Annex 1: Application form to apply for a temporary derogation to use a 'highly hazardous' pesticide and for renewal of derogations.

- This form shall be used to submit derogation requests for the use of 'highly hazardous' pesticides to FSC (initial applications and applications for renewal).
- In cases of joint applications, common information can be provided together. Information that is not common shall be presented by applicant.
- All fields have to be filled for Management Units (MUs) of all scale categories, unless otherwise specified.
- All fields have to be filled for both initial applications and renewal applications, unless otherwise specified.
- In this context 'scale' refers to the size or extent of the Management Unit (MU).

Scale category	Number of hectares in the Management Unit
Small Scale	≤ 1,000 ha
Medium scale	Between small scale and large scale
Large scale	> 10,000 ha (plantations) > 50,000 ha (non-plantation forest types)

- Applications shall be submitted in English or Spanish.

Part 1. GENERAL INFORMATION.

Application Submission date	
Name, and contact details of certification body submitting the application	Rainforest Alliance Arie Soetjiadi–Asia Pacific Coordinator JI Tantular Barat 88 Denpasar Bali Indonesia 80114 asoetjiadi@ra.org Soil Association Soil Association Woodmark South Plaza, Marlborough Street BRISTOL BS1 3NX Tel: + 44 (0)117 9142435 Email: wm@soilassociation.org Forest Management and Controlled Wood Larissa Chambers LChambers@soilassociation.org SCS Global Services 2000 Powell St., Suite 600 | Emeryville, CA 94608 USA Tel: 510.452.8049 | fax: (510) 452 6882 bgrady@scsglobalservices.com www.SCSglobalservices.com

Active ingredient for which a derogation is being requested	Alpha-Cypermethrin CAS 67375–30–8
Trade name and formulation type of the pesticide	• 4farmers Alpha-Cypermethrin 100 EC Insecticide • Fastac Duo Insecticide EC • Alpha-Scud Elite Insecticide EC • Fastac Xcel Insecticide SC • Echem Alpha-Cyp 100 Duo Insecticide EC • Cropro Buzzard Insecticide EC • Dominex Duo Insecticide EC • Prevail Termiticide SC • Imtrade Dictate Duo 100 Insecticide EC • Kenso Agcare Ken-Tac 100 Insecticide EC • Biotis Alpha 100 Insecticide EC • Ospray Alpha-Cypermethrin 100 Insecticide EC • Chemforce Alpha-Cypermethrin 100 Insecticide EC • Wsd Alphacyper 100 EC Insecticide • Titan Alpha Duo 100 Insecticide EC • Country Alpha-Cypermethrin 100 Insecticide EC • Grass Valley Alpha-Cypermethrin 100 Insecticide EC • Aw Alf 100 EC Insecticide • Googly Alpha-Duo 250 SC Insecticide • Rygel Alpha-Cyper 100 EC Insecticide • Unichoice 100 EC Insecticide • Opal Alpha Duo Insecticide EC • Rygel Alpha Forte 250 SC Insecticide • Acp Alphacyp 100 Insecticide EC • Mission Alpha-Cypermethrin 100 EC Insecticide • Rainbow Alpha-Cypermethrin 100 Insecticide EC • 4farmers Alpha Cypermethrin 250SC Insecticide • Chieftain Duo 100EC Insecticide • Titan Alpha-Cypermethrin 250 SC Insecticide

Method of application, application equipment and intended quantities	Method of application and application equipment: • All applications are conducted as per Australian label and permit instructions. • Depending on the size of trees ground or aerial applications may be used. • Consideration of the terrain weather conditions and stakeholder feedback will also influence chosen application method. • Ground based application with various vehicles using boom sprayers when targeting pests at the establishment phase where terrain and soil conditions are suitable. • Ground based application with various vehicles using boom sprayers or misters when targeting pests post establishment where terrain and soil conditions are suitable. • Aerial application by helicopter where trees are tall or terrain and soil conditions are unsuitable for ground based vehicles. Intended quantities: • As per label or permit instructions. • Indicative rates are 25 g per hectare (active ingredient).
Common and scientific name of the pest (or description of the problem /issue, as applicable)	A range of herbivorous insects, including, but not limited to: • Chrysomelid leaf beetles (*Paropis* spp. and *Paropsisterna* spp.), • Weevils (*Gonipterus* spp.), • Shot hole miner (*Perthisa* spp.), • Gum leaf skeletoniser (*Urabalugens*), • Cup moth (*Doratifera* spp.), Sawfly's (*Perga* spp.), • Scarab beetles (*Heteronyx* spp., *Liparetrus* spp., *Cadmus* spp.), • Christmas beetles (*Anoplognathus*

	spp.), • Autumn gum moth (*Mnesampela privata*).

Name and FSC certification codes of certificate holders[1] requesting a temporary derogation. Please indicate scale category and whether it qualifies as SLIMF.	**Large scale certificate holders** • Albany Plantation Forest Company Pty Ltd Certificate code: SA-FM/COC-001378 License code: FSC-CO23801 • Australian Blue Gum Plantation Ltd Certificate Code: RA-FM/COC-001327 License Code: FSC-C019740 • Bunbury Fibre Plantations Ltd Certificate Code :SA-FM/COC-001528 License Code: FSC-C014610 • Forico Pty Limited Certificate Code: SA-FM/COC-004896 License Code: C125199 • PF Olsen (Aus) Pty Ltd Certificate Code: SCS-FM/COC-004290 License Code: FSC-C111011 • WA Chip & Pulp Co. Pty Ltd trading as WAPRES Certificate Code: SCS-FM/COC-004647 License Code: FSC-C117107 **SLIMF scale certificate holders** • SFM Environmental Solutions Pty Ltd T/A SFM Forest Products Certificate Code: SA-FM/COC-002984 License Code:FSC-C102996 **Certificate pending** • Forestry Tasmania
Scope for which a temporary derogation is being requested (Please, attach map if possible)	Refer to attached map (Appendix 1).
Type of forest, species and expected forest area where use of the HHP is intended	Plantations of Eucalypt species including: • *Eucalyptus globulus;* • *Eucalyptus nitens; and* • *Eucalyptus smithii*.

[1] In the case of forest management enterprises applying for FSC certification, the FSC certificate holder code can be provided at a later stage, if and when the company achieves certification.

Part 2. SPECIFIC INFORMATION

1. Demonstrated need

a. *Please describe briefly the silvicultural system (methods for site preparation, practices for harvesting, regeneration, time between rotations) in the MU(s) included in the scope of the requested derogation.*

- The silvicultural systems employed can vary depending on the plantation species and site characteristics. Broadly:
    - Eucalypt plantations are grown on a 10-25 year rotation. Commercial thinning occurs where commercially viable.
    - Site preparation depends on previous site history and characteristics and harvest methodology. Consequently, site preparation ranges from weed control only, to heaping or chopper rolling residue, to ripping only or ripping and mounding. Spot cultivation is a technique often used on steeper slopes for first and second rotation crops.
    - At first rotation sites, planting is carried out manually or mechanically depending on site characteristics or species planted.
    - At second rotation sites, depending on the eucalypt species, survival rates and other site characteristics, coppicing (regrowth from the stump) is often used to re-establish plantations rather than re-planting.
    - Tree nutrition is monitored and supplementary nutrients may be added to maximize productivity.
    - Harvesting is carried out using a range of mechanised systems and every effort is made to avoid the use of manual felling and minimize the quantity of harvest residue.
    - The time between rotations is kept to a minimum, ideally less than 12 months, as any delay results in a lost year of production and a lost year of land cost. In areas of ongoing drought risk sites may be left fallow for 1-2 years to enable groundwater recharge.

b. *Please describe the Integrated Pest Management (IPM) system in place, including the plan to monitor the distribution and density of the targeted pest organisms in the MU(s).*

All forest managers follow an Integrated Pest Management system similar to the FSC Guide to integrated pest management in FSC certified forests and plantations (Willoughby et al. 2009). The essential components of these systems are:

1. Identification of the problem;
2. Assessment of the impact of the problem;
3. Assessment of consequences of no actions;
4. Where action is warranted, assess means of avoiding the problem;
5. If the problem cannot be avoided, assess non-chemical means of remediation; and
6. If non-chemical remediation is not possible, assess chemical means of remediation.

For each assessment, consideration should be given to the short and long term impacts of both the problem and any action on:

1. Operators;
2. Aquatic environments;
3. Terrestrial environments;
4. Stakeholders; and
5. Future operations.

In the case of alpha-cypermethrin this process has been followed and is demonstrated below for each of the targeted pest organisms that are the subject of this application.

Problem identification	• Insect pests impact plantations through sucking and chewing leaves, shoots and roots. • In Australia, there are a wide range of predominantly native insect pests that, if not managed in a timely fashion, have the potential to cause commercially significant damage to tree crops (Elliot et al. 1998, Wardlaw 2011). The plantation establishment phase is particularly vulnerable. A number of species of insect (e.g. scarab beetles and wingless grasshoppers) can occur in sufficient numbers to completely eliminate newly planted seedling crops. • In older plantations a variety of insect pests have the potential to defoliate entire plantations. Examples include, Chrysomelid leaf beetles, Autumn Gum Moth, scarab beetle species, weevil species and Gum Leaf Skeletoniser. In these age-classes, repeated defoliation episodes over successive years result in the stagnation of growth or extensive mortality. • Where these insects occur in large numbers and are not controlled, the crop can suffer sufficient mortality to require complete re-establishment, from weed control to planting. Reported impacts from pest damage include tree mortality (e.g. Loch & Floyd 2001; Matthiessen & Bulinski 2001, Jordan et al. 2002), reduced tree growth (e.g. Candy et al. 1992; Elliot et al. 1993; Stone 1993; Elek 1997, 1999; Candy & Zalucki 2002; Collett & Neumann 2002) and reduced timber value/quality (Elliot et al. 1998; Phillips 1996). The available literature demonstrates that insect damage can cause substantial growth losses and volume losses to plantations (Loch and Matsuki, 2010; Collett and Neumann, 2002; Elek, 1997; Quentin et al., 2010). The volume losses depend on the amount of damage and on the frequency with which damage occurs. Generally, crown defoliation levels of 30-50% will impact on growth. Damage to upper crowns having a bigger impact than damage to lower crowns. Increased frequency of defoliation events within a single year or over a number of years will increase the level of impact on growth (Quentin et al., 2010; Quentin et al., 2011; Eyles et al. 2009).
	

	Party / Aspect	No HHP Treatment	HHP Treatment
Assessment of impact	**Operators**	• Nil	• Potential exposure to lethal substance.
	Aquatic environment	• Nil	• Potential exposure to High toxicity to aquatic species (Product label)
	Terrestrial environment	• Significant damage to commercial plantation crop trees. • Increased weed burden. • Increased land degradation risk.	• Protection of crop trees. • High toxicity to bees and other non-target insects. • Reduced landholder weed burden and risk of land degradation.
	Stakeholders	• Economic loss to tree-owners.	• Potential drift onto neighbouring properties. • Tree-owners' crops protected.
	Future operations	• Unviable plantation enterprise	• Plantation viability
Consequence of no action	**Financial consequences** • Where insects occur in large numbers and are not controlled, the crop may suffer close to 100% mortality and depending on the age of the plantation, may require complete re-establishment, including site preparation works, planting, fertilising and weed control. This is an expense of up to $2,500/ha, excluding costs associated with lost productivity/growth from the destroyed crop. Damage to older plantations could have a more significant impact, with the loss of mature wood, with greater lost revenue and expensive clearing and re-establishment expenses. For example, Wardlaw et al. (2010) calculated that managing chrysomelids leaf beetles to prevent moderate / severe defoliation in a 25,000 ha plantation area averted growth losses equating to $950,000 in a single year (2009-10) with near-average leaf beetle populations. The understanding of the impacts of defoliation on growth is improving (Quentin et al., 2011) and the interaction with specific environmental conditions, such as water or nutrient limitation. Evidence suggests that damage is more deleterious to trees that are experiencing water and nutrient deficits (Eyles et al. 2009). • Large outbreaks of forests pest can result in negative environmental and sustainability outcomes. In areas where tree losses are substantial or crown cover is reduced by more than 30% there can be a corresponding increase in weed cover, erosion problems at some sites and the loss of visual amenity. This is a factor that can't be disregarded at it influences community attitudes regarding the sustainability of plantations in the landscape. • There are varying research results currently on damage and growth losses. What is clear is that there is an additive effect of severe damage, meaning that repeated attacks causing low damage levels can cause as severe or more severe losses in growth than one off damage events.		
How can problem be avoided?	• The majority of pest insect species affecting Eucalypt plantations in Australia are native. As such they form part of the background risk factors that may affect plantation productivity. From time to time climactic conditions will favour the reproduction of certain pest species and the build-up of large populations is unavoidable and may require intervention. • Tree stress factors such as nutrient deficiencies and lack of adequate water are known to contribute to the attractiveness of tree host to insect pests. Hence foresters predominantly avoid pest attacks by ensuring good tree health and tree vigour through high quality site preparation, good weed control and good management of tree nutrition. • In regions where insect pest populations are known to reach damaging levels		

	on a regular basis the prophylactic treatment of young trees (seedlings – 2 years) with systemic insecticides (e.g. clothianidin, imidacloprid) has greatly reduced the use of alpha-cypermethrin. These systemic insecticides are not a viable economic alternative for older and larger trees.
Are there non-chemical control options?	**Non-chemical control options** • There are limited means of non-chemical control of insects. (Elek and Wardlaw 2013). Insect pests of eucalypt plantations in Australia are well regulated by their natural enemies. The evidence for this is the lower levels of damage of several pests in their native Australian ranged compared with their behaviour overseas when accidentally introduced without their suite of natural enemies (Grimbacher et al. 2011). The regulation of pest populations by their natural enemies is a well-buffered system in Australian plantations. This has two consequences: (i) augmentation of the populations of natural enemies, for example by inundative release, does not provide anything other than very short-term changes in the populations of natural enemies (Baker et al. 2009); (ii) natural enemy populations recover quickly (within a month) after spraying (Elek et al. 2004). Management therefore aims to maintain native forest areas within the Forest Management Unit (FMU) to continue providing a diversity of natural habitat that supports stable and well-buffered populations of natural enemies. • As mentioned above, forest managers control the risk of pest attack mostly by promoting tree health and vigorous growth. Maintaining appropriate fertility, weed control and stocking is critical to ensure that avoidable stress does not impact crop trees as this can compound the adverse effects of insect damage (Michael and Zhong, 2004; Nambiar, 1990; Stone, 2001; Pinkard et al., 2006). • Efforts are being made in breeding to produce germplasm more resistant to pest damage. However, this involves long timeframes and is made difficult due to having to breed resistance to a multitude of pests rather than a single species. **Biological derived chemical control options** • **Success Neo** the commercial name of the active ingredient spinetoram which is a fermentation product of *Saccharopolyspora spinosa*, is a bio-rational insecticide, registered in Australia for the control of two chrysomelid species (*Paropsisterna bimaculata* and *P. agricola*) that are significant pests in Tasmanian forests. However, at label rates, this product is approximately four times more expensive than alpha-cypermethrin. Further, compared with alpha-cypermethrin, spinetoram does not reduce susceptible larval populations to the levels achieved by alpha-cypermethrin, and it is markedly less effective towards the later larval instars(Elek et al. 2004). This makes spinetoram a comparatively poor control option in situations where populations are very large, where larval development is well advanced, or where damage levels are already high. It is not effective on other damaging insects. • ***Bacillus thuringiensis*** is a parasitic fungus. Several strains of the bacterial insecticide Bacillus thuringiensis (Bt) are registered for the control of lepidopteran species in Australian forestry situations. This product does have some potential for controlling autumn gum moth outbreaks. However, at label rates, this product is nine times more expensive than alpha-cypermethrin. Further, due to its mode of action (needs to be ingested by larvae), successful control operations using Bt are critically dependent on timing of applications and mortality rates are generally lower than for alpha-cypermethrin (Neumann and Collett, 1997). Hence, multiple applications of Bt may be required to achieve a level of population reduction equivalent to that achieved with a single alpha-cypermethrin treatment. Again it is not effective against some of the most damaging insects like weevils and skeletonisers. The product is also very

	susceptible to rain and sunlight, requiring application approaching darkness, and therefore unsafe to be applied by helicopter due to logistics associated with the application (topography and plantation height). • **Green Guard** is the commercial name *of Metarhizium anisopliae var. acridum* spores, another biological based insecticide. The strain of this fungal product is highly specific to members of the grasshopper family (e.g. Locusts, wingless grasshopper). It is not effective against other damaging insects like weevils, beetle species or lepidopterans. At label rates, this product is more expensive than alpha-cypermethrin. Its effectiveness reduces as the grasshoppers grow in size and death can take 8-12 days, hence application timing is critical. Often large swarms of grasshoppers are not detected until summer when they are bigger by which time much of the damage may already have occurred. Hence application of the product is often recommended in spring when grasshoppers are in their nymph stage, although this leaves application at risk from rain events. Finally the product is sensitive to high temperatures and sunlight, requiring summer applications at dawn or dusk making application logistics difficult. While this product has potential for control of grasshoppers it remains an expensive niche product that can only be applied in certain situations. It remains unsuitable for situations where large swarms are detected and a rapid response is required. **Alternate chemical control options** • **Tebufenozide** (Trade name 'Mimic') is registered in Australian states for the control of Autumn gum moth (*Mnesampela privata*) in forestry situations. However, at label rates, this product is approximately seventeen times more expensive than alpha-cypermethrin. Further, as compared with alpha-cypermethrin, tebufenozide's mode of action is slower, mortality rates are generally lower, and efficacy is reduced against late instar larvae. This makes tebufenozide a comparatively poor control option where populations are very large and/or where larval development is well advanced (Elek et al., 2003). • **Clothianidin** (Trade name 'Shield') - In regions where insect pest populations are known to reach damaging levels on a regular basis many forest managers are now using clothianidin, a systemic insecticide as a highly targeted sub-soil application. This once off application provides up to 2 years of protection from most herbivorous insects, except for those insects that swarm in very large numbers and are capable of causing plantation failure despite protection, for example, wingless grasshoppers and scarab "spring" beetles. This targeted application means that insecticide is not broadcast so impacts on non-target and in particular, predatory insects are eliminated. This ensures that natural pollinators and honey bees are not harmed by the use of this chemical. The handling of the insecticide is also very safe with no potential for drift or runoff of insecticide and if handled according to strict procedures, the risk of exposure for applicators is eliminated. Clothianidin is a systemic insecticide applied to the root zone of the tree. Mechanical ripping of the ground is required. This technique is logistically problematic where local topography, understory species growth make plantation access difficult. Under normal growing conditions it will take several weeks for application to be effective, hence the insecticide is not an effective treatment when rapid response is required. The chemical is only registered for use on tress less than 8 metres tall. As a consequence, clothianidin is not a viable alternative for older and taller plantations. Each of the above products may be employed as part of an integrated management program for selected species; there are significant limitations to their widespread adoption. For most species there is no selective insecticide available and consequently, a non-selective insecticide is required. Alpha-cypermethrin is

	the only non-selective insecticide registered for the purpose of controlling a broad range of insects in plantations.
What are the impacts of chemical control options?	• Alpha-cypermethrin is known to be, and it is stated clearly on the product label, particularly toxic to bees and aquatic species. Forest managers work closely with stakeholders and any neighbours known to be keeping bees or hives are recorded. Where bees or hives are within the vicinity of an operation or are known to forage for pollen in the vicinity, spraying with alpha-cypermethrin is not carried out or is targeted for early morning application when bees are not foraging. The relevant state government organizations (eg. Department of Environment, Land, Water & Environment Victoria; Department of Primary Industries, Parks, Water, and Environment Tasmania) require apiarists to be registered (http://www.depi.vic.gov.au/agriculture-and-food/livestock/honey-bees) so they can be contacted to determine if there are hives in an area. In addition, each state and territory has a peak honey bee representative body (eg, for Victoria, VAA, or, Victorian Apiarists Association, http://www.vicbeekeepers.com.au/; for Tasmania, Tasmanian Beekeepers Association, http://www.tasmanianbeekeepers.org.au/) and there is a national peak body (Australian Honey Bee Industry Council, http://honeybee.org.au/). • Where other sensitive animals, invertebrates or ecosystems are known to exist, buffers are put in place to avoid contamination. In addition to the buffers already in place, forest managers are participating in industry wide research project to examine the real spray drift risks based on actual spray set ups and application scenarios which will further refine downwind spray buffers and lead to an improvement in confidence of the buffers used. This project is supported by the APIPRC (Australian Plantation Industry Pesticide Research Consortium) which is jointly funded by Industry and the FWPA (Forest & Wood Products Association). The research project uses actual spray set ups and application scenarios to derive the droplet size distribution generated by a spray operation. This droplet size distribution can then be used in the validated model, Agdisp, to determine at what downwind distance the level of alpha-cypermethrin no longer poses a risk. This process has now been recognised by the APVMA and will in future contribute to the conditions on registered labels.
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	physiology of *Eucalyptus globulus* Labill. Seedlings? *Annals of Forest Science.* 67(2): 203 Stone, C. (1993). Fertiliser and insecticide effects on tree growth and psyllid infestation of young Eucalyptus grandis and E. dunnii plantations in northern New South Wales. *Australian Forestry,* **56**: 257-263. Stone, C. (2001). Reducing the impact of insect herbivory in eucalypt plantations through management of extrinsic influences on tree vigour. *Austral Ecology*. 26: 482-488. Wardlaw, T. (2011) Managing biotic risk. Pages 105-126 In Walker, J. (Editor) Proceedings from the workshop: Developing a Eucalypt Resource: Learning from Australia and elsewhere. 3-4 November 2011, Marlborough Research Centre, New Zealand. http://nzdfi.org.nz/wp-content/uploads/2014/12/Developing-a-Eucalypt-Resource-Workshop-Proceedings-November2011.pdf Wardlaw, T., Jordan, L. and Wotherspoon, K. (2010) Integrated Pest Management of leaf beetles by Forestry Tasmania: costs, benefits, and future improvements. DFRD Technical Report 18/2010, Forestry Tasmania, Hobart. 30 pp. Willoughby, I., Wicken, C., Ivey, P., O'Grady, K. and Katto, F. (2009). FSC guide to integrated pest, disease and weed management in FSC certified forests and plantations. Forest Stewardship Council.

