

Monitoring Weeds in Southland - a report on a meeting between Environment Southland, University of Canterbury and AgResearch

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Present: **Richard Bowman (ES), Randall Milne (ES), Amy Rush (ES),
Graeme Bourdôt (AgResearch), Jennifer Brown (UC) and Britta Basse
(UC)**

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Purpose of Meeting:

Environment Southland asked for advice on monitoring weeds and on the potential uses of collected data.

Summary of Meeting:**1 Current data collection**

The current ES database allows information on known weed locations to be displayed in GIS. This visual display of the weed locations on a map is very useful and an excellent tool for understanding distribution.

The data in the database largely reflect locations of “known presence” with no distinction between “known absences” and locations which have not been visited and are therefore “unknown” with respect to the presence/absence of the weed of interest.

The current distribution maps would be enhanced by having areas delineated that have not been visited (unknown) from areas of known absences, by grey-shading the areas where there has been no weed surveys. The grey areas would be a visual indicator that the local-scale weed distribution is unknown rather suggesting weeds are absent. This method should be used for relatively large areas only, e.g., > 500ha.

This grey-shading could be developed further into a two-level grey scale, separating areas of “unknown” status from areas where weed presence/absence has been estimated based on opportunistic sightings and casual reports. With this two-level gray scale the map would identify (1) areas of high-reliability presence/absence, (2) areas of low-reliability presence/absence, and (3) areas of unknown presence/absence.

We discussed the need for a regular spatially-extensive survey for collecting information to use in distribution maps of known presence and known absence.

2 Sample design

The importance of a structured sampling design based on probability sampling can not be underestimated. Such a structured programme facilitates regular data collection of both presence and absence, and allows some measure of reliability to be associated with data. In addition to a structured sampling programme opportunistic sightings and other casual observations should still be recorded. These types of observations are valuable but they should be integrated into a regional database only if their observation-type is clearly recorded.

The most basic sampling design is simple random sampling. This unbiased design does not build on existing knowledge of weed distribution. Unequal probability sampling where sampling is targeted at high intensity in areas of special interest (e.g., high likelihood of weed occurrence, or areas of high natural value) is a simple way to build on existing weed-knowledge while keeping the sample design unbiased and based on probability. The most common example of unequal probability sampling is

stratified sampling where a region is divided into strata and each strata sampled at a different intensity.

Another important feature of a large-scale monitoring design is having spatial spread over the entire region, so while areas of special interest receive the bulk of survey effort, all areas receive some sampling effort even if it is very light intensity.

Sampling intensity is a jargon word we are using loosely here, but it refers to the size of the area one sample point represents. For example, if 10 1-m² plots were used to sample a 20 m² area, each of the 1-m² plots can be thought of as representing 2 m², i.e. 50% of the area we are interested in has been sampled. Alternatively, if 10 1-m² plots were used to sample a 2000 m² area, each of the 1-m² plots can be thought of as representing 200 m², and sampling would be at a lower “intensity” than the first example - only 0.5% of the area of interest being sampled.

Sample designs that combine both the flexibility for unequal probability and spatially-extensive sampling are stratified sampling and grid random tessellation (GRTS) sampling. Stratified sampling is what is used in the NPCA possum monitoring protocol. GRTS sampling is much the same but is more flexible and adaptable and achieves better spatial coverage. Both designs can be implemented in GIS to map the location of sample points. A GIS – compatible version of software for the GRTS sample is being developed by Meghan Williams, a current PhD student at UC.

We roughly sketched out a possible sample design for a budget of \$20K pa. Using a rotating panel design, approximately 400 sample locations could be visited in one year. In year 2 another 400 sites would be visited, and so on up to year 5. Then in year 6 the first 400 would be revisited, etc, giving in total 2000 sites visited over a 5 year period. This design gives reasonable coverage over Southland (to assess distribution) and with revisits to the same sites (once every 5 years) data can be collected to assess trends. Assuming Southland is 1million ha of rateable land, 2000 sites evenly spread out (equal probability sampling) translates to a sample intensity of about 1 site per 5 km². Such a design can be made more complex by having, every year, 10% of the sites dropping out and being replaced by new sites to bring new sites into the system. There are many design options and quite a lot of literature on this (mainly from USA).

3 Data Collection

What to measure at each site depends on the objective of the survey. Options are presence/absence or some measure of abundance of each species on a list of weeds of interest, some of which could be newly arrived species.

Presence/absence surveys are relatively straightforward. Abundance or density can be estimated in many ways including cover class, biomass, size class distributions etc. These measures typically are more time-consuming than presence/absence and the appropriate measure will be species specific. Department of Conservation may have

developed protocols for surveying various weed species which could be relevant. We discussed that if possible, data should not be collected as classes (e.g., cover class) because such data is complex to analyse.

