the failure to give priority to the development of a comprehensive operational plan. Such a plan should have been the primary reference for all activities and, as a live document, constantly updated to reflect changes in strategy and new decisions. While the operation was not seriously compromised by this failure, due to the close integration of the operational, science and policy teams, it would have improved communication and provided greater documentation of the response. The operational phase was rated 7/10 with all other key activities undertaken to a high level. It would have been further enhanced by follow-up environmental impact monitoring and also by a comprehensive review at its conclusion.

Monitoring was carried out to a high standard across the whole programme and provided a high level of confidence to the true extent, stage, and density of the target insect population, and the efficacy and coverage of the spray programme. Both health monitoring and community support was effectively managed, with the overall monitoring phase rated 9/10, its only failure being the lack of follow-up environmental monitoring of the fate and impact of Btk.

The final phase, **Review,** was the most notable failure of the white-spotted tussock moth programme, and potentially had the greatest long term impact through a failure to document and learn from such an outstanding success. Not only was a review not undertaken, but little effort was made to protect records and data, and no formal account of the programme was produced. The review phase was rated 1/10 against best practice, and its failure has been reflected in the costly mistakes of a similar subsequent operation.

The key lessons which can be learnt from the white-spotted tussock moth operation are:

- the need to capitalise on the eyes of the community in the detection of new pests and diseases, by providing well defined and responsive pathways for public involvement;
- that an operational plan is an essential tool once response is underway and needs to be afforded the highest priority and expertise;
- the review, documentation and evaluation of a response, whether a success or failure, is critical to improving performance in the future.

The successful white-spotted tussock moth eradication made little contribution to the closely related painted apple moth programme just a few years later. New Zealand can ill afford to squander such intellectual capital and experience, given the magnitude of challenges involved in effective biosecurity.

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Response of red beech to fertiliser, Island Block coal mine, North Westland

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Restoration of mine sites to indigenous vegetation is now generally a standard condition of access arrangements for mining on public conservation land. However, the overburden materials associated with mine sites, especially when soil is not available, presents serious problems for the establishment of forest species particularly because of shortages of nitrogen and phosphorous. This note examines the fertiliser response of field grown red beech (*Nothofagus fusca*) established on sandstone and siltstone overburden from the Island Block open-cast coal mine, north Westland (42°10' S, 172°58' E, 760m a.s.l.).

After ripping to 1 m, the restoration trial was established during winter 1985 using 3-year old bare-rooted red beech. The fertiliser trial was established in November 1991 when fertiliser was applied to two of four 14 x 15 m plots at an application rate of 110 g diammonium phosphate (DAP; 18% N and 20% P) per plant and applied in one spade slot in the ground approximately 15 cm from the plant. Plant height was measured at the time of fertilisation and again in November 1993. A second fertiliser treatment was applied in October 1994 using 150 g DAP per plant. During October 1996, following the obvious red beech response to fertiliser, mine staff inadvertently fertilised all plants in the trial with approximately 100 g DAP per plant. Plants were not re-measured at this time. No subsequent fertiliser additions were made with final plant measurements in March 2001.

Fertilised red beech put on substantially more height growth than unfertilised plants, with no overlap of 95% confidence intervals in either 1993 or 2001 (Fig. 1).

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Table 1: Mean annual red beech height growth (cm yr-1). 95% confidence intervals (CI) are calculated for individual trees within plots, but mean plot values were used in the analysis of variance models.

Treatment	Mean ± 95%CI replicate 1	Mean ± 95%CI replicate 2	F	P
1993-1991 difference				
Fertilised	31.1 ± 2.75	31.0 ± 2.71	66.5	0.015
Unfertilised	12.8 ± 1.91	7.7 ± 0.90		
2001-1993 difference				
Fertilised	18.5 ± 1.54	19.3 ± 1.04	26.0	0.036
Unfertilised	8.9 ± 1.82	4.1 ± 1.04		
2001-1991 difference				
Fertilised	21.0 ± 1.23	21.6 ± 0.88	32.4	0.030
Unfertilised	9.7 ± 1.04	4.8 ± 0.90		

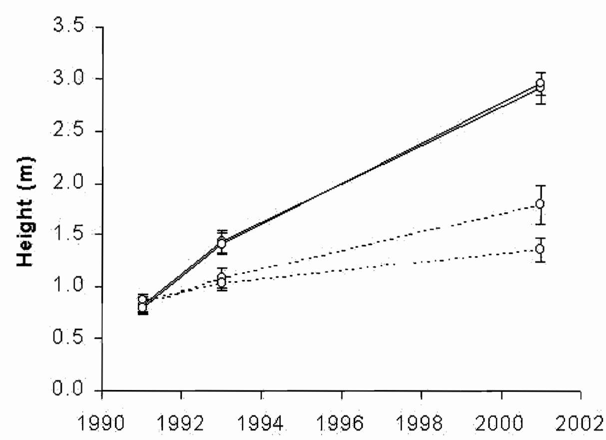
Average height at age 15 years was 2.9 m for fertilised and 1.6 m for unfertilized plants. None of the fertilised red beech died during the study while 10% of unfertilised plants either died or experienced substantial leader dieback. Mean annual height increment was substantially greater for the period 1991-93 than for the period 1993-2001 (Table 1), and the difference between fertilised and unfertilised treatments was significant for both these time periods, and for the whole study (1991-2001).

Despite the unplanned blanket fertilisation of the whole trial in 1996, fertilised red beech showed a clear and significant response to fertiliser addition compared to unfertilised plants. Red beech occurs on more fertile soils than other beech species and is thought to have the highest nutrient requirements of these species (Adams 1976). Langer *et al.* (1999) observed a marked reduction in red beech growth with the omission of N and P when red beech was grown in both stockpiled soil and overburden gravels, and Stephens *et al.* (2001) observed a significant response in red beech seedling growth to increased nitrogen supply in glasshouse trials. It is not possible to identify which of N and P are most limiting in our trial area, although Langer *et al.* (1999) suggest that both are limiting to red beech in overburden gravels in their study.

That planted red beech showed a significant response to fertiliser application is not surprising given the generally infertile nature of overburden materials associated with coal mines. Certainly after 10 years in this trial, fertilised plants had increased in height by > 2 m while unfertilised plants had increased by < 1 m.

While the result of this study are confounded to some extent by the unplanned 1996 fertiliser application, they nonetheless support the results of other mine site restoration trials (Davis *et al.* 1997, Langer *et al.* 1999) and highlight the need for fertiliser addition when restoring overburden material. However, more research is required on the costs and benefits that nitrogen-fixing species provide compared to fertiliser addition, and on the relative role of N and P for maximizing plant growth, especially when nitrogen-fixing plants are used as part of restoration. Finally it is important that trials such as this one and that at Giles Creek (Davis *et al.* 1997, Langer *et al.* 1999) are maintained and monitored, as their value will increase with age.

Figure 1: Red beech height growth (means ± 95% confidence intervals) for fertilised (—) and unfertilised (----) treatments.



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