c. *Please indicate the thresholds above which, the damages caused by the targeted pest organisms are classified as severe and how they have been established.*

Unlike agricultural settings that follow well determined annual cycles, plantation forest estates follow cycles of many decades. The large areas involved in forestry and the random spatial and temporal nature of insect pest attacks makes the study of pest population and damage dynamics very difficult. As such much of what is known regarding the damage thresholds has been garnered from small scale case studies or artificial defoliation studies. There is little published evidence for any particular insect pest species; however some general patterns and trends have been noted. Generally, actual tree/seedling losses of more than 30% would be deemed as potentially affecting the economic viability of the site. Crown defoliation levels of 30-50% have been shown to impact on growth (Quentin et al., 2010; Quentin et al., 2011). Damage to upper crowns has a bigger impact than damage to lower crowns. Increased frequency of defoliation events within a single year or over a number of years will increase the level of impact on growth (Quentin et al., 2010; Quentin et al., 2011; Eyles et al. 2009).

In practice most forest managers work on the basis that if a particular insect species is causing losses of greater than 20% and/or visible crown damage above 40% it should be the subject of some management action, especially if the damage or losses occur on a regular basis. This may or may not involve chemical control.

d. *Please indicate the population size of the targeted pest organism in the MU(s).*

Depending on the species in question cumulative experience and field studies have led to a number of methods to assess pest populations within plantations. These have then been used to determine thresholds above which pests are known to cause damage sufficiently severe to affect growth and impact the plantation economically (See table below):

Pest	**Threshold For Damage**	**Basis of Threshold**
Chrysomelid leaf beetles	Varies dependent on plantation health status (requiring remediation, protection from repeat severe defoliation, routine protection). Threshold for routine protection is an egg / larval population that would cause severe (>50% crown loss) if not managed.	Threshold for routine protection adapted from Candy (1999). Cumulative research reports and experience.
Cadmus beetles		
Weevils (*Gonipterus* spp.)	Varies annually but population peaks in October to April. Spraying is recommended if population exceeds mean of 2-3 eggs/shoot/tree.	Cumulative research reports and experience.
Shot hole miner		
Gum leaf skeletoniser	Varies annually but population peaks in October to April. Spraying must occur if population ranking exceeds 1 insect per shoot/tree.	Cumulative research reports and experience.
Cup moth		
Sawfly's		
Spring beetles		
Christmas beetles		
Autumn gum moth	Varies annually but population peaks in October to April. Spraying must occur if population ranking exceeds 1 insect per shoot/tree.	Cumulative research reports and experience.

e. **(Fill in only if you represent a large-scale MU)** *Please indicate the conclusions of the comparative Cost/Benefit Analysis of using the requested pesticide versus other non-highly hazardous control alternatives,* *The cost – benefit analysis shall include, at minimum, the following scenarios:* ○ *no action vs. remedial control (short-term)* ○ *no action vs. preventive practices (long-term)*
• Refer to Appendix 2 – Cost Benefit Analysis.
f. **(Fill in only if you represent a large-scale MU)** *Please provide a review carried out by independent experts of the Cost/Benefit Analysis in e).*
• The experts nominated by the FSC Australia board will review the costs benefit analysis at their meeting on 29th January 2016 prior to submission of the final applications.
g. **(Fill in only if you represent a medium or small-scale MU)** *Please describe possible non HHP alternatives to the use of the requested HHP and explain why they are not considered feasible to control the targeted pest organisms.*
• Please refer to information above for large scale MU's.

h. *Please include an estimate of the amount of area over which the pesticide is to be applied and how much of the pesticide is expected to be used annually.*	
Albany Plantation Forest Company Pty Ltd	
Estimated Annual Area of application (ha)	Up to 2000 ha
Estimated Annual Use Active Ingredient (kg)	Up to 60 kg
Australian Blue Gum Plantation Ltd	
Estimated Annual Area of application (ha)	Up to 600 ha
Estimated Annual Use Active Ingredient (kg)	Up to 15.0kg
Bunbury Fibre. Plantations Ltd	
Estimated Annual Area of application (ha)	100 ha
Estimated Annual Use Active Ingredient (kg)	Up to 3.0 kg
Forico Pty Limited (*Forico are recently certified to the FSC FM Standard (Nov 2015) and do not currently possess a derogation. Non-HHP must be applied until such time as a derogation is in place*).	
Estimated Annual Area of application (ha)	2,500 ha
Estimated Annual Use Active Ingredient (kg)	0
PF Olsen (Aus) Pty Ltd	
Estimated Annual Area of application (ha)	Up to 1,500 ha
Estimated Annual Use Active Ingredient (kg)	Up to 50 kg
WA Chip & Pulp Co. Pty Ltd trading as WAPRES	
Estimated Annual Area of application (ha)	Approximately 400 ha
Estimated Annual Use Active Ingredient (kg)	Up to 10kg
SFM Environmental Solutions Pty Ltd T/A SFM Forest Products	
Estimated Annual Area of application (ha)	200 ha
Estimated Annual Use Active Ingredient (kg)	Up to 5.0 kg
Certification Pending	
Forestry Tasmania	
Estimated Annual Area of application (ha)	3,480 ha (5-year average)
Estimated Annual Use Active Ingredient (kg)	101 kg (5-year average)

i. **(Fill in only if you are applying for the renewal of a derogation)**

Please attach a report on the implementation of the IPM system during the previous derogation period, covering at minimum:

- *Brief description of the silvicultural system in the MU(s) included in the scope of the requested derogation.*
- *A list of the monitored pest organisms.*
- *The results of the annual monitoring of the target species in relation to the defined thresholds.*
- *Quantitative data of the use of 'highly hazardous' pesticides per year for the full period of the existing derogation, areas of application and application method.*
- *A description of the programs that have been implemented to investigate, research, identify and test alternatives to the 'highly hazardous' pesticide, and the results.*

- Much of this material is described in detail elsewhere in this application:
  - Details of the silvicultural systems in the MU(s) are included in response to Question 1.a.
  - Details of the monitored pest organisms are included in response to Question 1.c. and 1.d.
  - Details of the results of monitoring programs are summarized in response to Question 1.d.
  - Details of the amount of alpha-cypermethrin used during the period of the previous derogation is included below.
  - Details of the programmes that have been implemented to investigate, research, identify and test alternatives to the use of alpha-cypermethrin in response to Question 3.a. and 3.d.

Albany Plantation Forest Company Pty Ltd

	2011	2012	2013	2014	2015
Total are treated (ha)	0	0	0	0	0
Total active ingredient used (kg)	0	0	0	0	0
Total Defined Forest Area (ha)	21,665	21, 690	19,666	19,202	18,117

Australian Blue Gum Plantation Ltd

	2011	2012	2013	2014	2015
Total are treated (ha)	640.0	830.0	679.7	377.2	556.0
Total active ingredient used (kg)	16.0	20.0	22.0	9.43	7.70
Total Defined Forest Area (ha)	92,041	113,116	107,861	98,362	89,390

Bunbury Fibre. Plantations Ltd

	2011	2012	2013	2014	2015
Total are treated (ha)	195	416	0	42	265
Total active ingredient used (kg)	4.9	10.4	0	1.1	6.5
Total Defined Forest Area (ha)	14,426	14,426	14,129	14,129	14,129

Forico Pty Limited					
	2011	2012	2013	2014	2015
Total are treated (ha)	Forico was established in September 2014. Insecticide application in 2014 – 2015 occurred when Forico was not certified				1,975
Total active ingredient used (kg)					47.95
Total Defined Forest Area (ha)					179,261
PF Olsen (Aus) Pty Ltd					
	2011	2012	2013	2014	2015
Total are treated (ha)	Not managing plantations	469	6	677	763
Total active ingredient used (kg)		15	0.08	20	23
Total Defined Forest Area (ha)		Not certified	20,090	52,530	159,459
WA Chip & Pulp Co. Pty Ltd trading as WAPRES					
	2011	2012	2013	2014	2015
Total are treated (ha)	0	0	0	0	265
Total active ingredient used (kg)	0	0	0	0	6.6
Total Defined Forest Area (ha)	20,918	22,885	35,000	37,354	34,569
SFM Environmental Solutions Pty Ltd T/A SFM Forest Products					
	2011	2012	2013	2014	2015
Total are treated (ha)	SFM have not used any alpha-cypermethrin on certified plantations in the last five years.				
Total active ingredient used (kg)					
Total Defined Forest Area (ha)		356	340	289	2,989
Certification Pending					
Forestry Tasmania					
	2011	2012	2013	2014	2015
Total are treated (ha)	5,939	5,784	2,533	4,741	1,402
Total active ingredient used (kg)	148	145	63	119	32
Total Defined Forest Area (ha)	55,700	56,000	56,000	58,000	55,000

2. Specified measures to prevent, minimize and mitigate impacts

a. *Please describe the best management practices (BMP) that will be implemented in the MU(s) to prevent, minimize and mitigate negative social and environmental impacts of the application of HHPs during the requested derogation period, covering at minimum: application method, water courses, land use or terrain and weather conditions.*

Measures required by Australian stakeholders

In addition to compliance with regulatory controls, forest managers seeking to use alpha-cypermethrin will undertake the following controls to reduce risks:

- Hand delivery of notices to adjacent neighbours.
- Integrated Pest Management (IPM) Strategies ensure alpha-cypermethrin is only used after other chemical control methods have failed and is restricted to periods of known risk and only then if the damage thresholds are exceeded.
- Nutrient levels in plantations will be managed to reduce risk of insect outbreaks.
- Where sensitive animals, invertebrates (e.g. bees) or ecosystems are known to exist, additional buffers are put in place to avoid harm in consultation with relevant stakeholders. Spraying is also undertaken early in the morning to avoid peak flying periods to minimize any potential negative impact on non-target species (e.g. bees).
- Spray buffers along water courses and between adjacent neighbours to be calculated using the USDA Forest Service validated model AGDISP on each forest.

Measures required by Australian law and other requirements

Each forest manager operates under a BMP or equivalent (eg, a BOP or Best Operating Practice) which stipulates compliance with a number of processes which ensures the risk of pesticide use is managed to a level that mitigates any potential impacts. The processes which BMP's consider include:

Compliance With National Regulation

In Australia the Australian Pesticides & Veterinary Medicines Authority (APVMA) is responsible for the registration and control of pesticides up to the point of retail sale. The registration process is governed by Commonwealth legislation and undertaken according to accepted scientific principles and through rigorous independent analysis by several government agencies and the APVMA. Before being registered for sale, products must go through a risk assessment process and specifically meet the requirements of the Agvet Code 5a with regard to safety of the environment and humans:

(1) An active constituent or chemical product meets the safety criteria if use of the constituent or product, in accordance with any instructions approved, or to be approved, by the APVMA for the constituent or product or contained in an established standard:
(a) is not, or would not be, an undue hazard to the safety of people exposed to it during its handling or people using anything containing its residues; and
(b) is not, or would not be, likely to have an effect that is harmful to human beings; and
(c) is not, or would not be, likely to have an unintended effect that is harmful to animals, plants or things or to the environment.
(2) For the purposes of being satisfied as to whether an active constituent meets the safety criteria, the APVMA:
(a) must have regard to the following:
(i) the toxicity of the constituent and its residues, including metabolites and degradation products, in relation to relevant organisms and ecosystems, including human beings;
(ii) the method by which the constituent is, or is proposed to be, manufactured;
(iii) the extent to which the constituent will contain impurities;
(iv) whether an analysis of the chemical composition of the constituent has been carried out and, if so, the results of the analysis;
(v) any conditions to which its approval is, or would be, subject;
(vi) any relevant particulars that are, or would be, entered in the Record for the constituent;
(via) whether the constituent conforms, or would conform, to any standard made for the constituent under section 6E to the extent that the standard relates to matters covered by subsection (1);

(vii) any matters prescribed by the regulations; and
(b) may have regard to such other matters as it thinks relevant.
(3) For the purposes of being satisfied as to whether a chemical product meets the safety criteria, the APVMA:
(a) must have regard to the following:
(i) the toxicity of the product and its residues, including metabolites and degradation products, in relation to relevant organisms and ecosystems, including human beings;
(ii) the relevant poison classification of the product under the law in force in this jurisdiction;
(iii) how the product is formulated;
(iv) the composition and form of the constituents of the product;
(v) any conditions to which its registration is, or would be, subject;
(vi) any relevant particulars that are, or would be, entered in the Register for the product;
(via) whether the product conforms, or would conform, to any standard made for the product under section 6E to the extent that the standard relates to matters covered by subsection (1);
(vii) any matters prescribed by the regulations; and
(b) may have regard to one or more of the following:
(i) the acceptable daily intake of each constituent contained in the product;
(ii) any dietary exposure assessment prepared under subsection 82(4) of the Food Standards Australia New Zealand Act 1991 as a result of any proposed variation notified under subsection 82(3) of that Act in relation to the product, and any comments on the assessment given to the APVMA under subsection 82(4) of that Act;
(iii) whether any trials or laboratory experiments have been carried out to determine the residues of the product and, if so, the results of those trials or experiments and whether those results show that the residues of the product will not be greater than limits that the APVMA has approved or approves;
(iv) the stability of the product;
(v) the specifications for containers for the product;
(vi) such other matters as it thinks relevant.

(Agricultural and Veterinary Chemicals Code ACT 1994 – Schedule Agricultural, Commonwealth Consolidated Acts, http://www.austlii.edu.au/au/legis/cth/consol_act/aavcca1994382/sch1.html)

APVMA take a risk management approach to product registration which includes the imposition of conditions on product approvals or registrations. These conditions of use are legally enforceable strategies to reduce risk. Further, the Agvet Code regulations allow APVMA to restrict the use of certain chemicals that have a high risk profile so that only persons with additional training, licensing and compliance steps may purchase or use a pesticide. These conditions include detailed label instructions for safe use and associated Material Safety Data Sheets (MSDS) for the safe handling and application of pesticides. Label/MSDS instructions include details for mixing, treatment rates, protection of wildlife, protection of non-target plants, storage, disposal, operator safety and first-aid.

Registrants must provide the APVMA with information about the product to allow independent evaluators to decide whether it is effective and safe for people, animals and the environment, and not a trade risk. The APVMA notifies the public of the results of the evaluation and invites public comment on the registration proposal before making its decision. It also invites members of the public to participate in its programs such as reporting adverse chemical experiences through the Adverse Experience Reporting Program (AERP) and contributing to chemical reviews.

Compliance With State Regulation

State and Territory Governments are responsible for controlling the use of pesticides beyond the point of retail sale. Each state or Territory has a regulatory body or bodies responsible for pesticide use, for example Department of Environment, Land, Water and Planning (Victoria);the Department of Agriculture and Food and, WA Health (Western Australia); Department of Primary Industries, Parks, Water, and Environment (Tasmania). All have similar legislation and codes of practice to ensure safe and effective application of registered chemicals.

For the states concerning the National Derogation applications, the relevant regulations are:

Queensland - Agricultural Chemicals Distribution Control Act 1966
(https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/A/AgrChemDisA66.pdf)

South Australia - Agricultural and Veterinary Products (Control of Use) Act 2002 and Regulations 2004

(http://www.legislation.sa.gov.au/LZ/C/A/AGRICULTURAL20AND%20VETERINARY%20PRODUCTS %20%28CONTROL%20OF%20USE%29%20ACT%202002.aspx)

Tasmania - Agricultural and Veterinary Chemicals (Control of Use) Act 1995
(ndex.w3p;cond=phrase;doc_id=106%2B%2B1995%2BAT@EN%2B20040310000000;histon =;prompt=;rec=;term=Agricultural%20and%20Veterinary%20Chemicals %20%28Control%20of%20Use%29%20Act%201995)

Victoria - Version No. 004 Agricultural and Veterinary Chemicals (Control of Use) Regulations 1996 S.R. No. 71/1996 Version incorporating amendments as at 6 May 2003
(http://www.vic.gov.au/search-results.html?q=pesticide+regulation)

Western Australia – Health (Pesticides) Regulation 2011
(http://www5.austlii.edu.au/au/legis/wa/consol_reg/hr2011277/)

Each of these acts or regulations interacts with other acts, for example, in South Australia:

- Controlled Substances Act 1984;
- Controlled Substances (Poisons) Regulations 1996;
- Controlled Substances (Pesticides) Regulations 2003;
- Dangerous Substances Act 1979 and Regulations 2002;
- Work Health and Safety Act 2012 and Regulations 2012;
- Environment Protection Act 1993.

While these differ from state to state, since 2008, each state and Territory has agreed to a common framework for the control of use of agricultural and veterinary chemicals. As a result, the control of use is now becoming increasingly consistent across States and Territory's (COAG, 2008).

The end result for each state is that pesticides are:

- transported and stored safely;
- used only by persons that are appropriately trained and where deemed necessary, licensed;
- used in a way that ensures the safety of applicators and the public;
- used in a way that ensures the safety of the environment;
- used in an accountable manner through detailed recording of all areas of application, pesticide application methodology and environmental conditions at the time of application.

Like the APVMA, states and territories take a risk management approach to pesticides and frequently there are limitations on which states or territories pesticides may be used and how they may be used in those states.

