INVASIVE ANTS ON CHRISTMAS ISLAND

DRAFT ACTION PLAN – with appendix

FEB 03 – FEB 05

Background

This action plan has been prepared by Parks Australia North in conjunction with the Christmas Island Crazy Ant Management Steering Committee. Its primary aim is to control and mitigate the impact of the invasive yellow crazy ant *Anololepis gracilipes* on the ecology of Christmas Island, Indian Ocean. In conjunction with poison baiting, monitoring and education are key components of this action plan.

In the Risk Watch list compiled for the Christmas Island National Park and Conservancy, the crazy ant invasion was rated as a high risk to biodiversity and conservation values, with catastrophic consequences of failure to implement effective control measures. The most obvious impact has been on the red crab with local populations of red crabs completely wiped out in areas of where supercolonies have formed, and at least 30 to 50% of all red crabs on Christmas Island have been killed since the mid to late 1990s. Prior to aerial baiting, over 90% of ant infestations were found within the National Park.

After an exhaustive island-wide survey in 2001, supercolonies of the crazy ant*s* were found to infest around 2500 ha of forest on Christmas Island. This ant, and its scale insect mutualists, are having a range of devastating impacts on the biota of the island. After unsuccessful laboratory and field trials with several commercially available ant poisons, PAN identified a fish-meal bait with an active constituent of fipronil at 0.1 g kg^{-1}, a broad spectrum, neurotoxic insecticide, as appropriate for controlling crazy ants on Christmas Island. Up until August 2002, 371 ha of infested forest had been treated by hand broadcasting bait. The majority of the remaining infestations were impossible to bait effectively on foot.

Following a review of progress of the control program at the end of 2001, the Steering Committee recommended that alternative strategies be investigated for the control of crazy ant supercolonies on Christmas Island. Orchard et al. (2002) identified the use of a helicopter for dispersing toxic ant bait as a feasible and cost-effective alternative to the on-ground baiting program, and the use of a helicopter as a means of dispersing bait was unanimously endorsed by the Steering Committee in February 2002.

The aerial baiting operation occurred in September 2002 in two phases. In the first phase, a trial covering 292 ha was conducted in order to identify the most appropriate application rate of the bait (4 or 6 kg ha^{-1}), and to estimate the degree of bait penetration through the canopy to ground level. In the second phase (after a successful trial, and endorsement from the Steering Committee), baiting of all other areas of infested forest with ant bait at 0.1g kg^{-1} at an application rate of 4kg ha^{-1} was undertaken.

The benefits of such an island-wide, simultaneous reduction in crazy ant infestations were manifold and included:

- A decreased likelihood of future supercolony formation.
- The preservation of remaining land crab populations (especially red crabs and robber crabs), already severely impacted by crazy ants. In the longer term, these populations should recover, and land crabs will

resume their regulatory control over many aspects of ecosystem functioning on the island. In addition, re-established land crab populations should control the invasion of other exotic species, which are entering the forest in the wake of crazy ants.

- Preservation of other vertebrate & invertebrate populations that are impacted by crazy ants to an unknown degree.
- The preservation of high quality forest habitat for native species. By relieving plant stress induced by scale insects, rates of canopy dieback should slow, and in the longer term, the canopy in affected areas should begin to recover.
- The proposed control operation provided a unique opportunity for Parks Australia North to highlight its commitment to the maintenance of biodiversity and conservation values of the National Park. By reducing ant density to very low levels, the operation will improve the recreational and educational values of many areas currently infested with ants.

During 2002, Parks Australia North completed a number of activities to facilitate the success of the aerial baiting program. Boundaries of all infestations identified during and after the 2001 island wide survey have been accurately mapped and entered into the Christmas Island GIS. A thorough environmental assessment report has been produced, and a referral submitted to EA under the Environmental Protection and Biodiversity Conservation Act 1999. Environment Australia approved the aerial baiting program subject to a number of conditions.

An aerial baiting trial was undertaken on the 8 and 9th of September, 2002 to :

1. assess the efficacy of bait delivery by helicopter for controlling crazy ant supercolonies, by monitoring ant activity at replicate trial sites both before and after bait application;
2. trial two-bait application rates (4 & 6 kg ha^{-1}) at replicate sites, to identify the lowest effective rate for supercolony control;
3. assess the degree of bait penetration through the canopy to ground level at replicate trial sites;
4. trial the use of a lower-concentration bait (0.01 g kg^{-1}) for crazy ant control after 2002;

Following the success of the trial, the Steering Committee approved (on 13 September 2002) the second stage of the aerial baiting campaign; the eradication of all known supercolonies on Christmas Island, using the higher concentration bait at a rate of 4 kg/ha. More than 2100 ha were treated by helicopter in the period 14-21 September. The only known supercolonies not treated by helicopter were several areas near freshwater streams and soaks (total untreated area 33.4 ha), and five Monash University research plots (total area 42.8 ha). The record of flight paths downloaded from the helicopter's differential GPS showed, in exquisite detail, that the pilot achieved blanket coverage in all target supercolonies, totaling more then 2500 ha (including the trial plots).

A further 134 hectares of supercolonies have been hand baited between the end of the aerial baiting program (exclusion areas, research plots and newly discovered supercolonies) and the commencement of the Island Wide Survey in June 2003, bringing the total area baited to over 3000 hectares since the commencement of the control program in 2000.

Between June and August 2003 an island-wide survey was undertaken to determine yellow crazy ant and red crab distribution and abundance. This survey replicated the 972 belt transects from the 2001 survey. The survey confirmed the success of the aerial baiting program but also identified between 30 and 40 small supercolonies. A summary of the survey results is attached (see Attachment 1)).

Research and education have also been concentrated on during the last four years. Research into ant dynamics, ant-scale interactions, and the impact of crazy ants on species of high conservation value has provided valuable information which can be fed immediately into on-ground PAN management decisions. Research into the impact of baiting on non-target litter invertebrates and canopy fauna were also completed. . Public information has been mediated via regular 'Islander' articles, static displays and public meetings.

A key to the success of the program includes effective administrative arrangements and the provision of adequate resources. Australian Research Council SPIRT and Parks Australia North funding has allowed an extensive Monash University research project into various aspects of the crazy ant to take place. This research

project concluded in March 2003. Future funding requirements to implement the action plan are dependent upon the degree of success of the aerial baiting program, but continued baiting will have to carried out for an unknown period. Finally, an ongoing monitoring program of ant infestations and the success of ground and aerial baiting in reducing supercolony infestations will need to be adequately resourced.

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1. Background

1.1 This plan has been prepared by Parks Australia North (PAN) in response to the report '*Status, Impact and Recommendations for Research and Management of Exotic Invasive Ants in Christmas Island National Park'* by Dr D. J. O'Dowd, Dr P. T. Green, and Prof P. S. Lake. The concerns of these authors about the potential impact of the ants on the islands ecology are shared by PAN. Accordingly, this issue is a top priority for the Christmas Island conservancy.

