



# Assessment of Cyclone Ita Wind-blow Damage to West Coast Indigenous Forests

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## Summary

The extent of wind-blown indigenous forest through the West Coast region that resulted from the Cyclone Ita weather event, as informed from an aerial assessment on 10/11 May 2014, is presented. An analysis of potentially salvageable timber volumes is provided for conservation lands eligible for timber salvage under the recently enacted West Coast Wind-blown Timber (Conservation Lands) Act 2014. National Parks, Ecological Areas, the South-west World Heritage Area, and the Waitangiroto Nature Reserve are excluded from the analysis. Wind-blown damage to indigenous forest on privately-owned lands is also assessed in this report.

Wind-blown damage to indigenous forests on eligible conservation land area is estimated at approximately 100 000 m<sup>3</sup> for rimu and 35 000 m<sup>3</sup> for red/silver beech, key species that are commercially-valuable. A small proportion of this volume is expected to be available for salvage under the West Coast Wind-blown Timber (Conservation Lands) Act 2014. On privately-owned lands, there is an estimated 19 000 m<sup>3</sup> and 8 000 m<sup>3</sup> of wind-blown rimu and totara.

The volume estimates given in this report were derived primarily for wind-blow in the larger patches able to be readily observed during visual assessment from a light aircraft. The extent of isolated tree-fall and small-patch damage is not yet known, or included in wind-blown volume estimates. Anecdotal reports suggest such damage may be common in some areas where more obvious damage occurs. This, and the fact that damage could only be assessed in broad classes, means there remains considerable uncertainty in the values of wind-blown timber volume given in this report.

# 1 Introduction

On the 17<sup>th</sup> of April 2014 extreme winds associated with Cyclone Ita hit the West Coast of the South Island, resulting in extensive wind-blow damage to public and private forests. Over the subsequent weeks it became apparent that large areas of indigenous forest on conservation lands were particularly affected. Some smaller areas of privately-owned indigenous forest had also been significantly damaged.

To obtain an initial assessment of the extent and severity of wind-blow damage to indigenous forests, the Ministry for Primary Industries (MPI) and the Department of Conservation (DOC) jointly completed an aerial inspection to identify and map damage areas on 10/11 May 2014. The DOC produced a brief initial report based on this inspection that gave an initial assessment of what was observed. The MPI then undertook to do a more detailed analysis to provide an estimate of wind-blown<sup>1</sup> timber volumes that were likely present for the key commercially-valuable species. This report is that detailed assessment.

This report outlines the aerial damage assessment methodology used, and provides maps of the areas of major damage. Also provided are estimates of wind-blown timber volumes in damaged areas outside of National Parks, Ecological Areas, the South-west World Heritage Area and the Waitangiroto Nature Reserve. The methodology used to derive estimates of wind-blown timber volume, is also outlined.

Considerable uncertainty remains in the estimates of wind-blown timber volume. Assessments of damage are at present qualitative, are available only for larger wind-blown areas, and are based on broad damage classes within which damage intensity may vary substantially. Isolated tree-fall and small patch damage are not yet included to any significant extent, as it could not be assessed reliably by aerial inspection. Local ground-level observations from roads and recreational tracks suggest such damage may be common.

Reducing uncertainty would involve a significant programme of detailed aerial photography and analysis, supported by ground-based inventory of (damaged) standing and lying wind-blown trees for key species.

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<sup>1</sup> *Wind-blown* timber means timber irreversibly damaged by Cyclone Ita. *Irreversibly damaged* in relation to timber means— dead or damaged to the extent that it is likely to die within the near future. West Coast Wind-blown Timber (Conservation Lands) Act 2014.

## 2. Wind-blow Assessment Methodology

### 2.1 Area assessed

The aerial assessment covered both privately- and publically-owned coastal indigenous forest, from Fox Glacier in the south to the Kohaihai River in the north. Also assessed were the indigenous forests in the:

- Ohikaiti, Ohikanui and Blackwater Valleys that drain north into the lower Buller River from the Paparoa Range;
- Mackley Valley (north of Inangahua Junction) and inland to the foothills of the main divide; and
- mid-Maruia, Grey, Taramakau and Hokitika Valleys to the west of the main alpine fault.

The assessment flight path is shown in Map 1, in the Appendix. The flight path enabled assessment of as much forest as possible that was reported as damaged or understood as likely to be damaged. Areas already known to have little damage were excluded from assessment, including areas south of Fox Glacier and the south-eastern aspect of the Paparoa Range in the Grey River catchment. This may have meant some minor areas of damage in remote locations have not been assessed. However, it is likely almost all areas of major damage have been assessed.

A further area excluded was the extensive scattered damage in Kahurangi National Park – specifically the coastal area north of the Kohaihai River and up the Heaphy River. Information on the wind-blow damage affecting approximately 21,000 ha of indigenous forest in this area was obtained separately by the DOC during a helicopter overflight.

#### *Estimating Extent and Intensity of Wind-blown Damage*

The aerial assessment of wind-blown damage involved locating the boundaries of damage areas on topographic maps, assigning a damage intensity rating in one of three classes, and recording the observed indigenous forest type (former major canopy species).

Assessment information was originally intended to be recorded electronically, using an iPad equipped with ARC-GIS software and digital topographical maps, with the GPS-tracked aircraft location displayed on the maps in real time. Although this set-up proved invaluable for establishing locality, electronic data capture took too long to complete with a single iPad. Two of the three observers in the aircraft therefore recorded information on hard-copy 1:50,000 scale topographic maps. The hardcopy information was later digitised and combined with the electronically-recorded data.

The information on damage location and extent is shown in Maps 2a, 2b & 2c in the Appendix. Each wind-blow area assessed was assigned to one of the following visually-assessed damage intensity classes:

- Class 1 – an area with over 50% of trees irreversibly damaged within a well-defined boundary;
- Class 2 – an area with 5%–50% of trees irreversibly damaged within a well-defined boundary;
- Class 3 – small areas with over 50% of trees irreversibly damaged, scattered amongst a larger area of apparently intact forest or scattered woodlots within pasture land;
- Class 4 – scattered trees only.

The low sun-angle in mid-May meant that the canopy gaps created by scattered individual trees (damage intensity Class 4) could not be observed reliably due to shadowing within the canopy. As a consequence, this class was observed reliably only on one occasion in the Southern Zone as it was directly flown over. The damage area mapped as Class 4 was not, however, on conservation land eligible for timber salvage under the West Coast Wind-blown Timber (Conservation Lands) Act 2014, (the Act).