Forestry Application

All certified companies have well documented policies and operational procedures, best practice manuals or similar for the use and handling of chemicals that are in alignment with State and Federal Government requirements. These include Integrated Pest Management Strategies, detailed Site operation plans and Site Specific Silviculture plans.

Staff are trained to a high level and only qualified staff or contractors, are used to carry out pest control operations. All aerial operations are carried out using helicopters only rather than fixed wing aircraft as helicopters are known to achieve more accurate placement of pesticide. All label and MSDS instructions are adhered to. Follow-up monitoring of the impacts of the operation on the pest population and the crop is carried out.

Endangered Species

Each forest manager maps the presence of endangered species. Where the use of a highly hazardous pesticide presents a risk, either the pesticide is not used in the area or appropriate buffers or exclusions are used.

Special Management Zones

Forest managers consider special management zones whether they be environmental, scientific or cultural. Where the use of a highly hazardous pesticide presents a risk, either the pesticide is not used in the area or appropriate buffers or exclusions are used.

Site Risk Assessment

There are multiple levels of risk assessment carried out for each and every site as part of operational planning. Site-specific application plans are developed that address any known stakeholder and environmental concerns. For high risk or impact activities, adjacent stakeholders are notified and given the opportunity to both provide feedback and influence the operation. Application plans include details of un-treated buffer zones, which are used to protect sensitive areas within, or adjacent to, the plantation. In addition to the above, application plans consider access to the site, slope, soils type, current and future climatic factors. Based on this risk assessment, appropriate application techniques, rates and timings are chosen prior to operations being undertaken. When operations are to be undertaken, further risk assessment is carried out on the day or days of operation and where circumstances have changed, most particularly climate, additional risk management is put in place or if appropriate, operations are not carried out.

b. **(Fill in only if you represent a large or medium-scale MU)**

Please describe the training program on the use of the PPE and the application of the HHP that will be implemented in the requested derogation period.

- All business involved in the direct application of alpha-cypermethrin will be required to hold relevant pest applicator licences.
- All persons involved in use of alpha-cypermethrin will be required to hold statements of attainment demonstrating their competence in the following nationally recognised units of competency.
  - AHCCHM101A Follow Basic Chemical Safety Rules;
  - AHCCHM201A Apply Chemicals Under Supervision;
  - AHCCHM303A Prepare and Apply Chemicals;
  - AHCCHM304A Transport, Handle and Store Chemicals;
- Through the completion of the units, applicators must demonstrate:
  - Understanding current chemical application issues;
  - Determining suitable weather conditions;
  - Knowledge to limit spray drift including latest innovations in application and nozzle selection criteria;
  - Safe storage requirements;
  - Record keeping requirements.

c. (Fill in only if you represent a large-scale MUs and you are applying for the renewal of a derogation)

Please indicate the conclusions of the environmental and social impact assessment related to the use of HHP occurred during the previous derogation period.

- Please refer to Appendix 3 - Stakeholder report.

d. *Additional information (Eg: insurance providing coverages for pesticides related damage to environmental values and human health, etc.)*

- Public Liability and Work Cover insurance is held to ensure that the cost of any impact on the health of the public, employees, contractors, visitors or recreational users of the forest management units or their property is covered.

3. Program to identify, investigate, and test alternatives to the 'highly hazardous' pesticide (including preventive silvicultural measures)

a. **(Fill in only if you represent a large-scale MU)**

Please describe the research program (individually or in collaboration with other research agencies/institutions or commercial enterprises) and/or field trials of alternative non-chemical or less hazardous methods of pest management that have been planned for the requested derogation period, including devoted resources and expected timelines.

In 2008 a trial series was established to examine the potential for using barriers of treated seedlings to reduce insect impacts. This new trial series built on previous IPMG trials that have shown certain insects pests are associated with remnants and when they swarm and cause damage, they effect particular aspects. This represents a substantial effort towards highly targeted insect control that may substantially reduce or in some cases even eliminate the use of the alpha-cypermethrin for use against specific insects.

In the past, CSIRO (Commonwealth Scientific Industrial Research Organisation) and the University of Tasmania has conducted research into "info-chemicals The insects that were examined were AGM (Autumn Gum Moth) and Spring Beetles (a Scarab Beetle). While the work on Spring Beetles was not successful, the work on AGM was very successful in identifying two chemicals that were important for attracting adults (Steinbauer et al. 2004, Walker et al. 2009). In addition, it was found that the ratio of the 2 chemicals was critical and several different important ratios were identified. Delaying mating of AGM through mating disruption does significantly reduce egg populations (Walker ans Allen 2011). However, the high cost of synthesising these chemicals makes it unlikely that mating disruption will be financially viable. A new generation pyrethroid insecticide was identified as a potential replacement for alpha-cypermethrin. The new insecticide, Gamma-Cyhalothrin is rated as an S5 poison (compared to alpha-cypermethrin which is a S6) and has lower use rates. Unfortunately this insecticide is now listed on the FSC highly hazardous list and therefore is no longer considered a replacement option.

In a recent review (Elek and Wardlaw, 2013) of control options for Chrysomelid leaf beetles a broad range of treatments was considered along with their related economic, social and environmental impacts. This review did include non-chemical controls such as *Bacillus thuringiensis* var. *tenebrionis*, however it was concluded that while there was some level of control on larval life stages, the cost of the liquid product was prohibitive. Importantly no single option was identified that would be adequate for preventing economic loss. The two best options identified that provided alternatives to aerial spraying with insecticide were development of resistant genotypes and the implementation of attract and kill traps. As a proof-of-concept for an "attract and kill" approach, lethal trap trees were evaluated in project done by the CRC for Forestry. A small reduction in defoliation in trees nearby the lethal trap trees did occur Elek et al. (2012), however the "attract and kill" traps would need to find suitable info-chemical attractants which would be both expensive and highly speculative. To date, funding has only been sufficient to research attractants for one (Autumn gum moth) pest insect and it would appear that the expense will be a limitation to further development of attractants.

The presence of natural forest, interspersed amongst the broader Forest Management Unit (FMU), disperses the plantation component throughout the landscape. This creates an abundance of suitable habitat for natural predators to plantation pests. Promotion of suitable habitat through maintenance and enhancement of HCVs and associated natural forest areas within the FMU promotes the opportunities for natural predators to colonise within the FMU. Spraying operations will not have any impact on the natural predator populations within the natural forest zone, as spraying will be restricted to discrete specific vulnerable areas within the plantation resource. Natural forest remnants provide connectivity and diversity throughout the landscape.

The most viable long term solution is to breed genotypes that are resistant to a broad range of insects. In Australia there are several breeding programs for *Eucalyptus globulus* and forest managers maintain an active interest in each and aim to utilise the genotypes with the best resistance to insect pests so that threshold levels for economic impact are rarely if ever met. Forico supports an internal genetic improvement program for *Eucalyptus nitens.*

The program seeks to harness the genetic diversity of the species by selecting and breeding from elite genetic material. Elite genetic material is considered those that provide material improvement in wood characteristics and plantation performance, including resistance to pests and diseases. This is achieved in the first instance by the establishment of progeny trials across the production zones where a wide array of genetic material is exposed to a range of environmental abiotic and biotic conditions including predators. At approximately half rotation age these trials are then assessed for growth (strongly correlated with health and resistance to predators), wood properties and the superior individual trees selected for further breeding and / or inclusion in open pollinated seed orchards. In this way the genetic resistance to defoliation and insect infestation increases in the breeding and seed production populations and this characteristic passed on to seedlings for plantation establishment.

Forest managers have been active participants both in their own right and as members of AFPA (Australian Forest Products Association) in lobbying the APVMA in order to streamline the registration process. Registration is one of the major limitations in accessing alternative new products. With the investment required by chemical companies, there is little incentive to register products for forestry use only, due to the relatively low use rates of forestry. Similarly, with low use rates in forestry, chemical companies are hesitant to make the effort to put forestry use on labels that are already registered for other crops or purposes. In the past, there has been an issue with discrepancies between what the APVMA expected from trials and what the industry expected. Through the improved collaboration, a new set of guidelines has been developed with the APVMA so that current and future trials will contribute to the registration process with greater efficiency.

Certified plantation managers in Australia support a range of research programs that are aimed at reducing pesticide use, identifying alternative pesticide treatments, and developing non-pesticide based management options. Unfortunately the support that existed through the Cooperative Research Centre for Forestry no longer exists and most of the funding for forestry related research in the CSIRO has been withdrawn. Without strong support from industry, this would have likely been withdrawn entirely in 2014. The principal avenues for research currently are the West Australian based IPMG (Industry Pest Management Group) and the APIPRC (Australian Plantation Industry Pesticide Research Consortium).

Under the IPMG program, industry partners, including a number of FSC certified companies, provide funding for an entomologist to conduct research on insect pest management. The program, which is now into its 12th year, was initiated by industry and the CSIRO. The goal of IPMG is to minimise economic loss due to pests and diseases by sharing information, collaborating among members and conducting research toward development of safe, efficient, effective, economically sustainable, and environmentally responsible operational methods of managing pests and diseases. To date, over $1,000,000 and substantial in-kind contributions of forestry staff time and resources have been directed into this program.

The APIPRC is a collaborative body jointly funded by the plantation industry, the pesticide manufacturers and the FWPA (Forest and Wood Products Association). Equal funding has been provided over the last 5 years from industry members and FWPA, up to $200,000 annually. The group's principle aim is to fund and continue the work started by Dr. Barry Tomkins in searching for new methods or pesticides with either lower impacts, lower costs or lower environmental and social footprints for plantation establishment. In addition to this work, the consortium also funds other pest and pesticide related research. Examples of such research are the efficacy of copper for the control of Dothistroma needle blight infestations, control of certain noxious weeds and the modelling of potential impacts of aerial spray drift, a project which in particular, is leading the way across all agricultural and horticultural sectors.

There are also other collaborative groups dealing with specific problems, for example, in *Pinus radiata* there was strong support for the introduction of *Diaretus essigellae*, a biological control agent for the Monterey Pine Aphid, *Essigella californica* (Kimber et al., 2012). More recent reports indicate that the biocontrol has established successfully (Carnegie, 2014). Also in pine is the National Sirex Coordination Committee, which oversees the biological control of the Sirex wood wasp (http://australiansirex.com.au/). Research is ongoing and there is annual activity to continue the reintroduction of the nematode used as a biocontrol and also to examine the efficacy of the biocontrol over time.

Substantive research efforts such as these have and continue to greatly improve forest managers understanding of the biology and impacts of key pest species across the plantation estate. In some cases, research findings have resulted in changes to management practices that have reduced insecticide use (eg. Elek 1997; Bulinski & Mathiessen 2002; Bulinski & Matsuki 2002; Collett and Neumann 2002), or for some species, replaced insecticide based-approaches entirely (e.g. Faulds 1990, 1993; Bulinski et al. 2006). However, development of alternative pest management approaches remains challenging (eg. Clarke 1995, Matthiessen & Bulinski, 2001). Importantly, despite the successes reported overseas (e.g. Hanks et al. 2000), there appears little potential for successful biological control programs in Australian plantation eucalypt species, since many of the key pests already occur in association with their natural enemies (Elek and Wardlaw 2013).

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Journal of Chemical Ecology. 35:1411–1422.

Walker, P.W. & Allen, G.R. (2011) Delayed mating and reproduction in the autumn gum moth *Mnesampela privata*. *Agricultural and Forest Entomology* (2011), DOI: 10.1111/j.1461-9563.2011.00524.

b. **(Fill in only if you represent a medium-scale MU)**

Please describe how you will support and/or be involved in a research program from research agencies/institutions (e.g. universities) or commercial enterprises in the requested derogation period, including devoted resources and expected timelines.

There are no medium scale MU's who are party to this application.

c. **(Fill in only if you represent a small-scale MU)**

Please describe the program to exchange information related to pesticides use with other forest managers, to contact research institutions and/or search in alternative databases, that will be implemented in the requested derogation period.

All small scale MU's have participated in the national process and their group managers are members of relevant industry research programs.

d. **(Fill in only if you are applying for the renewal of a derogation)**

Please describe the programs that have been implemented to investigate, research, identify and test alternatives to the requested 'highly hazardous' pesticide, and the results.

Research for alternatives that is being done by the broader Australian community is described in detail in Question 3.a.

Below is a summary of the work that has been done by the applicants who are applying for a renewal of a derogation to investigate, research, identify and test alternatives. This work has been targeted to specifically address the FSC Board's recommendations in the existing derogation for alpha-cypermethrin.

Derogation Number: FSC-DER-30-V1-0 EN Alpha-Cypermethrin Australia 01022011

FSC Board recommendation 1	*Limit the use of alpha-Cypermethrin to ground application where possible in view of the rather high risks to beneficial insects and birds from spray drift which may be considerably greater for aerial application;*
Applicant's response	Current applicants have limited use in aerial applications to those situations where ground applications are unlikely to be effective, i.e. in trees older than 5 years and taller than 10 metres. There are no ground based blasters than can effectively reach the target insects. If the chemical can reach the target insects, there is an increased risk that blowing chemical upwards will result in off-site drift, where as an aerial application has downward force from draft of helicopter which helps the chemical infiltrate the tree canopy. The EC formulation of the chemical in combination with hydraulic nozzles minimises small droplet production and dramatically reduces the likelihood of drift. An Aerial Spray Management Plan is developed to identify sensitive values and AGDISP is used to manage drift issues and ensure the insecticide is contained within the target zone surrounded by a non-spray buffer.
FSC Board recommendation 2	*If ownership of a company which previously applied for a derogation has changed, submit information on the measures currently established for risk mitigation and risk management regarding the use of alpha-Cypermethrin (this applies to Elders Forestry Ltd and Australian Bluegum Plantations Pty Ltd);*
Applicant's response	Australian Bluegum Plantations Pty Ltd is the only applicant to whom this condition applies. Australian Bluegum Plantations Pty Ltd had and continues to have in place a risk assessment for alpha-cypermethrin (as with all chemicals) and controls have been established for each of the following hazards; spray drift; loading/unloading chemical; chemical transport; spills; spraying adjacent to neighbours; inadequate timing; exposure to operators; package and chemical disposal; incorrect calibration; spraying in poor weather conditions; spraying near waterways; cleaning equipment; incompatibility with other chemicals. The hazard, risk rating and control have been recorded in the company's Risk Register. Staff and contractors using this chemical are made aware of this information via MSDS and the chemical risk assessments. These policies and procedures have been reviewed at surveillance audits.
FSC Board recommendation 3	*Establish a working program to develop alternative control methods for each pest species, including research on biological alternatives and preventive silvicultural practices measures (such as planting more resistant tree species, e.g. other native tree species or mixed plantations);*
Applicant's response	ABP, WAPRES, APFL, PF Olsen are members of the Industry Pest Management Group (IPMG) which is an industry managed research group looking at a range of industry related pests and their management. The IMPG actively carries out research into alternate pesticides to control introduced pests and looks at environmental controls that may be available and assess these via cost benefit analysis. The IPMG have considered potential alternatives to Alpha-Cypermethrin and have conducted field trials using specific products and techniques: These include: • Seedling sleeves (mesh barrier) used as a physical barrier for African Black Beetle control. • Clothianidin (Shield®) is a product that has extensive field trials and is now used operationally as an alternate pesticide to Alpha-Cypermethrin to protective new young seedlings. The IPMG are also looking at ways of using this particular product in second rotation coppice sites by varying the application technique with the assistance of the chemical

	manufacturer. Application of Clothianidin to trees taller than 8 metres is prohibited to eliminate the risk of impacts on insect pollinators and honey bees. As a consequence of the development and use of Clothianidin, the use of Alpha-Cypermethrin has been limited to outbreaks of *Gonipterus* and *Chrysomelid* within plantations where insect population exceed pest thresholds. The IPMG is also looking into: • biological control methods for *Gonipterus* pests. This is a lengthy and costly process. However, it is considered to be financially beneficial in the long term. The IPMG has begun this process with genotyping the *Gonipterus* group through Murdoch University in WA to define the pest with certainty before focussing on predatory pests within and outside of Western Australia. Additionally, alternative species trials (e.g. *Eucalyptus smithii*) have been conducted and deemed a higher risk for pest damage particularly with regard to *Eucalyptus* weevil (*Gonipterus* spp).

FSC Board recommendation 4	*Establish or support research on the natural enemies of target pest insects, e.g. identifying species which parasitize or prey on pest insects, life cycles of major enemies, preferred types of habitat, and promote natural enemies, e.g. by providing suitable habitat on part of managed areas by planting hedges around seed beds in nurseries, leaving retention trees, putting up nesting boxes for birds and bats, etc.*
Applicant's response	The industry, via the IPMG, has made a significant investment since its inception in 2001 in determining life cycles of key pests and their natural enemies. The IPMG Pest and Weed Control calendar references the presence of natural enemies to evaluate risk in control operations. Work continues on broad IPM objectives including exploiting natural enemies of commercially significant pests such as the Eucalyptus Weevil. The medium term strategy of the industry centres on the use of *Anaphes nitens* for broad population control of *Eucalyptus* weevil (*Gonipterus* spp). Field research and molecular primer design will enable the identification of *Anaphes* spp. specimens to confirm the existence and prevalence (in control context) of local and regional parasitoid species. Molecular technology will enable a more rapid and targeted evaluation of the potential for biological control of *Eucalyptus* weevil. All plantations have a mosaic of native remnant vegetation associated with the plantations. These areas provide habitat for native species
FSC Board recommendation 5	*Keep records of insecticide use in plantations and nurseries (including information on the product, area treated, application method and rate), and monitor key natural enemies of pest insects shortly **after** applying alpha-Cypermethrin in plantations (at least once during the derogation period and on a representative scale);*
Applicant's response	All applicants are obliged to keep records of insecticide use under Australian law. These records include information on the product, area treated, application method and rate and the weather conditions during the application operation. These records are scrutinised by auditors during annual surveillance audits under Criteria 6.6. Treatments are timed to avoid emergence of natural predators where they are identified to exist. Guidance is provided by IPMG on the presence and life cycle of natural predators. Systematic records of natural enemies following application are not maintained due to the lack of a cost effective, safe and reliable sampling technique. However, managers conduct walk-throughs under the canopy of the treated forests 2-3days after application and report that they only find target species (e.g. *Eucalyptus* weevil (*Gonipterus* spp)).
FSC Board recommendation 6	*Use Bacillus thuringiensis (subspecies kurstaki), Metarhizium anisopliae (var. acridium), and/or Spinosad (a fermentation product), Neem extract (Azadirachthin), or other highly selective insecticides to control certain pest insects for which they are authorized;*
Applicant's response	Refer to "Summary of Alternative Treatments" contained in the body text of the Derogation
FSC Board recommendation 7	*Set voluntary reduction targets for insecticide use, with the treated area as an indicator (for example, at least 60% smaller area (ha) treated with alpha-Cypermethrin after two years, and at least 90% smaller treated area after three years);*
Applicant's response	Meaningful voluntary reduction targets have been difficult to establish because of the changing size of the plantation estate. However, all applicants have specified management targets to ensure that the use of Alpha-Cypermethrin is regarded by operational foresters as the last possible

insect control option. When Alpha-Cypermethrin is used strict controls are imposed on the operations. Better plantation silviculture, a move away from marginal plantation sites, a greater understanding of insect life cycles and the successful introduction of Clothianidin into young plantation silvicultural regimes has resulted in a dramatic decrease in the use of Alpha-Cypermethrin.

For example, the table below details ABP's reduction in the use of alpha-cypermethrin over the derogation period with additional context of the re-establishment/regeneration programs for each year.

