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TECHNICAL NOTE

CONTROLLING THE SEEDLING DEBARKING WEEVIL: AN ECONOMIC ANALYSIS

In Nova Scotia and Prince Edward Island, one of the most important considerations when establishing conifer plantations is the seedling debarking weevil. An economic analysis was made of the costs of various control options; this analysis should be of use in making management decisions.

The Pest

The seedling debarking weevil, *Hylobius congener*, a small beetle less than 1 cm long, is attracted by the residue of harvesting operations. The adults lay their eggs in stumps, where the new brood develops, but feed on the succulent growth of young seedlings, especially conifers. Eventually, the weevils disperse and the new adults seek freshly harvested stands.

This analysis examines the cost-effectiveness of plantation treatment options and ranks them according to the total cost of establishing the new stand and the various levels of risk of mortality caused by the weevil (Table 1).

The minimum cost for each level of risk is presented as the best economic choice. In many cases, the next best choice may cost only a few dollars more, an insignificant sum in view of the non-economic decisions that must be made and the precision with which some of the variables were estimated.

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For example, referring to Table 1, if 20% seedling mortality is expected, it is less costly to use Tanglefoot at $1166/ha or a chemical spray at $1176/ha (total stand-establishment cost), than to leave the site untreated at an establishment cost of $1210/ha. However, at a cost of $1220/ha, it is more expensive to scarify than it is to take no control measures

No treatment is advised when the estimated risk of mortality is expected to be 10% or less.[1]

Tanglefoot promises the greatest protection at the lowest cost for sites rated at 10-30% mortality hazard. Future tests will determine its persistence and ability to protect seedlings into the second year. It is interesting that anticipated mortality levels as low as 20% are considered worth treating.

Chemical sprays appear to offer somewhat greater protection at a slightly higher cost. They are most economical when the risk of mortality is between 40-80%. Canadian field tests have been minimal to date, so this option is not yet available. Our analysis would suggest that further development is merited. As with Tanglefoot, chemical spraying could be justified at a 20% mortality hazard.

Scarification is also an option, although further evaluation is needed of the potential for frost heaving and the success of this option over a range of natural conditions. Stand establishment costs considerably more using the scarification option than it does with Tanglefoot or chemical spraying.

Delayed planting is an option only when damage levels of 40% or more are expected and when there is little chance that additional chemical weeding will be necessary. Total stand establishment costs presume that some herbiciding will be required routinely for all stands.

Chemical Dipping was one of the least attractive options. Its cost effectiveness would have to be improved significantly for it to be competitive with other treatments.

As many of the costs are estimated and the treatment success rates are preliminary, this cost/benefit analysis is only tentative. The model it constructs, however, is a useful guide for selecting control tactics. It is the first step toward a more comprehensive analysis which

1 Corresponding to low or moderate on the Forestry Canada key (Forestry Canada-Maritimes Region, Tech. Note No. 171).

will be linked with improved hazard forecasting to produce a decision-making tool for Maritime forest managers.

Table 1. Total cost of stand establishment ($/ha) given the risk of mortality from the seedling debarking weevil. Minimum costs are underlined.

RISK OF MORTALITY (%)	NO CONTROL TREATMENT	TANGLE-FOOT	CHEM. SPRAY	SCARIFIC-ATION*	DELAY PLANT	CHEM. DIP
10	<u>1137</u>	1137	1159	1193	1211	1287
20	1211	<u>1166</u>	1176	1221	1238	1300
30	1253	<u>1193</u>	1196	1245	1265	1310
40	1292	1223	<u>1211</u>	1268	1290	1319
50	1332	1253	<u>1231</u>	1292	1317	1329
60	1399	1265	<u>1248</u>	1317	1334	1342
70	1480	1280	<u>1268</u>	1327	1349	1352
80	1532	1295	<u>1285</u>	1339	1362	1362

In Table 1, we assume, for the purpose of the analysis, that damage in scarification sites will be reduced by 70% and that frost heaving did not occur. When planting is delayed, we have assumed weed competition to be a problem on one out of three sites and assigned a treatment cost of $124/ha.

Control Options

Physical barriers: Tanglefoot, a sticky substance which causes the tree to be unpalatable; and plant stockings, netting placed around the seedling. The latter appears to be prohibitively expensive.

Chemical insecticides: applied at the nursery or at planting time.

Scarification: includes the use of a disk trencher, Bracke or possibly anchor chains.

The objective is to create a microenvironment favorable for the seedlings but not for the weevil.

Delay planting: a delay of two or three years (a two-year minimum has been used for this study) allows time for the weevils to disperse, after which seedlings may be safely planted. Weed problems are created.

ANALYSIS

The economic analysis is based on various cost estimates, treatment efficacies, and biological components.

1. The Costs Of Hylobius-caused Mortality

The costs associated with uncontrolled weevil damage can be calculated as the additional expenses of fill-planting or replanting the affected areas. For this analysis, the fraction of surviving seedlings, which determines the amount of additional planting to be done, was calculated as the amount planted, less the level of expected Hylobius damage, and less 15% for expected mortality from other causes occurring commonly in most plantations.

