WESTERN AUSTRALIA

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Plantations

Pinus radiata

Insect pests

***Sirex* spp.**
Sirex wood wasp (*Sirex noctillio*) trap trees were not monitored in FPC's mature pine estate during the summer of 07/08. Steely-blue wood wasps (*Sirex juvencus*) were detected in dunnage from Germany in April 2006**.** The initial detection was a Post Quarantine Detection at Laminex Dardanup in Bunbury, Western Australia. No further incursions have been detected. (I Dumbrell, FPC)

Ips grandicollis
No significant reports were received in 2007-08.

Monterey Pine Aphid *(Essigella californica)*
Although *Essigella* is present it is still not regarded as a problem in WA. Ian Dumbrell (FPC) is the WA representative on the *Essigella* biocontrol project steering committee. (I. Dumbrell, FPC)

Pinus Pinaster
European House Borer (*Hylotrupes bajulus*)

Above: Adult European house borer (*Hylotrupes bajulus*)

EHB was first found in Perth in 2004 and now more than 60,000 properties and 300,000 ha of pine plantation have been inspected for this pest. There are 129 infested sites, including nine pine plantations, centred about two main clusters in the Mundaring Hills and Gnangara/Ellenbrook areas.

EHB response surveillance crews are undertaking extensive surveys in the Perth Metropolitan area to determine the spread of EHB. Originally, dead pine trees in approximately 1200 sites throughout the greater Perth metropolitan area and the South-West were surveyed. There have

been no positive finds in regional areas, including the main softwood plantations and private plantations in the South-West. EHB Response staff have recently undertaken their third annual delimiting survey, driving every street from Geraldton to Esperence in the search for EHB, as well as continuing survey buffer regions within two kilometres of every confirmed infestation. Parts of the Gnangara and Mundaring pine plantations were infested, predominantly in dead standing pine trees. Infestation in the Peel pine plantation has also been confirmed. Peel plantation has now been clearfelled, debris burnt and not planned to be replanted.

EHB has not been found in any structural timber, although it was detected in an ornamental beam in a house in Parkerville. This timber was infested prior to installation. A wall beam in a house in Beechina has also been confirmed to contain EHB, however, this was also infested prior to installation. The current phase of surveillance includes targeted roof inspections in high risk areas and the placement of traps and lures to measure the existing population density and identify areas of concentrated pest activity.

Increased understanding of the biology of the EHB has resulted in an increase in the intensity of tree destruction activities by the EHB Response group on private properties. Regulations have now been enacted (Agricultural and Related Resources Protection (European House Borer) Regulations 2006) which place restrictions on the movement of pine wood, of certain types within certain geographical and seasonal constraints. These have resulted in modification of some of the FPC's harvesting activities. A number of research activities have been undertaken into the EHB, such as DNA profiling, acoustic detection, pheromone trapping and efficacy of insecticidal timber preservatives. FPC is currently awaiting approval for a permit to trial the application of Permethrin as a foam to the outside of logs which should allow transport out of restricted areas during the flight season. The latest innovation in detection is the use of sniffer dogs that can reliably detect adults and larvae inside timber prior to emergence. A group of industry and government representatives have travelled to South Africa to gather first hand knowledge of the behaviour and impact of EHB in similar climatic conditions.

Wingless Grasshopper (*Phaulacridium* sp.)
During November 2007 to March 2008, wingless grasshopper incursions occurred in plantations in the Esperance and Dinninup areas, but were not in plague proportions and were not as bad as the previous year. Misting with alphacypermethrin was undertaken on affected properties on a fortnightly basis.

Rutherglen Bug (*Nysius vinitor*)
Are a regular problem in plantations from October to late December. Infestations are misted in conjunction with wingless grasshopper control.

Diseases

No major problems reported.

Eucalyptus globulus
Insect pests (M. Matsuki, IPMG)
Psyllids
The blue gum psyllid (*Ctenarytaina eucalypti*) is common across the plantation. The impact of this species on growth of seedlings needs to be re-evaluated.

Autumn gum moth (*Mnesempela privata*)

There were some moderate levels of damage in two and three year old plantations near Albany.