The forest type was also recorded for each damaged area, as the dominant or co-dominant (former) canopy species. The recorded forest type for a damaged area sometimes differs from the forest class given for an area in the *Ecological Survey of New Zealand's Indigenous Forests – Forest Service Mapping Series 6 (scale 1:250,000)*. The reason for this is that a 1:250,000 mapping scale does not always adequately represent local variation in species composition within a forest class. For example, in steepland east of but adjacent to the main alpine fault in areas south of Hokitika, much of the damage observed was restricted to ridge crests covered by pure kamahi and rata (i.e. pure hardwoods) which lie in a forest class classified in the *Series 6* mappings as rimu-general hardwoods.

Oblique aerial photographs were taken across a range of sites to illustrate the type and intensity of damage, in terms of topography and forest composition. Photographs have been geo-tagged and indexed with a brief description of location and direction of view. A sample of photographs is attached in the Appendix. Photographs were used to review and corroborate the data collected during the aerial assessment flight.

## 2.2 Estimating wind-blown timber volumes

Developing estimates of wind-blown timber volume requires that the following is known for each damaged area:

- the area in hectares;
- the damage intensity (percentage of trees irreversibly damaged);
- the forest type and its merchantable timber yield by key species, prior to damage.

The product of area, damage intensity and the timber yield in the forest prior to Cyclone Ita provides an estimate of the wind-blown timber volume for the key species in each damaged area.

The information used to determine the location and area of forest damage was that obtained during the aerial assessment described in section 2.1 above, assembled as GIS spatial layers. Analysis of potentially-available wind-blown timber volume was then completed for that subset of the total area of wind-blown damage mapped, consistent with the area proposed for timber salvage as available for timber removal under the Act – that was being developed in parallel with this analysis. That is, the only areas of damaged West Coast indigenous forests considered as part of the wood volume analysis were those areas:

- of conservation land outside of National Parks, Ecological Areas, the Waitangiroto Nature Reserve, and Te Wahipounamu (the South-west World Heritage Area); and
- on privately-owned land.

Damage areas on conservation lands eligible for timber salvage, and on private lands, are shown in Map 3 of the Appendix. Information on land tenure used to identify eligible



conservation lands (shown as either Conservation Park or Stewardship Area in Map 3) was supplied by DOC.

Information on damage intensity for the analysis was recorded during the aerial assessment described in section 2.1 above. However, because damage intensity was only rated in broad damage classes (for classes 1 and 2), or involves mapped areas within which only scattered damage occurs (class 3), it was necessary to first assign an average damage rating to the areas in each mapped damage class. The average damage ratings – the average percentage of trees irreversibly damaged – for the four mapped damage classes are based on an expert consensus estimate from the observers that took part in the aerial assessment<sup>2</sup>:

- Class 1 – 75% average damage within the area mapped;
- Class 2 – 30% average damage within the area mapped;
- Class 3 – 20% average damage within the total area mapped as having small areas with >50% damage scattered amongst apparently intact forest or scattered woodlots within pasture land.

The forest type or description recorded for each area of wind-blown damage mapped – if not already one of the forest classes recorded in the *Forest Service Mapping Series 6* – was assigned to the most closely-related *Series 6* forest class. Two sources of information were then used to estimate (merchantable) timber volumes present prior to Cyclone Ita for the key tree species of interest in each *Series 6* forest class: Timberlands West Coast Ltd inventory data (1998), and sub-region reports of the National Forest Survey of New Zealand 1955.

To improve the accuracy of merchantable timber volume estimates, the West Coast region was split into three zones – Northern, Central and Southern. This allowed timber volumes in the forest classes within each of those zones to be better matched to the locations from which the volumetric information was originally derived. The zones are marked on Maps 1 – 3 in the Appendix.

The key merchantable species considered in the timber volume analysis are rimu, red and silver beech, and totara. Rimu is found in damaged areas of all zones, though occurs most frequently in the Southern zone. Areas of damaged red and silver beech occur mainly in the inland areas of the Central zone. Damaged areas of totara occur exclusively on privately-owned lands in the Southern zone (on the Wanganui and Whataroa flats of South Westland). The average volumes of these key tree species in *Series 6* forest classes, for each forest class in each of the three zones, are given in Table A.2 of the Appendix. The specific sources of volumetric data used, by forest class and zone, are given in Table A.3 of the Appendix.

Within the total area of conservation lands eligible for timber removal, and damaged forest on privately-owned lands, some further areas were excluded from the timber volume analysis for the reasons given below:

- hardwood forest, and forest dominated by hard beech – on the basis of being in remote sites with limited access, and/or there being a lack of any significant volume of merchantable species;
- some very small areas of private land, or conservation land eligible for timber removal – where the land resides almost totally within conservation lands excluded from timber removal, and access would likely be difficult;

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<sup>2</sup> As the area mapped as Class 4 was not on conservation land eligible for timber salvage, and does not feature in the timber volume analysis, no average rating has been assigned for this class.

- land in the Northern and Central zones for which no forest class was assigned in the *Series 6* maps – presumably this was not classified as tall forest when the Eco-survey was undertaken in the 1960's and so now likely consists only of a non-merchantable mix of young regenerated beech and hardwoods.

Some damaged forest in the Southern zone was retained even though no forest class information exists in the *Series 6* maps, as the areas were too small to appear at a 1:250,000 mapping scale. These areas comprise scattered regenerated totara forest on pasture land, which is common on private lands of the Wanganui and Whataroa flats of South Westland, and fall under Class 3.

## 3. Results of the Wind-blown Damage Assessment

### 3.1 Overview of the extent of wind-blown damage

The aerial assessment found that overall the wind-blow was not as extensive as initial damage reports had suggested – that is, the degree of damage readily observed, particularly from roading networks, was not usually present in more remote areas. The exceptions were large contiguous areas of forest which have been severely impacted inland from Karamea and Little Wanganui. These areas are bounded by the Karamea River in the north, the Stormy Ridge/Radiant Range to the east and Mokihinui River to the south. Little damage was observed east of the Alpine Fault up the major river valleys. Throughout the remainder of the West Coast region, west of the main alpine fault and as far south as Franz Josef, localised wind-blow has occurred predominantly over smaller areas. Much of the damage was to forests on conservation land.

The most significant wind-blow damage on privately owned forest has occurred to totara woodlot remnants on the Wanganui and Whataroa flats. The majority of the forests operating under registered sustainable forest management plans and permits under the Forests Act 1949 on the West Coast, with the exception of those in the Karamea area, have been little affected.