1.2 Although the report addresses invasive ants in the Christmas Island National Park, it highlights the need to manage ants on a 'whole island' basis. Part 9 of the Regulations under the *Environmental Protection and Biodiversity Conservation Act 1999* apply outside the national park boundaries and PAN has a legal responsibility for conservation outside the park. However, other agencies and organisations (ie the Christmas Island Administration, Christmas Island Phosphates (CIP) and the Shire of Christmas Island (SOCI)) also have land management responsibilities . These agencies are regularly updated about crazy ant management issues, and their support and involvement has been harnessed.

1.3 A Steering Committee was established in June 1999 see attachment 1.

1.4 This plan was originally prepared in February 1999, and revisions completed in February 2000, March 2001, April and August 2002. The current version is the fifth revision, and the first since the aerial baiting program was undertaken in September 2002.

2. Goals and Objectives

The goal of this plan is to conserve the unique tropical rainforest system of Christmas Island and its natural ecological processes. This is being achieved by undertaking research, management, and education directed towards control and mitigation of the impact of the yellow crazy ant *Anololepis gracilipes* on the ecology of Christmas Island, Indian Ocean.

Specific management objectives are to:

- eradicate all yellow crazy ant supercolonies as soon as possible after detection.
- regularly monitor yellow crazy ant distribution and abundance across the entire Island.
- endeavour to prevent spread of crazy ants into uninfested areas by means of public education, quarantine management and monitoring.
- avoid extensive ecosystem disruption on the island, primarily by preventing (a) massive reduction in numbers of endemic land crabs that largely regulate forest regeneration and ecosystem processes and (b) canopy dieback as a result of scale insect outbreaks;
- prevent massive population reductions, if not extinctions, of island endemic species and species of conservation value, including vulnerable and endangered seabirds, land birds, reptiles, and mammals.

3. Action Plan

3.1 Monitoring, surveillance and follow-up control.

The success of the aerial baiting program means that the crazy ant control program is now moving from crisis management to longer-term maintenance management. An essential part of a control program is long-term monitoring, surveillance and follow-up action.

Strategy	Action	Status/Timeline	Officer Responsible
3.1.1 Systematically survey the distribution and abundance of *Anoplolepis* across the island. Also monitor ant impacts through crab burrow counts.	Carry out initial survey	Island Wide Survey completed in June 2001. (The survey was conducted by 3 teams of 2 people working for 13 weeks).	Mick Jeffery and Steve Comport.
	A follow up island wide survey will take place in 2003 and 2005.	2003 survey completed.	
3.1.2 Monitor the long term effectiveness and outcomes of the baiting program	Monitoring of areas pre and post ground baiting over a range of sites and baiting years (2000 to 2002).	Ongoing, begun November 2000. From June 03, 15 Waypoints will be used as permanent monitoring points. Monitoring to occur twice yearly.	Mick Jeffery, Steve Comport
	Monitoring of crazy ant numbers pre and post aerial baiting	Commenced August 2002. 44 Waypoints will be monitored twice yearly.	
3.1.3 Monitor the long term effectiveness of bait concentration and application rates.	Monitoring of crazy ant numbers in aerial baiting trial plots.	Monitoring of 8 trial plots to occur three times per year.	Mick Jeffery, Steve Comport
3.1.4 Surveillance	Passive surveillance as part of duties of all PANCI staff	Ongoing	PANCI staff
3.1.5 Monitor the impact of baiting on non-target vertebrates	Investigate the potential impacts on non-target vertebrates.	Commenced in Sept 2002. Final survey completed in April 2003.	JCU Team
3.1.6 Determine with more accuracy the boundaries of infestations	Where supercolonies are identified the boundaries of these will be carefully mapped prior to the control phase.	After Island Wide Survey – Aug to Nov 03. Dry season 2004.	Mick Jeffery, Steve Comport.
3.1.7 Targeted control activities	Hand baiting of remaining and newly detected supercolonies.	Before and after Island Wide Survey in 2003. During dry season 2004.	Mick Jeffery, Steve Comport

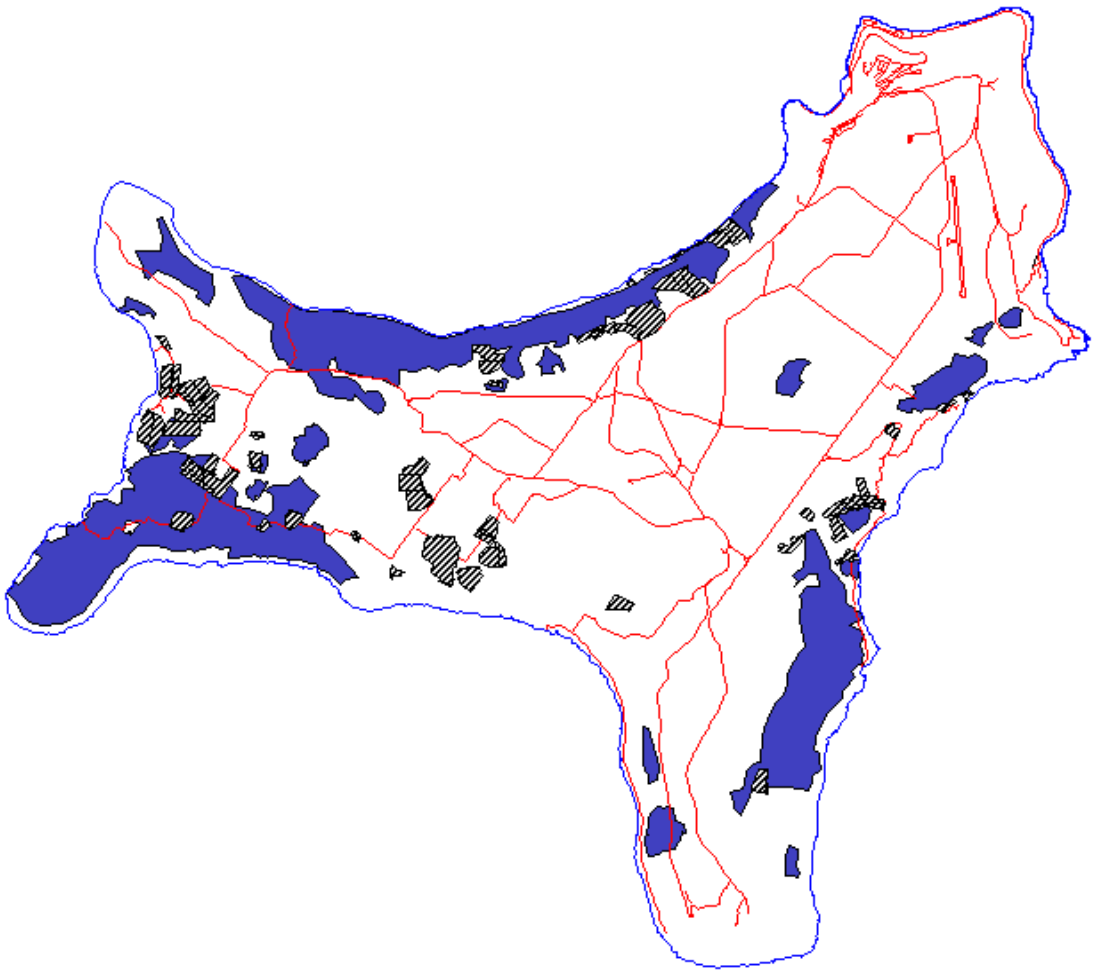
3.1.8 Aerial baiting	If monitoring indicates that supercolonies have expanded to the point that they cannot be controlled by hand baiting, further aerial baiting will need to be considered.	When required.	CA Steering Committee, PAN Darwin, Conservator.