Leaf beetles
Population levels of *Paropsisterna variicollis* has been increasing in south-west WA in the last three years or so, probably due to increased areas of coppice. However, damage due to this species is not consistent and widespread enough to trigger large scale management action. There is a suite of (so far effective) natural enemies that attack this species in WA. In spring 2007, *Paropsisterna m-fuscum* was recorded for the first time in WA in several plantations east of Albany between Manypeaks and Wellstead. The ID was confirmed by Chris Reid of Australian Museum in Sydney. Based on the extent and the number of individuals found, we suspect that this species has been in the area for two years or longer without being detected. This species has not been found in plantations outside of the above mentioned area.

Eucalyptus weevil (*Gonipterus* scutellatus)
The distribution range of *Gonipterus scutellatus* has now expanded to the northern and western limits of blue gum growing areas. In areas where the weevil has recently colonised, damage levels tended to be higher than areas where the weevil populations have been around for a number of years. We think that natural enemies are tracking the expansion of weevil distribution range. Along with chrysomelid beetles and *Heteronyx* beetles, adult *Eucalyptus* weevils defoliate tips of trees in January – March.

Black beetle (*Heteronyx* spp.)
Adult *Heteronyx elongates* caused severe damage in a P2006 plantation near Albany in the summer of 2006-07. Outbreak of *H. proxima* was observed in January – March 2007 in Esperance causing severe and extensive damage in young as well as mid rotation plantations. Outbreak of *H. proxima* in Esperance was repeated in February – March 2008.

African black beetle (*Heteronychus arator*)
The use of "socks" on seedlings prior to planting in known African black beetle areas continues to be effective. The impact of this insect has been reduced to minimum. This species has not appeared to be as much problem in the 2R sites.

Leaf blister sawfly (*Phylacteophaga froggatti*)
There was moderate damage by leaf blister sawfly around Esperance.

Wingless grasshopper (*Phaulacridium* sp.)
Wingless grasshoppers caused damage in P2008 plantations
from Bremer Bay to Esperance. A small area of P2007 plantation was affected on sand hill in Scott River late in the year.

"Spring" beetle (*Liparetrus jenkinsi*)
Damage due to this species was severe and extensive in areas between Collie and Boyup Brook and east of Albany in 2006. Due to more proactive management strategy in 2007, damage due to this species was much reduced in the area between Collie and Boyup Brook. Some damage due to this species was observed in Esperance in 2006 and 2007.

Small lucerne weevil (*Atrichonotus taeniatulus*)
High density of this species was found in one plantation about 100km E of Albany in spring of 2007. Distribution of this species within the plantation was restricted to areas that were ex-pasture.

Diamondback moth (*Plutella xylostella*)

Many pupae of this species were found on leaves of seedlings in one plantation near Boyup Brook in early summer of 2007. Affected seedlings were growing in high densities of wild radish. Therefore, larvae of this species probably moved from wild radish to blue gum seedlings.

Summary of the activity of the main insect pests of Eucalyptus globules plantations in Western Australia (M. Matsuka, IPMG)[1]

Pest	Area with moderate damage (Ha)					Area with severe damage (Ha)					Area inspected (Ha)	Area treated (Ha)	Hosts
	<10	10-100	100-500	500-1000	>1000	<10	10-100	100-500	500-1000	>1000			
Autumn gum moth				x						x	27935	0	***E. globulus***
Leaf blister sawfly					x					x	28359	0	*E. globulus*
"Spring" beetles (scarabs)					x					x	26600	354	*E. globulus*
Weevils (defoliating)					x					x	28359	2380	*E. globulus*
Heteronyx (establishment)			x							x	1730	0	*E. globulus*
Heteronyx (post-establishment)					x					x	25000	0	*E. globulus*
Wingless grasshopper				x			x				1700	354	*E. globulus*

[1]This table only summarises responses from APFL, Great Southern, and Timbercorp.

Diseases

***Mycosphaerella* leaf disease**

Mycosphaerella predominantly causes damage to the juvenile leaves of *E. globulus*. Plantations east of Albany affected by AGM and LBS are often also affected by *Mycosphaerella*. Another high risk area is near Northcliffe. *Mycosphaerella* is also found throughout the region at low levels. Damage by *Mycosphaerella* was less extensive and intensive in 2006-07 than in the previous season. Seedlings seem to be infected in the nursery. In May 2008, some P2007 plantations around Albany showed early signs of increased infection over the last two seasons (M. Matsuka, IPMG).

Other *Eucalypus* spp. (*E. cadocalyx, E. maculate & E. saligna*)

Insect pests

Leaf blister sawfly (*Phylacteophaga froggatti*)

Leaf blister sawfly has been noted on stress exposed *E saligna* (G. Hodgson, FPC).