Alpha-cypermethrin	2011	2012	2013	2014	2015
Total active ingredient used (kg)	16.0	20.0	22.0	9.43	7.70
Total Defined Forest Area (ha)	92,041	113,116	107,861	98,362	89,390
Active ingredient per Defined Forest Area (ai/ha)	0.173g	0.176g	0.204g	0.095g	0.086g
Forest area treated (ha)	640.0	830.0	679.7	377.2	556
Area re-established (PLT)	449.3	508.9	697.8	862.5	2935.3
Proportion of Establishment Area Treated	1.42	1.63	0.97	0.04	0.19

FSC Board recommendation 8	*Provide (preferably jointly) a mid-term report until the end of January 2012 which shall include the following information:* *a. use of pesticides and biological agents (amount applied and hectares treated, for particular tree species and major pest insects);* *b. progress in the implementation of a program to develop alternatives (including schedule, research partners, and resources);* *c. reductions achieved in the use of alpha-Cypermethrin (total use (kg or litres) and hectares treated);* *d. results of field surveys of natural enemies of pest insects and of a progress in the identification and promotion of key natural enemies;*
Applicant's response	a. Refer to responses to questions 1.h and 1.i. in the above application. b. Progress culminated in Clothianidin as being a replacement pesticide following rigorous IPMG trials. c. Refer to responses to questions 1.h and 1.i. in the above application. d. IPMG Report on "Natural enemies of insect herbivores in bluegum plantations in SW WA. Mamoru Matsuki & Andrew Loch- 2005. This reports is included as Appendix 4.
FSC Board recommendation 9	*Strictly follow all legal requirements in Australia (or particular states/territories) for risk mitigation and minimization during pesticide use, in particular measures required by the APVMA for occupational and environmental safety including worker*
Applicant's response	Alpha-Cypermethrin is a heavily regulated product in Australia. As detailed above the APVMA registration process is based on risk mitigation and minimisation principles. Once a chemical is registered for use it use must be in accordance with the conditions specified by Australian laws and the label conditions. Most importantly: • Contractors applying chemical must hold licences • Operators must be trained and supervised. • Records of use must be kept. Records or contractor licences and training are carefully scrutinised by FSC auditors at each surveillance audit under the requirements of Criteria 6.6.

4. Stakeholder consultation

a. *Please indicate the dates when the stakeholder consultation was conducted.*

- Stakeholder consultation was commenced on the 25th of September 2015, with the distribution of letters, information and a survey to stakeholders. All draft derogations were published on the FSC Australia website.
- From the 28th of September to the 16th of November stakeholders were encouraged to meet with forest manager's representatives.
- The initial opportunity for stakeholders to provide feedback to forest managers ceased on the 16th of November.
- A webinar public forum was held on the 23rd of November.
- As recommended by the FSC Australia Board an advisory group was formed including an environmental expert and a social expert to provide advice and suggestions around the derogation applications and the stakeholder feedback received. The advisory group first met on the 24th of November.
- After consultations with the advisory group, revised derogation applications were made available for comment again on the FSC Australia website from 22nd of December until the 24th of January.
- The advisory group will meet again on the 29th of January to discuss any further stakeholder comment.

b. *Please indicate which affected stakeholders (eg. neighbouring, local communities, forest workers) have been consulted. Neighbours, local communities, other forestry companies, silviculture contractors and customers.*

- Please refer to the Stakeholder Engagement Report - Appendix 3.

c. *Please indicate other stakeholders consulted (e.g. government agencies for environmental protection or public health, scientific experts, regional/local authorities and associations, representatives of hunters, farmers or non-governmental organizations).*

- Please refer to the Stakeholder Engagement Report - Appendix 3.

d. *Please describe the information on hazards, intended use of the HHP and commitment to prevent, mitigate and/or repair damage to environmental values and human health that has been provided to stakeholders.*

- Summary information on each relevant pesticide was provided to all stakeholders, including:
  - The hazardous attributes of the pesticide which led to it appearing on the FSC Highly Hazardous list.
  - Why forest managers use the pesticide as part of their forest management practices.
  - Controls which forest managers put in place to mitigate the risk the pesticide presents.
  - Efforts forest managers are making to avoid or reduce the need to use the pesticide.
  - Research underway to seek alternatives to the pesticide.
  - Copies of draft applications for derogations.
- A copy of the pesticide summary provided to stakeholders is included in the attached stakeholder engagement report - Appendix 3.

e. *Please describe the consultation mechanism (i.e. public notices in local newspapers or on local radio stations, letters sent to potentially affected persons, meetings, field observations etc.) used to inform, consult and receive significant feedback.*

- A range of stakeholder consultation mechanisms have been utilised, commencing with emails or letters to known stakeholders to participate in the derogation consultation process. Information was also posted on forest manager websites and on the website of FSC Australia. This information included:

    - Downloadable information (technical and jargon free) regarding the derogation application detailing the pesticides, their hazards, rationale of continues use, intended use and management strategies to mitigate potential impacts, including weblinks to other information sources (e.g. FSC).
    - Information regarding stakeholder consultation opportunities, including a summary of the engagement plan.
    - A link to the online survey and contact information to request hardcopy or telephone survey options.
    - Information regarding public comment submissions, including a link to the public comment template and return options (email and postal address).
    - Contact information to talk with a company representative to provide feedback in person or over the telephone.
    - Online forums and recordings of these for download (if requested).
    - Contact information for the National Coordinator.
- Upon request hardcopy information packs were provided with relevant information.

f. *Please summarize the comments received and how stakeholder concerns were addressed. (Where necessary, the original stakeholder comments may be requested).*

- Please refer to Appendix 3 – Stakeholder Engagement Report.

5.Certification Body Evaluation of the compliance with the requirements of the previous derogation approval

(To be filled in by the certification body only in renewal applications)

a. *Please confirm if during the previous derogation period the applicant has identified and located on maps the streams, rivers, lakes and other water zones, as well as buffer zones and other sensitive areas (e.g. groundwater zone providing water for public consumption, natural reserves, conservation zones and protection areas for rare and threatened species, or habitat with biodiversity refuge.*

b. *Please confirm if during the previous derogation period the applicant has effectively implemented control measures to prevent, minimize and mitigate negative social and environmental impacts associated with the use of the 'highly hazardous' pesticides.*

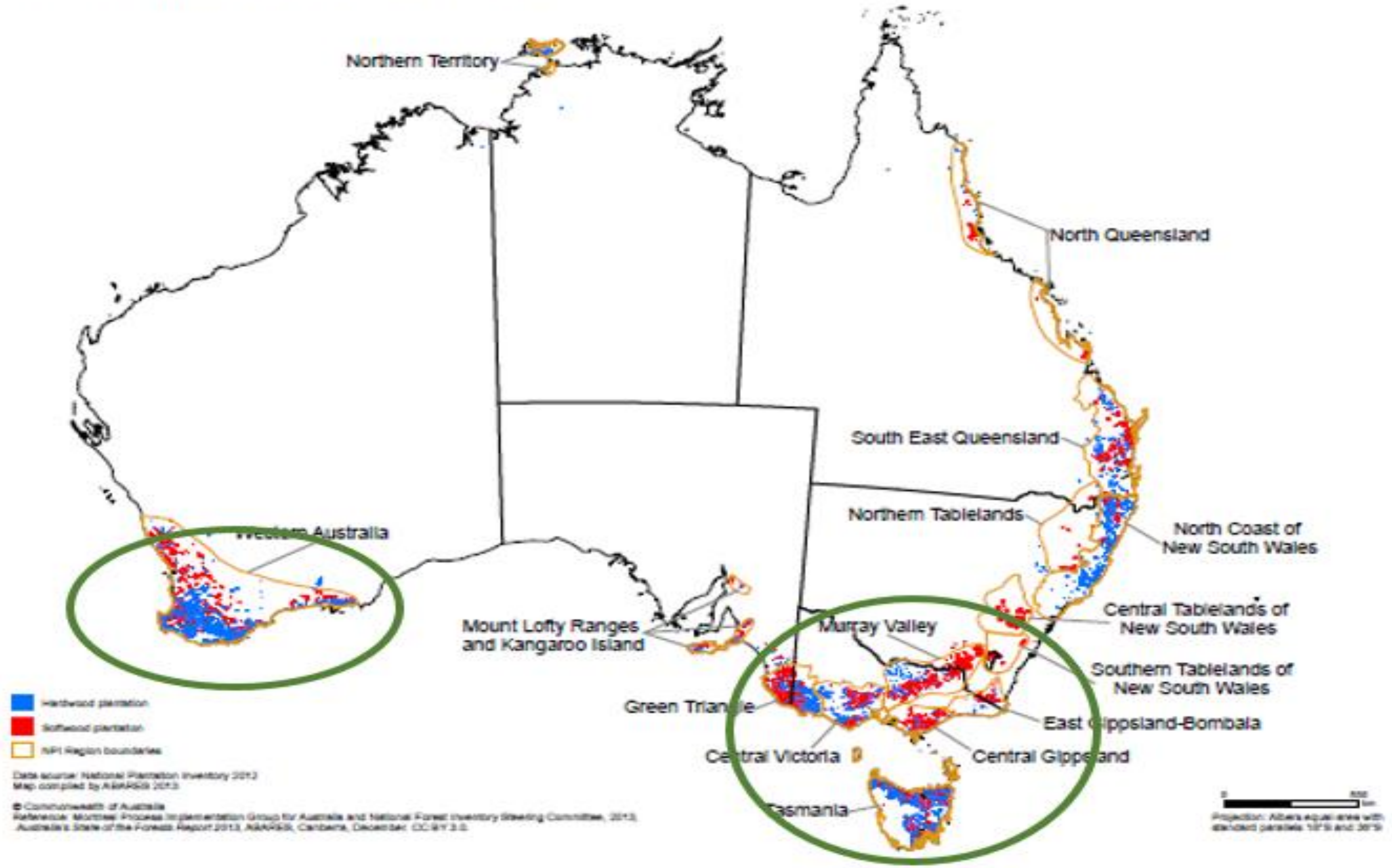
c. *Please confirm if during the previous derogation period workers dealing with HHP were provided with appropriate training on the use of the PPE and the application of the HHP.*

d. *Please confirm if during the previous derogation period workers dealing with HHP were provided with appropriate personal protective equipment (PPE) and the use of them was enforced.*

e. *Please confirm if the applicant has implemented all the conditions set by the Pesticides Committee as part of the derogation approval.*

Appendix 1. Map of plantation areas involved in the Alpha-cypermethrin derogation application

Distribution of industrial plantations and National Plantation Inventory regions



Appendix 2: Cost Benefit Analysis. Alpha Cypermethrin

Stakeholder Feedback:

Stakeholders were highly concerned about the off-site impacts of Alpha Cypermethrin on humans and the environment. While many stakeholders would prefer this pesticide to not be used, others would like to see improved monitoring programs and well developed conditions on its use including IPM approaches, buffers, notification of neighbours and other stakeholders.

		Economic Impacts		Environmental Impacts		Social Impacts			Overall Outcome
		Criteria 1	Criteria 2	Criteria 1	Criteria 2	Criteria 1	Criteria 2	Criteria 3...	
	Control Regime Description	**Basic NPV type analysis (item 1.5)**	**Other economic impacts**	**Onsite impacts**	**Off-site impacts**	**Worker health and safety**	**Impacts on neighbours**	**Legal compliance**	
No use of Alpha Cypermethrin	*Alpha Cypermethrin will not be used. Alternatives will be used where applicable.*	NPV scenarios detailed below demonstrates the significant economic impact where no treatment is considered. A 20% to 50% reduction in yield within a 100 ha plantation, due to insect infestations can result in a NPV -$27,000 to -$123,000 loss in revenue.	Alternative treatments do not target the egg - larvae - adult growth stages of the target insect species. Spinetoram is four times more expensive than alpha-cypermethrin. Clothianidin is effective between the ages of 1- 2 years so is not an effective treatment within semi-mature - mature plantations. Tebufenozide is seventeen times more expensive than alpha-cypermethrin. *Bacillus thuringiensis* is susceptible to rain and sunlight.	**LOW**: Risk to non-target species from Alpha Cypermethrin poisoning is eliminated, however risk from alternative pesticides needs to be considered. Risk to the health and viability of the affected plantation is potentially higher due to the reduced efficacy of alternative pesticides.	**LOW**: Risk to non-target species from Alpha Cypermethrin poisoning is eliminated, however risk from alternative pesticides needs to be considered.	**LOW**: Risk associated with Alpha Cypermethrin toxicity to worker health and safety is mitigated, however risk from alternative pesticides needs to be considered.	**LOW**: Risk associated with Alpha Cypermethrin toxicity to neighbours and other sensitive businesses (e.g. apiaries, fish farms) is mitigated, however risk from alternative pesticides needs to be considered.	**LOW:** Minimal to no risk of non-compliance with legal requirements.	Greatly increased costs, reduced effectiveness of pest control affect the viability of this option.
Use of Alpha Cypermethrin in compliance with existing regulations	*Compliance with regulations*	NPV scenarios detailed below demonstrates the positive return where action is taken to control alpha cypermethrin. Treatment at age 5 within a 100 ha plantation improves the NPV from the rotation between +$7,500 and +$33,000.	The application of alpha-cypermethrin is effective and efficient.	**MODERATE:** Risk to environment from Alpa Cypermethrin exists but is be reduced through best-practice application practices, including reduced instances of application through use of IPM approaches, increased buffer widths to protect water courses and other sensitive environmental assets.	**MODERATE:** Risk to environment from Alpa Cypermethrin exists but is be reduced through best-practice application practices, including reduced instances of application through use of IPM approaches, increased buffer widths to protect water courses and other sensitive environmental assets.	**LOW:** Worker risk minimised due to controlled pesticide application procedures.	**MODERATE:** A risk of off-site Alpha Cypermethrin contamination remains, however the risk is reduced through best-practice application practices, including reduced instances of application through use of IPM approaches, increased buffer widths to protect water courses and other sensitive environmental assets.	**LOW:** Compliance with legal requirement to effectively control pest species.	Low cost, good control of pest populations and reduced risk to humans and the environment through well developed application procedures make this option viable.
Use of Alpha Cypermethrin with additional preventative controls	*Control Regime: In high risk environments (e.g. near houses) non-toxic alternatives to be used.*	NPV calculations of a combined strategy will vary between the effectiveness of the alternative treatment. NPV calculations will vary between the various scenarios detailed within the NPV calculations.	The application of alpha-cypermethrin is effective and efficient. Use of helicopters is the prefered method of application to minimise drift.	**LOW**: Risk to non-target species and hte broader environment from Alpha Cypermethrin poisoning is further reduced in sensitive areas. In those areas deemed sensitive, alternative pest control approiaches will be used, including the use of alternative less hazardous pesticides or the use of no pesticides.	**LOW**: Risk to non-target species and the broader environment from Alpha Cypermethrin poisoning is further reduced in sensitive areas. In those areas deemed sensitive, alternative pest control approaches will be used, including the use of alternative less hazardous pesticides or the use of no pesticides.	**LOW:** Worker risk minimised due to less appliaction of Alpha Cypermethrin and controlled pesticide application procedures. Risk associated with alternative pesticides needs to be considered.	**LOW:** Risk of off-site Alpha Cypermethrin contamination reduced, particularly in proximity to neighbours and other sensitive sites. Risk associated with alternative pesticides needs to be considered.	**LOW:** Risk of non-compliance with legal requirement to effectively control pest species.	Moderate cost, poorer localised control of pest populations, reduced risk to neighbours, other stakeholders and non-target domestic species make this option potentially viable in those locations where alternatives are feasible and not cost prohibitive.

Appendix 2a. Tasmania Insect Control

	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3
MAI	25	20.00	12.50	25
Hectares	100	100	100	100
Stumpage	$ 20	$ 20	$ 20	$ 20
Discount Rate	9%	9%	9%	9%
Insect Remediation Cost per Ha				$ 50

Scenario 1) Standard Rotation

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 750,000
Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 748,600.00**
NPV	$10,426.65																
IRR	9%																

Scenario 2A) Small Insect Event Year 5 untreated - 20% Reduction in Yield

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 600,000
Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation																	
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 598,600.00**
NPV	-$27,353.81																
IRR	8%																

Scenario 2B) Major Insect Event Year 5 untreated - 50% Reduction in Yield

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 375,000
Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation																	
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 373,600.00**
NPV	-$84,024.51																
IRR	4%																

Scenario 3) Major Insect Event Year 5 Remedied

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 750,000
Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation							-$ 5,000										
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 6,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 748,600.00**
NPV	$7,445.32																
IRR	9%																

Appendix 2b. Western Australian and Victorian Insect Control

	Scenario 1	Scenario 2A	Scenario 2B	Scenario 3
MAI	22	17.60	11.00	22
Hectares	100	100	100	100
Stumpage	$ 25	$ 20	$ 13	$ 25
Discount Rate	9%	9%	9%	9%
Insect Remediation Cost per Ha				$ 50

Scenario 1)	**Standard Rotation**											
		0	1	2	3	4	5	6	7	8	9	10
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 550,000
Plantation Management Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 548,600.00**
NPV	$36,777.71											
IRR	11%											

Scenario 2A)	**Small Insect Event Year 5 untreated - 20% Reduction in Yield**											
		0	1	2	3	4	5	6	7	8	9	10
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 352,000
Plantation Management Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation												
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 350,600.00**
NPV	-$39,953.79											
IRR	6%											

Scenario 2B)	**Major Insect Event Year 5 untreated - 50% Reduction in Yield**											
		0	1	2	3	4	5	6	7	8	9	10
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 137,500
Plantation Management Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation												
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 136,100.00**
NPV	-$123,079.59											
IRR	-4%											

Scenario 3)	**Major Insect Event Year 5 Remedied**											
		0	1	2	3	4	5	6	7	8	9	10
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 550,000
Plantation Management Costs		-$ 180,000	-$ 4,350	-$ 2,050	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400	-$ 1,400
Insect Remediation					-$ 5,000							
Total		**-$ 180,000.00**	**-$ 4,350.00**	**-$ 2,050.00**	**-$ 6,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**-$ 1,400.00**	**$ 548,600.00**
NPV	$33,235.59											
IRR	11%											

Appendix 3. INTERIM Stakeholder Feedback Report – Alpha Cypermethrin

Report Overview

The following report provides a summary of the outcomes of the FSC Highly Hazardous Pesticide Derogation stakeholder feedback, including survey responses and additional feedback received from public comments and communication with forest company representatives.

This feedback was used by the independent advisory group in making recommendations to forest managers regarding pesticide acceptance and preferred conditions of use. These recommendations were then consideration in the further development of the various derogation applications.

Overall stakeholder response

In total 125 stakeholders have provided feedback on the derogations applications as December 21, 2015. This includes 75 survey respondents and 50 stakeholders who participated through providing public comment and communication with the National Coordinator or forest company representatives. Many survey respondents also provided feedback through other approaches such as email and/or communication with forest company representatives.

The majority of survey respondents were individuals living on or owning properties adjacent to forested areas (63%) as shown in Table 1. These high numbers of stakeholders who live on or adjacent to forest areas was expected given that forest companies primarily approached those stakeholders registered on company databases for stakeholder feedback. The number of survey respondents identifying as being members of environmental groups was lower than anticipated given the typically high level of interest of such groups in forestry issues.

Table 1: Types of stakeholders who participated in feedback opportunities

Stakeholder Type (n=75)	No. Survey Responses	% of Survey Responses	No. Comment Responses	Total % of Responses
I am a member of an environmental group with an interest in forestry activities	5	7%	4	7.2%
I am a member of the general public with an interest in forestry activities	10	13%	4	12.8%
I live on a property adjacent to or near a forested area (native forest and/or plantation forest)	22	29%	1	18.4%
I own or manage land adjacent to near a forested area (native forest and/or plantation forest)	18	24%		14.4%
I work, or used to work, within the forest industry	11	15%		8.8%
My business, or place of employment, is impacted by forestry activities	4	5%	4	6.4%
Government	3	4%	2	4.0%
Other, or unknown	2	3%	35	29.6%

State of origin (survey respondents only)

Survey respondents were predominantly from Tasmania (49%), followed by Victoria (35%) and Western Australia (9%) See Figure 1, with very little response from other jurisdictions. The majority of survey respondents were potentially affected stakeholders from rural and regional areas, with 51% living on a rural property and a further 29% in regional and rural towns See Figure 2.