3.1.9 Monitoring & Control Program Timelines and Outcomes

Approximate timeline for monitoring and control activities showing May-December in each of 2002-2005. Major activities are confined to the dry season (May-November) in each year. Grey fill for follow-up control indicates lower effort during the island-wide surveys. R = meeting focusing on review; P = meeting focusing on planning.

	2002								2003								2004								2005							
Month	M	J	J	A	S	O	N	D	M	J	J	A	S	O	N	D	M	J	J	A	S	O	N	D	M	J	J	A	S	O	N	D
Monitoring																																
Island-wide Survey																																
Hi-lo aerial baiting trial																																
Hand-baited/ Heli-waypoints																																
Control																																
Island-wide aerial baiting																																
Follow-up Control																																
Planning/Review																																
Steering Comm. meeting								R	P							R	P							R	P							R

3.1.10 Map of Previously Baited Infestations



Map of aerial baited infestations marked in solid colour, and hand baited infestations (2000 –2003) marked in dark stripe (pre 2003 island wide survey).

3.2 Resources

3.2.1 Resource Requirements for 2002/03

Activity	Details	Resource Requirements	2002/3
Aerial treatment of ant infestations - helicopter	Baiting of over 2400 ha of ant infestations using a helicopter. Baiting will conducted in Sept 2002	Bell 47 Soloy helicopter for a minimum of 30 hours	$135,000
Aerial treatment - bait requirements	Aerial treatment with Presto will be at 5.5kg/ha	At an average rate of 5.5kg/ha x 2400ha we need 13,000kg of bait @ $19/kg.	$247,000
Monitoring ant densities in aerial baited areas in conjunction with hand baiting of remaining	Regular monitoring of selected points in areas baited by helicopter. Hand baiting of remaining	One Project Officer (40 weeks), three people for 7 months, one person for 3 months.	$147,400

infestations.	research plots, exclusion zones and newly detected supercolonies.		
SPIRT grant field assistance	Under the SPIRT grant PAN agreed to provide 20 weeks per year field assistance	One person for 15 weeks (until March 03)	$13,200
Operational Costs	Vehicle, fuel, admin. costs, equipment, consumables, freight, etc..		$32,000
Total			**$574,600**

3.2.2 Resource Requirements for 2003/04 (estimates)

Activity	**Details**	**Resource Requirements**	**2003/4**
Bait requirements	Hand baiting with Presto will be at 4 to 6 kg/ha	. Approximately 600 kg. Currently 2000 kg in storage.	$11,400 (in stock – no additional purchase required)
Monitoring ant densities in ground and aerial baited areas (including island wide survey) in conjunction with hand baiting of remaining infestations	Regular monitoring of selected points in areas baited by hand and by helicopter. Area to be baited	One Project Officer (40 weeks), Invasive Species Team (3 person) for 7 months. Additional casuals (3) for baiting supercolonies discovered during island survey.	$182,000
Island wide survey	Intensive survey of 1025 points across the entire island	Employ additional three people for 8 weeks	$24,300
Operational Costs	Vehicle, fuel, admin. costs, equipment, consumables, freight, etc..		$13,000
Total			**$230,700**

3.2.3 Identify resource requirements including grant funding programs

Strategy	Action	Resources	Officer Responsible
3.6.1 Identify and obtain resources	Identify PAN/EA resources available. Allocate resources to reflect the priority of this issue.	Endeavour to include cost of crazy ant program within PANCI's operational budget. Currently only Project Officer's salary and some minor operationsl costs are covered by PAN budget.	Julian Barry, Conservator, Zuraidah Mohamed
	ARC SPIRT grant	Expended	
	NHT application submitted.	$100,000 NHT grant approved for 03/04	

3.3 Public Relations/Liaison with other agencies

The crazy ant issue has attracted considerable media attention, interest from environmental groups within Australia, and the Christmas Island community. It is vital to keep information on the situation and what action is being undertaken up to date and readily available.

Strategy	Action	Status/Timeline	Officer Responsible
3.3.1. Brief the Christmas Island National Park Advisory Committee (CINPAC) on the situation	Maintain liaison with CINPAC members, providing regular updates on progress.	When CINPAC is re-established.	Conservator PANCI
3.3.2. Brief CI Admin/Territories Office, CI Quarantine Officer, SOCI and CIP on the situation	As per above.	Ongoing	Conservator PANCI
3.3.3. Inform the local CI community	Keep the local community informed via articles in the *'Islander'*, interviews on Radio VLU2 and presentations at other forums eg Community Consultative Committee (CCC)	Ongoing. Community presentation of island wide survey results completed in October 03.	Conservator PANCI / Natural Resources Manager
3.3.4 Keep senior EA officers and the Minister informed of developments. Prepare and release articles for the general media and for specialist science and nature media.	Prepare these when appropriate	Ongoing. National media exposure of success of aerial baiting program in Feb 2003.	Conservator & NRM PANCI, Dale Starr, Julian Barry
3.3.5 Develop interpretation / communications strategy material associated with crazy ants	Design an interpretation flier to be inserted in the red crab brochure and posted on the Christmas Island web site and the EA Invasive Species web site.	Completed and distributed. The interpretation flier was translated into Mandarin and Malay.	Dale Starr, Julian Barry, Max Orchard and CI staff

3.4 Consider **Anoplolepis** *invasion in the broader management plans for Christmas Island National Park*

Strategy	**Action**	**Status/Timeline**	**Officer Responsible**
3.5.1 Incorporate impact assessment and mitigation in the revision of the Christmas Island National Park Management Plan	Incorporate appropriate text about crazy ants into the Management Plan	Action completed.	Conservator PANCI
3.5.2 Consider nomination of crazy ants as a key threatening process, The Dales as a threatened ecological community, the blue crab and the red crab as threatened species	Crazy ants as a KTP application submitted to EA in Feb 03.	Scientific Committee meets to review application in December 03. Entire process could take 15 months.	Dennis O'Dowd

4. Administration and Management

The Steering Committee oversees the program and meets regularly by teleconference. The steering committee comprises scientific experts including a leading ant ecologist and chairperson Dr Alan Andersen (CSIRO Darwin); an eminent wildlife ecologist with Christmas Island experience Dr Hal Cogger (Australian Museum); an expert on Christmas Island rainforests Dr Peter Green (Monash University); an expert in the ecology and management of invasive species Dr Dennis O'Dowd (Monash University); an entomologist with leading expertise in the control of social insects Mr Peter Davis (WA Agriculture); an expert in the ecology and management of pest ants Dr Cas Vanderwoude (QLD Department of Primary Industries); Dr Gerry Maynes (Wildlife Australia EA); Alistair Graham & Mick Jeffery (Parks Australia North).

