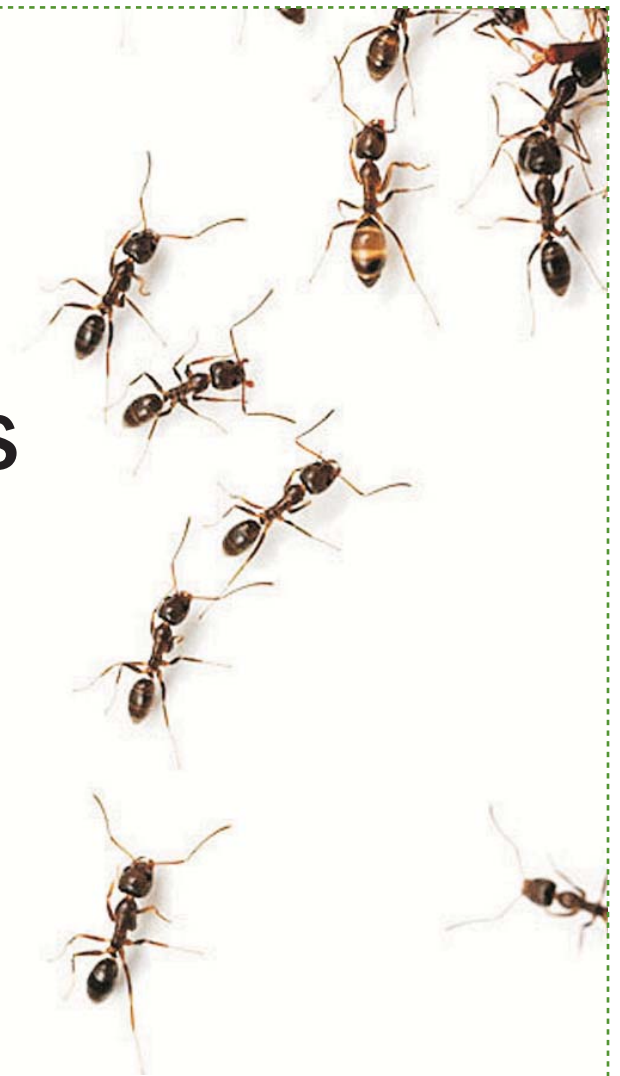


Prioritised surveillance for invasive ant species in Northland

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PREPARED FOR:
Northland Regional Council
Envirolink Project: NLRC18

DATE: November 2006



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Northland**

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Summary

Project and Client

- Provision of advice on surveillance for invasive ant species was undertaken for Northland Regional Council by Landcare Research in September–November 2006.

Objectives

- The aim of this report is to design a surveillance programme for targeted invasive ant species in Northland. The surveillance programme gives priority to sites of highest risk and highest ecological value.
- The outcome is to prevent the establishment and subsequent spread of targeted ant species into significant ecological areas in Northland.

Methods

Sites were split into three classes: 1) points of entry, 2) risk of establishment and 3) ecological value.

- A list of high risk point of entry sites were obtained through discussion with Northland Regional Council and Biosecurity New Zealand. These sites are most likely where invasive ant species would arrive in the Northland region from overseas, and includes the surveillance species of concern to the Northland region.
- High risk sites were categorised on the basis of their association with the movement of high risk goods. Risk goods and sites were determined based on data from scientific literature and the experience of invasive ant species experts.
- Sites of ecological value were obtained from Northland DOC staff and were ranked on various criteria, including Protected Natural Area guidelines, a broad habitat classification, and the relative number of visitors.

Results

- Point of entry sites: nine high risk points of entry were selected. These sites include a mix of wharves, the two major transitional facilities in Northland and several boat yards that store and refit boats.
- Establishment risk sites: seventeen sites were given a high risk ranking, and 163 sites a medium risk ranking. High risk sites are based around businesses that are most likely to supply and frequently move bark, garden material, and fresh produce (e.g. fruit, flowers, vegetables). Sites of medium risk are based around plant material (lawn turf, trees), rubbish disposal (rubbish bins, scrap metal), landscape suppliers (including orchard suppliers, garden centres), timber and wood products, and camping grounds.
- Value sites: forty five value mainland sites were ranked, and twelve were given a high priority ranking. Within the priority framework, sites were also graded on two factors. First, on the basis of habitat, where sand/gumlands and wetland had priority over forest. Second on the basis of visitor numbers, where sites with higher visitor numbers were given priority.

Recommendations

- Sites classified as high risk or high priority rank should be visited first.
- If time and resources are available then re-visiting the same site for the same amount of time would be beneficial – to determine detection probability. However, because of resources this should apply only to high risk and high value sites.
- Direct searching for ant species should be used, as this method is highly suitable for detecting the presence or absence of invasive ant species.
- Approximately 30 minutes should be spent at each site.
- If this surveillance strategy is to be carried out over multiple years, it is recommended that high risk and high priority sites are re-visited before other sites of lower priority.
- The results of the surveillance should be briefly evaluated after the first year. This will assist in developing a longer term surveillance strategy and optimising the process of site prioritisation.

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1. Introduction

1.1 Invasive ant species

Invasive ant species are currently receiving considerable attention around the globe. There is increasing evidence of economic and agricultural losses, health effects on humans, and disruption to natural ecosystems as a result of invasive ants (Holway et al. 2002). Although only a handful of invasive ant species are well studied, there are many other ant species with the opportunity to become invasive (McGlynn 1999, Lester 2005, Suarez et al. 2005).

Ants are the second most common family of insects intercepted by quarantine personnel at the New Zealand border (Keall 1980). A total of 115 ant species from 4355 interceptions have been detected over the last fifty years at the New Zealand border (Ward et al. 2006). Many of the species commonly intercepted are invasive species, and several have already become established in New Zealand.

To reduce the threat of invasive ants three aspects need to be identified: 1) a national priority list of invasive ant species, 2) the regions and habitats most at risk, and 3) high risk pathways, vectors, and commodities, both into and within the region of interest (Anon 2006). A recent assessment of these intercepted species shows that many pose a high risk to New Zealand and could negatively impact on economic, cultural and environmental sectors (Harris et al. 2005). This reports builds on the framework of high risk invasive ant species for New Zealand (Harris et al. 2005), specifically for Northland.

Two important factors that contribute to the establishment and subsequent spread of invasive ant species are 1) suitable climate and 2) dispersal ability.

It is well known that climatic variables, especially temperature, rainfall and humidity, play a large role in determining the distribution of ant species. Many of the invasive ant species currently established in New Zealand show restricted northern distributions which are associated with warmer temperatures (Harris et al. 2005). When invasive ant species are discovered in cooler environments, they are often closely associated with artificial heating sources (e.g. buildings, concrete, etc). The warm, and relatively mild, climate conditions in Northland predispose this region to the establishment of invasive ant species, and their rapid colony growth.

Dispersal ability is also an important aspect of biological invasions. Although most ant species disperse by flying or walking, this generally occurs on a small scale. However, many pest ant species are closely associated with humans and are accidentally transported by humans to new locations. Typically ants are transported in soil, bark, potting mix, vegetative material and within vehicles. This human-mediated dispersal (HMD) can occur over hundreds of kilometres (Suarez et al. 2001), and is primarily responsible for the range expansion of Argentine ants (*Linepithema humile*) in New Zealand (Ward et al. 2005). There is less certainty about the dispersal of other invasive ant species (because they are not well studied), although it is probable that HMD is also important in their spread and distribution (Harris et al. 2005).

Currently there are 28 invasive ant species established in New Zealand (Ward 2005, see Appendix 1). Several of these invasive ant species are widespread throughout the country, especially the North Island, and are usually conspicuous, as they often occur in residential areas and houses. This is in contrast to the small native ant fauna of 10 species, which are seldom seen and more commonly found in native ecosystems.

Of the invasive species already in the country, of most concern is the Argentine ant, whose negative impact on native biodiversity and horticulture has been well documented overseas (Harris 2002, Harris et al. 2002a). In New Zealand, the habitats most at risk of invasion by Argentine ants are open canopy environments (scrub, coastal open forest, mangroves), while forests are less susceptible (Ward & Harris 2005). Although it is possible to successfully control, and even eradicate small populations, of Argentine ants (Harris et al. 2002b, Stanley 2004), the key to this is surveillance and early detection.