Figure 1: State of origin of survey respondents (n=75)

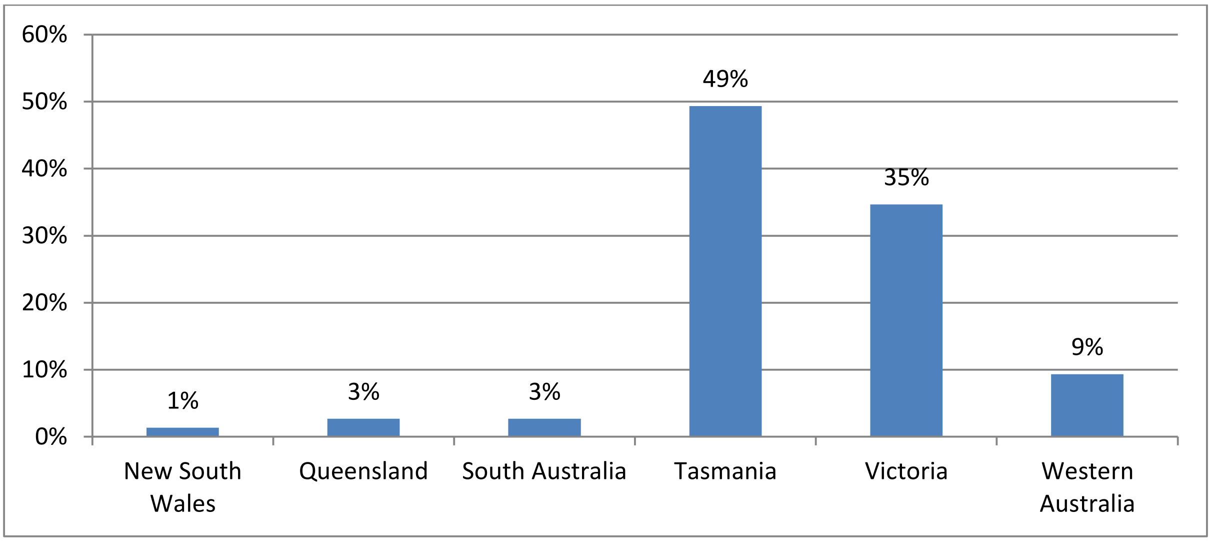
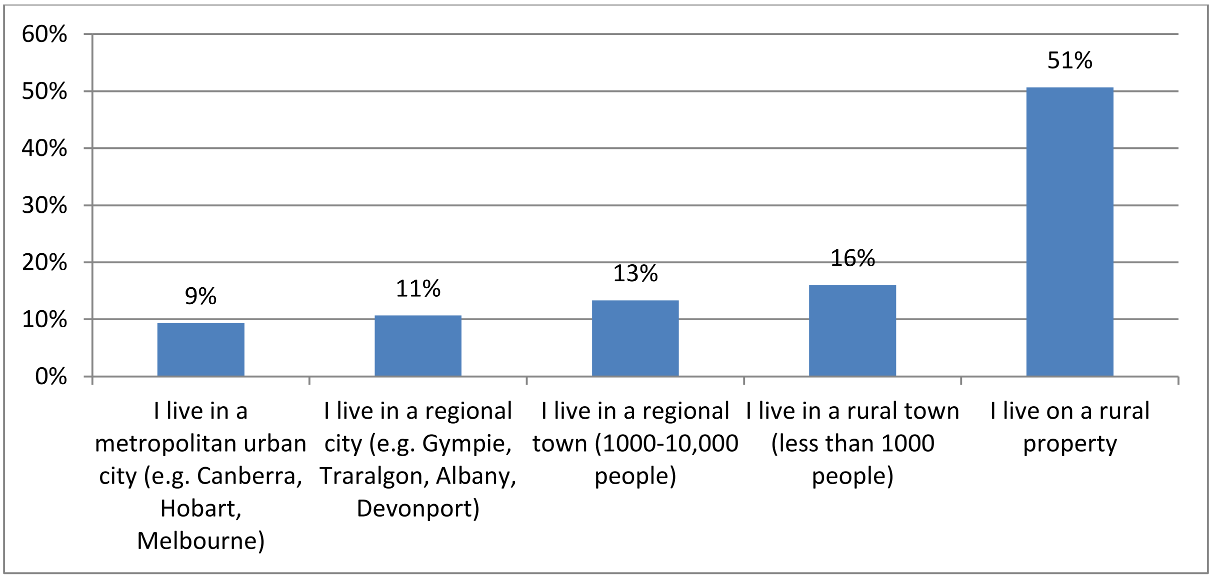


Figure 2: Location of residence (n=75)

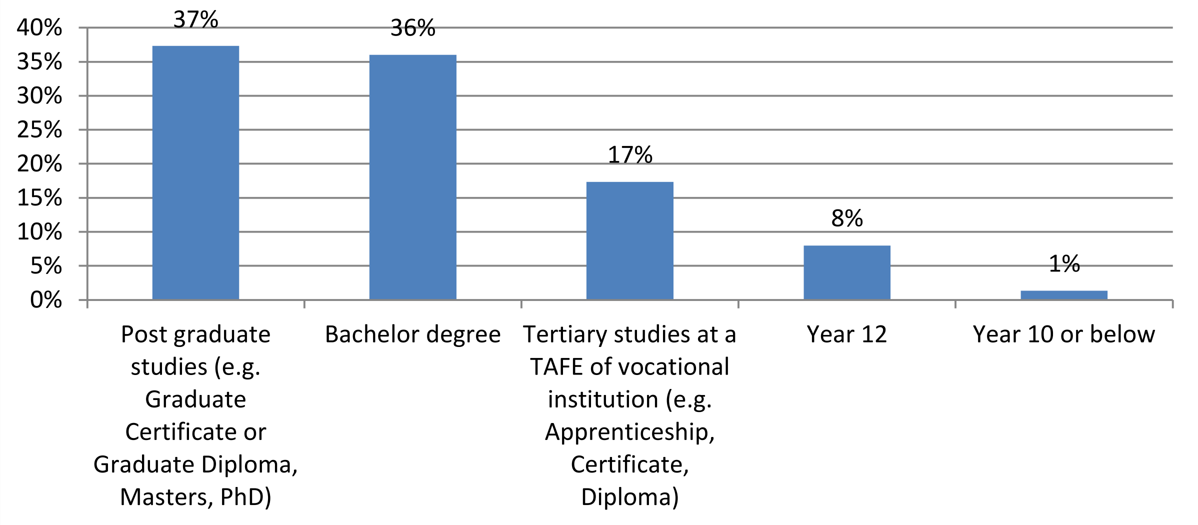


Survey responder demographics

Of the 75 survey respondents 41% were female, 55% male and 4% preferred not to state their gender. This represents a higher sample of men to women; however this is a good sample of women, with rural and regional women not often completing surveys pertaining to rural matters.

Survey respondents were highly educated as shown in Figure 3, with 74% of stakeholders have a bachelor degree or higher. While this is not representative of the general Australian public with a substantially higher level of education reported, it is indicative of the education levels of those individuals interested in forest management with forest managers reporting that this level of education is typical of their stakeholder registers.

Figure 3: Educational achievement of survey responders (n=75)



Stakeholder interest in derogation applications

As indicated in Table 2, the majority of survey comments were in regards to Tasmanian derogation applications. Some stakeholder comments were received for pesticides not under application for that jurisdiction (e.g. 1080 received 5 comments from Tasmania despite Tasmanian companies not seeking a derogation for this pesticide). This widespread interest highlights the level of concern of stakeholders regarding the use of pesticides.

Table 2: Stakeholder interest in derogation applications by state (n=75)

Pesticide commenting on*	NSW	QLD	SA	TAS	VIC	WA	Total
1080	0	0	1	5	15	4	25
Amitrole	0	0	1	5	5	2	13
Alpha-cypermethrin	0	1	1	28	5	2	37
Fipronyl	0	0	0	24	7	1	32
Cuprous Oxide	0	0	0	2	8	1	11
Copper Sulphate	0	0	0	2	1	0	3
Picloram	0	0	0	3	2	1	6
Glufosinate ammonium	0	0	0	4	3	1	8
Pindone	0	0	0	4	2	5	11
All Derogation Applications	1	1	1	9	11	3	26
Total	1	2	4	86	59	20	172
	1%	*1%*	*2%*	*50%*	*34%*	*12%*	
***Note – due to a change by FSC International derogations are now only being sought**							

for 1080, Amitrole, Alpha-Cypermethrin and Fipronil pesticides

Table 3 provides a breakdown of the company derogations survey respondents provided comment on, highlighting the high focus of stakeholders on Tasmanian and to a lesser extent Victorian forest companies derogations.

Table 3: Company derogations commented on (n=75)

Derogations Commenting On	Number of respondents
Albany Plantations Fibre Limited (WA)	14
Hancock Queensland Plantations – HQP (QLD)	8
PF Olsen (Aus) Pty Ltd (VIC, SA, QLD, WA)	20
Australian Bluegums Ltd (VIC, SA, WA)	25
Forestry Tasmania	41
Hancock Victoria Plantations - HVP (VIC, SA)	20
WAPRES(WA)	14
Bunbury Fibre (WA)	13
Forico (TAS)	30
SFM (TAS, VIC, SA)	26
National Coordinator (Pinnacle Quality)	9

Initiation of stakeholder participation

The majority of survey respondents were attracted to the stakeholder feedback process through invitations received from local forest company(s) or friends (see Table 4). Participation through environmental group dissemination of invitations was very low. Public comment feedback provided some insights into this potential low rate of interest from environmental groups, with a poor perception of FSC engagement processes and hence a lack of interest in participating due to perceived no influence on the process.

Table 4: Participant involvement initiation (n=75)

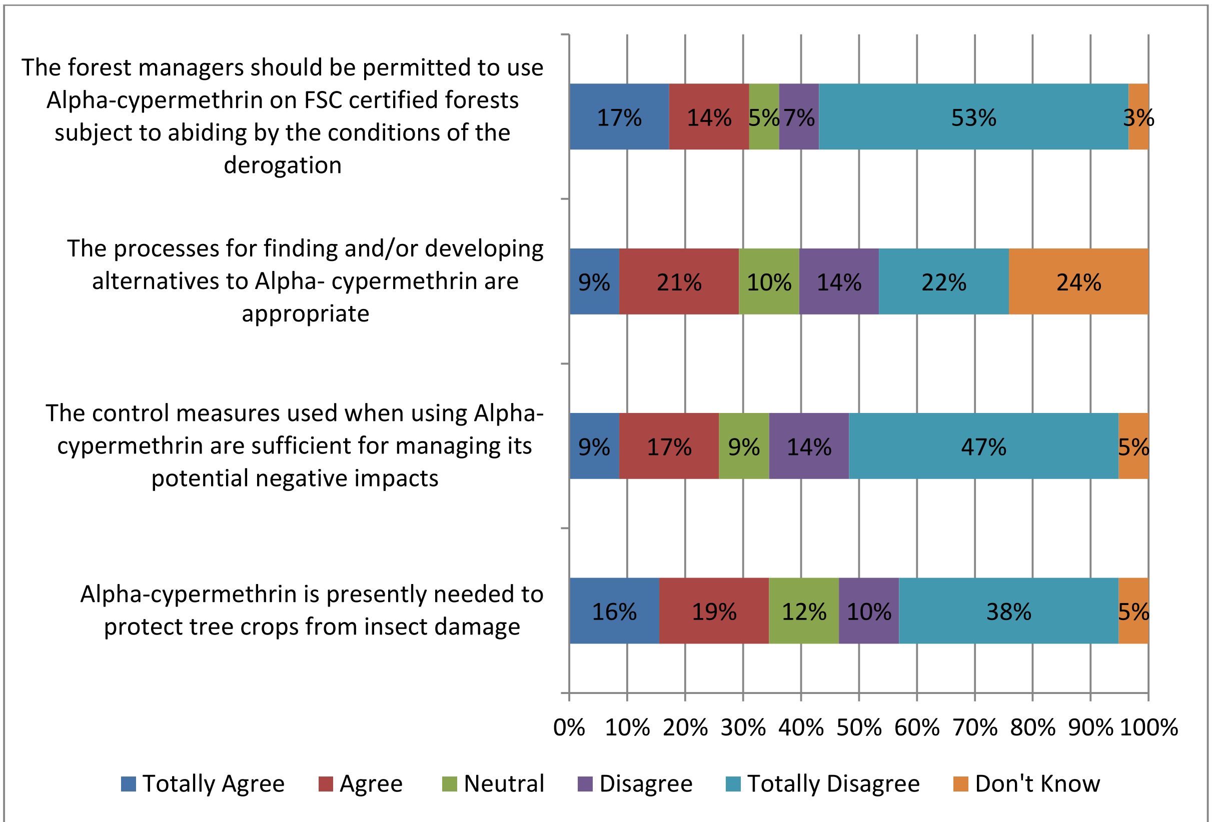
Participation Initiation	Response	% Responses
Direct email invitation from my local forest company	39	52%
Direct email invitation from the National Coordinator (Kevin O'Grady)	2	3%
Forest company website	4	5%
FSC Australia website	4	5%
Information was provided to me from a friend	23	31%
Information was provided to me from an environmental group	2	3%
Information was provided to me from through my place of work	8	11%

Feedback on Derogation Applications- Alpha-Cypermethrin

Responding stakeholders do not accept the use of Alpha-Cypermethrin, with 60% of respondents disagreeing with the use of Alpha-Cypermethrin on certified land, and 21% agreeing See Figure 4. The perceived need for Alpha-Cypermethrin is questioned with 35% of survey respondents agreeing that there is a need to use the pesticide, and 48% disagreeing that there is a need.

Stakeholders are concerned about acceptable control measures given the perceived potential impacts of the pesticide, with 61% disagreeing that control measures provided in the draft derogations are sufficient.

Figure 4: Stakeholder perceptions on Alpha-Cypermethrin (n=58)



Stakeholders expressed significant concern over the use of Alpha-Cypermethrin due to its potential toxicity to the environment and human health:

"It is a broad spectrum insecticide that is highly toxic to fish, water insects, aquatic invertebrates and bees."

"Any pesticide with this degree of toxicity and potential to cause harm should not be used anywhere … we believe the use of Alpha-cypermethrin should not be considered for use given its highly toxic properties."

"It is highly toxic to fish and highly toxic to bees... this is disastrous given the importance of bees and the other issues impacting bees."

"Due to its acute toxicity to aquatic organisms, mammals and birds there is just too much risk involved with the use of this pesticide over such large areas in so many States."

For some, aerial application further heightens this risk due to perceived increased risks of spray drift, although others feel that proper control measures such as buffers, and technical advances GPS tracking as being important and effective in reducing this risk:

"NO AERIAL SPRAYING [emphasis original] should be permitted of this or any other chemical as spray drift cannot be prevented.

"Aerial application of pesticides results in widespread and indiscriminate impacts on non-target species, and can affect water quality."

"[Stakeholder] has concerns about Alpha-Cypermethrin due to aerial application, but as long as buffers are applied it can be used safely."

"An excellent chemical for insect pest control in hardwood plantations. Modern DGPS tracking systems in aircraft have ensured application is accurately targeted and chemical is kept out of waterways."

However, despite these improvements some stakeholders see that more work is needed on such control measures as the risks are too high for potentially affected stakeholders and the environment:

"The Tasmanian Code of Practice for Aerial Spraying has not been significantly upgraded since 1998. … As it currently stands it does not provide adequate provisions to ensure that aerial spraying does not contaminate certified organic operations … If our property is contaminated with a hazardous pesticide such as Alpha cypermethrin, we are likely to lose our organic certification."

"Aerial spraying has great capacity to drift from target areas … The water sampling technique, mid level/mid stream (relatively high flow) is not the habitat of most aquatic insects and may not be location of the highest concentrations of any contaminants present."

The perceived environmental costs of using Alpha-Cypermethrin and perceived economic costs of not controlling pest insect populations are often difficult to reconcile, with some stakeholders concerned over the priorities of forest management organisations and the lack of efforts in finding safer alternatives:

"One of the criteria for chemical use of alpha cyphermethrin (costs vs alternatives) makes it clear that economics are considered more important than human and environmental health … So called 'safe' use in a forestry context can have impacts way beyond forestry operations … what efforts have been made to find safer alternatives ? … Is financial gain more important?"

"Invest money in the research for safer alternatives......maybe more costly now but in the long term it will benefit everyone … The report clearly states that there are alternatives available but that they are more expensive. The forestry industry needs to factor this cost in."

"Forestry should send the money and make sure less toxic pesticides get registered in Australia rather than just claim there is no alternative."

Some stakeholders are more pragmatic on the use of Alpha-Cypermethrin and see it as being an important, regulated and controlled pesticide that can be used safely when sufficient controls are put in place:

"The use is essential for control of leaf defoliating insects"

"This product is widely used in the agricultural industry for management of pests on crops. Forestry in Tasmania has strict controls on usage and if used appropriately it should be available for use"

"If leaf beetle populations are monitored to determine if controls are necessary after most natural predation has occurred the negative effects of applying alpha-cypermethrin are reduced if it is applied on this basis."

"This chemical has a known off-target negative impact on aquatic life. If to be used in environments where seasonally ephemeral wetlands and remnant water bodies are located - either in adjoining land or within remnants within forestry plantations; careful application to avoid run-off and contamination impacts must be observed."

The acceptance of using Alpha-Cypermethrin on FSC certified lands for each of the relevant states is provided in Table 5 and Figure 5. Again New South Wales, Queensland, South Australia and Western Australia have been combined due to the low number of respondents within each state.

