



Ministry for the
Environment
Manatū Mō Te Taiao

Environmental Reporting

Technical Paper

**Ecological Footprints
of New Zealand
and its Regions**

**Garry McDonald
Dr Murray Patterson**

September 2003

Signposts for sustainability

Ecological Footprints of New Zealand and its Regions, 1997/98

Garry McDonald
Bright Future Scholar
Massey University

Dr Murray Patterson
Associate Professor
School of People, Environment and Planning
Massey University

September 2003

The authors and publishers have endeavoured to ensure that the information contained in this publication is accurate at the date of publication. Neither the publishers nor the authors accept any responsibility for any errors or omissions or for the results of any actions taken in reliance on the contents of this publication. The authors and publishers expressly disclaim any and all liability for any loss or damages, whether direct, indirect or consequential, arising from anything done or omitted to be done based wholly or in part on the contents of this publication.

Published in September 2003 by the
Ministry for the Environment
PO Box 10-362, Wellington, New Zealand

ISBN [0-478-24085-6](#)

This document is available on the Ministry for the Environment's Environmental Reporting website: www.environment.govt.nz



Ministry for the
Environment
Manatū Mō Te Taiao

Preface

This report assesses New Zealand’s sustainability performance against two criteria – the amount of land ‘appropriated’ by each person to support their consumption (ecological footprint per capita), and whether we’re living within the ‘carrying capacity’ of the land we have available.

So, how are we doing? This report shows that, overall, New Zealand is one of the few developed countries that is living within its carrying capacity. However, the picture is somewhat different around the country. The report gives a valuable insight into the nature and extent of interdependence of regions around New Zealand. Regions that are more urbanised and have a higher population density (such as Auckland, Wellington, and Nelson) ‘overshoot’ their carrying capacity in that they rely on the use of land in other regions (and other countries) to support their consumption levels. This is sustainable as long as New Zealand as a whole is living within its carrying capacity. To continue this good performance is a goal to which the Government is firmly committed.

The publication of this report and its companion web-based indicator report card and personal footprint calculator (see www.environment.govt.nz/footprint) signal a milestone for environmental and sustainability reporting in New Zealand. As a technical report, it includes sufficient detail for those who want to explore the regional pictures more closely. For others, it provides a new way of thinking about sustainable development at both the regional and national levels.

I hope it will stimulate further discussion and debate, not only about the way we measure sustainability performance in New Zealand but also about the implications for sustainable development policy directions and objectives.



Hon. Marian Hobbs,
MINISTER FOR THE ENVIRONMENT

Acknowledgements

We would like to acknowledge the useful comments received from the reviewers of the first draft of this publication: Dr Barney Foran (Resource Futures Group, CSIRO, Canberra) and Dr Beat Huser (Environment Waikato, Hamilton). In particular, their comments enabled us to fine-tune the presentation of the report and hopefully make it more accessible to a wider audience.

We would also like to thank Kirsty Johnston and Robyn Reid for managing this project and the related work on the ecological footprint Calculator. We are also grateful to the Ministry for the Environment for providing funding for this report, which enabled us to expeditiously implement the first recommendation of the report *Headline Indicators for Tracking Progress to Sustainability in New Zealand*.

Finally, we would like to thank Panjama Ampanthong, Vicki Martin and Ann Flintoft for their assistance in compiling this report for publication.

