ARGENTINE ANTS ON NORFOLK ISLAND – AN INVESTIGATION INTO THEIR EXTENT AND FUTURE MANAGEMENT OPTIONS
Report of a visit 4th – 10th May, 2008

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Executive summary

- Argentine ants are considered one of the world's worst invasive species with impacts on urban lifestyle, commercial enterprises, agricultural production and the environment
- Norfolk Island provides an ideal environment for Argentine ants and, left untreated, they will eventually spread over its entire land surface area
- The permanent establishment of Argentine ants on Norfolk Island will seriously threaten the island's self sufficiency in horticultural production
- The requirement for the ongoing and increasing use of insecticides with time as the Argentine ant population spreads will cause increased exposure of the island's population to insecticide residues and be a 'trade balance' issue
- The unrestricted spread of Argentine ants on Norfolk Island has potentially serious impacts on the environment with several rare bird species at greatest risk
- The current known extent of Argentine ants on Norfolk Island is limited to two separate infestations – the apparent original infestation of 64 hectares on the western edge of the island and a younger infestation of 12 hectares centred on the Waste Management Centre
- The Waste Management Centre has been selling mulch for the past 18 months and it is probable that further spread of Argentine ants has occurred via this means although follow up surveillance to date has not detected any new infestations
- The options available to the Norfolk Island government are to (1) do nothing and allow the Argentine ant infestation to spread unhindered, (2) contain the infestation by limiting its spread via human-assisted means and (3) attempt eradication
- Eradication is considered practically feasible and is the recommended option
- There are two eradication strategies available for use by the Norfolk Island Government – spray application of the insecticide fipronil at 50gai/ha or use of the bait Xtinguish® at an application rate of 0.3 – 0.6gai/ha
- Use of Xtinguish® bait is the preferred option but current licensing agreements restrict its use to New Zealand. This will need to be resolved prior to its consideration for use in an eradication program on Norfolk Island.

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Background

The existence of a new and unusual ant species on Norfolk Island had been suspected for several years but confirmation that it was *Linepithema humile* (Mayr) (= *Iridomyrmex humilis*), Argentine ant occurred approximately 3 years ago. Since that time no direct co-ordinated action has been taken to control or limit the spread of Argentine ants on the island. However, the extent and density of the Argentine ant population finally reached a level requiring action. John and Vivian Van Dyk, Managers of Flybusters and with experience in Argentine control and eradication in New Zealand, and Peter Davis, Entomologist with the Department of Agriculture and Food Western Australia, with experience with eradication strategies for tramp ants, especially Argentine ants, were invited to the island by the Norfolk Island Government (NIG) to provide advice. The visit took place between Sunday 4th and Saturday 10th May, 2008.

Norfolk Island personnel had already undertaken surveys to determine the extent of the infestation and had identified a second infestation sited at the Waste Management Centre. The Waste Management Centre is a catchment for the entire island accepting all household waste including green waste. Two years ago a mulching machine was installed at the centre and after 6 months of composting mulch was sold to residents.

Activities undertaken throughout the week included:

- Initial briefing meeting with island management personnel
- Initial inspection of the original infested site
- Confirmation of extent of the two known infestations
- Surveys of other high risk sites
- General random surveillance of sites around the island
- Field demonstration of Argentine ants for inspection and identification
- Public meeting to inform interested residents
- Training of island personnel in microscope identification of Argentine ants and distinction from other ants present on the island
- Final briefing of Norfolk Island management on the Argentine ant status and options for management

- **Argentine ants – biology and impacts**

Argentine ant workers are small (3mm long), brown, a uniform shape and size (monomorphic) which move in slow moving, unhurried trails often several to many ants wide. Colonies have multiple queens (polygynous) and all nests in an area remain inter-connected (polydomous nesting

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structure) with a constant exchange of workers and queens (Markin, 1968). All worker caste Argentine ants are sterile females. While reproductive male and female (queen) Argentine ants possess wings, queens are only able to establish new nests with the aid of workers. At least one queen and a dozen attending workers is required for the successful establishment of a viable nest. Therefore, only new nests can be established by queens walking (or floating) to a new site in the company of workers. Worker ants forage, locate food sources, recruit other workers to the food via laying scent trails and monopolise the food thereby denying it to competing ants and other fauna. Typically, new nests are established when foraging workers clear an area of other dominant ant species, locate and secure a food source and then guide a queen or queens to the new site. While this produces a relatively slow rate of expansion, it is offset by a much increased success rate in new nest establishment compared to many other ant species which establish new nests via flight of winged (alate) reproductive castes. Establishment of new nests of many other ant species involves flight and requires mated queens initiating the nest on their own and raising the first brood of workers alone – consequently this method is characterised by high failure rates (>99%). Argentine ants can form super-colonies in which nests over hundreds of kilometres are inter-connected into a single co-operative community (Giraud et al, 2002).
This type of community structure allows Argentine ants to dominate areas and develop huge population densities. In competition with other ants species, especially those with single queen colonies which do not co-operate and are in competition with each other as well as other ant species, Argentine ants displace the other ant species leading to severely depressed ant species richness. Not only are the ants affected but there can be effects on the flora as well since some plants depend on co-evolved ant species to disperse and bury their seeds. Without the seeds being buried more are eaten by birds and mammals (eg rats) leading to reduced survival rates and a change in the floral ecology (Bond and Slingsby, 1984). Argentine ants also impact other animal species including vertebrates such as lizards and birds. Nesting birds are especially at risk with sitting parent birds driven from the nest and hatchlings attacked just after the egg shell is pipped. Local Norfolk Island residents report avoidance of trees in the infested area by terns.