1.2 Surveillance

To reduce the threat of invasive ants two major points of action need to be considered. First, measures to prevent their entry, and second, responses to eradicate or control incursions and limit their spread (Anon 2006). Both of these points rely heavily on surveillance strategies to detect invasive ants.

Most detection programs rely on the inspection of cargo and known pathway associations of pest species at points of entry along the border (Murphy 2004). However, border surveillance does not provide 100% detection ability. Furthermore, border inspection does little to detect and assess the movement of pests within a country, especially movement from an infected region to a non-infected region. Thus, as part of a larger biosecurity strategy, there is a need for active post-border surveillance (Anon 2006).

Risk goods should be targeted in the following order (Murphy 2004). The first targets are the points of entry into New Zealand (ships and aircraft). The second targets are goods moved to devanning sites (i.e. transitional facilities). The third targets are essentially those that fall “outside” the first two, in particular sites where requirements for the survival and reproduction of species are met (Murphy 2004). However, as it is not practical (and often impossible) to inspect all potential sites of invasive ant establishment, it is crucial that resources are allocated to maximise surveillance effort and detection.

Murphy (2004) outlined the concept of high risk site surveillance (HRSS). This is the deliberate targeting of high risk sites associated with risk goods and pathways, and are thus more likely to be sites of establishment that spread invasive species (Murphy 2004). Critical to this concept is the ability to rank sites and identify their location. Efficient surveillance methods, flexible design, and the ability to measure surveillance effort are also important (Murphy 2004).

The ability to rank risk sites is often limited by the quality of information on risk good (Murphy 2004). However, for invasive ants, several recent publications give us an excellent ability to characterise risk goods and pathways, and thus link these to specific sites (MAF 2002, Harris et al. 2005, Lester 2005, Suarez et al. 2005, Ward et al. 2006).

2. Objectives

The aim of this report is to design a surveillance programme for targeted invasive ant species in Northland, which gives priority to sites of high risk of establishment and high ecological value. The intended outcome is to prevent the establishment and subsequent spread of targeted ant species into ecologically significant areas in Northland.

2.1 Scope

The Northland Regional Pest Management Strategy for invasive ant species currently recognises two categories of invasive ant species: pest species and surveillance species. Pest species include the Argentine ant (*Linepithema humile*) and Darwin’s ant (*Doleromyrma darwiniana*), both of which are present in Northland. Surveillance species include four species not recorded as being present in Northland; the big headed ant (*Pheidole megacephala*), the tropical fire ant (*Solenopsis geminata*), the crazy ant (*Paratrechina longicornis*), and the ghost ant (*Tapinoma melanocephalum*).

Although these six species are the focus for this report, the proposed prioritisation of sites and sampling methodology could also be used to detect a wide range of other invasive ant species in Northland.

This report focuses on ecologically significant areas in Northland. Although not specifically addressed; some sites of significant economic and cultural value will be included. It is intended that passive surveillance opportunities such as, advocacy and stakeholder workshops are used to target areas of economic and cultural significance.

3. Methods

3.1 Site prioritisation

Sites were split into three classes:

3.1.1 *Points of Entry*

Points of entry sites are where goods are unloaded into a site that is the first point of entry into New Zealand. These sites include seaports, airports and transitional facilities and are typically where the majority of surveillance is undertaken.

High risk points of entry and transitional facilities in the Northland region were determined through discussions with the Northland Regional Council and Biosecurity New Zealand (BNZ) staff.

3.1.2 *Establishment Risk Sites*

High risk sites have a strong association with, and movement of, risk goods. As a consequence, these sites have a higher probability of acting as a source for the spread of invasive ants, and as sites of early establishment within a region.

Because invasive ants are often easily dispersed through the actions of humans, risk sites are those that will be primarily associated with humans. To determine what constitutes a high risk site, it is necessary to consider the movement (i.e. pathways) of risk goods. Information on what constitutes risk goods for invasive ant species was obtained from the hazard identification and import release assessment for the red-imported fire ant, *Solenopsis invicta* (MAF 2002); the invasive ant pest risk assessment for New Zealand (Harris et al. 2005); and the scientific publications of Lester (2005), Suarez et al. (2005), and Ward et al. (2006).

The Telecom yellow pages (for Northland 2006/2007) were searched for business categories that could be associated with risk goods. These categories were given a high-medium-low ranking (Appendix 3), and businesses (i.e. sites) from the high-medium categories were compiled into an excel spreadsheet.

3.1.3 *Ecological Value Sites*

A list of natural sites which significant ecological value in the Northland conservancy was obtained from Department of Conservation (DOC) staff. To be included on this list, a site needed to fit one or more of the following criteria (based on level one guidelines from the Protected Natural Area (PNA) criteria): 1) contains or is regularly used by critical, endangered, vulnerable or declining or naturally uncommon taxa, or taxa of indeterminate threatened status nationally (Molloy et al. 2002); 2) contains the best representative examples in the Ecological District of a particular ecological unit or combination of ecological units; 3) has high diversity of taxa or habitat types for the Ecological District; 4) forms ecological buffers, linkages or corridors to other areas of significant vegetation or significant habitats of indigenous fauna; 5) contains habitat types that are rare or threatened in the Ecological District or regionally or nationally; 6) covers a large geographic area relative to other similar habitat types within the Ecological District.

These sites were then divided into a high-medium-low priority ranking on the following criteria:

- High priority sites were defined as containing the best representative examples in Northland of a particular ecological unit or combination of ecological units; and containing a high number of acutely threatened or chronically threatened taxa.
- Medium priority sites were defined as containing the best representative examples in the Ecological District of a particular ecological unit or combination of ecological units; contains or is regularly used by critical, endangered, vulnerable or declining or naturally uncommon taxa (i.e. species and subspecies), or taxa of indeterminate threatened status nationally; and contains habitat types that are rare or threatened in the Ecological District or regionally or nationally.

- Low priority sites were defined as having a high diversity of taxa or habitat types for the Ecological District; forming ecological buffers, links or corridors to other areas of significant vegetation or significant habitats of indigenous fauna; and covering a large geographic area relative to other similar habitat types within the Ecological District.

Sites within the high-medium-low priority framework were further graded on the basis of a broad habitat classification, and the relative number of people that might arrive in the site. Current knowledge of Argentine ants (and many other invasive ant species) suggests they prefer habitats that are relatively disturbed and/or have open canopy (Harris et al. 2002a, Ward & Harris 2005). Thus open canopy habitats (e.g. sand dunes, scrub, geothermal areas, etc) are at greater risk than closed canopy environments (e.g. forest). However, it should be noted that this is a generalisation of habitat use, and under certain situations this 'habitat rule' may not hold. A higher number of people generally equates to a greater risk of ants being transported to the site. DOC staff supplied estimates of visitor numbers at each site on a relative basis of high, medium or low.

Grid references of all sites (NZMG and latitude/longitude, WGS84 datum - in decimal degrees) were obtained using Topomap® software. It should be noted that grid references are approximate because Topomap® does not contain references to street numbers, but only streets/roads.

3.2 Surveillance strategy

3.2.1 Site Visits

The order of site visits is determined by the site risk/priority ranking. Sites with a high risk or a high priority are the most important to visit first. However, flexibility is also a key element in any surveillance strategy (Murphy 2004). It may be beneficial to examine a combination of high and medium risk sites at the same time within a region to save on travel time/costs. For example, a mixture of high and medium risk sites could be surveyed in the far north region of Northland. This combination strategy is useful as long as it does not jeopardise the ability to visit all of high risk and high priority sites by the end of the project. Once a site is selected, sampling for ants should be carried out as described in section 3.2.2.