Contents

Preface	v
Acknowledgements	vi
Executive Summary	xiii
Scope of the report	xiii
New Zealand’s ecological footprint	xiii
Regional ecological footprints	xiv
Assessing the sustainability performance of the regions	xiv
Outstanding research issues	xvi
1 Introduction	1
1.1 Scope of the report	1
1.2 Ecological footprint concept and its measurement	2
1.3 Critique of the ecological footprint	4
1.4 Related New Zealand studies	8
1.5 Key definitions	9
2 Methodology	11
2.1 Rationale for the input–output approach	11
2.2 Methodology for measuring New Zealand’s ecological footprint	12
2.3 Methodology for measuring regional ecological footprints	15
2.4 Data sources	24
3 New Zealand’s Ecological Footprint	26
3.1 Overall ecological footprint and comparison with other countries	26
3.2 Footprint disaggregated by land type	29
3.3 Footprint disaggregated by economic sector	32
3.4 Footprint disaggregated by region	34
3.5 Ecological Balance of Trade	40
3.6 Assessing the ecological performance of New Zealand regions	43
4 Northland’s Ecological Footprint	46
4.1 Profile of the region	46
4.2 Overall ecological footprint and comparison with other regions	47
4.3 Ecological footprint disaggregated by land type	47
4.4 Ecological footprint disaggregated by goods and services purchased	48
4.5 Ecological Balance of Trade and ecological interdependencies	49
5 Auckland’s Ecological Footprint	53
5.1 Profile of the region	53
5.2 Overall ecological footprint and comparison with other regions	54
5.3 Ecological footprint disaggregated by land type	54
5.4 Ecological footprint disaggregated by goods and services purchased	55
5.5 Ecological Balance of Trade and ecological interdependencies	56
6 Waikato’s Ecological Footprint	59

6.1	Profile of the region	59
6.2	Overall ecological footprint and comparison with other regions	60
6.3	Ecological footprint disaggregated by land type	60
6.4	Ecological footprint disaggregated by goods and services purchased	61
6.5	Ecological Balance of Trade and ecological interdependencies	62
7	Bay of Plenty’s Ecological Footprint	66
7.1	Profile of the region	66
7.2	Overall ecological footprint and comparison with other regions	67
7.3	Ecological footprint disaggregated by land type	67
7.4	Ecological footprint disaggregated by goods and services purchased	68
7.5	Ecological Balance of Trade and ecological interdependencies	69
8	Gisborne’s Ecological Footprint	73
8.1	Profile of the region	73
8.2	Overall ecological footprint and comparison with other regions	74
8.3	Ecological footprint disaggregated by land type	74
8.4	Ecological footprint disaggregated by goods and services purchased	75
8.5	Ecological Balance of Trade and ecological interdependencies	76
9	Hawke’s Bay’s Ecological Footprint	80
9.1	Profile of the region	80
9.2	Overall ecological footprint and comparison with other regions	81
9.3	Ecological footprint disaggregated by land type	81
9.4	Ecological footprint disaggregated by goods and services purchased	82
9.5	Ecological Balance of Trade and ecological interdependencies	83
10	Taranaki’s Ecological Footprint	86
10.1	Profile of the region	86
10.2	Overall ecological footprint and comparison with other regions	86
10.3	Ecological footprint disaggregated by land type	87
10.4	Ecological footprint disaggregated by goods and services purchased	88
10.5	Ecological Balance of Trade and ecological interdependencies	89
11	Manawatu–Wanganui’s Ecological Footprint	92
11.1	Profile of the region	92
11.2	Overall ecological footprint and comparison with other regions	93
11.3	Ecological footprint disaggregated by land type	93
11.4	Ecological footprint disaggregated by goods and services purchased	94
11.5	Ecological Balance of Trade and ecological interdependencies	95
12	Wellington’s Ecological Footprint	99
12.1	Profile of the region	99
12.2	Overall ecological footprint and comparison with other regions	100
12.3	Ecological footprint disaggregated by land type	100
12.4	Ecological footprint disaggregated by goods and services purchased	101
12.5	Ecological Balance of Trade and ecological interdependencies	102
13	Marlborough’s Ecological Footprint	106
13.1	Profile of the region	106
13.2	Overall ecological footprint and comparison with other regions	106

