Plantation forestry statistics

Contribution of forestry to New Zealand

NZIER report to New Zealand Forest Owners Association and New Zealand Farm Forestry Association funded by the Forest Growers Levy Trust Inc

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Key points

Plantation forestry and logging make a strong direct contribution to the New Zealand economy

The plantation forestry and logging sector[1] directly accounts for 0.6% of GDP or $1,389 million.

This contribution is:

- Greater than the GDP contribution of the sheepmeat and wool sector by over 20%
- About 45% larger than beef sector in GDP terms
- At a similar level of contribution with horticulture
- 0.9% of the total goods producing industries
- Approximately 2.9% of merchandised exports.

On the back of planting in the late 1980s and early 1990s, forestry production has risen from 10 million cubic metres in 1989 to 28.7 million cubic metres in 2016.

Forestry and logging are extremely important to regional New Zealand:

- To the Waikato and Bay of Plenty economies, forestry contributes nearly $280 million and $184 million respectively (just over 1% of regional GDP for both regions)
- The contribution to Gisborne and the surrounding area amounts to $96 million, nearly 5.5% of that region's GDP.

Plantation forestry is hugely important to New Zealand's environment (see Summary Table). Not the least of which is the importance of carbon capture. The wider contribution to the environment – worth at least $2 billion per annum – is made through:

- The extraction of materials from forests to provide food, fibre, energy and chemicals for pharmaceutical and other uses
- Contributions to the stabilisation of soils and reductions in erosion and sedimentation, moderation of water flows and microclimates, retention of carbon and nutrients from being discharged into the atmosphere and water
- Contributions to providing space for recreation and tourism, natural and historic heritage, general amenity and protection of biodiversity and spiritual associations of iconic locations
- Basic physical and chemical functions of nutrient and water recycling.

And contribute to the health of the New Zealand economy...

- The plantation forestry industry's influence extends well beyond its direct impacts. Forestry and logging are closely intertwined with the rest of the economy and society. This includes jobs, and the incomes it provides, its

[1] The plantation forestry sector consists of growing the plantation forests and the logging sector is the process of harvesting trees.

links to other industries (e.g. transport), the impact it has on rural and urban centres and the environment

- $3.8 billion[2] in plantation forestry production value was produced by growing and logging trees nationally in 2015:
  - $301 million went on wages and salaries
  - $1,100 million went on capital and land
  - $2,400 million was spent on inputs (mainly contractor services)
  - $171 million was spent on freight to get products to market (not included but dependent on forestry)
- The harvesting of logs is the first part of the marketing chain. It provides the wood flow to transport (domestic and export operations), domestic processing, exports, and domestic consumption all of which provide further contributions to GDP.

The sector generates jobs

- The plantation forestry sector is estimated to employ around 9,500 people (see Appendix D). The sector will support many more jobs in industries that supply forestry, and that experience benefits many regions e.g. it provides the transport industry with approximately 2,000 jobs and approximately 900 port service workers
- The plantation forestry sector accounts for 3.2 percent of all employment in Gisborne and 1.5 percent in Northland
- An increase in returns to the sector both upstream and downstream benefits workers in many different industries.

And creates exports that improves our standard of living

- Plantation forestry exports were nearly $5 billion in 2015 accounting for around 2.9% of New Zealand's total goods exports
- This is larger than sheepmeat (mutton and lamb) and wool exports
- This is larger than beef and veal exports
- Forestry makes a positive contribution to narrowing our current account deficit
- The forecast for forestry exports is extremely bright rising by 25% by 2020 (6,300 million).[3]

It drives many rural economies

- Forestry production is hugely important for many regional economies. It injects $262 million into the Gisborne regional economy and $377 million into the Northland economy

[2] Note that the contribution to GDP is included in the production calculation. The contribution to GDP includes wages ($301m) and capital and land (1,100m). This is slightly more that the contribution to GDP figure which takes off depreciation.

[3] Ministry for Primary Industries (2016) Situation and Outlook for Primary Industries. www.mpi.govt.nz

- Nationally, forestry and logging's contribution to GDP ($1,389 million) compares favourably with sheepmeat and wool production ($1,115 million).
- Its GDP contribution is significantly more in the north of the North Island (such as Northland) and also Tasman/Nelson, relative to sheepmeat and wool
- Compared to beef production ($953 million), forestry also compares favourably ($1,389 million). Forestry is more important, relative to beef and veal production in Bay of Plenty, Tasman/Nelson and Otago.

Forestry faces constraints

- No one ministry or department is responsible for forestry. As forestry becomes more important with its dual roles as an export earner and its contribution to the environment (particularly carbon capture) policy coordination becomes more crucial
- Its environmental contribution is not factored into its economic value. The impact on soil conservation, nutrient run-off, water quantity and flow moderation, water quality and biodiversity are significant
- Its impacts on tourism and recreation are also important both for domestic and foreign tourists.

Recognition of forestry through a satellite account is needed to reflect its growing importance …

- A satellite account rearranges existing information/data (economic data such as exports) from industries in the national accounting structure to highlight aspects of a specific industry with re-defined boundaries. It can be extended with the introduction of new information/data (such as social and environmental values) to properly reflect the industry's importance
- As plantation forestry becomes more important (increased removals and the necessity for carbon capture) a satellite account either connected to the tourism satellite account or as a stand-alone satellite account would assist in better reflecting forestry's wider benefit to New Zealand
- For the latest tourism satellite account (2016) go to: http://www.stats.govt.nz/browse_for_stats/industry_sectors/tourism/tourism-satellite-account-2016.aspx.

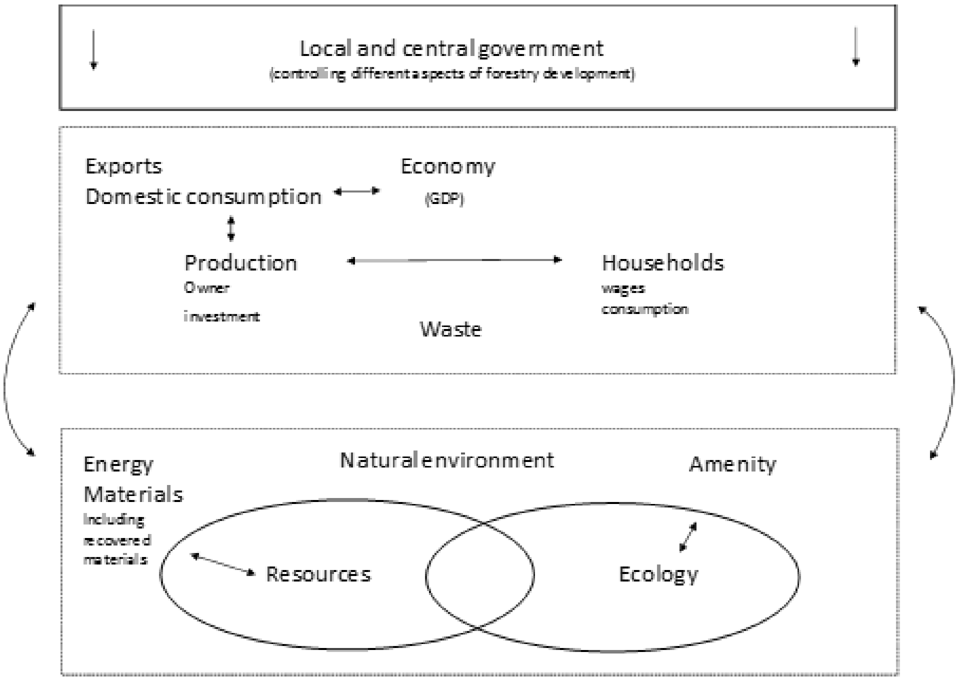
Approach taken to showing forestry's value

Below we have set out the approach to the project. We:

- Developed a framework for forestry which sets out how forestry is regulated, its economic contribution, and its contribution to the environment
- Used various economic and data tools to inform the importance of the industry e.g. consistent economy wide models at the national and regional level, the LEED database that uses tax data to better inform employment numbers, and literature that further helped us understand environmental values

- Engaged with the industry, government and other stakeholders to further understand industry detail and economic behaviour.

Plantation forestry connections



Source: NZIER

Summary of the economic, social and environmental impacts of plantation forestry

2015

	Per year ($ millions)	
Forestry and logging contribution to GDP	1,389 m	
Forestry and logging: Selected GDP contribution of regions		
Northland	138 m	
Waikato	280 m	
Bay of Plenty	184 m	
Gisborne district	96 m	
Hawkes' Bay	100 m	
Tasman / Nelson	114 m	
Otago / Southland	120 m	
Numbers directly involved in forestry and logging	9,500	
Transport	2,000	
Port service workers	900+	
Seasonal workers	Small	
Environmental and recreational values[1]		
	Ohiwa[3] est. extended over NZ	Conservative estimate
Overall eco-system services estimate[2]	9,600 m	1,900 m
Nutrient value (Taupo study)	5,800 m	
Energy saved by recycling resins and waste (value added)	789 m	
Value of carbon capture (conservative)	300 m	
Reduced soil erosion benefit	208 m	
Water quantity/ flow net benefit[4]	14 m	
Water quality benefit	420 m	
Biodiversity benefit	Only localised studies, no national figures	
Recreation (only localised studies but visitor numbers suggest at least 1 million visitors per year)	$40 m	
Relative externality value comparison[5]	Dairy	Forestry
	-18 m	31 m
Note (1) See environmental sections (Appendix J and K) for explanation of estimates. (2) The overall national figures for eco-system services are based site specific examples. (3) Yao RT & Velarde SJ (2014) Ecosystem services in the Ohiwa catchment; Report to Bay of Plenty Regional Council, Scion. (4) See section J.3.2: Water quantity and flow moderation for explanation of net benefits. (5) Monge et al 2015, Scion. A relative externality value shows the impact of different industry's activity on society measured in comparable terms. Monge et al (2015) is a study of 26,000 hectares of dairy land and the equivalent amount of forestry land in the central North Island		

Source: NZIER

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1. Forestry industry summary

Figure 1 Summary

National economic contribution

National GDP

Forestry & logging contribute

$1.39b

to national GDP.

Plus a further

$2.16m

in downstream activity.

Exports

Forestry products exports total

$4.8b

Forestry products are the second largest commodity export after dairy products. Australia and China are the main destinations.

Domestic sales

Logs and sawn timber are the main forestry products domestically. Domestic sales are mainly tied to local construction activity.

Employment

9,500 FTEs

are employed in the forestry sector.

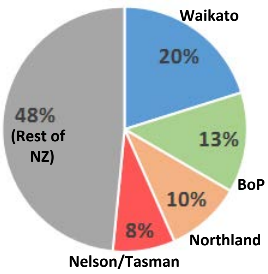
+ 2,000 Truck drivers

+ 900 Port services workers

Regional economic contribution

Regional GDP

Four regions (Waikato, Bay of Plenty, Northland and Nelson/Tasman) contribute over 50% of national forestry GDP.



Regional importance of forestry

Based on its share of regional GDP, forestry has the greatest significance to these regions:

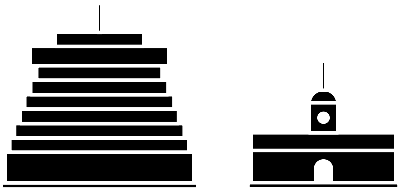
Region	Share of region's GDP
Gisborne	> 5%
Tasman/Nelson Northland Marlborough West Coast	> 1-4%

Regional employment

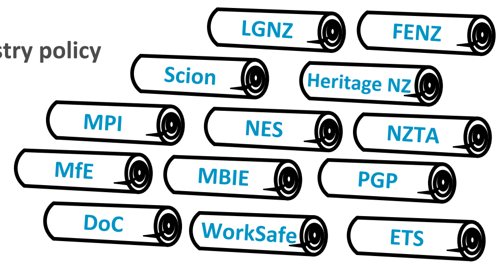
Source: Statistics NZ & NZIER

Central and local government

No single entity has control over all of forestry policy



Central government and local government develop the institutional setting (the regulatory environment).



Responsibility for government policy in forestry is spread over a number of government departments with no all-embracing national forestry policy.

Source: NZIER, icons8.com

Industry characteristics

Role of forestry managers

H&S

The majority of forest managers have robust health and safety standards because of the accountability of managers to owners, increased mechanisation, training, and operational transparency.

Number of forest owners

There are approximately

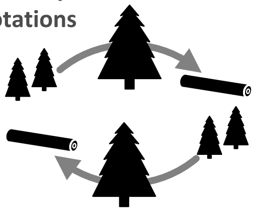
15,000

forest owners in New Zealand with forests of 5 ha or greater

Seasonal workers

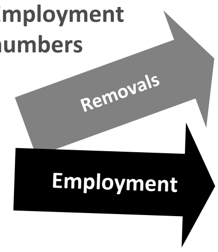
Finding workers for silviculture & planting is increasingly difficult. The outlook for seasonal workers may become increasingly important to the industry.

Forestry rotations



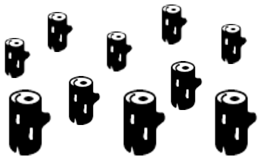
New Zealand forests have not declined in yield past the 2nd rotation; they have gained in productivity through better genetic selection and better management.

Employment numbers



Removals are increasing and employment is static.

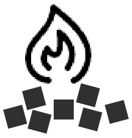
Stumpage values



Stumpage values remain flat.

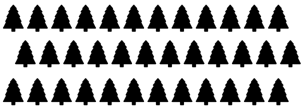
Environmental values are important

Waste



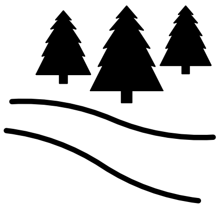
Sawdust is used to fuel sawmills.

Carbon capture



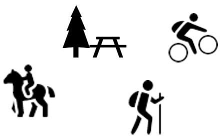
Sequestering carbon through forestry is one way to assist in meeting our climate change agreement targets.

Land stabilisation and water quality



Forests in general can also create value or save costs by providing soil stability, reducing erosion and run-off into streams.

Recreation & tourism



Recreational uses of plantation forestry blocks includes users walking, mountain biking, horse riding, trail biking, hunting and fishing.

Habitat

Plantation forestry blocks provide habitat for native species and support local biodiversity.

Source: NZIER, icons8.com

2. The brief

This report has been commissioned by the New Zealand Forest Owners Association and New Zealand Farm Forestry Association funded by the Forestry Growers Levy Trust Inc. These entities are looking to facilitate a better understanding of the role of forestry in the New Zealand economy, environment, and society.

Our main focus is on the planting, silviculture, and harvesting that occurs on site. However, we do examine some of the ancillary services such as logging trucks, port service workers, and refer to processing, exporting, the domestic market and its economic contribution.

This report sets out the data available and approaches that can be potentially taken to systematically collect data and to illustrate forestry's economic potential and facilitate further understanding (e.g. environmental statistics).

Where statistics are not well described (e.g. forestry employment), we have focused on examining different approaches that can be used to obtain estimates (using the principle of triangulation). By triangulation we mean using two or more methods to estimate data points in a particular area.

Our examination has been to:

- Briefly survey the existing situation
- Set out the framework for identifying the areas where data should be collected
- Describe our approach to collecting data and estimating contribution to the economy
- Conclude with some final remarks.

The study consolidates the information gathered into a useable format: we have included forestry's direct contribution as well as the indirect effects. The latter would involve looking at the forest sector's contribution to the demand for goods and services of other industries such as transport, and the flow on effects to other sectors such as wood processing, retail and newsprint.

The direct and indirect contributions are measured and highlighted as summary indicators such as output, value added, employment, wages, payments to capital and land, and taxes. There are also a number of important functions forestry performs that may or may not go through markets (the non-market valuations).

3. Forestry is different from other land-based industries

The forestry (growing the trees) and logging (harvesting the trees) sector is an integral part of New Zealand's economy, environment, and society. Therefore, it is important for the industry to properly reflect the industry's social and economic value through up-to-date and transparent data and context.

As a completely different industry from any other land-based industry it is also important to reflect its complete contribution to the New Zealand economy and society, particularly given its positive environmental impact.

Forestry statistics represent a challenge given the biological processes are quite different from other land-based industries e.g.:

- It takes between 25 and 35 years before harvesting occurs requiring long term planning (longer for Douglass-Fir, Cypresses etc.)
- Harvesting presents challenges and costs that other industries do not face (e.g. first rotation forests on hill country might require large road networks to be built)
- There are positive environmental benefits such as carbon capture, biodiversity gains, high water quality, land stability and recreational options from commercial forests.

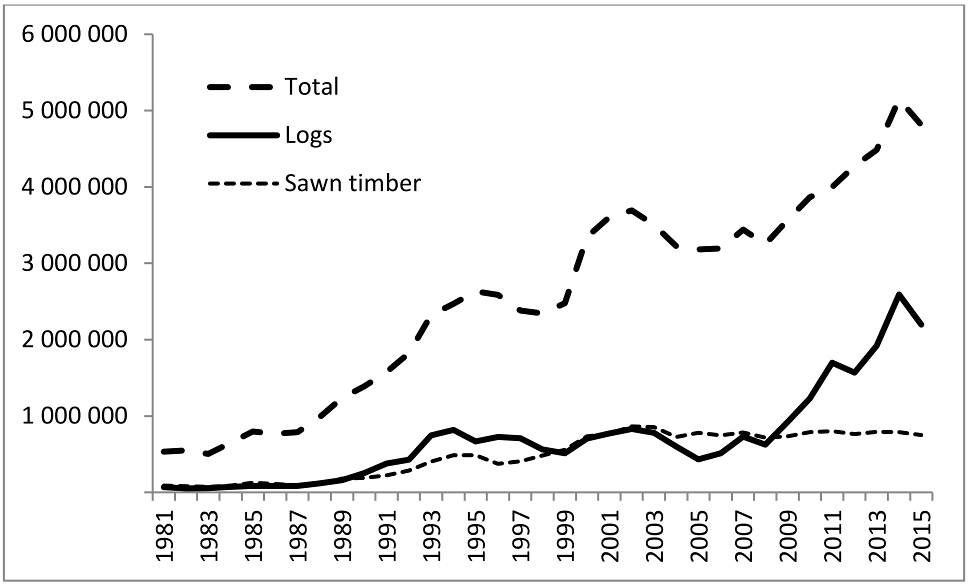
The Ministry for Primary Industries (MPI) sets out the parameters for forestry in the "*National Exotic Forest Description*". Key facts (p2) from that publication include:

- New Zealand's net stocked planted production forests covered an estimated 1.70 million hectares as at 1 April 2016
- The total planted forest standing volume is estimated to be 503 million cubic metres with an average forest stand age (area weighted) of 17.1 years
- As at 1 April 2016, New Zealand's net stocked forest area has **decreased** by 13,000 hectares from 1 April 2015
- Harvested areas awaiting either replanting or a land use decision decreased by 3,000 hectares in the year to 1 April 2016.

The forestry industry's importance to economic activity is highlighted in Figure 2 of selected forestry exports.

Figure 2 Exports of selected forestry products

Value, NZ$ 000s

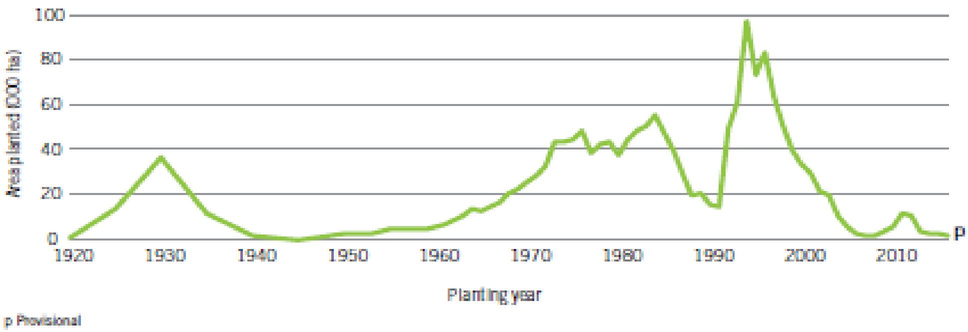


Source: Ministry for Primary Industries and Statistics New Zealand

Figure 3 shows new planting in New Zealand has declined from a peak in the mid-1990s to 3,000 hectares in 2015. Further plantings are dependent on:

- The profitability of selling logs
- Confidence in markets for all forestry products
- Confidence in future policy settings
- Further changes to the ETS scheme that favour New Zealand grown credits.[4]

Figure 3 New forest plantings 1920-2016



Source: National Exotic Forest Description, 2016 p5

Plantation forest sizes vary significantly. Further, we do not have a good statistical handle on the ownership profile. Ministry for Primary Industries (MPI) statistics

[4] There is some cause for optimism that as carbon credits rise in value the forestry planting supply response will also increase. However, there is a large debate about how emissions are accounted for after the wood is harvested. Some in the forestry industry would contend that the Government needs to give effect to the Harvested Wood Products emissions accounting to replace the current assumption of instant oxidisation at harvest in the liability rules.

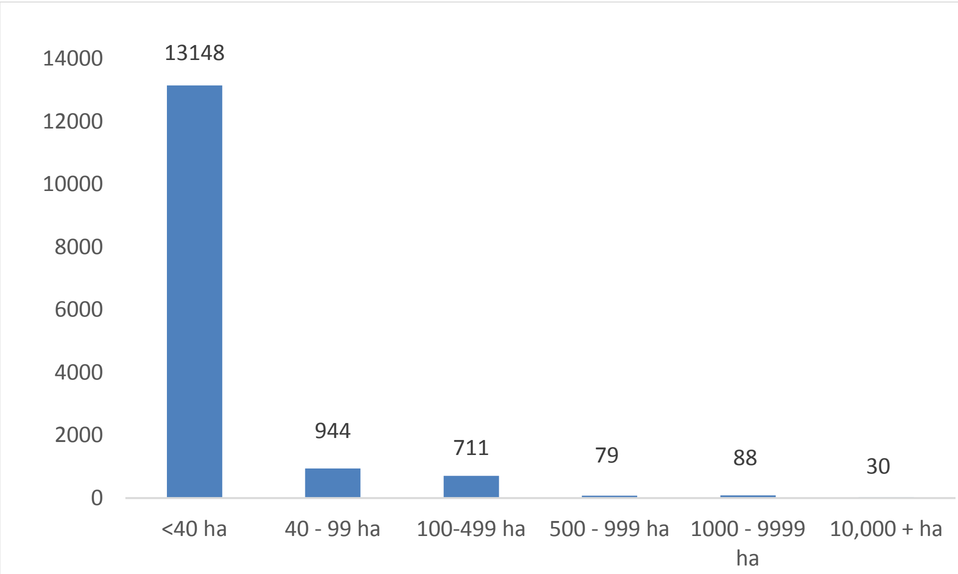
suggest that the majority of plantation forests are established on land holdings greater than 500 hectares (approximately 72%, National Exotic Forestry Description 2015, p25). The reverse is the case in relation to the numbers of owners. Approximately 89% of forest owners in New Zealand own less than 500 hectares (see National Exotic Forest Description 2015 p24).