If time and resources are available then re-visiting the same site for the same amount of time would be beneficial. A problem in surveillance strategies are records of "absence". Does "absence" really mean the species was absent, or it is possible that when the sampling was carried out the species was present but not detected? Repeat sampling will increase the probability of detecting a species at a site. Repeat sampling and the issue of detectability are particularly important for detecting invasive ant species. If time and resources are available, sites of highest risk/priority should be revisited first.

If this surveillance strategy is to be carried out over multiple years, it is recommended that repeat surveillance visits be made to the high risk and high priority sites before other sites of lower priority. The surveillance results should be briefly evaluated after the first year. This will assist to develop a longer-term surveillance strategy and optimise the ability of site prioritisation.

3.2.2 Sampling Techniques

Direct or hand searching involves searching for, and collecting, ants in different microhabitats within an area (Bestelmeyer et al. 2000). Direct sampling is particularly useful when the main objective is to determine which ant species are present or absent, and no information is required on their abundance or biology. Direct searching it is highly suitable for detecting the presence or absence of invasive ant species.

Direct searching uses a minimum of material in the field. Field materials include: an aspirator (to collect ants), vials (5mm, plastic, to store ants), ethanol (95%), a timer, and site labels. An additional advantage of direct searching is that less time is needed in the laboratory to sort and identify ant species. No time is needed to extract ants from messy baits, or from the litter or soil. The amount of time spent in the surveillance of sites is therefore maximised.

Direct searching is an easily learned technique. It basically requires good observation skills and careful examination of different microhabitats where ants are commonly found: such as curbing and

the edges of paths, garden edging, bare ground, leaf litter, twigs, under and on plants, under stones/metal, at the base of plant roots. Although the targeted ant species are quite small (1-4 mm), they are diurnal and usually very active on the ground. Therefore, they should be relatively easy to observe.

When ants are discovered, an aspirator is the best method to collect them. The aspirator (also known as a “pooter”) is used to “suck” ants into a tube, where they can then be transferred to a vial. Approximately five ant specimens should be collected if possible – having several specimens may help during identification. Every vial should be labelled with site name/code, date, and collector. Labels should be written either in pencil or with a drawing pen (e.g. Staedtler pigment liner) – otherwise the ink will run when placed into the ethanol. A biro pen is not suitable.

To standardise collecting effort, it is recommended that the time spent searching for ants at each site be recorded. Approximately 30 minutes should be spent at each site, however, this may vary depending on the size of the site, etc. However, a minimum of 15 minutes must be spent at each site. At the end of the 30 minute period all ants collected are placed into one vial of ethanol.

Ants should be identified using a binocular microscope of between 10-40x power. Any difficult or suspicious specimens can be sent to the author. To identify ants, the online key to New Zealand ants in combination with a reference collection is an excellent method. The online key can be found at: <http://www.landcareresearch.co.nz/research/biosecurity/stowaways/key/index.asp>

4. Results

4.1 High Risk Point of Entry Sites

Nine high risk points of entry were selected (Appendix 2). These sites include a mix of wharves, the two major transitional facilities in Northland and several boat yards that store and refit boats (M. Sarty *pers. comm.*). These sites are most likely where invasive ant species not already established in New Zealand would arrive in the Northland region. This includes the four surveillance species of concern to the Northland region: the big headed ant (*Pheidole megacephala*), the tropical fire ant (*Solenopsis geminata*), the crazy ant (*Paratrechina longicornis*), and the ghost ant (*Tapinoma melanocephalum*). Argentine ants have been recorded throughout the Whangarei, Whangarei Port and Marsden Point areas (Landcare Research 2006, L. Maria *pers. comm.*, D. Ward *pers. obs.*).

4.2 Sites of High Establishment Risk

Based on a previous risk assessment for the red imported fire ant (*Solenopsis invicta*), high risk goods were classified as untreated soil, sea containers (at both wharves and transitional facilities), packing materials, vehicles, used car parts, used machinery, used electrical equipment, bark and hay (MAF 2002). Harris et al. (2005) was used to obtain the frequency of detection of three major invasive ant species (the tropical fire ant (*Solenopsis geminata*), the crazy ant (*Paratrechina longicornis*), and the ghost ant (*Tapinoma melanocephalum*)) from different goods. The data showed fresh produce, containers, and personal effects made up 75% of detection records (Harris et al. 2005). This information is summarised in Table 1.

Thus, the subsequent prioritisation of sites is based on the information of risk goods and pathways found within MAF (2002) and Harris et al. (2005). Business categories that were most likely to be associated with these risk goods were determined (Appendix 3), and sites from the high and medium categories are compiled in Appendix 4.

Seventeen sites were given a high risk ranking, and 163 sites a medium risk ranking (Appendix 4). High risk sites are based around businesses that are most likely to supply and frequently move bark, garden material, and fresh produce (e.g. fruit, flowers, vegetables). Sites of medium risk are based around plant material (lawn turf, trees), rubbish disposal (rubbish bins, scrap metal), landscape

suppliers (including orchard suppliers, garden centres), timber and wood products, and camping grounds.

4.3 Sites of High Ecological Priority

Forty five sites were ranked, and twelve were given a high priority ranking (Appendix 5). Sites are ranked in an approximate order of risk within the high-medium-low priority framework, on the basis of two factors. First, sand, gumlands and wetland habitat had priority over forest. Second, sites with higher visitor numbers are given higher priority.

Many of these sites cover a large area and contain a number of locations that could be sampled. Surveillance should be focused around locations that are most associated with humans. For example, road ends, picnic grounds, rest stops, entrances to walkways, houses and holiday houses. In such situations, it is recommended to continue to use direct searching and an approximate 30 minute time period. However, in order to cover a large area, use a series of 30-minute time periods – with all ants collected in one 30-minute period placed into one vial of ethanol.

Sixteen offshore islands were also included in the initial ranking obtained from DOC staff. However, I have separated them from the mainland sites because they present additional logistical demands, and consequently are unlikely to be visited over the 2006-2007 summer period. It is suggested that the islands are either surveyed for invasive ants as part of ongoing DOC work, or as a separate project.

5. Recommendations

5.1 Surveillance and Monitoring Strategy

Sites with a high risk or high priority rank should be surveyed first. This includes nine sites of high risk points of entry, seventeen sites of high risk, and twelve sites of high priority. A total of thirty-eight sites. Sampling should be through direct searching for ant species, using an aspirator to collect ant specimens. Approximately 30 minutes should be spent at each site.

The two goals identified in the NRC regional pest management strategy for the long term management of invasive ants in Northland are: 1) to prevent their spread into sites of significant ecological value, and 2) to restrict their spread to other areas of human habitation.

To achieve these two goals, it is recommended that in subsequent years of surveillance, high risk/high priority sites are *always* visited before other sites of lower priority. Additionally, a mixture of medium risk and medium priority sites are then selected, depending on the amount of remaining resources.

It may be useful to split the total number of medium risk/medium priority sites, and survey a certain number of sites each year (e.g. Table 2). Such a strategy may be best determined after the first year of the surveillance program has been completed.

Argentine ants are currently the invasive ant species of most concern in Northland (and New Zealand); they are already widespread, continue to spread rapidly at several spatial scales, and have well documented ecological and economic impacts overseas. Although Argentine ants are already widespread throughout the Northland region (Appendix 6), they appear not to have spread into many areas considered of significant ecological value. Therefore, it could be argued that the long term goal (goal one) of the regional pest management strategy can be achieved. However, this may necessitate a re-focus of surveillance effort, towards sites of ecological value rather than sites of establishment risk.

Advocacy and education of businesses and residents in the Northland region will also play a key role in the continued surveillance and management of invasive ant species in Northland. Advocacy will be particularly important at medium and low priority sites because many of these medium/low sites will

not be surveyed regularly. Advocacy will be also useful for targeting a large number of industrial sites (areas of economic significance), that cannot be surveyed because of limited resources.

5.2 Caveats

Rankings of sites/categories have been on the basis of expert experience and what is known about invasive ant species. Unfortunately, knowledge of invasive ant species is often limited, especially concerning their movement/dispersal and association with humans.

