# Measuring the Reduction in Abundance of Pest Ants

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## Project and Objective

This project involves the provision of advice on measuring the reduction in abundance of pest ants, particularly the Argentine ant (*Linepithema humile*), in order to audit the performance of pest contractors.

The project was undertaken for Northland Regional Council by Landcare Research in July – September 2007.

In terms of the advice we assumed that the abundance of ants would be reduced to 10% of their pre-poison levels by the contractor (i.e. a 90% reduction, a 'contractual success'). To determine this, the pre-poison and post-poison abundance of each vial was compared. If post-poison levels were ≤10% of pre-poison levels this was deemed a success. The number of vials which were 'successes' and failures' were totalled to give a percentage of overall success. The number of vials which were 'successes' had to reach a ≥90% level for contractual success.

Contractual failure to adequately control pest ants was not based on individual vials; because even one vial that did not reduce abundance to 10% of pre-poison levels could be deemed a contractual failure. Rather, contractual failure was based on the overall number of vials.

## Results

**Historical data**
To get some background information on measuring the reduction in pest ants, I examined data from various control attempts and toxic bait trials undertaken by Landcare Research over the last six years.

Data from five trials was examined, three for Argentine ants (*Linepithema humile*), and two for Darwin's ant (*Doleromyrma darwiniana*).

These trials are used to illustrate changes in pre- and post-poison abundance, and the type of results that can be achieved (rather than reporting on specific details of these trials).

The sample sizes of these trials ranged from 39-70 vials of baits (Table 1). Of these, 49-73% had >10 ants in pre-poison monitoring (a cut-off value of 10 ants was used because a 90% reduction subsequently gives 1 ant; anything less than 10 ants results in a fraction of one ant – which is often hard to get in samples!).

Post-poison monitoring showed that 71-100% of vials had a ≥90% reduction in ant abundance. One trial had a low success (71%) which corresponded to the use of an experimental bait – this was not Xstinguish™ bait. The other four trials all used Xstinguish™ bait, and the overall success of these was 91-100% (Table 1).

Combining the trials for the Argentine ant resulted in 5 of 69 vials failing to meet the ≥90% reduction target. This is 7.2% of vials overall (92.8% success). On average, Argentine ants were reduced to 3.5% of their pre-poison levels (SD +/- 0.19%, 95% Confidence intervals 0 – 8.2%).

Combining the trials for Darwin's ant resulted in 5 of 64 vials failing to meet the $\geq$90% reduction target. This is 7.8% of vials overall (92.2% success). On average, Darwin's ants were reduced to 2.4% of their pre-poison levels (SD +/- 0.09%, 95% Confidence intervals 0.3 – 4.5%).

These trials show that as $\geq$90% reduction can be achieved but there are failures, and its clear that ant abundance does change through various factors. Additionally, these trials were conducted in relatively small and heavily urbanised areas, where the ground cover is likely to be more homogeneous and accordingly, control efforts could have greater success. Whether these results can scale up to larger areas, especially those with greater vegetation cover and with more heterogeneity are unknown.

**Theoretical Distribution**

Another factor to consider is the theoretical variation in the number of vials and probabilities used to assess success and failure. It is important to understand this variation, because it can influence the outcome of 'contractual success'.

However, this variation can also be used to determine if results are outside expected values and thus give confidence that a contractual failure has occurred.

Such variation is examined through the binomial distribution, a common and very useful probability distribution. It occurs when there are N number of trials (e.g. sample size), there are two outcomes (e.g. success or failure of reaching a target), and a probability of the outcomes (e.g. success = 90%).

Table 2 outlines some theoretical limits for different sample sizes. For example, if 80 vials (column 1) are placed out, and there is a 10% failure (90% success) target, we expect 8 vials to fail [80*10% = 8] (column 2).

However, the number of vials which fail will vary; if we could repeat the study many times there would be a range (distribution) of these vales (i.e. like rolling a dice, or tossing coin). For example, it is possible that 4-13 vials could fail (using a 90% probability of obtaining a reduction to 10% with 80 vials; see columns 3+4).