Both the steering committee and the action plan should have a sunset clause of 3 years (*this period can be shortened or lengthened if necessary)*. Although it is highly likely that invasive ants will continue to be a concern on the island for many years it is appropriate that management action not be too open ended. A set period will enable actions to be more focused and adherence to deadlines and time frames. Progress should be reviewed at the end of this period.

Terms of Reference for the Steering Committee are:

1. Recognising the special conservation value of Christmas Island and the threat posed by *Anoplolepis*, as a matter of priority
2. Review and report on the situation
3. Develop a strategy to manage *Anoplolepis* and reduce or remove its impact on the flora and fauna
4. Implement the actions and/or recommendations of the report and strategy.

In terms of project management, the SC reports to Mr Julian Barry (Programs Director Parks Australia North, Darwin Office). On ground day to day management of this project is the responsibility of the Project Officer and the Natural Resources Manager for Parks Australia on Christmas Island.

Administrative Issues

Action	**Timeline**	**Officer Responsible**
Crazy Ant Management Steering Committee Meeting Schedule	To be held in April and November each year.	Julian Barry
Minutes of Steering Committee meetings	Within 2 weeks of each steering meeting.	Steve Comport
Update Crazy Ant Action Plan	Prior to the Biannual CASC meetings.	Mick Jeffery

Attachment 1.

Summary of Results from the 2003 Island Wide Survey
Parks Australia North, Christmas Island

Introduction

The established island-wide survey network is the cornerstone of an effective monitoring program. This survey, comprising a grid network of 1023 waypoints across the island and built upon the Christmas Island GIS, was conducted initially in 2001 to identify the spatial extent of crazy ant supercolonies and the island-wide status of the red land crab. Additional island-wide surveys are essential. The survey conducted in the dry season of 2003 aimed to capture the short and longer-term effectiveness of the control program (particularly the helicopter baiting program), to identify areas of concern for future supercolony formation, to direct follow-up control, and to determine patterns of population recovery by the red crab. The assessment of recovery is restricted to the red land crab because it is a documented indicator species for the status of island rainforest.

In 2001, 972 of the 1023 waypoints were accessible for survey work. In 2003, all but 4 of the 972 points were replicated, plus an additional 11 points which were not accessed in 2001. A further 9 new waypoints within hand-baiting areas were added where there was no pre-exiting survey point. Thus a total of 988 waypoints were surveyed in 2003.

Results

General

GPS coverage – only 49 survey points with no GPS coverage versus 255 during 2001 survey, giving greater accuracy in locating survey points.

Yellow crazy ants (see attached PDF files for maps).

Supercolony density (greater than or equal to a total of 38 ants recorded at a survey point– sampling points at 5m intervals along a 50m transect line) was identified at 30 points in 2003, a dramatic improvement on the 188 points in 2001. A summary of the ant counts is found in Table 1.

Level of Ants	**2001 Survey Points**	**2003 Survey Points**
Supercolony (≥38 ants)	188	30
Medium (20 – 37 ants)	30	19
Low (1 –19)	110	143
Present (in area, not on card)	62	147
Nil	582	649
TOTAL POINTS	972	988

Table 1: Comparison of ant counts between survey years.

On a few occasions, supercolonies were also identified in between survey points. These locations were noted for follow up mapping and baiting. A total of 32 sites were listed as high priority baiting sites based on a number of factors:

- Presence of supercolony (or nearing supercolony density) or,
- Presence of dead, anted crabs or,
- Supercolony located within crab migration path or,
- Supercolony located adjacent to aerial baited site and/or inaccessible terrain.

Eighteen of these thirty two sites are located an shore terraces, while the remaining 14 are located on the plateau.

General comments:

- No supercolonies identified in any of the previous hand baiting sites (over 420 hectares since 2000 - excluding the 86 hectares which were baited again by the helicopter). Supercolonies have developed in some areas adjacent to hand baiting sites (eg WayPts 369, 401, 354), indicating a possible need to review baiting and monitoring methods close to supercolony boundaries.
- Most of the newly identified supercolonies can be accessed for ground baiting, but some areas (such as above the Chinese Cemetary) are inaccessible. Cost effective methods for containing and treating these inaccessible supercolonies needs to be considered.
- The size of the new supercolonies ranges from 1 to 20 hectares (excluding the cemetery supercolony). An estimated total of 300 to 500 hectares of crazy ant supercolonies existed as of mid August 2003. Of this area, 101 hectares had been hand baited as of October 21, 2003.
- Particular areas of the island are displaying expansions of ants and overall increases in numbers. The Blowholes / Middle Point area and NE of the island are of most concern.
- Ants are also becoming more widespread in plateau environments. Further analysis is required to draw conclusions from this raw data. One concerning trend is that recent expansions of ants on the plateau appear to be directly related to roads. Vehicles could be facilitating a spread of crazy ants to uninfected areas, in combination with providing a constant supply of ants to existing and previously baited areas.

Aerial baiting effectiveness:

- Aerial baiting was extremely effective, with supercolonies totaling only 5 hectares identified in aerial baited areas (approx. 2500 hectares). These supercolonies are due to reinvasion of aerial baited sites from surrounding areas. The time lag between mapping supercolony boundaries in early to mid 2002 and bait dispersal in September 2002 allowed some supercolonies to expand, remain untreated and become a source of reinvasion. New supercolonies discovered within tens of metres of helicopter boundaries (eg NW Point terrace, Egeria Point, North Coast, South Point) can be explained by this boundary creep.
- If the aerial baiting exercise was to be repeated, and there is a time lag between mapping supercolonies and baiting, an additional 50 to 100m may need to be added to all mapped boundaries before aerial baiting commences. A limitation on bait quantity did not allow this extra 'boundary creep' zone to be added to the aerial baiting program in 2002.

Red Crabs

Crab GIS modeling is still underway, but overall the crab burrow count total across the island has been reduced by 8% since 2001.

Some areas have seen rapid crab recolonization after baiting where there is a large reservoir of crabs nearby. Other areas such as the NW Point to West White Beach area have had, and continue to have a decimation of the local crab population with no adjacent sources of red crabs to recolonize the area.

Several biases in data collection (including only sampling 50% of the transect area as was surveyed in 2001) have increased the inaccuracies within the red crab population data set.

INVASIVE ANTS ON CHRISTMAS ISLAND

Appendices to ACTION PLAN – Post Aerial Baiting

FEB – DEC 03

Appendix 1

Research

Monash University and Parks Australia made a successful application for an Australian Research Council SPIRT (Strategic Partnership with Industry – Research and Training) grant. The grant was for a three year, collaborative research project between the partners which addressed many of the biological issues necessary to understand the impact of crazy ants on Christmas Island.