Therefore, this prioritisation process must be put in context - all sites have the potential to have invasive ants, but the probability of this occurring depends on the site being associated with the movement of risk goods and the volume/frequency of that association. But also note that risk classifications are not static. New high risk sites can be built, and changes at a site may result change its risk status. Furthermore, there is no correct definition of a 'risk good', this may vary between species, and invasive ant species are generalists and can thus tolerate a wide range of transport mediums and conditions.

As a consequence of this uncertainty, individual expert opinions may differ in the rankings of different sites and categories. However, such differences in opinion should be satisfied in a flexible surveillance strategy that is based on a strong long-term goal, and through advocacy of businesses and residents.

To further assist in developing a longer-term surveillance strategy and optimising the process of site prioritisation, the results of this surveillance program should be briefly evaluated after the first year.

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Table 1. List of pathways and goods often associated with invasive ant species and deemed 'high risk goods', ranked in order of decreasing risk. Information from MAF (2002, *Solenopsis invicta*), and Harris et al. (2005, *Solenopsis geminata*, *Paratrechina longicornis*, *Tapinoma melanocephalum*).

Reference	Pathways and goods
MAF (2002)	untreated soil sea containers - wharf inspected or transitional facility inspected packing materials vehicles used car parts used machinery non-wooden building materials untreated and non-manufactured wooden building material bark hay used electrical equipment personal effects (unaccompanied baggage) animal containers packaging materials-air packaging materials-sea - transitional facility inspected nursery stock (dormant bulbs) manufactured wooden building materials
Harris et al. (2005)	fresh produce containers (sea + air) personal effects air passenger baggage cut flowers timber (+wood products) machinery plants

Table 2. A recommended schedule of site prioritisation over multiple years, splitting “medium” sites across time.

	Year 1	Year 2	Year 3	Year 4
All High priority sites	√	√	√	√
Medium: sites 1-20	√			√
Medium: sites 21-40		√		
Medium: sites 41-60			√	

8. Glossary

High risk	sites that have an association with, and movement of, risk goods. As a consequence of this association, these sites have a higher probability of acting as a source for the spread of invasive ants, or as a site of establishment.
High value	sites that have a significant biodiversity and conservation value to Northland.
HRSS	high risk site surveillance. The deliberate targeting of trade pathways and high risk areas for possible incursions of invasive organisms (Murphy 2004).
Invasive ant species	an ant species that does not naturally occur in a region, and has been introduced to the region through the actions of humans. The terms of exotic, alien and non-indigenous are treated as synonymous with invasive.
Points of entry	sites where goods are unloaded into a site which is the first point of entry into New Zealand. These sites include seaports, airports and transitional facilities. These sites are typically where the majority of surveillance is undertaken.
Risk goods	any goods considered higher than average risk for the transport of invasive ants into New Zealand [and also within New Zealand] (Murphy 2004).
Surveillance	a planned process targeted to detect a particular pest.
Transitional facility	any site where accredited people devan containers (Murphy 2004).

9. Appendices

Appendix 1. Endemic and invasive ant species recorded from Northland and New Zealand (source Ward 2005).

Endemic	Invasive	Invasive
In Northland +NZ	In Northland + NZ	Not present in Northland but in NZ
<i>Amblyopone saundersi</i>	<i>Amblyopone australis</i>	<i>Cardiocondyla minutior</i>
<i>Discothyrea antarctica</i>	<i>Doleromyrma darwiniana</i>	<i>Hypoponera punctatissima</i>
<i>Heteroponera brounii</i>	<i>Hypoponera eduardi</i>	<i>Monomorium pharaonis</i>
<i>Huberia brounii</i>	<i>Iridomyrmex</i> sp.	<i>Monomorium sydneyense</i>
<i>Huberia striata</i>	<i>Linepithema humile</i>	<i>Pheidole megacephala</i>
<i>Monomorium antarcticum</i>	<i>Monomorium fieldi</i> (antipodum)	<i>Pheidole proxima</i>
<i>Monomorium smithii</i>	<i>Ochetellus glaber</i>	<i>Rhytidoponera metallica</i>
<i>Pachycondyla castanea</i>	<i>Orectognathus antennatus</i>	<i>Solenopsis</i> sp.
<i>Pachycondyla castaneicolor</i>	<i>Paratrechina</i> sp.A	
<i>Prolasius advenus</i>	<i>Paratrechina</i> sp.B	
	<i>Pheidole rugosula</i>	
	<i>Pheidole vigilans</i>	
	<i>Ponera leae</i>	
	<i>Rhytidoponera chalybaea</i>	
	<i>Strumigenys perplexa</i>	
	<i>Strumigenys xenos</i>	
	<i>Technomyrmex albipes</i>	
	<i>Tetramorium bicarinatum</i>	
	<i>Tetramorium grassii</i>	

Appendix 2. High risk points of entry and transitional facilities in Northland. All sites are in the Whangarei area, except for the two Opua sites. Grid references of sites (NZMG and latitude/longitude, WGS84 datum - in decimal degrees) were obtained using Topomap® software. It should be noted that grid references are approximate because Topomap® does not contain references to street numbers, but only streets/roads.

Site	Address	Site Used For	NZMG East	NZMG North	Longitude	Latitude
Marsden Point Oil Refinery	Marsden Point Rd	Wharf	2646035	6594775	174.499	-35.838
Doclands	211-219 Port Rd	Boat Yard	2631920	6605680	174.340	-35.742
Norsand	10 Fraser Street	Boat Yard	2631920	6605680	174.340	-35.742
McRae's Engineering	7 Hewlett St	Wharf/Industry	2631920	6605680	174.340	-35.742
Ray Roberts Marine	Riverside Drive	Boat Yard	2630725	6607790	174.327	-35.723
Opua Marina	Opua	Wharf	2612725	6653560	174.121	-35.313
Ashby's Boat Yard	Baffin Street, Opua	Boat Yard	2612725	6653560	174.121	-35.313
Toll Consolidated	Porowini Ave	Transitional Facility	2630035	6606910	174.319	-35.731
United Carriers	4 Hewlett St	Transitional Facility	2631920	6605680	174.340	-35.742

**Appendix 3. Risk categories obtained from the Telecom Northland Yellow Pages 2006/07.
Categories not listed are considered of negligible risk.**

Risk	Category	Page
High	Bark products	67
	Garden and Horticultural Suppliers	251
	Fruit and Vegetable Wholesalers	235
	Packhouse-Flowers, Fruit and Vegetables	354
Medium	Lawn and Turf	316
	Tree Services	480
	Rubbish Bin Hire/Waste Disposal	412/499
	Scrap Metal Dealers	419
	Orchardists' Suppliers	351
	Landscape Contracting and Supplies	312
	Timber Merchants	468
	Hire-plants	279
	Garden Centres and Nurseries-Retail	249
Holiday Parks and Camping Grounds	279	
Low	Aero clubs	44
	Automotive Parts, Truck Parts	58/483
	Backpackers	65
	Boat Charter, Repairs	81/83
	Building Suppliers	103
	Bus Charters	105
	Caravan Rentals	117
	Carriers and Cartage	127
	Earthmovers	190
	Farm Supplies & Services, Machinery	212/213
	Fishing Trips	225
	Forestry Equipment	230
	Freight Forwarders	234
	Fruit and Vegetable Growers, Wholesalers	235
	Furniture Removals	239
	Garden Maintenance	251
	Importers	288
	Lawn mowing Services	317
	Machinery Importers and Dealers	328
	Motels and Lodges	340
	Packaging Machinery	354
	Pallet Hire, Manufacturing	358
	Port Services	379
	Quarries, Stone and Rock Merchants	385/446
	Recycling	393
	Rental Vehicles	395
	Sawmills	468
	Second-hand Dealers	421
	Shipping Agents	433
	Storage	446
	Supermarkets and Grocers	451
	Tours and Sightseeing	471
	Tree and Shrub Seeds	483

Appendix 4. High and medium risk sites in Northland. Grid references of sites (NZMG and latitude/longitude, WGS84 datum - in decimal degrees) were obtained using Topomap® software. It should be noted that grid references are approximate because Topomap® does not contain references to street numbers, but only streets/roads.