However, these figures only represent larger known owners and are therefore biased towards those who report their situation. The number of forest owners reported in National Exotic Forest Description is 1,852 but the NEFD only surveys owners who hold more than 50 hectares. Thus the NEFD has an inherent bias as it does not survey the majority of the 15,000 forest owners estimated in Appendix C. Adding these numbers into the equation results in the number of forest owners by class size changing dramatically.

The number of forest owners with forests under 500 hectares rises to 98% when all forest owners are taken into account.

Figure 4 Adjusted forest owners by size class, 2015

Assumes that all the unidentified forest owners have forests under 40 hectares



Source: National Exotic Forest Description and NZIER

3.1. Non-market valuation

As an example of the quantification of the ecosystem benefits of plantation forestry. Scion (2014) has examined the eco-system services in the Bay of Plenty's Ohiwa catchment. It demonstrates a large positive ecosystem service value from exotic forestry of $5,609 a hectare each year (see Table 1).

Table 1 Value of ecosystem services from the Ohiwa catchment

Dollars per hectare

	$ per hectare
Carbon sequestration/emission and greenhouse gas regulation using $4 per New Zealand Unit	$48[5]
Avoided erosion and flood/disturbance regulation	$121
Regulating nutrient supply by avoiding leaching	$2,800
Pollination	$206
Water regulation	$6
Waste treatment	$244
Pest and disease regulation/biological control	$11
Water supply	$8
Recreation	$900
Species conservation	$257
Nutrient cycling	$994
Soil formation	$14
Net ecosystem services value in dollars per hectare each year	**$5,609**

Source: Source: Yao & Velarde, Scion (2014)[6]

Such values, if applied to 1.72 million hectares of planted exotic forest in 2015, would imply the generation of $9.6 billion per year in non-market benefits from forests in addition to the marketed output of wood and pulp products and recovered energy. However, a conservative approach should be taken in interpretation of these statistics. The ecosystem services approach is still at the experimental stage, uses mixed methods and is site specific and not able to be extrapolated or replicated across the country as yet. But even if the national average were only 1/5th that of the Ohiwa catchment in the Bay of Plenty ($1122 /ha/year), this would still amount to $1.9 billion of non-market value annually.

However, some forestry participants are frustrated that the current reported statistics do not fully reflect the importance of the industry in both economic and non-economic terms, particularly around:

- Estimates of employment in the industry
- The importance of the non-economic benefits of forests to New Zealanders.

Forestry's value is therefore understated. One of the reasons for this is that those trying to gauge the importance of the industry can only see part of the value that forestry is contributing.

5 Since mid-2016 the value of New Zealand Emission Units has been $15/tonne or more, which would make the value per hectare $180 or greater.

6 Yao RT & Velarde SJ (2014) Ecosystem services in the Ohiwa catchment; Report to Bay of Plenty Regional Council, Scion

4. Project organisation

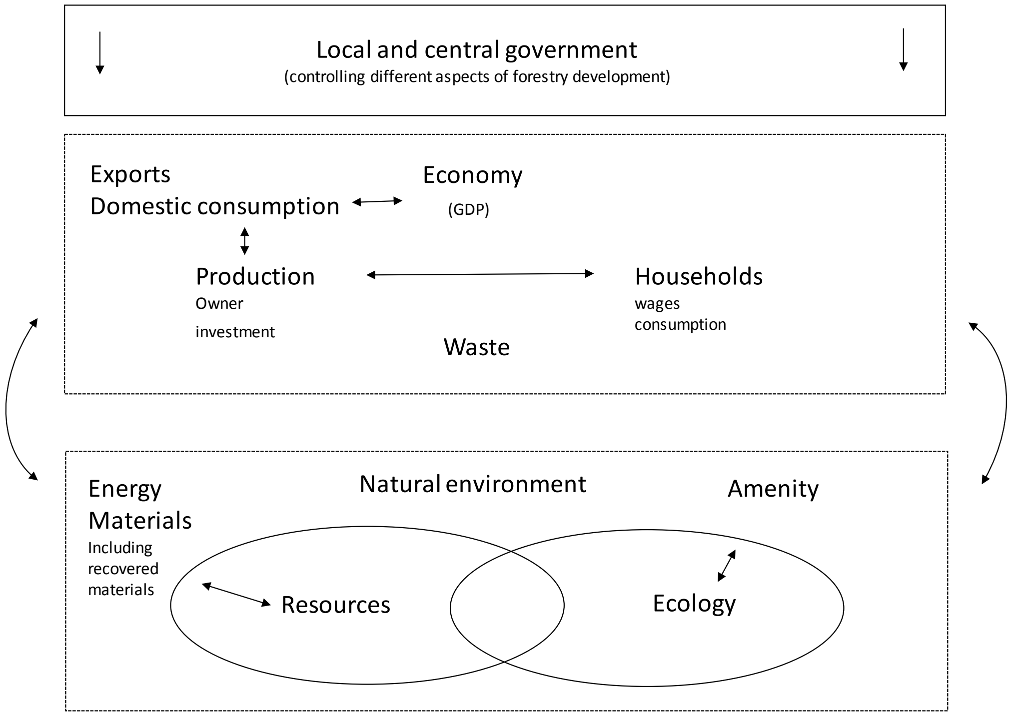
NZIER have constructed a simple model to demonstrate the relationships between forestry and the government, economy, society, and environment.

The model portrays a system of relationships which, although abstract, seeks to capture the salient elements of the real world. Any real world problem will have a large number of variables, often with complex, relationships between them. We wish to draw out the main points without the complications of all the issues. In this way we can focus on the issues that matter to the industry.

For example, one key advantage that the framework has is that it shows the positive contribution that forestry makes to both market and non-market values in New Zealand. Of particular importance, is the positive contribution forestry makes to the environment. This is portrayed in the following framework for the industry where we show the:

- Impact of central and local government control
- Domestic consumption and exports, employment, and economic activity generated by forestry through planting, silviculture and harvesting
- Environmental and amenity benefits delivered by forestry.

Figure 5 Framework for collecting plantation forestry statistics



Source: NZIER

Applying this approach, helps us to:

- Identify the important areas where we need to gather statistics
- Ensure that we cover the important activities of the forestry industry
- Demonstrate the interrelationships between economic and non-economic activity.

The design of the approach has been deliberately kept simple. We have abstracted from the detail of the physical and financial flows between the forestry industry and the economic, social and environmental forces that it interacts with. This approach allows us to capture and illustrate where available statistics “fit” within forestry activity and how to think about the use of those statistics e.g. do they contribute towards GDP calculations or other measures of value? And are they important?[7]

The approach focuses on the interactions between the government, economy, and the physical environment. Central and local government develop the institutional setting (the regulatory environment). Investment, domestic processing, export supply etc. are determined by firms through their interaction with households (e.g. through the supply of labour and demand for outputs). From both the production process and households, waste is generated with some of it recoverable (particularly in the processing industry).

Also important is the interaction between the market activity and the physical environment (e.g. households and the amenity, industry and the resource base, the interaction between resources and ecology etc.).

In this project, we have captured and reported on the work that identifies the various areas (amenity values and mountain biking, the role of forests in protecting flora and fauna), and other interacts that are important.

[7] It also allows us to understand where the gaps are in forestry statistics.

5. Conclusion

To inform the statistical approach we ensured that:

- Where practicable the principle of data triangulation was used where there is some question about its validity
- We engaged with policymakers prior to putting statistics together. In particular, with Ministry for Primary Industries and Statistics New Zealand.
- We spoke to industry participants to further understand the issues around forestry statistics.

We have set out to collect a comprehensive data set for forestry.

- Government policy (Appendix A)
- Market values: export and domestic (Appendix B)
- Number of forest owners (Appendix C)
- Employment (Appendix D)
- Seasonal overseas workers (Appendix E)
- Portable sawmills (Appendix F)
- Forestry rotations (Appendix G)
- Components of the value chain (Appendix H)
- Contribution to GDP: national and regional (Appendix I)
- Environmental values and studies (Appendices J and K)
- Potential satellite account (Appendix L).

The summary statistics are set out in the key facts section and the pictorial summary statistics at the beginning of the document. All other statistics are in the appendices.

Appendix A Government policy

A.1 Most change has occurred to plantation forestry management

New Zealand has large tracts of indigenous and plantation forests. Over time these forests have provided many benefits for society, the environment and the economy.

Most of the indigenous forests are owned by government. The Crown owns 5.187 million hectares of indigenous forest or nearly 83% of the total indigenous forests in New Zealand. The Department of Conservation manages this on behalf of the Crown. Other indigenous forests are in private ownership or owned and controlled by Māori entities.

Most of the changes in government forestry policy since the 1980s have related to plantation forestry. At one time the government owned at least 50% of the plantation forestry and large processing facilities. It has divested itself of its ownership of forests to facilitate Treaty Settlements with iwi with wood processing now solely owned by private sector companies. The current government has signalled to the sector that it will attempt to sell down its remaining forests overtime, though climate change policy imperatives could see that position change.[8]

A.2 There is no one government entity responsible for forestry

Responsibility for government policy in forestry is spread over a number of government ministries and departments with no all-embracing national forestry policy:

- This means needs of research, training, biosecurity, and policy advice are being delivered by different parts of government
- There is a longstanding lack of recognition of the long term (positive) consequences of forestry and the positive externalities generated by a long term sustainable crop, especially compared to Switzerland, Germany and elsewhere in Western Europe i.e. the prices received for forestry products do not reflect its positive contribution it makes to society, particularly the positive environmental impact.

The Ministry for Primary Industries (MPI) and its predecessor MAF, have over the past decade, largely focused on the role of planted forests in relation to climate change, and to a lesser extent the institutional relationships creating blockages to innovation within the sector. MPI initiatives include a limited afforestation grant scheme, Primary Growth Partnership projects for steepland harvesting and Methyl Bromide control and recapture at ports for export logs, a proposed National Environmental Standard for Plantation forestry (RMA), erosion control funds, biosecurity control, wilding pines etc.

[8] Conversation with Forestry Owners Association (FOA).

A.2.1 Carbon capture is likely to become more significant

The Ministry for the Environment's primary focus on plantation forests relates to carbon sequestration and emissions the NZ ETS. Currently, the ETS covers land use change (deforestation in pre-1990 forests, driven largely by dairy conversions), afforestation, transport and energy (42% of total 2012 emissions), industry (7% of total 2012 emissions) and waste (5% of total 2012 emissions) but not agriculture (46% of 2012 total emissions, and rising).

In October 2016, the government ratified the Paris Agreement that aims to limit global warming "well below" 2 degrees Celsius, and possibly below 1.5 degrees Celsius, by 2100, as part of an ultimate global commitment to go to Net Zero emissions.

New Zealand will now have to develop a plan that reduces emissions to 30 percent below 2005 levels by 2030. Sequestering carbon through forestry is likely to be part of this strategy. A possible increase in the carbon price could help this process (i.e. MfE's lead policy official Kay Harrison has signalled price projections of NZ$50 to $300/t).[9]

Forestry has a positive role to play in New Zealand's approach to a carbon policy. How to date, the government has been slow to partner with the industry to ensure the best outcomes for New Zealand.

A.2.2 The challenges of biosecurity and GMOs

Biosecurity is an issue for some forestry stakeholders because of the risks of a biosecurity breach allowing in pine pitch canker or other defoliation disease that impacts *Pinus radiata*.

One possible solution to this issue is the use of gene editing (CRISPR technology) or other genetic modification technique. Innovation in Biotechnology could see:

- Improved uniformity and wood properties
- Potentially shorter rotations
- Increased genetic resistance to pests and pathogens[10]
- Prevention of wilding spread from any new stands (through deployment of sterile clones).

However, there is considerable resistance within New Zealand to growing GMO crops. It will require significant consultation with the public to arrive at a situation that is supported by the majority of New Zealanders.

A.2.3 Science and innovation will be crucial

The Ministry for Business, Innovation and Employment's (MBIE) involvement in the forestry sector is primarily concerned with funding research. A recent project made $5 million available for research into developing a broader range of high value wood products from different species of trees.

The CRI Scion and its connections with the forest producing sector has is important in highlighting the value of forestry in the primary sector landscape & economy. Scion

[9] www.radionz.co.nz/news/national/316003/nz's-greenhouse-gas-bill-could-top-$70-billion
www.carbonnews.co.nz/tag.asp?tag=Carbon+prices

[10] See http://woodco.org.nz/images/Woodco_BiotechnologyPositionStatement_101116_public.pdf

are funded mainly by government to underpin, protect, and future-proof the forestry industry in New Zealand. Its research spans forestry management and tree improvement, biosecurity and risk management, wood processing, and forest-based ecosystem services.

A.2.4 Health and safety focus

A big recent challenges which will escalate over the next ten to twenty years is to improve health and safety standards, especially amongst some of the smaller players who will make up an increasing large part of the harvesting industry.

This is compounded by the potential for general rural earthwortks contractors to enter the forest industry as the demand for harvesting contractors ramps up. The ease of entry means that extra effort will be required to ensure that good health and safety levels are met and maintained.

The forestry industry is heavily involved in safety initiatives. The Forestry Industry Safety Council (FISC) is responsible for the Independent Forestry Safety Review (IFSR). The role of FISC is to document, evaluate and share forestry safety initiatives across the sector. By engaging with the industry in this way they can constructively assist government as a health and safety partner.

Most contractors and corporate forest owners have robust health and safety standards because of the accountability of managers as PCBUs under NZ's 2015 H&S at Work Act, increased mechanisation, training, and operational transparency.

Worksafe NZ provides educational material,[11] codes of practice, assessments, monitoring and enforcement. It also provides regulation and investigations of health and safety system failures. Worksafe has a focus on forestry because of the historical high rates of serious injuries and fatalities, the physical nature of the work, steep terrain, and the use of specialist heavy machinery including cable log extraction (hauling) systems.

[11] This includes educating duty holders about their work health and safety responsibilities (e.g. through guidance) http://www.worksafe.govt.nz/worksafe/about

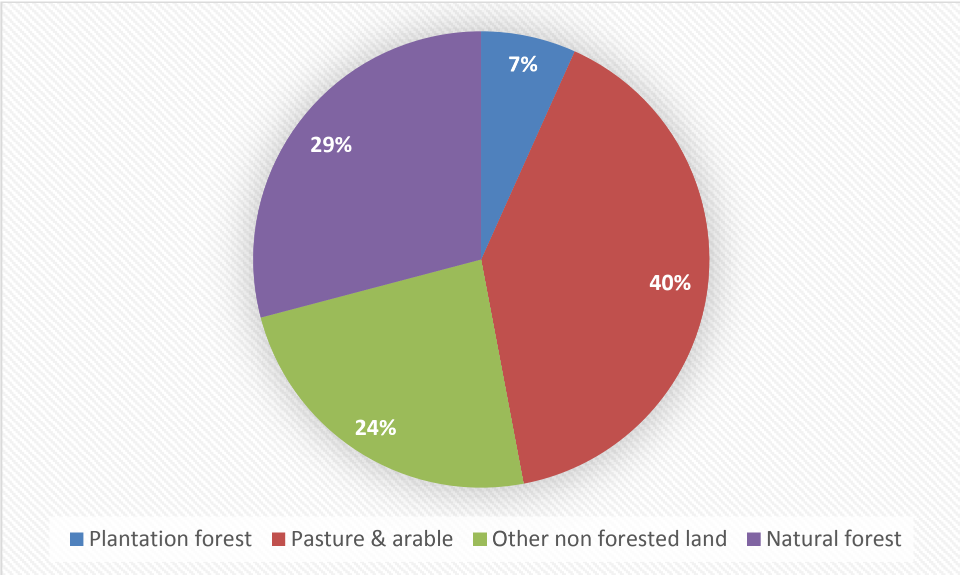
Appendix B Market values

Forestry is a substantial part of the New Zealand economy and in recent years the second largest commodity export after dairy.[12] Most commercial forestry use exotic tree species which are relatively fast growing in the New Zealand environment and yielding a range of wood qualities for use in sawn timber production, reconstituted panel products, pulp and paper manufacture.

Figure 6 below sets out New Zealand land use. Plantation forests use 1.8 million hectares of land (7%).

Figure 6 Land use

2016



Source: Forestry Facts and Figures (2015/16), New Zealand Forest Owners Association

Pinus radiata is the predominant species grown in plantation forestry in New Zealand, currently accounting for about 90% of planted area, 93% of harvested volume and 94% of exports by value.

Douglas-fir is the second most important species with about 6% of planted area and 4% of annual harvested volume.

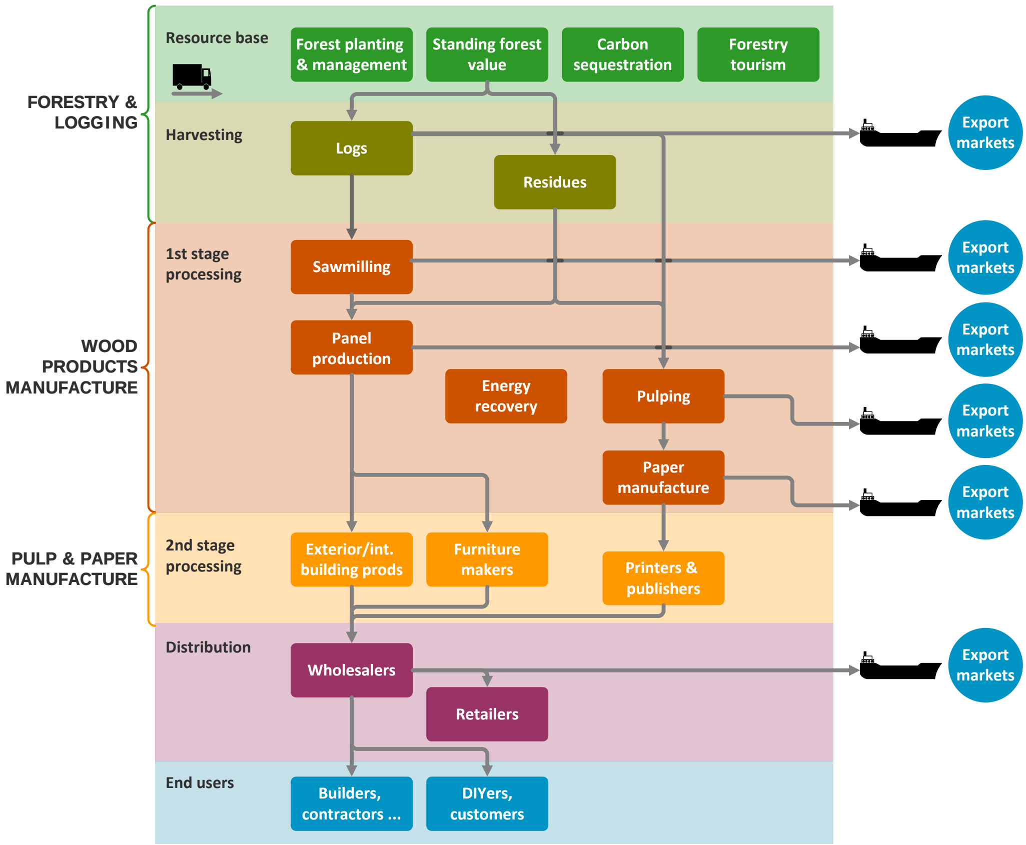
The remainder of exotic forests comprise *California Redwoods, Eucalyptus*, *Cupressus* and other "minor" or special purpose species. A part from Douglas fir, minor species face quite different marketing chain challenges in both growth and use, as described below.

[12] That is, if you split beef and veal and sheepmeat and wool into separate categories.

B.1 Economic connections of forestry

Forestry in the national accounts comprise forestry and logging, wood products and pulp and paper manufacture. The connections between these and other parts of the value chain are outlined in Figure 7 below.

Figure 7 Connections between industries in the forestry sector



Source: NZIER

Forestry and logging covers the management of the resource base – the planting and management of plantation forests – and harvesting.

First stage processing includes the New Zealand wood processing and manufacturing industry, which produces sawn timber, veneers, plywood and reconstituted panels such as fibreboards, and the pulp and paper manufacturing industry.

Second stage processing involves industries whose products have more specific wood components, including hygiene products and composite building materials for the construction industries. Furniture making, printing and publishing (other than online and electronic media publishers) are very minor end uses for New Zealand grown wood fibre.

The term 'forestry' is commonly applied only to forestry, logging and first stage processing, in which forest products (wood-fibre) comprises 25% or more of the value of inputs (according to Statistics New Zealand's Input-Output tables). In second stage processing, non-wood inputs comprise more than 80% of total input value, and more substitutes exist for wood-fibre (e.g. steel framing in building, metal or plastic furniture, or cement and wood pulp composite wall cladding or cardboard wrapped plaster board interior wall linings) so the share of economic value added attributable to wood or tree species is lower than in first stage processing.

Figure 7 above also shows that the wholesale and retail trade and transport operators are involved in the distribution of forest products to domestic and export markets. If these services are specialised to distributing forest products, they would face a short term loss of revenue in the event of disruption of the wood harvest. But such services as building supplies wholesaling and retailing often trade in more than just forest products, and in the longer term, resources in these distribution services would be redeployed to other things, so they are less directly part of the value at risk from threats to forestry activity.

Other features to note from Figure 7 are:

- While the main material flow between forestry-related parts of the value chain is of logs from harvest to wood processing and pulping, there are also large flows of residues from both harvesting and sawmilling activities that are collected and provide inputs to reconstituted wood products (e.g. MDF panels and chip board flooring) and wood pulp manufacture
- Residues are also used to provide heat and power to parts of the manufacturing process, particularly in pulp making and timber drying, providing value savings in the cost of energy. In the South Island, wood fibre is also used as a feedstock for bioenergy production i.e. wood pellets for domestic home heating and wood chips for commercial and industrial heating[13]
- There is limited commercial value in standing forests in their role as the setting for forest-based recreation and tourism
- There is a role for plantation forests to foster biodiversity as a home for kiwi, falcon, karearea, kokako and other native birds, skinks, frogs, native fish bats, plants, and invertebrates
- There is potential value to be gained by storage of carbon under New Zealand’s greenhouse gas accounting system (but also matching emissions liability under the NZ ETS).

The harvesting of trees seldom impacts domestic recreation and tourism since in forests such as Woodhill, Bottle Lake and Naseby the clubs or concessionaires are generally able to move their operations. However, it does have an impact on carbon storage and biodiversity, at least in the short term until forest growth recovers.

In economic terms an estimate of the contribution that forestry makes is set out in Table 2.