'Spring' beetle (*Liparetrus jenkinsi*)

Spring beetle features as a significant problem in establishment of *E saligna*, *E cladocalyx*, and *E maculata* plantations. Attacks predominate in late September/October. 2007 spring season was not severe as past years and no significant damage recorded (G. Hodgson, FPC).

Jarrah leaf miner (*Perthida glyphopa*) (JLM)

Symptoms of what appeared to be an attack of JLM was noted in a *E. saligna* plantation east of Collie. Confirmation is currently underway.

Native budworm (*Helicoverpa punctigera*)

Large numbers of larvae of this species were found on older *E. saligna* plantations in drier areas in late spring of 2007. Larvae of this species were also found on *C. maculata* seedlings in a plantation near Kojonup at around the same time. Larvae of this species have been found feeding on blue gum in WA in the past.

Sandalwood (*Santalum spicatum*) plantations

Insect pests

Rutherglen bug (*Nysius vinitor*)

FPC is finding significant Rutherglen bug attacks on newly established sandalwood seedlings. This is providing new challenges in taking sandalwood into the pastoral areas in the intermediate/low rainfall zones of the South-west. (G. Hodgson, FPC).

Vertebrate pests (all plantations)

Kangaroos

There is a significant kangaroo issue on several plantation/farm sites. DEC accredited/licensed shooters are engaged to assist with controlling numbers. (Generally all kangaroos taken are for consumer or pet food use). The major impact is on the eucalypt/*Acacia* establishment sites across the Boyup Brook /West Arthur Shires. (G. Hodgson, FPC).

Port Lincoln (twenty eight) parrot:
Parrot control (trapping/shooting) has occurred for the last 4 years (since April 2004). Damage is occurring in eucalypt, *P. pinaster* and *Acacia* establishment sites. It is expected to have a significant control program in place as new plantations are established. A coordinated program for parrot control is in place. Trapping is under permit with DEC. (G. Hodgson, FPC).

Environmental and site related problems
Waterlogging
Tree deaths in the Lake Warden Catchment near Esperance started within a few weeks of the heaviest rainfall on record, which occurred in January 2007. Deaths were in plantings on duplex soils adjacent to saline areas, sites that would have become waterlogged within a few days of the rain. Farmers that had established these demonstration trials in the early 1990's were understandably disappointed at these deaths. An investigation of affected trees was conducted in association with the South East Forest Foundation and the Department of Agriculture and Food. A survey of affected plantings showed that some species (*E. camaldulensis, E. occidentalis* and *E. spathulata*) had survived better than others. Excavations of four affected trees showed that the root systems were shallow, being confined by the clay sub-soil. There was a high concentration of salts in the soil, and soil morphological evidence of protracted waterlogging and shallow perched water tables. There were no signs of pests or pathogens. Anatomical examination of roots showed low levels of starch, and changes consistent with waterlogging damage in some of the trees. Foliar analysis showed high sodium and chloride levels in some of the trees. The most likely cause of tree deaths is saline waterlogging. Future landcare and revegetation projects in this area should include species or provenances that are tolerant to saline waterlogging. (E. Davison, Curtin University of Technology).

Managed natural forests

Jarrah forest (*Eucalyptus marginata)*
Insect pests
Jarrah leaf miner (*Perthida glyphopa*) (JLM)
Populations still exist extensively throughout the forest but levels are below severe damage thresholds. A cut-out boundary survey is due to be conducted in 2009 (A. Wills, DEC).

Gum leaf skeletoniser (*Uraba lugens*)
Populations of gum leaf skeletonizer (*U. lugens*) remain very low in the southern Jarrah forest however some minor populations were located during the Donnelly spring FORESTCHECK survey at Easter and Thornton forest blocks (J. Farr, DEC).

Helena gum moth (*Opodiphthera helena*)
Although not normally recognised as a serious pest of native forests, populations of Helena gum-moth have increased significantly over the last two years (see table below). Severe crown decline due to larval feeding has not been quantitatively or

informally observed, however adult numbers, as measured from light trap captures for spring 2007, have been recorded at over 100 individuals in some sites with consistent captures across most sites. This compares with isolated captures of only one or two individuals in previous years (J. Farr & A. Wills, DEC).

Table: Helena gum-moth captures from FORESTCHECK sites using light traps from 2001-2007.

Yr	Helena abundance
2001	4
2002	1
2003	0
2004	6
2005	0
2006	No data
2007	633

Above: Light traps overwhelmed with Helena gum moth (Nov 2007).

