A Regional Carbon Balance of the Forestry and Wood Processing Sectors in Otago, Southland and South Canterbury.

A report for the Southern Wood Council Inc.

by

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1. Introduction

The scope of this study was to:

- Determine the area of Kyoto forests in the region,
- Provide a breakdown by species and age,
- Assess the volume of carbon that the region's post 1990 (Kyoto) forests will accumulate during the first commitment period,
- Outline the assumptions underlying the assessment, identify factors that could affect the projected volumes,
- Undertake a desktop assessment of greenhouse gas emissions produced by forestry and first stage wood processing industries, including transport,
- Prepare an overall carbon balance for the southern forestry sector, and
- Examine the implications of New Zealand's declining planting rates on regional and national carbon estimates, for future assessment periods.

The participants for this study include both forestry and wood processing members of the Southern Wood Council Inc.

Forestry companies involved were:

- City Forests Ltd.
- Craigpine Timber Ltd.
- Ernslaw One Ltd.
- PF Olsen and Company Ltd. (Includes the Wrightson managed Trinity Foundation estate).
- Rayonier Asia Pacific Ltd.
- Southwood Export Ltd.
- Wenita Forest Products Ltd.

Wood processing companies include:

- Blue Mountain Lumber Ltd.
- Bright Wood NZ Ltd.
- City Forests Ltd.
- Craigpine Timber Ltd.
- Dongwha Patinna NZ Ltd.
- Southland Veneers Ltd.
- Southwood Export Ltd.
- Wenita Forest Products Ltd.

These participant companies comprised the SWC group referred to throughout this report.

There are other foresters and processors operating in the region. These activities have not been included in this study, but data from participants has been scaled up to provide an indication of the regional situation for both forestry and wood processing.

2. Executive Summary

The desk study has provided forestry and wood processing information on the extent of the Kyoto forests, the carbon sinks in both Kyoto and pre-Kyoto forests, and greenhouse gas emissions from forestry and wood processing operations covering a group of Southern Wood Council members. These members represent approximately 51% of the regional planted forests, and approximately 78% of the emissions from regional wood processing.

Kyoto forest sinks for the SWC group are predicted to be 4.343 $MtCO_2$ (million tonne of CO_2) for the first Kyoto commitment period (CP1), and 5.978 $MtCO_2$ for the second commitment period (CP2). The SWC group sinks for CP1 are 6.1% of the predicted national planted forest sinks.

Pre-Kyoto forest sinks for the SWC group are predicted to be 11.235 $MtCO_2$ for the first Kyoto commitment period (CP1), and 11.556 $MtCO_2$ for the second commitment period (CP2).

Decreased planting rates have already had a significant impact on New Zealand's Kyoto forest sinks and the net position. Incentivising increased planting rates should be a priority for Government, but significant benefits will not accrue until after the first commitment period.

The carbon balance included in this report provides a strong basis for any advocacy in terms of the significant planted forest sinks, for both Kyoto and pre-Kyoto forests. The net balance for the forestry and wood processing activities shows Kyoto forest sinks dominate the sector emissions by a factor of approximately 19:1. The net credit for the SWC group is 3.82 $MtCO_2$ for the first Kyoto commitment period, and approximately 8.06 $MtCO_2$ for the region. These net credits are respectively 5.4 % and 11.3 % of the latest Government predictions for the national first commitment period sinks.

Forestry activities for the SWC group, including log transport, emit 22,880 tCO_2/year from the use of mainly diesel. At the proposed level of \$15/tCO_2 for the carbon tax these emissions will cost the SWC group \$ 343,000/year. This increases to \$ 572,000/year at the carbon tax cap level of \$25/tCO_2.

Wood processing activities for the SWC group, including product transport, result in emissions of 75,051 tCO_2/year. At \$15/tCO_2 tax this will cost \$1,126,000/year. The cost will be \$1,876,000/year at \$25/tCO_2.

Wood processors in the SWC group are already utilising a high proportion of bio-fuel (wood waste), comprising about 70 % of total energy requirements.

Options to reduce greenhouse gas emissions include substitution of coal with wood waste. Some companies using coal are exposed to relatively high carbon taxes because coal is the highest emitting fuel.

Electricity is a significant contributor to wood processing exposure to the carbon tax liability. Energy efficiency audits may be useful for reducing electricity and other energy use.

The carbon tax will impose significant costs on both forestry and wood processing activities. The tax is set at a level that is already below the international price for greenhouse gas emissions trading, and this price will increase over time as countries fail to meet emissions reduction targets and sinks become scarce.

The Southern Wood Council members should consider possible collective actions to limit the impact of the carbon tax on profitability and protect competitiveness. Key options include energy efficiency audits, and Negotiated Greenhouse Agreements (NGA's) that seek to provide relief from up to 100% of the carbon tax. These require an assessment of the position in relation to 'World Best Practice' for energy greenhouse gas emissions efficiency.

3. Approach

Data was collected from participating companies covering forest estates, wood processing energy use and for transport of logs and products. The forest data included planted area by age and species, identification of Kyoto forests, and fuel use data for forestry activities.

The data was analysed as a desk study to provide the outputs required to meet the project objectives. In particular the approaches for forest sinks and emissions are the same as those taken by Government agencies.

Kyoto forests were the main focus for the forestry component of this study. The planted pre-Kyoto forests have been included in separate assessments.

The outputs covering carbon sinks, used for this report, are expressed as Carbon Dioxide (CO_2). Climate change and the associated Kyoto Protocol drive this issue, with CO_2 in the atmosphere being the important measure. Data is reported internationally as CO_2 with forest sinks being converted from carbon, using the chemistry factor of 3.67 tCO_2/tC. Additionally the use of a common measure assists in consistency and minimizes potential for misunderstanding.

3.1. Forestry approach

Forestry companies involved in this study have provided comprehensive data for their estates. This has met the requirements for input into the available carbon sequestration models. Specific inputs were established forest area by both age class and species.