The ARC has provided a total of $300,000 over three years and Parks Australia, as an 'Industry Partner', has provided cash and 'In-kind' contributions of $211,480 during the life of the project. Specifically, the grant has allowed the employment of a Research Fellow (Dr Peter Green) and a postgraduate student (Kirsti Abbott) who have undertaken research in the following key areas:

1. Crazy ant dynamics, scale insects, and their interaction;

2. Impact of crazy ants on forest structure, composition, and dynamics;

3. Impact of crazy ants on species of special conservation value.

These areas have been identified as critical in the Monash University report '*Status, Impact and Recommendations for Research and Management of Exotic Invasive Ants in Christmas Island National Park'*, and confirmed in the subsequent '*Crazy Ant Action Plan'* prepared by Parks Australia North.

Strategy	**Action**	**Status/Timeline**	**Officer Responsible**
3.4.1 Analyze the population dynamics of *Anoplolepis*, its interaction with scale insects, and their role in understorey and canopy dieback. These studies will determine the temporal stability of invasive ant and scale insect populations, rate and means of spread, and help evaluate designs for control and containment efforts.	3.4.1 is an extension of long term research that has been carried out by O'Dowd *et al.*.This work will be conducted under the ARC SPIRT grant.	This has been ongoing research.	Dennis O'Dowd, Peter Green, Kirsti Abbott

3.4.2 Assess the impact of *Anoplolepis* on the dominant red land crab, following the domino effect caused by crab removal, and develop a monitoring program for long-term effects on ecosystem integrity. Such studies will identify the nature, rate, and scale of ecosystem change, and provide information necessary to determine the magnitude of control/containment efforts'.	Assess the population status of the red crab while conducting the whole island ant survey (see 3.2 above) and compare to pre-infestation estimates	This has been ongoing research	Peter Green
	3.4.2 is an extension of long term research that has been carried out by O'Dowd *et al*..This work will be conducted under the ARC SPIRT grant. Same as 4.3.1 above.	Begun March 2000, ongoing for 3 years	Dennis O'Dowd, Peter Green, and Kirsti Abbott
3.4.3 'Assess the impact of *Anoplolepis* on island species of concern, including selected endemic seabirds, land birds, bats and reptiles. These results will inform on the likely impact of invasive ants on Christmas island endemic fauna and species listed under the *Endangered Species Protection Act'*.	See also 3.4.1 and 3.4.2 above. Develop and implement a methodology for assessing impacts	Ongoing since June 1999. Methodology for assessing impact on Abbott's Boobies completed and initial assessment completed. Study of impacts of ants on land birds completed April 2002.	David Slip, Dennis O'Dowd and Peter Green in consultation with other CI researchers
3.4.4 Identify further research needs.	Identify research priorities as need arises.	Ongoing	CASC, PAN

Appendix 2

Issues Relating to Control Strategies

Background

(1) There are two techniques for the chemical control of insect infestations: contact sprays or slow acting stomach poisons. While contact sprays are effective in urban and domestic situations they are unlikely to be effective over large scale applications against ant infestations as they do not effectively kill the breeding queens. Slow acting stomach poisons are relatively target specific and are picked up in baits by worker ants and passed it to their nest mates and the queen.

(2) The potential impact of poisons on non-target native species is also a key issue. In a domestic situation a comparatively aggressive approach to invertebrate extermination can be employed, such as spraying or fogging. In a high conservation value natural environment more caution must be taken. Poisons delivered by spray or fogging would be likely to have high impact on non-target species such as land crabs or invertebrate litter fauna. Stomach poisoning baits Hydramethylnon and Presto are being trialed because of their safety and selectivity, as well as their potential for maximum effectiveness.

(3) The two main elements of an effective stomach poison are the poison itself and the attractant. The poison should be slow acting giving it time to reach the nest and spread among the brood, and it should be effective over a wide range of concentrations. The attractant masks the poison and makes the bait attractive for the worker ants to eat. Commercially available ant baits are usually tailored for specific species and the attractants may not always be effective in other ant species. The way in which the bait moves throughout the nest needs to be known. For example, in Argentine ants sugar baits are generally passed among workers and cause high mortality in workers but little mortality to queens and the brood.

(4) There are three currently available poisons that have potential for use in baiting crazy ants - sulfluramid, hydramethylnon, and Presto. The first of these has no registered use in Australia and WA Department of Agriculture advised us against its use because of likely registration difficulties. Hydramethylnon and Presto are registered for use in some circumstances in Australia and there are available data on their possible environmental effects. Presto has a number of advantages over hyramethylnon in that it is non water soluble and therefore should not end up in the water table. It is effective at killing Argentine ants at concentrations that vary 1000 fold, and as it is effective at wiping out individual crazy ant nests it is likely to be effective against them at a wide range of concentrations.

(5) Presto and hydramethylnon appear to the most suitable control agents trialed to date. Neither product is registered in Australia for use in the control of yellow crazy ants. Final steps are being completed so that a permit can be issued from the National Registration Authority and approval given for broad acre distribution. The NRA will only issue an off-label permit if it is satisfied that the use of the chemical is effective and would not cause undue hazard to people, the environment, plants and animals. As both chemicals are toxic to land crabs Parks Australia have been testing methods of application that do not cause crab mortality. An experimental trial suggests broadacre distribution of Presto and hydramethylnon will not cause mortality to land crabs, as broadacre distribution makes it difficult for crabs to pick up enough bait to get a toxic dose

(6) The results of initial Presto and hydramethylnon trials on broadacre plots have shown an initial reduction in ant activity of up to 50%. While this result is promising and has resulted in an increase in crab activity on the perimeter of the plots, it may not lead to the long term effects we want. At one study site ant activity recovered in about 3 months. To achieve long term reductions of ant densities, techniques need to be refined to determine the most effective attractants, concentrations of poison and baiting strategies (including treatment time frames). In addition, the dynamics of crazy ant populations need to be understood to the maximum extent possible before a large scale control program is commenced. For example, for the Argentine ant production of new queens is inhibited by the presence of queens and at a certain time of the year workers will execute 90% of the queens to stimulate royal brood production. If this occurs in crazy ants it would present an ideal time to intensify baiting effort as queen density would already be naturally low. PAN is currently undertaking research and consulting literature and ant experts in an attempt to

understand how these sort of dynamics occur in crazy ants. Distributing baits on Christmas Island will be a labour intensive exercise and maximum return for effort is essential. Added to this, Presto is a relatively new product only recently commercially available and is still subject to field trials.

(7) While Presto and hydramethylnon appear to be effective poisons, the attractants tested to date appear to be less effective than we would like. The WA Department of Agriculture recently agreed to allow us to test an attractant developed by them to bait Argentine ants. This attractant is not effective in wet conditions, and Agriculture WA has recommended we trial this using a laboratory colony.

(8) The situation at hand is an extremely complex ecological problem. While the impacts of the ant on other species needs to be better understood the population dynamics of the ant holds the key to management. This will provide information on the stability of ant and scale insect populations, rate and means of spread and the nature and scale of ecosystem change. Such analysis will aid in the evaluation and design of control and containment efforts.