These figures are based on preliminary estimates (for biosecurity purposes) of economically valuable plants.[14] While the NZIER estimates are only approximate,[15] and

13 The wood processing industry has long utilised bio-energy for a good portion of its energy needs.

14 This is an initial examination of the impact of selected economically valuable plants. At this stage it does not include native plants.

15 Relatively simple approaches to estimates for GDP contribution were produced because of costs (therefore estimates are only approximate).

have been devised for ranking purposes only, they do point to the importance of plantation forestry products.

Table 2 Ranking of selected economically valuable plants

2012 base year, $ M

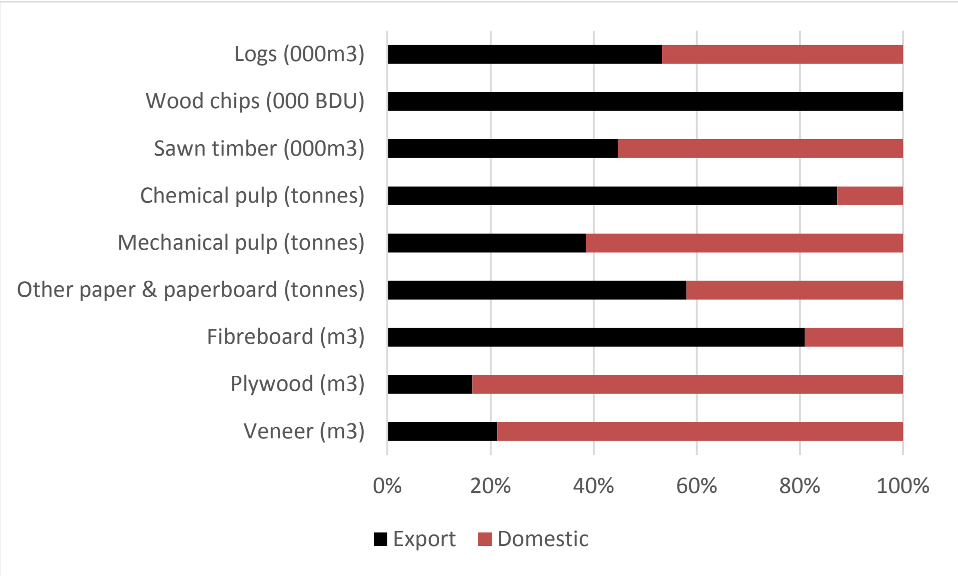
Ranking	Plant	Estimate (including dependent industry)
1	Rye grass	14,000 – 15,000 million
2	Pinus radiata	3,500 – 4,500 million
12	Douglas-fir	150 – 200 million
23	Eucalyptus	30 – 50 million
31	Cypress	15 – 25 million

Source: NZIER (2016) How valuable is that plant? Working paper for the Ministry for Primary Industries

Further the split between domestic and export forestry products is set out in Figure 8. The domestic wood products market is a significant part of New Zealand's economic activity, even without taking into account domestic and overseas tourism, recreational activities, and the contribution of eco system services.

Figure 8 Export-domestic split

June year 2016



Note that wood chips do not include MDF, wood chips used in energy production or wood chips used in sheds, particularly for over-wintering dairy cattle. Further it does not include woodchips generated in sawmills that are mainly used domestically in pulp and fibreboard production.

Source: Forestry Facts and Figures (2015/16), New Zealand Forest Owners Association

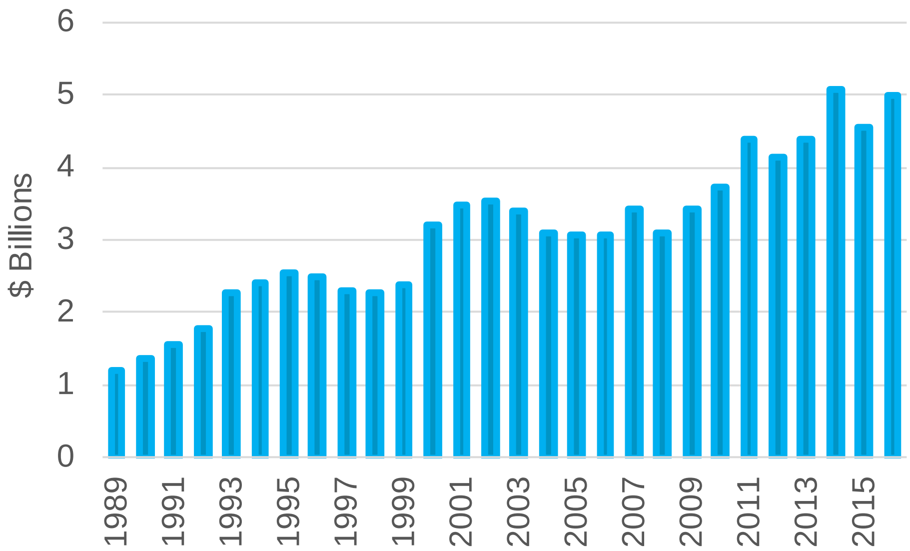
B.1.1 Non-market considerations

Plantation forests can also create value or save costs by providing soil stability, reducing erosion and run-off into streams, and moderating water flows, but these effects are often experienced as externalities that do not provide commercial return to those who own the forests.

B.2 Exports

The data comes from Statistics New Zealand (SNZ). We have good data on all products[16] that cross the New Zealand border. Forestry exports have risen from below $2 billion in 1990 (inflation adjusted) to nearly $5 billion in 2015 (see Figure 9). The rise in value has been production-led driven by plantings in the early to late 1980s. MPI expect that forestry value will reach $6,000 million by 2020.

Figure 9 The rise in forestry exports



Source: Statistics New Zealand

B.2.1 Export destinations

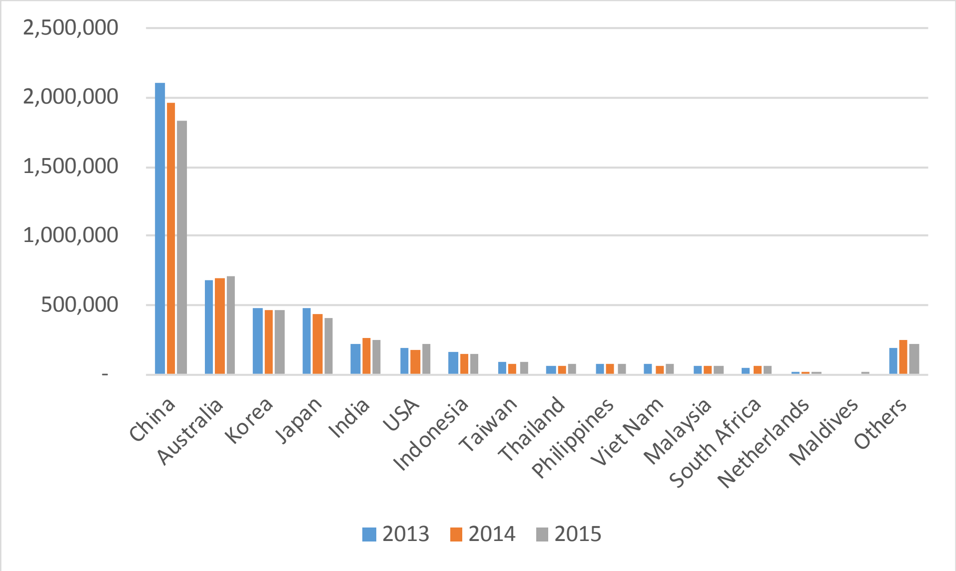
The plantings of the late 1980s and early 1990s coincided with the integration of China on to world markets. A sustained infrastructure boom in China has created a maturing demand for logs. Demand from other markets has remained steady.

The importance of China is set out in Figure 10. Roughly 80% of the exports are logs. Australia and Japan take a wider range of wood products (logs, lumber, wood pulp, paper & paperboard, and panel products). The Republic of Korea has a similar, but much smaller, importing profile to China.

[16] The information on services is less clear.

Figure 10 Exports of wood products by destination

December years, NZ$



Source: Forestry Facts and Figures (2015/16), New Zealand Forest Owners Association

Most of the forestry exports are channelled through ports on the east coast of the North Island. Three ports (Whangarei, Tauranga, and Gisborne) export 63% of all sawn timber and log exports. Without forestry exports the Gisborne port would not be viable.

Table 3 Volume of sawn timber and logs exported by port

Quantity m^3

	Sawn timber	Logs	Share of sawn timber & log exports
Whangarei	10,182	2,613,742	15%
Auckland	198,896	122,602	2%
Tauranga	837,189	5,158,739	35%
Gisborne	279	2,167,697	13%
New Plymouth	-	280,692	2%
Napier	322,048	1,012,167	8%
Wellington	2,173	930,446	5%
Nelson	114,284	559,081	4%
Picton	1,561	665,150	4%
Christchurch	132,805	421,320	3%
Timaru	537	258,958	2%
Dunedin	73,328	773,555	5%
Invercargill	93,721	431,486	3%

Source: Forestry Facts and Figures (2015/16), New Zealand Forest Owners Association

B.2.2 Domestic consumption of forestry products

Understanding the markets associated with domestic activity is much more difficult. Products that do not cross a border are typically not as well tracked.

The fiercely competitive nature of the domestic market also means that information is tightly held by companies involved in the trade e.g. BRANZ does a quarterly survey that indicates approximately the breakdown between steel framing (6%) and wood framing (94%) for houses.[17] However, apartment buildings are more likely to favour concrete or steel framing.[18]

We expect further pressure in this market as smaller incumbents feel increased economic pressure because of their lack of scale.

Sawn timber

The past few years have seen an increase in domestic consumption of sawn timber. Per capita consumption of wood has remained flat, although New Zealand experienced 40% population growth since 1990.

Further, the total production of sawn timber has also remained flat since 2011, despite a decline in exports. Domestic production of sawn timber has increased at the expense of export sawn timber.

The sharp dip in sawn timber production in 2009/10 followed the GFC and coincided with a reduction in demand for sawn timber from New Zealand and abroad, but an increase in export log prices.

Total sawn timber production is approximately 4.0 million cubic metres with 2.3 million cubic metres domestically consumed. This is a dramatic increase from 2011 where approximately 1.7 million cubic metres was consumed domestically. The main reason for this has been the huge growth in demand from:

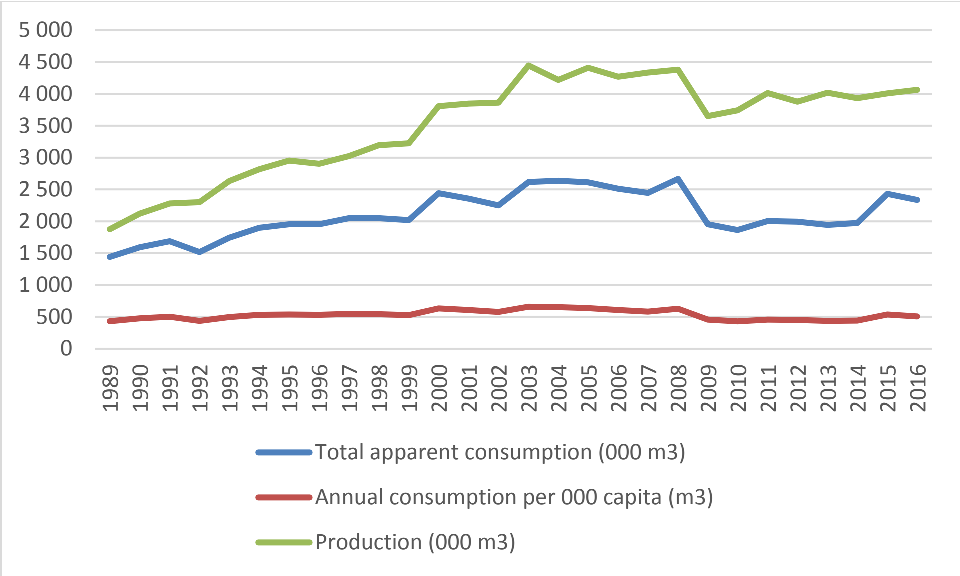
- Christchurch because of the post-earthquake construction boom
- Housing demand, mainly in Auckland due to increased population pressures.

17 Pers. Comm. Ian Page, BRANZ. 16th February 2017.

18 The article referenced in this footnote sets out what we know about the battle between wood and steel framing. http://www.stuff.co.nz/dominion-post/business/residential-property/9435020/The-battle-between-steel-and-wood

Figure 11 Domestic production and consumption of sawn timber

March years (000s, m^3, total consumption and production, m^3 per capita consumption)



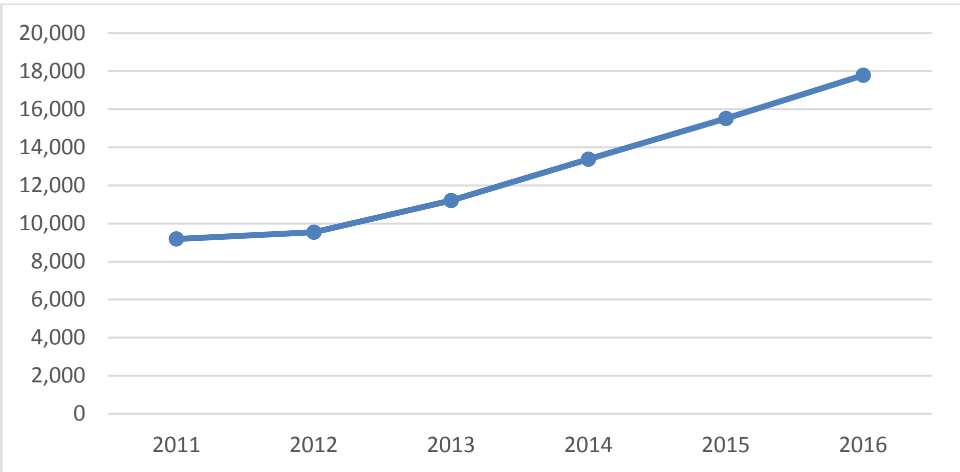
Source: Statistics New Zealand

Figure 12 below sets out the value of consents, rising nearly 80% in the past 5 years.

BRANZ forecasts in 2011 suggested that sawn timber increases under quite sober assumptions could increase by 146,000 cubic metres (on 2010 consumption of 832,000 cubic metres).[19] Because of the Christchurch earthquake and high population growth (fuelled by migration) this assumption has been dramatically exceeded with total consumption approximately 1.42 million cubic metres (an increase of 600,000 cubic metres).

Figure 12 Value of building consents

$ Millions



Source: Statistics New Zealand

[19] The time period for this potential increase was not specified by BRANZ.

Other uses for sawn timber include:

- Agriculture (e.g. fencing, structures such as hay sheds etc.)
- Manufacturing (e.g. furniture etc.)
- Transport and storage (pallets, creates and packaging)
- Civil infrastructure (port facilities, formwork for concrete, civil structures, etc.)

Is the future LVL and CLT?

New technology is also having an impact on sawn timber consumption. The development of laminated veneer lumber (LVL) and cross-laminated timber (CLT) are becoming increasingly important in New Zealand construction. LVL is an engineered wood product that uses multiple layers of thin wood assembled with adhesives. CLT is layers of timber that are glued perpendicular to their adjacent layers - cross lamination.[20]

LVL has been around for some time but it only in recent years that it has been sawn to specifications (e.g. 90 x 45mm) to compete head on with sawn lumber, while CLT is relatively new to the New Zealand market. According to BRANZ (2015), over the past twenty years there has been some remarkable progress in the technology using LVL and CLT in building structures.

These engineered woods provide greater carrying loads over longer spans relative to conventional sawn timber and also use knotty woods. This is significant advantage and potentially opens up new market possibilities.

CLT and LVL materials are becoming favoured by the many design professionals in the engineering community in New Zealand given their uses in seismic resistant design for earthquake prone areas. A number of high profile buildings such as the Tait Electronics building in Christchurch use CLT and LVL. In the recent Kaikoura earthquake the newly completed Kaikoura District Council building, which makes extensive use of CLT came through the earthquake unscathed. The three- storey building has been used as the civil defence headquarters.

BRANZ (2015)[21] suggests that CLT and LVL products will become extremely important building materials in the Asia-Pacific region as their properties are realised by the markets. Already the prospects for the use of CLT and LVL are very good in the New Zealand market. Both Juken New Zealand and Nelson Pine Industries have developed quality LVL products – most of which is exported.[22]

Currently, LVL and CLT face strong competition from imported Chinese steel in the New Zealand market. However, if Chinese steel continues to have quality and anti-dumping issues the case for increased use of LVL and CLT will improve.

LVL and CLT products are also much more environmentally friendly than steel. The potential for this technology is large. Government encouragement will ensure that this part of the industry maximises its chance of success.

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20 For further information see: http://www.wpma.org.nz/UserFiles/WPMA/File/New_Zealand_Pine_E-Manual.pdf

21 http://www.branz.co.nz/cms_show_download.php?id=b2f57abbdf05f70b1b8eda1dfed82dd38ead0d30

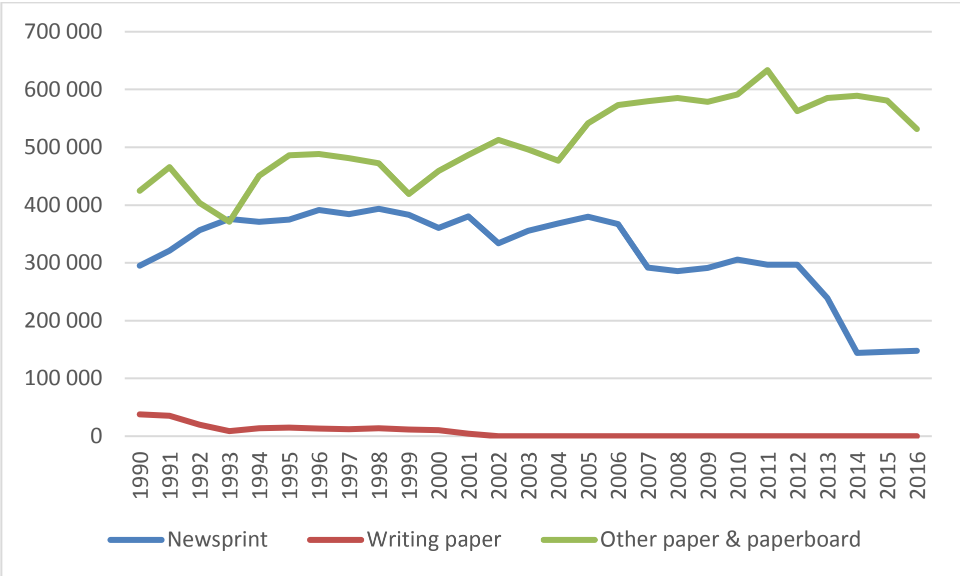
22 The majority of LVL products are exported and include LVL beams, ceiling battens and stair treads.

Newsprint

Newsprint production, has declined dramatically over the past five years, driven by declining exports and domestic market sales. The main reason for this has been the decline in demand for newsprint as consumers switch to electronic media. All major daily newspapers have declining circulations, paper products such as diaries are declining in sales, businesses use paper more efficiently, and emails are replacing letters. PwC (2012)[23] expect this decline in paper products to continue as the shift to electronic media increases.

Figure 13 Newsprint, writing paper, and other paper & paperboard

Production, Tonnes, March years



Source Ministry for Primary Industries

Pulp

Production in pulp has remained relatively stable over the past thirty years, although it has declined since 2011/12. Currently production is approximately 1.4 million air dried tonnes much of which is exported. Production is down from 1.6 million air dried tonnes in 2011 to 1.4 million air dried tonnes in 2016 driven by a reduction in domestic newsprint consumption (production of tissue and hygiene products are mainly made from imported pulp or recycled fibre). The decline in demand for newsprint has been a major reason for the reduced pulp consumption in New Zealand.

Pulp exports are up since 2011 driven by increased Chinese demand, although the demand has not been as great for pulp relative to logs. The demand for market pulp is expected to soften over the next five years as global supply increases.[24]

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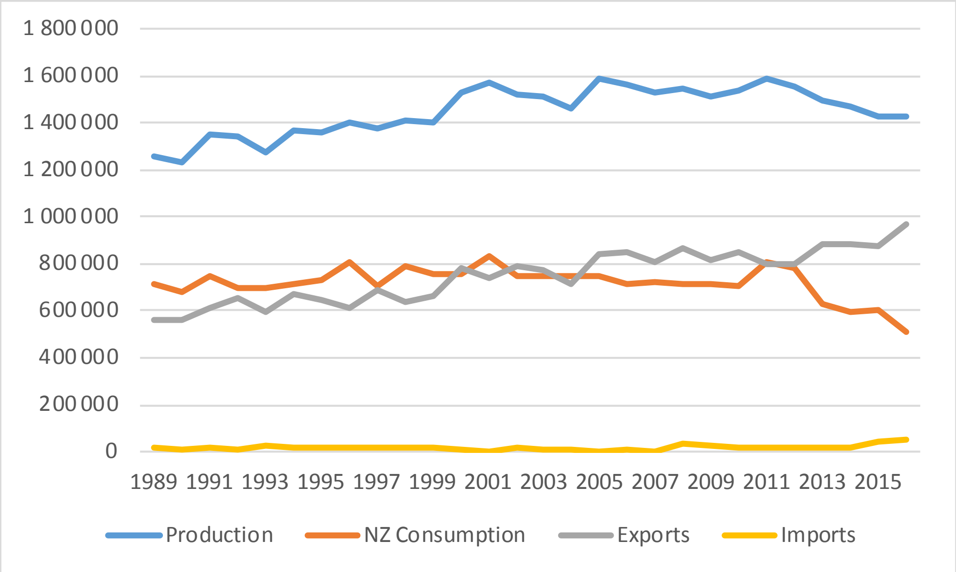
[23] Quoted in the New Zealand Herald http://www.newshub.co.nz/business/can-the-paper-industry-survive-in-new-zealand-2013011613.

[24] Pers. Comm. Dr Jon Tanner 18th December 2016.

Pulp imports are up to approximately 50,000 tonnes in 2016. Imports have increased with the ending of hardwood pulp manufacture at Tasman. Imported hardwood pulp is being used at the Kawerau tissue mill (ex Caxton) and also used at Kinleith for speciality paper board.[25]

Figure 14 Total pulp production, New Zealand consumption, exports, and Imports

Air dried tonnes



Source: Ministry for Primary Industries

Woodchip industry

We have almost no volume numbers on the local wood chip industry, although we know volumes are small. However, interest is growing in the woodchip industry for bioenergy both from government and potential users.