Category (Yellow pg) + Site	Address	Phone	District	NZMG East	NZMG North	Longitude	Latitude	#
High Risk								
Bark products (p 67)								
Greenfingers Growing mixes Ltd	500 Kamo Rd	435 1488	Whangarei	2628175	6613000	174.298	-35.676	1
Greenfingers Growing mixes Ltd	Kioreroa Rd	438 5264	Whangarei	2628175	6613000	174.298	-35.676	2
Garden and Horticultural Suppliers (p 251)								
Poppa's Garden Supplies	19 Rewa rewa Rd	438 6984	Whangarei	2629110	6604540	174.310	-35.752	3
Kericell Nurseries	1589 State Hwy 10 RD3	407 7996	Kerikeri	2597140	6662660	173.948	-35.233	4
Pacific Growers		0800 777999		?				5
Veg Gro Supplies Ltd	43 Porowini Ave	438 1045	Whangarei	2630035	6606910	174.319	-35.731	6
Cover n Gro	13 Parkland Cre, Kamo	437 3196	Whangarei	2628150	6613000	174.298	-35.676	7
Waipapa landscape supplies	State Hwy 10, Waipap	407 6668	Waipapa	2594650	6665325	173.921	-35.209	8
Fruit and Vegetable Growers and Wholesalers (p 235)								
Delta Produce co-op	97 Jervois St	439 0717	Dargaville	2590400	6585050	173.884	-35.933	9
Manna wholesalers	110 George St	027 4509472	Hikurangi	2627300	6619950	174.287	-35.614	10
Turners & Growers	249 Port Rd	459 8500	Whangarei	2630700	6607050	174.327	-35.729	11
Wholesale fresh, Redwood Centre	State Highway 10	407 1136	Kerikeri	2597140	6662660	173.948	-35.233	12
Packhouse-Flowers, Fruit and Vegetables (p 354)								
Alcom Limited	517 Kerikeri Rd	407 1354	Kerikeri	2598650	6662950	173.965	-35.230	13
Apotu Carnation Gardens	45 Apotu Rd Kauri	435 3101	Whangarei	2628000	6616250	174.295	-35.647	14
Golden Mile Fruitpackers Ltd	Austin Rd	438 2326	Whangarei	2625750	6605500	174.272	-35.744	15
Satara Glenbervie	cnr Ngunguru & Maruata Rd	437 3003	Whangarei	2633350	6613800	174.355	-35.668	16
Satara Poroti	cr McBeth & Mangakahia Rd	434 6553	Whangarei	2633350	6613800	174.355	-35.668	17
Medium Risk								
Lawn and Turf (p 316)								
GreenGables Landscape	18 Rewa rewa Rd	459 1108	Whangarei	2629110	6604540	174.310	-35.752	1
Recreational Services Ltd	PO Box 473	437 3440	Whangarei	?				2
North Coast Turf & Lawns	Ormiston Rd Waipuu RD 2	432 1386	Waipuu	2636100	6583740	174.391	-35.939	3

Rapid Lawn Northland Ltd	Saleyard Rd Kauri 1	435 3119	2628025	6612425	174.296	-35.681	4
Tree Services (p 480)							
B.Js Shelter Belt Trimmers	33 Escalona St Kamo	435 6285	2627725	6612325	174.293	-35.682	5
Branching Out Treecare Ltd	PO Box 1323	436 4466	?				6
Cowley's Hire Centres	54 Commerce St	438 3613	?				7
Far North Contracting Ltd	Kaitaia	406 7971	2534400	6676750	173.258	-35.111	8
Hooker Contracting	PO Box 4131 Kamo	435 1310	2627975	6613025	174.296	-35.675	9
North End Tree Services	160 Gt North Rd RD 1 Kamo	435 2662	2627725	6612325	174.293	-35.682	10
Northpower Contracting	28 Mt Pleasant Rd	430 1803	?				11
Park Shelter Trimming Services	Whangarei RD 9	434 7215	?				12
R & J Mulching Services Ltd	Johnson Rd Hukerenui RD2	433 9868	2621350	6632250	174.219	-35.504	13
Shelter Trim Ltd	Tokatoka Rd RD 2	439 2142	2597800	6571150	173.968	-36.057	14
Special Branch Tree Services	PO Box 175	434 3814	?				15
Stump Chipping Ltd	Whangarei Heads Rd 4	436 3538	2646425	6599525	174.502	-35.795	16
The Branch Manager	State Highway 14 RD 9	430 8078	?				17
The Stump Grinding Man	PO Box 3238 Onerahi	027 4903678	?				18
Total Tree Trimming Ltd	Marlborough Rd Tutamoe	439 6482	2569925	6616325	173.654	-35.653	19
Tree Chipping Services	1 Mahanga Rd Pataua	436 1881	2648575	6607925	174.524	-35.719	20
Rubbish Bin Hire/Waste Disposal (p 412)							
Dargaville Tidy Bins Ltd	Awakino Rd Dargaville	439 8768	2589320	6584625	173.872	-35.937	21
East West Waste Ltd	Puketona Junction RD 3	0800 492 783	2598355	6654875	173.963	-35.303	22
EasyWay Bins	22 Hill Crest Rd Kaitaia	408 2594	2534400	6676750	173.258	-35.111	23
Kiwi Bins	Waipu Caves Rd Waipu	435 2259	2636100	6583740	174.391	-35.939	24
Northwaste Ltd	PO Box 11116 Whangarei	438 0802	?				25
Parkes Bins	150-154 Lower Port Rd	438 6984	2631000	6605150	174.330	-35.747	26
Waste Management NZ Ltd	PO Box 910	438 5585	?				27
Waste Works Ltd	51 Rankin St	401 1475	2583420	6642850	173.800	-35.413	28
Wastecare Ltd	150-154 Lower Port Rd	438 6039	2631000	6605150	174.330	-35.747	29
Scrap Metal Dealers (p 419)							
Kamo Scrap Metals Ltd	Hiko Rd RD 6 Kamo	435 2488	2627725	6612325	174.293	-35.682	30
Little River Transport Ltd	Beach Rd Dargaville	021 1693564	2588425	6583775	173.862	-35.944	31
Mega Metals	34 Rewa Rewa Rd	438 9887	2629110	6604540	174.310	-35.752	32
Northland Scrap & Coal Ltd	22 Kaka St	438 6489	?				33
Quest Metals	37 Port Rd	438 9886	2632290	6605445	174.345	-35.744	34

Orchardists' Suppliers (p 351)