(9) Baiting is largely ineffective during the wet season (November to April) because:

- Heavy monsoonal rain inhibits access. Even in the dry season much of the island is difficult to access. Limestone pinnacle areas are particularly inaccessible and hazardous.
- During wet weather crazy ants tend to be subdued with reduced foraging activity. Accordingly, they are less receptive baits.
- Rains dilutes or dissolves the bait rendering it ineffective.

(10) Presto and hydramethylnon work very slowly (in some cases it takes up to 2 months to eradicate a single isolated nest). Staff need to monitor for two to three months before the effectiveness of such baits can be determined. As outlined above, the wet season effects this program.

(11) Crazy ants and baits may impact on other introduced species, such as the wolf snake, geckoes, black rat, feral cats, feral dogs etc. It may be that the current situation presents a window of opportunity for control of other exotics, however on the other hand these species may be advantaged and could increase in density and distribution.

Other Issues

Choice of Poisons: Two poisons will continue to be trialed, Presto and hydramethylnon. If the effectiveness of these poisons is similar then Presto will be favoured due to its insolubility which may allow early wet season baiting.

Choice of Attractants: Several attractants will be trialed. These will be tested on captive colonies of ants and trialed on artificial nests that are set up within the infestations. Field 22S and the Dales will be used as experimental sites. Once a bait is found that ants find highly attractive large scale baiting of infestations will be possible.

Measuring Ant Density: Ant density will be measured using a 250*250 mm card. Nest density will be measured through direct counts of 5x5 m quadrats.

Statistical Design: All field trials will be analysed using a BACI (Before After Control Impact) design.

Impacts on Non-Target Species: As the heavily infested areas contain few other species of ants there are likely to be only minor impacts on non-targets. The above poisons are non-toxic to vertebrates in the given concentrations and the only areas of concern are the impact on land crabs and on invertebrate leaf litter fauna. The latter is probably difficult to estimate and as most of this fauna would be under threat from the ant infestation it is considered impractical to monitor impact. While baits are toxic to land crabs it may be possible to distribute the poison in such a way that it is inaccessible to them. In infested areas there are few if any land crabs present.

Source of Baits: Presto is available from the manufacturer Rhone-Poulenc at approximately $100 per 40 kg. Rhone-Poulenc have also supplied some attractants for testing and others have been provided by WA Agriculture.

Appendix 3

Aerial Baiting Program

Aerial baiting was undertaken over a two-week period in September 2002 in National Park and Vacant Crown Land. Over 2,500 hectares of yellow crazy ant supercolonies were treated with a fipronil-based insecticide at the rate of four kilograms per hectare. The baiting program also included monitoring of target impacts (crazy ants), non-target impacts (other invertebrates and vertebrates), and the fate of the fipronil baits on the soil surface and in the soil.

Two weeks after the completion of aerial baiting, monitoring revealed a large knockdown of crazy ants. Their activity had been reduced by 99 percent. Knockdown of crazy ants at 50 monitoring stations across the island indicated that immediate control of all known crazy ant supercolonies had been achieved through the aerial baiting program.

Aerial Baiting Program

Strategy	**Action**	**Status/Timeline**	**Officer responsible**
Arrival of helicopter reps	Two helicopter reps will come to the island for a reconnaissance visit to see first hand the extent of the problem	Completed March 2002	Steve Comport, Zuraidah Mohamed, Peter Green, Max Orchard
Aerial tendering process	Receive aerial treatment tender quotes.	McDermott Aviation selected as tender 22.5.02	David Slip, Max Orchard, Peter Green, Mike Johnson, Steve Comport
Verification of Permit issued by National Registration Authority to allow aerial treatment of ant supercolonies	Receive verification that the wording of the permit issued to broadcast ant bait is consistent with allowing broadcast application by aerial applicators.	The current permit allows for treatment by aerial applicators Completed May 2002	Steve Comport
Environmental assessment and EPBC Act referral	Undertake an environmental assessment of the potential impacts of the aerial baiting of crazy ants. Submit referral under the EPBC Act.	Referral approved 14.8.02	Peter Green, David Slip
Mapping of known ant infestation boundaries	Map boundaries of known ant infestations using hand-held GPS units to provide information for helicopter flight paths	Completed 16.8.02	Steve Comport in conjunction with PANCI staff
Development, purchase and delivery of Presto 01 and Presto 001 ant bait	Development of more consistent bait particle size is being undertaken by Aventis Crop Science. PAN needs 13000 kg (12000 high conc. and 1000 low conc) to undertake aerial treatment of remaining ant infestations on Christmas Island	Delivered 31.8.02	Steve Comport
Purchase and delivery of chook food pellets for robber crab lure	Robber crab lures are being used to draw robber crabs away from ant infestations during aerial treatment.	Delivered late July 2002	Steve Comport

stations			
Design of methodology for robber crab lures	Determine GPS position of waypoints to be used for aerial drops of chook pellets by helicopter. 4000 kilos of chook pellets, 400 aerial drops (defined by waypoints), 10 kilos per drop, 100km of supercolony perimeter. Each drop is 200m apart and ~150m away from an ant boundary	Completed	Steve Comport in conjunction with PANCI staff and helicopter contractor
Design and implement aerial baiting trial	Determine the lowest application rate and Fipronil concentration rate necessary to achieve knockdown effect of ants; estimate fraction of bait penetrating canopy to ground level; Evaluate the application rate of the toxic bait (4 vs 6 kg/ha), concentration - 0.1 g/kg (high conc) vs 0.01g/kg (low conc) over 8 plots (292 ha).	Trial completed Sept 02.	Peter Green, David Slip, Crazy ant Steering Committee
Quality assurance trials for aerial treatment	Construct catch bags to evaluate bait rate penetration through the canopy. 240 catch bags of 1m diameter, spread randomly through 8 trial plots.	Completed	Steve Comport, Peter Green in conjunction with PANCI staff
Design and implement a long –term strategy for monitoring ant densities post aerial treatment	Develop and implement a long-term methodology for monitoring ant density post aerial treatment	Design occurred in December 2002 and implementation commenced post aerial treatment.	David Slip, Peter Green, Crazy ant Steering committee, Steve Comport
Public information campaign	➢ Regular articles in 'The Islander' detailing the aerial baiting program. ➢ Static display at June market day. ➢ Environmental assessment on public display. ➢ Road closure information on roundabout chalkboard. ➢ Contract photographer to record aerial baiting program on video. ➢ Media briefing material prepared for national audience.	Regular public information supply prior, during and after the aerial baiting program. EA Canberra will promote success of program in Feb 03.	PANCI staff , PAN Darwin, EA Canberra, Monash University, Steering Committee.
Helicopter landing pad preparation	Preparation of helicopter landing pads to allow sufficient area for load and refuel operations. 4 sites selected.	Completed August 2002	Max Orchard, Azmi Yon, Eddly Johari
Conduct aerial treatment of all remaining ant infestations	Aerial dispersal of ant bait for treatment of 2078 hectares ant infestations	Completed during the 3rd and 4th week in Sept 02.	PANCI staff in conjunction with helicopter company