3.1.1. Carbon sink models

The models available for predicting planted forest carbon sinks are arguably still relatively crude despite New Zealand being in a leadership situation. Work on model refinement is progressing, but it remains questionable as to whether New Zealand will be in the best position required in time for the Kyoto first commitment period (CP1) reporting, (2008 – 2012). However, the international measurement and reporting protocols provide for a series of tiers reflecting the robustness of measurement and assessment for reporting, with a requirement to move toward the more robust end of the tier structure as measurement systems and models are developed and enhanced.

Radiata carbon sink modeling is understandably the most robust in New Zealand, followed by Douglas Fir. Many species have not been dealt with in models but reasonable data for other species sequestration studies such as this can be obtained for the group of Eucalypts. Most of the slower growing minor softwood species can be reasonably characterised in terms of sequestration by using the Douglas Fir model. This situation will improve over time, but there will be more data uncertainty for the less common species for some time. For the above reasons it has been necessary to treat minor species in this study by their inclusion normally with Douglas Fir, or using the Eucalypt model for hardwoods.

The sequestration models for both Radiata and Douglas Fir include adjustments of carbon stock as a result of thinning and pruning. This can be seen as decreased incremental annual sequestration at those normal times, particularly as a result of thinning. This is not evident in the aggregated data provided in this report, but can be seen in the individual company annual sinks data, particularly for the smaller forest estates. The current models assume normal average stocking rates, with any sensitivity to stocking rate not being provided for at this time because of model limitations.

It should be noted that the models used are set up for average New Zealand growth and site fertility, and other growth factors. Clearly there will be regional and site differences. Present models can be manipulated by experts to attempt to reflect more local conditions. However, given the lack of accepted or formalized approaches for this, and the need for this project to be comparable with Government work and data, it is appropriate to use the available 'one size fits all' models.

The Radiata estate has been modeled separately for the first and second rotations using the 'C-Change' carbon sinks model. This is because the sequestration model for Radiata provides for the carbon residuals remaining on the forest floor and soil after harvest, with allowance being made for this material to be decayed and emitted over time. The residuals include slash, roots, ground litter and soil carbon. Therefore the carbon stock following harvest does not decrease to zero. The result is that the second rotation sequestration data is significantly higher in the early years, but in later years they align with the first rotation situation after the decay processes are completed.

Models used in this study align with those used by New Zealand Government agencies, namely Ministry of Agriculture and Forestry (MAF) and the New Zealand Climate Change Office (NZCCO). In particular the forest sinks model used for the most significant species, Radiata, is the one used by MAF for the 2005 national forest sink projections earlier in 2005 and for other modeling work for Government.

An indication of the sinks model predictions for sequestration is given in Table 1.

Table 1: Model predictions for carbon sequestration, (tCO_2 per Ha)

Age, years	Radiata, 1st rotation	Radiata, 2nd rotation	Douglas Fir	Eucalypts
10	230	300	120	380
20	510	535	300	710
30	890	890	560	940

The annual carbon sequestration for Radiata essentially reaches close to maximum at about 40 years, and flattens off at year 60 at the 1250 tCO_2/ha level. Douglas Fir continues to grow for a much longer time, but the model predicts sequestration is significantly higher than Radiata at 1570 tCO_2/ha at 50 years.

3.1.2. Kyoto forests

It is now well known that there is significant uncertainty regarding the predicted levels of future Kyoto Forest sinks in New Zealand. This has major consequences for New Zealand's position in the first commitment period (CP1). A significant component of this uncertainty arises from the interpretation of the definition of a Kyoto Forest that has been agreed under the Kyoto processes. For the purposes of this study newly established forests that owners have identified as being on 'native cutover' land have been excluded from the Kyoto Forest category. This is prudent because it is in line with the current New Zealand Government interpretation. This should not be taken as being the correct and final position, because the current Government position is not necessarily correct. This is currently under review, including an international peer review.

3.1.3. Pre- Kyoto forests

Pre-Kyoto forests have been considered in this study to provide the full planted forest picture. The recent revised New Zealand sink position was severely reduced from 105 to 71

$MtCO_2$ for the first commitment period, because of the recent adjustment of Kyoto forest estate based on New Zealand's changed interpretation and declined planting rates. The pre-Kyoto forests now arguably assume a more important role in New Zealand's positioning in respect to forest sinks.

The pre-Kyoto forests, which come under Article 3.4 in the Kyoto Protocol, are extensive in New Zealand and provide an increasing sink through to the end of the second commitment period. New Zealand has time to include these forests in the national accounting under the Protocol but has so far elected not to do so. This is discussed further in section 6.2.

3.1.4. Forestry operations and transport

Forestry operations and transport necessarily require fuels for undertaking day to day activities. These contribute to the greenhouse gas emissions profile of both the sector and New Zealand. The dominant fuel is diesel, followed by petrol. Forestry operations, harvesting, and transport of logs to wood processing plants and ports have been included in the emissions profile for the forestry companies. The carbon tax on these activities will have a significant effect on the costs of forestry and transport activities.

3.2. Wood processing approach

Energy use determines the emissions of CO_2 from the wood processing operations. Energy use data provides inputs for conversion to emissions, based on the carbon content of the fuels that will be emitted as CO_2. The conversion factors are established and widely used. These are provided in Appendix 1.

Wood processing requires energy primarily as heat, for moving materials in processes, and for product drying. Key energy inputs in terms of greenhouse gas emissions for processing are electricity, followed by various sources of heat energy. Wood waste (hog fuel) does result in CO_2 emissions but these are not included because they come from a renewable resource, and under the Kyoto Protocol the tree carbon is considered to be an emission as CO_2 at the time of harvest.

