Model of the probability of detecting the red imported fire ant
RIFA Surveillance Sensitivity
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User Guide

Introduction

The red imported fire ant (RIFA), Solenopsis invicta, is one of the 100 worst invasive alien species in the world (Lowe et al. 2000), infesting more than 130 million hectares in the United States and Puerto Rico (USDA APHIS 2009). It is estimated that this ant costs the US economy almost $7 billion annually in damage repair, medical care, and control costs, affecting households, electric service and communications, agriculture, schools and recreation areas (Lard et al. 2006). Over the past decade S. invicta has changed from an invasive pest ant in the United States to a global problem, with infestations occurring in Australia (Henshaw et al. 2005), China (Zeng et al. 2005), Mexico (Sánchez-Peña et al. 2005) and many Caribbean Island countries (Davis et al. 2001), with incursions into and successful eradication from New Zealand.

Discovering established satellite nests during an incursion response is a key outcome for a successful eradication. These nests may be small, such as those newly founded by a queen (Figure 1A) or may be larger (Figure 1B). Because of the limited occurrences of S. invicta (hereafter referred to as RIFA or fire ants) in New Zealand, we do not know whether current surveillance techniques are sensitive enough to detect these single nests, if present, during an incursion response.

To estimate the surveillance sensitivity we travelled to Gainesville, Florida, where fire ants are abundant and there are climate similarities with Auckland, New Zealand. We tested the food preference of the fire ant in the field on naturally occurring nests and investigated their foraging distance using food attractants and pitfall traps of fire ants from different sized nests. The data were then applied to a Microsoft® Excel-based interactive model that could be used by surveillance managers to estimate the probability of fire ant detection based on fire ant nest size and various baiting parameters.

Experiments were conducted with technical and collegial support from Dr Robert Vander Meer, research leader at the imported fire ant and household insect research unit at the United States Department of Agriculture, Agricultural Research Service, Center for Medical, Agricultural and Veterinary Entomology (USDA ARS CMAVE).

Figure 1. A small sized RIFA ant colony A, and a large colony B.

Overview of model and parameters

This Microsoft® Excel-based interactive model displays the estimated probability of detecting red imported fire ant (*Solenopsis invicta*) workers based on four parameters: nest size, trap type (bait vial or pitfall trap baited and pitfall trap un-baited), duration of surveillance and distance between traps. The probability estimates of detecting *S. invicta* have been derived from data collected in Florida 2008 and 2009. The different social forms, either monogyne (one functional queen) or polygyne (multiple functional queens) has not been included as there were no differences detected in foraging distance between the two forms.

Data collection was conducted by trapping ants in baited vials and into pitfall traps both baited and un-baited. The bait used was a food attractant consisting of peanut butter in soya oil and minced meat, a blend of beef and pork, 60:40). The foods were smeared about 1 cm apart inside the vials and dropped into the baited pitfall traps. This food type was chosen based on cafeteria experiments that showed to be the best at attracting fire ants ($P < 0.001$).

Three different mound sizes were tested, as mound size is related to colony size (Vinson 1997). Different maximum distances were tested for the different colonies, as the small colonies were unlikely to forage very far from the nest. The social form of the colony, either monogyne (one functional queen per nest) or polygyne (multiple functional queens per nest), was assumed from historical data then confirmed at the end of the study by Gp9 analysis.

Size 1 small (n = 24 nests)

Mound diameter 0-15cm. Distances (m) 0.25, 0.5, 1, 1.5, 2, 3, 4, 5

Size 2 medium (n = 9 nests)

Mound diameter 15-30 cm. Distances (m) 1, 1.5, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 17

Size 3 large (n = 11 nests)

Mound diameter +30 cm. Distances (m) 0.25, 0.5, 1, 1.5, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 17

Baited vials were placed out at increasing distances from a central isolated fire ant nest, from 0.25 m out to 5 m for the small nests (<15 cm mound diameter) and out to 17 m for larger nests. No 0.25 or 0.5 m distances were tested for the size 2 nest as there were no size two nests present in spring. The two distances were added in the spring due to results from the autumn trials. For the vials, distances were measured out along four arms radiating from the nest and the distance marked with fluorescent orange paint or a flag. The direction of each arm from the nest was randomly allocated once and then left in place for the entire trial (Figure 2). Four arms were allocated per nest to reduce the role of foraging tunnel direction on results. Fire ants build tunnels underground with exit holes for foraging along the distance of the arm. As such, there may be a bias of foraging direction for each colony.
Two distances were tested simultaneously per day at each nest until all distances were tested along all arms for all nests. One distance was tested on two arms and another distance was tested on the remaining two arms per day.

See MAF report # 28979 for further details.