Diseases

No new major disease problems were reported. Management and survey of *Phytophthora* root disease in jarrah forests continues to command attention (see Forest Health Surveillance and Diagnosis, and Research and Development).

Karri forest (*Eucalyptus diversicolor*)

Insect pests

No major pest problems reported.

Diseases

Karri is the second most important commercial timber tree in Western Australia. Results from surveys and studies conducted in the 1990s on decay in live trees were recently published (Donnelly and Davison 2008, *Australian Forestry* 71: 27-32,

Davison and Tay 2008, *Australian Forestry* in press). Sawlogs from regrowth trees had a discolouration in the heartwood that was more abundant than in sawlogs from mature trees. Other symptoms in regrowth logs included white rot, white pocket rot and brown rot. Fungal isolations and pathogenicity tests were conducted to determine whether this discolouration is incipient rot, and if so, what causes it, and which rot(s) would eventually develop. A sample of symptomatic discs from newly felled trees and freshly cut scantling had discolouration in 48%, white rot in 14%, white pocket rot in 12% and brown rot in 4% of pieces of wood. *Hymenochaete semistupposa* was isolated from 22% of discoloured wood and 39% of white pocket rot samples. *Stereum hirsutum* was isolated from 4% of discoloured wood and 13% of white rot samples. Koch's postulates in regrowth karri trees showed that *H. semistupposa* caused extensive discolouration, with white pocket rot developing in the heartwood within 4 years, while *S. hirsutum* caused extensive discolouration, with white rot developing in both the heartwood and sapwood within 2 years. It was concluded that the discolouration is incipient rot which will eventually develop into either white rot or white pocket. (E. Davison, Curtin University of Technology).

Nurseries

No major problems have been reported in either hardwood or conifer seedlings in nurseries.

Native plant communities

Diseases

Aerial application of phosphite at sites of biodiversity significance funded through South Coast Natural Resource Management Inc. and Biodiversity Conservation Initiative was successfully completed in autumn 2008. Sprayed sites included the Stirling Range National Park (240 ha), Albany Coastal (93 ha), Bell Track in the Fitzgerald River National Park (377 ha), Cape Le Grand National Park, Esperance (35 ha), Mt Lindesay National Park (15 ha) and the Busselton Ironstone Threatened Ecological Community (TEC) (74 ha). This included five new rare flora target sites: one largely disease-free Montane mallee-heath TEC in the Stirling Range National Park; three new Albany coastal targets, two of these are off-reserve, and a tree injecting site in Narrikup to protect *Lambertia orbifolia* ssp. *orbifolia*. Phosphite target sites included a number of associations of the Montane mallee-heath and Montane heath and thicket TEC and the Mt Lindesay *Little Lindesay Vegetation Complex* TEC and one priority ecological community, Open low *Allocasuarina fraseriana – Eucalyptus staeri* woodland in association with *Banksia coccinea* thicket. Target rare flora included: 16 critically endangered taxa; 10 endangered taxa; three vulnerable taxa and two nominated vulnerable taxa (N. Moore, DEC).

Monitoring of occurrences and survivorship of individual flora species and rate of spread trials of Phytophthora dieback at target sites continues throughout 2008 including sampling to confirm disease status and species susceptibility within sites. An ongoing effort to increase community awareness of Phytophthora dieback disease and the establishment of strong partnerships between the Department of Environment

and Conservation and South Coast NRM Inc. also remains a priority focus. Awareness raising activities to date include: The Great Quiz on Legs Trail; Kings Park Wildflower Festival; Albany Agricultural Show; a dieback tree injecting workshop to the Friends of Twin Creeks; presentations at Mediterranean Ecosystems Conference by Nicole Moore and Sarah Barrett, presentations to the Albany Wildflower Society members and Land for Wildlife members and a local ABC radio interview, and distribution of the new Phytophthora dieback bumper sticker (N. Moore, DEC).

DEC Phytophthora Research Project

Funded through the State Government's Biodiversity Conservation Initiative a research project was commenced in late 2006 into the epidemiology and control of *P. cinnamomi* on the south coast of WA. The project is investigating the seasonal disease dynamics of *P. cinnamomi* including the mechanisms to disease centre extension and survival. Further the project is also investigating the use of phosphite basal stem application to prevent disease centre expansion and its effect on the epidemiology of the pathogen (C. Dunne, DEC).