In the south the pattern of damage suggests the wind funnelled down river valleys to become constricted and highly damaging at the point where the river emerges onto the coastal flats, glacial terraces or foothills. It appears the release of pressure or turbulence in these areas also resulted in a sporadic pattern of damage across a range of adjacent sites. By contrast, the significant damage in lowland forests of the Karamea/Little Wanganui area suggests additional dynamics came into play. Here, the wind not only funnelled down the Karamea and Little Wanganui Valleys, but also appears to have “boiled over” the northern section of the Radiant Range in a broad front, resulting in strong downwards pressure.

A summary of the total known forest area damaged in the West Coast region is given in Table 1. The area of damage to indigenous forests on conservation lands deemed eligible for timber salvage, and on private lands, is given in Table 2 for the Northern, Central and Southern zones. More details on the data presented in Table 2 can be found in Table A1 of the Appendix.

Table 1. Known areas of irreversibly damaged West Coast indigenous forest on private lands and on all conservation lands. <sup>3</sup>

Location of Damaged Forest Area	Damage Area (ha)
Kahurangi National Park	20 700
Other National Parks, Ecological Areas, the Waitangiroto Nature Reserve, and Te Wahipounamu	9 390
Eligible conservation lands with rimu or red/silver beech	6 550
Eligible conservation lands without rimu or red/silver beech	2 150
Privately-owned lands	2 090
Total	40 880

Table 2. Areas of irreversibly damaged West Coast indigenous forest on eligible conservation lands, and on private lands.<sup>4</sup>

Zone	Eligible Conservation Lands (ha)	Private Lands (ha)	Total
<i>Northern</i>	4 670	1 090	5 760
<i>Central</i>	660	80	740
<i>Southern</i>	1 220	920	2 140
<i>Totals all zones</i>	6 550	2 090	8 640

## 3.2 Description of wind-blown damage by zone

### *Northern Zone*

This zone extends from the Kohaihi River in the north to the Buller River in the south and inland to include the Orikaka (Mackley) catchment. In the northern reaches the Stormy Ridge/Radiant Range forms the eastern boundary. Beech-podocarp-hardwood forests dominate this zone.

- Complete loss of canopy has occurred in an estimated 80% of lowland podocarp-beech-hardwood forest below 650 masl on the western flanks of the Radiant Range between the Little Wanganui River in the north to the Tidal Creek catchment in the south.
- West of the Karamea/Westport highway from the lower reaches of Tidal Creek valley in the north to the southern end of the Karamea Bluffs, an estimated 60% of forest has suffered large patches of damage ranging from 5% to 100% canopy loss. This includes scattered areas of Class 1 and 2 damage from a wind-blow event some 4–5 years ago in the forest west of the Karamea bluffs.

<sup>3</sup> Those lands considered eligible for timber removal under the Act, as well as on excluded lands in National Parks, Ecological Areas, the Waitangiroto Nature Reserve, and Te Wahipounamu).

<sup>4</sup> Eligible conservation lands are those approved for timber salvage under the Act.

- Some scattered localised areas of damage are apparent in the Oparara Basin north of the Karamea River; however, there did not appear to be any significant damage around the Oparara arches.
- There was no apparent damage along the eastern flanks of the Radiant Range from the Mokihinui River in the south to as far north as the Johnson River (a tributary of the North Branch of the Mokihinui River).
- While the bulk of the forest affected in the Karamea/Little Wanganui area lies in the conservation estate, there has been significant damage to some privately-owned forests in hill country which adjoins coastal farmland. Some of this forest has been or is still, subject to registered sustainable forest management permits.
- South of the Mokihinui River, damage is mainly restricted to localised sites on very steep coastal-facing ridges above Ngakawau/Granity.
- Minor damage was observed in the broad Orikaka (Mackley) catchment located in the south-eastern section of the Northern Zone.
- Hard beech, which has little commercial value, forms a significant component of the forests affected in the Northern Zone.

### *Central Zone*

This zone is the widest in terms of distance from the coast to the alpine fault. It comprises the Paparoa Range running parallel to the coastline from Greymouth to the Buller River, and the broad expanse of the lower Grey and Inangahua Valleys occupying the centre of the zone. It also includes the Brunner, Victoria and Elliot Ranges running in a north-south direction west of the main alpine fault, and which form the eastern boundary. Forests in this zone include beech-podocarp-hardwoods and pure beech (red and silver).

- There was no observed damage in the Lower Buller Gorge, the Ohikaiti, Ohikanui and Blackwater catchments that drain into the Buller River from the northern aspects of the Paparoa Range.
- Localised damage has occurred in podocarp-beech-mixed hardwood forest in the Westland Petrel Special Protection Area on the true left of the Punakaiki River facing the southern part of the inland basin. This damage is largely on bluff crests, exposed knobs and ridges.
- There is damage to scattered patches of podocarp-beech-mixed hardwood forest in the inland basin between the Punakaiki and Fox Rivers, and further north in catchments inland from Charleston. The areas inland from Charleston lie largely in podocarp-beech-mixed hardwood forest, much of which has been logged in the past for rimu.
- Occasional scattered areas of damage were observed in beech-podocarp forest in the Inangahua Valley east of Reefton.
- Discrete sites (0.5 to 5 ha) of red-silver beech forest have suffered 50%–100% canopy loss in the Station Creek and Marble Hill areas of the Maruia Valley.
- Scattered damage to red and silver beech forest is evident through the Upper Grey Valley and southwards to Lake Brunner, in the foothills and rolling country west of the main alpine fault.
- Scattered areas of damage (0.5 to 5 ha) were observed in rimu-general hardwoods forest on the lower northern and western slopes of the Hohonu Range.

- The eastern flanks of the Paparoa Range that fall to the mid- and lower-Grey Valley, and the largely cutover low/rolling hill country forests that lie to the east of the main highway in the Grey Valley, were not closely assessed as independent local reports indicated little if any damage.
- Privately-owned indigenous forests under sustainable forest management permits in the coastal section north of Charleston suffered some damage, while forests under sustainable forest management plans at Waipuna (Grey Valley) and Inchbonnie (Lake Brunner) appeared unaffected.

### *Southern Zone*

This zone extends from the Taramakau River in the north to Fox Glacier in the south and inland to the main alpine fault. The forests are varying compositions of podocarps (largely rimu) and mixed hardwoods. No beech is present<sup>5</sup>.