13.3	Ecological footprint disaggregated by land type	107
13.4	Ecological footprint disaggregated by goods and services purchased	108
13.5	Ecological Balance of Trade and ecological interdependencies	109
14	Tasman’s Ecological Footprint	113
14.1	Profile of the region	113
14.2	Overall ecological footprint and comparison with other regions	113
14.3	Ecological footprint disaggregated by land type	114
14.4	Ecological footprint disaggregated by goods and services purchased	115
14.5	Ecological Balance of Trade and ecological interdependencies	116
15	Nelson’s Ecological Footprint	119
15.1	Profile of the region	119
15.2	Overall ecological footprint and comparison with other regions	119
15.3	Ecological footprint disaggregated by land type	120
15.4	Ecological footprint disaggregated by goods and services purchased	120
15.5	Ecological Balance of Trade and ecological interdependencies	121
16	West Coast’s Ecological Footprint	125
16.1	Profile of the West Coast region	125
16.2	Overall ecological footprint and comparison with other regions	126
16.3	Ecological footprint disaggregated by land type	126
16.4	Ecological footprint disaggregated by goods and services purchased	127
16.5	Ecological Balance of Trade and ecological interdependencies	128
17	Canterbury’s Ecological Footprint	132
17.1	Profile of the region	132
17.2	Overall ecological footprint and comparison with other regions	133
17.3	Ecological footprint disaggregated by land type	133
17.4	Ecological footprint disaggregated by goods and services purchased	134
17.5	Ecological Balance of Trade and ecological interdependencies	135
18	Otago’s Ecological Footprint	138
18.1	Profile of the region	138
18.2	Overall ecological footprint and comparison with other regions	138
18.3	Ecological footprint disaggregated by land type	139
18.4	Ecological footprint disaggregated by goods and services purchased	140
18.5	Ecological Balance of Trade and ecological interdependencies	141
19	Southland’s Ecological Footprint	144
19.1	Profile of the region	144
19.2	Overall ecological footprint and comparison with other regions	145
19.3	Ecological footprint disaggregated by land type	145
19.4	Ecological footprint disaggregated by goods and services purchased	146
19.5	Ecological Balance of Trade and ecological interdependencies	147
20	Further Research and Refinements to the Ecological Footprint Analysis	150
20.1	Improving the relevance of the analysis for individuals	150
20.2	Improving the relevance of the analysis for policymakers and planners	151
20.3	Methodological and accuracy improvements	152

20.4 Updating the ecological footprint analysis	153
Appendix A: Description of the Interregional Flows Optimisation	155
References	158
About the Ministry for the Environment	162

List of Tables

Table 1.1	Assumptions made by three different ecological footprint calculation methods	5
Table 2.1	Transactions matrix for the hypothetical study region	17
Table 2.2	Technical coefficients matrix for the hypothetical study region	17
Table 2.3	Leontief inverse matrix for the hypothetical study region	17
Table 2.4	Matrix of direct plus indirect land requirements for the hypothetical study region	18
Table 2.5	Within-region land supporting domestic final demand for the hypothetical study region	19
Table 2.6	Within region energy land supporting domestic final demand for the hypothetical study region	19
Table 2.7	Imports for three hypothetical regions	20
Table 2.8	Direct plus indirect land requirements for the hypothetical study region	21
Table 2.9	Land appropriated from other regions for the hypothetical study region	22
Table 2.10	Land appropriated from other regions supporting domestic consumption for the hypothetical study region	23
Table 2.11	Land appropriated from other nations supporting domestic consumption for the hypothetical study region	24
Table 3.1	New Zealand's ecological footprint, by land type, 1997–98	30
Table 3.2	New Zealand's ecological footprint, by economic sector, 1997–98	33
Table 3.3	Ecological footprints of New Zealand regions, 1997/98	35
Table 3.4	Per capita ecological footprints and land productivity of New Zealand regions, 1997/98	37
Table 3.5	Ecological surplus/deficit and degree of overshoot of New Zealand regions, 1997/98	38
Table 3.6	New Zealand's Ecological Balance of Trade by economic sector, 1997–98	41
Table 3.7	New Zealand's Ecological Balance of Trade by land type, 1997–98	43
Table 4.1	Northland's ecological footprint by land type, 1997–98	47
Table 4.2	Northland's ecological footprint by economic products, 1997–98	48
Table 4.3	Northland's Ecological Balance of Trade by economic sector, 1997–98	50
Table 4.4	Northland's Ecological Balance of Trade by land type, 1997–98	50
Table 5.1	Auckland's ecological footprint by land type, 1997–98	54
Table 5.2	Auckland's ecological footprint, by economic products, 1997–98	55
Table 5.3	Auckland's Ecological Balance of Trade by economic sector, 1997–98	56
Table 5.4	Auckland's Ecological Balance of Trade by land type, 1997–98	57
Table 6.1	Waikato's ecological footprint by land type, 1997–98	60