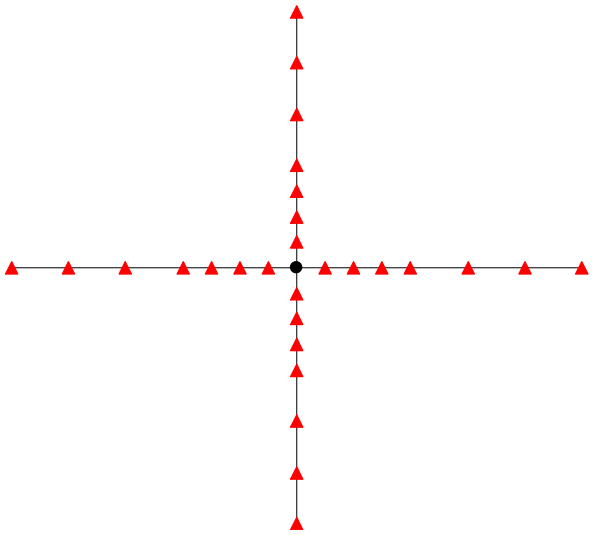

Figure 2. Diagrammatic figure of the foraging distance layout. The four radial arms were placed at random, thus did not necessarily conform to this layout. Triangles represent bait vials and the circle at the intersection of the two axes represents the central nest.

Using the model

The user chooses values within four parameters (Figure 3A) to estimate the probability of detecting red imported fire ants.

Parameters (Figure 3A)

1. Trap type: Vial, Baited pitfall trap or Un-baited pitfall trap
2. Nest size: **1**. 0 – 15 cm mound diameter, **2**. 15 – 30 cm, **3**. + 30 cm and unknown (a mixture of 1,2 and 3)
3. Duration of trapping: 1 – 30 days
4. Distance between traps 1 – 200 m

As each parameter is changed, the Detection Probability (Figure 3B) value below the parameter box is automatically updated, as are the graphs (Figure 3C). The graphs display the probability curve of detection for distances, and duration of trapping for the nest size and trap type selected. The Detection Probability value indicated is shown by a green point on the red curve which is bound by 80% confidence limit. This allows the user to see the probability of detection by distance or duration without changing the parameter values.

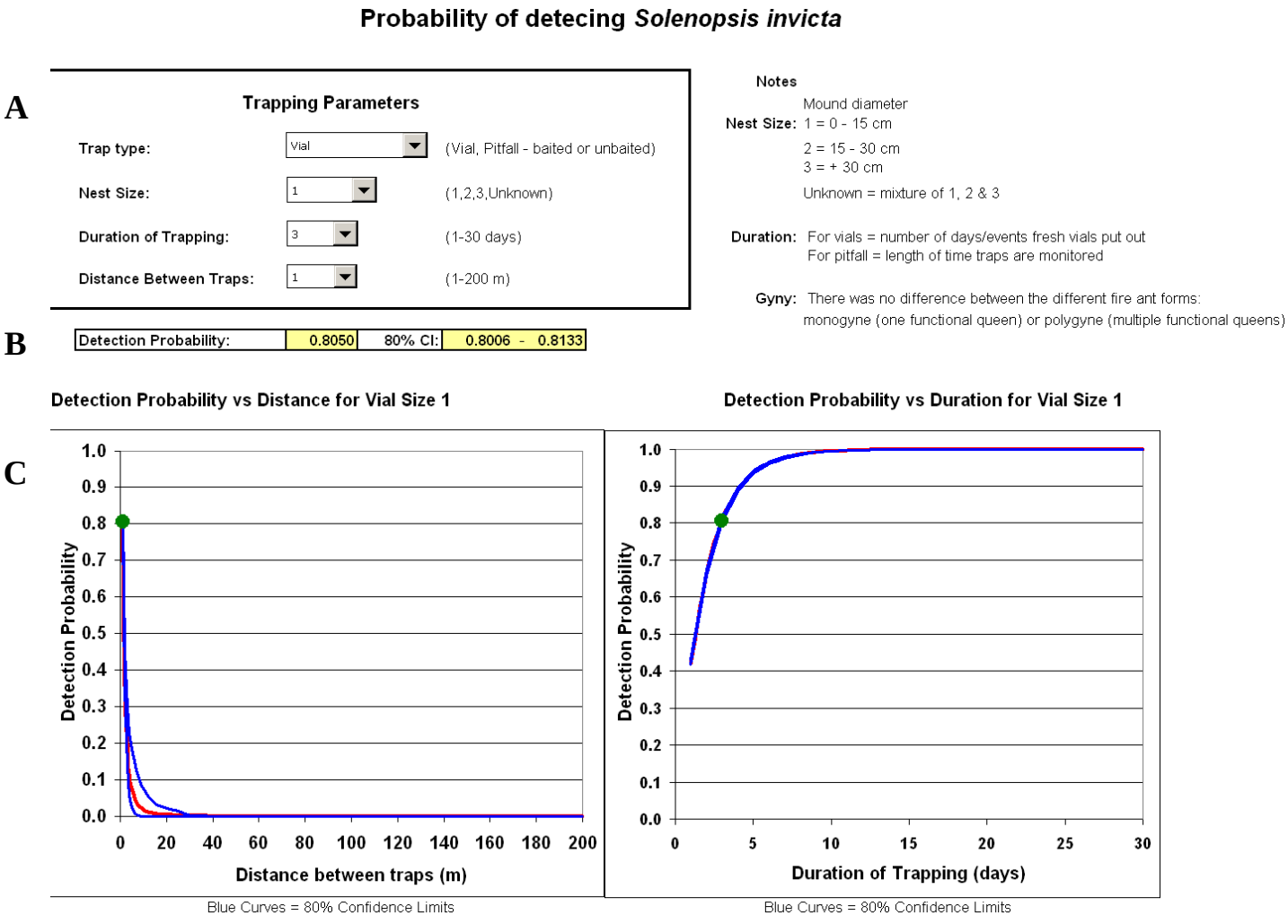

Figure 3. Probability of detecting RIFA model displaying; A. Trapping parameters, B. Detection Probability and C. Probability Curves in red bound by 80% confidence limits in blue.