- Scattered areas (0.5 to 5 ha) of wind-blow, were observed in the terrace podocarp/hardwood forests of Okuku and Kaniere.
- Pockets of damage were observed to hill country forests (rimu/general hardwoods) on high terraces/ridgelines and lower terraces where rivers and streams emerge into the foothills and coastal floodplains. This was a consistent pattern for the Tuke, Waitaha, Wanganui, Little Man, Potters, Tatare and Waiho Valleys. Most ridgeline damage has occurred in pure kamahi-rata stands with some scattered individual large wind-blown rimu on adjacent slopes. Damage on some sites was in the form of wind-burn – 100% stripping of foliage giving the forest a skeletal appearance. Such severe foliage stripping was not evident on standing podocarps.
- Scattered damage was observed on foot-hill terraces southwest of Hari Hari between the Little Wanganui flats and the Poerua River; similar damage was observed on the foothill terraces between the Poerua River and Little Man River and the terraces immediately southwest of the Waitangi River Bridge. These areas may hold reasonable volumes of wind-blown rimu.
- The rimu-dominant coastal forests – Saltwater, North and South Okarito and Waikukupa – appeared little affected.
- Forests under sustainable forest management plans in the Wainihinihi/Taupo Valley and Arahura Valley in the northern part of the zone, and at Abut Head at the mouth of the Whataroa River in the south, were little affected. The most affected privately owned forests are lowland totara remnants on the Wanganui and Whataroa flats.

### *Other damage*

For all zones, where damage occurred as discrete areas, it is highly likely that in adjacent areas of apparently intact forest there will be varying levels of wind-blow involving both individual trees and small groups of 2–3 trees. This scale of disturbance could not be readily observed during the aerial assessment, as any gaps created by wind-blown trees were often indistinguishable from shadowing within the canopy due to the low sun elevation at the time of the assessment. The actual extent of this class of wind-blow would need to be ascertained through ground-based inspection, or aerial survey using high resolution aerial photography in summer when the canopy was well-illuminated. However, reports from DOC staff performing track-clearing work suggest that isolated tree-fall as a result of Cyclone Ita is common in proximity to where areas of more obvious damage occur.

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<sup>5</sup> The zone as assessed lies within the area known as the “beech gap” which runs from just north of the Taramakau River south to Paringa.

### 3.3 Estimates of wind-blown timber volumes

The estimates of wind-blown timber volume – determined by multiplying the average percentage damage in each mapped area by the merchantable volume in the forest in that area prior to Cyclone Ita – are summarised in Tables 3 and 4 below. A detailed breakdown of these estimates by forest class, damage class, and zone can be found in Tables A1 and A2 of the Appendix.

The estimates provided for conservation lands eligible for timber salvage in Table 3 should be regarded as the potential maximum available within areas of mapped damage. In practice, significantly less volume than indicated may be able to be safely extracted from the complex jumble of trees, often occurring in multiple layers, that is typical of wind-blown sites. In addition, although the recently-enacted West Coast Wind-blown (Conservation Lands) Act provides for salvage of wind-blown timber on eligible conservation lands, conditions in the Act will effectively limit salvage to a small proportion of the total wind-blown timber. Taking these restrictions into account suggests salvageable volumes of about 10 000 to 15 000 m<sup>3</sup> of rimu and about 3 000 m<sup>3</sup> of beech, are more likely to be available from conservation lands. It is possible these values may increase if there are also large number of individual or small groups of trees present and accessible, but yet to be identified.

Table 3. Estimates of wind-blown timber volumes in indigenous forest on eligible conservation lands, for key species with commercial value<sup>6</sup>.

Zone	Rimu (m <sup>3</sup> )	Red/silver Beech <sup>7</sup> (m <sup>3</sup> )
<i>Northern</i>	66 400	–
<i>Central</i>	13 300	35 400
<i>Southern</i>	21 900	–
<i>All zones</i>	101 600	35 400

Table 4. Estimates of wind-blown timber volumes in privately-owned indigenous forest, for key species with commercial value.

Zone	Rimu (m <sup>3</sup> )	Red/silver Beech <sup>8</sup> (m <sup>3</sup> )	Totara (m <sup>3</sup> )
<i>Northern</i>	11 600	–	–
<i>Central</i>	1 500	600	–
<i>Southern</i>	5 500	–	8 200
<i>All zones</i>	18 600	600	8 200

<sup>6</sup> Eligible conservation lands are those approved for timber removal under the Act.

<sup>7</sup> The beech volumes comprise about 85% red beech.

<sup>8</sup> The beech volumes comprise about 85% red beech.