Electricity is an important component because the electricity generation-mix uses coal and natural gas, both of which are emissions intensive, and emit large quantities of CO_2. Electricity emissions are called indirect emissions and these have been included in wood processing site emissions data, as per normal practice. The proportion of these fuels in the future generation mix will increase in New Zealand, resulting in increased CO_2 emissions per kWhr of electricity generation.

4. Key assumptions

Key assumptions for this study include:

- Raw data from the companies is the best obtainable at this time.
- Interpretation of the Kyoto Forest definition by forest owners in this study is believed to be consistent with the Government position at this time.
- The carbon sinks data in the models has been extrapolated for this study where there are sometimes higher age classes to be included. This obviously applies only to the non-Kyoto forests.
- In the absence of comprehensive regional data, appropriate for sinks predictions, it has been necessary to assume the SWC group is an appropriate indicator of the total planted production forest in the region. Regional data is an important part of the overall carbon balance later in the report. In this case if this assumption is not robust it will not make any material difference to the conclusions drawn that the sinks far outweigh the emissions for the region.

- The models used for predicting forest carbon sinks are the best that are available at this time.

5. Forest area

The total planted production forest area in the Otago, Southland and South Canterbury region is 242,341 Ha (June 2004 report for the Southern Wood Council Inc). The area included for the participants of this study is 123,521 Ha, which is 51% of the region.

The forests not included in this study comprise 88,100 Ha of small growers (<1,000Ha), seven from 1 - 5,000 Ha, and one above 15,000 Ha.

5.1. Species distribution

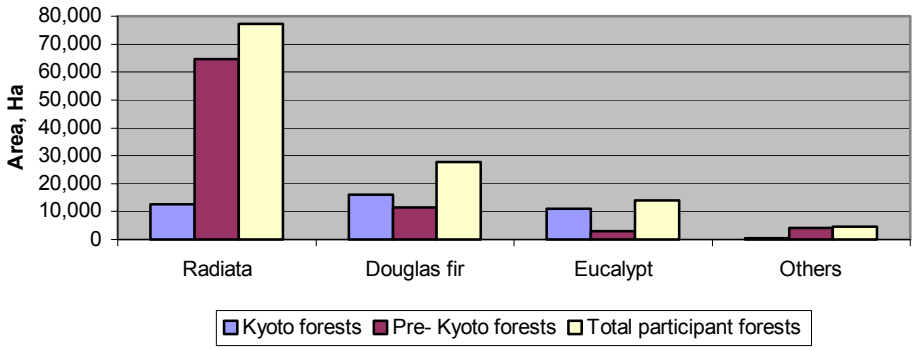
The participant data provides the species distribution for the Kyoto forests, pre-Kyoto forests and the total SWC group estate, shown in Table 2. This table also shows the regional species distribution, from the June 2004 report for the SWC Inc.

The aggregated data is given in Table 2, and is shown in Figure1. Kyoto forests are dominant for both Douglas Fir and Eucalypts.

Table 2: SWC group species distribution, Ha (%)

	Radiata	Douglas fir	Eucalypt	Others	Total
Kyoto forests	12,641 (31.4%)	16,129 (40.1%)	11,049 (27.4%)	434 (1.1%)	40,253 (100%)
Pre-Kyoto forests	64,581 (77.5%)	11,574 (13.9%)	2,883 (3.5%)	4230 (5.1%)	83,268 (100%)
Total SWC group forests	77,222 (62.5%)	27,703 (22.4%)	13,932 (11.3%)	4664 (3.8)	123,521 (100%)
Regional forests	159,343 (65.8%)	58,541 (24.1%)	15,603[1] (6.4%)	8.853 (3.6%)	242,341 (100%)

Figure 1: Species distribution



5.2. Age distribution

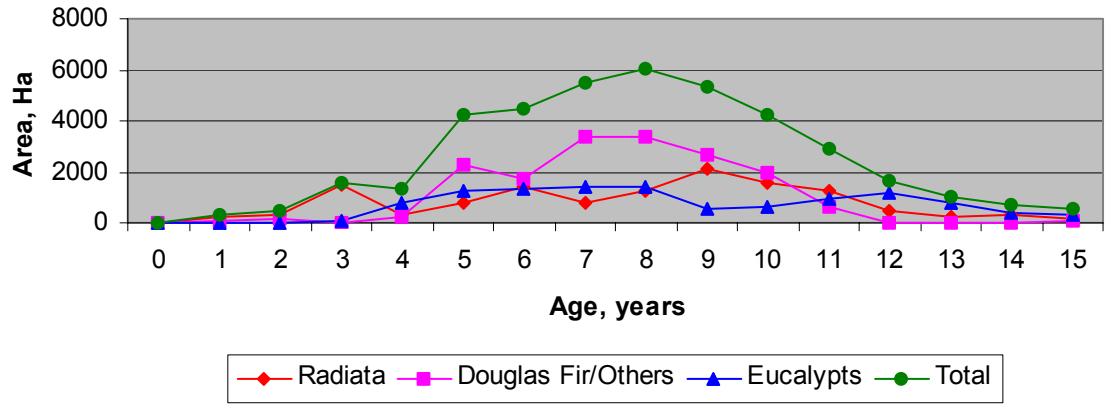
Analysis of the SWC group forest data provides the age distribution for Kyoto forests. This is given in Table 3.

