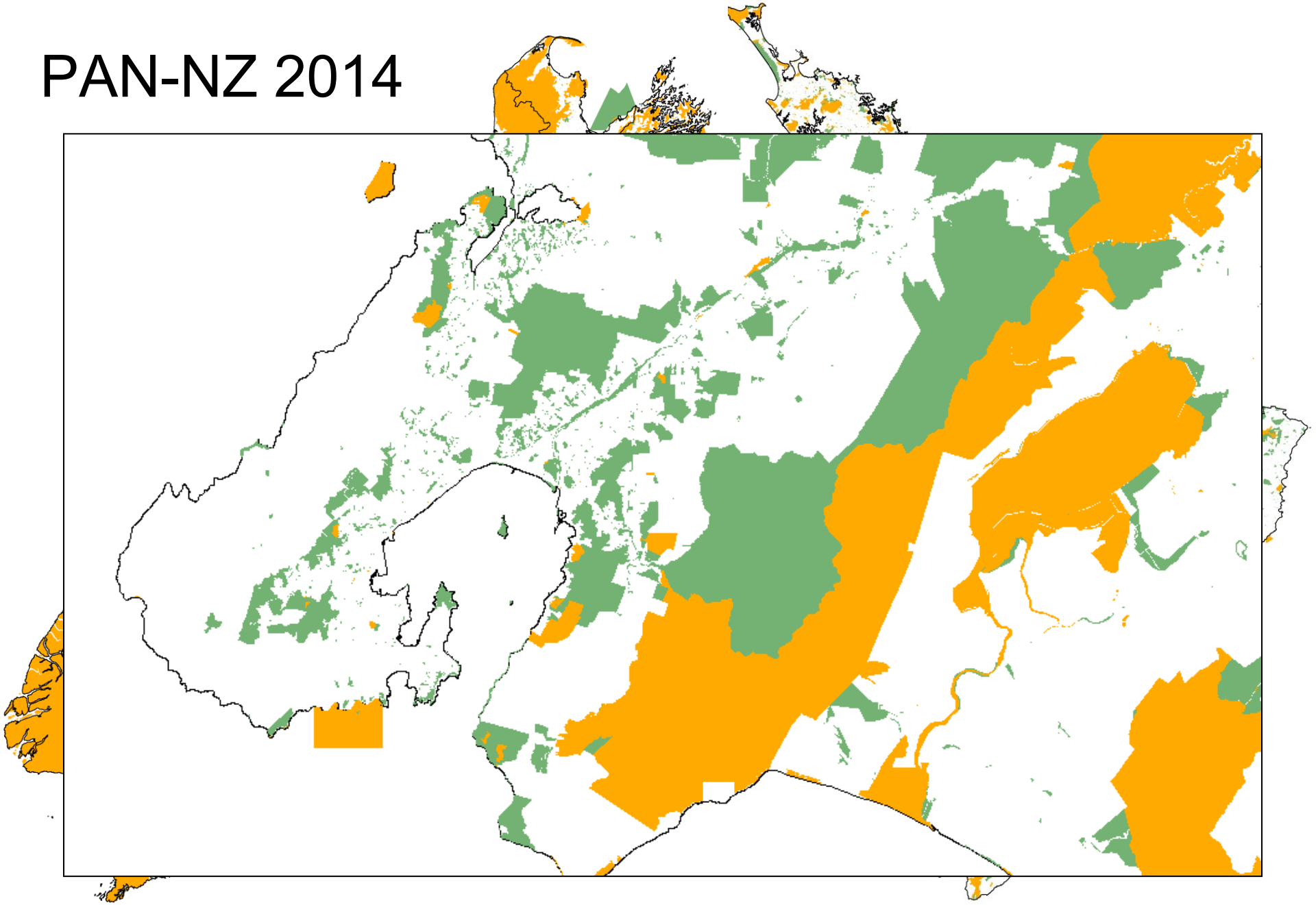
Canterbury

Southland

PAN-NZ 2014

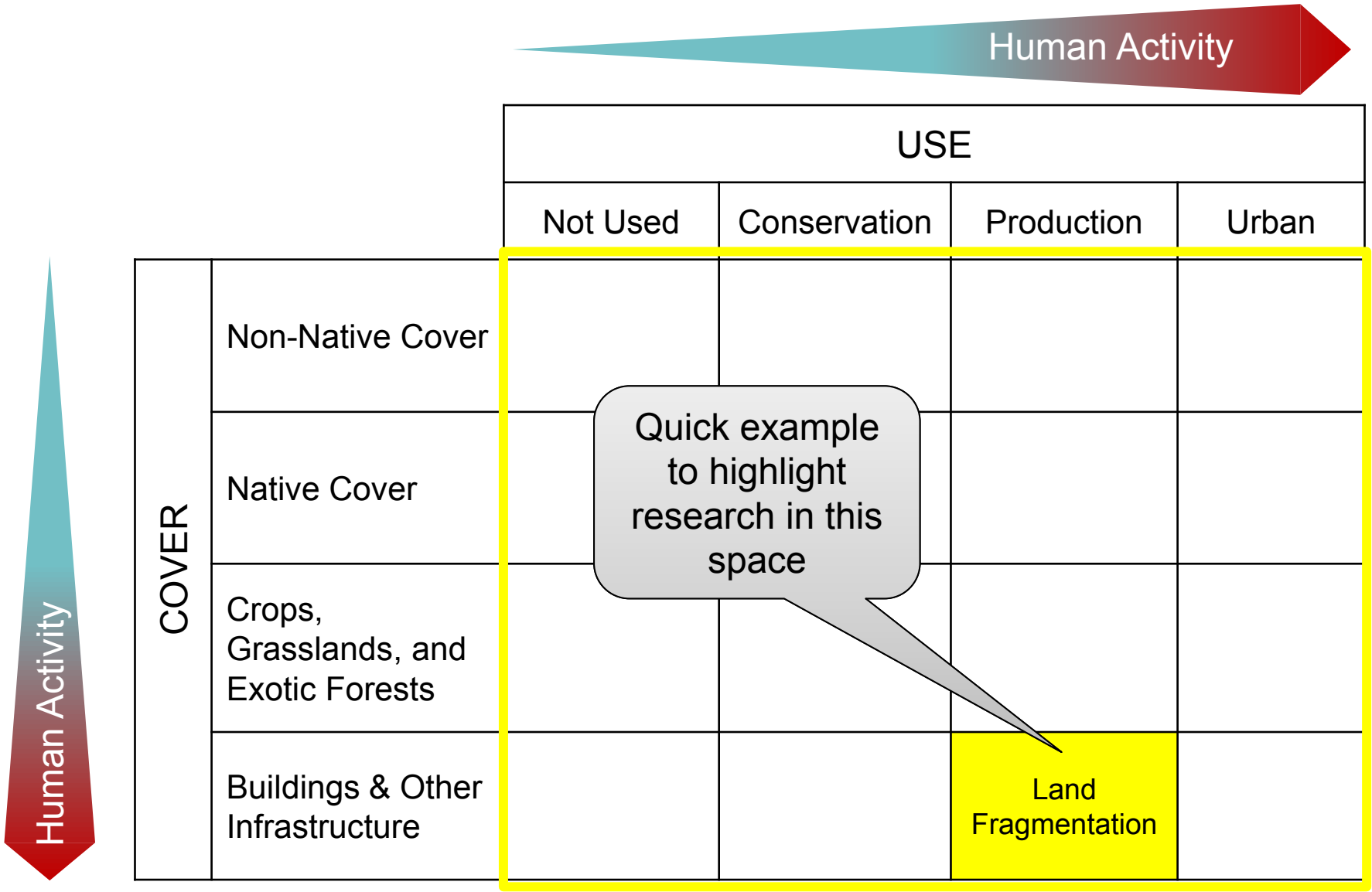


PAN-NZ 2014



Use-Cover Trends

Cover-Use Trends



Land Fragmentation Background: Why do we care?