The Energy Efficiency and Conservation Authority (ECCA) believe that wood energy has numerous benefits – economic (lower unit running costs than diesel LPG or electricity), social (increased local employment) and environmental (lower CO_2 emissions). But like any fuel, there are pros and cons. If the sole criterion is fuel cost, then wood is unlikely to be cost effective relative to coal, which has fallen drastically in price and is cheaper to buy.[26] Looking at the bigger picture however, wood can be cost-effective – when considering environmental and social factors. As a result, ECCA have assisted 31 schools to switch from coal to wood energy, under the Renewable Heating in Schools pilot, with the Ministry of Education. Reasons for assisting the change include:

25 Once the eucalyptus plantations were depleted there was no raw material to make hardwood pulp in sufficient quantities. Growing eucalyptus for pulp is less profitable due to the slower growth rates relative to warmer and wetter climates such as Brazil, Indonesia, Vietnam etc. Pers Comm. Dr Jon Tanner 20th December 2016.

26 Cheaper coal is mainly due to the introduction of fracking in the US market which has produced large amounts of cheap gas. This has displaced coal in the US market which is now being exported in large quantities. As a result, the price of coal around the world has tumbled.

- In cities like Christchurch and Dunedin, emissions standards for new boilers are very stringent due to air quality constraints. Emissions control equipment on a coal boiler can cost as much as the boiler itself. Switching to wood was often a low-cost option when assessed on a ‘whole-of-life' economic basis because of on-going operations, maintenance, and labour costs were lower
- Modern wood energy technology can produce 80% less particulate (PM10) emissions than older coal boilers. Some types of coal discharge heavy metals (including mercury) plus sulphur and nitrous oxides to the air – as well as other pollutants that worsen air quality and can be harmful to human health
- Coal ash can be toxic, so needs careful disposal to prevent soil contamination. Wood produces only about a fifth of the volume of coal ash – and as a natural fertiliser can be simply spread on school grounds. Many of the pilot schools commented positively on the reduction in waste disposal costs, and found caretakers spent far less time cleaning boilers.

A number of hospitals (e.g. Burwood in Christchurch) and other medical and aged care facilities have converted to woodchip burners for similar reasons.

Industry is also taking a closer look at woodchips as a source of energy. Heavy industry (e.g. cement works), commercial enterprises (such as office blocks), and exporting business (e.g. wineries) have found that woodchip burners are cost effective and environmentally friendly. This not only saves money through “whole of life economic costings” but also assists in branding products by reducing their carbon footprint.

BRANZ – the building research and testing agency – has also installed a woodchip burner in its office complex. Their view is that it reduces fossil emissions and reduces running costs, despite the high initial capital investment.

Other uses for woodchips include bedding for cows over-wintering in purpose built sheds. If this practice continues to increase, then the demand for woodchips will increase dramatically.

Wood pellets

Wood pellets are a dense form of biomass produced from the forest industry. Residues come from both harvesting and processing depending on price, availability, and transport costs. The production and demand for wood pellets has increased considerably in recent years around the world as countries looked to meet their emissions targets.

Pellets are the highest grade wood fuel providing a consistent, high energy density, and easy to handle product. They do however require specialised plant[27], special storage (i.e. must be kept dry), and availability of alternative sources of fuel is always an issue since it is usually cheaper (BANZ[28], 2010).

[27] BANZ (2010) commented that the choice of wood pellet heating relative to other heating forms such as from electricity is constrained because of a lack of familiarity with wood pellet heaters and poor performance by some previously installed equipment.

[28] Bioenergy Association of New Zealand.

The market for wood pellets in New Zealand is well established. There are two major producers (in Nelson and Taupo)[29] who provide fuel for both residential and industrial burners.

Domestic consumption statistics are scarce but most pellets are consumed in Canterbury and Otago.[30] Since 2010 the household pellet market has been through a major downturn which it is only now just recovering from.[31] The recovery may be further helped by recent ECAN and Nelson City Council rules stating that pellet burners are low carbon emitters and do not require a consent to be installed.

The distribution of wood pellets in Canterbury is well established and pellets are easily available. In other parts of the country (according to BANZ) pellets can be purchased:

- Directly from the producers
- At local hardware DIY stores and service stations in 15kg bags
- At heating specialists.

BANZ estimates that 80% of pellets are sold through retail outlets.

The increased popularity by householders of pellets has been driven by the replacement of open fires to more efficient forms of heating. However, the current growth potential for household use of wood pellets is limited. This is because of previous house design approaches; although as new heating design approaches become more common and new regulation has an impact, pellet burners are likely to become more popular.

Commercial use of pellets is also growing and the government has provided leadership on the conversion to pellet burners. More than 40 schools have converted to using wood pellet fuel.

There are several examples of innovation in pellets use, not least Radford Yarn Technologies, an innovative Christchurch manufacturer of high - quality carpet yarns who converted from electricity to wood pellets for its primary energy.

The supply of wood pellets to commercial scale buyers requires bulk delivery capability. Consistency of product, overseas market regulations (particularly tightening EU regulations), and easy handling are some of the advantages that firms state for opting for pellet burners.[32]

Further the ease of obtaining, storing, and handling wood pellet fuel with its low ash characteristics makes it an ideal fuel for operators such as school or institutional heating.

Firewood

Firewood market volumes are difficult to quantify. However, the regional firewood markets are highly competitive indicating a vibrant market. Price comparisons

[29] While the Taupo plant was set up to export pellets only a small amount is exported, given the low prices.

[30] BANZ (2010), New Zealand Wood Pellets: Making the most of National and International Opportunities. Occasional Paper No. 18, 28th July 2010.

[31] Pers. Comm. Brian Cox, 10th February 2017. One of the main reasons for this is that heater retailers – in the past - preferred to promote efficient wood burners in preference to wood pellet burners.

[32] Pers. Comm. Brian Cox 10th February 2017.

therefore are readily available in the market. As an example, we set out below the various costs of different types of firewood in New Zealand.

Another indication of the importance of firewood is that Consumer magazine provides a guide to buying firewood focusing on storage, drying, and discusses the use of wood burners and open fires.

According to www.firewood.co.nz prices of firewood vary markedly between cities i.e. prices of firewood in Auckland and Wellington can be 80% more expensive than in Christchurch. Therefore, the figures below need to be treated with some caution.

Other types of logs used include sawdust logs which can be bought from Bunnings, Mitre 10, the Warehouse and supermarkets. These have the advantage of being convenient. Anecdotal evidence suggests that they have the same heat output as other firewood and burn quickly. Many consumers prefer to mix and match sawdust logs with traditional firewood.

Molly Melhuish, a long time electricity consumer advocate and Grey Power member argues that New Zealand is not making enough use of firewood as a heat source,[33] suggesting that wood burning has been supressed by air quality rules. Melhuish understands that firewood that previously provided 45% of home heating requirements in 2005 now only provides 12% in 2015.[34] By implication this reduces heating options for less well-off sections of society.

EECA's energy end-use statistics shows that wood provided 36% of delivered household energy in 2014, but 63% of that was in open fires without wetbacks which lose a lot of heat up the chimney. Air quality standards have phased out installation of new open fires and replaced them with closed burners that are cleaner and more efficient at heating homes. Very recent ECAN regulations (November 2016) now allow wood pellet burners without consent requirements.

33 Melhuish M (2016), It's time for action against electricity monopolies. Stuff, April 10th 2016.

34 This cannot all be attributed to air quality rules as other factors have been influential, like the convenience of heat pumps and their promotion with subsidy under the Warm Up NZ Clean Heat scheme.

Table 4 Types, quality, and costs of different types of firewood

These values are based on a 20% moisture content. Firewood is typically as a "thrown measure" so will reduce by one-third in volume when stacked.

Firewood	NZ Avg. cost $/m³	Heat output kWh/m³	Price per kW heat produced (cents)	Burn time	Type	Firewood NZ rating
Poplar	100	1,200	0.08	Fast burning	Soft hard wood	C-
Eucalyptus	140	1,270	0.11	Fast burning	Hard wood	A-
Pine	80	1,091	0.07	Fast burning	Soft wood	B-
Macrocarpa	130	1,150	0.11	Slow burning	Medium density wood	B+
Manuka	180	1,860	0.10	Slow burning	Very hard wood	A
Kanuka	180	1,860	0.10	Slow burning	Very hard wood	A

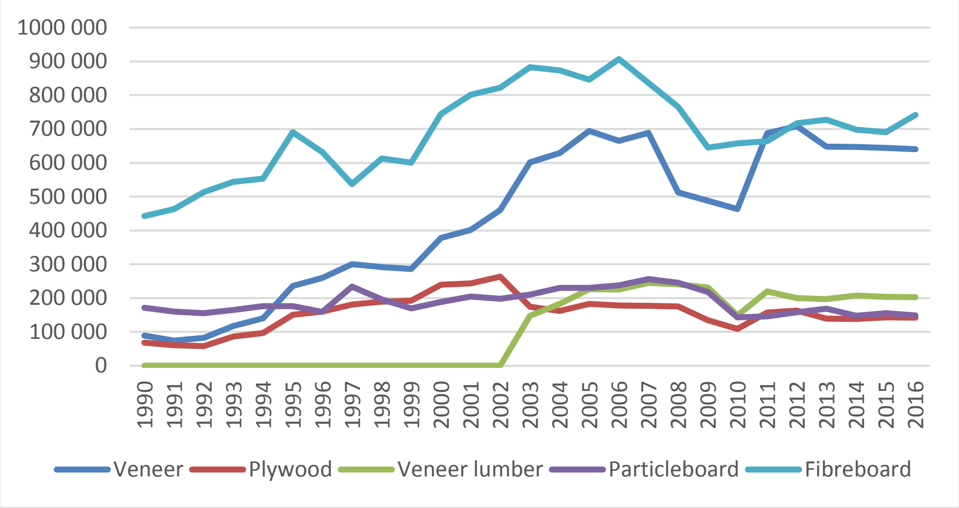
Source: www.firewood.co.nz

Other timber uses

Production of other wood products (plywood, MDF, veneer, and particleboard etc.) has been relatively stable over time as domestic demand has been static. There are limited opportunities to export because of the tough international conditions, particularly strong competition from Chinese mills.

Figure 15 Veneer, plywood, veneer lumber, particleboard, and fibreboard

New Zealand Production, Cubic metres



Source: Ministry for Primary Industries

Summary

Table 5 sets out production and domestic demand for the March 2016 period. Highlights include:

- Just over half of all logs are exported
- Heavy domestic demand for sawn timber has tipped the balance in favour of domestic demand, although total production has remained stable for the past 6 years. New technology in the form of CLT and LVL offers real potential for domestic and export growth
- Paper production is declining both for domestic and export consumption
- Pulp production is declining although exports (mainly to China) and imports (hardwood pulp) are increasing
- Other forestry products (veneer, plywood and fibreboard etc.) production, exports, and domestic consumption has remained static. There are limited opportunities to export because of the tough international conditions and particularly strong competition from Chinese mills
- Woodchip and firewood markets are predominately domestically focused and are relatively small volume markets. Both markets have potential for expansion.

Table 5 Summary of production

March year, 2016

	Production	Domestic demand	Comments
Sawn timber	4,066,000 m^3	2,334,000 m^3	Heavy domestic demand. Total production is stable. New technology
Paper (total production and trade)	679,262 tonnes	782,888 tonnes[1]	Domestic demand peaked in 2008 (1m tonnes). Declining demand ever since
Other manufactured wood products	1,875,037 m^3	784,194 m^3 [2]	Static demand. Production peaked in 2007 (2.2m^3)
Pulp (air dried tonnes)	1,425,422	508,611	Reducing domestic demand but increasing exports and imports
Woodchips, wood pellets, and firewood	Unknown[3]	Focused on domestic demand	Potential to expand giving more favourable policy settings

Notes (1) This includes New Zealand production of 337,208 tonnes and 445,680 tonnes of imports. (2) Veneer, plywood, and fibreboard. (3) BANZ report that there are no statistics collected on individual suppliers to domestic wood burning markets. Work is currently underway to rectify this. Pers. Comm. Brian Cox, 10th February 2017.

Source: Statistics New Zealand and Ministry for Primary Industries

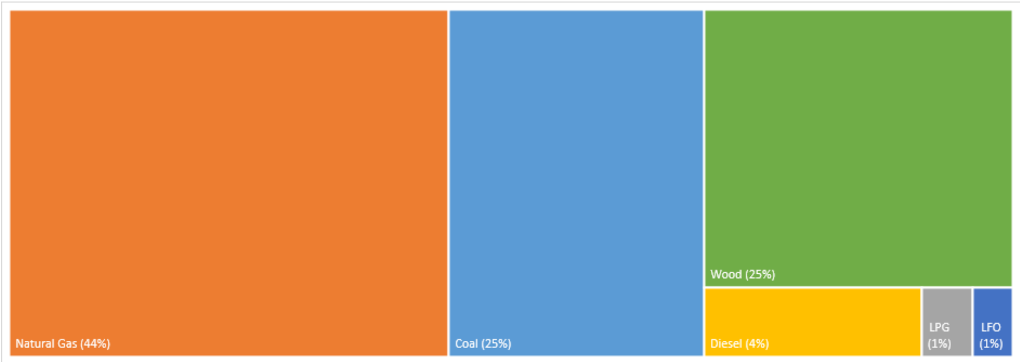
While we have no statistics on the use of wood in domestic New Zealand markets one way of gaining an indication of woods importance is to look at installed capacity of heat plant per sector. Wood provides 25% of installed capacity (1420 MW) over all sectors (see Figure below).

Caution is required in interpreting these numbers since we are measuring installed capacity. However, it does give an indication of the importance of wood as a source of fuel. Most of the installed capacity (1232.94 MW or 78%) for wood is used in the wood processing sector.

In the household sector BANZ (Facts and Figures,2016) p4 report that 12% of fuel heating requirements are met by wood, with 50% of households having a solid wood burner of some description.

Figure 16 Installed Capacity of Heat Plant by Fuel Type

Percent



Source: BANZ Facts and Figures 2016 p9

Appendix C Number of forest owners[35]

The New Zealand Farm Forestry Association (NZFFA) has identified approximately 15,000 forest owners in New Zealand with forests over 5 hectares.[36]

To identify small owners, the NZFFA used satellite imagery and land survey data to create a compilation of exotic forests by location, area, and owner.

Public domain addresses were found for approximately 49% of the owners. Of the identified 49%, 26% were individuals and 23% were companies.

A further survey in the lower North Island was carried out to understand in more detail the ownership of forests. Table 6 sets out the results.

Table 6 Breakdown of forest owners

2011

Owner type	Share
Private individuals	54%
Companies	30%
Trusts/councils	6%
Unknown	10%

Source: Levack H and Moore H (2013)

35 In is not strictly correct to call the owners forest owners. They are forest owning entities.

36 Levack H & Moore H (2013) Why identify forest owners? NZFFA AGM April 2013 Orewa, New Zealand.

Appendix D Employment

Measuring who is employed in forestry is not a trivial exercise. Due to the seasonal nature of silviculture and planting, some official statistics can under-estimate forestry employment depending on when employees are surveyed. Statistics New Zealand also classifies industries by main economic activity, this means any part-time forestry operators will not be included in official statistics.

The Census showed that on 5 March 2013 there were 7,056 employed in the forestry sector. The Census is self-reported; it relies on people correctly filling in their occupation and employer and for Statistics New Zealand to correctly classify that occupation.

To demonstrate the impact of classifying industry by main activity and self-reported occupation. In the latest Census, 35 percent of forestry related occupations[37] were employed in non-forestry industries (largest being Management Advice and Related Consulting Services).

Further, the Census will under report forestry employment since it collects data in March, while the peak typically in occurs in September/December quarters.

A more reliable approach is to use the Linked Employer Employee Data (LEED). The LEED database uses employer monthly tax returns. Being administrative data of all economical significant businesses[38] that file a tax return it has great coverage and unlike the Census collects monthly tax returns. However, like the Census it has problems with industry data being classified by main activity.

The LEED database shows 7,287 people employed in the forestry sector, with an additional 2,223 people self-employed in the sector. A total of 9,510 people working in forestry.

For health and safety reasons the major industry players also collect the number of hours worked through the Incident Recording Information System (IRIS) database. It records the number of hours worked by employees in larger forest owner/management companies. Unfortunately, not all companies contribute consistently to the IRIS database.

The number of hours can be converted using average hours from the quarterly employment survey. This suggests 7,142 FTEs. Since we know that not all companies contribute or contribute only infrequently to the database, this number therefore is conservative.

Informetrics also report on the Competenz[39] website that forestry has 10,846 filled jobs. A filled job is not equivalent to FTE since it could be part time. Therefore, the Informetrics estimates are not comparable.

[37] Forestry Worker, Production Manager (Forestry), Logging Assistant, and Forest Scientist.

[38] Turnover greater than $30,000 per year.

[39] https://www.competenz.org.nz/

Table 7 Triangulation of employment data

2015

Source	Totals
Census	7,056[1]
LEED database	9,510[1]
IRIS database	7,142[1]
Informetrics	10,846[2]
Note (1) full time equivalents. (2) Filled jobs.	

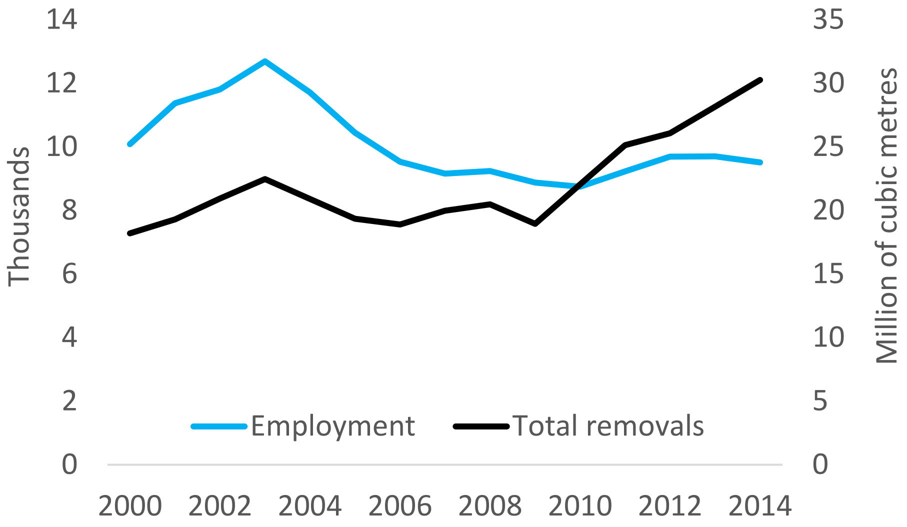
Source: NZIER

There are other sources of employment related to forestry in addition to the figures above:

- Approximately 2,000 employees/contractors are involved in the forestry road transport sector[40]
- Approximately 600 science related jobs are focused on forestry
- Approximately 900 employees are involved in the transport support services sector (which includes port service workers i.e. stevedores, marshallers, fumigation services etc.).[41]

The Figure below shows that productivity is constantly improving (employment numbers are slowly declining as mechanisation increases production per worker) in combination with a reduction in silviculture activity (cessation of pruning).

Figure 17 Numbers employed in the plantation / forestry industry



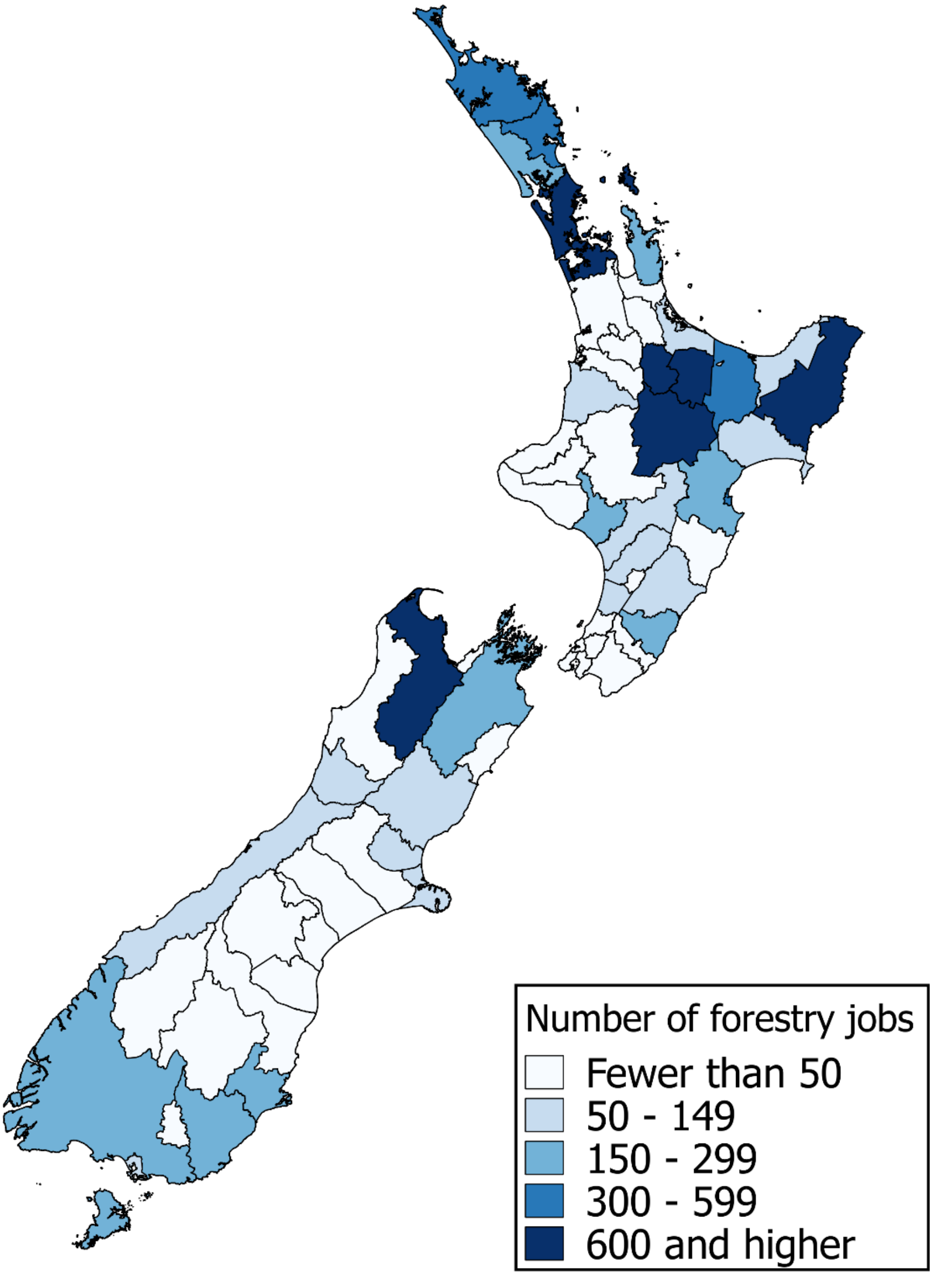
Source: Statistics New Zealand

[40] Input-Output table calculation.

[41] Estimates from a number of port service companies within New Zealand.