Table 6.2	Waikato's ecological footprint by economic products, 1997–98	61
Table 6.3	Waikato's Ecological Balance of Trade by economic sector, 1997–98	63
Table 6.4	Waikato's Ecological Balance of Trade by land type, 1997–98	63
Table 7.1	Bay of Plenty's ecological footprint by land type, 1997–98	67
Table 7.2	Bay of Plenty's ecological footprint by economic products, 1997–98	68
Table 7.3	Bay of Plenty's Ecological Balance of Trade by economic sector, 1997–98	70
Table 7.4	Bay of Plenty's Ecological Balance of Trade by land type, 1997–98	71
Table 8.1	Gisborne's ecological footprint by land type, 1997–98	74
Table 8.2	Gisborne's ecological footprint by economic products, 1997–98	75
Table 8.3	Gisborne's Ecological Balance of Trade by economic sector, 1997–98	76
Table 8.4	Gisborne's Ecological Balance of Trade by land type, 1997–98	77
Table 9.1	Hawke's Bay's ecological footprint by land type, 1997–98	81
Table 9.2	Hawke's Bay's ecological footprint by economic products, 1997–98	82
Table 9.3	Hawke's Bay's Ecological Balance of Trade by economic sector, 1997–98	83
Table 9.4	Hawke's Bay's Ecological Balance of Trade by land type, 1997–98	84
Table 10.1	Taranaki's ecological footprint by land type, 1997–98	87
Table 10.2	Taranaki's ecological footprint by economic products, 1997–98	88
Table 10.3	Taranaki's Ecological Balance of Trade by economic sector, 1997–98	89
Table 10.4	Taranaki's Ecological Balance of Trade by land type, 1997–98	90
Table 11.1	Manawatu-Wanganui's ecological footprint by land type, 1997–98	93
Table 11.2	Manawatu-Wanganui's ecological footprint by economic products, 1997–98	94
Table 11.3	Manawatu-Wanganui's Ecological Balance of Trade by economic sector, 1997–98	96
Table 11.4	Manawatu-Wanganui's Ecological Balance of Trade by land type, 1997–98	97
Table 12.1	Wellington's ecological footprint by land type, 1997–98	101
Table 12.2	Wellington's ecological footprint by economic products, 1997–98	101
Table 12.3	Wellington's Ecological Balance of Trade by economic sector, 1997–98	102
Table 12.4	Wellington's Ecological Balance of Trade by land type, 1997–98	104
Table 13.1	Marlborough's ecological footprint by land type, 1997–98	107
Table 13.2	Marlborough's ecological footprint by economic products, 1997–98	108
Table 13.3	Marlborough's Ecological Balance of Trade by economic sector, 1997–98	110
Table 13.4	Marlborough's Ecological Balance of Trade by land type, 1997–98	111
Table 14.1	Tasman's ecological footprint by land type, 1997–98	114
Table 14.2	Tasman's ecological footprint by economic products, 1997–98	115
Table 14.3	Tasman's Ecological Balance of Trade by economic sector, 1997–98	116
Table 14.4	Tasman's Ecological Balance of Trade by land type, 1997–98	117
Table 15.1	Nelson's ecological footprint by land type, 1997–98	120
Table 15.2	Nelson's ecological footprint by economic products, 1997–98	121
Table 15.3	Nelson's Ecological Balance of Trade by economic sector, 1997–98	122
Table 15.4	Nelson's Ecological Balance of Trade by land type, 1997–98	123
Table 16.1	West Coast's ecological footprint by land type, 1997–98	126
Table 16.2	West Coast's ecological footprint by economic products, 1997–98	128
Table 16.3	West Coast's Ecological Balance of Trade by economic sector, 1997–98	129
Table 16.4	West Coast's Ecological Balance of Trade by land type, 1997–98	130
Table 17.1	Canterbury's ecological footprint by land type, 1997–98	133
Table 17.2	Canterbury's ecological footprint by economic products, 1997–98	134