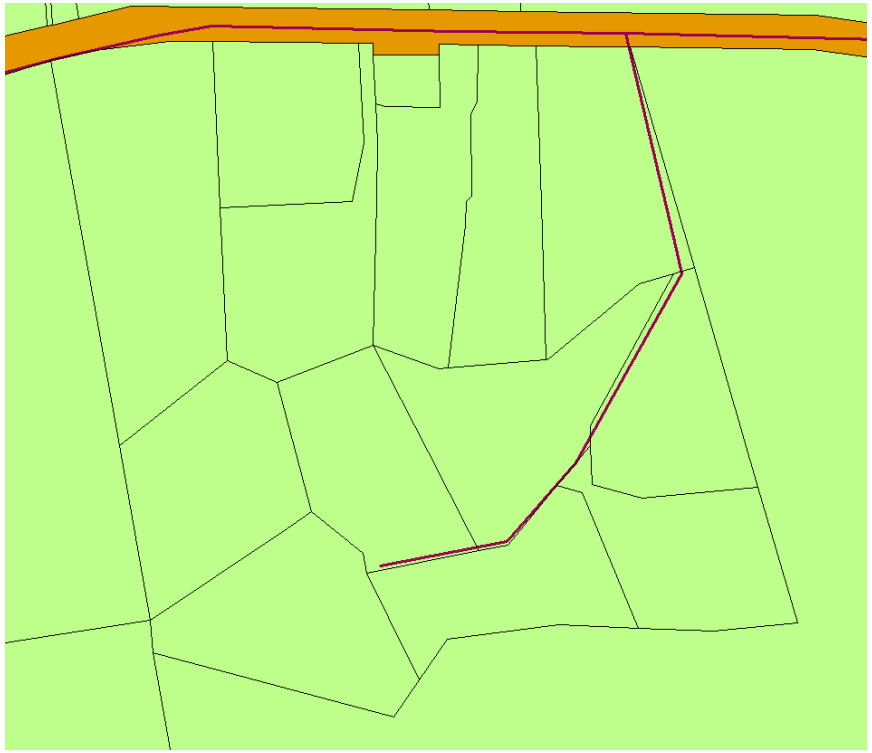
- Conversion to urban and (rural) residential land uses reduces the potential available stock of productive land

	TO (% Converted from Original Area)					
FROM	LUCAS Settlements 1990	LCDB1 Urban 1996/1997	LCDB2 Urban 2001/2002	LUCAS Settlements 2008	Agribase Lifestyle Blocks 2008	Total Agribase + LCDB2
LUC 1	**2.2**	**1.6**	**2.3**	**2.2**	**3.3**	**5.6**
LUC 2	**1.5**	**0.9**	**1.7**	**1.6**	**2.2**	**4.0**
LUC 3	0.9	0.5	1.0	0.9	1.4	2.4
LUC 4	0.5	0.3	0.7	0.5	1.0	1.7
LUC 5	0.4	0.2	0.4	0.4	0.9	1.3
LUC 6	0.2	0.1	0.2	0.2	0.5	0.7
LUC 7	0.1	0.1	0.1	0.1	0.2	0.3
LUC 8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Rutledge et al. 2010. Thought for food: Impacts of urbanisation trends on soil resource availability in New Zealand. Proceedings of the New Zealand Grasslands Association 72: 241-246.