Lake Omapere orchards	Te Pua Rd RD 2	405 2356	Kaikohe	2584520	6644780	173.812	-35.395	35
Landscpe Contracting and Supplies (p 312)								
Blue Nikau LTD	RD3 Whangarei	434 3077	Whangarei	?	6584850	174.427	-35.928	36
Central Mountfield quarry	Mountfield Rd	432 0606	Waipu	2639375				37
Cowleys	54 Commerce St	438 3613	Whangarei	?				38
Diesel & Dirt Landscape supplies	SH 14 Maungatapere	434 7777		2619850	6604400	174.207	-35.755	39
Garden Works	15 Weir St, Onerahi	434 3962	Whangarei	2633350	6602575	174.357	-35.769	40
Garden Works	Sands Rd Tikipunga	437 6706		2631900	6612475	174.339	-35.680	41
Gourmet Gardens	Loop Rd	432 2456		2628425	6600400	174.303	-35.790	42
Graham Parkes Ltd	19 Rewa rewa Rd	438 6984	Whangarei	2629110	6604540	174.310	-35.752	43
Groundworks landscaping	6 Pine Rd, Ngunguru	434 3066	Ngunguru	2646445	6617305	174.499	-35.635	44
Islandscapes	1 Manawaroa Rd	403 8171	Russell	2613025	6659285	174.123	-35.261	45
Landscaping rocks	Puhipuhi Rd	433 9658		2626400	6634775	174.274	-35.480	46
Magivers Landcare	35 Apotu Rd RD 1	435 1935	Kamo	2626550	6618450	174.279	-35.627	47
Manu Landscaping	Hollington Way RD 10	434 6689		?				48
Northern subtropical landscapes	1 Tree point Rd	432 7048	Ruakaka	2640135	6588765	174.434	-35.893	49
Northland park care	Snooks Rd RD 9	434 6688	Whangarei	2617550	6602525	174.182	-35.772	50
Palmo	Wairoa Rd	407 9293	Kerikeri	?				51
The Woodlot	Waipapa Rd	407 0726	Waipapa	2594375	6665600	173.918	-35.206	52
Waipapa landscape Supplies	State Hwy 10	407 6668	Waipapa	2594375	6665600	173.918	-35.206	53
Timber Mechants (p 468)								
Ancient Kauri Kingdom	229 State Hwy 1 Awani	406 7172	Awanui	2534660	6684115	173.261	-35.044	54
BBS Timbers Ltd	27 Kioreroa Rd Whgri	430 0455	Whangarei	2629950	6604535	174.319	-35.752	55
Benchmark Building Supplies	Commerce St	438 4579	Whangarei	?				56
Benchmark Building Supplies	Mangakahia Rd	401 5089	Kaikohe	2584530	6641780	173.812	-35.422	57
Benchmark Building Supplies	Kauri Branch Main Rd Kauri	435 0377						58
Bunnings Trade	State Hwy 1, Kauri	435 0377	Whangarei	2628000	6616250	174.295	-35.647	59
Cains Timber Co NZ Ltd	Waipanga Rd	435 1072	Whangarei	2627975	6613025	174.296	-35.675	60
Croft Pole & Timber	SH1 Kauri Postal RD1 Kamo	435 5040		2628025	6612425	174.296	-35.681	61
Demolition Supermarket	28 Kioreroa Rd	438 2887	Whangarei	2629950	6604535	174.319	-35.752	62
Earth & Trees Sawmilling	Ryan Rd RD2	475 5555	Waipu	2638905	6574140	174.424	-36.025	63
Grand Pine Enterprises NZ Ltd	Sir William Hale Crescent	404 0453		?				64
Herman Pacific	110 Foundry Rd Svdle	426 5475	Hibiscus Coast	?				65
Herman Timber Ltd	Factory Lane Hikur	433 8555		?				66
Juken NZ Ltd	Whangatane Dr	408 9121		?				67
Just Macro	127 Ford Rd Mingto	431 8335		2627000	6561200	174.294	-36.143	68
Kaihu Valley Sawmill Ltd	Kaiwi Lakes Rd Maman	439 0833		2568815	6598265	173.644	-35.816	69

Mac Direct	15b Rewa rewa Rd	4381727	Whangarei	2629110	6604540	174.310	-35.752	70
Michelsen Timber	Huanui Rd Glenbervie	437 5845	Glenbervie	2633100	6615000	174.352	-35.657	71
Mitre 10	Whangarei Kamo Rd Regent	4383119		2628025	6612425	174.296	-35.681	72
Motukiore Timber Co	Motukiore Rd Horek	401 9197		?				73
Mt Pokaka Timber Products Ltd	Bulls Rd	407 7271		?				74
Northland Kauri Ltd	State Hwy 10 Oromahoe	405 9612	Kerikeri	2599775	6652850	173.979	-35.321	75
NorthPine Ltd	34 Cove Rd	432 1155	Waipu	2641100	6578550	174.447	-35.985	76
Northsawn Lumber	458 Marsden Point Rd,	432 7078	Ruakaka	2642025	6590650	174.455	-35.876	77
NZ Green Pine Ltd	Lot 12 Marsden Point Rd	433 0048	Ruakaka	2642025	6590650	174.455	-35.876	78
Palms Timber Yard	State Hwy 1F Awanui	021 3411229	Awanui	2534660	6684115	173.261	-35.044	79
Pyac Timber	Kohukohu	409 5754	Kaitiaki	2560000	6648700	173.542	-35.362	80
Rosvall ITM Building Centre	Kioreroa Rd	438 9359	Whangarei	2629950	6604535	174.319	-35.752	81
Rosvall Sawmill Ltd	Whareora Rd 5	437 5509	Whangarei	2635900	6610850	174.384	-35.694	82
Sheppard Sawmills Ltd	Ararua Rd R D 2 Matko	431 7108		2616300	6565700	174.174	-36.104	83
Timber Enterprises	State Hwy 10 Oromahoe	408 7991	Kerikeri	2599775	6652850	173.979	-35.321	84
Trilog Treeworx	State Hwy 12	431 9181		?				85
Topuni Timber Ltd	Schiska Rd, Topuni, SH1	431 2855		2642125	6553025	174.463	-36.215	86
Hire-plants (p 279)								
Living décor	63E Great North Rd	435 5964	Kamo	2628025	6612425	174.296	-35.681	87
Plans for occasions	9 Aratiatia Pl	437 0708	Whangarei	?				88
Garden Centres and Nurseries-Retail (p 249)								
Alter-natives Wholesale	571 Ormiston Rd	432 1333	Waipu	2636100	6583740	174.391	-35.939	89
Bream Bay Landscape Centre	One tree point rd RD1	432 7048	Ruakaka	2640135	6588765	174.434	-35.893	90
Doubtless Bay Garden Centre	Walters Way CoopB	406 0212	Coopers Beach	2557355	6689710	173.509	-34.992	91
Duck Creek Garden	29 Gladstone St Dargv	439 8386	Dargaville	2589320	6584625	173.872	-35.937	92
Forest floor	Mangakahia Rd	434 7216		2613400	6606425	174.136	-35.737	93
Gala's Garden	Kapiro Rd Kerik	407 5941	Kerikeri	2593850	6667275	173.912	-35.191	94
Greens Garden Nursery	Kioreroa Rd Whgri	438 9389	Whangarei	2629950	6604535	174.319	-35.752	95
Harvies Plant Warehouse	Kerikeri Rd Kerik	407 6541	Kerikeri	2597420	6663545	173.951	-35.225	96
In 2 Plants	Puhipuhi Rd R D 2	433 9658	Hikurangi	2625900	6628325	174.270	-35.538	97
Kerikeri Flora	139a Ness Rd	407 9066	Waipapa	2592775	6668025	173.900	-35.185	98
Kerikeri Plant Production	Riddell Rd Kerik	407 9448	Kerikeri	2598140	6661925	173.959	-35.239	99
Koanga Organic Garden Centre	RD 2 Mngto	431 2732	Maungaturoto	2633525	6565175	174.366	-36.106	100
Kwan Garden Creations	334 Kerikeri Rd	407 6845	Kerikeri	2597420	6663545	173.951	-35.225	101
Lemonwood GardenWerx	Main Rd Awanui	406 7039	Awanui	2534660	6684115	173.261	-35.044	102
Longreach Tree Nursery	Onerahi	436 0997	Whangarei	2633630	6602980	174.360	-35.766	103
Loop Road Nursery	113 Loop Rd Otaka	432 2456	Otaika	2628410	6601140	174.302	-35.783	104