The following Figure sets out forestry job locations. There is a concentration of jobs on the east coast of the North Island (Bay of Plenty, Waikato and Gisborne), Northland, Tasman/Nelson, and Southland.

Figure 18 Location of forestry jobs



Source: Statistics New Zealand, NZIER

Appendix E Temporary overseas workers

Those working in the forestry industry are more likely to have been born in New Zealand. Our assumption was that most of those employed in the New Zealand forestry sector are New Zealanders.

The predominant employment of New Zealanders in the industry is confirmed by an informal survey of large forestry managers conducted as part of this project. However, large forestry managers say that it is getting harder and harder for their contractors to find employees to work in silviculture and planting. Many silvicultural contractors said they were considering their options, and there was a much stronger possibility that they would look to employ seasonal workers from overseas in the future.

Possibly, the strong economy means that workers suitable for forestry work are more difficult to attract from other industries.[42]

In recent work for MPI (forthcoming), NZIER has shown that increasing wages in the horticultural industry would only lead to a minimal increase in the number of New Zealand horticultural workers. This is not just the response in New Zealand but also the response in other countries.[43] We would expect that the same is true for the forestry industry. What this means is that an increase in the price of forestry labour is unlikely to increase substantially the supply of labour from New Zealand sources.

We have few statistics to understand the size of the overseas workforce. A MBIE (2013)[44] paper shows that the relatively high growth in temporary migrant employment in some industries (e.g. horticulture) is not matched in forestry. MBIE aggregates forestry employment with fishing and other agriculture so we are unsure of the exact temporary overseas worker numbers.

Information from forest owners obtained through an informal survey suggests that there are a few temporary migrants currently only working on silviculture and planting.

42 Silviculture is often done on piece rates, and tough working conditions and is poorly paid, therefore there are problems of recruitment and retention.

43 In the jargon the supply of labour is relatively inelastic.

44 http://www.mbie.govt.nz/publications-research/research/migrants---economic-impacts/rise-of-temporary-migration-in-NZ-and-its-Impact-on-the-Labour-Market2013.pdf

Appendix F Portable sawmills

The portable sawmill industry began in New Zealand in the 1980s. It allowed the do-it-yourself community to have a go at the milling process on site using their own equipment.

While still a cottage industry, technology has advanced to the point where portable sawmilling can be:

- Developed as a hobby
- Run as a small business.

The entry value for new equipment can be anywhere between $4,000-$80,000 for new sawmilling equipment – a similar price (at the top end) to what it was twenty years ago but the technology/quality of the machinery is better.

The number of portable sawmills in operation are increasing as second hand equipment comes on to the market reducing further the barriers to entry e.g. there are a number of websites selling brand new equipment but also organisations such as Trademe selling second hand equipment.

The portable nature means that mills are able to move location, going directly to the site where the logs are stored or where they are harvested.

Between 10 and 20 websites offer machine sales and services associated with portable mills. Industry participants could not be specific about the numbers of portable sawmills in operation, however portable mill operators said that number was likely to be in the low hundreds. Some are in constant use, others brought out occasionally, and others rusting in a back shed.

If follows that the degree of professional services varies and depends on the objectives of the owner and other equipment that supplements the portable sawmill e.g. to successfully mill eucalyptus trees requires drying facilities which can include kiln drying to stop the milled wood from warping.

Different strategies are in operation by portable sawmill operators. Some operators believe to be successful requires access to different varieties of wood lots since they are uncompetitive when it comes to milling *Pinus radiata*. Others participants have other strategies in play which include milling *Pinus radiata*.

We do know that the stationary mills are becoming larger and more competitive in the domestic market as new entrants take advantage of new technology and make themselves more efficient. How portable sawmills will attempt to counter this new competition is unclear. In other self-employed businesses, we have seen “life-style” type behaviour where operators accept lower prices to maintain their business and/or taken other jobs to supplement incomes. Some of this behaviour is already evident in the portable sawmill business.

We expect the focus on a variety wood lots (including macrocarpa) to continue. Whether portable mill owners will be able to mill *Pinus radiat*a in any quantity looks unlikely. This will depend on regional competition, location and accessibility of wood lots and profit margins (and the degree that profitability is important to the operator).

Appendix G Forestry rotations

A concern in the international literature has been the declining yields between forestry rotations. Australian studies have demonstrated a significant decline in yields from 2nd rotation onwards e.g. South Australia in the 1960s saw a 30% drop in yields in 2nd rotation forests.[45]

New Zealand has not experienced similar issues. Evidence suggests that not only have New Zealand forests not declined in yield past the 2nd rotation, they have gained in productivity through:

- Better genetic selection
- Careful silviculture management
- Ensuring that slash is left behind
- A warmer climate.

The combination of effects is important. A warmer climate may improve productivity, fix more carbon, increase nutrient cycling, and build up soil fertility through enhanced soil organic matter, but it may also increase the prevalence of foliar diseases which reduce site productivity. A warmer climate in combination with elevated CO^2 concentrations will only be beneficial if other aspects of forest management are done well.[46]

Better genetic selection, careful silviculture management, good weed management, and land preparation are crucially important since not many soils on land affordable to forest owners have naturally high fertility, in fact some soils were extremely poor when forests were first planted.

There is evidence of soil improvement as rotations progress on some of these very poor soils as management has added limited amounts of phosphate fertilisers or trace elements such as boron as well adopting careful site management to avoid soil compaction. As a result of this, yields have improved in some case by as much as 15%.[47]

A number of conclusions can be drawn from the literature:

- Care is required to ensure that sites do not deteriorate over rotations. Weed management, conservation of organic material (including slash), and adoption of best practice harvesting techniques are all critical in minimising nutrient loss
- Successive rotations are unlikely to have an impact on yield given best practice site management and fertilisation
- Improving the genetic stock offers the best chance of sustaining long term yield gains over successive generations.

We have informally surveyed forest owners/managers about the age of their estate. Below we set out the national rotation profile for radiata.

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45 http://www.fao.org/forestry/25863-0cff9cd2dd78cc5b1b0bfee2b24991027.pdf

46 Personal communication with Tim Payn, Scion 16th December 2016.

47 Personal communication with Tim Payn, Scion, 25th November 2016.

Table 8 National rotation profile

Self-reported from large forestry managers/owners

Rotation	Percent
First rotation forest[1]	35.8%
Second rotation forest	56.3%
Third rotation forest	4.6%
Fourth rotation forest	0.4%
Unknown	0.9%
Total[2]	**100%**
Note (1) 40% of all forests under 10 hectares assumed to be first rotation forests. (2) Numbers rounded.	

Source: NZIER

Appendix H Components of the value chain

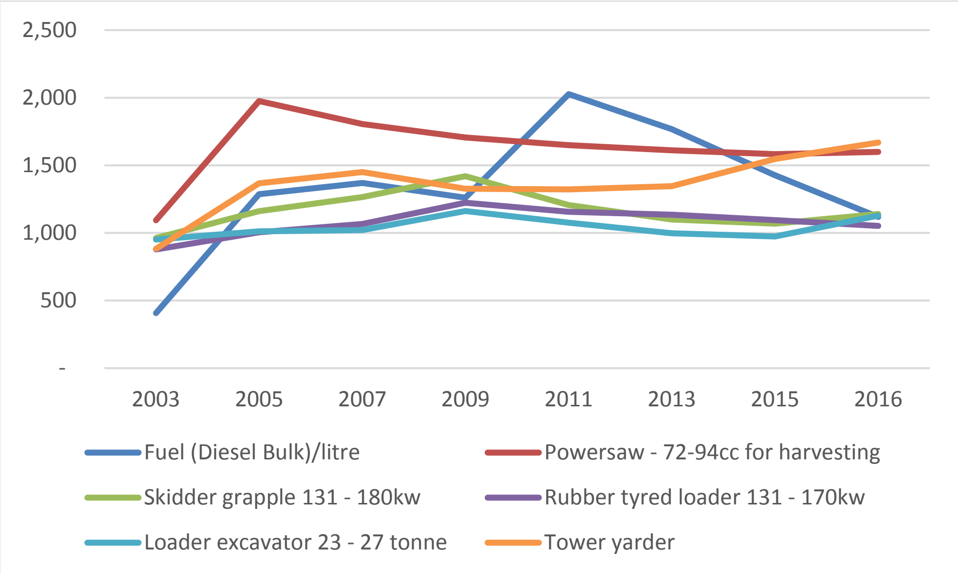
H.1 Factors affecting stumpage value

H.1.1 Harvesting

The general capital price index has dropped for most capital items. In New Zealand, the cost of imported machinery in the 2000s dropped by almost 50% because of the impact of Chinese imports.[48] However, the price index for forestry harvesting equipment does not follow the general capital price index, since specialised equipment is not sourced from China. Figure 19 shows a steady real price in forestry harvesting equipment since 2003. Unlike machinery for other land-based industries (e.g. tractors), forestry equipment is specialised with a much smaller market, therefore competition for equipment is much less. Movements in the price index for forestry machinery have steady as demand has grown. Prior to the 2000s harvesting equipment costs remained relatively stable.

Figure 19 Movements in the costs of harvesting equipment

Index, Adjusted for CPI, 2006 dollars



Source: Forme Consulting

Current costs are set out in Table 9. Much of the equipment required for forestry is fit for purpose. Yarders towers, loaders, rubber-tyred loaders, log forwarders, and grapple skidders are almost exclusively used in forestry. They all require considerable capital expenditure.

48 http://www.treasury.govt.nz/publications/research-policy/wp/2013/13-15/15.htm

Table 9 Current harvesting equipment costs

March 2016

Category	Cost implication
Powersaw - 72-94cc for harvesting	$2,500
Skidder grapple 131 - 180kw	$502,800
Rubber tyred loader 131 - 170kw	$361,000
Loader excavator 23 - 27 tonne	$423,900
Tower yarder	$1,840,000

Source: Frome Consulting

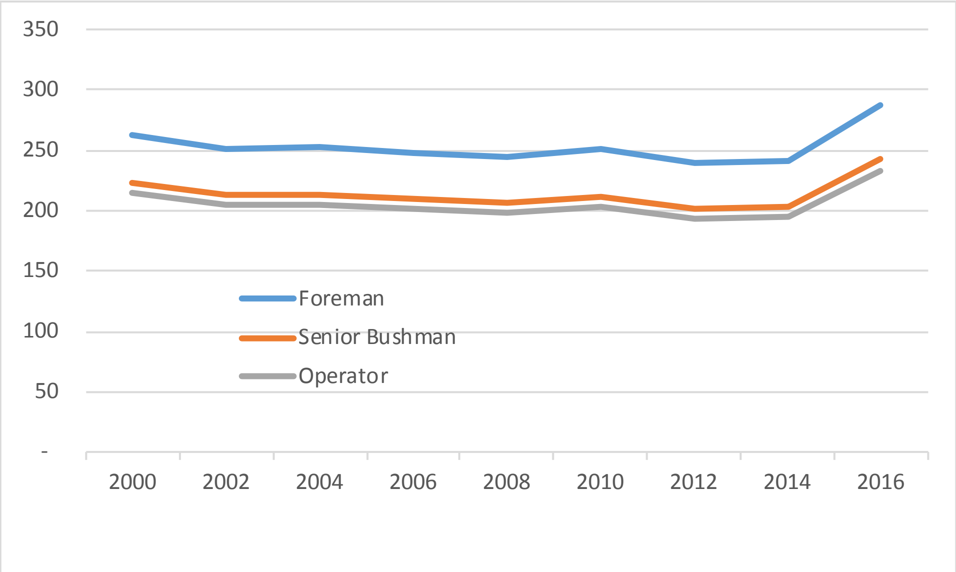
H.1.2 Labour costs

Labour cost relativities have remained constant through the period. Wages are also keeping pace with inflation with some being slightly above levels (in real terms). There has been a significant increase in labour cost over the past 2/3 years. There are a number of reasons for this:

- The increase in production
- The shortage of skilled labour required for harvesting, planting and silviculture
- The increase in competition for jobs in other sectors as the economy grows more quickly.

Figure 20 Labour costs

2006 Dollars, March years, Daily rates



Source: Frome Consulting

Table 10 sets out surveyed labour cost data for harvesting. Costs range from approximately $280 to $350 per day per worker, while a harvesting crew costs can reach approximately $2,500 per day.

Some in the industry believe this figure to be on the low side, suggesting that a 10-person crew could be as much as $4,000 per day.

Table 10 Labour costs

March 2016

	Per day	Annual[2]
Foreman	$345	$84,600
Senior Bushman	$290	$71,250
Operator	$279	$68,400
Harvesting crew [1]	$2,323	$570,000
Notes (1) To estimate harvest crew cost e.g. 1 foreman, 2 leading bushmen, 5 operators at March 2016: ((345.56 + (290.82*2) + (279.28*5)) = 2,323/day. Calculated sample labour costs using 8-hour day + 2-hour travel. (2) Based on 245 working day year.		

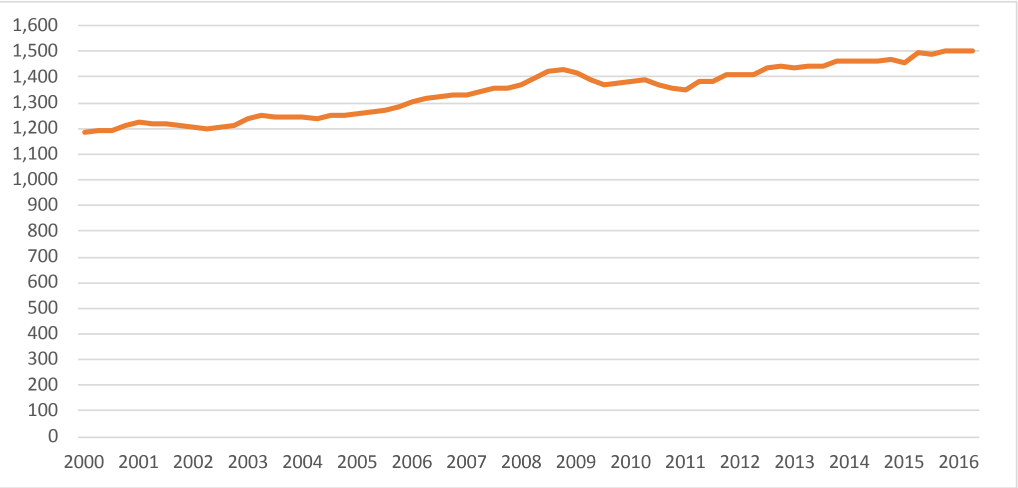
Source: Frome Consulting

H.1.3 Transport costs

Transport costs are hugely influential in determining forestry profitability. Since 2000 transport costs in forestry have risen steadily in real terms, although costs have risen more slowly since 2008/09 (see Figure 21). Transport can either be to mills or to the wharf.

Figure 21 Real transport costs

March years, index base year = 1000 (1997), 2006 dollars



Source: Adapted from information supplied by Forme Consulting

H.1.4 Forestry roading costs

The Table below sets out forestry roading costs. On best sites the wood yield is more than double that of a poor site. This is reflected in the ratio between yield and roading costs. For smaller forest owners where sites are less accessible, this may have large ramifications for profitability.

The NZFOA suggest that this does not give the picture of roading costs since the roading cost per hectare can vary depending on terrain and soil. Therefore, the costs need to be treated with some caution and the calculations are purely illustrative of the type of costs that can be incurred.

Table 11 Indication of roading costs

2016

Site quality	Expected yield per hectare m^3	Roading cost per hectare ($)	Roading costs $/$m^3$
Best	868	4,357	5.02
Good	684	4,357	6.37
Typical	526	4,357	8.28
Poor	368	4,357	11.84

Source: Frome Consulting

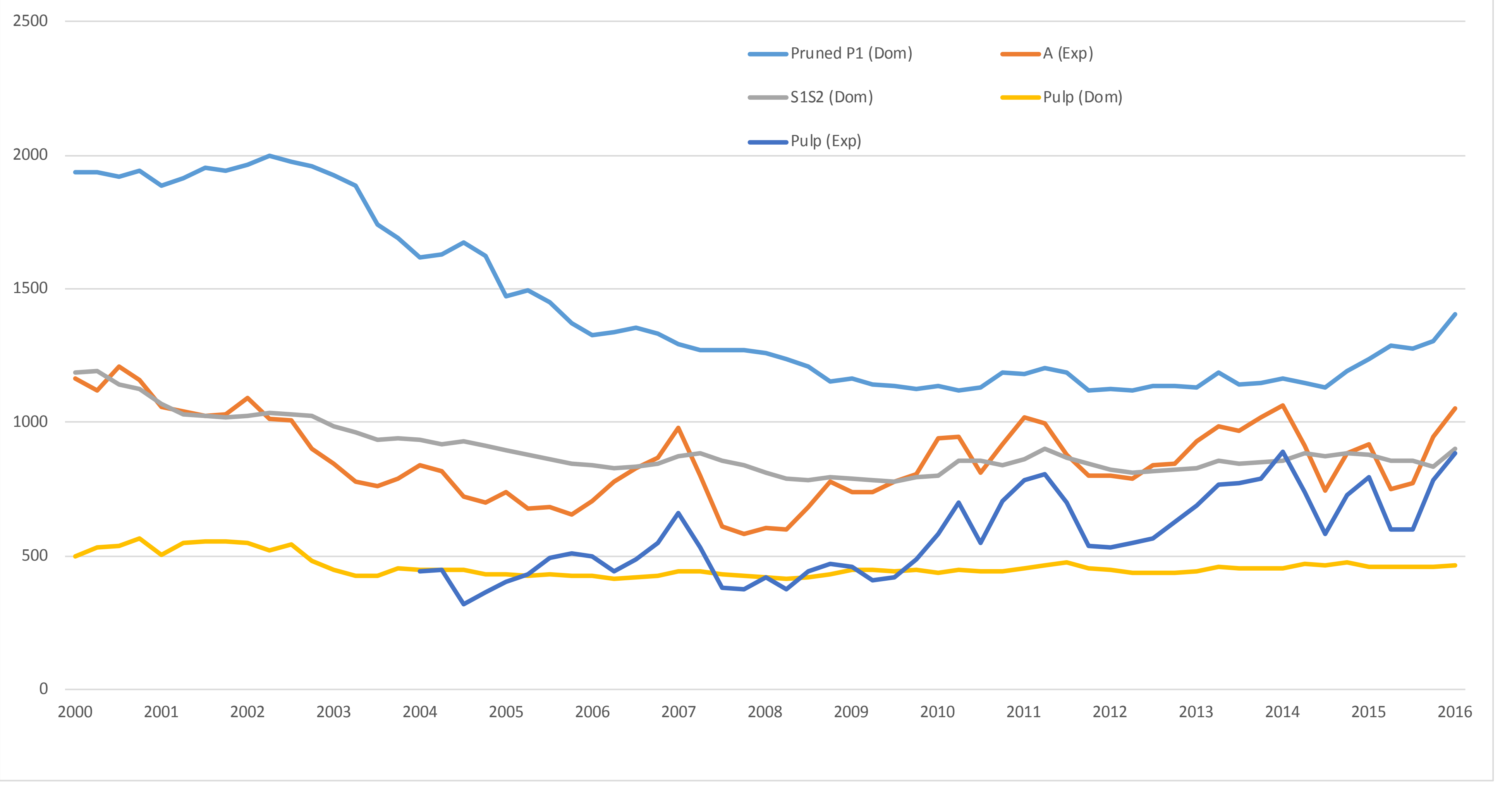
H.2 Log price trends

Figure 24 below sets out log prices for a variety of different log markets. They include pruned grades (P1), export grades (A (Exp), and Industrial Pulp (Exp)) and domestic (S1S2, and Domestic Pulp). While products such as pulp attract lower prices, export and domestic prices are in a relatively narrow band.

After the high prices of the 1990s, prices settled at a lower level over most of the 2000s. Price expectations have been mainly governed by supply constraints in countries such as Russia and US. Over the past five years the dominant force has been the export tax imposed on Russian logs. This has restricted supply and lifted prices for Pacific Rim exporters, especially New Zealand.

Figure 22 Real Log price trends

2000 – 2016, Index adjusted for CPI, 2006 dollars



Source: Adapted from Frome Consulting

H.3 Harvest stumpage values

Stumpage values are set out on the following page (see Figure 25). They reflect prices relatively closely. Stumpage consists of stumpage values less transport and site harvesting costs. Transport costs are to port or mill.

The most profitable sites are on easy (flat) country, where trees had been pruned with easy access to a port. In most cases, good profits have been realised this has occurred (refer blue line).

Company data suggest that stumpage prices (the log price at the forest) are more volatile month-to-month. In the following Figure, this is masked by the quarterly averaging of stumpage prices and the inclusion of transport and harvesting costs.[49]

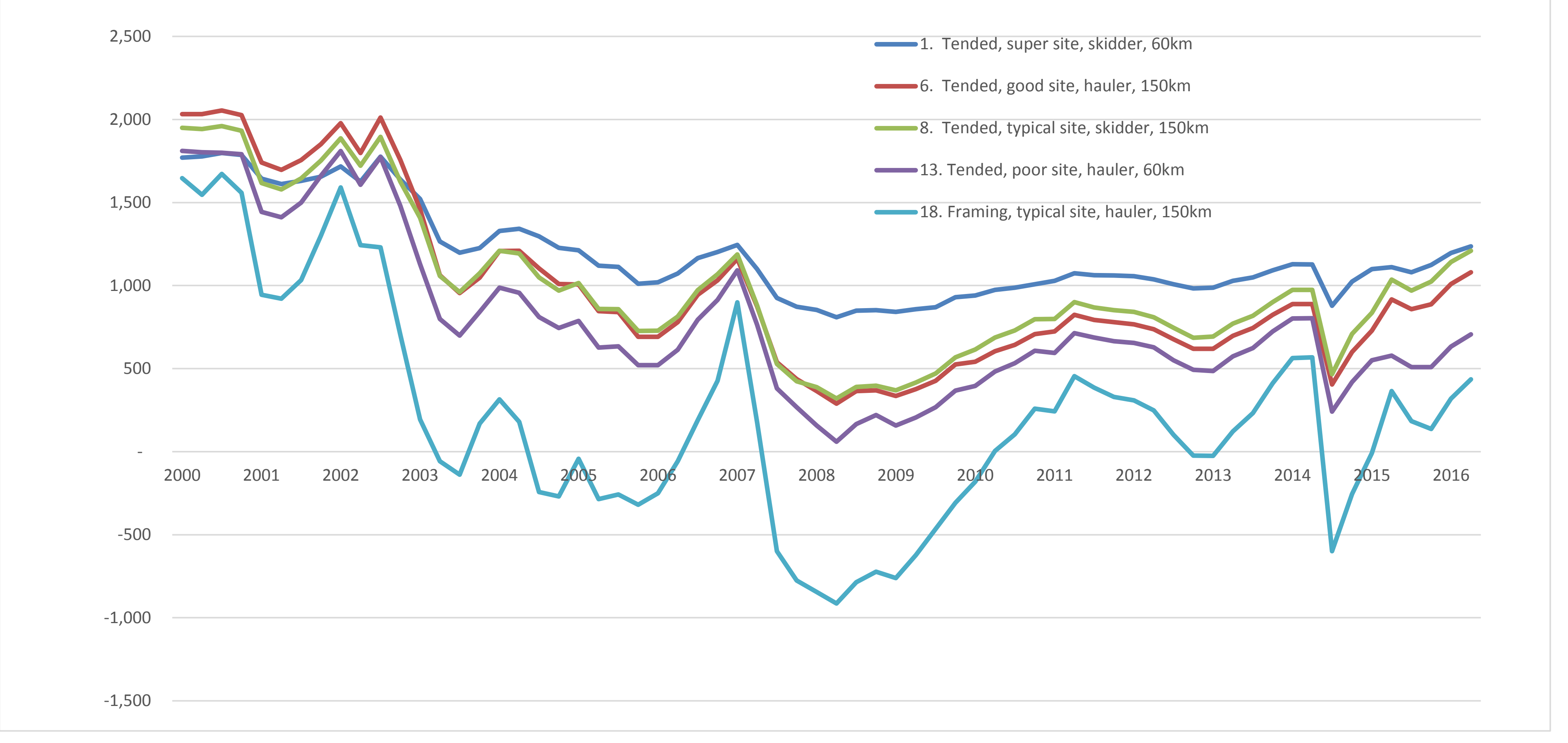
On good sites, typical sites, and poor sites with a mixture of transport costs (high and low), stumpage prices relativities tend to clump together.