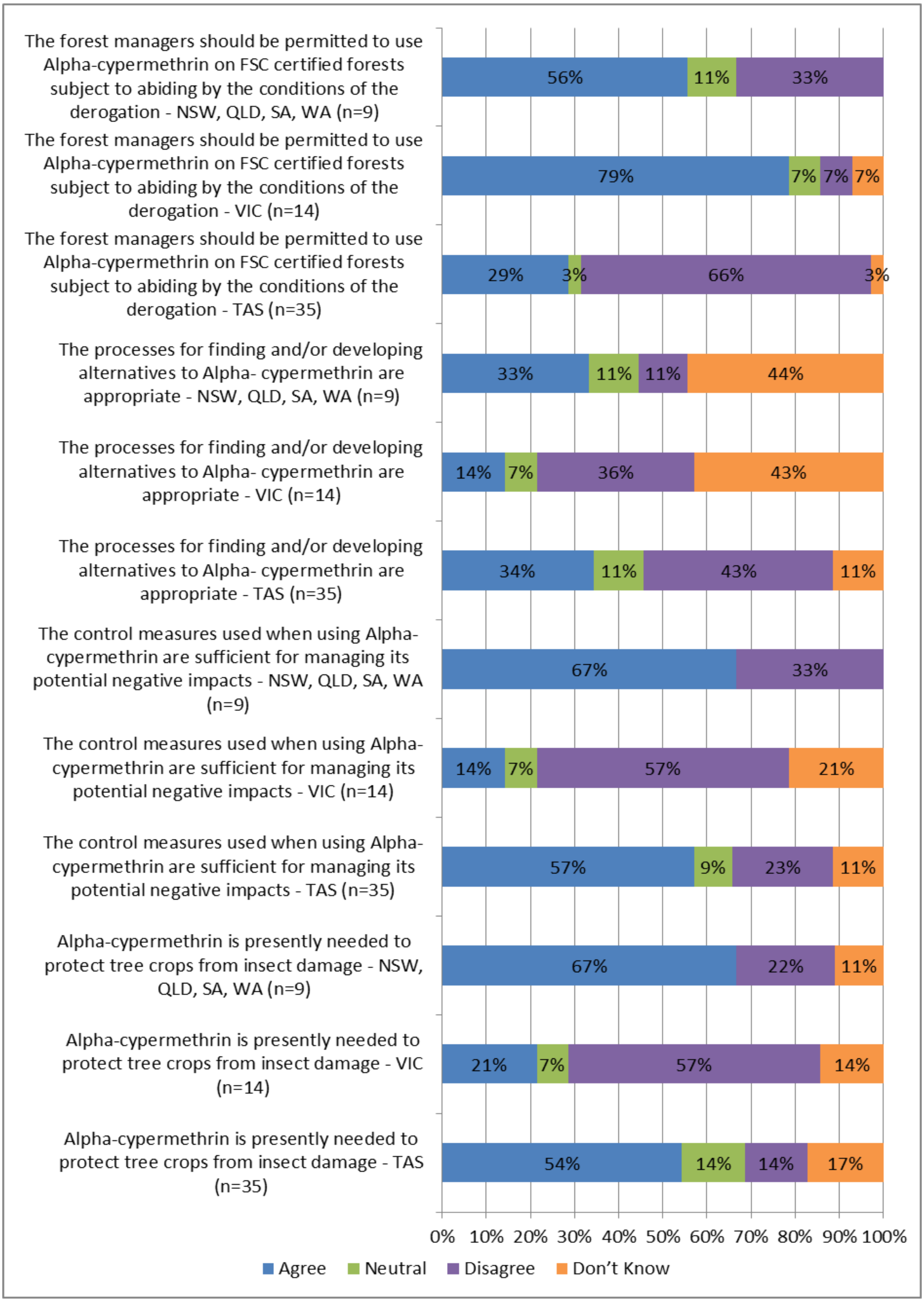
The acceptance of Alpha-cypermethrin for use on FSC certified lands varies considerably across each state, with Tasmanian survey respondents critical of its use with only 29% of respondents agreeing that forest managers should be able to use Alpha-cypermethrin on FSC certified forests, compared to 79% in Victoria and 56% across the other states. This is in stark contrast to survey respondent's perceptions of the need for Alpha-cypermethrin where 54% of Tasmanians agreed it was necessary, 67% of NSW, QLD, SA and WA, and only 21% of Victorians. This acceptance of the need is similar to the perceived sufficiency of control measures where again those interested in Victorian derogations were critical, with 57% disagreeing that control measures are sufficient, compared to 57% agreeing in Tasmania and 67% in NSW/QLD/SA and WA.

Table 5: A comparison of acceptance of Alpha cypermethrin for use on FSC certified forests across the states

	Agree	Neutral	Disagree	Don't Know
Alpha-cypermethrin is presently needed to protect tree crops from insect damage - TAS (n=35)	54%	14%	14%	17%
Alpha-cypermethrin is presently needed to protect tree crops from insect damage - VIC (n=14)	21%	7%	57%	14%
Alpha-cypermethrin is presently needed to protect tree crops from insect damage - NSW, QLD, SA, WA (n=9)	67%	0%	22%	11%
The control measures used when using Alpha- cypermethrin are sufficient for managing its potential negative impacts - TAS (n=35)	57%	9%	23%	11%
The control measures used when using Alpha- cypermethrin are sufficient for managing its potential negative impacts - VIC (n=14)	14%	7%	57%	21%

The control measures used when using Alpha- cypermethrin are sufficient for managing its potential negative impacts - NSW, QLD, SA, WA (n=9)	67%	0%	33%	0%
The processes for finding and/or developing alternatives to Alpha-cypermethrin are appropriate - TAS (n=35)	34%	11%	43%	11%
The processes for finding and/or developing alternatives to Alpha-cypermethrin are appropriate - VIC (n=14)	14%	7%	36%	43%
The processes for finding and/or developing alternatives to Alpha-cypermethrin are appropriate - NSW, QLD, SA, WA (n=9)	33%	11%	11%	44%
The forest managers should be permitted to use Alpha-cypermethrin on FSC certified forests subject to abiding by the conditions of the derogation - TAS (n=35)	29%	3%	66%	3%
The forest managers should be permitted to use Alpha-cypermethrin on FSC certified forests subject to abiding by the conditions of the derogation - VIC (n=14)	79%	7%	7%	7%
The forest managers should be permitted to use Alpha-cypermethrin on FSC certified forests subject to abiding by the conditions of the derogation - NSW, QLD, SA, WA (n=9)	56%	11%	33%	0%

Figure 5: Acceptance of Alpha-Cypermethrin for use on FSC certified forests across the states



Appendix 4. Natural enemies of insect herbivores in blue gum plantations in SW WA (June 2005 Mamoru Matsuki & Andrew Loch)

Natural enemies of insect herbivores in blue gum plantations in SW WA

June 2005
Mamoru Matsuki & Andrew Loch

Note added in September 2006: After this report was written, genus *Chrysophtharta* was merged into genus *Paropsisterna* (Reid 2006).
Reid, C. A. M. 2006. A revision of the Australian Chysomelinae, with a key to the genera (Coleoptera: Chrysomelidae). Zootaxa 1292: 1 – 119.

Summary

Please read the entire document carefully.

Introduction

Some insect herbivores are well known for their periodic or occasional outbreaks during which vast tracts of natural forests can be defoliated. However, only an extremely small proportion of herbivores show outbreaks in natural environments, and outbreak species tend to be found in somewhat marginal habitats such as forests in subarctic and north temperate zones where the season for growth of plants and insects is short. In Australia, insect outbreaks are also reported from somewhat marginal habitats: sub-alpine forests, south temperate forests, and semiarid regions. It has been hypothesised that fluctuations in the environment (e.g., temperature and rainfall) and natural enemy populations cause insect outbreaks in these natural environments.

Unlike in natural environments, insect herbivores cause more severe defoliation more frequently in eucalypt plantations. Of the major pests in blue gum plantations, none are known to show outbreaks in natural environments. It has long been speculated that monocultures of plants support only limited diversity of natural enemies of insect herbivores and thus facilitate insect herbivores to cause extensive and frequent defoliation.

This report summarises known and potential natural enemies of insect herbivores in blue gum plantations in SW WA. We also briefly mention natural enemies in the eastern states. Compared with insect pests, relatively little is known or understood about biology of natural enemies in blue gum plantations. Information presented in this report is obtained during our field studies and from literature. Not all known natural enemies were observed during this study. Also, we have collected some undescribed species. Therefore, this report should be best viewed as a starting point for further research into natural enemies and their interactions with insect herbivores. Topics for future research projects are suggested at the end of this report.

Comparisons between WA & other parts of Australia

Natural enemy	**SW WA**	**Other parts of Oz**
Anaphes nitens	Present but not very effective, especially in early spring	Presumed to be effective but no study has been carried out
Parasitoid wasps on eggs of chrysomelid beetles	Scarce in blue gum plantations but common in native forests?	Scarce in Tas & more common in NSW & SE Qld
Parasitoid wasps on AGM eggs	Absent?	Present (& especially effective in the GT)
Parasitoid wasps on eggs of bugs	Present but rare (?)	Present
Parasitoid wasps on larvae of *Eucalyptus* weevil	None reported or known	Present in Tas & unknown elsewhere
Parasitoid wasps on larvae of chrysomelid beetles	Absent?	Common and effective in Tas and SE mainland but scarce in SE Qld
Parasitoid wasps on LBS larvae	Most effective species (*Bracon phylacteophagus*) is missing	Present & effective (?)
Parasitoid wasps on AGM larvae	Present but there are fewer species than in SE mainland	Present (9 spp.) & effective (?)
Tachinid flies on larvae of chrysmelid beetles	Present & apparently effective	Present & apparently effective
Tachinid flies on larvae of *Eucalyptus* weevil	Present	Present
Soldier beetles	Present but rare	Present
Ladybird beetles	Present but rare	Present & particularly effective against *C. bimaculata* in Tas (but rare in the GT & unknown in other regions)
Predatory bugs	Present but uncommon	Present but uncommon (except some mirid bugs in Tas)
Birds	Present	Present
Virus against AGM larvae	Present and common	Present but uncommon to

		rare
Pathogenic fungi	Present	Present

Phenology

x = present in small numbers.
X = main season.

***Eucalyptus* weevil and its parasitoids**

Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul

adults xxxxxxxxxxxxxxxxxxxxxxXXXXXXXXxxxxxxxxxxxxxxxxx
eggs xxxxxxXXXXxxxxxxxxxxxxxxxx x xxxxxxxxxxxxxxx
larvae xXXXXXXxx xxxxxxxx
A. nitens ???xxxxxxxxxxxXXXXXXXXXxxxxxxxxxxxx??????????xx
Eudelus sp. ?????????????????????XXXXXXXXxxxxxxxxx??????????????
adults of tachinid flies ????????xxxxxxxxxxxxxxxxxxxxxx????????????????????????
pupae of tachinid flies xxXXXXxx

chrysomelid beetle (*Chrysophtharta variicollis*) and its tachinid parasitoids

Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul

adults xxXXxxxxxxxxxxxxXXXXXXXXxxx
larvae xxxxxXXXxxxxxxxXXXXXXxxx
adults of tachinid flies ??????????xxxxxxxxxxxxxxxxxxxxxxx???????????????????
pupae of tachinid flies xxxxXXXXXXxx

generalist predators

Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul

Oechalia schellembergii (predatory bug)xxxxxxxxxxxxxxxxxxxx
Gminatus australis (predatory bug) xxxxxxxx
Onchocephalus sp. (predatory bug) xxxxxx
Jewel spiders XXXX
Orb-web spiders XXXxxxxx
Lacewings xxxxxxxx
Robber flies xxxxxx

Parasitoids

Parasitoids lay eggs on or in their host species. Larvae of parasitoids are like parasites in that they develop inside of their hosts. However, the hosts die when the larvae complete their development. Wasps and tachinid flies are two major groups of parasitoids. Unlike predators, usually only one individual of the host is required for development of an individual parasitoid. Therefore, some parasitoid species can be common (more abundant than predators). However, parasitoids are often overlooked by untrained eyes because (1) larvae are inside of their hosts and (2) adult parasitoids often do not look very different from non-parasitoids.

Adult females of parasitoids are extremely adept at finding their hosts, and parasitoids can be very effective in keeping herbivore populations to low levels. Unlike predators, each parasitoid species tends to attack a small number of host species. Because of these traits, parasitoids can be successful biological control agents of introduced pests.

Some parasitoids are themselves hosts of other parasitoids (hyperparasitism). When there are more adult females of parasitoids (of the same or different species) than the host, multiple eggs are laid on a single host (superparasitism).

In SW WA, the key pest species and other herbivoures (Host) in blue gum plantations are attacked by a number of parasitoid species.

Host	**Parasitoid**	**Order**	**Family**
Eucalyptus weevil	*Anaphes nitens*	Hymenoptera (wasps)	Mymaridae
Eucalyptus weevil	*Centrodora* sp.	Hymenoptera (wasps)	Aphelinidae
Eucalyptus weevil	*Eudelus* sp.	Hymenoptera (wasps)	Eulophidae: Euderinae
Eucalyptus weevil	Gen. nov. sp. nov.	Diptera (flies)	Tachinidae
Eucalyptus weevil	To be identified	Diptera (flies)	Tachinidae
Leaf-blister sawfly	*Bracon confusus*	Hymenoptera (wasps)	Braconidae
Leaf-blister sawfly	*Cirrospilus margiscutellum*	Hymenoptera (wasps)	Eulophidae
Chrysophtharta variicollis (chrysomelid beetle)	*Anagonia scutellata*	Diptera (flies)	Tachinidae
Chrysophtharta variicollis (chrysomelid beetle)	*Anagonia* sp.	Diptera (flies)	Tachinidae
Chrysophtharta debilis (chrysomelid beetle)	To be identified	Diptera (flies)	Tachinidae
Chrysophtharta m-fuscum (chrysomelid beetle)	To be identified (sp. 1)	Diptera (flies)	Tachinidae

Chrysophtharta m-fuscum (chrysomelid beetle)	To be identified (sp. 2)	Diptera (flies)	Tachinidae
Chrysophtharta variicollis (chrysomelid beetle)	To be identified	Hymenoptera (wasps)	Scerionidae
Chrysophtharta variicollis (chrysomelid beetle)	*Enoggera nassaui*	Hymenoptera (wasps)	Pteromalidae
Paropsis elytura (chrysomelid beetle)	*Enoggera* sp.	Hymenoptera (wasps)	Pteromalidae
Paropsis sp. near *wilsoni* or *variolosa* (chrysomelid beetle)	To be identified	Diptera (flies)	Tachinidae
Paropsis geographica (chrysomelid beetle)	To be identified	Diptera (flies)	Tachinidae
Paropsis geographica (chrysomelid beetle)	*Enoggera* sp.	Hymenoptera (wasps)	Pteromalidae
African Black Beetle	*Palpostoma testaceum*	Diptera (flies)	Tachinidae
Perga schiodtei (spitfire sawfly)	*Froggatimyia nicholsoni* (or *fergusoni*)	Diptera (flies)	Tachinidae
(coreid bug)	To be identified	Hymenoptera (wasps)	Pteromalidae
Autumn Gum Moth	*Casinaria micra*	Hymenoptera (wasps)	Ichneumonidae
Autumn Gum Moth	*Euceros* sp.	Hymenoptera (wasps)	Ichneumonidae
Autumn Gum Moth (need confirmation)	*Therion* sp. (Gravenhorstiinae)	Hymenoptera (wasps)	Ichneumonidae
(leaf tier moth)	To be identified	Hymenoptera (wasps)	Braconidae
(leaf tier moth)	*Carria* sp.	Hymenoptera (wasps)	Ichneumonidae
(leaf tier moth)	*Glypta* sp.	Hymenoptera (wasps)	Ichneumonidae
(leaf tier moth) (need confirmation)	*Campoletis* sp. (Porizontinae: Macrini)	Hymenoptera (wasps)	Ichneumonidae
(leaf tier moth)	*Cirrospilus* sp.	Hymenoptera (wasps)	Eulophidae
(leaf tier moth)	*Elachertus* sp.	Hymenoptera (wasps)	Eulophidae

Parasioid wasps without host records were also collected in blue gum plantations in SW WA.

Possible hosts	**Species**	**Family**

Wood-boring and bark-mining beetles	(Doryctinae)	Braconidae:
Larvae of butterflies and moths	(Rogadinae)	Braconidae
Larvae of butterflies and moths	(Rogadinae)	Braconidae
Larvae of butterflies and moths	(Rogadinae)	Braconidae
Larvae of butterflies and moths	*Macrocentrus* sp. (Macrocentrinae)	Braconidae
	Gptra sp. (Mesosteninae: Gabunini)	Ichneumonidae
Larvae of butterflies and moths	*Netelia* spp. (Tryphoninae: Phytodietini)	Ichneumonidae
Larvae of butterflies and moths	*Ophion* spp. (Ophioninae: Ophionini)	Ichneumonidae

Anaphes nitens:

This is a small (approximately 1 mm in length as adults) black wasp. It belongs to the family Mymaridae, and other species in this family are 0.2 – 1 mm in length and typically parasitise insect eggs which are more or less concealed. There are approximately 270 species of mymarid wasps recorded in Australia. There are three species of *Anaphes*, and all three species parasitise eggs of *Eucalyptus* weevil.

Adult *A. nitens*. The dark mass on the left-hand side of the photo is an egg mass of *Eucalyptus* weevil (Photo: Andrew Loch).

Larvae of *A. nitens* develop in *Eucalyptus* weevil eggs. It is generally believed (but without any studies) that population levels of *Eucalyptus* weevil in SE Australia (its native distribution range) are effectively controlled by *A. nitens*. However, *Eucalyptus* weevil has started to cause damage in blue gum plantations in southern Tasmania in recent years. *Anaphes nitens* has been introduced to SW Europe, South Africa, New Zealand, and SW USA for controlling *Eucalyptus* weevil. There has been large variation (even within a region) in effectiveness of *A. nitens* as a control agent. Because *Eucalyptus* weevil has not been a serious pest of eucalypt plantations in SE Australia, there have been hardly any studies on *Eucalyptus* weevil or *A. nitens* in Australia. However, many studies have examined *Eucalyptus* weevil and *A. nitens* outside of Australia.

Parasitism rates were studied in 1999 – 2001 in four plantations by AL and in 2004 – 2005 in five plantations by MM. Both studies showed that parasitism rates were higher towards the end of egg-laying period of *Eucalyptus* weevil (November to January) than the peak egg-laying period (September). In December and January, the parasitism rates by *A. nitens* decrease because there are two other species of wasps. The parasitism rates of *Eucalyptus* weevil egg cases by all species of wasps combined are nearly 100% in December and January. One of the wasp species may be a hyperparasitoid of *A. nitens*. In 2005, small number of egg cases of *Eucalyptus* weevil was observed from mid April to early May. Adult *A. nitens* emerged from some of the egg cases.

AL attributed the low parasitism rates in early season to low population levels of *A. nitens* at the end of winter. Only a small number of egg masses of *Eucalyptus* weevil is found from February to mid August. Adult *A. nitens* emerged from egg masses collected in April and May 2005 (see Appendix) and mid July 2005 (a plantation near Mt Barker). Species of *Oxyops*, an uncommon weevil species on WA blue gum, lay eggs during winter but no *A. nitens* was reared from *Oxyops* eggs by AL. Laboratory studies in Europe have shown that *A. nitens* adults live for 6 days (male) to 8 days (female) at 20 – 23°C or 15 days (male) to 18 days (female) at 10°C.

The mean number of *A. nitens* adults emerging from an egg mass is 5, with the range of 1 – 23 in 2004 – 05. When adult *A. nitens* emerge, they immediately mate, and females are ready to start laying eggs. Eggs of *Eucalyptus* weevils are covered in a case and are not visible to ovipositing female *A. nitens*; however, they are able to tell whether host eggs have already been parasitised when they insert the ovipositor to host eggs. A laboratory study in Europe has shown that female *A. nitens* lay an egg in already parasitised egg of *Eucalyptus* weevil (superparasitism). This behaviour is considered to be one of the reasons which make *A. nitens* a successful biological control agent. In 2004-05, all viable eggs in each egg mass are parasitised in 81% of parasitised egg masses. In the remaining 19% of parasitised egg messes, 9 – 96% of viable eggs in each egg mass are parasitised.

In Europe and Africa, *A. nitens* naturally dispersed from the release locations. In SW WA, *A. nitens* appear to be following the spread of *Eucalyptus* weevil in the region. In October 2005, a small number of adult *A. nitens* emerged from eggs collected in a plantation E of Collie where *Eucalyptus* weevil has recently colonised.

Within areas where both *A. nitens* and *Eucalyptus* weevil already exist, *A. nitens* appear to be able to colonise into new plantations within a month or so. In September 2004, *A. nitens* was found in two out of five P2002 plantations. *Eucalyptus* weevil eggs were absent or very rare in the previous season in the P2002 plantations, and thus, *A. nitens* is likely to have colonised the two plantations from other plantations at the beginning of this season. *Anaphes nitens* was found in all five P2002 plantations in December 2004. The sampling intensity was roughly the same in four of the five plantations throughout the season. Therefore, it is possible that *A. nitens* has colonised the three P2002 plantations from other plantations in October to November.

The majority of adult *A. nitens* emerged from eggs within three weeks of egg being brought in from the field. Therefore, there is at least one generation of *A. nitens* each month. A study in Europe has shown that one *A. nitnes* female produces the average of 46 eggs. The average number of *Eucalyptus* weevil eggs per egg mass was 6.7 in 2004 – 05. With the information above and a simple model of population growth, we are able to see a few things.

