

# Lessons Not Learned at University #11

## How significant is significant?

*The Forester* set out to analyse the initial results from a large and complex research trial that had 25 tree plots established with twelve fertiliser regimes, three thinning levels and 4 replicates. The trial had been established on a number of sites. The objective was to determine whether the optimum thinning regime for a stand would vary if fertiliser was applied. The objective was to determine how heavily a stand could be thinned without losing volume increment, and to see whether this was different for different levels of fertiliser application. At this stage the first 5 years or so of data were available and preliminary conclusions were wanted by management. The organization did not want to wait for a further 12 years until the trial would be completed before making key silvicultural decisions.

It was a difficult analysis although there were trends evident and the trends seemed consistent across sites. The challenge was to demonstrate the trends, as the graph needed to show the annual changes by thinning and fertiliser treatments. A simple Analysis of Variance showed that the extreme values were just significantly different but many of the comparisons were not statistically significant. A very simple tentative model was developed and this was then evaluated in a simulation model to see if the small differences had any effect economically.

The results indicated that the economic gain in terms of the net present value of the forest could be measured in millions of dollars!

Even better, the gain came at no cost. It was simply a matter of re-scheduling thinning operations if the stand was going to be fertilised.

*The Forest Managers* naturally wanted to implement a new silviculture based on this analysis the very next day, but the organisation was wary because of the lack of statistically significant differences. It was argued that the experiment needed to run longer. *The Forester* was caught in the middle and the pressure was on.

In time, the interim results were presented at an external meeting. *The Academic* who was present argued that you couldn't build a model unless the results were statistically different or unless you could demonstrate that the new model was significantly different from no model at all. This was good statistical theory, but if the trend was in fact real then it was very important to get the results out into practice.

At a second meeting *The Lesser Light* made the same observation but went further and said that "as there were no statistically significant differences there were no differences". Now this was patently absurd. He could have said that there was no evidence that there were significant differences; he could have said that there were not enough data; and he could even have said that the experiment had not run long enough. Or he could have argued that there were insufficient replications. This latter point, while statistically satisfying and a nice way out of the argument, would have been physically impossible to fix as the experiment was already huge in size covering many hectares and costing a lot of money to maintain and measure.

Nothing was resolved. Over years more data were collected and eventually the experiment was successfully analysed and written up. A model was developed that could be implemented in the planning system. The thinning regime was revised and this was implemented in practice. The final model was not markedly different from the model put forward years earlier. Implementation had just been delayed, and the delay had come at a considerable cost.

*The Forester* came to the conclusion that the issue was really not one of statistical significance at all. The question was whether or not *The Forest Managers* believed that the original model was a sensible model and was supported by the data.

He had long concluded that simple statistical techniques were not good enough to discriminate the response after a few years, that more complicated statistical techniques had to be used, and that although more replicates would have been desirable that was simply not possible. He remembered the comment by a senior manager "we are not here to grow volume, we are here to make money". Although the statistical analyses were not wholly satisfactory, *The Forest Managers* in the organisation were happy!

Chapter 40 of Kim Iles<sup>1</sup> presents a similar tale where non-significant results in a fertiliser experiment led an organization to decide not to fertilise stands.

**Lesson:** Statistical significance must be interpreted too, it is not a simple matter of determining whether a result is significant or not.

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<sup>1</sup> Iles, Kim (2009) *The Compassman, The Nun, and the Steakhouse Statistician*. Kim Iles and Associates Ltd., 359pp.