Consequently, Argentine ants are listed in the top 100 worst invasive species by the Global Invasive Species Group.

Honeydew excretions from Homopteran sapsucking insects form the primary food source utilised by Argentine ants but they are also very effective predators, scavengers and harvesters of nectar. Honeydew is high in carbohydrates (mainly simple sugars) but also contains amino acids and lipids and is thus a complete food. Argentine ants literally farm homopteran insects (aphids, scales, mealybugs) by protecting them

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from predators and parasites, transporting juveniles to the new growth of plants and to previously un-infested trees and milking them for the honeydew. Consequently, populations of these plant pests can reach high levels to the point that the thrift and productivity of the infested plants is affected even to the extent that the tree or plant can be killed. The production of honeydew by the scale insects can reach a level whereby it even exceeds the ability of the Argentine ants to remove it resulting in affected trees having their foliage covered with sticky honeydew which eventually serves as a medium for the growth of sooty mould fungus. This black mould covers foliage and further reduces the productivity of plants via reduction of photosynthesis. Many ant species farm homopteran insects but Argentine ants perform this task far more intensively and effectively thereby creating a more severe impact.

Argentine ants also infest bee hives causing increased bee mortality and reduced productivity of hives.

Given that Norfolk Island is self-sufficient in vegetable and fruit production, it is particularly vulnerable to the impacts of Argentine ants. If Argentine ants become widely established over the island, fruit and vegetable production will be significantly affected requiring the frequent and ongoing application of insecticides to control both the Argentine ant populations and the associated pest homopteran insects. Furthermore, the requirement to import insecticides onto Norfolk Island will be an ongoing balance-of-trade commercial issue.

Extent of infestation

Prior to the visit, Norfolk Islanders had undertaken initial surveys and established the boundaries of a large infestation on the west coast and detected another smaller infestation centred on the Waste Management Centre. They had also inspected properties which had received mulch from the Waste Management Centre in the last 6 months but had not detected any other infestations (Figure 1).

Viv and John van Dyk and myself inspected the infestations and surveyed their extent to establish current boundaries. Our surveys confirmed the accuracy of the survey of the western infestation. NIG personnel mapped the infestation (Figure 2) using geographic information system (GIS) software as well as the rate of spread as surveyed by Kane Anderson over the past 5 years. The GIS mapping determined the western infestation to be 63.5 hectares in extent. It should be understood that this is a cadastral plan area and that the actual area is likely to be greater due to topographic complexity. NIG personnel agreed to estimate the real area using a calibrated wheel.

The infestation around the Waste Management Centre was smaller indicating a more recent origin most likely as a result of transport of