Table 17.3	Canterbury's Ecological Balance of Trade by economic sector, 1997–98	135
Table 17.4	Canterbury's Ecological Balance of Trade by land type, 1997–98	136
Table 18.1	Otago's ecological footprint by land type, 1997–98	139
Table 18.2	Otago's ecological footprint by economic products, 1997–98	140
Table 18.3	Otago's Ecological Balance of Trade by economic sector, 1997–98	141
Table 18.4	Otago's Ecological Balance of Trade by land type, 1997–98	142
Table 19.1	Southland's ecological footprint by land type, 1997–98	145
Table 19.2	Southland's ecological footprint by economic products, 1997–98	146
Table 19.3	Southland's Ecological Balance of Trade by economic sector, 1997–98	147
Table 19.4	Southland's Ecological Balance of Trade by land type, 1997–98	148

List of Figures

Figure 2.1	Components of the ecological footprint and Ecological Balance of Trade	25
Figure 3.1	Comparison of the New Zealand per capita ecological footprint with other countries after making adjustments for land productivity	28
Figure 3.2	Ecological footprints of New Zealand regions	36
Figure 3.3	Regional and international origins of Auckland's ecological footprint, 1997/98	39
Figure 3.4	Flows of embodied land through the New Zealand economy, 1997/98	41
Figure 3.5:	Assessing the sustainability performance of 16 New Zealand regions, using ecological footprint indicators	44
Figure 4.1	Flows of embodied land through the Northland economy	52
Figure 5.1	Flows of embodied land through the Auckland economy	58
Figure 6.1	Flows of embodied land through the Waikato economy	65
Figure 7.1	Flows of embodied land through the Bay of Plenty economy	72
Figure 8.1	Flows of embodied land through the Gisborne economy	79
Figure 9.1	Flows of embodied land through the Hawke's Bay economy	85
Figure 10.1	Flows of embodied land through the Taranaki economy	91
Figure 11.1	Flows of embodied land through the Manawatu-Wanganui economy	98
Figure 12.1	Flows of embodied land through the Wellington economy	105
Figure 13.1	Flows of embodied land through the Marlborough economy	112
Figure 14.1	Flows of embodied land through the Tasman economy	118
Figure 15.1	Flows of embodied land through the Nelson economy	124
Figure 16.1	Flows of embodied land through the West Coast economy	131
Figure 17.1	Flows of embodied land through the Canterbury economy	137
Figure 18.1	Flows of embodied land through the Otago economy	143
Figure 19.1	Flows of embodied land through the Southland economy	149
Figure A.1	Structure of the interregional trade flows optimisation problem	155

Executive Summary

Scope of the report

This report estimates the ecological footprints for New Zealand and its 16 regional council areas for the year 1997/98. The ecological footprint measures the total amount of productive land (in hectares) required to support a given population. It is increasingly being used as an indicator of sustainability performance after being developed by Wackernagel and Rees (1996) in the early 1990s.

An input–output methodology based on the one developed by Bicknell et al (1998) is extended in this report and then used in the calculation of the ecological footprints. The report also critically reviews the ecological footprint concept and methodology, particularly as it relates to the analysis and calculations contained in the report.

New Zealand’s ecological footprint

The New Zealand ecological footprint was calculated to be 11,684,500 ha for 1997/98. This represents the total amount of land required to sustain the New Zealand population in 1997/98. It consists of inputs of agricultural land (8,036,600 ha), forest land (744,410 ha), degraded/built-up land (959,250 ha) and of so-called energy land (1,944,940 ha) which is the hypothetical amount of land required to absorb the CO₂ emissions produced by New Zealand.