Pukekohe East Road, Pukekohe

Aerial image ©2014 DigitalGlobe via GoogleMaps



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Rotokauri Road, Hamilton

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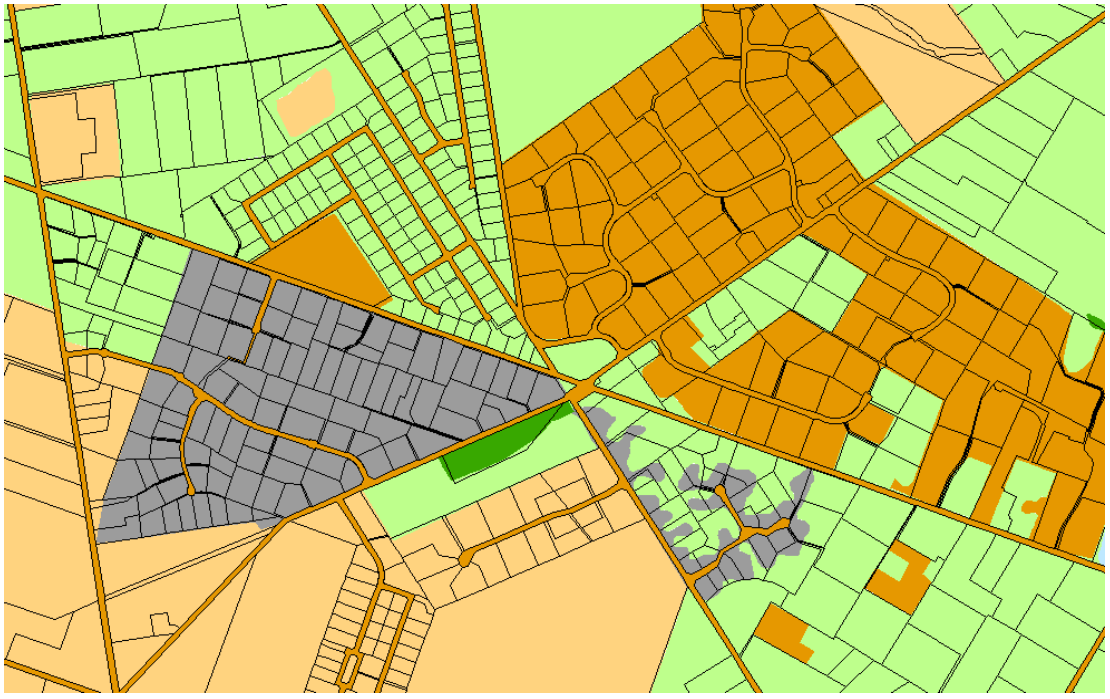
Tram Road, Christchurch



Tirohanga Road, Otago

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Pukekohe East Road, Pukekohe

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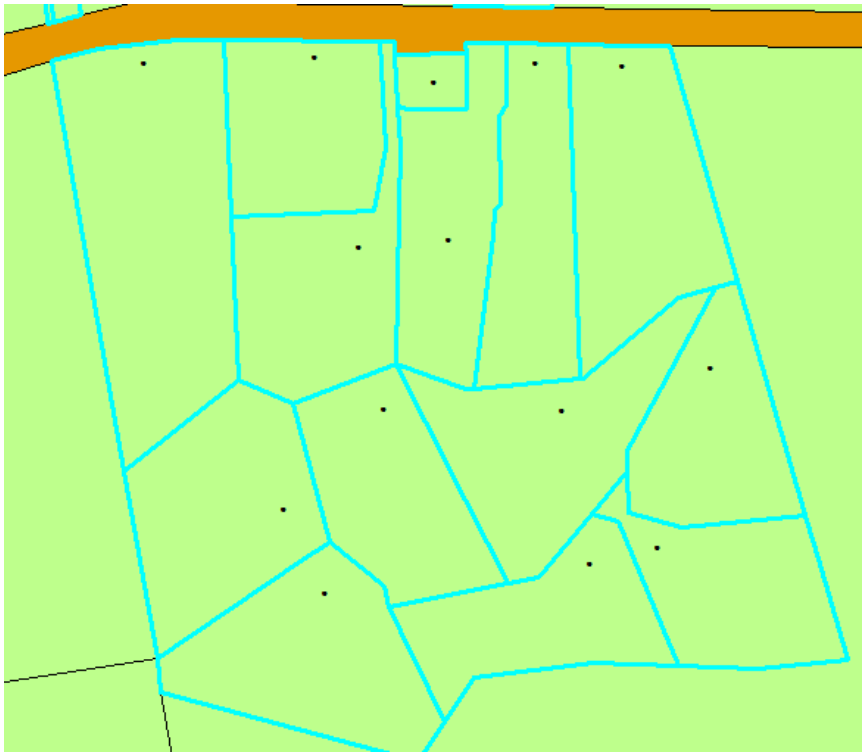