Oakleigh Nurseries	State Highway 1	432 2542	Oakleigh	2629435	6595715	174.315	-35.832	105
Palmsco	Wairoa Rd Kerik	407 9293	Kerikeri	?				106
Palmers	Cnr Water St & Central Ave	430 4070	Whangarei	2629925	6608900	174.318	-35.713	107
Rainbow @ Redwoods	State Highway 10 Kerik	407 9148	Kerikeri	2597420	6663545	173.951	-35.225	108
	Cnr Aurerere Beach Rd &							
River Of Life Garden Centre	State Hwy 10	406 0813	Taipa	2549315	6689970	173.421	-34.991	109
Sciadopitys	460 Maunu Rd	438 9715	Whangarei	2625875	6605450	174.274	-35.745	110
Smith's Garden Centre	414 Kerikeri Rd Kerik	407 8550	Kerikeri	2597420	6663545	173.951	-35.225	111
South Pacific Palms	Kerikeri Rd Kerikeri	407 8899	Kerikeri	2597420	6663545	173.951	-35.225	112
Subtropica	Massey Rd	432 0018	Waipu	2642275	6573250	174.461	-36.032	113
Tangihua Trees	Tangihua Rd	432 3800	Tangihua	2617810	6594215	174.186	-35.847	114
Trees Company Nursery	Pukepoto Rd Kaita	408 0153	Kaitaia	2533625	6674625	173.250	-35.130	115
Twin Palms Succulent Nursery	45 Apotu Rd Kauri RD 1	435 1935	Whangarei	2628000	6616250	174.295	-35.647	116
	461 Whangarei Heads Rd							
Waikaraka Nursery	Waikr RD 4	436 1212	Whangarei	2635800	6603925	174.384	-35.757	117
Waipu Plants	503 Heimsdale Rd	432 1503	Waipu	2638275	6581500	174.415	-35.959	118
West End Nursery	15 Normanby St Dargv	439 5996	Dargaville	2589320	6584625	173.872	-35.937	119
Wharepuke Nursery	Stone Store Hill 190 Kerikeri Rd	407 8933	Kerikeri	2597420	6663545	173.951	-35.225	120
Holiday Parks and Camping Grounds (p 279)								
Ahipara Motor Camp	Takahe Rd Ahipara	409 4864	Ahipara	2525245	6670785	173.158	-35.165	121
Alpha Motel & Holiday Park	34 Tarewa Rd	438 6600	Whangarei	?				122
Bay Of Islands Holiday Park	Lilypond Puketona Rd	402 7646	Paihia	2603500	6656190	174.019	-35.290	123
Baylys Beach Holiday Park	22 Seaview Rd Baylys Bea.	439 6349	Dargaville	2577885	6583125	173.746	-35.951	124
Beachside Holiday Park	1290 State Highway 11	402 7678	Paihia	2610920	6654880	174.101	-35.301	125
Blue Heron Holiday Park	Scott Rd RD 4	436 2293	Whangarei	2639055	6600905	174.420	-35.784	126
Camp Waipu Cove	Waipu Cove	432 0410	Whangarei	2646185	6573520	174.504	-36.029	127
Dargaville Campervan Park	16-18 Gladstone Rd	439 8479	Dargaville	2589320	6584625	173.872	-35.937	128
Dargaville Holiday Park	10 Onslow St Dargaville	439 8296	Dargaville	2589320	6584625	173.872	-35.937	129
Gibby's Place	331 Kerikeri Rd Kerikeri	407 9024	Kerikeri	2597420	6663545	173.951	-35.225	130
Haruru Falls Resort	Haruru Falls	402 7525	Paihia	2606345	6657370	174.050	-35.279	131
Hih Beach Holiday Camp	Hih Rd Mangonui	406 0307	Mangonui	2563130	6688520	173.572	-35.003	132
Houhora Heads Motor Camp	Houhora Hds Rd RD 4	409 8564	Kaitaia	6707050	6707050	173.135	-34.838	133
Kamo Springs Holiday Park	1 State Hwy, North of Kamo	435 1208	Whangarei	2627725	6612325	174.293	-35.682	134
Kauri Coast Top 10 Holiday Park	Trounson Park Rd Kaiti	439 0621	Dargaville	2572925	6603625	173.689	-35.767	135
Kerikeri Top 10 Holiday Park	Kerikeri Rd Kerikeri	407 9326	Kerikeri	2597420	6663545	173.951	-35.225	136
Matakohe Holiday Park	Church Rd Matakohe	431 6431	Maungaturoto	2617175	6562875	174.184	-36.129	137
Matauri Bay Holiday Park Ltd	Matauri Bay Rd	405 0525	Kaero	2593025	6683650	173.900	-35.044	138

Oakura Motels & Holiday Park	433 6803	Whangarei	2632810	6644705	174.343	-35.390	139
Opononi Beach Holiday Park	405 8791	Kaikohe	2546400	6632750	173.393	-35.506	140
Orongo Bay Holiday Park	403 7704	Russell	2615210	6657025	174.148	-35.281	141
Otaika Motel & Holiday Park	438 1459	Whangarei	2619900	6604350	174.208	-35.755	142
Pagoda Lodge	407 8617	Kerikeri	2599050	6663295	173.969	-35.227	143
Pahi Beach Motor Camp	431 7322	Maungaturoto	2621075	6565375	174.227	-36.106	144
Paparoa Motor Camp	431 6515	Paparoa	2621005	6560055	174.227	-36.154	145
Pukenui Holiday Park	409 8803	Kaitaia	2523300	6707050	173.135	-34.838	146
Rawene Motor Camp	405 7720	Rawene	2556365	6644230	173.502	-35.402	147
Ruakaka Reserve Motor Camp	432 7590	Whangarei	2641935	6587400	174.455	-35.905	148
Russell Top 10 Holiday Park	403 7826	Russell	2613980	6659425	174.134	-35.260	149
Taupo Bay Camping Ground Ltd	406 0315	Mangonui	2575575	6689550	173.709	-34.992	150
Tokerau Beach Motor Camp	408 7150	Kaitaia	2544500	6701025	173.367	-34.891	151
Treasure Island Trailer Park	436 2390	Whangarei	2648125	6607675	174.519	-35.721	152
Tutukaka Holiday Park	434 3938	Whangarei	2648765	6620415	174.524	-35.606	153
Twin Pines Tourist Park	402 7322	Paihia	2610475	6656375	174.096	-35.288	154
Wagener Holiday Park	409 8564	Kaitaia	2523300	6707050	173.135	-34.838	155
Wagon Train R.V. Park	407 7889	Kerikeri	2595640	6660360	173.932	-35.254	156
Waitangi Motor Camp	402 7866	Paihia	2609010	6657770	174.079	-35.275	157
Whananaki North Motel	433 8896	Whangarei	2643830	6631390	174.467	-35.508	158
Whangarei Falls Holiday Park	437 0609	Whangarei	2633340	6613835	174.355	-35.668	159
Whangarei Top 10 Holiday Park	0800 455488	Whangarei	2629425	6609175	174.312	-35.711	160
Whangaroa Harbour Holiday Park	405 0306	Kaero	2578725	6681670	173.744	-35.063	161
Whangaruru Beachfront Camp	433 6806	Hikurangi	2631215	6649150	174.325	-35.350	162
Whatuwhiwi Holiday Park	408 7202	Kaitaia	2548350	6702425	173.409	-34.878	163

Appendix 5. Ranking of sites of ecological value in Northland. Visitor numbers are based on a relative grade of H = high, M = medium, L = low. Grid references of sites (NZMG and latitude/longitude, WGS84 datum - in decimal degrees) were obtained using Topomap® software.

Ranking	Site	Habitat	Visitors	NZMG East	NZMG North	Longitude	Latitude
High priority							
1	Pouto Peninsula	Wetland	H	2615900	6537175	174.174	-36.361
2	Te Pahi/North Cape	Sand/Forest	H	2492800	6744325	172.801	-34.503
3	Ngunguru Sandspit/Whakariora	Sand	M	2647350	6617075	174.509	-35.637
4	Ahipara Massif	Gumlands	M	2522200	6668675	173.125	-35.184
5	Kaimaumau/Motutangi Wetlands	Wetland	M	2510000	6715000	172.990	-34.767
6	Kokota Sandspit	Sand	L	2509000	6739500	172.978	-34.546
7	Manganui River	Wetland	L	2608425	6584600	174.084	-35.935
8	Maitahi Wetland	Wetland	L	2578300	6592600	173.749	-35.866
9	Waipoua/Mataraua/Waima Forest complex	Forest	H	2564450	6626600	173.593	-35.561
10	Bream Head	Forest	H	2654225	6592850	174.590	-35.854
11	Puketi/Omahuta Forest	Forest	H	2569225	6662400	173.642	-35.238
12	Utakura/Pukewharariki Forest	Forest	L	2575450	6645750	173.712	-35.387
Medium priority							
13	Ngawha Geothermal Field	Geothermal	H	2589500	6642800	173.867	-35.412
14	Waipu sandspit	Sand	H	2645050	6575800	174.491	-36.009
15	Mangawhai Sandspit	Sand	H	2654585	6566290	174.599	-36.093
16	Hikurangi Swamp	Wetland	H	2624680	6623505	174.257	-35.582
17	Mimiwhangata	Wetland/Forest	H	2638450	6638550	174.407	-35.444
18	Lake Ohia	Wetland	M	2543995	6692450	173.363	-34.969
19	Maunganui Bluff	Forest	H	2561400	6604800	173.561	-35.757
20	Trounson Forest	Forest	H	2569465	6608725	173.650	-35.721
21	Cape Brett	Forest	H	2625600	6662350	174.261	-35.232
22	Whangaruru	Forest	H	2634505	6647945	174.361	-35.360
23	Mt Manaia Forest	Forest	H	2647575	6596550	174.515	-35.822
24	Waipu Gorge Forest	Forest	H	2635590	6570730	174.387	-36.056
25	Brynderwyn Forest	Forest	H	2638915	6568810	174.425	-36.073
26	Herekino Forest	Forest	M	2533500	6667000	173.249	-35.199
27	Warawara Forest	Forest	M	2539000	6647000	173.311	-35.378
28	Raetea/Maungataniwha Forest	Forest	M	2551500	6667500	173.447	-35.193
29	Marlborough Forest	Forest	M	2576000	6613000	173.722	-35.682
30	Kaihu Forest	Forest	M	2574575	6604175	173.707	-35.762