Eradication of *Phytophthora cinnamomi* from spot infections in native plant communities in Western Australia and Tasmania

Funded by the Department of Environment, Water, Heritage and the Arts funded projects, this project examined the potential to develop protocols to contain and eradicate *P. cinnamomi* from spot infestations that, if untreated, would destroy extensive areas of vegetation. We designed a treatment strategy based on two assumptions: in the absence of living hosts, *P. cinnamomi* is a weakly competitive saprotroph, and; within the experimental sites, transmission of the pathogen was most probably by root-to-root contact alone. At two *P. cinnamomi* infested sites, within scrub-heath in south-western Australia and woodland in Tasmania (2500 km apart), we applied a succession of increasingly robust treatments that included (1) vegetation (host) destruction, (2) fungicides, (3) fumigation, and (4) physical root barriers. *P. cinnamomi* was never recovered at any of three assessments over six to nine months after completion of the treatments. Given the high rates of recovery of *P. cinnamomi* from untreated infested soil, and the sampling frequency at each assessment, the probability that we failed to detect *P. cinnamomi* in treated soil ranged from $p < 0.0003$ to $p < 2 \times 10^{-12}$ depending on site and assessment. This study demonstrated that a devastating soil borne plant pathogen can be eradicated from spot infestations in natural ecosystems ((W. Dunstan (Research Fellow, Murdoch University), Supervisors: G. Hardy, B. Dell, B. Shearer, and T. Rudman).

Does the physiological status of the plant at the time of spraying affect the efficacy of phosphite?

This project examined the impact of waterlogging and drought pre and post phosphite application on the efficacy of phosphite to contain *P. cinnamomi* in native plant species. Re-sprouting and reseeding species were used. Drought or waterlogging did not impair the uptake and translocation of phosphite *in planta*, and phosphite was able induce host defence responses when plants were challenged by *P. cinnamomi*. However, not all plant species induced defence responses when challenged by *P. cinnamomi* despite having high concentrations of phosphite present in their tissues. (Daniel Hüberli (Research Fellow, Murdoch University), Supervisors: G. Hardy, B.

Dell, B. Shearer, B. Bowen and M. Calver).

The efficacy of phosphite to control *Phytophthora cinnamomi* in plants treated pre- and post-fire. (Daniel Hüberli (Research Fellow, Murdoch University), Supervisors: G. Hardy, B. Dell, B. Shearer, B. Bowen and M. Calver).

Urban and rural

Insect pests
See section on wandoo decline (below).

Diseases and Declines

Diseases of Boabs: Surveys for fungi associated with boab (*Adansonia gregorii*) are underway in both South Africa and Western Australia. Seven new species in the Botryosphaeriaceae have been identified: *Lasiodiplodia* sp. nov, *Dothiorella* sp. nov, *Botryosphaeria* sp. nov and *Pseudofusicoccum* sp. nov (3 species). The most commonly isolates species was *Lasiodiplodia theobromae*. A pathogenicity test has shown that this species is highly pathogenic to boabs (Monique Sakalidis, T. Burgess and G. Hardy, Murdoch University and M. Wingfield, Tree Pathology Cooperative Program (TPCP) Sth Africa).

Mundulla Yellows: Monitoring of the occurrence and symptom development of Mundulla Yellows (MY) in WA has continued. Symptomatic eucalypts (both planted trees and remnant native trees) have been observed in several additional locations. Spread of symptoms within affected sites appears generally to be slow. The observed distribution of MY symptoms in the south of the state is from north of Geraldton to Esperance, and it occurs on alkaline coastal sands as well as on acid soils including laterites. As in South Australia, MY in WA is only seen in vegetation in disturbed sites or modified landscapes such as road verges and medians, parks and gardens, and in parkland or paddock remnant stands where symptomatic trees can be several hundred metres from, and sometimes upslope from, any road. Symptoms have not been observed within undisturbed native forest or woodland stands in WA. Collaboration is continuing in the investigation of the cause(s) of MY with D.Hanold and J.Randles from the University of Adelaide. (M.Stukely, DEC).