Stumpage values of poor sites, with larger transport costs, and with wood suitable for framing (unpruned but thinned) and suitable for the domestic market, prices are much more variable. This reflects wood quality, higher transport costs, and a variable domestic market.

[49] Taking off the transport and harvesting costs means that some sites are not profitable to harvest.

Figure 23 Stumpage values adjusted for transport and site costs (from port or mill)

2000 – 2016, CPI adjusted index, 2006 dollars



Source: Frome Consulting

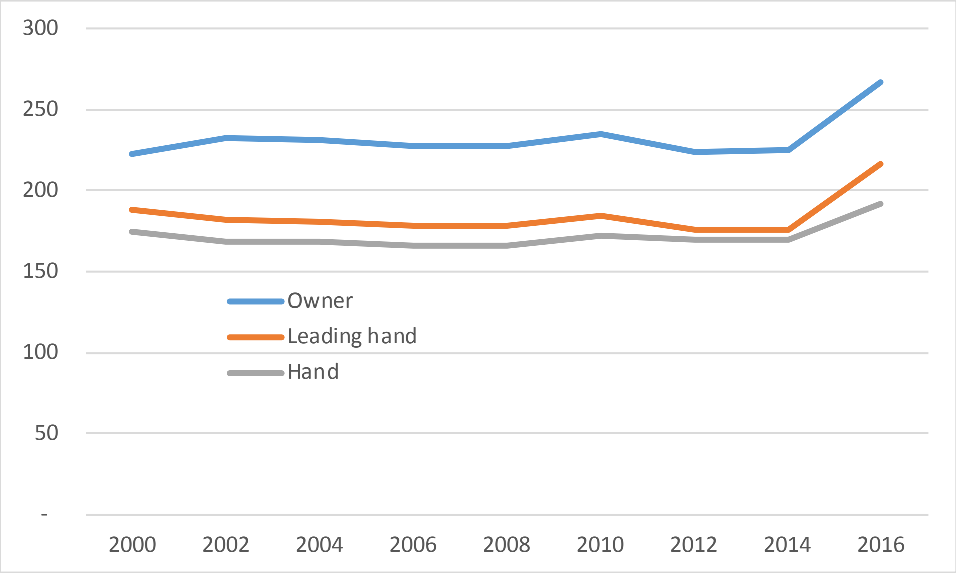
H.4 Silviculture and planting costs

H.4.1 Labour

Labour costs for planting and silviculture are similar to harvesting costs, although they have risen slightly faster than harvesting wages. Costs have risen more quickly in the past few years for reasons discussed earlier (under harvesting).

Figure 24 Silviculture and planting labour costs

2000 – 2016, Dollar per day in 2006 dollars



Source: Forme Consulting

Current rates for silviculture and planting are set out in Table 12.

Table 12 Current labour costs

March 2016

Description	Per day
Owner	$320.00
Leading hand	$259.00
Hand	$230.00

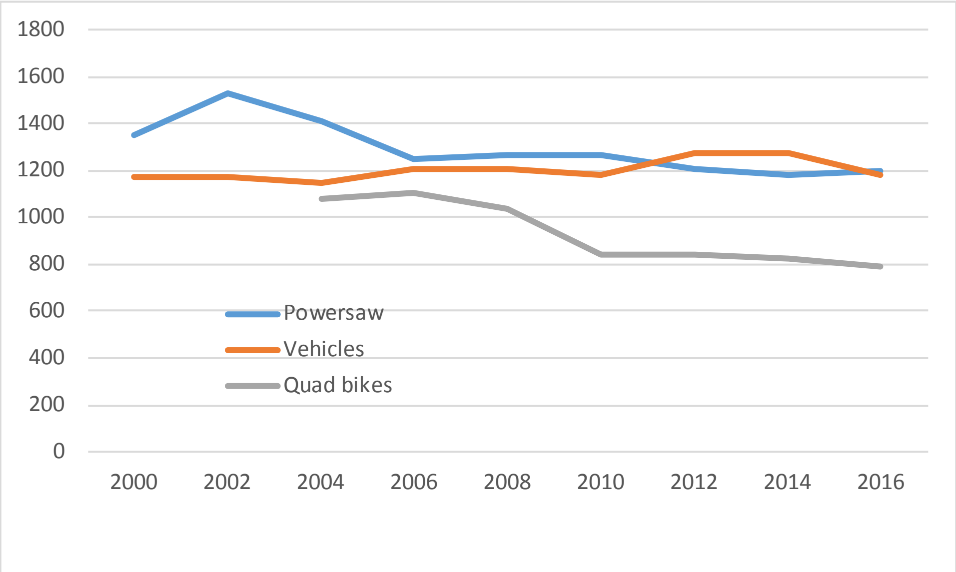
Source: Forme Consulting

H.4.2 Equipment prices

Equipment such as chainsaws, 4WD vehicles and quad bikes have dropped in real price terms (see Figure 25 below). This suggests that the market for these products is highly competitive as suppliers compete for market share.

Figure 25 Equipment required for planting and maintenance

Index, Adjusted for CPI base year = June 2006



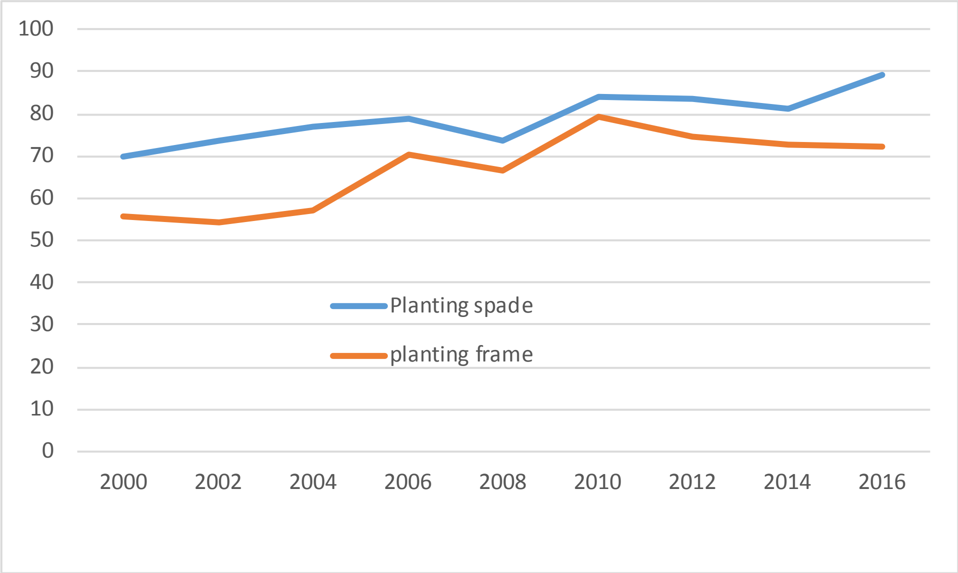
Source: Forme Consulting

The indexes for establishment equipment (planting spades and planting frames) has moved faster than inflation since 2000 while pruning equipment (pruners, jacksaws, belt and holsters, and ladders) have moved less quickly and become cheaper in real terms overtime.

Possibly, the more specialised equipment has managed to maintain higher prices overtime.

Figure 26 Establishment equipment

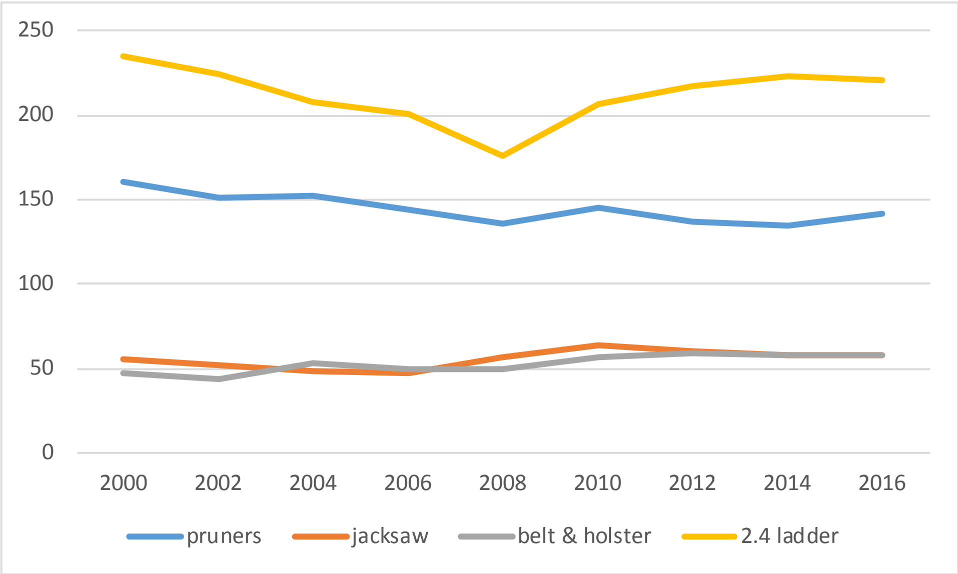
2000 – 2016, Real prices (CPI adjusted base year June 2006)



Source: Forme Consulting

Figure 27 Pruning equipment

2000 – 2016, Real prices (CPI adjusted base year June 2006)



Source: Forme Consulting

Appendix I Contribution to GDP

I.1 Objectives

Forestry is witnessing significant growth as plantings from the late 1980s and early 1990s come ready for harvest.

With the value of forestry increasing key questions include what is the economic contribution nationally and regionally of forestry?

We use two consistent economy wide models to examine these questions.

The economy wide models have major advantages over other commonly used approaches (such as Input-Output tables or multiplier analysis). These advantages are that:

- Multiplier analysis and Input-Output tables do not accurately reflect the reallocation of resources as forestry grows. They do not consider how those resources are reallocated. In reality if forestry is growing then it must bid resources away from other industries. The output of those industries must fall. Overall impacts must consider gains and losses to the economy
- Wage rates don't change in a multiplier analysis. This assumes that forestry can take unlimited labour from other sectors at the same wage rate while it grows.

Multiplier analysis therefore tends to vastly overstate the economic impacts of changes in demand in a specific sector. These unrealistically large impacts are not particularly informative for policy makers or firms.

Economy wide models address both resource allocation and relative price shifts, allowing for a more credible, richer analysis of economic contribution. These models tend to produce more conservative estimates of impacts, but are more consistent with theory and practice.

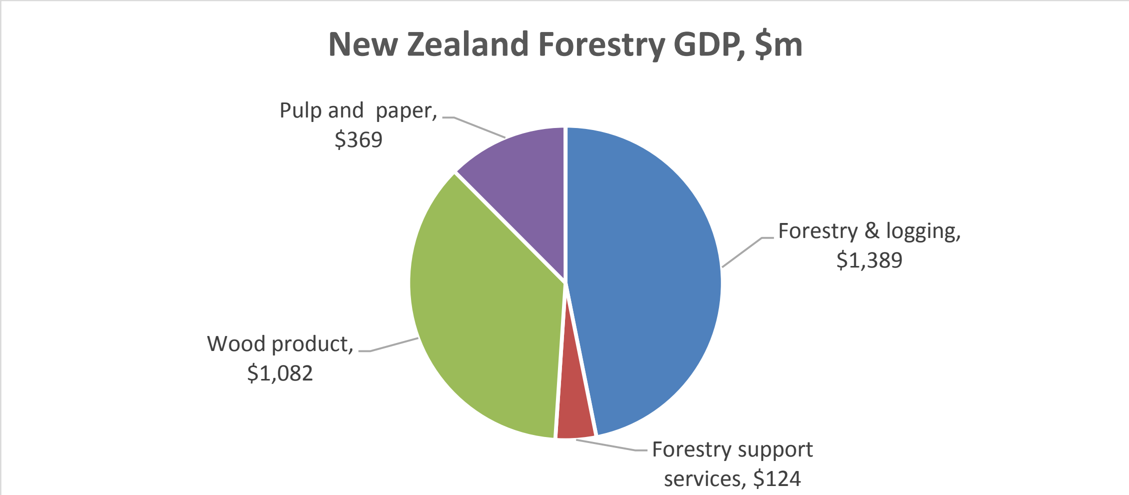
I.2 Total forestry GDP

Figure 28 shows that the total forestry industry contribution to New Zealand's GDP was $2,965 million in 2015 comprising of Forestry and logging ($1,389 million), Forestry support services ($124 million), Wood product ($1,082 million), and Pulp and paper ($369 million).[50]

[50] This information has been updated from the latest Statistics New Zealand estimates from 2013.

Figure 28 Contribution of forestry to GDP

In $ million

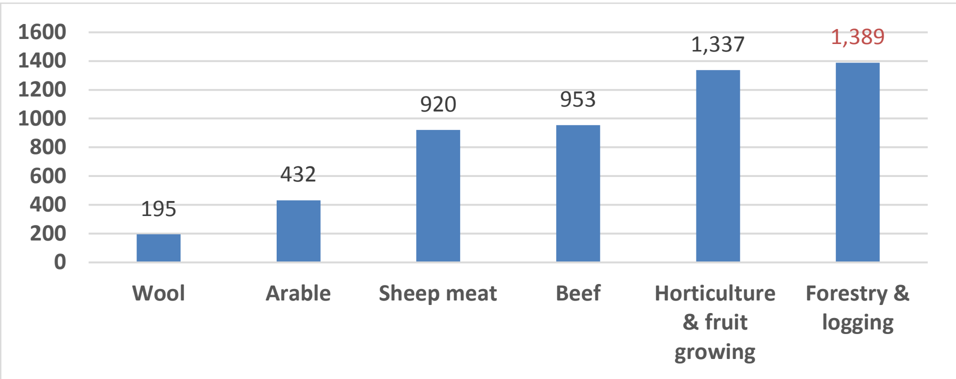


Source: NZIER

Figure 31 compares GDP of Forestry and logging ($1,389 million) to Horticulture & fruit growing ($1,337 million), Beef and veal ($953 million), Sheep meat ($920 million), Arable ($432 million), and Wool ($195 million).

Figure 29 GDP comparison

In $ million



Source: NZIER

I.3 Regional GDP

Figure 32 shows contribution of forestry to regional and national GDP by sector.

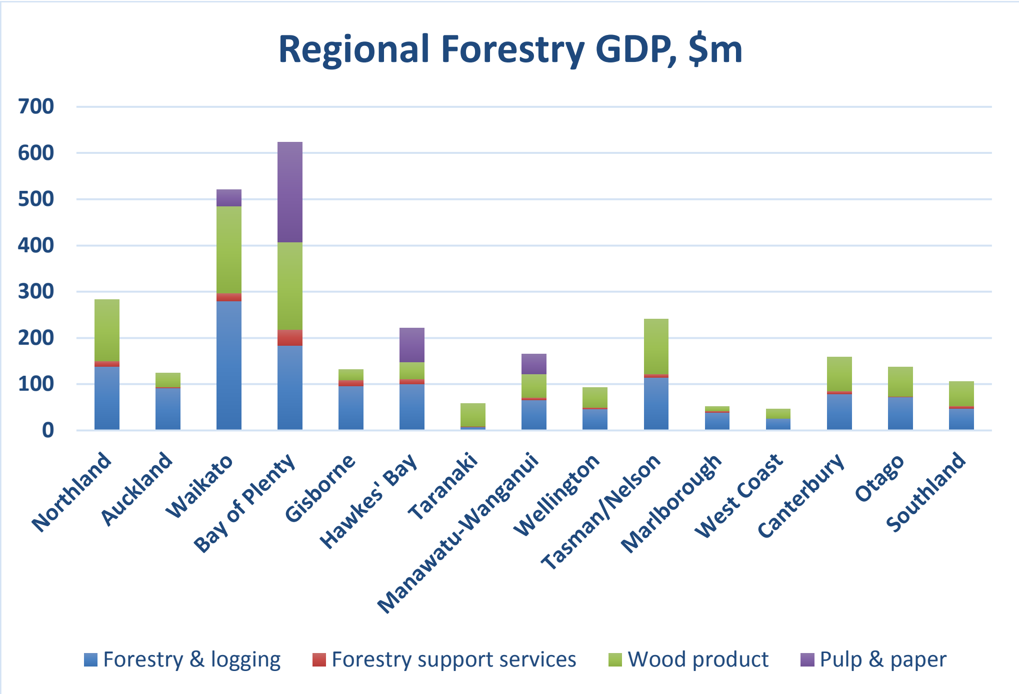
The highlights are:

- The main growing areas are Northland, Waikato, Bay of Plenty Otago/Southland, and Tasman/Nelson. The Bay of Plenty also has processing facilities
- Gisborne is highly dependent on forestry and the percentage contribution to GDP is much greater than any other region

- Hawkes' Bay has significant forestry and logging operations as well as pulp operations
- Tasman/Nelson has significant forestry and logging operations and wood processing
- Canterbury, Otago, and Southland all have significant forestry operations.

Figure 30 Contribution of forestry to regional GDP

In $ million



Source: NZIER

Figure 31shows the share of forestry in regional and national GDP. Nationally, forestry contributes 0.6 percent ($1,389 million) to New Zealand's GDP ($239,500 million).

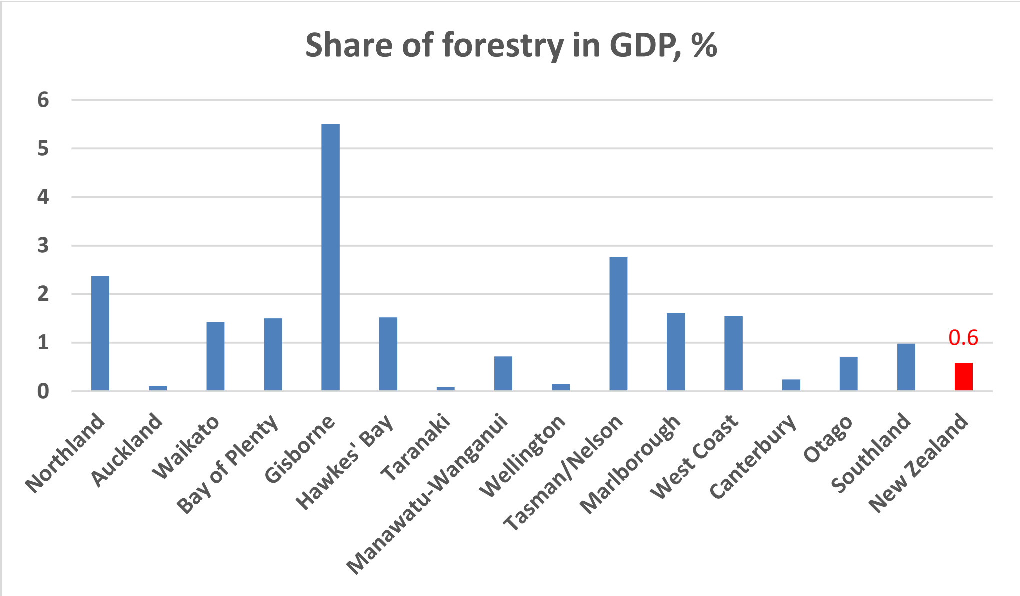
Of interest is in which districts forestry's contribution to the share of regional GDP is significant. Three regions stand out where forestry is extremely important to the local economy:

- Gisborne region where forestry is the most significant contributor with between 5% and 6% of regional GDP
- Tasman/Nelson where forestry contributes nearly 3% to the regional GDP
- Northland where forestry contributes approximately 2.5%.

In the Bay of Plenty, Waikato, Hawkes' Bay, Marlborough, West Coast, and Southland/Otago the forestry contribution to the regional economies is higher than the national average.

Figure 31 Share of forestry in GDP

percent



Source: NZIER

The contribution to GDP numbers that correspond to Figure 31 are presented below in Table 13.