Determine success of aerial baiting on ant supercolonies	**Trial Plots** :Pre and post aerial baiting ant counts of ant densities will occur in 10 x 30ha plots.	3 pre and postbait counts will take place in the week pre and post aerial trials - completed	Steve Comport, Peter Green in conjunction with PANCI staff
	Island wide samples: Ant surveys within a selection of supercolonies throughout the island pre and post aerial baiting.	Pre-baiting survey in August, post baiting in October – completed.	Steve Comport, Peter Green in conjunction with PANCI staff
Monitor the impact of aerial baiting on non-target birds and canopy invertebrates	Investigate the potential impacts on non-target birds and canopy invertebrates and their recovery from aerial baiting treatment	First stage of field work completed in September 2002. Last stage scheduled for April 2003.	JCU Team
Report on the aerial baiting program	Produce a report describing methodology and results of aerial baiting program.	Draft completed February 2003.	Peter Green & PANCI
Island Wide Survey of the distribution and abundance of crazy ant distribution	This will repeat the island wide survey undertaken in 2001 to assess the distribution of ant super colonies and their impacts	This will take place from June to August 2003	Dave Slip, Steve Comport and PANCI staff

The following is a broad outline of the 4 week aerial control program that took place following helicopter deployment on Christmas Island in September 2002 (more comprehensive detail can be obtained in P.Green, *The Management and Control of the Invasive Alien Crazy Any on Christmas Island, Indian Ocean: The Aerial Baiting Campaign, September 2002(Draft))*

Week 1- Commencement of the trial phase of the aerial control program;

There were eight plots in this trial (total area 292 ha), two for each combination of application rate (6 and 4 kg/ha) and Presto bait concentration (0.1 g/kg and 0.01 g/kg). Bait was spread by helicopter at the varying rates over the entire plot, but monitoring only occurred within a core area, allowing 100m buffer zones on all sides. Within each core area there were 4 ant monitoring transects and 30 catch bags. Two ant infested 30 ha plots were designated as unbaited control sites. Robber crab lures were used prior to the aerial control program to attract robber crabs away from baited areas. Lures were dropped by helicopter around the perimeter of areas to be treated. The trial plots, monitoring transects, control sites (**C**), buffer zones, and treatment combinations are displayed in Figure 1.

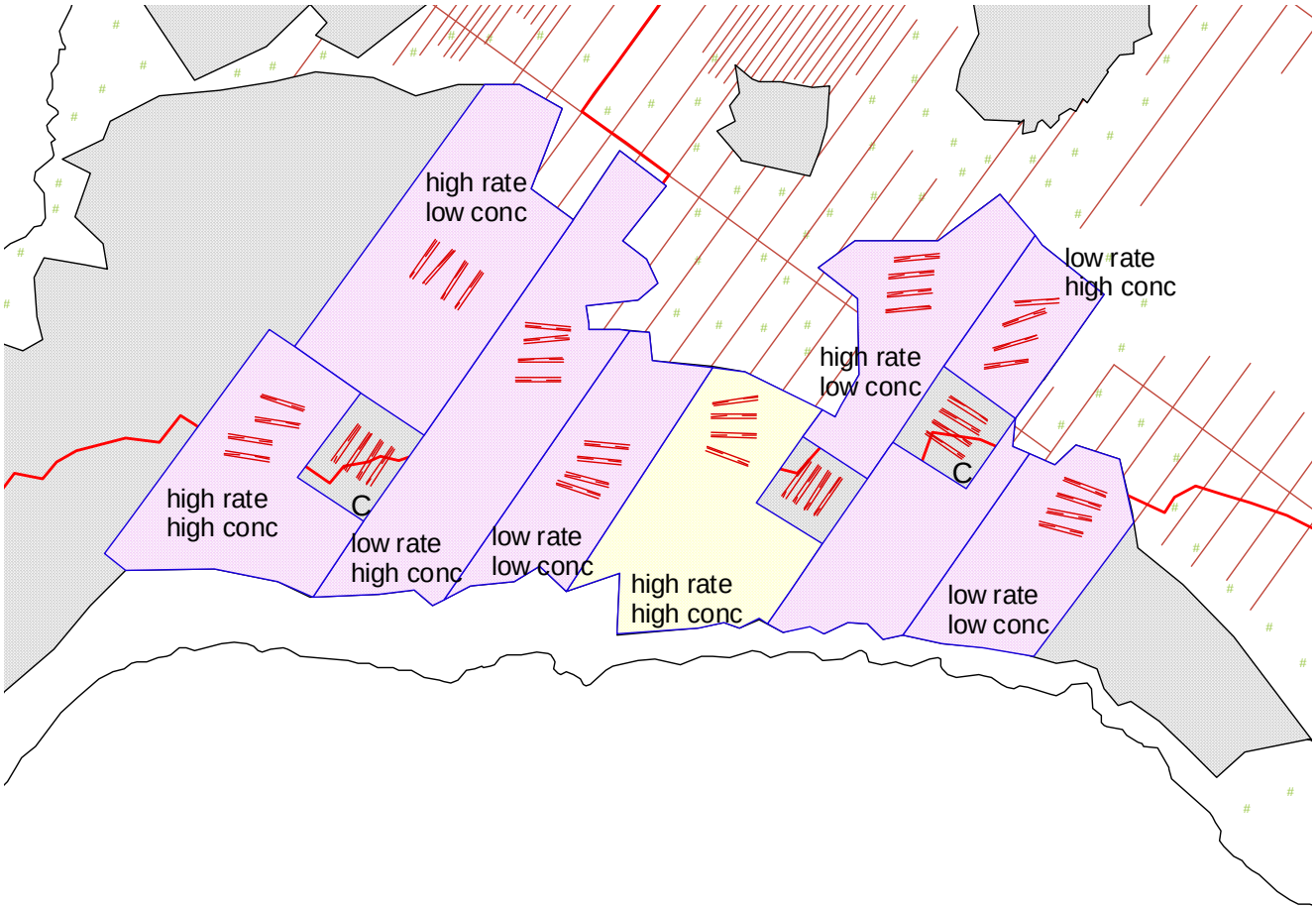


Figure 1. *Map of Christmas Island showing location of trial plots located in the south west area of the island, treatment combinations, monitoring transects and buffer zones*

Week 2 – The steering committee met by tele-conference at the end of this week to review progress. A positive review by the steering committee, enabled the aerial treatment of all remaining supercolonies to be implemented in weeks 3 and 4 of the operation using the high concentration bait at 4kg/ha.

Week 3,4 – aerial baiting of the remaining 2078 hectares of crazy ant supercolonies.