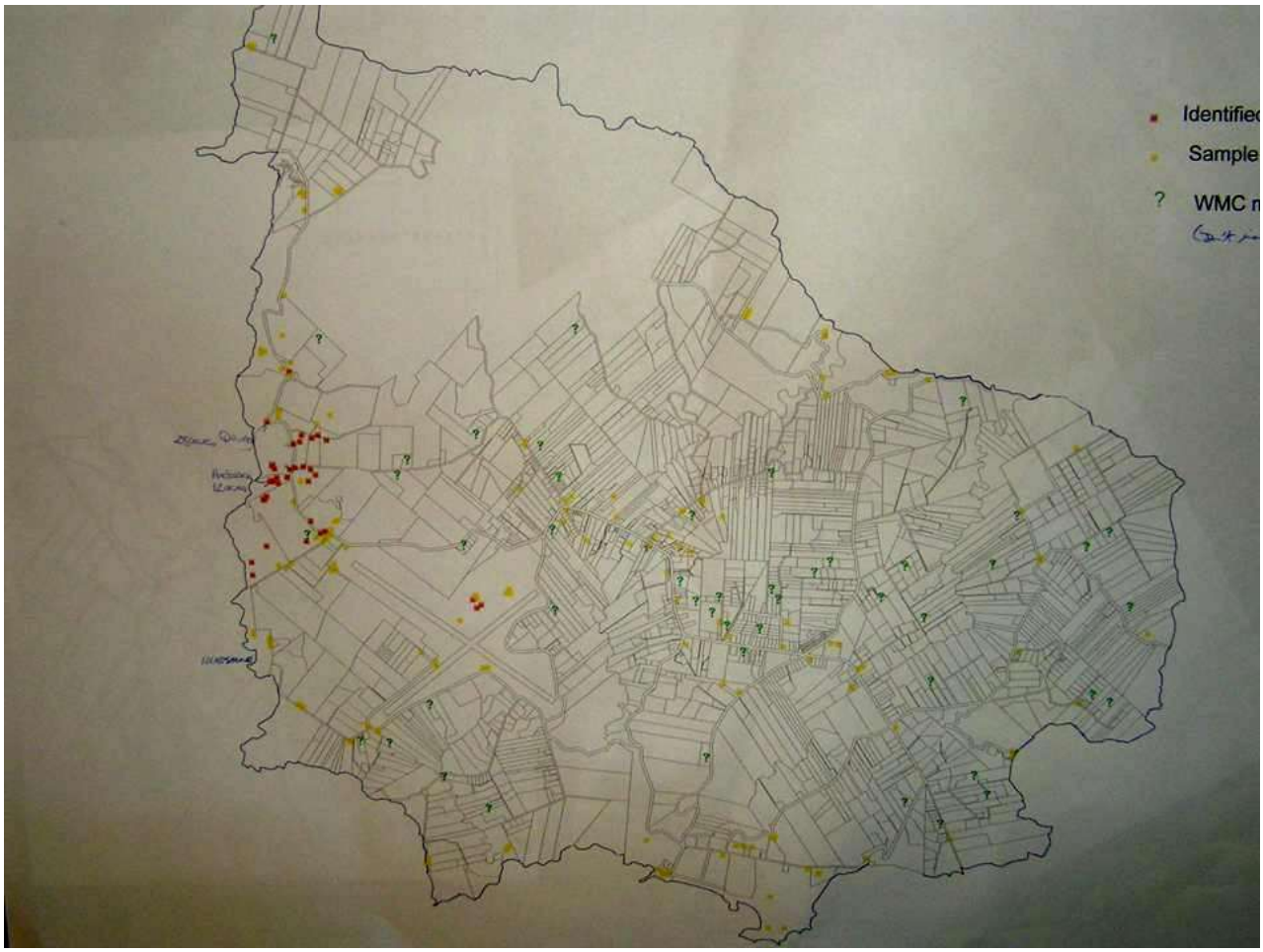

Figure 1: Survey points of initial NIG Argentine ant survey

infested material from the original western infestation. Its extent was not measured using GIS software but is approximately 12 hectares in size.

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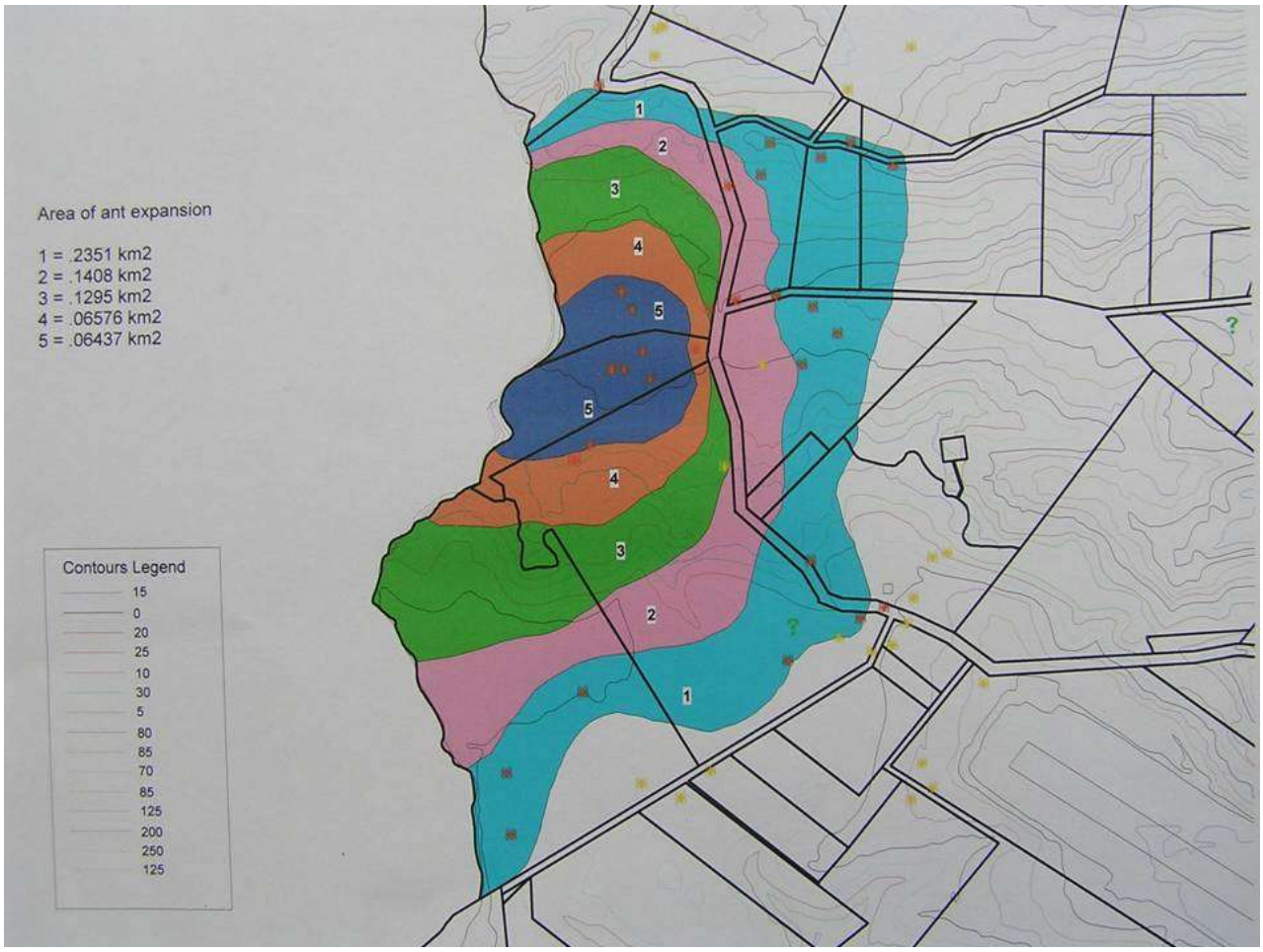