At low seedling mortality (15% or less), the effect of the reduced stocking level on volume at rotation age is negligible and no fill-planting is necessary. When the fraction of seedlings surviving drops below certain thresholds, a decision must be made to fill-plant or replant. Typically, fill-planting will be done if mortality exceeds 30%, while the entire area will be replanted if mortality exceeds 60%. By estimating the additional labor and the number of seedlings required, the cost of the additional planting, which increases with the level of Hylobius-caused mortality can also be estimated (Figure 1).

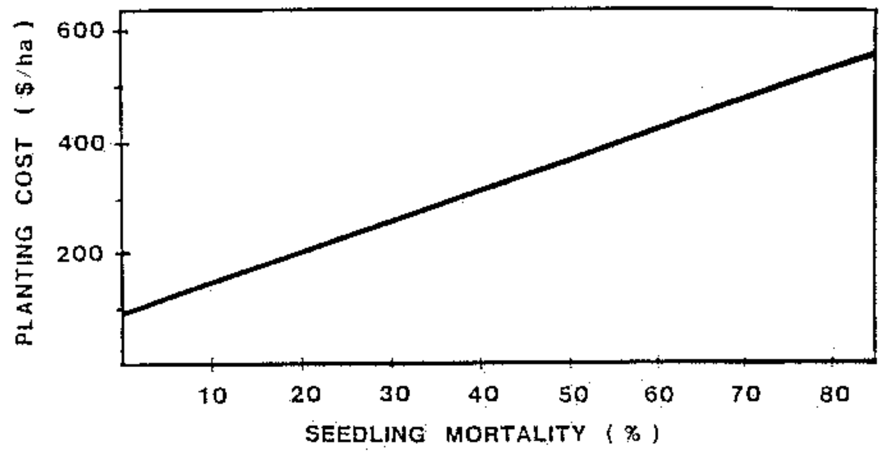

Figure 1. Increase in fill-planting or replanting costs ($/ha) associated with seedling mortality (%).

2. Treatment Value

The value of a treatment to reduce *Hylobius* damage depends on the expected level of mortality (risk or hazard) and the effectiveness of the treatment. The treatment value is equivalent to the amount saved in planting and fill-planting costs. This is computed for varying levels of effectiveness and for a range of anticipated levels of *Hylobius* damage (Table 2).

Table 2. Treatment values ($) for various treatment effectiveness and mortality risk levels.

EXPECTED SEEDLING MORTALITY (%)	TREATMENT VALUE ($/ha) TREATMENT EFFECTIVENESS(%)								
	10	20	30	40	50	60	70	80	90
10	7	17	25	32	40	49	57	64	74
20	7	22	40	54	72	89	104	121	136
30	12	25	37	47	72	96	119	143	168
40	15	32	47	64	79	104	136	168	200
50	20	40	59	79	99	119	151	190	232
60	47	77	99	124	148	173	195	242	292
70	57	111	151	180	208	235	264	306	363
80	35	99	163	208	240	272	304	341	405

For example, if a site will sustain 50% seedling mortality with no treatment (requiring the corresponding value of fill-planting, as in Figure 1), then for a treatment which reduces damage to 40%, Table 2 indicates that it is worth spending up to $79/ha, rather than fill-planting. A treatment which reduces damage to 50% allows a further expenditure of $20/ha ($99 less $79).

3. Effectiveness and Costs of Control Options

The costs of most treatments were determined using estimates for labor and materials. The costs of delayed planting were based on the reduction in volume resulting from a decrease of two years in the age of the stand at harvest.

A measure of effectiveness has been assigned to each control option by estimating the percentage reduction in *Hylobius*-caused damage resulting from using the treatment. This is based on results from one year of field trials, together with the experience of researchers in Scandinavia with *Hylobius abietis* (Table 3).

Table 3. Summary of cost effectiveness of control treatments.

TREATMENT	MORTALITY REDUCTION (%)	COST ($/HA)
Tanglefoot	65	49
Chemical Spray	78	82
Chemical Dip	87	217
Scarification	50-70*	111
Delayed Planting	67	59-272**

*depends on occurrence of frost heaving
** depends on need for additional chemical weeding

For example, on a high hazard site which would typically sustain 30% damage in the absence of treatment, Tanglefoot could reduce *Hylobius*-caused damage by 65% (to 10.5%) at a cost of $49 per hectare.

4. Comparing Control Options

Using Figure 1 and Table 3, the total cost of establishing a fully stocked plantation can be computed for each option:

TOTAL COST = COST OF SITE PREP. & INITIAL PLANTING + COST OF TREATMENT + COST OF FILL PLANTING

DISCUSSION

The analysis presented here should serve as an aid in deciding which treatment option is most suitable for controlling weevil-caused mortality, given the site under consideration.

There are still many unknowns. The costs used in this study were the best available at the time. Any modification to these costs, e.g., lowering costs by combining brush raking with scarification, will influence the outcome of the analysis.

An accurate and reliable assessment of mortality hazard is clearly important, since the anticipated mortality level has a significant effect on the choice of a control option. The value of a treatment depends on this hazard value and can range from useless to worthwhile over the range of mortalities experienced in the Maritimes.

This analysis is the first step in producing an economic model for pest/plantation interactions. As more and better data becomes available, and their economic effects can be evaluated, the analysis will become more precise and useful. Also, a variety of treatment scenarios may be tested in the model to predict their effects.

This note describes a novel and useful approach to insect damage appraisal in plantations. Readers' opinions are welcomed.

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