Table 13 Contribution of forestry to regional GDP

Dollar millions

Regions	Forestry and logging	Forestry support services	Wood product processing	Pulp and paper
Northland	138	12	133	0
Auckland	92	2	30	0
Waikato	280	17	188	36
Bay of Plenty	184	34	189	216
Gisborne	96	13	23	0
Hawkes' Bay	100	11	37	74
Taranaki	8	1	50	0
Manawatu-Wanganui	66	5	51	43
Wellington	46	4	43	0
Tasman/Nelson	114	8	119	0
Marlborough	39	3	10	0
West Coast	26	0	21	0
Canterbury	79	6	74	0
Otago	72	2	63	0
Southland	48	5	53	0
New Zealand	**1389**	**124**	**1,082**	**369**

Source: NZIER

I.4 Comparisons with other industries

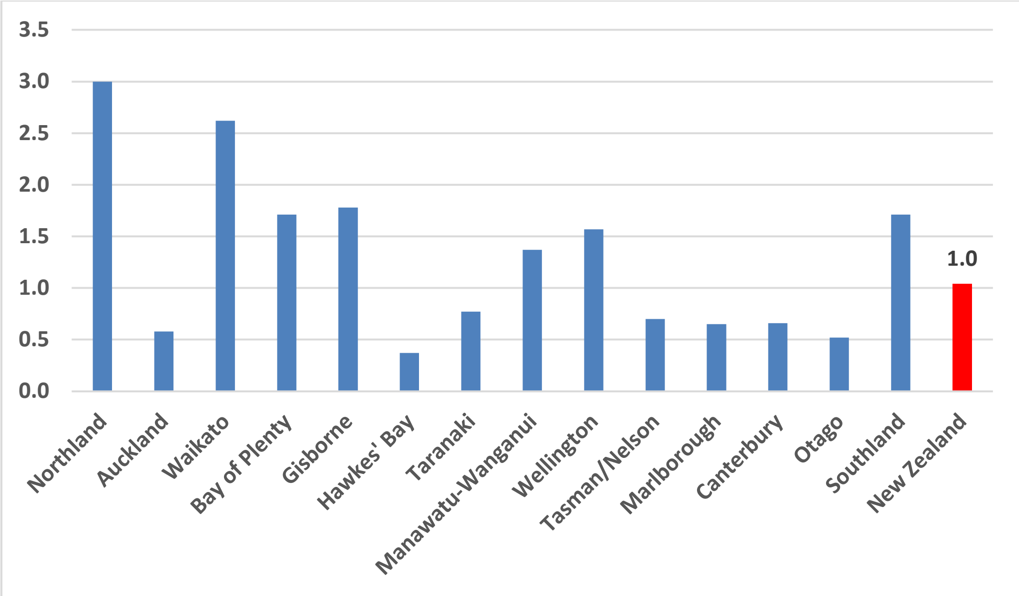
Figure 32 shows the relative size of forestry and logging to other land users' GDP. For example, Forestry and logging GDP in Northland is three times larger than Horticulture and fruit growing. Nationally Forest and logging GDP is the same size of Horticulture and fruit growing GDP.

Forestry is much more significant relative to horticulture in regions such as the West Coast,[51] Northland, Waikato, Bay of Plenty, the lower North Island, and Southland.

[51] The West Coast is not included in this graph because 46 times less important than forestry.

Figure 32 Comparison of foresty and logging to other land users' GDP

Ratio of Forestry and logging to Horticulture and fruit growing GDP by region (*)

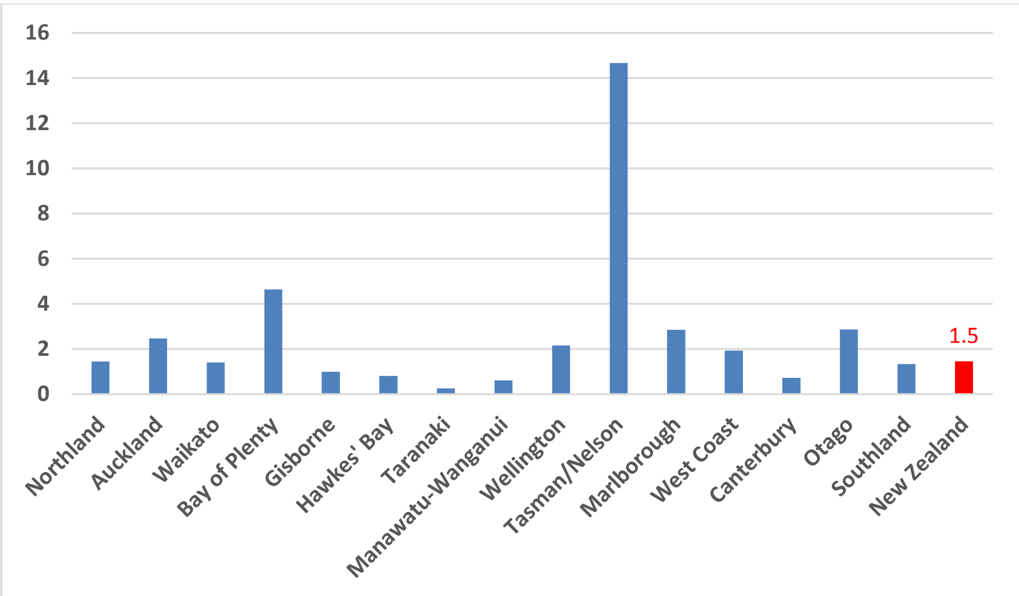


Source: NZIER

Relative to beef the region that stands out the most is Tasman/Nelson. Forestry's contribution is 14 times more than beef production (in regional GDP terms). Other areas where forestry is more important in GDP contribution terms are Otago, Marlborough, Wellington, Auckland and the Bay of Plenty.

Figure 33 Regional comparison between beef and forestry

Ratio of Forestry and logging to Beef GDP by region

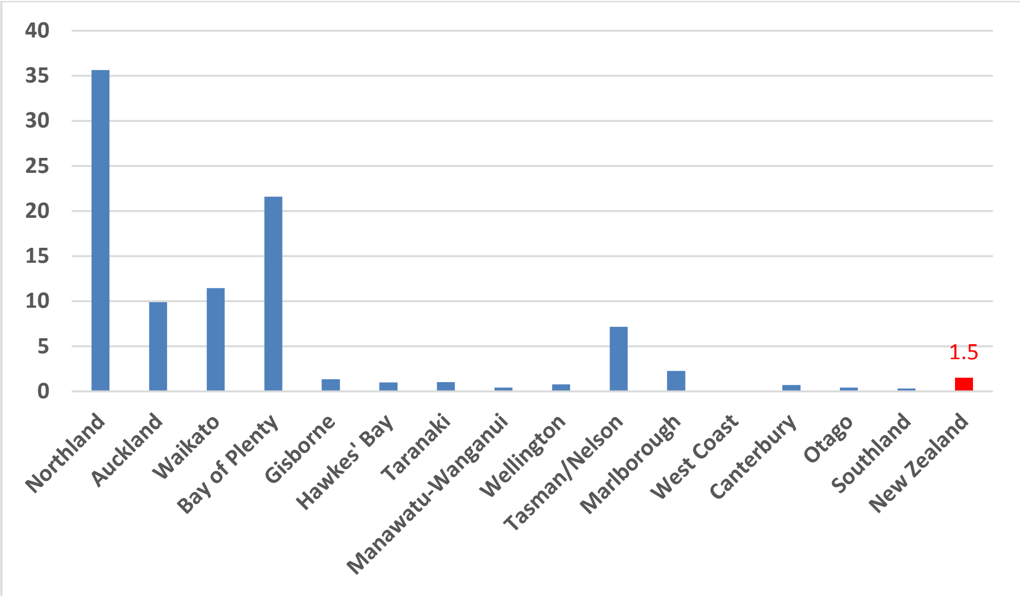


Source: NZIER

Forestry is more important in the northern half of the North Island (Northland, Auckland, Waikato and the Bay of Plenty) as well as the Tasman/Nelson regions.

Figure 34 Regional comparison between sheepmeat and forestry

Ratio of Forestry and logging to Sheep meat GDP by region



Source: NZIER

Appendix J Environmental values

J.1 What we know: forestry has a large benefit beyond timber production

Forestry is now recognised as contributing to a range of benefits for the economy that fall beyond growing trees as timber and pulping material. Because they are external to the growers' primary interest they may not be taken properly into account in national decision-making processes, resulting in under-provision of forestry in potentially beneficial situations, and distortion of policies around use of land for which forestry competes.

J.2 Setting out the framework: eco-system services is one way of classifying environmental effects

The ecosystem services framework is one way to describe what the natural environment provides to New Zealanders. It is a framework to understand the relationship between natural resources like forestry, the bio-physical functions they perform and their contribution of services to human well-being (Figure 35).

Figure 35 Definition of ecosystem services[52]

Source: NZIER

Ecosystem services are defined as the benefits people obtain from ecosystems. Ecosystem services are divided into four categories of services (Millennium Ecosystem Assessment, 2005). This breaks down the services obtained from natural ecosystem functions into:

- Provisioning services: in the case of forests, the extraction of materials from forests to provide food, fibre, energy and chemicals for pharmaceutical and other uses
- Regulating services: for forests, contributions to stabilisation of soils and reductions in erosion and sedimentation, moderation of water flows and microclimates, retention of carbon and nutrients from being discharged into atmosphere and water

[52] The ecosystem structure refers to biological, physical and chemical components.

- Cultural services: for forests these are contributions to providing space for recreation and tourism, natural and historic heritage, general amenity and protection of biodiversity and spiritual associations of iconic locations
- Supporting services: these are basic bio-physical and chemical functions of nutrient and water recycling, pollination of plants.

Ecosystem services contribute to human well-being in different ways which require different approaches to valuation.

The cultural services of forest visitation commonly exhibit characteristics of market failure, due to high transaction costs in enforcing access controls over wide areas and relatively small numbers of participants, although there are exceptions where access can be controlled and use concentrated in manageable areas. Even in those cases cultural services retain positive external benefits for the wider community that it is hard for forest owners to assess or get recognition for, such as the contribution to a community's physical and mental health of recreation and sporting events held in forest settings.

Although fundamental, the value of supporting services is commonly not separately accounted for, because they are difficult to ascribe value to without double counting values included elsewhere in the ecosystem service supply chain.

J.2.1 Non-market values

The ecosystem services approach covers many benefits that are not explicitly traded in markets, but still have value. The economic approach to non-market value is based on a framework of Total Economic Value comprising a number of components:

- The direct value of current uses of a resource or site (e.g. of recreational visits to a forest)
- The indirect value of current uses of a resource (e.g. the downstream effects of a forest's impact on water quality)
- The value of retaining a resource for future uses:
  - option value is the "pure" value of retaining for future use
  - quasi-option value is the value of waiting for improved information
- Non-use values associated with a resource:
  - the "existence value" of retaining a resource for its own sake
  - the "bequest value" of retaining a resource to pass on to the future.

This indicates the value is not confined to currently observed activity, and for some environmental attributes that current value may not be the main component (e.g. species loss). Techniques used to infer non-market values fall between:

- Market surrogates or cost-based estimates – these can provide a value for only some non-market attributes (e.g. forestry's contribution to water flow management could be estimated as the avoided costs of damage from reduced flood frequency and severity) and depend on data availability
- Revealed preference methods that infer a value for the non-market attribute from the value of related activity e.g.:
  - the premium of in-house prices attributable to proximity to desirable environmental features, such as parks, clean air

- the value of recreation sites inferred from analysis of travel costs incurred by visitors in using the sites

- Stated preference methods that infer a value for a non-market attributes using market-research type methods of direct questioning:
  - people's willingness to pay for securing (or accept compensation for giving up) some component of environmental quality
  - choice modelling of people's preferences for different combinations of attributes that affect environmental quality.

These methods figure largely in the valuations of recreation and amenity outlined below. There are limitations in using these methods alongside compilations of statistics of contributions of forestry to the economy. These limitations include:

- These methods are context specific in application and too few have been undertaken in New Zealand to reliably infer generic values to apply to questions like the "what is the value of forests to recreation" across the country as a whole
- Internationally there are more examples of such studies, but the context of such studies is so variable that it is difficult to reliably infer a value relevant to New Zealand contexts
- The basis of all non-market valuation methods is to estimate an economic surplus for consumers of the attributes in question – which makes them incompatible with the System of National Accounts, which measures values in production, not the economic surplus that consumers obtain from all their consumption decisions (not just those relating to non-market goods).

While non-market values may be used in cost benefit analysis of individual project proposals, in their current form they are problematic for inferring the aggregate value of externalities across the national economy.

J.2.2 Value estimates

Table 1 in Section 3.1 above reproduced results of one study applying the ecosystem service approach to valuing forestry in the Ohiwa catchment in the Bay of Plenty. These provide values per hectare of various components of ecosystem services. Table 1 estimates the net ecosystem services value to be $5,609 per year, half of which is attributable to forestry's reduced leaching of nutrients compared to other productive uses of the land. Other significant components of value are the supporting service of nutrient cycling (18% of value, but carries risk of double counting in other values) and the value of recreation which is site specific and unlikely to be characteristic of all forests. Excluding those values the remaining components sum to $897 per hectare per year.

These are average values per hectare specific to that catchment, so extrapolating them across other areas can only give rough indicative figures of the scale of values associated with forestry across the country. More such studies customised to different sites across the country that can be considered representative of variation in terrain and environment would be required to refine such figures to closer approximation of a national figure.

A more recent study has examined the relative returns in ecosystem services of forestry and dairying.[53] This compared the market values of production and non-market values of environmental externalities from similar areas of land used for dairying and forestry, ecosystem services. From this modelling, although 26,000 hectares of land in dairying could produce a production surplus per year of $96 million about three times that from forestry on the same land, on externalities there is an estimated loss of $18 million from dairying compared to an estimated benefit of $30 million from forestry. Dairying also has a relatively high probability of low returns and negative surplus on production, whereas the production returns on forestry have lower variability. So forestry has lower returns but its environmental impacts are net positive, whereas dairy may have productive returns that can be higher or lower than those from forestry, but its environmental impacts are significantly net negative.

Table 14 Relative externality value of forest and dairying

Monge et al (2015) estimates are based on 26,000 hectares of dairy land in the central North Island and an equivalent amount of forestry land.

	Forest	Dairy
Land value $/ha	$10,000	$36,100
Surplus range Low $m/yr[1]	22	-6
Surplus range High $m/yr[1]	32	96
Probability of loss %	0%	13%
Environmental benefit $m/yr	31.0	-18.0
Note (1) The economic surpluses are based on revenue minus easily observable costs for the 26,0000 hectares.		

Source: Monge et al 2015, Scion

An earlier Scion report examined the impact of carbon forestry under the ETS,[54] adapting a method for comparing returns from major rural land uses.[55] Assuming carbon prices would be higher than those recently experienced ($22 and $50/t CO_2-e), the Scion report examined the effect of afforestation ("carbon farming") against dairying and a range of sheep and beef farms on different land classes, finding the ETS lowered the farm internal rate of return on all classes examined except two (on which the IRR was unchanged). This pointed to the importance of bringing other environmental benefits of forestry into the analysis which has been demonstrated in the later studies, but not yet in detailed studies comparing all land uses across all regions.

Two New Zealand studies that estimate ecosystem services for forestry at the national level are outlined in Appendix K.

53 Monge JJ, Velarde SJ, Yao RT, Pizzirani S & Parker WJ (2015) Identifying complementarities for the dairy and forestry industries in the Central North Island; Report by Scion for Oji Fibre Solutions and Waikato Regional Council.

54 West G, Wakelin S, Wall A, Turner JA, Poole B (2011) Achieving multiple regional goals with carbon forestry; Scion report to Environment Waikato.

55 Evison, D. 2008b. A method for comparing investment returns from major rural land uses including forestry. New Zealand Journal of Forestry, 53, 3, 27-32.

J.2.3 Compatibility with national accounts

The ecosystem services approach described above (and employed in the study behind Table 1) used a variety of methods to infer the value of benefits not traded in markets. These may include non-market valuation techniques which measure value as preferences of a representative sample of people affected by the benefit, both revealed preference and stated preference techniques. The essence of these is to estimate the consumer surplus associated with a given level of benefit from people's willingness to pay for it.

These values are not strictly commensurable with the national accounts, which are focused on production, unless the accounting frame is enlarged to account for consumer surplus from all spending. The non-market values are more suited to providing values for situations of choices at the margin, than for preparing national aggregate figures like adjusted GDP. The UN System of National Accounts recognises this and provides for two levels of satellite accounts compatible with, but not within, the main GDP accounts: a set of core accounts for things that can be measured in market terms (like the market value of standing timber) and more experimental accounts for things that cannot.

J.3 New Zealand: setting out the analysis gaps

J.3.1 Provisioning services – materials and energy

Provisioning services of supplying timber, recovered energy and sometimes foodstuffs from forests are for the most part subject to market exchange, so their value is covered by the national accounting structure. For New Zealand's planted forests the material provisioning services are currently well covered by the main production statistics contained in MPI's National Exotic Forest Description (NEFD) and Statistics New Zealand's export data and inter-industry transaction tables. No further adjustments are required to cover the value of wood production.

In the New Zealand context provisioning of foodstuffs from planted forests is negligible, much of it a by-product of the cultural ecosystem service of recreational hunting.

Energy

Energy production from forest residues is already covered by statistics prepared by MBIE in its energy balances and by MPI in its forestry statistics. Most of this is energy recovered from the use of saw-milling and pulp production residues that can be used in heat-requiring processes on site (e.g. drying timber). There remains a proportion of waste material and residues left in forests after clearing that could enable greater energy recovery from forest materials. These forest residues contribute to soil fertility so there are limits to recovery beyond which such recovery affects forest growth.

There is also the hard to quantify use of firewood and wood pellets in domestic heating, much of it supplied through the informal market (e.g. farmers supplying shelterbelt trimmings to neighbours), or scavenging in public forests, river beds and beaches. Value estimates can be inferred through such sources as EECA's Energy End Use statistics which show wood accounting for 36% of delivered household energy; the Bioenergy Association's Facts and Figures which suggest 50% of houses have solid wood burning appliances, and that wood accounts for 12% of household energy use on space heating and water heating; and the Household Energy End Use Project (BRANZ).

Yao et al (2013) estimated that in 2011 wood-based bioenergy was approximately 54.4 petajoules (7.4% of the country's primary energy demand) with a value of $921 million (assuming a value of $16.9 million per petajoule). This is $921 million of input cost that the forestry industry saves by utilising its wastes and residues, and is a gross output value rather than a contribution to GDP (value added). If the industry did not do this it would need to acquire the energy it needs from some other source, which would be more expensive (assuming the industry regards biomass is its least cost energy option). A portion of that cost of alternative energy would be value added for the sectors supplying the alternative energy so the value to New Zealand of recovered biomass energy can be estimated as the net cost of the next best alternative energy source, i.e.:

Annual Energy Volume x Mean Cost of Alternative Energy – Value Added Component

In Calendar year 2015 wood processing residues provided 58.3 Gross Petajoules for the wood processing industry. Valued on the same basis as Yao et al (2013) this would be worth $987 million gross or $789 million net of value added at 20% which accrues to another sector in the economy.

J.3.2 Regulatory services – resources and ecology

Most regulatory services are not exchanged through markets, except for carbon sequestration. For the rest, there is clear scientific evidence of the existence of benefits from forestry, but a less clear indication of the generic rate of benefit that would support a nationwide value estimate as most studies are site specific and reflect local characteristics. But indicative values can be inferred by extrapolation from such studies. Care is needed in using these diverse studies to ensure that there is no double counting (e.g. between value of avoiding erosion and value of improved water quality) and to clarify whether values used equate to gross output or to value added, consistent with the definitions used in the System of National Accounts and the System of Environmental and Economic Accounts.

Carbon storage

Among regulating services, the most readily estimated in economic terms is the value of carbon storage. The estimation of carbon stored by forestry is in principle relatively straightforward from the volume of standing timber, the carbon content of that timber (varying with species and age profile) and the value of carbon credits available in New Zealand. The Ministry for the Environment's National Greenhouse Gas Inventory provides details of carbon sequestered or emitted by land use change and forestry, from which annual values (consistent with annual production) and long term stock value can be estimated.

Carbon capture in growing trees and their root systems is subject to market prices under the New Zealand emissions trading scheme. This scheme was distorted in the early years of its operation due to the oversupply on the market of overseas-sourced UN approved carbon credits of questionable integrity, but since March 2015 supply from such sources has been ineligible for use in the New Zealand ETS and carbon prices have started to recover to levels where the incentive for tree planting is stronger (but not yet realised). The unit value of carbon will vary over time and there will be periods in the forest production cycle around harvesting when this will turn negative with net deforestation.

In practice, only a portion of forests – those newly planted since 1990, excluding replantings – are eligible for creating carbon credits. The cumulative area of new plantings since 1991 amounted to 714,000 hectares at 1 April 2016.[56] Assuming Yao et al's (2014) $48 per hectare on average (see Table 1) that amounts to just $34,300 carbon value. But Yao et al assume a carbon price of $4.00 per t$CO_2$-e, considerably lower than the current price of around $18 and the prices that could arise in future. At $18 the value of new planting rises to $154,000 and at $30 per tonne to $257,000.[57]

Deforestation of any forest attracts liability to surrender carbon units which can be offset by continuous replanting. So there is value in retaining existing forests in continuous rotation to the extent that it avoids the cost of surrendering carbon units in proportion to the volume of carbon in the trees.[58] Applying Yao et al's average carbon value to 1.72 million hectares of planted forest implies a total value of $82 million for the year; at $18/tonne that would be $372 million and at $30/tonne $619 million.

Ideally a long term expected value of carbon would be used or inferences drawn from the futures market, and applied to age-weighted models of the growing stock of trees, but the market for New Zealand units is relatively thin with a focus on relatively short term futures and reorientation to longer term value is highly unlikely under current policy settings. As a rough indicator, retaining the current area of planted forest is worth in excess of $300 million per year.

Nutrient retention and avoidance of run-off

Forests displace other land uses which apply more nitrates per hectare (e.g. livestock) and reduce the volume of nutrients leached into waterways. There is no market for this service in New Zealand to date, but there is value implicit in this as regional councils apply regulations to control nutrient application to land uses to reduce the run-off into waterways.

The Lake Taupo nitrate trading scheme is a partial nascent market introduced in one catchment to reduce nitrate leaching to groundwater. Larger taxpayer subsidies have encouraged retirement of surplus nitrate application entitlements. While some lessons can be drawn from studies of this scheme, extrapolation across other catchments with different land uses and intensity of nitrate use would be indicative, at best.

Recent estimates of the ecosystem services from forestry have placed a very high value on the reduction of nutrients entering the waterway of $400 per kilogram. These are based on the cost of fertiliser and the implicit waste of valuable input into agriculture. As a rough indicator of scale, if Yao and Velarde's estimate of $2,800 per hectare saved applied to the whole of the planted forest area, this would have an annual value of $5.8 billion to the nation.

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56 MPI (2016) National Exotic Forest Description Table 9.1. New land planted in production forest.

57 Yao et al's estimates imply a gross sequestration of 12 tonnes of CO_2-e per year, a conservative rate considering planted forests as a whole have sequestered 10 to 19 tCO2-e per hectare since 1990 (Yao et al 2013).

58 Dairy conversions show that on many types of land the expected return from dairy exceeds the expected return from forestry including carbon storage value.

Avoidance of soil erosion

Trees and their roots help to bind soils and reduce their susceptibility to erosion and run-off of sediment into waterways. The effect of trees tends to depend on local conditions of terrain and climate. Previous studies that estimate the national costs of erosion could be used to infer indicative value of the value of erosion prevention attributable to forested landscapes e.g. Krausse et al (2001).[59]

Later studies have developed a model for calculating regional estimates of erosion[60] and estimating values for specific regions.[61] But these still draw on Krausse's values which were derived from the diverse but few estimates available at the time and are more indicative than accurate depictions of the values across different terrains.

Yao and Velarde estimate the value of erosion protection at $121 per hectare per year. If this were applied to the whole planted forest area of 1.72 million hectares, the annual value would be $208 million per year to the nation.