[1] Specified as hardwoods in the report

Table 3: SWC group Kyoto Forest age distribution, Ha					
Year	**Age**	**Radiata**	**Douglas Fir and others**	**Eucalypts**	**Total Kyoto forests**
2005	0	0	0	0	0
2004	1	203.7	102.8	23.5	330
2003	2	295.5	145.3	8.9	449.7
2002	3	1,509.4	8	65.1	1,582.5
2001	4	349.5	257.4	748	1,354.9
2000	5	766.4	2,244.1	1,251.2	4,261.7
1999	6	1443	1,731.2	1,323.9	4,498.1
1998	7	783.7	3,356.2	1,378.5	5,518.4
1997	8	1,219.2	3,354.5	1,433	6,006.7
1996	9	2,084.1	2,705.1	537.3	5,326.5
1995	10	1,587.2	1,962.9	666.2	4,216.3
1994	11	1,257.7	643.9	973.8	2,875.4
1993	12	436.9	0.6	1,197.9	1,635.4
1992	13	265.8	2.5	747.7	1,016
1991	14	292.8	0	375.2	668
1990	15	145.6	48.1	319.1	512.8
Total, Ha		12,640.5	16,562.7	11,049.3	40,252.5

The age distribution of the Kyoto forests included in this study is shown in Figure 1. The highest planting rates during 1996 to 1998 clearly align closely to the national levels. The planting rates for Kyoto forests by the SWC group of participants are recently very low, also in line with national trends.

Figure 2: Kyoto forest age distribution



6. SWC group forest sinks

Data provided from the SWC forestry participants have been processed using the best available sequestration models that are consistent with Government generated data. These models have been used to assess the level of forest carbon sinks for each participant, each year, and for each species. Outputs have been aggregated for the SWC group for this report. As discussed in section 3.1.1, the lack of models for minor species requires that these be generally included with Douglas Fir because it is the most appropriate in terms of

growth, and in closer alignment than with either Radiata or Eucalypts. While this may seem crude the fact is the models do not exist, and any effect for the small areas of minor species is unlikely to be significant in most cases.

6.1. Kyoto forest sinks

The carbon models have been used to provide data on the current level of forest sinks (for the year 2005), and for the first two commitment periods of the Kyoto Protocol, (2008 - 2012 and 2013 - 2017). The forest sinks for the commitment periods is the total for the five-year periods. The figures from this study reflect only trees in the ground in 2004.

Table 4 summarises the aggregated predicted sinks data for the SWC group.

Table 4: SWC group Kyoto forest sinks

	Area planted	Current forest sinks (2005)	Forest sinks, CP1 (2008-2012)	Forest sinks, CP2 (2013- 2017)
	Ha	Tonne CO_2	Tonne CO_2	Tonne CO_2
Radiata	12,641	1,981,683	1,702,225	2,036,900
Douglas fir and others	16,563	998,655	804,966	2,331,809
Eucalypt	11,049	3,527,520	1,836,027	1,610,014
Total	40,253	6,507,858	4,343,218	5,978,723

6.1.1. First commitment period (2008 – 2012)

The predicted Kyoto forest sinks for the SWC group for the first commitment period totals 4.343 $MtCO_2$ (Million tonne CO_2).

The first commitment period forest sinks are dominated by eucalypt and radiata, with Douglas fir also being significant. The high numbers relative to the 2005-year totals reflect maturing young forests and the five-year commitment period.

6.1.2. Second commitment period (2013 – 2017)

The second commitment period forest sinks are for the same estate applied for the first commitment period. The second period is 37% higher at 5.978 $MtCO_2$ because of the higher annual incremental growth rates as the growth rates increase. Douglas Fir is the dominant sink in this period.

6.1.3. Total regional situation

The participant group represents about 51% of the planted production forest area of the region. If the SWC forest estate is assumed to be an indicator for the wider southern region, then based on the total regional planted production forest area of 242,341 Ha (June 2004 report for the Southern Wood Council Inc) the regional first commitment period Kyoto forest sinks for the region would be approximately 8.5 $MtCO_2$, and rising to 11.7 $MtCO_2$ for the second commitment period.

6.1.4. Kyoto forests - New Zealand context

Table 4 shows the first commitment period Kyoto forest sinks for the SWC group to be 4.343 $MtCO_2$. The mid-2005 prediction for New Zealand (Climate Change Office) was 70.9 Mt CO_2.

The SWC group projection is therefore approximately 6.1 % of the New Zealand total for the first commitment period.

6.2. SWC group pre- Kyoto forest sinks

The sinks data for the SWC group pre-Kyoto forests is given in Table 5.

The 2005 level of carbon sequestration reflects the age distribution and area of the pre-Kyoto forests. The commitment period pre-Kyoto forest sinks are currently not provided for in any credits New Zealand claims under the Kyoto Protocol. However there is provision for this in the protocol, and New Zealand still has the opportunity to include them. However, such a decision would lead to the need for full carbon accounting for all of the New Zealand estate, including indigenous forests. Full carbon accounting would include soil, roots and above ground carbon which is more complicated and expensive.

More importantly these pre-Kyoto forest sinks are increasing through towards the end of the second commitment period, and these sinks are included in New Zealand's national accounting under the obligations to the UNFCCC process. Therefore they are an important consideration in the context of enhancing New Zealand's contribution to reducing greenhouse gas concentrations in the atmosphere- the ultimate goal of the Kyoto Protocol.

Table 5: SWC group Pre-Kyoto forest sinks

	Area planted	Current forest sinks (2005)	Forest sinks, CP1 (2008-2012)	Forest sinks, CP2 (2013- 2017)
	Ha	Tonne CO_2	Tonne CO_2	Tonne CO_2
Radiata	64,581	30,672,659	8,503,477	8,844,621
Douglas fir and others	15,804	5,179,699	2,351,627	2,346,371
Eucalypt	2,883	1,763,950	380,864	365,752
Total	84,268	37,616,308	11,235,968	11,556,744

The pre-Kyoto sinks increase marginally from CP1 to CP2. This reflects the higher age distribution and the consequent lower annual sinks increment.

6.2.1. Pre-Kyoto forest sinks discussion

The SWC group pre Kyoto forest sinks are predicted to be 11.2 $MtCO_2$ for the first commitment period, and 11.6 $MtCO_2$ for the second commitment period. These are 2.5 and 1.9 times higher than the Kyoto forest sinks respectively.

When scaled up to the regional level, as in section 6.1.3, the predicted levels are 22.0 $MtCO_2$ for the first commitment period and 22.6 $MtCO_2$ for the second commitment period.