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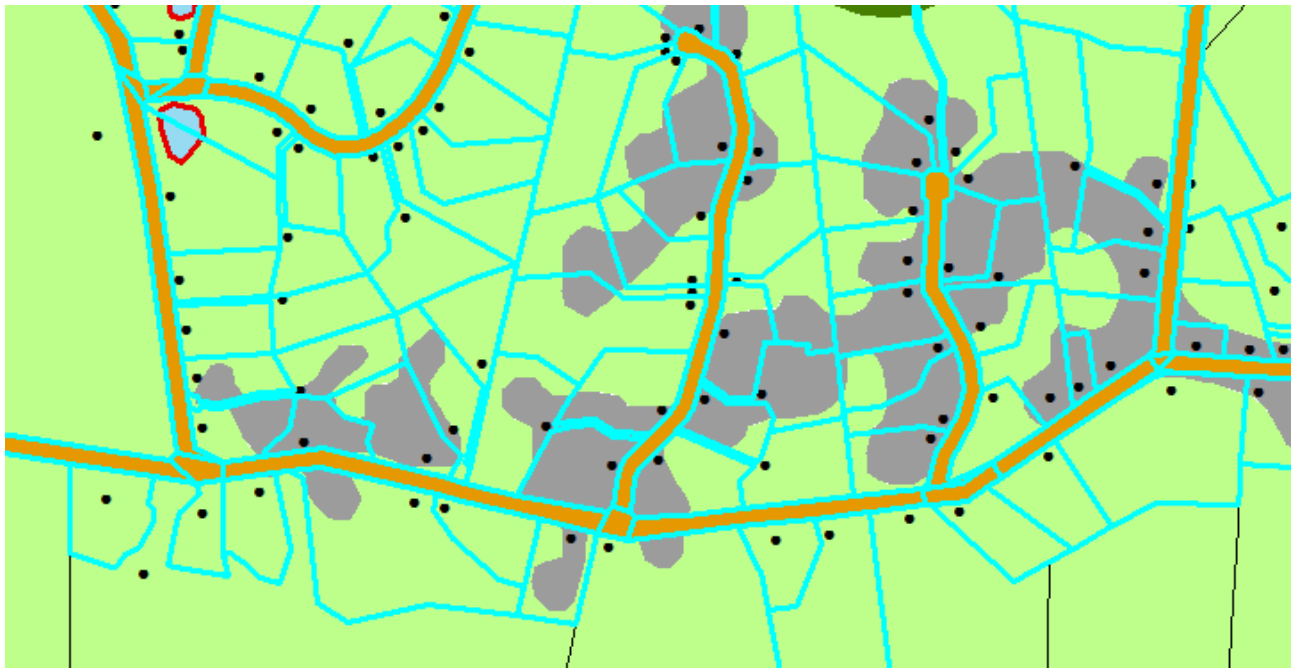
Rotokauri Road, Hamilton



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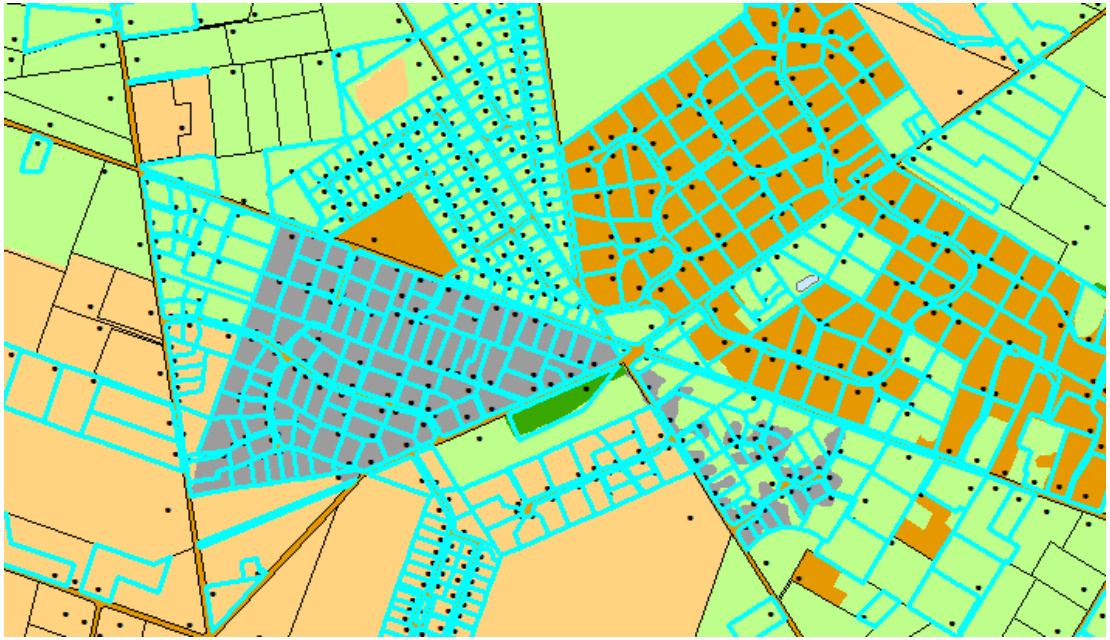
Tram Road, Christchurch