Figure 2: Extent and growth of Argentine ant western (initial) infestation – Norfolk Island

Surveys of other locations included a separate property also owned by one of the property owners in the western infestation, a mushroom enterprise which sources hay from a property on the edge of the infestation, the west coast tip site, some locations which had received mulch from the Waste Management Centre and sites chosen at random to demonstrate that the infestation was limited in extent over Norfolk Island. The results of these surveys appear in Figure 3.

The western infestation demonstrated the extremely high population densities typical of Argentine ants in an environment suited to their biology. The worldwide distribution of Argentine ants is broadly defined as suitable habitats between latitudes 28^0 and 38^0 north and south of the equator. However, exceptions do occur such as the pest populations experienced in Hobart, Tasmania (42^0 south latitude). Norfolk Island, situated at 29^0 south latitude and with its maritime climate of mean

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summer maxima of 26^{0}C and mean winter minima of 13^{0}C is absolutely ideal for Argentine ants.

Figure 3: Survey results. Red = Argentine ants, Blue = Negative for Argentine ants

The western infestation was modelled using a simple equation assuming a radial expansion at the edge of 100 metres per year. This was compared with the estimated and actual infestation sizes as judged by Kane Anderson over the years. The resulting graph (Figure 3) shows that the spread on Norfolk Island has been lower than the theoretical 100m radius expansion per year. However, the western edge of the infestation is bounded by the sea and thus limits expansion in that direction. Also, the road acted as a barrier to spread between areas 3 and 2 on the map (Figure 2). In modelling the estimated spread from the areas estimated to be infested by Kane, the spread radii for successive years was 65m, 75m, 80m and 90m respectively. Therefore, a theoretical spread radius of

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100m per year is a reasonable approximation for growth on the edges of the infestation. On this basis, the western infestation would naturally spread to infest over 1,000ha within another 13 to 14 years unaided by human activities while extrapolation of the estimated current spread rate of the western infestation suggests a slightly slower spread rate taking 18 years to reach 1,000ha. Currently, the infestation is increasing by about 25 - 30ha per year but in 13 – 17 years time it will be increasing by approximately 100ha per year (Table 1).

The models suggest that the western infestation is the initial infestation and is 8 – 9 years old.

The infestation around the Waste Management Centre is smaller and most likely the result of human-aided transport from the western infestation. It is approximately 12ha in cadastral size and estimated to be 3 - 4 years old. It is probable that the infestation has been spread around the site via human activities and therefore it would be easy to over-estimate the age of the population based purely on it's size.

Table1: Spread rates of Argentine ants

	Western Infestation		Theoretical Infestation	
Year of Infestation	Area(ha)	Increase(ha)	Area(ha)	Increase(ha)
1			0.001	
2			0.1	0.09
3			1.0	0.9
4	6.2	6.2	3.1	2.1
5	13.2	7.0	12.6	9.5
6	24.6	11.4	28.3	15.7
7	40.7	16.1	50.3	22.0
8	63.6	22.9	78.6	28.3
9	84.8	21.2	113.1	34.6
10	112.0	27.2	154.0	40.9
11	143.0	31.0	201.1	47.1
12	177.7	34.7	254.6	53.5
13	216.2	38.5	314.3	59.7
14	258.5	42.3	380.3	66.0
15	304.6	46.1	452.6	72.3
16	354.4	49.8	531.1	78.5
17	408.0	53.6	616.0	84.9
18	465.5	57.5	707.1	91.1
19	526.6	61.1	804.5	97.4
20	591.6	65.0	908.3	103.8
21	660.3	68.7	1018.3	110.0
22	732.8	72.5		
23	809.1	76.3		
24	889.1	80.0		
25	973.0	83.9		
26	1060.6	87.6		

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There is little doubt that some distribution of Argentine ants via the mulch has already occurred. While no actual such case has been proven, the fact that the mulch is infested and is an ideal means of distributing queens with workers and that incipient nests are difficult to detect, the risk needs to be acknowledged and contingency plans developed.