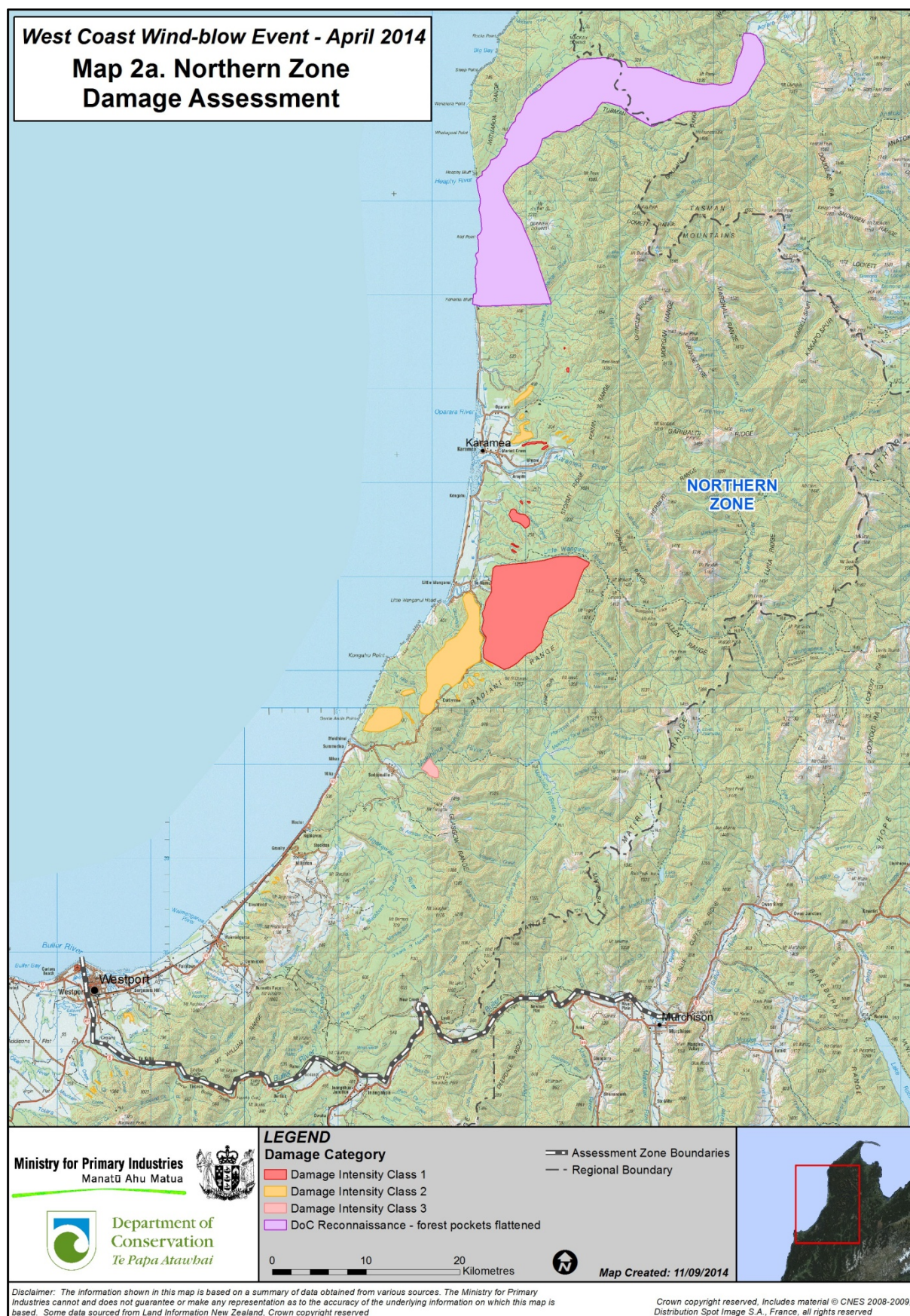
# APPENDICES

Map 1 – Flight Path, and Zones for which damage and wind-blown timber volumes were estimated.



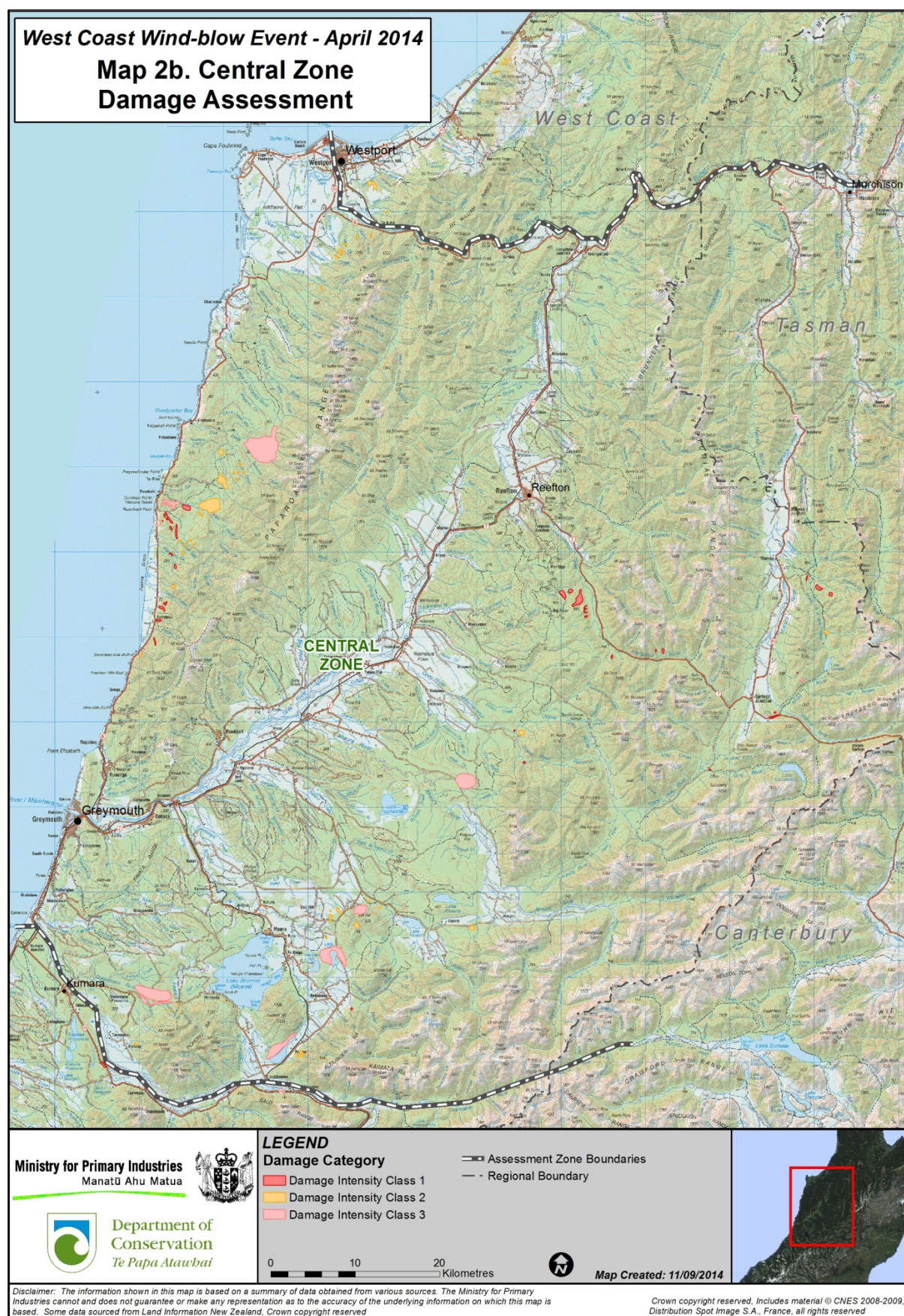


Map 2a – Areas of observed damage (Northern Zone).





Map 2b – Areas of observed damage (Central Zone).