Tirohanga Road, Otago

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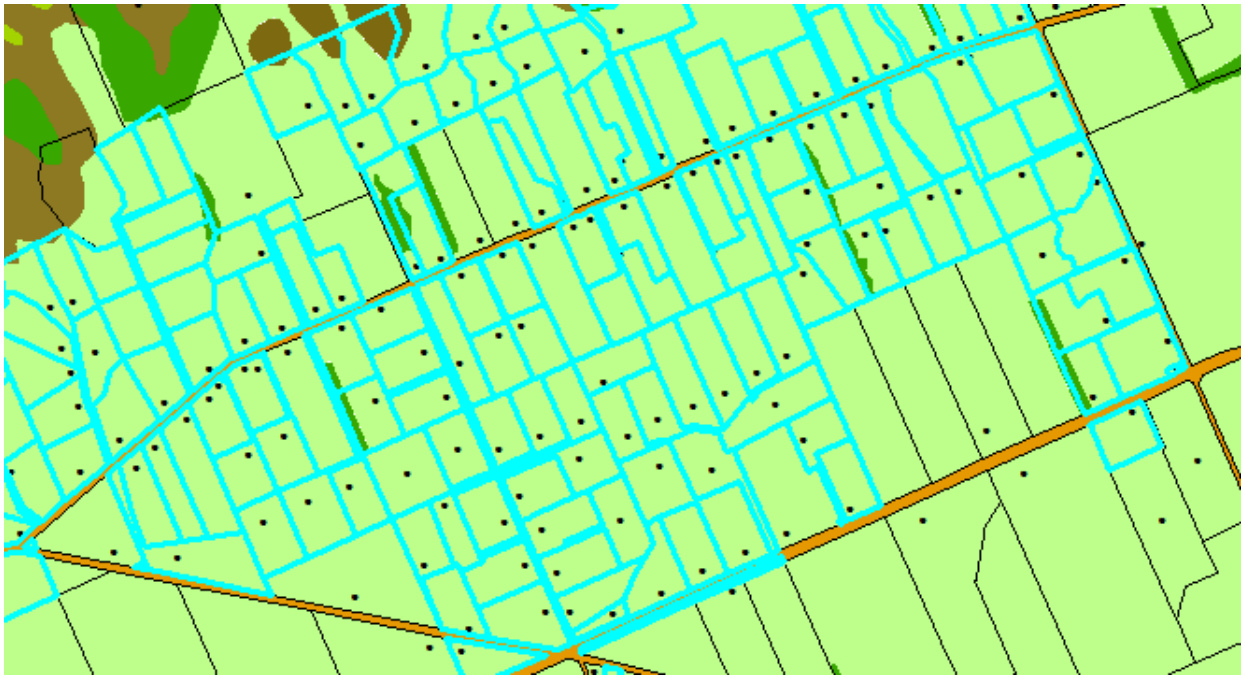

Future Research

- Continue to develop and improve the NZLD and associated analysis methods
- Improve understanding of trends, especially cover-use trends
- Link cover/use changes to underlying drivers (e.g. climate, soils, etc.) to assist modelling and exploration of future landscape change

Thank You