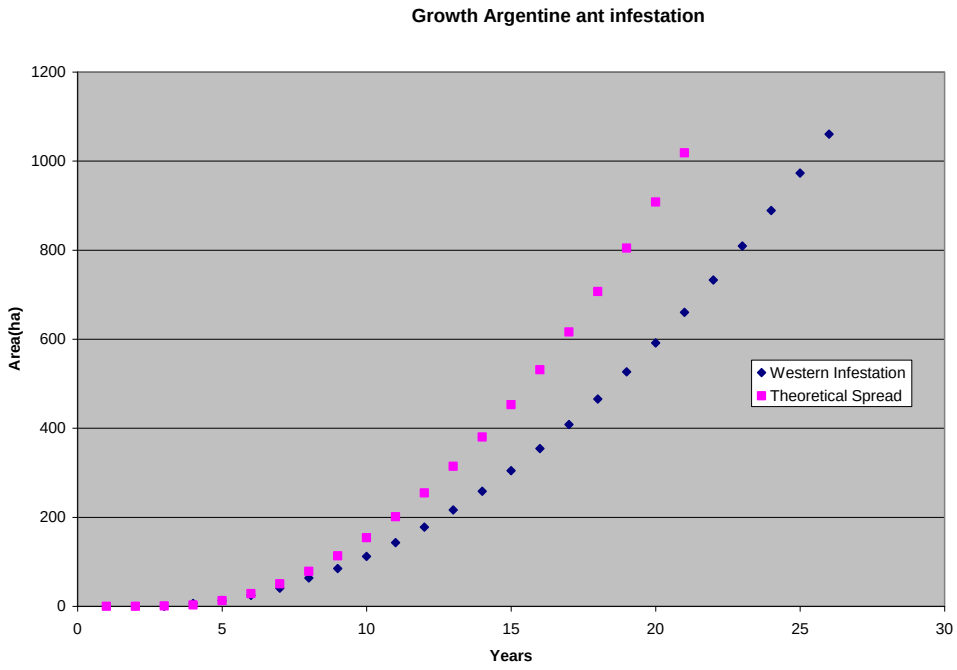

Figure 4: Spread of Argentine ants

Surveillance results – ant fauna

Most of the other ants detected by the limited surveillance possible while we were on the island are known tramp ant species – ants commonly distributed via human-aided means. The preliminary identifications included:

Sub-family Formicinae

- *Camponotus sp*
- *Paratrechina longicornis*, crazy ants

Sub-family Dolichoderinae

- *Iridomyrmex rufoniger gp*
- *Iridomyrmex nr notialis*
- *Linepithema humile,* Argentine ants
- *Ochetellus glaber*, black house ants

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- *Tapinoma melanocephalum*, ghost ants
- *Technomyrmex jocosus*, white-footed house ants

Myrmecinae
- *Cardiocondyla nr nuda*
- *Monomorium sp*
- *Pheidole sp*
- *Tetramorium bicarinatum*
- *Tetramorium nr simillimum*
- *Tetramorium sp*

These identifications do not match well with the species list of ants identified from Norfolk Island and reported in Smithers 1998. This included the following ants:

Sub-family Ponerinae
- *Amblypone australis*
- *Hypoponera punctatissima*
- *Ponera leae*

Sub-family Formicinae
- *Paratrechina obscur*a
- *Paratrechina vaga*

Sub-family Dolichoderinae
- *Iridomyrmex albitarsus*

Sub-familyMyrmecinae
- *Cardiocondyla emeryi*
- *Monomorium sanguinolentum*
- *Monomorium laeve*
- *Pheidole vigilans*
- *Tetramorium antipodum*
- *Tetramorium guineense*

Until the identification of the ants from this most recent survey are confirmed, it is best not to speculate on the significance of their occurrence on Norfolk Island. Despite the lack of agreement between the ant identifications in the two surveys, none of the ants, in either the 1998 list or the 2008 survey, are as pestiferous or invasive as Argentine ants.

Control Options General

Effective management of Argentine ants is difficult using conventional control techniques. At any one time, only 2 – 5% of an Argentine ant

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population is out of the nest foraging. Therefore, even if a spray application killed every ant that was outside the nest, the overall mortality is low and resurgence of high pest ant populations occurs. It should be noted that insecticide sprays which are highly repellent to Argentine ants are likely to be less effective in controlling their populations than less repellent insecticides (Davis and Widmer, unpublished). This is because foraging worker ants are more inclined to avoid residues thereby reducing their exposure and hence mortality. Consequently, residual insecticides which are of low repellency to Argentine ants will be the most effective as sprays. Organophosphorous insecticides, such as chlorpyrifos, diazinon and fenthion, tend to be less repellent and relatively effective in providing control although repeat treatments at 2 – 4 week intervals may be required. The synthetic pyrethroid insecticides such as permethrin, cypermethrin, beta-cyfluthrin and bifenthrin are more repellent and are more effective as barriers than in reducing the actual ant population. Therefore, they can be used around the foundation of buildings to prevent the entry of Argentine ants inside or around fence lines to prevent re-invasion from untreated neighbouring properties.