The problem with these values is that it is possible the contractor has done a great job and truly reduced pest ant abundance to <10% of the original pre-poison levels. But even-so, a range of 4-13 vials may actually fail. If it were 13, this would represent 16.3% failure (see columns 5+6, =13/80), which may be deemed a contractual difficulties because this is above the 10% target.

So in summary, there is a 90% probability that when using a sample size of 80 vials a true reduction to 10% could have occurred even if 13 vials actually failed to meet the target.

The message is that for realistic levels of sampling the limits are relatively wide. A contractor could do a good job, but that sampling variability makes it appear unacceptable.

However, we can also turn this around and say; here is a very acceptable range (i.e. a favourable range for the contractor). Thus, if the numbers of vials which fail are outside this range then there is a very strong case to say control hasn't worked. This range can be established by examining Figures 1 and 2.

The relationships between sample size and limits are also shown in Figures 1 and 2.

Figure 1 shows the lower and upper ranges around the 'expected outcome = middle line' (columns 3+4 in Table 2). There are also two probability ranges (these encompass the number of vials that have failed to achieve a $\geq$90% reduction). Within the wider range, there is a 90% probability of the number of failed vials of being within this range. Within the narrower range, there is a 75% probability of the number of failed vials of being within this range.

These values and trends can be used to establish an acceptable range in which contractual success/failure can be judged. By using the regression equations, it is possible to determine the upper limit of what should be contractually acceptable (i.e. what is the maximum number of failed vials which is acceptable, and anything above this is thus unacceptable).

The regression equation for the upper values of the 90% probability range is:

$Y = (0.1205*X) + 2.4552$

The regression equation for the upper values of the 75% probability range is:

$Y = (0.1145*X) + 1.6232$

X = sample size
Y = the number of 'failed' vials, above which is needed to trigger a contractual problem.

Running through an example: if 43 vials were put out into the field and a probability range of 90% was wanted:

$Y = (0.1205*43) + 2.4552$
$Y = 7.6$

Therefore, if more than 7.6 vials fail to meet the 90% reduction this is good cause for a contractual failure.

Figure 2 shows that is the deviation from a 10% target (horizontal line) (columns 5+6 in Table 2). This basically shows the effect of increasing sample size; with more samples the ability to accurately measure a 10% target becomes increasingly better.

## Recommendations & Best Practice Guidelines

I suggest the use of the 90% probability range (see table 2 and figures). This 90% probability range gives you 1) good confidence of the possible range of vials that have failed to reach the 90% reduction, 2) a very strong basis for determining what is outside this range (through the use of regression equations), and 3) allows some flexibility for the pest contractor.

**Recommendations for using baits**

Don't use the same bait type (i.e. Xstinguish) for monitoring and poison operations. These two operations must have different bait types otherwise bait shyness may become a problem in post-poison monitoring. Monitoring baits could consist of a vial with a smear of honey on one side, and a smear of sausage meat on the other.

Weather affects the abundance of ants, so it is important to standardise the weather during monitoring by placing baits out under the same weather conditions, especially temperature. Baits should not be placed out in the rain, or in wet conditions.

Also post-poison monitoring needs to be completed relatively soon after the poison operations. The longer monitoring is left after poison operations, the more likely ants will start to recover, or re-invade form elsewhere. This has implications for the pest contractor, and the timing of pre- and post-poison monitoring should be decided on with the pest contractor.

**Recommendations for increasing sampling size**

Having a greater number of samples allows more certainty that the pest contractor has achieved a target of 90% reduction.

To increase sample size (i.e. the number of vials placed out) I suggest that 1) the time baits are left put for is decreased to 30 minutes, and 2) sampling is completed by transects.

1) The time baits are left out should also be decreased. A 30 minute period is sufficient for Argentine ants to find baits, especially in high densities. Field experience in Northland has found that baits can be entirely consumed if a longer period is used in areas of high infestation density.

2) A site within the area to be controlled is randomly selected to place a transect. A circular transect with 20 baited vials placed five meters apart, is recommended, that is, an area small enough for a person to be able to place vials and retrieve them within 30 minutes.

With ~5 transects, the sample size is increased to 100 vials. Having the vials out for a shorter period will also help with the logistics of getting more transects completed. It is important that transects are stratified according to the land form, for example; at least one transect must be placed in each type within the target area: forest, pasture, landscape garden. In difficult terrain where it is difficult to obtain a 90% reduction analysis of stratified areas can be conducted separately.