Tuart Decline: In recent years, tuart (*Eucalyptus gomphocephala*) woodland within Yalgorup National Park, south of Mandurah has suffered a severe decline in health. Research carried out by the Tuart Health Research Group (THRG) has shown from surveys of tuart across the range, that the major decline syndrome is confined to the Yalgorup region. A *Phtophthora citricola*-like sp. has been recently isolated from a number of declining sites with the Yalgorup region. Further work is being conducted to determine the pathogenicity of these isolates and to characterise them (P. Scott, Murdoch University). A very close correlation between foliar zinc levels and crown health has been observed and treatment trials with nutrient implants have shown promising results. Trials with injection of phosphite have also shown promising results (P. Scott, Murdoch University). Strong correlations also exist between crown

health and soil microbial function and diversity (Y. Cai, Murdoch University). Studies on the role of fire and competition show a lack of fire may be contributing to the decline of tuart, however, it is not a major factor (R. Archibald, Murdoch University). Monitoring and capture of fauna within sites throughout the Yalgorup region have also shown a strong correlation between the abundance of particular reptile species and crown health of tuart (K. Wentzel, Murdoch University). A new project is looking at restoring sites where soils have lost their tuart seed banks (Katinka Ruthrof , Murdoch University) (P. Barber, THRG, Murdoch University- http://www.tuarthealth.murdoch.edu.au/).

Wandoo Decline: Wandoo (*Eucalyptus wandoo*) trees and woodlands have been affected by crown decline, sometimes resulting in the death of declining trees. The Wandoo Recovery Group (WRG) was established in 2003 and a Wandoo Strategy and Action Plan was developed, which included aims to support research, distribute information in the community and develop partnerships with stakeholders. UWA is the principal research provider for the WRG. Research strategy aims to increase the understanding of the relationships between climate, tree physiology and insect pests and pathogens associated with the decline. Future research will address links between environmental stress and susceptibility to pests and diseases. The recently approved State Centre of Excellence for Climate Change; Tree and Woodland Health will unite research efforts into wandoo, tuart and other tree declines (L. Manning, WRG).

Wandoo's physiology allows it to continue to take up water in fairly dry soils when species like jarrah and marri reduce their transpiration, however this ability may deplete soil water to dangerously low levels in a situation of long-term below-average rainfall, as is being experienced in WA at present. Despite the occurrence of the species in areas with more than 1000 mm to as little as 300 mm annual rainfall, differences among populations in drought tolerance in experiments with juvenile wandoo do not correlate with the provenance's rainfall or aridity index. Such trends are also largely absent in terms of salinity tolerance. These findings suggest that variation in wandoo crown decline across the species' distribution range is mainly due to local environmental factors (E. Veneklaas, UWA).

Wood boring insects and fungal pathogens are constantly associated with branch death. A wood-boring insect (known as Type-1 borer) has been found to exist in higher populations in Wandoo woodlands of declining health. The environmental factors driving population dynamics of Type-1 borer require further investigation. Monitoring phenology (development of bud formation, flowering and seed set) and growth in the wandoo forest will aid in this understanding (Ryan Hooper, UWA).

Broad-scale survey and mapping over a number of years is establishing a recorded trend in wandoo health. Temporal and spatial trends show decline patterns are broad scale, variable and not continuous across the landscape. A survey along three transects, encompassing wandoo’s east-west range in 2002 and repeated in 2008, shows that although wandoo decline is still occurring, recovery is also evident. Recovery appears most advanced in the northern transect (around York), intermediate in the central transect (Wickepin and Narrogin) and limited in the south (Jack Mercer).

Rudis decline: Rudis (*E. rudis*) has shown varying degrees of symptoms of crown decline throughout its range for many years. Collaborative research between Murdoch University, Serpentine-Jarrahdale Local Council and ALCOA has been initiated to investigate the efficacy of trunk injections to reverse canopy decline. Trials include treatments of phosphite, complete nutrient and also an insecticide. A trial established in spring 2005 at Pinjarra is currently in progress. Assessments of crown health are focusing at the crown, branch and leaf scale and the incidence and severity of a range of insect and fungal pests. Results indicate that stem injection with phosphite or a systemic insecticide induce an increase in crown health when compared to control and nutrient treatments. Workshops have been conducted to instruct stakeholders on methods of nutrient injection (P. Barber, Murdoch University).

Forest health surveillance and diagnosis

Dieback mapping and management

Mapping the presence of symptoms of the plant disease caused by *P. cinnamomi* was carried out by accredited interpreters to determine areas suitable for protection. Hygiene requirements were specified for activities likely to result in the movement of soil (and as a consequence, *P. cinnamomi*) on lands managed by DEC. A total area of 22,276 ha was mapped to assist the planning of roading and timber harvesting operations undertaken by the FPC. This included 5,174 ha of previous mapping that was checked for further spread. Mapping and hygiene planning were undertaken on a further 6,059 ha for the Parks and Visitor Services, Nature Conservation Service and Sustainable Forest Management Service of DEC, and 6,783 ha for external parties. Interpretation from helicopter, coupled with field sampling, was undertaken to explore for new infestations in the Fitzgerald River National Park. Training programs were carried out in disease mapping and hygiene management (G.Strelein, DEC).