6.3. SWC group total forest sinks

The data in Table 6 provides the total SWC group total forest sinks for both Kyoto and pre-Kyoto forests.

Table 6: SWC group total forest sinks				
	Area planted	**Current forest sinks (2005)**	**Forest sinks, CP1 (2008-2012)**	**Forest sinks, CP2 (2013- 2017)**
	Ha	**Tonne CO_2**	**Tonne CO_2**	**Tonne CO_2**
Radiata	77,222	32,654,342	10,205,702	10,881,521
Douglas fir and others	32,367	6,178,354	3,156,593	4,678,180
Eucalypt	13,932	5,291,470	2,216,891	1,975,766
Total	123,521	44,124,166	15,579,186	17,535,467

The total forest sinks for the SWC group are significant at 15.6 $MtCO_2$ for CP1 and 17.5 $MtCO_2$ for CP2. As discussed for the Kyoto forests in section 6.1.4 these figures increase to approximately 30.6 $MtCO_2$ and 34.3 $MtCO_2$ respectively as estimated for the region.

6.4. Potential factors affecting carbon sink predictions

Scaling sinks projections from the SWC group to predict the regional sinks may not reflect an accurate position, potentially because of the species and age difference of the 88,000 Ha of smaller forest holdings.

This study did not examine the extent that the national carbon sinks models reflect average national growth situations. Therefore there may be inaccuracies in the predictions for this region, particularly for Radiata.

Other factors discussed under assumptions in section 4 can also affect these predictions.

6.5. Implications of decreased planting rates

The recent decreased planting rates will clearly reduce the planted forest sinks significantly. In the case of not replanting after harvest the total carbon stock at the time of harvest is obviously lost in the event of a land-use change. In the case of new forest planting (Kyoto compliant) the lack of new credits creation is very significant for the whole of the species rotation period. For Radiata this loss is for close to six Kyoto commitment periods.

6.5.1. New forest planting

The age distribution for the Kyoto forests shows the recent planting rates have declined significantly, consistent with the national trend.

There is clearly a need for Government to actively examine present policy and incentivise additional planting. A more assertive and imaginative approach by Government is required in order to correct these adverse trends so that a number of wider Government objectives can be met. These include improving New Zealand's economic performance, achieving a bigger contribution from the forest sector activity, regional development, and increasing the nation's forest sinks. It is noted that the proposed permanent forest policy is unlikely to be very effective, and certainly will do little to contribute to achievement of these and other national and regional objectives. This is discussed further in section 6.6.5.

6.5.2. Regional and National implications

The national forest sinks have been predicted for three commitment periods to characterise the effect of planting rates, using a model used by MAF. Figure 3 is based on historical

planting rates through to and including 2004. Future annual rates from 10,000 through to 70,000 Ha/year have been applied at the fixed level from 2005. Whilst it is unrealistic to achieve higher in the shorter term a simple approach was used to generate data for Figure 3 to show the effect of planting rates.

Because of the short time available to accumulate sinks there is little impact from immediate increased planting rates on total New Zealand planted forest sinks for CP1.

Figure 3: Forest sinks relative to planting rates

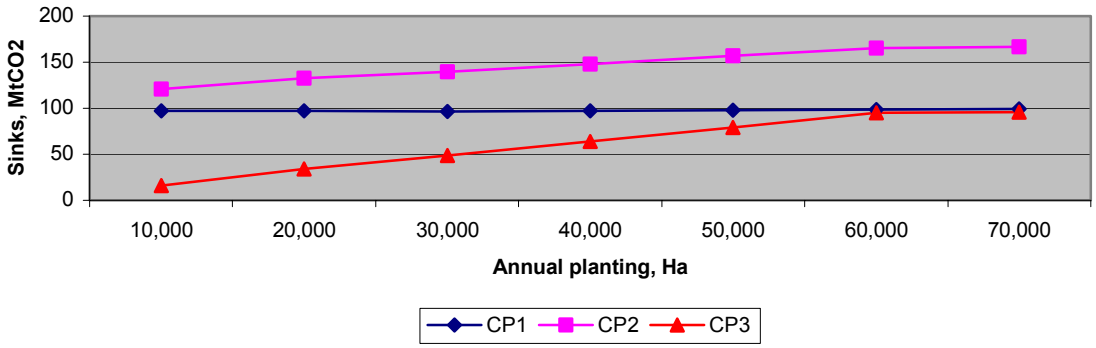


Table 7 provides national planted forest sinks predictions for the three commitment periods. 2005 plantings are set at 10,000 Ha, and 2006 at 20,000 Ha as a start to significant increases that may result from new Government initiatives. The data probably overstates the situation because of the time required to achieve the new higher levels of planting used here.

Table 7: New Zealand sinks- effect of new planting rates

Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
To 2004	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual
2005	10,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000
2006	10,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
2007 onwards	10,000	20,000	20,000	30,000	40,000	50,000	60,000	70,000
$MtCO_2$,CP1	93.7	97	95.3	96.2	97	97.7	98.6	99.1
$MtCO_2$,CP2	121	132.5	131.2	139.7	148.2	156.8	165.3	167
$MtCO_2$,CP3	16.1	33.7	32.8	48.3	63.8	79.3	94.8	95.9

The table clearly indicates that there are very significant opportunities for increasing national planted forest sinks well beyond 2012, the end of the first commitment period that seems to pre-occupy Government thinking in terms of policy. This severely limits New Zealand's position in both the short and medium term as countries respond to climate change. This will become more important if Government continues to be willing to take on obligations at the expense of the New Zealand economy in general.

6.5.3. Impact of planting on future commitment periods

Additional Kyoto forest plantings of Radiata will make little impact on the first commitment period, even if planted in 2006. Douglas fir will be even lower because of the early low growth rate. Indicative planted forest sink numbers for 1 Ha, planted in 2006, for four

successive 5-year commitment periods are given in Table 8. Note that CP3 figures are depressed because the model provides for thinning in this period for 2006 plantings.