The amount of usable land available in New Zealand is calculated to be 17,783,949 ha. Usable land is defined as the total land area of New Zealand excluding national parks, forest parks, reserves and non-productive land. On this basis, the ecological footprint of the New Zealand population occupies 65.70 percent of the usable land. This means, assuming the per capita footprint remains unchanged, New Zealand could increase its population by 1.52 times before it overshoots its carrying capacity. New Zealand is, in fact, one of the few developed countries along with Canada and Australia that lives within its land-based carrying capacity, and in that sense can be considered a sustainable economy.

An analysis of the Balance of Trade for New Zealand indicates that a further role for the New Zealand economy is to provide the rest of the world with land-based ecological capital. Overall, through the export of mainly agricultural products (meat, dairy, wool) but also horticultural products, forestry products and to a lesser extent some manufacturing products, New Zealand exports embodied land, amounting to 11,090,370 ha, to other countries. This means that in embodied land terms, about half of the production of the New Zealand economy is channelled into local consumption and about half into products for exports. In comparison, the land embodied in imported products such as food, motor vehicles, computers, textiles and raw materials for industry is much smaller at 3,293,000 ha.

The per capita footprint for New Zealand is calculated to be 3.08 ha per person. This was compared with the per capita footprint of other countries after making adjustments for land productivity, as is recommended by Wackernagel and Rees (1996) and Loh (2000). On an adjusted basis, New Zealand’s ecological footprint increases to 8.35 hectares (global equivalents/person), due to New Zealand land being 2.5 times more productive than the global average (ie. a hectare of New Zealand land is equivalent to 2.5 ha of the global average land). The United States (+46.70%), Denmark (+25.86%), Ireland (+14.13%) and Australia (+1.80%)

all had higher adjusted per capita ecological footprints than New Zealand. These differences can be explained by the higher income, higher levels of material affluence and consumption in these countries. There are however a number of countries that have higher per capita income (per capita GDP) than New Zealand, but somewhat surprisingly have lower ecological footprints per capita: Canada (-8.02%), France (-12.57%), Hong Kong (-14.49%), Germany (-25.03%), United Kingdom (-25.03%), the Netherlands (-28.33%) and Japan (-29.34%). There appears to be a greater decoupling between economic growth (income per capita) and the ecological footprint (embodied land per capita) in these countries, seemingly due to higher population densities usually but not always associated with urbanisation, diet and lifestyle factors, and technological factors all of which reduce the use of land and resource use in general.

Regional ecological footprints

The bulk of the report involves a detailed and systematic analysis of the ecological footprints for the 16 regional council areas in New Zealand. A particular feature of this analysis is the quantification of interregional flows of embodied land; which leads to insights into the ecological interdependencies between the regions and also between regions and other countries.

The largest regional ecological footprint is Auckland's at 2,319,940 ha which is not surprising given that it has the largest population of any region in New Zealand. Auckland makes up 21.66 percent of the New Zealand ecological footprint. Canterbury is a clear second with an ecological footprint of 1,737,860 ha that makes up 16.23 percent of New Zealand's ecological footprint. Although Canterbury has a similar population to Wellington, it has a relatively higher per capita footprint that gives it a much larger footprint than Wellington's of 1,029,010 ha. Waikato (1,048,860 ha) and Otago (1,019,050 ha) have similar size footprints to Wellington.

Next in the rankings is a cluster of provincial regions: Manawatu–Wanganui (879,500 ha), Northland (384,660 ha), Southland (375,310 ha), and Taranaki (233,150 ha). Last in the rankings come a number of smaller more peripheral regions: Marlborough (163,180 ha), Gisborne (141,660 ha), West Coast (121,810 ha), Tasman (82,180 ha) and Nelson (76,910 ha). Although population is the main determinant of size of these ecological footprints, the per capita footprint is important and varies according to regional differences in land productivity, consumption patterns, the degree of urbanisation and population densities.