A major project to undertake Phytophthora dieback threat assessment and risk analyses for vegetation in the South West and Northern Agricultural Natural Resource Management regions on both DEC and non-DEC managed lands continued with the South Coast Natural Resource Management group. This included the collation of biological assets, strategic disease mapping, predictive modelling of the future spread of *P. cinnamomi*, and estimation of threat and risk categories (G. Strelein, DEC).

In the year to 30th June 2008, a total of 2,353 samples were tested for the presence of *Phytophthora* by DEC's Vegetation Health Service (VHS). These samples were associated with verification of dieback mapping for the above projects, as well as external requests. DNA sequencing has been carried out at the Centre for *Phytophthora* Science and Management (CPSM), at Murdoch University, on various recent and historical isolates of unidentified *Phytophthora* in the DEC culture collection, from a range of WA locations and ecosystems. This had earlier led to the identification of *P. inundata* and *P. gonapodyides*; new records of *P. asparagi* and *P. niederhauseria* were added this year to the list of named *Phytophthora* species occurring in native vegetation in WA. At least nine new and undescribed *Phytophthora* taxa have been distinguished, based on their ITS rDNA sequences. Several of them are indistinguishable, on morphological characters, from known locally-occurring species such as *P. citricola, P. drechsleri*, or *P. megasperma*. Most

of the newly identified Phytophthoras have been associated with multiple species of dying native plants in natural vegetation communities. A PhD project commenced in April 2007 at Murdoch University to further investigate and describe these new Phytophthoras, and to test their pathogenicity (A. Rea – see Research and Development). A small number of other tree health and nursery problems were investigated (M.Stukely, DEC).

Research and Development

General

Western Australian State Centre of Excellence for Climate Change, Woodland and Forest Health.

This new Centre was approved for funding in 2008 is made up of four programs: Climate Change, Woodland and Forest Declines; Decline Ecology; Restoring Biodiversity Values; and Policies and Action for Woodland and Forest Restoration. Murdoch University together with the University of Western Australia and the Department of Environment and Conservation are the primary proponents, with cash and in-kind support from 27 agencies, non-government agencies and industry and collaboration with Universities and agencies in eastern Australia and overseas (G. Hardy, Murdoch University).

Molecular Diagnostic Facility at Murdoch University (MU)

Nari Anderson (Research Associate, CPSM) has developed Real Time PCR methods to diagnose *P. cinnamomi* from soil samples. She is now developing the method for high throughput and on large (250g) soil samples in order to make the process commercially viable. (Supervisors: P. O'Brien and G. Hardy, Murdoch University).

Plantations

Eucalyptus globulus

Several projects at Murdoch University are focusing on eucalypt plantation health and risks to biodiversity of native forests in Australia. In the past 3 years, surveys have been conducted in collaboration with State departments and private forestry companies in eucalypt plantations in QLD and NT. The surveys provide a framework for a database on disease already present in Australia. Several new fungal species have been found causing leaf diseases and these are currently being described. A database of exotic eucalypt diseases and their proximity to Australia and the risk they pose to Australia's forests and industry is being compiled. A number of diseases are of particular interest, *Kirramcyes destructans, K. zuluensis* and *Chrysoporthe cubensis*. Molecular markers have been developed for *K. destructans* and are already in existence for *K. zuluensis* and *C. cubensis* (through collaboration with the Forestry and Agriculture Biotechnology Institute in South Africa). These markers will be used to determine the origin, diversity and movement of potentially destructive eucalypt diseases. The population of *K. destructans* in Asia was found to be genetically uniform providing evidence for a founder effect in Asia. Australia was thought to be the most likely origin and surveys in northern Australia have now found *K.*

destructans in two locations, Derby Western Australia and Melville Island in the Northern Territory. A project has been funded to test the susceptibility (in trials in Asia) of several tropical and sub-tropical eucalypt species to *K. destructans* and *K. zuluensis.* These trials have been established in Thailand, Vietnam and China and will be rated by the end of 2007. A matching trial will be established on Melville Island in 2008 (T. Burgess, Murdoch University)

Work under the following grants is in progress at Murdoch University (MU).