Water quantity and flow moderation

Tree planting has been shown to moderate peak flood flows in small to medium sized storms. In low rainfall areas (e.g. east coast of the South Island) tree planting reduces the water yield by 30% or more, potentially impacting abstractive water users.

Forestry reduces the frequency and severity of flood events. The damage caused by such events, and their frequency in catchments with similar climatic characteristics but different distributions of forests would provide an indication of the specific value of forestry for this benefit. A number of previous studies of the cost of floods can be used to give indicative values of the avoided costs due to the extent of forests.

Flood events cause damage to the economy, reflected in insurance claims, lost productivity due to disruption of normal activities. Insurable damage includes both that caused by water and the clean-up of sedimentation which is the end result of erosion, so it is unclear where the distinction between erosion damage and flood damage falls. For instance, Yao and Velarde estimate $121 per hectare per year as the avoided cost from forestry of sedimentation and flooding, but of just $8 per hectare per year to the nation.

if this water supply value applied across 1.7 million hectares of forest the ecosystem service value would amount to $14 million per year. But this is a rough average which may not reflect the variability across catchments in the benefit achieved or the netting off of negative impacts on other water abstractors, which is site specific and can only be assessed through local monitoring.

Water quality

Water quality clean-up operations in the Lake Taupo and the greater Waikato catchment, and in the Rotorua lakes give an indication of the value of cleaner water bodies (i.e. society's willingness to pay for water improvements) and some local

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59 Krausse M, Eastwood C and Alexander R (2001), Muddied Waters: estimating the national economic cost of soil erosion and sedimentation in New Zealand. Landcare Palmerston North 2001.

60 Dymond JR, Betts HD, and Schierlitz CS (2010) "An erosion model for evaluating regional land use scenarios" *Environmental modelling and Software* 15(3) 289-298.

61 Dominati E & Mackay A (2013) "An ecosystems services approach to the cost of soil erosion and value of soil conservation" Report for Hawkes' Bay Regional Council by Agresearch, Palmerston North.

studies give an indication of the cost effectiveness of forestry as a contributor to such clean-ups. Indicative value of forestry for such purposes can be made by extrapolating from such local studies across a wider national setting, although with a wide margin for error.

Since 2000, government and local government have committed $526 million to multi-year (taxpayer funded) programmes to clean up freshwater bodies, including $220 million on the Waikato and Waipa Rivers, $144 million on four Rotorua lakes, $30 million on Lake Taupo and $30 million on the Manawatu River. The full costs of clean-up, including private costs and opportunity cost of lost production from other regulatory measures, are unclear but would be higher than government costs alone.

Afforestation (new land plantings) can contribute to improved water quality because of its lower nitrate leaching than other potential land uses; existing forestry makes the clean-up task less severe than it would otherwise be. But the extent to which these avoided clean-up costs can be attributed to forestry – i.e. how different would they be if there were more (or less) forestry – is not clear from current information on average values of ecosystem services.

Yao and Velarde estimate a forest benefit of $6 per hectare per year as the benefit of water regulation. As a rough indicator, if this value were applied to the 1.72 million hectares of planted forest it would amount to a benefit of $10 million per year. They also estimate a value of $244 per hectare per year for waste treatment, which presumably reflects forest undergrowth's ability to assimilate waste which could otherwise end up in waterways. That would be worth $420 million per year to the nation if it applied to 1.72 million hectares of planted forests.

Biodiversity

Although biodiversity is commonly associated with indigenous forests, planted exotic forests in New Zealand also provide habitat for at least 118 threatened native species and may have particular value in providing forested corridors linking areas of other indigenous habitats.[62] The implication is that planted forests can reduce the probability of irreversible loss of threatened species compared to other modified land uses like pasture, and thus contribute to biodiversity protection goals that government has drawn up in accord with international agreements.

In principle the value of planted forests for biodiversity can be inferred by examining its cost effectiveness in protecting native species compared to the cost effectiveness of protecting the same species in other ways (e.g. through native forest restoration). In practice there are too few studies that attempt to do this to draw generalisable values for applying across the national forestry estate. Assessments of the value of improvements in biodiversity are often couched in terms of a public choice question of willingness to pay for more protected habitat, and as such can be considered under the heading of the value of cultural ecosystem services to environmental amenity.

Yao and Velarde estimate a value of forests for biodiversity to be $257 per hectare in Ohiwa catchment. However, this is based on relatively few studies of willingness to pay for localised biodiversity improvement measures, mainly applying to indigenous forest and transferred to planted forest by assumption. It is unlikely that these local

[62] Pawson SM, Ecroyd CE, Seaton R, Shaw WB, Brockerhoff EG 2010. New Zealand's exotic plantation forests as habitats for threatened indigenous species. New Zealand Journal of Ecology 34: 342–355.

estimates are representative of the average value across all planted forests, many of which are not accessible to the public and hence lack the value of watchable wildlife that attaches to more accessible forests.[63] Hence there is no firm basis for estimating value for biodiversity of planted forests as a whole.

J.3.3 Cultural services – amenity values

Cultural values from ecosystem services refer to non-extractive activities that derive benefit from the forests, including the active uses for recreation and tourism and the more passive uses of appreciation of amenity, biodiversity and landscape. Most of these are not exchanged in a market context, so various techniques of non-market valuation have emerged to infer value in other ways.

Recreation and tourism values

Several planted forests in New Zealand provide public access opportunities for recreational activities such as walking, mountain biking, horse riding, running, 4WD outings, picnics and in some cases more formal provision such as paintballing, high wire courses, zip-lines and flying fox rides. Some forests are accessible by permit for activities such as hunting and fishing but there is no public access over most planted forest area in New Zealand.

The forests with most access are commonly close to urban centres, such as Whakarewarewa and Redwoods forest near Rotorua, Woodhill Forest near Auckland, planted forests around Hanmer Springs, Bottle Lake in Christchurch, and Naseby, Wanaka, and Queenstown. Only some activities such as zip-lining are charged for, so there is a mix of market and non-market values generated by such forests. The forests may also host special events which generate revenues for their organisers and spending in the district by people drawn to the event.

A study of Whakarewarewa Forest in 2007 estimated the total mountain bike spending in Rotorua to be $7.37 million, of which $2.56 million could be directly attributed to the Forest. Rotorua residents comprised around 26% of recreational visitors to the Forest, but accounted for 69% of the recreational activities undertaken there, indicating the Forest's contribution to local amenity and to attracting people from outside.

More recently, a single event in the Forest, the 2016 Crankworx Festival, is estimated to have boosted spending in Rotorua by $8 million, with 73% attributable to New Zealanders and 27% attributable to international visitors (including competitors).

Although recreation attractions in natural surroundings are recognised as an important drawcard for tourism in New Zealand there is a paucity of national level statistics to pinpoint the amount of time and value associated with these activities in specific settings.[64] Tourism statistics from MBIE identify participation by overseas tourists in various nature based activities, but not the level of use (visitor days) or whether forest activity is in indigenous forest or planted forest. Statistics New Zealand's Tourism Satellite Account identifies domestic (i.e. New Zealand) tourists account for more

[63] Non-accessible forest reduces the risk of interference by humans and dogs and may improve chances of rare species survival but this depends on the level of pest and predator control which is often higher close to public access ways.

[64] Clough P 2013. "The value of ecosystem services for recreation". *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.

national expenditure than international tourists, but gives little breakdown on where that spending occurs.

At present information on the economic value of planted forests for recreation is limited to reports on local economic impacts (like for Whakarewarewa above) or non-market valuation studies of particular forested areas. The latter include studies using a mix of methods and wide variability of results which are not strictly comparable, from which it is difficult to infer the generalised value of forests for recreation.[65] Some examples are tabled below.

Table 15 Selection of estimates of forest recreation values

	$/visit	Visits/year	$m/yr	$/ha/yr
Bottle Lake	47	400,000	18.8	15,667
Whakarewarewa MTB	52	304,000	15.8	2,468
Whakarewarewa Walk	36	304,000	10.9	2,468
Coromandel planted	93	20,000	1.9	26

Source: Yao et al (2013), Scion

Yao et al (2013) compare twelve studies calculating an economic value of culture ecosystem services in New Zealand forests. These include Dhakal et al's (2012) study of Whakarewarewa Forest that estimated values of $36 per walker visit and $52 per mountain biker visit;[66] and Barry et al's (2012) study of the Tauranga Energy Consumers' Trust park which estimated values of $4.40 per walker visit, $7.70 per mountain biker visit, $9.04 per horse riding visit and $18.76 per motocross visit.[67] Most other estimates are old, dating back to the 1980s.

The difference in values between estimates for similar activities of walking and mountain biking raises questions about what is a representative value for recreation. However, it is clear that some particular forests generate large economic benefit for their surrounding districts, both for local recreation and as visitor attractions that provide market value for local businesses that service the recreational activity and accommodation for visitors.

The importance of the development of forest recreation facilities particularly in peri-urban forestry settings is highlighted by the recently opened Christchurch Adventure Park (5km from the city centre in the Port Hills). This $20 million development includes

[65] See Yao RT, Barry LE, Wakelin SJ, Harrison DR, Magnard L-A and Payn TW (2013) "Planted forests" *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand

[66] Dhakal B, Yao RT, Turner JA, Barnard TD 2012. Recreational users' willingness to pay and preferences for changes in planted forest features. Forest Policy and Economics 17: 34–44

[67] Barry L, Yao R, Bayne K 2012a. Estimating non-market values for a new forest park in New Zealand. Rotorua, Scion

a 4-seater high-speed chairlift[68], mountain bike trails, zipline (flying fox) canopy tour, sightseeing, lodging, bike rental, retail and bar/restaurant facilities. The operation opened in December 2016 and employs over 100 staff.[69] Strong early demand has meant that the 9 month season passes have been popular. Over 1000 season passes costing $759 each have already been reserved.[70]

The level of investment in these types of activities is growing on the back of surging tourist numbers and increased local demand.

Amenity, biodiversity and landscape values

As with recreation, previous studies of ecosystem services of forests for amenity, biodiversity and landscape have drawn on non-market valuation studies of different sites or locations, rather than estimating an overall value of recreation to the nation (e.g. Yao et al 2013).[71] Studies that infer public preferences across a broader set of choices – for instance the relative preference for more planted forest or more indigenous forest – or that examine the relative costs and benefit in terms of contribution to biodiversity protection of different land uses and landscape elements to not appear to have been published in the New Zealand context.

While there are examples of non-market values of amenity, biodiversity and landscape, and it would be possible to infer value of planted forests for biodiversity, from the expenditures on pest control, as with previous estimates the result is a partial mosaic of localised values rather than a comprehensive picture of the value for these activities obtained from forests.

J.4 Summary

Table 16 below indicates the current state of knowledge of the economic value of different ecosystem services related to forests. A brief explanation of the components of an ecosystem services account of forest benefits is outlined below.

The principal provisioning services from planted forests, wood fibre for sawn timber, pulp and paper products, is relatively well covered by the production and export statistics of the sort that underpin this report's Table 2 above. Also well covered by current statistics is the plant based energy obtained from sawmilling and pulping residues that are recovered to heat parts of the respective production processes. Less well-covered is the energy derived from domestic firewood and some new bio-digester processes using forest materials. No reliable statistics exist on the production of food from planted forests or the extraction of bio-chemical materials for pharmaceutical and other uses.

Of the other ecosystem services from forests:

- Carbon worth is relatively straight forward, although the form of calculation will vary between valuing entire stock of forest carbon stored or the annual

68 The chairlift is 1.8kms long, has an evaluation of 430 metres, and can handle 1,200 people and bikes per hour. See http://www.porthillsleisure.nz/christchurch-adventure-park-video/

69 http://www.stuff.co.nz/travel/themes/adventure/81791461/100-jobs-at-christchurch-adventure-park

70 http://www.stuff.co.nz/the-press/news/85653924/early-bird-passes-for-christchurch-adventure-park-close-to-selling-out

71 Yao RT, Barry LE, Wakelin SJ, Harrison DR, Magnard L-A, Payn TW 2013. Planted forests. *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand

increments from new planting, and on the basis for pricing the stored value (past, current or expected future values of carbon)

- Soil conservation, sediment and water quality are more difficult, as there are some very high level aggregate estimates of national costs, and a few site-specific estimates of impacts on individual catchments, but these rest on a few local estimates that are now dated. But more such local specific estimates across different types of forested catchment would be required to extrapolate to national level estimates, and such estimates would also need to account for variations in harvest cycle.
- Recreation and tourism values are currently only available for a few specific forested sites and employ methods that may not be compatible with each other or with the national accounts statistics. More consistent data on visitors to the main publicly accessible planted forest areas, and visitor surveys to establish activity patterns by visitors in these areas would give improved picture of the value associated with different activities at forest sites, and trace the share of local economic activity their visits stimulate through payments for forest-related access, hire services, and payments for ancillary services like accommodation and goods retailing. A recent report on the value of recreational marine fishing gives an example of what could be achieved for forest recreation and tourism activity.[72]
- Biodiversity and natural heritage also require further work to establish their contribution to preservation of heritage and the use value and non-use value of these services for the public. This can only be approached through surveys of visitors to forests to probe their reason for visiting and to establish the relative preferences of visitors for these and more active recreational activities

Table 16 Forestry benefits

	Current situation	Gaps	What success looks like
Provisioning services			
Wood fibre (sawn timber, pulp and panel products)	Current statistics indicate \$3.7-\$4.8 billion/year (see Table 2 above)		
Plant based energy resources	Residues from sawmilling and pulping used as heat for wood and paper production. Equivalent in 2016 to 58.3 Gross PJ would be worth \$987 million to industry or \$789 m to NZ at large	Domestic firewood and wood pellets and industrial wood chip boilers incompletely covered: estimates could be made from building energy surveys	Estimate of the volume of energy from domestic and other sources to match against the industrial energy estimates already made

72 New Zealand Marine Research Association (2016) Recreational Fishing in New Zealand. A Billion Dollar Industry.

	Current situation	Gaps	What success looks like
Forest food (game, honey, plants and animal products)	Assorted hunting, gathering and cultivated animals in forests (e.g. crayfish in firebreak ponds)	No comprehensive tally of outputs from disparate activities	Specific surveys of different activities could provide estimates, but overall value is probably not large
Forest based genetic materials & pharmaceuticals	Bio-chemical extracts from forest resources	Essential oils extracted from douglas-fir	Estimates would need specific surveys but value is probably not large
Regulating services			
Global climate regulation	Forest contribution to carbon storage and value to offset against emissions cost is currently prepared by MfE. Current mean annual increment of over $300M at $15/tCO2	Distinction between planted forest and natural forest is not clear from published estimates	Engage with MfE to separate their stock estimates into values for planted and natural indigenous forests
Nutrient run-off	Significant advantage over other land uses; may be worth $5.86 billion a year	Too few specific estimates of different forest contexts exist to reliably extrapolate to national level	Prepare a range of estimates of characteristic estimates that enable reliable aggregate estimates
Soil conservation, sediment and flood mitigation	Crude national level estimates and site-specific estimates exist, but not reconcilable. Estimated forest annual benefit of $208 million for soil conservation and $6 million for flood mitigation	Critical gap is in knowing how more or less forest cover affects sediment and severity of flooding downriver	Develop functions of flood frequency variation with forest cover that can be applied to different terrains
Water quantity	One estimate of $10 million/year but may overlap with flood mitigation estimate. One study exists of how land cover affects cost of downstream water treatment	Critical gap is in knowing how more or less forest cover affects water quality and treatment costs	Develop functions of water quality variation with forest cover that can be applied to different terrains
Water quality	Catchment clean ups in Waikato and Lake Taupo indicate value. These values are significant	A full understanding of the average costs nationally is required.	Development of functions that illustrate forestry benefit on different terrains/catchments

	Current situation	Gaps	What success looks like
	suggesting at least \$420 m per year		
Cultural services			
Recreation and tourism	Some forests well used, but most not accessible. Site specific studies of various forest activities and sites exist, using various estimation methods, but little consistency for comparisons	Critical gap is in knowing visitor numbers and their activities in different forests. Aggregate values across all forests not feasible	Develop standard values per visitor and per activity in forest, to apply to survey-based estimates of the number of visitors in forests
Heritage protection	Visits to historic heritage sites in forest areas have value, but New Zealand valuation studies focus on natural heritage	Critical gaps in knowing how many people visit historic heritage in forest settings, and the value they place on doing so	Consistent surveys of visitors to a range of forest settings, purpose of visit and costs they incur in doing so, to build up a matrix of the types of setting, activity undertaken and value of activities across different types of forests
Biodiversity protection	New Zealand valuation studies are few in number and variable in method, providing no basis for overall valuation	Critical gap is value people place on use (wildlife visits) and non-use (supporting conservation)	
Supporting services			
Not separately estimated, to avoid double counting.			

Source: NZIER

The ecosystem services approach could be readily adapted to include current production statistics, and extended to include energy value and carbon storage value using other existing statistics. Recreation and tourism is a relatively tangible further extension, but that would depend on surveying forest owners to improve data on visitor numbers, and surveys of visitors to understand better the value they place in their forest visits.

Other cultural services would be even more heavily dependent on generating a wide range of survey data, and the regulatory services other than carbon all require a greater range of observational studies of forests' biophysical effects than currently exists.

Appendix K Environmental studies

K.1 General

Two studies reported in *Ecosystem Services in New Zealand* (Dymond ed. 2013) have attempted to value the contribution of New Zealand's forests to the wider range of ecosystem services. Yao et al (2013) follow the approach of MEA (2005) and UKNEA (2011) to estimate value components of planted forests' conventional market-based production, energy recovery and carbon sequestration and then infer values for effects not exchanged in markets, including avoided erosion and cultural services of recreation at a selection of sites.[73] Patterson and Cole[74] present a chapter on "Total Economic Value of New Zealand's Land-based ecosystems and their services", which follows the approach of Costanza et al (1997)[75] with a section that suggests forest ecosystems account for about 20% of the total calculated ecosystem services of all land uses across New Zealand.

Patterson and Cole's estimate covers all forests, including natural indigenous forest which is around 7 times more extensive in land area than planted exotic forests. Their estimates are in economic value added and identify value that is not covered in GDP. Yao et al's estimates are of gross output, and if converted to a value added equivalent (by applying the ratio of GDP: Gross Output of 0.47) their estimate of provisioning services value would be 55% of that of Patterson and Cole. This appears disproportionate to the share of national land use in exotic and indigenous forest and these two approaches are not yet readily reconciled.

Nevertheless, the approach of Yao et al in building on existing production statistics with more indicative estimates of other values is like the SEEA split between central accounts and experimental accounts and provides a practical way to proceed. Details of putting such an approach into practice for each element are outlined below.

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73 Yao RT, Barry LE, Wakelin SJ, Harrison DR, Magnard L-A, Payn TW 2013. Planted forests. *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.

74 Patterson MG, Cole AO 2013. "Total economic value" of New Zealand's land-based ecosystems and their services. *In* Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.

75 Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg, K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M 1997. The value of the world's ecosystem service and natural capital. Nature 387: 253–260.

Appendix L The aim: A Forestry Satellite Account

L.1 The first best option is a Forestry Satellite Account

One way of bring together the market and non-market attributes of forestry is through a Forestry Satellite Account. Ideally the Forestry Satellite Account would be linked to, and consistent with, the existing New Zealand System of National Accounts, and with the guidelines of the UN System of Economic and Environmental Accounts, which were reviewed in 2012.

Satellite accounts involve the rearrangement of existing information found in the national accounts so that an area of particular environmental and social importance can be analysed more closely.

Satellite accounts could serve two ends relevant to forestry statistics:

- Focus on New Zealand-forestry related activity (similar to the tourism satellite account's focus on tourism activity – see below) to more clearly highlight value added from forestry in New Zealand (as distinct from forest products based on imported wood fibre)
- Bring into accounts some sources of value attributable to forestry which are currently not in them or obscured by them (e.g. non-market values).

Resources will be a constraint to achieving this goal

Any new idea for funding will need to be socialised with policymakers sometime in advance. Even at that stage there is low likelihood of making the priority list early on. Despite the growing importance of forestry on economic, social and environmental grounds there is unlikely to be universal acceptance for the idea because of resource constraints and competing resource interests.

Option for moving forward

Reports such as this one highlight the need for further action and keep the pressure by showing the importance of forestry and the gaps that need to be filled. They present credible consistent evidence which is accepted by policy makers.

Including forestry in the tourism satellite account may also be an option that is more palatable and more easily accepted by policy makers. The tourism satellite account could potentially point to the value of forestry to visitors.

The detail of what should be put into the tourism account would need to be worked out with Statistics New Zealand. However, the process of engagement with Statistics New Zealand is likely to positive since it will raise awareness within Statistics New Zealand of the increasing importance of forestry to New Zealand in economic, social, and environmental terms.

This has the advantage of:

- Being less resource intensive than a Forestry Satellite Account
- Socialising the idea for further work on non-market activity and encouraging research that conforms to national accounting principles
- Acting as a bridge towards a Forestry Satellite Account i.e. its sets up the structure and framework for further work as non-market forestry activities become more important.

L.2 The rationale for a Forestry Satellite Account

Forestry plays a significant and increasing role in the New Zealand economy – both in terms of market and non-market activity. Forestry does not have its non-market values explicitly measured in the official economic statistics. A Forestry Satellite Account, similar to the Tourism Satellite Account would assist in beginning to fill that gap.

Statistics New Zealand produced a set of physical and monetary forestry stock and flow accounts for the period 1996-2002. This followed the then SEEA guidelines and had a fairly narrowly defined sector coverage, including the supply of inputs to forestry from the forest industry itself and agricultural sectors, and the use of outputs in wood product manufacturing industries, pulp and paper manufacturing, printing and publishing, furniture manufacturing, construction sectors, building supplies wholesalers and owner occupied dwellings.

Forestry's use of and impacts on rural contract services, transport and sundry other industries (like toys and sporting goods manufacture) were excluded. Forestry's contribution to national energy was also excluded, and carbon storage was not a matter of concern at that time.

An update of these accounts would both enable them to be aligned with SEEA's 2012 revised guidelines, and present an opportunity to experiment with extending them into new coverage (e.g. carbon stocks).

L.3 The Tourism Satellite Account

Statistics New Zealand produces annual satellite accounts for tourism, which extract from the national inter-industry transaction tables those activities that are directly and indirectly related to tourism activity by both foreign visitors and New Zealand travellers.

In other recent satellite accounts, Statistics New Zealand has pushed the boundaries of national accounting, for instance its 2013 accounts for Non-Profit Industries included an extension to account for the value of volunteer labour, which sits outside of, but consistent with, the main sector account.

In that light, a Forestry Satellite Account which includes more of the sectors that supply or use the forestry sectors, and has extensions to highlight Forestry's contributions to national energy supply, carbon sequestration and perhaps other environmental benefits such as tourism and recreation, could provide in a single source a fuller picture of the national impact of planted forestry and related industries.