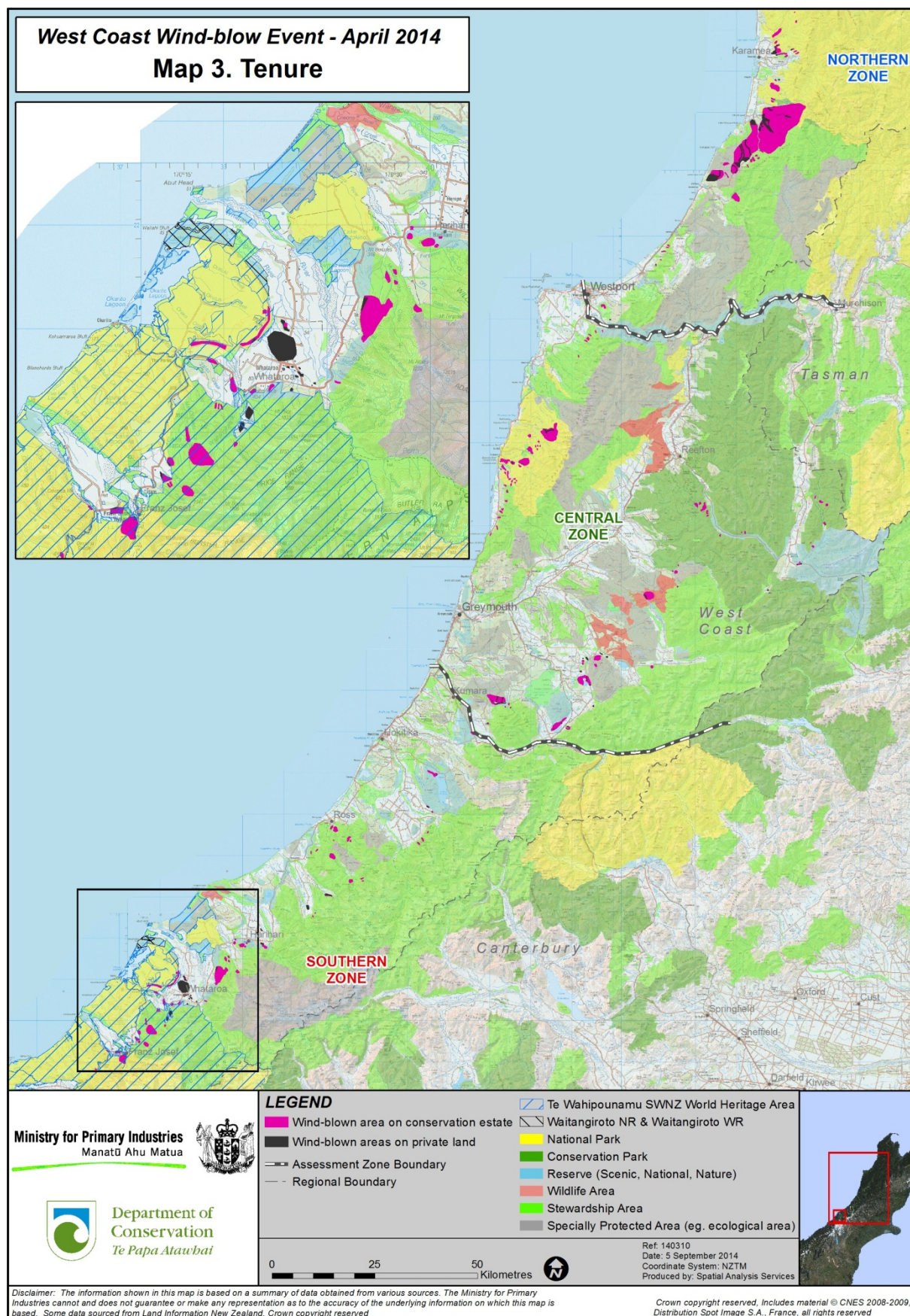


Map 2c – Areas of observed damage (Southern Zone).





**Map 3 – Land Tenure Classes.** Areas of Conservation Park, Stewardship Area and Other DOC Tenure are eligible for wind-blown timber salvage under the WCWT Act. National Parks, Ecological Areas, World Heritage Area and Waitangiroto wildlife reserve are excluded from timber salvage.



**Table A1. Damaged forest area by zone, forest class, and damage class – on conservation land eligible for timber salvage under the Act and on privately-owned indigenous forest land. Eligible conservation land excludes National Parks, Te Wāhipounamu (World Heritage Area), Ecological Areas and Waitangioto Nature Reserve.**

Damaged Forest Area (ha) by Zone, Forest Class and Land Tenure											
Forest Classes by Zone	Conservation Estate Area in Damage Classes:			Private Land Area in Damage Classes:			Total Area in Damage Classes:			Total Area in all Tenures and Classes	
	1	2	3	1	2	3	1	2	3		
NORTHERN ZONE											
Rimu - General Hardwoods	2	13	0	0	35	0	2	48	0	50	
Rimu - General Hardwoods-Beeches	3976	569	113	483	555	14	4459	1124	127	5710	
Softwoods	1	0	0	3	0	0	3	0	0	3	
Sub-totals	3979	582	113	486	590	14	4464	1172	127	5763	
CENTRAL ZONE											
Beeches	183	15	11	0	8	0	183	23	11	217	
Rimu - General Hardwoods	44	39	0	5	14	1	49	53	1	103	
Rimu - General Hardwoods - Beeches	50	55	65	2	10	29	52	65	94	211	
Softwoods	0	5	196	0	0	15	0	5	211	216	
Sub-totals	277	114	272	7	32	45	284	146	317	747	
SOUTHERN ZONE											
Rimu - General Hardwoods	86	52	961	4	57	171	90	109	1132	1331	
Softwoods	35	0	84	18	0	0	53	0	84	137	
Unclassified (mainly totara)	0	0	0	48	14	610	48	14	610	672	
Sub-totals	121	52	1045	70	71	781	191	123	1826	2139	
Totals	4377	748	1430	563	693	840	4940	1441	2270	8651	

Note: there are some minor differences in values reported in the table for individual figures, sub-totals and totals due to rounding

Damaged Forest Area (ha)	Conservation Estate Area in Damage Classes:	Private Land Area in Damage Classes:	Total Area in Damage Classes:
Class 1	Loss of over 50% of the trees	Loss of over 50% of the trees	Loss of over 50% of the trees
Class 2	Loss of between 5 and 50% of the trees	Loss of between 5 and 50% of the trees	Loss of between 5 and 50% of the trees
Class 3	Loss of over 50% of the trees in discreet patches	Loss of over 50% of the trees in discreet patches	Loss of over 50% of the trees in discreet patches
	Within larger areas of forest, or within pasture (for totara areas)	Within larger areas of forest, or within pasture (for totara areas)	Within larger areas of forest, or within pasture (for totara areas)

Mean Percentage Value Applied to Volume Data  
75%  
30%  
20%

**Table A2.** Estimated merchantable volume (timber capable of being milled) within damaged forest by zone, forest class, and damage class – on conservation land eligible for timber salvage under the WCWT Act, and on privately-owned indigenous forest land. Eligible conservation land excludes National Parks, Te Wāhipounamu (World Heritage Area), Ecological Areas and Waitangioto Nature Reserve. Estimates of merchantable volume are based on the sources of historical inventory data given in Table A3