The avoidance of insecticide residues by foraging worker ants translates into very little insecticide being transferred back into the nests and therefore exposure of the numerous queens to insecticides is negligible. Historically, the control and eradication programs waged against Argentine ants in Australia from the 1950's were effective (but eventually unsuccessful) using conventional sprays only where the highly residual organochlorine insecticides such as dieldrin, chlordane and heptachlor were used. In this case, the residues were so long-lived that foraging workers could not refrain from foraging long enough to avoid exposure to residues and eradication of entire Argentine ant populations was possible. Current registered insecticides are not as residual and all but one insecticide (to my knowledge) are not capable of achieving eradication of entire Argentine ant populations even with multiple applications. The exception is fipronil which is virtually non-repellent to Argentine ant workers and hence they do not avoid foraging when it is applied.

Davis and Widmer 2001, suggested the following approach in relation to their initial report on the options available for the eradication of Red Imported Fire ants in Queensland: *"There are two options for the use of fipronil sprays. The first is as a direct cover spray when the ants are active so that as many foragers as possible are contaminated. Because fipronil is not repellent to ants, they will continue to forage and will not avoid contact as usually happens with other active ingredients. It is possible sufficient active will get back to the nests to achieve eradication. The second option is to use the existing insect/invertebrate fauna as a 'second-stage' bait. If fipronil spray is applied when RIFA are not foraging,*

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few RIFA will be initially affected leaving their foraging capacity essentially intact. However, other insects/invertebrates will be affected and eventually succumb to fipronil whereby they will be predated upon by RIFA and other ant species. Given that these are a protein source it is likely their haemolymph will be transferred to the queens by comparatively direct routes. The insect bodies are also likely to be fed preferentially to the developing larvae resulting in their death. If the queens and brood can be affected there is a good chance the nest will die out. Competing native ants may reduce the effect of an initial spray and a second spray may be needed. If this approach is used, it will possibly need to be applied when the other insect fauna is high. An added advantage of using fipronil as a spray formulation is that it is systemic. It may affect underground homopterans farmed by RIFA, hence affecting RIFA directly and possibly reducing their food sources making them more susceptible to baits. These lines of research will need to be investigated if the baits alone do not prove to be effective." A similar approach could be used against Argentine ants.

This is not a registered use in Australia but fipronil is a non-repellent insecticide capable of achieving eradication of Argentine ants (Davis and Widmer, unpublished).

An alternative approach is to use baits. Baits have the advantage of using the Argentine ants' strength, its huge numbers of foraging workers, against itself by using them to actively collect the toxicant and bring it back to the nest and distribute it among the other nest mates, brood and queens. This means that the amounts of chemical used are drastically reduced (over 100 times) and, since Argentine ants monopolise food sources, also are far more targeted with consequently reduced impacts on non-target organisms.

Currently, there is only one bait known which can achieve eradication of entire populations of Argentine ants – a requirement if total eradication of Argentine ants on Norfolk Island is to be achieved. This bait was developed by Davis, Widmer, van Schagen and Craven of the Department of Agriculture Western Australia and commercialised in New Zealand by BaitTechnology/Flybusters as Xtinguish®.

Table 2 below provides a comparison between Xtinguish® and current registered uses of fipronil in Australia. The rate for controlling diamondback moth, 50gai/ha, is sufficient to achieve eradication of Argentine ant infestations.

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Table 2: Registered uses of fipronil in Australia compared to Xtinguish®

Product	Crop	Pest	Rate	gai/ha
Regent 200g/L	Cabbages, broccoli	Diamond-back moth	250mL/ha	50
	Mushrooms	Flies	16mL/bale	3.2g/bale
	Potatoes	Whitefringed weevil	500mL/ha	100
	Wine grapevines	Fig longicorn	100mL/100L	20+
Xtinguish® Ant Bait 0.1g/kg		Argentine ant	3-6kg/ha	0.3 – 0.6

Options for Argentine ants on Norfolk

Broadly, the options for Argentine ants on Norfolk Island are:

- Do Nothing
- Contain
- Eradicate

There will be consequences to whichever option is followed.

Option 1: Do Nothing

The consequences of dealing with an invasive species which is allowed to establish and for which no co-ordinated action is taken to curb its spread and impacts are permanent, increasing (initially at least) and ongoing. It can be expected that Argentine ants would eventually occupy the entire area of Norfolk Island and nearby islands visited by Norfolk Island residents. The consequences of allowing an unrestricted spread of Argentine ants on Norfolk Island will include:

- Severe impacts on the environment including severely reduced ant species richness, possible flora ecosystem impacts from reduced seed distribution and burial (leading to increased seed predation by birds and rodents) and impact on bird species which nest on the island. Some bird species on Norfolk Island are already endangered and others are rare or uncommon.