Table 1. Summary details for the historical data.

| | Trial | No. vials used | No vials >10 ants | % vials reduced to <10% |
|---|---|---|---|---|
| Argentine ants | 1 | 45 | 22 | 100 |
| | 2 | 30 | 14 | 71.4 |
| | 3 | 45 | 33 | 96.9 |
| Darwin's ant | 1 | 39 | 23 | 91.3 |
| | 2 | 70 | 41 | 92.6 |

Table 2. Range where there is a 90% probability there has been a true 90% reduction. It is the upper values that are more important for this project. Because we are looking for to fail a contractor and have confidence that the data shows a failure (i.e. is outside an acceptable range).

| Column =1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| | | **Binomial Range** | | **% of N** | |
| **No. of vials Sample size (N)** | **No. of vials Expected to Fail** | **Lower Limit** | **Upper Limit** | **Lower Limit** | **Upper Limit Target = 10%** |
| 10 | 1 | 0 | 3 | 0 | 30 |
| 20 | 2 | 0 | 4 | 0 | 20 |
| 40 | 4 | 1 | 7 | 2.5 | 17.5 |
| 80 | 8 | 4 | 13 | 5 | 16.3 |
| 120 | 12 | 7 | 18 | 5.8 | 15 |
| 200 | 20 | 13 | 27 | 6.5 | 13.5 |
| 400 | 40 | 30 | 50 | 7.5 | 12.5 |

Figure 1. Relationship between sample size (number of vials placed into the field) and the number (range) of vials that have failed to achieve a ≥90% reduction. Dashed line = 90% probability range; dotted line = 75% probability range, solid line = expected number.

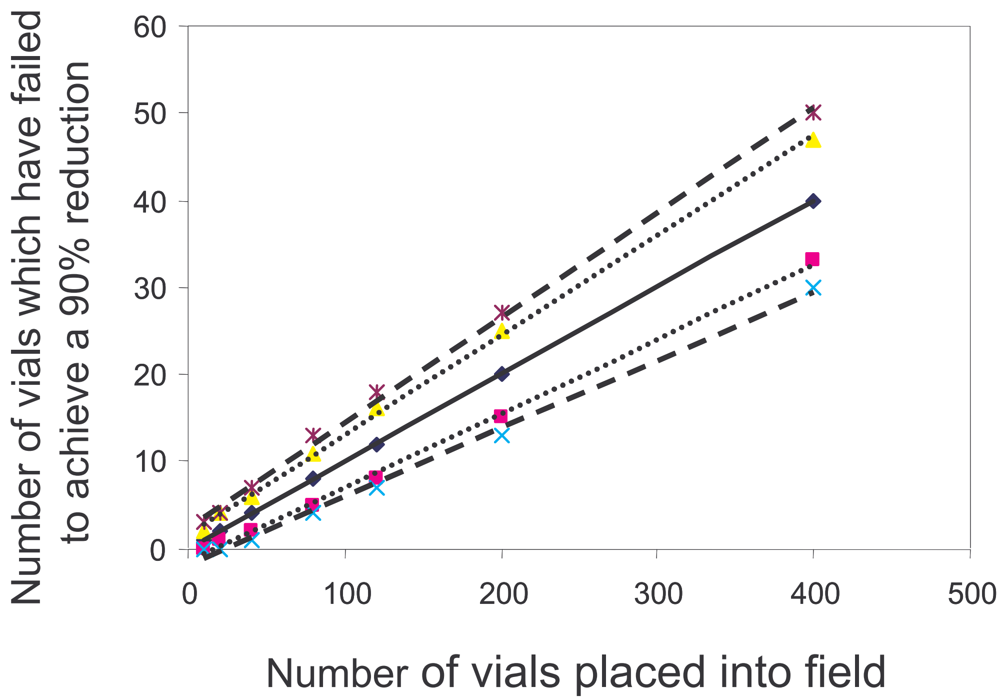

Figure 2. Relationship between sample size (number of vials placed into the field) and the % variability used to determine failure. Based on a reduction target of 10% of pre-poison abundance of pest ants (solid line). Dashed line = 90% probability range; dotted line = 75% probability range.