Table 8: Effect of additional Kyoto forests, tCO_2/Ha

	CP1	CP2	CP3	CP4
Radiata	88	160	125	170
Douglas Fir	18	118	33	160
Eucalypt	200	170	190	140

7. Greenhouse gas emissions

Greenhouse gas emissions for forest activities have been assessed from fossil fuel used for each of forestry operations and log transport. The more dominant emissions are from the more energy intensive wood processing activities. Emissions from transportation of processed products are also included.

The level of carbon tax payable on these emissions has been assessed based on the currently proposed level of $\$15/tCO_2$ and the announced current cap of $\$25/tCO_2$. As discussed in section 7.3 of this report these costs are likely to increase significantly over the next few years. It should not be assumed that these levels of carbon tax will be the future cost of financial instruments imposed by Government.

7.1. Forestry activities

The greenhouse gas emissions from forestry activities are CO_2 emitted from the use of fossil fuels, and include forest management activities, harvesting and an estimate of log transport activities.

An assessment of the forestry activities emissions for the SWC group has been made on limited data. However, this study realistically puts the relative magnitude of emissions in perspective.

The fuel use for two smaller participating forestry companies was not available. Data for these has been pro-rated using data from other similar operations.

7.1.1. Approach and assumptions

The CO_2 emissions from log transport activities have been estimated on the basis of average load size provided (m^3/load) and diesel consumption of 2.2 km/litre (typical value). Each participating forestry company has provided annual harvest volumes and average distance from the forests to the ports or processing plants.

7.1.2. Forestry operations and log transport emissions

Table 9 shows the emissions from forestry and log transport operations for the SWC group, and the level of carbon tax on these emissions.

Table 9: Emissions from SWC group forestry operations					
	Emissions	**Carbon Tax, $**		**Annual Harvest**	**Tax, $/m^3**
	Tonne CO_2	**At \$15/tCO_2**	**At \$25/tCO_2**	**m^3**	**At \$25/tCO_2**
Forestry operations	18,520	277,800	463,000	1,367,000	0.34
Log Transport	4,360	65,400	109,000	1,367,000	0.07
Total	22,880	343,200	572,000	1,367,000	0.41

The carbon tax will impose additional costs for the SWC group forestry companies, and contractors, amounting to about $343,000/year at the proposed carbon tax level of $15/t$CO_2$. This will rise to $572,000/year at the current tax cap level of $25/t$CO_2$. Unfortunately Government has not provided any realistic policy that will deliver any relief from the added cost of this tax, and forestry companies do not have any real options to reduce or mitigate these CO_2 emissions. Whilst the added cost per cubic metre harvested may be perceived to be low, the impact on low margin business can be significant, as demonstrated by the above numbers.

When applied to the total regional forest estate the annual regional costs of the tax would be approximately $ 670,000 and $ 1,117,000 respectively. These figures are derived from pro-rating the SWC group tax costs, based on the total regional planted forest area.

7.2. Wood processing activities

The greenhouse gas emissions for wood processing operations include the indirect CO_2 emitted from the electricity generation mix, and CO_2 from the on-site use of fossil fuels.

Wood processing activities in the SWC group include MDF, veneers, saw-milling and chip production. The new sawmill project for City Forests has been included using energy use predictions. The MDF mill is the dominant activity, particularly in terms of electricity use and CO_2 emissions.

7.2.1. Wood processing approach and assumptions

Wood processing companies in the SWC group provided data for on-site energy use, and for estimating emissions from product transportation.

Wood waste (hog fuel) is neutral to the atmosphere when used as a fuel. Emissions from wood waste use as an energy source is therefore excluded from the wood processing emissions. This is accepted convention. It has been included in the analysis and reported because of the important contribution to energy supply and avoiding the use of more fossil fuels.

The data has been processed to provide a breakdown of emissions using the accepted emissions factors at Government and international levels, for each fuel type. The emissions factors are provided in Appendix 1.

Electricity is included in the emitting energy grouping because the fossil fuel component of the electricity generation mix flows through to electricity consumers, in terms of the emissions profiles and the application of the carbon tax. The current generation mix in New Zealand is approximately 70% renewables, which includes geothermal. Renewable energy sources for electricity do not emit CO_2, except in the case of geothermal steam, which is a

relatively low greenhouse gas emissions factor. The electricity market price in New Zealand at any time is determined by the marginal generation that is usually from thermal fuels, so the carbon tax will generally flow through to all electricity pricing.

7.2.2. SWC group wood processing data

The data for the SWC group energy use and associated CO_2 emissions is aggregated in Table 10.

Table 10: SWC group wood processing energy breakdown

	Coal	Fuel oil	Diesel	Petrol	Electricity	Total for emitting sources
Energy use, GJ	216,269	6,059	23,139	85	304,576	550,152
% of total emitting energy	39.3	1.1	4.2	0.02	55.4	100.0
Emissions, tCO_2	19,933	470	1751	85	50,762	68,350
% of total emissions	27.3	0.6	2.4	0.1	69.6	100.0

Emissions from use of electricity for the SWC group of wood processors is obviously dominated by the MDF mill (62 % of emitting energy). However, the emissions from electricity use by other processors are significant in their own context. Coal is the highest emissions intensity fuel. Coal is used by five of the eight wood processing companies included in this study. It comprises over 39 % of the emitting energy for the SWC group.

The region has few options to switch fuels, particularly because of the non-availability of natural gas, which has a relatively low emissions factor for fossil fuels.

Table 11 summarises the site energy use and breakdown aggregated for the SWC group.

Table 11: SWC Group wood processing energy use

	Bio-fuel (hog fuel)	Emitting sources	Total energy
Energy use, GJ	1,277,400	550,100	1,827,500
% of total site energy	70.0	30.0	100.0

Table 12 summarise the aggregated production output from the SWC group of wood processors.