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- Most horticultural enterprises and pursuits would be severely and negatively impacted by Argentine ants. It would be almost impossible to undertake effective cultivation of fruit trees and, to a lesser extent vegetables, without ongoing and repetitive use of insecticide sprays to control homopteran insects and the ants themselves. Honey production is also likely to be adversely affected via infestation of bee hives by Argentine ants.
- Argentine ants are a highly invasive pest in urban situations entering houses in large numbers and causing more nuisance than actual damage. Although infestations in electrical equipment and switches can cause problems (and rarely fires), this is not restricted to Argentine ants. Commercial enterprises dealing in the preparation and/or serving of food would be quite adversely affected as control of Argentine ants in such situations is problematic. This also has the potential to impact the tourism industry both via the impacts on food enterprises and infestation of tourist accommodation facilities.
- Given that Argentine ant control is problematic the cost of ongoing control would be significant. This is further complicated by the unco-ordinated control attempts of individuals as compared to organised and co-ordinated programs on a community-wide basis. These latter are difficult to implement in the absence of Government legislation with the power to compel treatment and the widely varying attitude in the community to use of pesticides. Where ant control is left to the discretion of the individual, application of insecticides is unco-ordinated resulting in very inefficient control with Argentine ants re-invading treated areas from neighbouring untreated properties. These in turn can be treated later and re-infested from the previously treated property. Such control is ongoing and expensive in the long term. Further, use of pesticides is ongoing and cumulative over time. The need to constantly import insecticides for control of the ants and associated scale insects would also have a balance–of-trade aspect.

If the 'Do Nothing' option is chosen then there are strategies which can be implemented to effect management on an ongoing basis. However, there are no baits currently registered which are proven effective in the control of Argentine ants. Commercial liquid baits containing the active ingredients borax or imidacloprid may have some impact but control of large external populations of Argentine ants is wanting.

Since Argentine ant nesting is almost exclusively external to buildings (except where indoor gardens or other situations offering moist soil are present) this allows the use of insecticide sprays as outlined in the Gardennote (Davis and Widmer, Department of Agriculture and Food). As above, it should be noted that insecticide sprays which are highly

repellent to Argentine ants are likely to be less effective in controlling their populations than less repellent insecticides. Consequently, residual insecticides which are of low repellency to Argentine ants will be the most effective as sprays. Organophosphorous insecticides, such as chlorpyrifos, diazinon and fenthion, tend to be less repellent and relatively effective in providing control although repeat treatments at 2 – 4 week intervals may be required. The synthetic pyrethroid insecticides such as permethrin, cypermethrin, beta-cyfluthrin and bifenthrin are more repellent and are more effective as barriers than in reducing the actual ant population. Therefore, they can be used around the foundation of buildings to prevent the entry of Argentine ants inside or around fence lines to prevent re-invasion from untreated neighbouring properties.

Option 2: Containment

The most rapid rate of spread of Argentine ants is via human-assisted transport of infested items. Because Argentine ant colonies contain many hundreds or even thousands of queen ants (depending on the size of the colony) and they nest in pot plants, logs, mulch, piping and soil, they are readily spread. As above, the natural rate of spread of Argentine ants is essentially a radial spread from the edge at up to 100m per year. If the spread of the Argentine ant infestation can be limited to its natural rate then its impact on Norfolk Island will be significantly slowed. The time gained from this strategy will reduce the overall impacts and delay the requirement to implement control and hence reduce insecticide usage. It may also be valuable in that new technology in the future may provide another option which could be used if the population is still contained.

The Waste Management Centre represents the greatest risk of spread at this point in time. Sale and movement of mulch and other materials and equipment out of the centre needs to be prevented as much as possible immediately. Consideration may need to be given to disinfestation and relocation of the mulching machine to allow for the treatment and use of new garden refuse.

Given that the size of the infestation at the Waste Management Centre is small (~12ha) it may be possible to attempt eradication at this site using baits. This could be either achieved using Xtinguish® bait if negotiations can free its use or the Department of Agriculture and Food Western Australia could manufacture bait for this limited area if that permission is not forthcoming.

An example of the need for vigilance occurred during our visit when a bulldozer was about to be transferred from the Waste Management Centre to an area of National Park. The bulldozer was contaminated with significant quantities of soil which was found to contain Argentine ants.

All vehicles and equipment which needs to move out of the Waste Management Centre needs to be housed outside the infested area. Another example involved the grading of Headstone Road where a front-end loader was observed grading the road edge and moving soil excess which was destined to be trucked to another site.

Rubbish bins at infested properties may need to be treated with insecticide (at least monthly application of a synthetic pyrethroid insecticide to both the inside and outside of the bins) and possibly placed on ground treated with a similar chemical, preferably bifenthrin granules. Further, the transport of other commodities such as hay and bee hives will need to be regulated.

It is almost certain that some spread of viable Argentine ant colonies has occurred in mulch sourced from the centre. All the records of sales need to be investigated and all destination properties surveyed. This needs to be done at least annually for the next two years to ensure infestations are detected and treated. The follow-ups undertaken so far have not detected any infestations spread via mulch but incipient infestations are not obvious and difficult to find. If any such infestations are discovered they need to be eradicated. This can be achieved via spray application of fipronil.

This is not a registered use in Australia but fipronil is a non-repellent insecticide capable of achieving eradication of Argentine ants (Davis and Widmer, unpublished). Fipronil (as the product Regent®) is registered in Australia for the control of diamondback moth on cabbages and broccoli up to a rate of 50gai/ha. This rate would be sufficient to achieve eradication of Argentine ants where small isolated infestations are discovered.