Estimates of Merchantable Volume by Zone, Forest Class, Land Tenure and Key Species.										
Forest Classes by Zone	Conservation Estate Volume in Damage Classes:			Private Land Volume in Damage Classes:			Total Volume in Damage Classes:			Total Volume All Tenures and Classes
	1	2	3	1	2	3	1	2	3	
NORTHERN ZONE										
RIMU (cubic metres)										
Rimu - General Hardwoods	28	81	0	0	219	0	28	301	0	329
Rimu - General Hardwoods -Beeches	62620	3585	0	7610	3495	0	70231	7080	0	77311
Softwoods	66	0	0	274	0	0	339	0	0	339
Sub-totals	61714	3666	0	7884	3714	0	70598	7381	0	77979
CENTRAL ZONE										
Rimu-General Hardwoods	1861	655	0	202	230	11	2062	885	11	2959
Rimu-General Hardwoods - Beeches	2087	916	729	71	160	329	2159	1075	1058	4292
Softwoods	0	240	6831	0	0	536	0	240	7367	7607
Sub-totals	3948	1811	7560	273	390	876	4221	2200	8436	14858
SOUTHERN ZONE										
Rimu-General Hardwoods	3604	869	10759	185	953	1917	3788	1821	12676	18286
Softwoods	4515	0	2920	2401	0	0	6917	0	2920	9836
Sub-totals	8119	869	13679	2586	953	1917	10705	1821	15596	28122
BEECH (cubic metres)										
Totals for Rimu	74781	6346	21239	10743	5056	2794	85525	11402	24033	120959
CENTRAL ZONE										
Red Beech	28654	966	451	0	477	0	28654	1442	451	30547
Silver Beech	5073	171	80	0	84	0	5073	255	80	5408
TOTALA (cubic metres)										
SOUTHERN ZONE										
Unclassified (mainly totara)	0	0	0	720	84	2440	720	84	2440	3244

Note: there are some minor differences in values reported in the table for individual figures, sub-totals and totals due to rounding



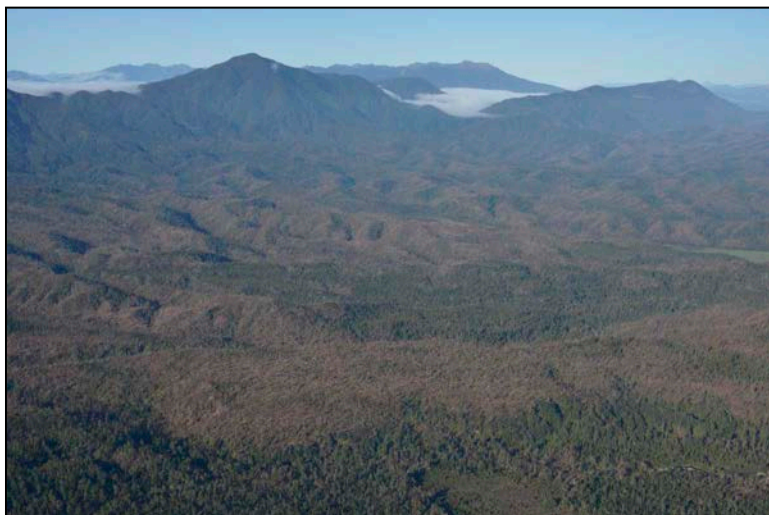
**Table A3.** Average merchantable volume by forest class, and sources of volumetric data.

Forest Classes by Zone	Species	Merchantable Volume (m <sup>3</sup> /ha)	Source of Volumetric Data (see below for key)	Forest Type Reference
<b><i>NORTHERN ZONE</i></b>				
Rimu - General Hardwoods	Rimu	21	TWC <sup>1</sup>	Sustainable Forest Management Prescriptions, Inangahua, Type 2A
Rimu - General Hardwoods - Beeches	Rimu	21	TWC <sup>1</sup>	Sustainable Forest Management Prescriptions, Inangahua, Type 2A
Softwoods	Rimu	146	NFS <sup>2</sup>	Karamea Unit, Type 2
<b><i>CENTRAL ZONE</i></b>				
Rimu - General Hardwoods	Rimu	56	NFS <sup>2</sup>	Westland Sub Unit 2 report, Type P5
Rimu - General Hardwoods - Beeches	Rimu	56	NFS <sup>2</sup>	Westland Sub Unit 2 report, Type P5
Softwoods	Rimu	174	NFS <sup>2</sup>	Westland Sub Unit 2 report, Type P5
Beeches	Red beech	209	TWC <sup>3</sup>	Sustainable Forest Management Prescriptions, Maruia, Type 3A
Beeches	Silver beech	37	TWC <sup>3</sup>	Sustainable Forest Management Prescriptions, Maruia, Type 3A
<b><i>SOUTHERN ZONE</i></b>				
Rimu - General Hardwoods	Rimu	56	NFS <sup>2</sup>	Westland Sub Unit 2 report, Type P5
Softwoods	Rimu	174	NFS <sup>2</sup>	Westland Sub Unit 2 report, Type P5
Unclassified (mainly totara)	Totara	20	NFS <sup>4</sup>	Westland Sub Unit 3 report, Types 19, 26

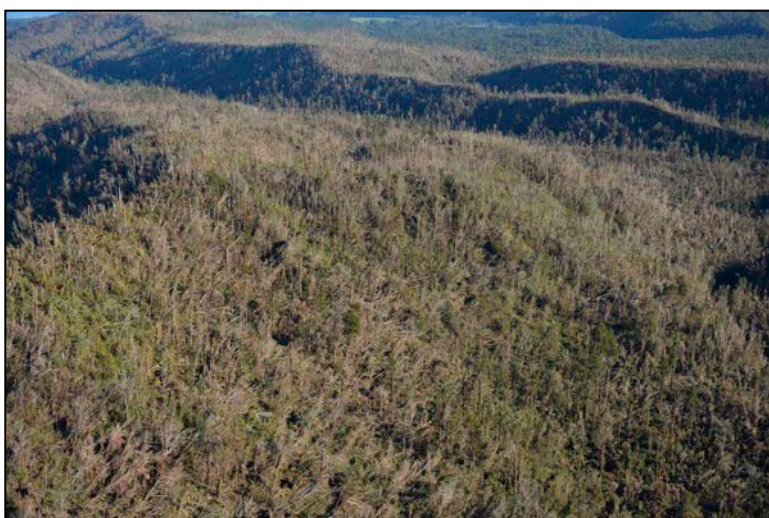
**Type Reference**<sup>1</sup> Timberlands West Coast Limited 1998. Sustainable Forest Management Prescriptions – Inangahua<sup>2</sup> Master et al 1957. The National Forest Survey of New Zealand 1955 (Westland Sub-Unit 2 report)<sup>3</sup> Timberlands West Coast Limited 1998. Sustainable Forest Management Prescriptions – Maruia<sup>4</sup> Master et al 1957. The National Forest Survey of New Zealand 1955 (Westland Sub-Unit 3 report)

## Photographs – Northern Zone

*Overview of severe damage in some of the forest in the foothills inland from Little Wanganui.*