Table 12: Processing output, m^3

	Product	Chip production,	Total production
Volume, m^3	498,300	235,600	733,900

Table 13 summarises the aggregated emissions from the SWC group for both site and estimated product transport activities. With the carbon tax of \$15/tCO_2 the average cost is \$1.53/m^3 of product, including chips. If the chips are excluded the cost is \$2.26/m^3 of product. These costs rise to \$2.55/m^3 and \$3.76/m^3 respectively when the tax is at \$25/tCO_2.

It should be noted that these are averaged over the range of wood processing activities so there is a range of costs covering the SWC group.

Table 13: Wood processing emissions and annual tax (Includes product transport)

	Total emissions	Carbon tax at $15/tCO$_2$	Carbon tax at $25/tCO$_2$	Total production	Emissions intensity
Units	**tCO_2/year**	**$/year**	**$/year**	**m^3**	**tCO_2/m^3 production**
Site	73,001	1,095,015	1,825,025	733,900	0.099
Transport	2,123	31,845	53,075	-	0.003
Total	75,124	1,126,860	1,878,100	733,900	0.102

Note: Emissions intensity is a measure of relative emissions 'efficiency'. It is expressed as greenhouse gas emissions/unit of production.

7.3. Discussion on forestry and processing emissions

The SWC participant group of wood processors has 70 % of the total energy requirement provided from wood waste (otherwise known as hog fuel or bio-fuel). This is a high proportion and an important contribution to minimising greenhouse gas emissions. Further use of wood waste for energy is the main opportunity for some companies to reduce greenhouse gases, provided it is economically viable and practicable. Substitution of coal would have the greatest impact in terms of reducing emissions and therefore the carbon tax liability. The emissions factors for fuels given in Appendix 1 provide an indication of the relative impact of each fuel type in terms of CO_2 emissions per GJ of energy supplied.

The predicted annual cost of the carbon tax at $15/tCO$_2$ for the SWC group of wood processors is $1,126,800. This is based on current announced tax levels, expressed per tonne of CO_2 emissions. It is likely that the New Zealand tax will be replaced by some form of international emissions trading in the short to medium term. Current limited trading in carbon credits internationally is at higher prices than the present New Zealand tax cap of $NZ 25/tCO$_2$. (Recently it has been around $NZ 35/tCO$_2$). Longer term, maybe only a few years, the international trading price will rise significantly if the Kyoto Protocol, or a like international process, survives.

Emissions levels globally are proving very difficult to reduce, and the availability of sink credits internationally will decline because of international limitations imposed on qualifying sinks activities. The result will be that emissions units will become scarce and expensive under any trading scheme. This remains one of the most serious and underplayed economic threats unless alternative approaches to the Kyoto Protocol concentrate on achieving affordable alternative technology applied globally, instead of forcing emissions reductions through punitive measures such as using taxes or emissions trading.

Prudent companies should anticipate that the cost of emissions will increase markedly, irrespective of the global response to any climate change threats. The options to reduce this exposure to the cost of the tax include:

- Conducting energy audits, and reducing fossil fuel linked energy use.
- Fuel switching to lower emitting sources. There is limited opportunity in the region due to lack of natural gas supply to replace coal. The already high use of bio-fuel in regional wood processing may prevent significant displacement of coal.
- Examining the appropriateness of obtaining a collective NGA (Negotiated Greenhouse Agreement), which provides relief for some or all of the tax, depending

on how close the operations are to 'world best practice' in terms of energy and emissions intensity.

- The electricity generation mix will move toward use of more fossil fuel. The result will be that New Zealand consumers will pay more tax per unit of electricity used. Consumers cannot influence this, but efficient use of electrical energy will minimise the impact.
- Positioning integrated forestry and processing companies and/or groupings such as the Southern Wood Council could continue to advocate offsets of sinks for forestry and wood processing emissions. This would be a major challenge under the position the previous Government has steadfastly held.

8. Regional carbon balance

A balance has been produced from the forest sinks data, and the emissions from forestry operations, transport and wood processing are offset from the sinks. In both the SWC and the regional context the forest sinks significantly dominate the greenhouse gas emissions from the sector.

The annual emissions data assessed from both forestry and wood processing has been totaled over five years to align with the 5-year first commitment period forest sinks data from Kyoto forests.

The regional data for forestry is based on the SWC data representing 51% of the total regional forest estate. Output figures given in the June 2004 report 'Otago and Southland Forest Industries Profile' indicates that the SWC processing group represents approximately 78% of the regional processed product, but 86% has been used to allow for the influence of the MDF mill. Table 14 summarises the SWC group and scaled up regional estimates for the overall sector carbon balance. The net credit is derived from the first commitment period Kyoto forest sinks, less the emissions for the forestry and wood processing operations.

Table 14: Regional balance (Expressed as tCO_2)

Forest sink credits			
		SWC group	**Region**
Kyoto forests, 1st commitment period		4,343,218	8,500,000
Emissions for 5 years			
	Annual emissions	**SWC group**	**Region**
Forestry operations	18,520	92,600	181,500
Log transport	4,360	21,800	42,700
Total forestry	**22,880**	**144,400**	**224,200**
Wood processing operations	73,000	341,300	396,500
Product transport	2,123	10,600	13,500
Total wood processing	**75,120**	**375,600**	**437,000**
Net Credit, tCO_2		**3,823,200**	**8,063,000**

The wood processing operational emissions at the regional level have been estimated using the SWC group operation emissions, and scaled up using the factor of 86% to remove the bias introduced by the dominant CO_2 emissions from the MDF plant. This results in an estimated 437,000 tCO_2 from regional wood processing operations and product transport for the first commitment period.

The total emissions from forestry and wood processing operations are approximately 8.2% of the forest sinks accumulated from Kyoto forests for the SWC group over the first commitment period. At the regional level, based on estimated emissions, the emissions are about 5.1% of the estimated Kyoto forest sinks for the first commitment period.

