

# The economic cost of *Dothistroma* needle blight to the New Zealand forest industry

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Forest growers in parts of New Zealand consider *Dothistroma* needle blight to be one of the most serious diseases affecting growth of radiata pine. Past attempts to place a value on the cost of this disease to the forest industry have varied widely. A modelling project undertaken by Scion has enabled the economic effect of *Dothistroma* needle blight to be estimated with reasonable certainty. The cost to the industry was found to be \$19.8 million per year. This cost was attributable to lost revenue in reduced growth and cost of chemical treatments. Results from this study indicate where economic losses due to *Dothistroma* needle blight could potentially be reduced.

## Background

*Dothistroma* needle blight, which is caused by the fungal pathogens *Dothistroma septosporum* and *pini*, infects over 70 species of pine worldwide. While first described from the northern hemisphere, *Dothistroma* needle blight is most damaging as an invasive disease of exotic plantations in the southern hemisphere. Radiata pine is particularly susceptible to this disease and substantial growth losses can occur at high levels of disease severity (Figure 1). The disease causes premature defoliation of the tree leading to death in severe cases.

*Dothistroma* needle blight was first observed in New Zealand during 1962 and spread across most of the country over the following decades. Currently the disease is controlled by aerial spraying of copper oxides and silvicultural practices that promote airflow and remove susceptible individuals. Areas are usually treated if the severity exceeds a threshold of 15%, as assessed aerially.

## Environmental influences on *Dothistroma* severity

*Dothistroma* needle blight is well known to foresters in most parts of New Zealand. Although the fungus *Dothistroma septosporum* is found throughout the country severity of the disease varies between regions. Research was recently carried out to quantify this variation in *Dothistroma* needle blight using a modelling approach (Watt, Palmer, & Bulman, in press). The modelling exercise, based on data collected from the forest health surveillance scheme, confirmed that severity was highest in moderately warm wet environments in the North Island and on the west coast of the South Island. In contrast, disease severity was lowest in drier eastern and southern regions of New Zealand. Severity increased to a maximum at a stand age of 12 before declining.

The modelling study highlighted the important

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role environmental factors play in the development of *Dothistroma* needle blight and integrated the environmental determinants into a single mathematical function. Using this function spatial predictions of disease severity for New Zealand can be made and are shown in Figure 2.

## Counting the cost

Several previous attempts have been made to estimate the annual costs of *Dothistroma* needle blight to the New Zealand forest industry. These estimates range from \$1.6 to \$24 million. This range has primarily resulted from variation in the following assumptions: stumpage; average disease severity and associated growth loss; forest area affected by the disease and mean annual increment of plantation forests. Using the recently developed maps of disease severity it was possible to increase the accuracy with which the economic effect of the disease can be estimated.

The costs associated with *Dothistroma* needle blight were determined for three components assumed to encompass the economic impact associated with the disease:

- **Component 1 - Cost of spraying**  
Spraying cost = the average sprayed area over the last five years x average cost per hectare (\$35/ha).

- **Component 2 - Value losses on sprayed area**

The value of annual growth losses in sprayed areas were determined using the following procedure:

Volume affected = area sprayed x average mean annual increment (MAI) of plantation forests within New Zealand ( $20.6 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$ ).

Volume losses = Volume affected x mean disease severity/100 x modifier (0.1613).

For the disease severity a value of 15% was used which is the minimum value at which stands are treated. The modifier is based on research that describes the volume reduction attributable to *Dothistroma* needle blight as a function of disease severity (van der Pas, 1981).

Value lost = volume losses x stumpage value (\$55/ha)

- **Component 3 - Value losses on unsprayed area**  
Determination of component 3 follows the method used for component 2 except that mean disease severity for areas with disease < 15% was



Figure 1. Young radiata pine trees showing high *Dothistroma* needle blight severity.

determined across the unsprayed remainder of the plantation estate. The total area used in this calculation was reduced to ensure that the effect of disease severity was only limited to stands that were  $\leq 15$  years. The national exotic forest description (MAF, 2010) was used to determine the proportion of the estate with age classes  $\leq 15$  years.

**Assumptions that have been made in this research are as follows :**

- The North Island sprayed area used (84,752 ha) is an average of treated areas over the last five years. Within the South Island an average area of 25,000 ha has been assumed, as between ca. 20,000 and 30,000 ha is annually treated.
- It is assumed that losses in volume occur in sprayed areas (see discussion). Losses were determined using a disease severity of 15% as this is the minimum severity at which spraying takes place.
- There is some controversy over whether stands with relatively low stocking ( $\leq 300$  stems  $ha^{-1}$ ) are negatively affected by disease levels of  $< 15\%$  (see discussion). Based on previous research (van der Pas, 1981) we have assumed that there are losses in these stands and have used the function described in this research to estimate these losses from mean disease severity for this component.
- Stands over 15 years of age are assumed not to be affected by the disease within either sprayed or unsprayed areas. This is a conservative assumption as previous research does suggest there may be growth losses from the disease in older stands (Watt, et al., in press).
- The plantation area that is  $\leq 15$  years of age was determined from the 2010 National Exotic Forest