Aerial baiting plan timelines and outcomes

2002	**Pre aerial treatment**							**Aerial treatment**								**Post aerial treatment**		
month	jan	feb	mar	apr	may	jun	jul	**AUG**				**SEPT**				oct	nov	dec
								1	2	3	4	1	2	3	4			
Arrival of helicopter reps																		
Selection of helicopter tender																		
Environmental assessment																		
Boundary mapping of supercolonies																		
Delivery of 13000kg of Presto ant bait for aerial baiting																		
Delivery of chook food pellets for robber crab lure stations																		
Finalisation of design for aerial bait trial																		
Selection of GPS waypoints for robber crab (chook food) lure stations																		
Development, purchase and construction of catch bags for quality assurance experiments during aerial baiting																		
Preparation of landing pads for helicopter																		
Public information campaign																		
Ant counts pre trial aerial baiting																		
Aerial dispersal of robber lures																		
Aerial treatment trials of ant infested plots																		
Ant counts post trial aerial baiting																		
Steering Committee meeting to assess trial results (tentative 13th September)																		
Aerial treatment of remaining ant infested supercolonies																		
Post aerial monitoring and control of ant infestations																		

Appendix 4

Presto Poisons Action Plan

Presto is a reversible GABA receptor inhibitor that effects the central nervous system in invertebrates. It is very effective against insect pests and has very low toxicity to mammals and birds. Its toxicity to crabs is unknown. In humans signs and symptoms will generally appear after prolonged exposure. Due to slow absorption through the gut, symptoms of intoxication may be delayed several hours to one day.

Handling instructions

- Avoid skin and eye contact
- Avoid inhalation of dust, droplets and vapour
- Wash hands after use with soap and water
- Store product under lock and key

Signs and symptoms

- Neurological stimulation with possible convulsions following intoxication
- Hyper-excitability including over activity, irritability, tremors and possibly lethargy. These symptoms are reversible after termination of exposure

First aid measures

- In case of contact, wash immediately with water and soap for at least 15 minutes
- If contact with eyes, wash immediately with plenty of water for at least 15 minutes
- If swallowed, try to induce vomiting, seek medical advice, do not induce vomiting in an unconscious person

No specific antidote is known. Phenobarbitol and benzodiazepines have been shown experimentally to be effective in preventing convulsions induced by Presto

Presto is slowly absorbed through the gut. Absorption may be decreased by the use of gastric lavage, saline purgative and activated charcoal.

Toxicology studies indicate that no cumulative effects of Presto are known in animals, therefore the risk to animals along the food chain is low.

Toxicology

Avian

- Presto is considered toxic to birds in the Galliformes family (e.g. rails) and non-toxic to other avian species.

Aquatic animals

- Presto is considered highly toxic to some aquatic species. However, tests are only available for trout, carp and sunfish.

Small mammals

- Acute dermal effects have been observed on rats and rabbits when doses of >2000 and 354 mg/kg were given, respectively.

Effects on soil microflora

- Presto shows no effect on soil microflora

Environmental Fate

- Laboratory soil adsorption/desorption and leaching studies as well as field studies have shown that Presto and its major degradation products are relatively immobile in soil, and therefore the risk of residues leaching to groundwater is considered to be low. The half-life of Presto when applied to the soil surface showed half-life values ranging from 4-22 days.

Table 1 presents data showing the oral toxicological effects of Presto on small mammals and some birds following exposure to a single dose. Based on the dose required to cause death to small mammals, Presto is

moderately toxic following exposure to a single dose. In palatability studies containing Presto treated seeds or granules, birds evidenced an aversion to Presto treated substrates even in no-choice situations. Based on observations and the large doses necessary for effects to occur (Table 1), the manufacturers concluded that Presto appears to have a reduced palatability for birds, reducing the risk to avian species (Presto Worldwide Technical Bulletin, Rhone-Poulenc 1996).

Table 1: Toxicological properties of Presto based on a single dose for two species of small mammals and three avian species (adapted from the Worldwide Technical bulletin on Presto, Rhone-Poulenc 1996)

Animal	*(LD_{50}) mg/kg	Application
Rat	97	oral
Mouse	95	oral
House sparrow	1120	oral
Pigeon	>2000	oral
Mallard duck	>2150	oral

*LD_{50} – Dose rate that causes 50% of sample to show an acute effect in 24 hours.

Table 2 presents data showing the estimated amount of Presto bait needed to have an effect on mammals and birds that are also found on Christmas Island. To have an acute effect on a rat weighing 400g, it would have to consume almost the equivalent of it's bodyweight while a pigeon weighing 600g would have to eat almost 200 times it's body mass of Presto 0.1. Based on these figures it is reasonable to conclude that the risk posed to mammals and birds from the current baiting program is extremely low.

Table 2. Estimated doses of Presto needed to have an acute effect (LD_{50}) on selected mammals and birds found on Christmas Island.

Animal	*estimated mass (g)*	*mass of bait required (g) (Presto 01)*	*mass of bait required (g) (Presto 001)*
Rat	400	388	3880
Mouse	30	28	280
Sparrow	15	168	1680
Pigeon	600	12000	120 kg

Use of Presto on Christmas Island

The toxicity of Presto to pigeons on Christmas Island (eg the Christmas Island Imperial Pigeon) is considered low as their main diet is fruit on trees, thus they would be unlikely to come in contact with a ground based bait. Emerald Doves are ground feeders and may come in contact with the baits. However, they are not often seen in infested areas and are primarily seed eaters so are unlikely to be attracted to the bait. Similarly, sparrows feed extensively on grass seeds close to or on the ground, but are unlikely to be attracted to a fish protein based attractant. The Christmas Island Thrush, is a ground feeder in the rainforest and may come in contact with the bait. However, it is an insectivore and is not likely to be attracted to the bait, and unlikely to consume significant amounts of bait.

Presto may be toxic to reptiles but in ant infested areas few if any reptiles exist. They are also unlikely to be attracted to a fish protein based bait.

Presto is toxic to crabs, however, in ant infested areas there are few crabs present. Red crabs are unlikely to be attracted to baits as they are largely herbivores. Robber crabs are attracted to baits and the use of food lures prior to baiting and hand removal of crabs during baiting is necessary. A survey of non-target impacts was undertaken in October 2002 to ascertain the impact on robber crabs in the vicinity of aerial baiting boundaries. The survey found an average robber crab mortality rate of 5% over the 30 sites (45 ha in total). This rate is probably an overestimate as many robber crabs were not visible due to the extremely dry conditions.

Trials have been carried out on the photolysis degradation process of Fipronil, and laboratory analysis undertaken of degradation products. Conversion of the bait into more toxic degradates has proven to be minimal due to the nature of the bait (encased in opaque fish meal), the minimal sunlight penetrating the rainforest canopy, and the rapid removal of bait underground by crazy ants. Further tests on soil residues of Fipronil from recently baited sites to sites baited 16 months previously have also proven there to be no detectable soil residues.

During the initial helicopter baiting trial a study of the potential non-target impacts of the bait was conducted. This study assessed the impacts of the aerial application of the bait on the canopy fauna, and the impact on birds and reptiles both directly through contact with the bait and indirectly through impacts on the food supply of these taxa. Preliminary findings indicate no impact on canopy invertebrates, birds or reptiles.

A research project aimed at assessing the non-target impacts of the current foot-baiting program on ground-dwelling invertebrates began in June 2002, and this project assessed the extent of recovery of these communities 6 and 18 months post ground baiting. Results from this research indicate no evidence of non-target impacts on litter invertebrates mainly due to rapid bait monopolisation by crazy ants.