Assuming that there is no limitation in the number of *Eucalyptus* weevil eggs, the number of *Eucalyptus* weevil egg masses parasitised by *A. nitens* quickly multiplies in the course of a season. The table below shows that if there was one female in August, then five egg masses would be parasitised in August, 115 egg masses would be parasitised in September, and so on. The table also shows cases where there were 10 females and 100 females in August.

Initial number of adult female	Number of parasitised egg cases				
	August	September	October	November	December
1	5	115	2645	60835	1399205
10	69	1579	36319	835346	19212964
100	687	15791	363194	8353463	192129642

Still using the same model, but additionally assuming (1) 1000 stems per ha, (2) two egg cases per growing tip, and (3) 20 growing tips per tree, we can see that 4% of egg masses would be parasitised in September if there were 10 females per ha in August.

Initial number of adult female	% parasitism rate of egg cases				
	August	September	October	November	December
1	0.02%	0.4%	9%	100%	100%
10	0.2%	4%	91%	100%	100%
100	1.7%	39%	100%	100%	100%

The observed maximum parasitism rate in late September is 14% (Appendix). If all the assumptions are correct, then 14% parasitism rate in September can be achieved by 35 females per ha in August. To achieve 100% parasitism rate in September, we need 255 females per ha in August. So, for one 100ha plantation, we need 25500 females. In the above model, the survivorship of *A. nitens* is assumed to be 100%. If we assumed that the survivorship was 50%, then we would need 51000 females to achieve 100% parasitism rate in September in a 100ha plantation.

Pteromalid wasp:

Peteromalid wasps are diverse morphologically (0.6 – 40mm) and biologically (gall-forming or parasitoids of eggs, larvae, pupae, or adults of many different species of insects). There are 525 species of pteromalid wasps in Australia.

Another species of pteromalid wasp emerged from eggs of a coreid bug (*Amorbus* sp.).

Enoggera nassaui is a parasitoid of eggs of chrysomelid beetles (*Chrysophtharta* spp., *Paropsis* spp., *Trachymela* spp., *Paropsisterna* spp., and *Trocholodes* spp.) in the eastern states and in WA. *Enoggera nassaui* was successfully introduced to New Zealand from WA as a biological control agent of *Paropsis charybdis*. Another species *Enoggera reticulata* was successfully introduced to South Africa from WA as a biological control agent of *Trachymela tincticollis*. A species of *Enoggera* emerged from eggs of a chrysomelid beetle (*Paropsis elytura*). This is the only incidence of parasitism on chrysomelid beetles by pteromalid wasps in SW WA during this study.

Ichneumonid wasp:

Ichneumonid wasps parasitise larvae, prepupae, and pupae of various insects, spiders, and spider eggs. Approximately 1245 species of ichneumonid wasps have been recorded from Australia. These wasps vary greatly in size (1.5 – 120mm). These wasps parasitise larvae, prepupae, and pupae of various insects, spiders, and spider eggs. Adult ichneumonid wasps are often attracted to nectar and honeydew.

There are nine species of ichenumonid wasps parasitising AGM in the eastern states. There are fewer species (yet to be determined) of ichneumonid wasps parasitising AGM in SW WA.

An ichneumonid wasp (*Therion* sp.) looking for AGM larvae? (Photo: Bob Edwards)

Leaf tier moths (*Strepsicrates macropetala* and *S.* nr *infusa*: Tortoricidae) are parasitised by at least three species of ichneumonid wasps (*Campoletis* sp., *Carria* sp. & *Glypta* sp.). Although the sample size was small (ten larvae), the parasitism rate of leaf tier moths by these and a braconid wasp was 50% between January and March. In autumn, the leaf tier moths are less common, and the parasitism rates appear to be much lower (the study is still continuing).

Mesochorus spp. parasitise larvae of tachinid flies which are parasitoids of chrysomelid beetles (hyperparasitism) in the eastern states. *Mesochorus* spp. were not found during our studies.

Braconid wasps:

Braconid wasps are a family of wasps which parasitise larvae (or rarely adults). Approximately 800 species of braconid wasps have been recorded from Australia.

Some species of braconid wasps lay eggs on the host, but many other species lay eggs inside of larvae or eggs. When the wasp eggs are laid in the host eggs, development of the wasp eggs are delayed until the larvae of the host hatch.

Leaf Blister Sawfly (LBS: *Phylacteophaga froggatti*) larvae are parasitised by *Bracon confusus* in SW WA. In SE Australia, there is another species (*Bracon phylacteophagus*) which is considered to be the main natural enemy of LBS. Unfortunately, *B. phylacteophagus* has not been recorded from SW WA.

Leaf tier moths (to be identified) are parasitised by a species of braconid wasps (to be identified).

Eadya paropsides is an important natural enemy of a number of chrysomelid beetles in the eastern states, but *E. paropsides* was not recorded during this study in SW WA. Parasitism rates of larvae of a chrysomelid beetle (*Chrysophtharta bimaculata*) by *E. paropsides* can be as high as 80% in Tasmania. Larvae of *Eucalyptus* weevil are parasitised by *Apanteles* sp. in Tasmania. Another *Apanteles* species parasitises larvae of Jarrah Leaf Miner in SW WA. *Iphiaulax* spp. and *Virgulibracon* spp. parasitise larvae of longicorn beetles and wood boring moth, respectively, in the eastern states. *Cotesia urabae* and *Dlichogenidea eucalypti* parasitise larvae of Gum Leaf Skeletoniser in the eastern states.

Other wasps:

Larvae of LBS are also parasitised by *Cirrospilus margiscutellum* (Eulophidae) in SW WA. There are approximately 750 species of eulophid wasps recorded in Australia. These wasps are 0.5 – 6 mm in length. Many species are parasites of leaf-mining or stem-tunnelling insects. This and two other species of *Cirrospilus* are also known to parasitise Jarrah Leaf Miner in native forests in SW WA. *Cirrospilus* sp. and *Elachertus* sp. were also rerared from larvae of leaf tier moths. (*Ophelimas* (approximately 50 species) is a genus of eulophid wasps which forms gall on eucalypts, and thus, they are herbivores rather than natural enemies.)

A pupa of *Cirrospilus margiscutellum* (the black thing on the bottom-centre of the photo). The wasp larva emerged from its host and pupated. The pupal case of the host is shown on the top-centre (Photo: Andrew Loch).

Larvae of *Eucalyptus* weevil are also parasitised by *Proctotrupes turneri* (Proctotrupidae) in Tasmania. There are approximately 40 species of proctotrupid wasps recorded in Australia. These wasps are 3 – 15 mm in length. Most species are parasitoids of beetle larvae.

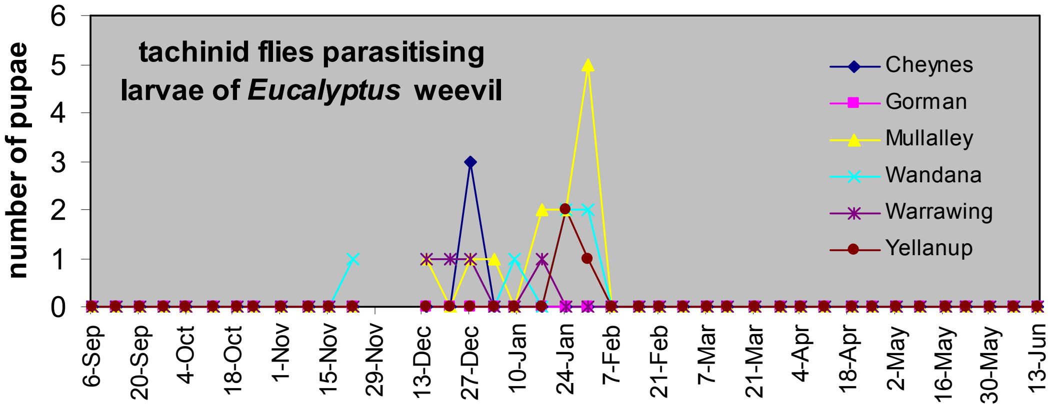
Eggs of coreid bugs in Tasmania are parasitised by *Xenoencyrtus hemipterus* (Encyrtidae). Another encyrtid wasp *Avetianella longoi* parasitise eggs of longicorn beetles. There are approximately 600 species of encyrtid wasps recorded in Australia. These wasps are 0.5 – 5 mm in length. Encyrtid wasps parasitise hemiptera (bugs, aphids, and scales) and eggs and larvae of other insects such as chrysomelid beetles, longicorn beetles, and moths.

Tachinid flies:

Tachinid flies are a family of flies which parasitise larvae and adults of other insects. There are 420 species in 136 genera of tachinid flies named from Australia; however, when all species are described, the final number of species is estimated to be between 1500 and 2000. Unlike many parasitoid wasps, tachinid flies lay eggs on the external surface of their hosts.

	
Pupal case of a tachinid fly. The fly larva pupated inside of a larva of *Eucalyptus* weevil, and the epidermis of the larva of *Eucalyptus* weevil is covering the pupa (Photo: Andrew Loch).	**Early instar larvae of Chrysophtharta variicollis with eggs of tachinid flies (white dots) (Photo: Andrew Loch).**

Larvae of *Eucalyptus* weevil are parasitised by at least one species of undescribed tachinid fly in SW WA. When a tachinid larva completes its development, the tachinid larva pupates inside of a *Eucalyptus* weevil larva, and the fly's pupal case fills up the entire weevil larva. The dark brown pupal case covered in epidermis of *Eucalyptus* weevil larva can be found stuck to leaves from mid November to early January in SW WA. There are at least four species of wasps (*Brachymeria* sp.: Brachymeriini, Chalcidinae, Chalcididae, *Perilampus* sp.: Perilampidae, *Tetrastichus* sp.: Tetrastichinae, Eulophidae, and a species to be identified) which parasitise this tachinid fly larvae/pupae (hyperparasitism) in SW WA. *Anagonia lasiophthalma* and three other undescribed species of *Anagonia* have been recorded to parasitise *Eucalyptus* weevil in SE Australia (D. Colless, personal communication to AL).



Larvae of *Chrysophtharta variicollis* (chrysomelid beetle) are also parasitised by tachinid flies (*Anagonia scutellata* and another species). There is at least one species (**to be identified**) which parasitise 3rd & 4th instars. Small white eggs can be observed on late instar larvae in the field. The fly larva pupates when the beetle larva (host) pupates. Larvae of another chrysomelid beetle (*Chrysophtharta debilis*) are also parasitised by tachinid flies. These flies were found in blue gum plantations throughout the breeding season of the chrysomelid beetles. In the eastern states, parasitism rates of chrysomelid beetles by tachinid flies are usually less than 10%. The parasitism rates by tachinid flies appear to be higher in SW WA than in the eastern states.

Paropsis geographica and *P.* sp. near *wilsoni* or *variolosa* (large chrysomelid beetles) are found in small numbers in blue gum plantations in SW WA. Larvae of these two *Paropsis* species are parasitised by tachinid flies (**to be identified**).

No tachinid fly has been reared from *P. elytura* larvae, a rare *Paropsis* endemic to SW WA. Closely related *P. atomaria* from eastern Australia is parasitized by at least three species of tachinid flies (*Anagonia anguliventria*, *Froggattimyia tillyardi*, & *Paropsivora grisea*).

Some tachinid flies parasitise adult scarab beetles. African black beetle (*Heteronychus arator*) is parasitised by *Palpostoma testaceum*. During the 2003-04 season, some adult *Heteronyx* beetles (of a number of different species) caught in light traps had eggs of tachinid flies.

Tachinid flies are also known to parasitise coreid bugs in Tasmania.

Predators

Unlike parasitoids, predators kill and consume their prey upon capturing. By nature, predators are uncommon to scarce. An individual predator kills a number of individuals of their prey in the course of its life. When predators become abundant, that may cause local extinction of their prey species. We serve as a textbook example of this simple ecological principle, as we have driven many species to extinction or near extinction by overharvesting. For predators to be effective in keeping population levels of their prey species, population levels of their prey cannot be too low. This might seem paradoxical, but it is not a paradox because many predators feed on more than one species of prey. Thus, when the population level of one prey species is low, a predator feeds on more abundant prey species. In a healthy ecosystem where population levels of herbivores are naturally regulated by natural enemies, one tends to find many species of herbivores and natural enemies.

One practical implication of this concept is that by providing alternative prey species (which are not pests of blue gum), population levels of predators may be kept at higher levels than having just a few species of pests in blue gum plantations. Establishment of alternative prey species may be encouraged by having patches of healthy native vegetation.

Predators found in and around blue gum plantations in SW WA are summarised below. Some of the species listed may not prey upon the pests in blue gum plantations.

Predator	**Type**	**Prey**
Spiders	Spider	Adults of: *Liparetrus jenkinsi* *Liparetrus striatus*? *Heteronyx* spp. *Aplospsis* LBS *Cadmus excrementarius* *Eucalyptus* weevil
Oechalia schellembergii	Pentatomid Bug	AGM larvae, *Eucalyptus* weevil larvae, chrysomelid beetle larvae
Cermatulus nasalis	Pentatomid Bug	AGM larvae, *Eucalyptus* weevil larvae, chrysomelid beetle larvae
Dictvotus caenosus	Pentatomid Bug	

Gminatus australis	Reduvid Bug	chrysomelid beetles *Cadmus excrementarius*
Ploiaria sp.	Reduvid Bug	
Onchocephalus confuses	Reduvid Bug	
Onchocephalus sp. 1	Reduvid Bug	
Onchocephalus sp. 2	Reduvid Bug	
Dieuches sp	Lygaeid Bug	
Chauliognathus sp.	Soldier Beetle	
Heteromastix sp.	Solider Beetle	
Amblytelus leai	Carabid Beetle	
Amblytelus sp.	Carabid Beetle	
Trigonothops longiplaga	Carabid Beetle	
Demetrida vittata	Carabid Beetle	
Demetrida infuscata	Carabid Beetle	
Exochomus quadripustulatus	Ladybird Beetle	
Cleobora mellyi	Ladybird Beetle	
Coccinella transversalis	Ladybird Beetle	
Coccinella umdecimpunctata	Ladybird Beetle	
Scymnus sp.	Ladybird Beetle	
Rhyzobius sp.	Ladybird Beetle	
Orthodera ministralis ?	Preying Mantis	
Bolbe sp.	Preying Mantis	
Large green manis	Preying Mantis	
Mantispa sp. (Mantispdae)	Lacewing	
Protoprocteron sp. (Myrmeleontidae)	Lacewing	
Myrmeleon pictifrons (Myrmeleontidae)	Lacewing	
Myrmeleon uniseriatus (Myrmeleontidae)	Lacewing	
Formicaleon sp. (Myrmeleontidae)	Lacewing	
Acanthaclisis sp. (Myrmeleontidae)	Lacewing	
Osmilidae sp. 1	Lacewing	
Chrysopidae sp. 1	Lacewing	
Chrysopidae sp. 2	Lacewing	
Chrysopidae sp. 3	Lacewing	
Berthoidae sp.	Lacewing	
Bathypogon sp. 1 (Asilidae)	Robber Fly	
Bathypogon sp. 2 (Asilidae)	Robber Fly	
Bathypogon sp. 3 (Asilidae)	Robber Fly	
Western Ringneck Parrot	Bird	Jarrah leaf miner
Western Rosella	Bird	Jarrah leaf miner
Grey Fantail	Bird	LBS & adult moths
Silvereye	Bird	LBS, Jarrah leaf miner & AGM
Willy Wagtail	Bird	LBS & adult moths
Scarlet Robin	Bird	LBS & adult moths
Western Yellow Robin	Bird	LBS & adult moths

Western Thornbill	Bird	LBS & moth larvae
Inland Thornbill	Bird	LBS & moth larvae
Yellow-rumped Thornbill	Bird	Moth larvae & adults
Western Gerygone	Bird	Moth larvae & adults
Restless Flycatcher	Bird	LBS and adult moths
Spotted Pardalote	Bird	Moth larvae & adults
Striated Pardalote	Bird	Moth larvae & adults
Welcome Swallow	Bird	LBS and adult moths
Tree Martin	Bird	LBS and adult moths
Red Wattlebird	Bird	Moth larvae & adults & phasmatid
White-naped Honeyeater	Bird	Moth larvae & adults AGM larvae *Eucalyptus* weevil (?)
Purple-gaped Honeyeater	Bird	Moth larvae & adults
New Holland Honeyeater	Bird	Moth larvae & adults
Western Spinebill	Bird	LBS and adult moths
Golden Whistler	Bird	Moth larvae & adults
Grey Shrike-Thrush	Bird	Moth larvae & adults
Black-faced Cuckoo-Shrike	Bird	Moth larvae & adults & phasmatid
Grey Currawong	Bird	Moth larvae & phasmatid
Yellow-throated Miner	Bird	Moth larvae & adults
Australian Raven	Bird	Larvae and pupae of any insects in the litter and soil & phasmatid
Australian Magpie	Bird	phasmatid
Southern Boobook	Bird	Adult *Heteronyx* beetles
Spotted Nightjar	Bird	Adult *Heteronyx* beetles
Tawny Frogmouth	Bird	Adult *Heteronyx* beetles
Silver Gull	Bird	Adult *Heteronyx* beetles
Australian White Ibis	Bird	Larvae of *Heteronyx* spp.
Straw-necked Ibis	Bird	Larvae of *Heteronyx* spp.
Southern Brown Bandicoot	Mammal	Larvae and pupae of any insects in the litter and soil
Bats	Mammal	Insects flying at night

Spiders:

Spiders are generalist predators and feed on insect herbivores, beneficial insects (i.e., natural enemies) and other insects. *Eucalyptus* weevil, a number of species of *Heteronyx* beetles and LBS have been observed after being captured in spider webs. Orb-web spiders are the most conspicuous web-building spiders found in blue gum plantations, as their webs can span the entire inter-row and can be found as high as 3m off the ground. These spiders are found mostly in early autumn and can be abundant. There is, however, large within- and between-plantation variation in their abundance. Jewel spiders are another type of web-building spiders found commonly in blue gum plantations. Their webs are span between trees at about knee to head hight. Jewel spiders are found mostly in summer. There are many other species of smaller web-building spiders in blue gum plantations. Free-living spiders are very common on tips of shoots with juvenile leaves. Small scarab beetles (*Liparetrus* spp. and *Heteronyx* spp.) and *Cadmus excrementarius* have been observed after being captured by free-living spiders.

Adult LBS caught in a spider web (Photo: Andrew Loch)

Adult *Cadmus excrementarius* caught by a spider (Photo: Andrew Loch)

Insects:

Insect predators can be roughly divided into seven major groups: predatory bugs; ladybird beetles; soldier beetles; carabid beetles; lacewings; robber flies; and others.

Predatory bugs:

In SW WA, predatory bugs belonging to four different families are found in blue gum plantations: Pentatomidae; Reduviidae; Miridae; and Lygaeidae. Predatory bugs stab their prey with their tube like mouthparts, inject digestive fluid, and suck the digested inner body of the victim.

Pentatomids and reduviids are relatively large bugs (up to 2 cm in length) and are generalist predators. They tend to be found singly near shoot tips, especially on shoots with juvenile leaves. They feed on larvae and adults of prey species.

There are 391 described species of pentatomid bugs in Australia. These bugs are known as stink bugs or shield bugs. Many species are herbivorous. For example, introduced green vegetable bug is a pentatomid bug. Species belonging to six genera are predators. In SW WA, two species of predatory pentatomid bug have been collected from blue gum plantations: *Oechalia schellembergii* and *Cermatulus nasalis*. These two species are also found in the eastern states, and *O. schellembergii* in particular has been well recognised as a predator of insect herbivores on eucalypt. In

SW WA, *O. schellembergii* have been observed feeding on larvae of *Eucalyptus* weevil, chrysomelid beetles, and AGM.