Option 3: Attempt Eradication

The establishment of an exotic pest, such as Argentine ant, is permanent and forever with ongoing impacts on lifestyle, commercial enterprises, agricultural production and the environment. Successful eradication of Argentine ants on Norfolk Island would be the ultimate goal. Eradication programs have the following components:

- Define 'Eradication Zone'
- Locate all infestations
- Prevent further introduction of exotic pest
- Delimit extent of infestations
- Prevent spread from infestations
- Eradicate within infestations

The first five components are relatively easy to achieve on Norfolk Island although the ability to prevent the transport and spread of infestations from privately owned land needs to be investigated to ensure compliance can be legally enforced.

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Achieving eradication of Argentine ants at all infested sites does pose logistical problems. There are two broad options for achieving eradication – spray application of fipronil at 50gai/ha or use of Xtinguish® at 0.3 – 0.6gai/ha. The bait is the preferred option but is restricted for sale and use to New Zealand via the licensing agreement of the active ingredient fipronil. There may be opportunities to have this extended for use on Norfolk Island given the extenuating circumstances and this should be investigated at the earliest opportunity if the eradication option is seriously considered. Alternatively, BaitTechnology could supply matrix only to Department of Agriculture and Food Western Australia personnel who could incorporate toxicant into it on the island and use it on a non-commercial, trial permit basis. This would overcome the licensing problems if they could not be resolved.

The size of the western infestation, currently estimated to be 63.5ha in extent on a cadastral basis is probably closer to 90ha in real terms and as such represents a very large area in which to achieve eradication using hand application via mastic guns. As the area increases in size, the complexities and difficulty in achieving eradication increase. Davis, Widmer, van Schagen and Craven have successfully treated areas up to 25ha in extent and the van Dyk's have achieved eradication of Argentine ants on ecologically sensitive islands in New Zealand using baits. The New Zealand experience was achieved in topographically challenging circumstances.

The western infestation is bounded by high and steep cliffs descending down directly into the sea. This will present severe challenges in applying baits in the even and methodical way required to achieve eradication. It was suggested that the Norfolk Island volunteer rescue group, experienced in rappelling down cliff faces, may be interested in applying the bait in this difficult terrain. This does present a possible solution to this difficult problem.

It is worthwhile putting the Norfolk situation into perspective with another Argentine ant eradication program. Argentine ants were first detected in Western Australia in 1941 but effective eradication strategies were not developed until 1954 when an eradication program was mounted. At that time the size of the infestation was estimated to be 17,000ha in extent and included wetlands and farmland. The program was based on the use of the persistent organochlorine insecticides of dieldrin and heptachlor and was terminated in 1988 when use of these was not supported by public opinion. At that time only 1,458ha of Argentine ant infestation was known to exist of which 75% was in areas such as wetlands and farmland which was not able to be treated. What this does demonstrate is that it is quite feasible to eradicate Argentine ant infestations and the current options of either baits or sprays containing fipronil are improved over the organochlorine sprays of the

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past. Norfolk Island, with its combined infestations totalling less than 100ha, is a comparatively simple situation and, therefore, eradication of Argentine ants on Norfolk Island is considered possible.

Although it would be more efficient and cost-effective to attempt eradication in a single treatment, the operation could be phased through the eradication of smaller sections of the infestation, for example around the Waste Management Centre and initially to the east of Headstone Road.

As above, before eradication can be seriously considered, the NIG must be sure that it has sufficient legal power to compel treatment of all infested land if it proves necessary where private land owners object to treatment. If this pre-condition can be met then eradication should be seriously considered. Eradication, while initially being the most costly option, has the benefit of possibly being the cheapest in the long term as it saves on the impacts and repetitive and ongoing application of insecticides into the long-distant future. The environmental and ecological impacts from Argentine ants will also be minimised.

For an eradication program to be successful all infestations need to be detected. Early detection of infestations is key as it reduces the opportunities for spread prior to discovery, increases the chances of eradicating the infestation and decreases the cost of the program. It is therefore imperative that the Norfolk Island community are actively engaged in the surveillance for Argentine ants.

If a co-ordinated control program is implemented, livestock will need to be excluded from the areas being treated. This is not only to avoid insecticide residue issues but to prevent any disturbance which could reduce the efficacy of the treatment. Cattle can adversely impact the use of the bait simply by walking on it and removing its availability to the ants. The large numbers of feral chickens could also pose a problem as would domestic dogs and cats if they ate the bait and reduced its availability to the ants. These factors can be taken into consideration in a more detailed action plan if a program is attempted.

There is no guarantee that an eradication program will be successful and this needs to be given due consideration when assessing the costs and options for dealing with the Argentine ant infestation on Norfolk Island. However, the size of the Argentine ant populations and the two suggested options available for achieving eradication, provide a high degree of confidence that eradication is feasible.

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NOTE:

This visit was undertaken on the basis of a private consultancy and not as an agent of the Department of Agriculture and Food, Western Australia.

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