Further detection probability values illustrating the differences between nest size and the duration of trapping when using bait vials can be seen in Figure 4.

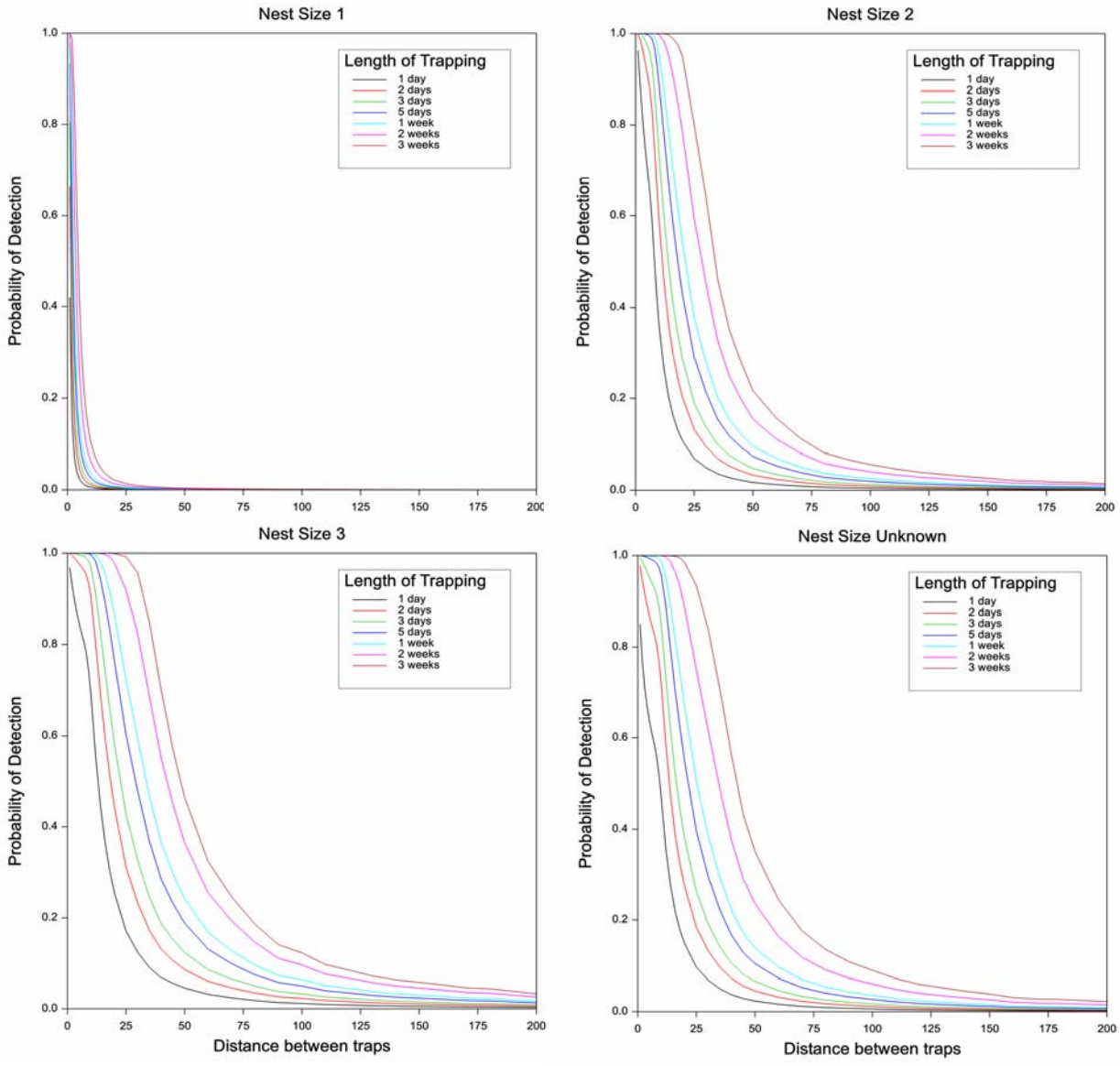

Figure 4. The probability of detecting fire ants when traps arranged in a grid, with traps at different distances apart. The three nest sizes are related to mound diameter: size 1. 0-15 cm, size 2. 15-30 cm, size 3 +30 cm and unknown is a mix of all of the sizes.

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