31	Maungatapere Mountain	Forest	M	2618205	6601865	174,189	-35,778
32	Mareteu Forest	Forest	M	2633230	6578105	174,360	-35,990
33	Puketotara Peninsula remnants	Forest	L	2627525	6547075	174,302	-36,270
Low priority							
34	Otokairangi	Wetland	L	2617050	6620775	174,174	-35,608
35	Maitai Bay Remnants	Forest	H	2548475	6706100	173,411	-34,845
36	Tangihua Forest	Forest	H	2610175	6595800	174,102	-35,834
37	Pukenui Forest	Forest	H	2627765	6607000	174,294	-35,730
38	Berghan Point/Whakaangi	Forest	M	2561500	6694500	173,554	-34,949
39	Mangonui Forest	Forest	M	2575000	6687000	173,703	-35,015
40	Motatau	Forest	M	2607500	6623000	174,068	-35,589
41	Mangakahia Forest	Forest	M	2597300	6614125	173,957	-35,670
42	Russell Forest	Forest	M	2622725	6648700	174,232	-35,355
43	Pukekaroro Forest	Forest	M	2640325	6562250	174,442	-36,132
44	Berghan's Bush	Forest	M	2598000	6572700	173,970	-36,043
45	Bream Tail	Forest	M	2653590	6571540	174,587	-36,046
High priority - Offshore Islands							
	Motuopao Island			2477800	6748000	172,638	-34,470
	Matapia Island			2492500	6732900	172,798	-34,606
	Simmonds Islands			2525200	6716200	173,156	-34,755
	Cavalli Islands Group			2596700	6688400	173,940	-35,001
	Motukokako Island			2632800	6669675	174,339	-35,165
	Bream Islands			2654550	6594400	174,593	-35,840
	Poor Knights Islands			2667500	6635600	174,727	-35,466
	Hen and Chickens Islands			2665500	6580100	174,717	-35,967
	Three Kings Islands			2432300	6781100	172,145	-34,170
Medium priority - Offshore Islands							
	Stephenson Island			2582400	6692800	173,783	-34,963
	Motuaroia Island			2616775	6662400	174,164	-35,233
	Moturu Island			2619200	6663500	174,191	-35,222
	Motukiekie Island			2620350	6664150	174,203	-35,216
	Okahu Island			2620925	6666150	174,209	-35,198
	Waewaetorea Island			2621375	6665625	174,214	-35,203
	Urupukapuka Island			2623200	6664250	174,234	-35,215

Appendix 6. Records of Argentine ants in Northland (Landcare Research database 2006).

Site	Year detected	NZMG Map	NZMG East	NZMG North
114 Reotahi Rd, Whangarei Heads	2001	Q07	26460	65966
52 Sherwood Rd., Whangarei	2001			
Ahipara Beach, Northland	2002	N04	25250	66710
Awakino Rd., Dargaville	2001	P07	25897	65850
Bank St outside building, Whangarei	2001	Q07	26303	66084
Bay View Rd, Paihia	2002	P05	26101	66570
Bayleys Beach, Bayleys Beach	2000	P07	25776	65834
Brooker Bay, Whananaki North	2002	Q06	26424	66349
Dent St., Whangarei	2001	Q07	26302	66078
DOC field centre, Whangarei	2001	Q07	26301	66067
Dutch Point Rd, Norfolk Ave, Reotahi	2001	Q07	26475	65966
end of Seacrest Rd, Langs Beach	2002		26495	65711
Fraser St, Port, Whangarei	2000	Q07	26324	66058
George Point Rd, Whangarei	2002		26332	66049
Goodwin St., Whangarei	2001			
Gordon St, Dargaville	2001	P07	25897	65850
Grey St East, Mangonui	2002	Q05	25592	66905
Handforth St., Whangarei	2001			
Hatea Drive, Whangarei	2002			
Hewlet St., Whangarei	2001	Q07	26323	66057
Hewlett St, Whangarei Port	2000	Q07	26324	66056
Hillcrest Rd, Kaikohe	2002	P05	25821	66436
Islington St, Dargaville	2001	P07	25897	65850
Jacaranda Place, Kerikeri	2002	P05	25973	66634
Kaitaia	2001	O04	25346	66766
Kauika Rd West, Whangarei,	2002		26290	66077
Kerikeri	2000	P05	25938	66674
Langs Beach, Langs Beach	2001	Q08	26491	65715
Long Bay (Long Beach?), Russell	2002	Q05	26137	66596
Mangawhai Heads, Mangawhai	2002	R08	26532	65670
Mangonui	2000	O04	25592	66905
Marsden Point oil refinery,	2002	Q07	26456	65944
Matauhi Road, Russell	2002	Q05	26136	66586
Maungatapere, Whangarei	2004	Q07		
Maungaturoto - Bickerstaff Rd	2002	Q08	26335	65641
Mcleods Bay, McLeods Bay	2002	S11	26998	64821
Mill Bay, Mangonui	2002	Q05	25590	66901
Ngunguru, Northland	2002	Q06	26468	66177
Onerahi, in house, Whangarei	2001	Q07	26341	66039
Onerahi, Whangarei	2002	Q07	26336	66029
outside Astral Marine, Whangarei	2000	Q07	26318	66058
Paroa Bay, Russell	2002	Q05	26171	66575
Parore St, Dargaville	2001	P07	25897	65850
Plunket/Ranfurlly St, Dargaville	2001	P07	25897	65850
Port Rd, Whangarei	2001	Q07	26318	66058
Puckey Ave, Pak 'n' Sav, Kaitaia	2001	O04	25346	66766
Reyburn House, Whangarei	2000	Q07	26306	66077
Rimu St, Dargaville	2001	P07	25897	65850
Riverside Drive, Whangarei	2001			
Rockells Bay, Whananaki	2002	Q06	26422	66352
Ruakaka, beach and dunes	2002	Q07	26416	65867
Russell Heights Road, Russell	2002	Q05	26126	66597
Russell, 46 Oneroa Rd, Russell	2002	Q05	26132	66590
SH1 Awanui, Kaitaia	2002	O04	25343	66837
Station Rd., Whangarei	2001			

The Heights Rd, Reotahi Bay	2002	Q07	26461	65964
Tirarau St, Dargaville	2001	P07	25897	65850
Tokerau Beach	2004	O03	25449	67022
Tutukaka	2002	Q06	26488	66201
Urquharts Bay	2002	Q07	26493	65937
Victoria St, Dargaville	2001	P07	25897	65850
Waipu township, Waipu	2002	Q08	26413	65785
Whananaki, Northland	2001	Q06	26436	66314
Whangaparaoa, Whangaparaoa	2001	R10	26665	65058
Worth St, Kaitaia	2002	O04	25346	66766