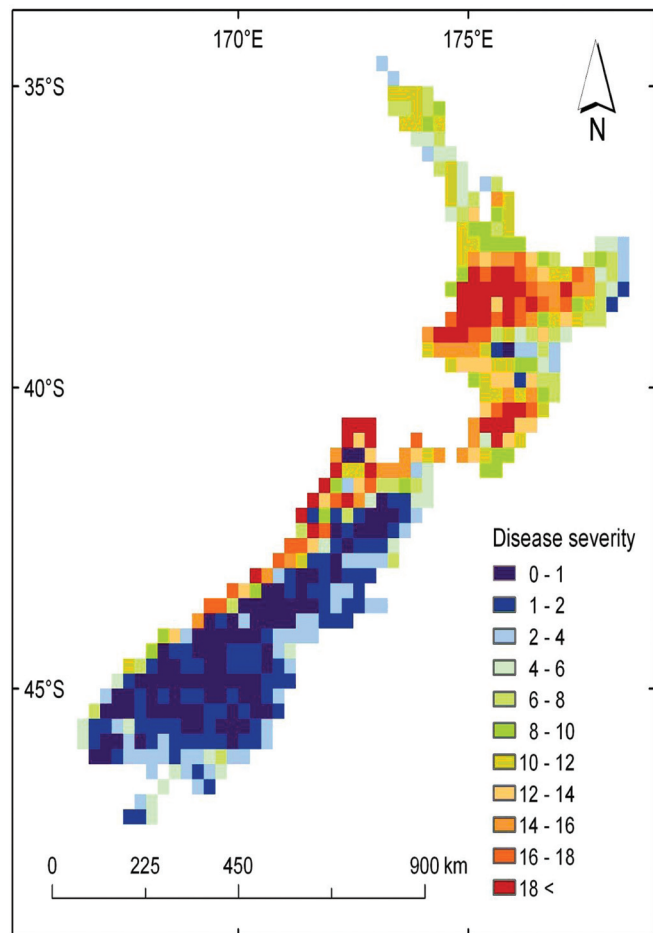


Figure 2. Map of New Zealand showing spatial variation in *Dothistroma* needle blight severity.

Description (MAF, 2010).

- The MAI used in calculations for estimating unaffected plantation growth is the average 300 Index for New Zealand plantations, determined from a previously developed model and surface (Palmer, et al., 2010). The 300 Index describes the mean annual increment over a 30 year rotation for a stand growing at a final crop stocking of 300 stems  $ha^{-1}$ . It is assumed that the MAI obtained from the 300 Index is reasonably representative of stands that are  $\leq 15$  years.
- The mean 300 Index used for average MAI has been converted from a total stem volume to a recoverable volume by reducing values by 25% to account for unstocked areas and stem breakage.
- It is assumed that the average estate MAI applies to areas denoted by both component 2 (areas that have been sprayed) and component 3 (areas not sprayed).
- A stumpage value of \$55 has been assumed.

**Results**

Results show losses from component 1 (cost of spraying) and component 2 (losses in value from sprayed stands) to be similar in magnitude, totalling \$3.8 M and \$3.0 M,

Table 1. Summary of disease severity, area affected and cost for each component.

	Disease severity	Affected area (radiata pine aged 1-15 years)	Cost
Component 1			\$ 3.8 M/yr
Component 2	15%	0.110 M ha	\$ 3.0 M/yr
Component 3	7.9%	0.744 M ha	\$13.0 M/yr
Total			\$19.8 M/yr

respectively (Table 1). Although the disease severity was lower for component 3 (losses in value from unsprayed stands) the total losses from this component exceeded that of sprayed stands by almost five-fold (\$13.0 vs. \$3.0 M) as the area affected was far larger (Table 1).

## Discussion

The total cost of *Dothistroma* needle blight to the New Zealand forest industry was estimated at \$19.8 million per year resulting from a combination of lost growth and treatment costs.

Average disease severity in unsprayed stands was estimated to be 7.9% over the entire estate. This is likely to be an overestimate because forest health surveyors usually assess disease when it is causing obvious damage. There is no requirement to record the absence of a disease.

Despite the numerous assumptions made in this study analyses described here clearly indicate the most important component of cost is the loss accrued through untreated areas. This finding raises two important points. Firstly, it raises the issue of whether compensation in plantation growth occurs in stands with relatively low severity (less than 15%). The function we have used to describe growth losses suggests that there are net losses for stands with disease less than 15%. However it has also been shown that the most dominant 300 stems ha<sup>-1</sup> in the stand display no growth loss regardless of the overall average disease level and that only the less dominant trees are affected. This suggests that stands grown at a final crop stocking exceeding 300 stems ha<sup>-1</sup> may benefit from spray application if protecting the sub-dominant component of the crop is important.

The current crop is predominantly pruned stands (59%) that are likely to have final crop stockings of 300 stems ha<sup>-1</sup> or lower (New Zealand Forest Owners Association, 2010). However, there is also a substantial unpruned component (41%) that is likely to include a high proportion of structural grade stands with final crop stockings exceeding 300 stems ha<sup>-1</sup>. This balance may shift in the future as highly stocked stands produce a greater return under carbon forestry (Manley and Maclaren, 2009). Such a shift towards higher stockings may result in the disease negatively impacting growth of a higher proportion of crop trees.

Secondly, analyses presented raise the general issue

of the severity threshold at which *Dothistroma* needle blight is controlled. Although lowering this threshold will increase costs (Component 1) this decision would need to be weighed against the volume losses resulting from the disease. Further research is needed to investigate this trade-off more closely. Specifically, it would be useful to investigate the effect of low disease levels on growth across a final crop stocking range.

We conservatively assumed that there would be volume losses for stands with severity above 15% that are treated, as treatment will not cure needles that are already diseased. Although this assumption may result in over prediction of value losses, the analysis indicates that this was not a large component of losses for *Dothistroma* needle blight, so is unlikely to represent a major source of sensitivity.

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