A survey protocol will need to be developed to outline what is to occur at each site – whether to use fixed area plots or transects, what size plots or transects, how much time should be spent at each site, and what other information should be collected at the site (e.g., environmental information).

4 Survey Objectives

Defining the survey objectives down to the level of defining the metric that will be reported or shown in a graph can be a very useful exercise. Survey objectives that we discussed included surveying to allow weed distributions to be mapped. In this objective the metric of interest could be proportion of area occupied, the fragmentation of the total occupied area, proportion area occupied by site-value classes (a case where “class” data probably cannot be avoided), or proportion of area occupied by low, medium, high weed-diversity categories etc.

Another objective we discussed was reporting on the change in distribution (i.e. spread) over time. This can be done using maps for year 1 and year $1 + x$, but the actual reported metric is not so obvious. The reported metric could be change in proportion of area occupied, or change in proportion of area occupied by site-value classes, or fraction of high-value site areas that were occupied in year 1 and now are not occupied, or were occupied in year 1 that remain occupied etc.

Another management-specific objective we discussed was the need for information on weed distribution to enable the classification of weed species in management categories. The current categories are exclusion, eradication, containment, suppression and risk assessment. Other objectives were to assess the effectiveness of management policies and strategies for particular weeds and, for some particular species, surveying to provide detailed information on life-phases, abundance and density.

5 Modelling

Uses of survey data, other than for basic reporting, are (1) for understanding possible future patterns in weed distribution, (2) for identifying at-risk locations and (3) for assessing relative risk among weed species.

Given a reliable spatially-extensive survey design, information on presence/absence of weed species, can be used to predict likelihood of weed occurrence by using the basic GIS environmental and social information. A typical approach would be logistic regression modeling the probability of weed-presence with predictor variables such as geology, soil, habitat, distance to roads, rivers and houses, and occurrence of other weed species. This can be used to map a weed species based on the chance that it could occur – similar to a contour map where the high contours are areas of high

chance of occurrence, and low contours are areas of low chance. This modeling requires information on both weed presence and weed absence. This method of predicting the chance that a species could occur at a particular location is best suited to a species that is already widely spread and occupying sites representing its ecologically suitable range.

For a species that does not yet occur in Southland, and/or is very limited in its current distribution in NZ, modelling of its potential distribution in NZ, and in Southland, is best achieved using international data to build a climate-based model (e.g. using the modeling programme CLIMEX). Such a model will identify Southland localities of similar climatic conditions to those overseas areas of weed abundance and enable these areas to be represented on a map showing the weeds potential distribution. For example, this has been done for nassella tussock (Kriticos et al. 2004), revealing that the species has to date occupied less than half its potential range in NZ.

Modelling of the local population growth and dispersal of an individual weed species can provide detailed information on its potential trajectory in population size and distribution under alternative forms of management. Such models can be used “prospectively” to determine the best control strategy, and “retrospectively” to explain why a control strategy either succeeded or failed.

6 Early Alert of New Weeds

While we focused on weeds of known occurrence in Southland there is clearly a need for an early alert system to signal the potential arrival of new weeds into Southland. AgResearch and Landcare are currently working on this. This discussion highlighted the need for site-surveys to be searching for known weeds and identifying any new plant species.

7 National Co-ordination

It was clear that national co-ordination among councils for weed monitoring would be beneficial for sharing skills, knowledge, monitoring systems and for providing the weed-occurrence data that is necessary for constructing robust national or regional models of weed spread/distribution. Environment Southland has a clear commitment to weed monitoring and could consider developing a standard for “good practice” that could be adopted by other councils.

Recommendations

1. A standardized data collection methodology be developed for Environment Southland. A medium level Envirolink grant be applied for to assist in developing this. AgResearch (Graeme Bourdôt) will act as co-ordinator with input from Jennifer Brown, Meghan Williams, and Britta Basse.

2. Meghan Williams (PhD student, UC) was unable to attend the meeting. She is developing as part of her research a GIS-based system to create the site-locations for a spatially-extensive unequal probability sample. The design has considerable flexibility in options for intensifying effort e.g., in buffers around roads, towns and other GIS features. Meghan is interested in visiting ES to show her work to ES, and if it were suitable, to use ES as a case study in her research on optimal survey designs for early detection of weed spread. We discussed sharing between UC and ES the costs of a 2-day visit.

Kriticos DJ, Lamoureaux S, Bourdôt GW, Pettit W 2004. *Nassella tussock*: current and potential distribution in New Zealand. *New Zealand Plant Protection* 57: 81-88.