	
***Oechalia schellembergii* (Photo: Andrew Loch)**	***Gminatus australis* with *Cadmus excrementariu* (Photo: Andrew Loch)**

There are about 400 species of reduviid bugs in Australia. All species in this family are predatory, and they are known as assassin bugs. When handled, large reduviid bugs can inflict painful stings/stabs. Five species have been collected from blue gum plantations in SW WA: *Gminatus australis*, *Ploiaria* sp., and three species of *Onchocephalus*. In SW WA, *G. australis* has been observed feeding on larvae of chrysomelid beetles and adult *Cadmus excrementarius*.

Mirids and lygaeids are relatively small bugs (usually up to 1 cm in length). They tend to feed on eggs and small larvae of their prey species. Small groups of some mirid species can be found on a single shoot. Mirid and lygaeid bugs are rare in blue gum plantations in SW WA.

There are about 600 species of mirid bugs in Australia, but many species are yet to be described. The majority of mirid bugs are herbivores, but some species are predatory. A small number of mirid bugs feed on both plants and animals. Many mirid bugs mimic ants or wasps in colouration (and sometimes morphology).

There are about 400 species of lygaeid bugs in Australia. They are collectively called seed bugs because the majority of species feed on seeds. However, some species are sup-sucking, predatory, or blood-feeders. Rutherglen bug is an example of sup-sucking lygaeid bug.

Ladybird beetles and soldier beetles:

Ladybird beetles (Coccinellidae) and soldier beetles (Cantharidae) are known predators of eggs and larvae of chrysomelid beetles in the eastern states. There are about 300 species of ladybird beetles in Australia. Larvae and adults of most species of ladybird beetles are predators on aphids, mealybugs, scales or other small insects. There are about 150 species of soldier beetles in Australia. Adults feed on other insects, pollen, nectar and leaves, and larvae are predator in soil and leaf litter. Unlike the majority of beetles, adult soldier beetles are soft-bodied. They produce defensive chemicals (hence distasteful to vertebrate predators), and some insects (other beetles, wasps, moths, and flies) mimic their coloration.

These predators are highly mobile and are able to locate patches with high densities of their prey species. Once adult ladybird beetles locate high densities of prey species, ladybird beetles lay eggs on the host plants of the prey species, and both adults and larvae of ladybird beetles feed on eggs and larvae of their prey species.

Two species of ladybird beetles (*Harmonia conformis* and *Cleobora mellyi*) appear to be specialists on *Chrysophtharta bimaculata*, the most damaging insect herbivores in *E. regnans* and *E. nitens* plantations in Tasmania, at least during the breeding season of *C. bimaculata*. Up to 60% of *C. bimaculata* eggs are eaten by the two species of ladybird beetles. *Cleobora mellyi* has been collected from blue gum plantations in SW WA, but prey species have not been identified. In SW WA, a number of ladybird beetle and soldier beetles species are found in blue gum plantations. However, their densities are very low.

Other insect predators:

Carabid beetles (Carabidae: about 2500 species), lacewings (Neuroptera: 623 species), preying mantis (Mantodea: 162 species) and robber flies (Asilidae: about 640 species) are generalist predators. In eastern states, these predators have been observed to feed on herbivorous insects on eucalypts. In SW WA, a number of species belonging to these groups are found in blue gum plantations; however, there has been no observation of any of these species feeding on herbivorous insects.

Birds:

Like spiders, all bird species described here are generalist predators and feed on insect herbivores, beneficial insects and other insects.

The following species of birds were observed foraging in blue gum plantations: Silvereye, Western Thornbill, Inland Thornbill, Yellow-rumped Thornbill, Western Gerygone, Scarlet Robin, Western Yellow Robin, Grey Fantail, Willie Wagtail, Restless Flycatcher, White-naped Honeyeater, Western Spinebill, Grey Shrike-Thrush, Golden Whistler, and Black-faced Cuckoo-Shrike. All these species forage in the native vegetation, but they also forage in blue gum plantations adjacent to native vegetation. In blue gum plantations, larger species (Grey Shrike-Thrush, Golden Whistler, and Black-faced Cuckoo-Shrike) probably feed on larvae and adults of various moth species. A large number of Black-faced Cuckoo-Shrike has been observed in a plantation near Mildura, NSW during an outbreak of AGM. Smaller species probably feed on moths (adults or larvae) and LBS. Silvereye has been observed proving into curled up leaves and feeding on AGM larvae. A White-naped Honeyeater was seen foraging in new growth with larvae and eggs of *Eucalyptus* weevils; however, there was no direct observation of feeding.

Welcome Swallow and Tree Martin are observed feeding over blue gum plantations and firebreaks. They are probably feeding on small flying insects, such as LBS.

Some other species of insectivorous birds are observed in blue gum plantations, although it is not clear if they forage in blue gum plantations. These include Red Wattlebird, Yellow-throated Miner and Grey Currawong.

Nocturnal birds such as Tawny Frogmouth, Southern Boobook, and Spotted Nightjar are likely to feed on adult *Heteronyx* beetles. Silver Gulls have been observed feeding on adult scarab beetles emerging from soil in late afternoon and early evening.

Australian Raven has been observed feeding on pupae of AGM in SW NSW. It is also reported to feed on stick insects (phasmatid) in the eastern states. This species feed on any insect large enough for its bill. Australian White Ibis and Straw-necked Ibis have been observed feeding on larvae of scarab beetles in sporting fields in ACT. These species are regularly observed feeding on fields in the region.

In addition to Australian Raven, the following species are reported to feed on stick insects in the eastern states: Australian Magpie, Red Wattlebird, Noisy Friarbird, Black-faced Cuckoo-shrike, Pied Currawong, Grey Currawong, Laughing Kookaburra, Sacred Kingfisher, and Silvereye. Failure of these birds to locate patches of stick insects at low density is considered to be one of two factors triggering outbreaks of stick insects. These species are likely to feed on any small to medium-sized insects with soft body.

The following species are reported to feed on Jarrah Leaf Miner: Western Ringneck Parrot, Western Thornbill, Inland Thornbill, Yellow-rumpted Thornbill, Striated Pardalote, Spotted Pardalote, Silvereye, White-naped Honeyeater, Grey Fantail, and Western Gerygone. These species are found foraging in blue gum plantings and or patch of remnant vegetation adjacent to blue gum plantings and are likely to feed on any small insects.

Bird species which feed on insects in and adjacent to the six P2002 blue gum plantations near Albany from mid August 2004 to mid June 2005. The numbers show frequency of observation out of 40 weekly visits. Chey = Cheyne, Gorm = Gorman, Mulla = Mullalley, Wand = Wandana, Warr = Warrawing, & Yella = Yellanup. Species sometimes found in blue gum plantations are **bold-faced**. Species found on fire breaks are *italicised*. Other species are found in native vegetation or flying over. The numbers with * are those found in native vegetation just outside of the plantations.

species	Chey	Gorm	Mulla	Wand	Warr	Yella
Western Ringneck Parrot	6	7	12		9	10
Fan-tailed Cuckoo	1	3		1	3	1*
Shining Bronze-Cuckoo				2*	1*	2*
Southern Boobook		1		1		
Rufous Treecreeper						2
Splendid Wren		6	2*	7*	16*	4*
Yellow-throated Miner		6		1	2	1*
White-naped Honeyeater				2	1*	
Western Wattlebird	1	3				
Red Wattlebird	3	13	2	1	4	1
Brown Honeyeater					2	
New Holand Honeyeater	1*	5		10	9	
White-cheeked Honeyeater	3*					
Tawny-crowned Honeyeater	1*	2			1	
White-fronted Chat						1
Spotted Pardalote		1		1*		
White-browed Scrubwren					3*	
Weebill		1	1			
Western Gerygone					1	1*
Inland Thornbill	1	3	4	4		1
Western Thornbill		1			2	1*
Yellow-rumped Thornbill	9	5	8	14	9	13
Western Whipbird	1*					
Grey Butcherbird	2	8			1*	
Grey Currawong	15	21			1*	
Australian Magpie	36	22	33	23	6	29

Dusky Woodswallow						2*
Black-faced Cuckoo-Shrike	3	1	2	2	8	1
Grey Shrike-Thrush	2		3	12	3	9
Golden Whistler		1	3	1		7
Willy Wagtail	11	11	5	2	2	3
Grey Fantail	1	10	15	14	14	15
Restless Flycatcher	1	7	2		1	
Magpie-Lark	7	3	2	1		4
Australian Raven	25	17	20	11	6	19
Scarlet Robin			1	7		5
Tree Martin			2	2		5
Welcome Swallow	2		2	2	3	5
Silvereye	11	22	5	4	16	5
Red-eared Firetail					1*	1*
Richard's Pipit	4	1				16

Mammals:

If present in blue gum plantations, Southern Brown Bandicoot and Yellow-footed Antechinus should feed on insects found in leaf litter and soil. Bats would feed on any small to medium-sized insects flying at night. A biodiversity study by Hobbs *et al.* (2003) found four species of bats in blue gum plantations.

Pathogens

We know or understand very little about pathogens affecting insect pests in blue gum plantations in SW WA.

Virus:

Larvae of AGM are attacked by unidenfied virus (non-occluded baculovirus) in SW WA. This virus appears to be very effective. However, no study has been conducted to quantify the effect of the virus on population levels of AGM in SW WA.

An AGM larva killed by the virus (Photo: Andrew Loch).

Pathogenic fungi:

Presence of pathogenic fungi on insect herbivores has not been documented in SW WA, although these fungi are probably present in the region. One species (*Beauvaria bassiana*) is thought to be responsible for stopping an outbreak of a species of looper in native forests near Hobart, Tasmania. *Beauvaria* spp., *Metarhizium* sp., and *Entomophthora* sp., have been found on chrysomelid beetles in Tasmania.

Future Research Projects

The goal of any research projects on natural enemies in blue gum plantations should be the reduced impact of insect 'pests' on harvestable volume due to reduced population levels of the 'pests' by their natural enemies. There are two different approaches to using natural enemies to control 'pest' populations. One is the artificial augmentation of natural enemies, such as mass releases of native species and introduction of non-native natural enemies. The other can be called natural augmentation. This could possibly be achieved by minimising impacts on existing natural enemy communities in and around blue gum plantations and creating suitable habitats to encourage natural enemies to move into blue gum plantations. In its native habitats, none of the key insect 'pests' in blue gum plantations in SW WA show such high population levels as observed in plantations. One explanation for this is that, in native habitats, population levels of herbivores are usually checked by communities of natural enemies, while plantation monocultures are believed to support fewer species of natural enemies than native vegetation.

Artificial augmentation:

- Identify suitable natural enemy species for mass releases. This will involve better understanding of biology of key natural enemies and their effectiveness in controlling populations of key insect 'pests'.
- Develop laboratory techniques for mass rearing.
- Introduce non-native natural enemies, such as *Bracon phylacteophagus* for LBS. This will involve a series of studies to show that the introduction (1) is necessary and (2) does not affect native insects.
- Identify of alternative hosts/food source of key natural enemies.

- Develop techniques to augment alternative hosts/food source of key natural enemies to maintain high population levels of natural enemies when their main host/food source is scarce.

'Natural augmentation':

- Compare natural enemy communities between blue gum plantations and adjacent native vegetation. A pioneering study was conducted in the region by CSIRO. However, in this study: (1) Biodiversity in general was examined; (2) native vegetation was large tracts of habitat outside of plantations; and (3) sampling was carried out in late Sept/early Oct and April. Therefore, we will probably benefit from conducting a study more specifically targeting natural enemies of the pests. Perhaps comparing plantations with native forest/bush with cleared farmland would be good. They are the three main types of vegetation, and it would be interesting for growers to see if there are differences. This has ramifications for what species are likely to immigrate into plantations from surrounding vegetation.
- Document and quantify effects of insecticide use in blue gum plantations on natural enemy populations in and off plantations. Two short-term studies have already been conducted (one in WA by AL and the other in Tasmania by Jane Elek, Geoff Allen & MM), but long-term studies are missing. The new project should look at the effects of insecticides spatially and compare the same plantation at different edges with different surrounding vegetation. AL's work highlighted this as a logical next step.
- Identify habitats and conditions that encourage establishment of natural enemies in blue gum plantations.
- Develop techniques to create habitats and conditions that encourage establishment of natural enemies in blue gum plantations.
- Document and quantify effects of pathogens on population levels of insect 'pests'.

Acknowledgments

Dick Bashford provided the names of parasitoid wasps of larvae of *Eucalyptus* weevil. Helen Nahrung and Jane Elek kindly shared their knowledge of natural enemies of some herbivores.

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APPENDIX

Seasonal changes in parasitism rates of eggs of *Eucalyptus* weevil by *A. nitens* in four plantations studied by AL. Numbers in parentheses are the number of viable egg cases examined.

Sampling date	Chelgiup	Morgan	Rocky Gully	Stevens
Oct 99	--	--	--	17% (87)
mid Nov 99	--	91% (34)	78% (120)	96% (144)

late Nov 99	95% (110)	88% (33)	89% (159)	--
early Dec 99	100% (123)	100% (10)	97% (199)	97% (424)
late Dec 99	--	77% (74)	91% (119)	--
mid Jan 00	96% (24)	47% (19)	72% (228)	83% (36)
late Jan 00	--	--	22% (9)	--
Aug 00	50% (4)	--	--	--
Sep 00	5% (242)	16% (218)	2% (681)	2% (330)
Oct 00	61% (71)	84% (347)	12% (333)	23% (194)
Nov 00	67% (6)	100% (3)	60% (5)	--
Dec 00	--	0% (1)	--	--
Jan 01	0% (1)	20% (5)	--	--

Seasonal changes in parasitism rates of eggs of *Eucalyptus* weevil by *Eudelus* sp. in four plantations studied by AL. Numbers in parentheses are the number of viable eggs examined.

Sampling date	Chelgiup	Morgan	Rocky Gully	Stevens
Oct 99	--	--	--	0% (87)
mid Nov 99	--	0% (34)	7% (120)	0% (144)
late Nov 99	0% (110)	27% (33)	11% (159)	--
early Dec 99	0% (123)	0% (10)	7% (199)	0.2% (424)
late Dec 99	--	62% (74)	11% (119)	--
mid Jan 00	0% (24)	74% (19)	53% (228)	14% (36)
late Jan 00	--	--	78% (9)	--
Aug 00	0% (4)	--	--	--
Sep 00	0% (242)	0% (218)	0% (681)	0% (330)
Oct 00	1% (1)	4% (347)	0% (333)	0% (194)
Nov 00	33% (6)	0% (3)	40% (5)	--
Dec 00	--	100% (1)	--	--
Jan 01	100%(1)	100% (5)	--	--

Seasonal changes in parasitism rates of eggs of *Eucalyptus* weevil by *A. nitens* in five plantations studied by MM. Numbers in parentheses are the number of viable egg cases examined. -- = No egg masses were found.

Sampling date	Cheyne	Mullalley	Wandana	Warrawing	Yellanup
23 Aug 04	0% (1)	0% (4)	20% (20)	0% (5)	13% (16)
30 Aug 04	--	0% (13)	16% (19)	0% (6)	0% (18)
7 Sep 04	--	0% (27)	--	0% (29)	2% (42)
13 Sep 04	0% (1)	0% (23)	6% (33)	0% (30)	3% (36)
27 Sep 04	--	--	14% (28)	--	9% (64)
14 Dec 04	--	42% (12)	47% (19)	73% (11)	80% (5)
20 Dec 04	100% (1)	92% (25)	82% (28)	77% (30)	38% (24)
27 Dec 04	--	47% (38)	63% (24)	94% (18)	23% (10)
3 Jan 05	100% (4)	86% (36)	77% (26)	88% (17)	20% (7)
9 Jan 05	--	94% (54)	100% (9)	75% (8)	57% (7)

17 Jan 05	--	95% (19)	87% (15)	71% (14)	8% (12)
24 Jan 05	--	82% (11)	88% (17)	100% (5)	0% (9)
31 Jan 05	--	67% (3)	80% (5)	--	--
7 Feb 05	--	33% (3)	--	--	--
8 Mar 05	--	--	--	--	0% (4)
12 Apr 05	--	--	--	--	0% (1)
19 Apr 05	--	33% (3)	--	--	--
26 Apr 05	--	50 %(4)	--	--	--
2 May 05	--	--	100% (2)	--	--
18 May 05	--	0% (3)	--	--	--

Seasonal changes in parasitism rates of eggs of *Eucalyptus* weevil by *Eudelus* sp. in five plantations studied by MM. Numbers in parentheses are the number of viable egg cases examined.

Sampling date	**Cheyne**	**Mullalley**	**Wandana**	**Warrawing**	**Yellanup**
23 Aug 04	0% (1)	0% (4)	0% (20)	0% (5)	0% (16)
30 Aug 04	--	0% (13)	0% (19)	0% (6)	0% (18)
7 Sep 04	--	0% (27)	--	0% (29)	0% (42)
13 Sep 04	0% (1)	0% (23)	0% (33)	0% (30)	0% (36)
27 Sep 04	--	--	0% (28)	--	0% (64)
14 Dec 04	--	0% (12)	0% (19)	9% (11)	40% (5)
20 Dec 04	0% (1)	8% (25)	4% (28)	30% (30)	71% (24)
27 Dec 04	--	18% (38)	0% (24)	39% (18)	92% (10)
3 Jan 05	0% (4)	19% (36)	0% (26)	41% (17)	80% (7)
9 Jan 05	--	19% (54)	11% (9)	38% (8)	57% (7)
17 Jan 05	--	21% (19)	7% (15)	29% (14)	100% (12)
24 Jan 05	--	45% (11)	29% (17)	0% (5)	89% (9)
31 Jan 05	--	33% (3)	20% (5)	--	--
7 Feb 05	--	33% (3)	--	--	--
8 Mar 05	--	--	--	--	100% (4)

Parasitism rates of viable eggs in each egg case and the number of wasps emerged from egg cases in 2004-05 season.

	When eggs were parasitised, the % of viable eggs in each egg mass which were parasitised by *A. nitens*.	When eggs were parasitised, the % of viable eggs in each egg mass which were parasitised by all wasp spp.	Number of *A. nitens* emerged from an egg mass	Number of *Eudelus* sp. emerged from an egg mass
Number of egg masses examined	411	505	403	156
Mean	91.6%	94.3%	5.2	4.9

SD	21.7%	16.2%	3.1	3.1
Maximum	100%	100%	23	22
Minimum	0%	9.1%	1	1

Potential natural enemies sampled from *E. globulus* plantations by canopy fogging between October 1999 and February 2002 by Andrew Loch (Loch 2005).

Class	**Order**	**Family**	**Species**
Arachnida	Aranea		Several
Insecta	Coleoptera	Cantharidae	*Chauliognathus* sp.
			Heteromastix sp.
		Carabidae	*Amblytelus leai*
			Amblytelus sp.
			Demetrida infuscata
			Demetrida vittata
			Sarothrocrepis sp.
			Trigonothops longiplaga
		Coccinellidae	*Cleobora mellyi*
			Coccinella transversalis
			Coccinella umdecimpunctata
			Exochomus quadripustulatus
			Rhyzobius sp.
			Scymnus sp.
	Dermaptera		
	Diptera	Asilidae	
		Dolichopodidae	
		Syrphidae	
		Tachinidae	
	Hemiptera	Pentatomidae	*Cermatulus nasalis*
			Oechalia schellembergii
		Reduviidae	*Gminatus australis*
	Hymenoptera		Several
	Mecoptera	Bittacidae	
	Neuroptera	Chrysopidae	
		Hemerobiidae	
		Mantispidae	
		Myrmeleontidae	
		Nymphidae	
	Odonata		