*Typical damage in the forest in the foothills inland from Little Wanganui.*

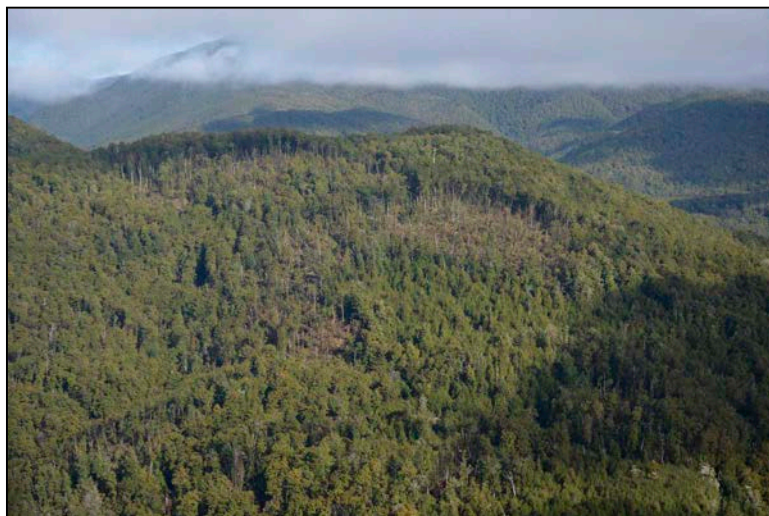


*View west down the true left of the Little Wanganui River illustrating the interface between beech forest with large contiguous areas of severe damage on the left, and areas of beech-podocarp forest with pockets of damage scattered within apparently intact forest on the right. The areas of scattered damage are expected to contain significant volumes of wind-blown rimu.*

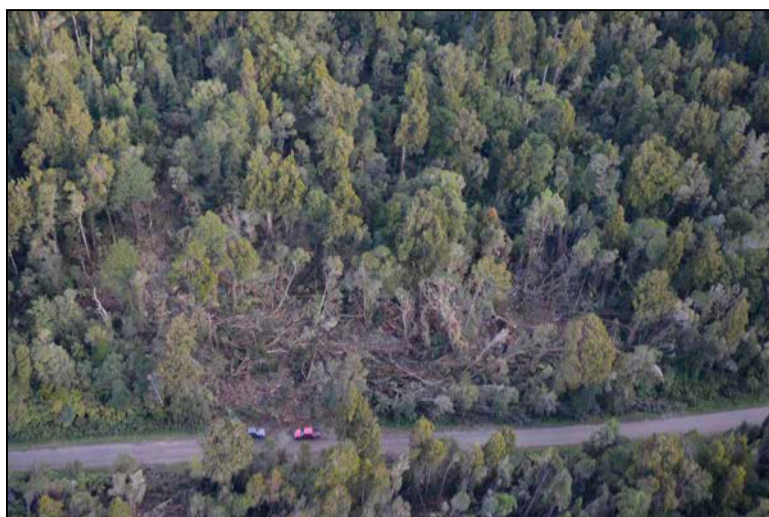


## Photographs – Central Zone

*Damage in red-silver beech forest in the Maruia Valley.*



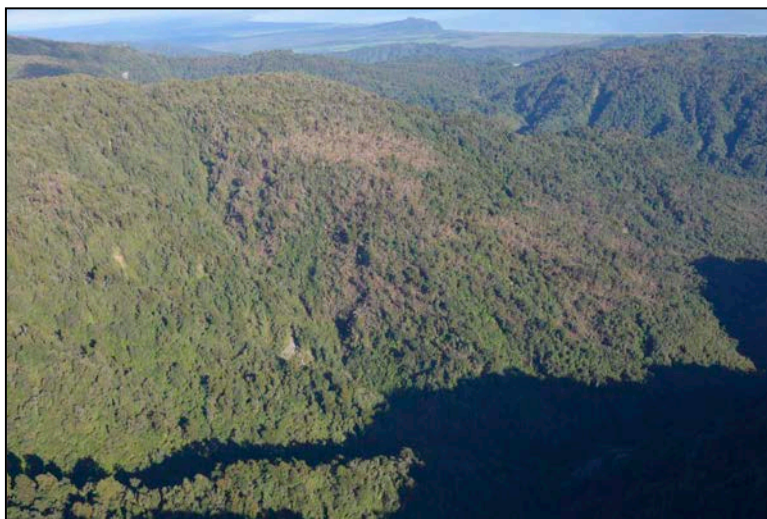
*Typical wind-blown site on a roadside reserve and adjacent conservation land. Scattered individual wind-blown trees are likely in the surrounding forest.*



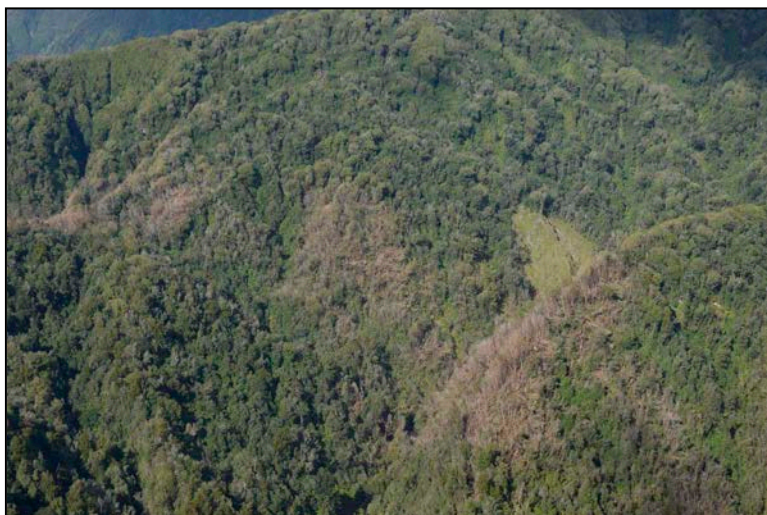


## Photographs – Southern Zone

*Wind-blown area in steep land east of Ross township in rimu-mixed hardwood forest. Scattered individual wind-blown trees were observed in nearby forest.*



*Typical damage sites in steep land adjacent to the main alpine fault where exposed ridges/knobs of predominantly kamahi and rata have been wind-burnt, with other sites wind-blown and including large individual wind-blown rimu.*



*A significant area of wind-blown rimu-mixed hardwoods adjacent to the Waitangi River bridge south of Whataroa township.*



## Photographs – Southern Zone

*Privately owned totara woodlot with extensive damage – Whataroa flats.*



*Extensive areas of wind-burn in rata-kamahi and podocarp-mixed hardwoods forest – edge of Wanganui River flats.*