8.1. New Zealand context

The sector group in the region has a large net surplus of forest sinks after deduction of emissions from both forestry and wood processing operations. This situation will exist throughout New Zealand despite some high-energy demand mechanical pulp mills and therefore higher emissions in some regions.

The SWC group net credit prediction of 3.823 $MtCO_2$ for the first commitment period (Table 14) is 5.4% of the latest CP1 sinks position (70.9 $MtCO_2$) established by the Climate Change Office. It is 4% of the total predicted New Zealand emissions growth since 1990, for the 5 years of the first commitment period (94.1 $MtCO_2$). The estimated net credit of 8.06 $MtCO_2$ for the region is 8.9% of the latest predicted national sinks, and more than 8% of the predicted national emissions growth for the first commitment period. The SWC group and the region therefore provide a significant sectoral net sinks credit to contribute to New Zealand's first commitment period sinks, and to offset national emissions growth for that period.

The sector clearly is in a very positive position in terms of its major contribution to New Zealand's economy and well-being of regions and people. It is also arguably clearly the best sectoral performer in terms of delivering a strong net position in terms of contributing to the Government's desire to respond to climate change and the demands imposed by the Kyoto Protocol.

9. Definitions

'Biofuel' means wood waste used as fuel- also known as hog fuel. It consists mainly of sawdust, shavings and bark.

'Carbon model' means a model designed to predict the quantity of carbon sinks contained per Ha of forest area for a given species and age. The models are known as 'C-Change'.

'Carbon sequestration' means the amount of carbon sinks in the forested area. Dependent on the sophistication of carbon models this includes all tree carbon, forest floor and soil carbon. The amount is expressed as either tonne carbon/ha, or tonne CO_2/ha. The latter has been used in this report.

'Carbon Tax' means the tax the Government has decided to introduce on 1 April 2007, to be charged on all carbon containing energy and process inputs, including electricity. Initially it will be set at \$15/tCO_2 with a cap at \$25/tCO_2.

'Climate Change Office (CCO)' means the New Zealand Government office responsible for climate change policy and other matters.

'CO_2' means carbon dioxide, the main greenhouse gas in terms of emissions, particularly in this study. Forest sinks are expressed in terms of equivalent CO_2 in this study. Conversion of carbon to CO_2 is by multiplying by 4/12 = 3.667.

'Commitment periods' mean the five-year periods agreed for the commitments under the Kyoto Protocol. Commitment period one (CP1) is from 1 January 2008 to 31 December 2012.

'CP1' means the first commitment period of 5 years under the Kyoto Protocol. Successive periods are CP2, CP3 etc.

'Emissions factor' means the measure of CO_2 emissions per unit of fuel use (eg tCO_2/litre of diesel or tCO_2/MWhr). Factors used in this study are those used by the NZ Climate Change Office. (See Appendix 1).

'Emissions intensity' means greenhouse gas emissions expressed per unit of production (eg tCO_2/m^3).

'Energy intensity' means the quantity of energy used per unit of production (eg GJ/m^3).

'Forest sinks' means the amount of carbon sequestered in a planted forest area, expressed in terms of equivalent carbon dioxide (CO_2), for the purposes of this report.

'GJ' means the unit of energy, gegajoule.

'Kyoto forest' definition: "Forest" is a minimum area of land of 1.0 hectares with tree crown cover (or equivalent stocking level) of more than 30 per cent with trees with the potential to reach a minimum height of 5 metres at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 30 per cent or tree height of 5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest. (This definition has been adopted by New Zealand, under the Kyoto Protocol).

'KWhr' is a measure of electrical energy. It is the equivalent of 1 kW use for one hour.

'MDF' means medium density fibreboard.

'MWhr' is 1000 kW usage for one hour.

'MtCO2' means million tonnes CO_2.

'NZCCO' means the New Zealand Climate Change Office. It is part of MFE, the Ministry for the Environment.

'Other species', for the purposes of this study, means species other than Radiata, Douglas fir and the eucalypt group.

'Planting rate' means the annual area of forest planted. These can be new forests on previously non-forested land, or replanting after harvest.

'Pre-Kyoto forest' means a forest area established before 1 January 1990.

'Region' for this study means the area covered by the Southern Wood Council Inc. This includes South Canterbury, Otago, and Southland.

'SWC' means the Southern Wood Council Inc.

'SWC group' means the group of Southern Wood Council participants to this study.

'UNFCCC' means United Nations Framework Convention for Climate Change. The Kyoto Protocol is designed to implement UNFCCC commitments.

10. References

- 'Otago and Southland Forest Industries Profile', Southern Wood Council Inc. report, June 2004
- 'Carbon Inventory of New Zealand's Planted Forests', Stephen J Wakelin, Forest Research, March 2005. (Radiata carbon sinks model on page 27)

11. Appendix

A1: Fuel emissions factors.

The greenhouse gas emissions factors for fuels are given in Table A1. These are expressed as tonnes of CO_2 emitted per GJ of energy in the fuel.

Table A1: CO_2 emissions factors

Fuel type	Fuel units	tCO_2/GJ
Coal	15 GJ/tonne, for lignite	0.0950
Light fuel oil	0.00294 tCO_2/litre	0.0725
Diesel	0.00271 tCO_2/litre	0.0687
Petrol	0.00232 tCO_2/litre	0.0666
LPG	0.00303 tCO_2/kg	0.0604
Natural gas	0.0524 tCO_2/GJ	0.0524
Bio-fuel	-	0
Electricity	0.6 tCO_2/MWh	-

Electricity emissions are based on 0.6 tCO_2/MWh. This figure has been established and accepted by the NZ Climate Change Office as a 'likely average level' over the next 8 years. This will clearly require regular verification going forward.
Electricity energy can be converted to GJ by the factor 3.6 GJ/MWh.