Assessing the sustainability performance of the regions

The sustainability performance of the 16 regions can be assessed against two criteria:

- (1) *Ecological footprint per capita.* This measures the amount of land appropriated by a person (in a nation, region or city) in supporting their consumption. The smaller this amount of land, then the more sustainable this pattern of consumption is deemed to be, because it requires less appropriated natural capital (as measured by embodied land).
- (2) *Degree of overshoot.* It is argued that to be sustainable, a population (of a nation, region or city) must consume less embodied land, than the amount of useful land which is available. That is, the population must live within its carrying capacity or biocapacity. If the population overshoots its carrying capacity, by using too much land, then it is argued that this amount of land cannot sustain the population.

Graphical analysis reveals, that in terms of these two criterion, there are three significant clusters of regions:

- (1) *Auckland, Wellington and Nelson.* These regions have overshoot their carrying capacity, but all have a per capita footprint below the New Zealand average. Notably, these are the three most urban regions in New Zealand. It is predictable, that if an ecological footprint analysis was undertaken for any other ‘urban’ area in New Zealand that a similar result would occur (eg. if an ecological footprint was calculated for Christchurch City, instead of the entire Canterbury region). The reason why one indicator (per capita footprint) is performing well, and the other (overshoot) is performing poorly is straight forward – urban areas simply use land more efficiently in terms of retail, housing, infrastructure and transport functions, as high population densities reduce space requirements. At the same time the more urban a region is, the more it has to draw resources (particularly food) from outside the region, resulting in an ecological deficit or overshoot situation.
- (2) *Waikato, Bay of Plenty, Gisborne, Hawke’s Bay, Taranaki and Tasman.* These are apparently the ‘best’ performing regions. They perform favourably for both indicators – their footprint per capita is below the New Zealand average and they are not in an ecological deficit or overshoot situation. This result however needs to be interpreted with caution. All of these regions have above average land productivities (except Gisborne) which will decrease their per capita footprint – in other words, the per capita footprint is lower, not so much because people in these regions consume less products or live more sustainably, but more because the land in their region is more productive and therefore less of it is required to produce the same amount of products. None of these regions is urban, and if a footprint analysis was undertaken for any one of the urban areas within these regions (eg. Hamilton City) undoubtedly an ecological deficit or overshoot situation would arise.
- (3) *Northland, Manawatu–Wanganui, Marlborough, West Coast, Canterbury, Otago and Southland.* These regions are not in an overshoot or ecological deficit situation which is a favourable outcome. However, their per capita footprints are above the New Zealand average which is not a favourable outcome. Again, the interpretation of these results needs to be approached with caution. The unfavourable outcome, in terms of the relatively high per capita footprint, in most cases can be explained away purely by the low land productivities in these regions. All of these regions (except Northland and Manawatu–Wanganui) have land productivities below the national average, meaning more land is required to produce the same amount of product that inflates their per capita footprint. This is particularly the case for Otago. Therefore, it could be argued that these regions do not necessarily consume more products and resources than other regions on a per capita basis, rather they require more land to produce the same amount of products.

Outstanding research issues

This analysis represents the first comprehensive and systematic quantification of regional level ecological footprints in New Zealand. The analysis could however be improved by:

- (1) undertaking the analysis at the 48 sector (or greater) level, instead of at 23 sectors. This would lead to more accurate results particularly concerning the appropriation of agricultural land. This would be especially useful in understanding the impact of diet on the ecological footprint
- (2) a series of New Zealand based land productivity factors need to be derived and applied to the data. This should allow for a more rigorous comparison of sustainability performance across the regions
- (3) improving the accuracy of the regional input–output matrices and the interregional trade flow model which were used in the ecological footprint calculations
- (4) including coastal and marine ‘land’ in the analysis. It is recommended in any future application of this methodology to calculate regional-level ecological footprints that these improvements be implemented.

The report also contains a number of specific suggestions for enhancing the relevance of the analytical results for individuals, policymakers and other end-users. For individuals, the calculations could be refocused to show people how they can reduce their footprint by changing their consumption behaviour and lifestyles. The recently instigated personal ecological footprint calculator which is available on the Ministry for the Environment’s website, is a positive move in this direction. For policymakers, the strategic and policy implications of future trends in the ecological footprints are of particular relevance, and this is an area that requires further research. The setting of targets and performance standards for ecological footprints is another area that requires attention by policymakers and planners.