Collaborative Project - Murdoch University and the Tree Pathology Cooperative Program (TPCP) South Africa. The project 'New and emerging pathogens threatening the biodiversity of Australia's eucalypts' continues, and concentrates on some of the major eucalypt pathogens worldwide (*Kirramcyes* spp. *Mycosphaerella* spp., *Botryosphaeria* spp. *Cryphonectria* spp.). The aim is to determine their origin, movement and the risk they pose to Australia's eucalypts (T. Burgess, MU and M. Wingfield, TPCP).

PhD Theses in progress at Murdoch University (MU)

Francisco (Paco) Tovar: The cause of basal stem rot in second rotation *Eucalyptus globulus* plantations (Supervisors: T. Burgess, G. Hardy, MU and R. Robinson, DEC). Surveys completed during 2005-2007 indicated that 6 main species of fungi were associated with white rot of *E. globulus* coppice stumps. These species were identified as *Trametes versicolor, Stereum hirsutum, Stereum illudens, Pycnoporus coccineus, Bjekandera adusta and Lopharia crassa.* Levels of fungal colonisation of stumps across all plantations surveyed averaged 56% and were as high as 86 % at a plantation in Collie. Nonetheless, an average of 85% of stumps coppiced succesfully, indicating that fungal colonisation was not interferring with coppice shoot emergence. Surveys also showed that less than 1% of stumps lost major shoots due to windthrow. Previous reports of 'significant' losses due to wind throw were attributed to obsevational bias, possibly, an edge effect. A two year trial testing antifungal treatments on coppice stumps was set up to determine the possibility of preventing fungal colonisation. None of the anti-fungal preventative treatments were effective. A number of other trials and surveys have been undertaken, including:

- An inoculation trial on *E.globulus* coppice shoots was set up to determine the capacity of the above mentioned fungi to move from the stump into the new coppice shoots and cause further rot during the rotation. First results are expected in December 2008.
- An experiment investigating the effect of harvest season on subsequent fungal colonisation is due to be completed in August 2008.
- Further surveys of both 1st and 2nd rotation plantations are currently being conducted to ascertain if there is an overall increase in levels of rot from first to second rotations.

Vera Andjic: The movement of *Kirramcyes destructans* throughout Asia, a potential threat to Australias forests and plantations (Supervisors: T. Burgess and G. Hardy, MU and M.Wingfield, TPCP).

Katherine Taylor: A detailed study of *Mycosphaerella cryptica* and *M. nubilosa* in Western Australia, focusing on the threat to native remnants (Supervisors: T. Burgess, G. Hardy and P. Barber, MU, C. Mohammad, Forestry CRC and A. Carnegie, SF NSW).

Monique Sakalidis: Investigation and analysis of taxonomic irregularities within the fungal genus *Botryosphaeria.* This thesis is answering questions that have arisen within the genus *Botryosphaeria* relating to divisions amongst and within taxa (Supervisors T. Burgess, G. Hardy, MU and B. Wingfield University of Pretoria).

Sarah Jackson: Taxonomy and biology of *Mycosphaerella* species found on *E. globulus*. (Supervisors: G. Hardy and B. Dell, MU)

Michaela King: Genomic analysis of phosphite responsive genes from *Phytophthora cinnamomi* (Supervisors: G. Hardy, J. McComb, W. Reeve and P. O'Brien, MU). Submitted late 2007.

Patsy Stasikowski: An investigation into the mechanism of action of phosphite mediated resistance of plants to *P. cinnamomi* infection. Patsy is also in the process of developing a rapid analytical method to rapidly and cheaply determine the levels of phosphite in plant tissues under field conditions. We hope to be commercialising this in a kit form in the near future (Supervisors: G. Hardy, McComb and P. O'Brien, MU).

Leila Eshraghi: The role of plant defense pathways in Phosphite induced protection of *Arabidopsis thaliana* from *Phytophthora cinnamomi* infection (Supervisors: P. O'Brien, . McComb, and G. Hardy MU).

Kylie Ireland: Susceptibility of Australian plants to *Phytophthora ramorum,* an emerging potential threat to Australian plant industries and ecosystems. Kylie is working at the University of California Davis (UCD) screening Australian species for potential susceptibility to *P. ramorum.* She has found a large number of sporulating hosts and will start to look at 'dead-end' hosts in the near future. She will also use risk modelling to determine areas in Australia most at threat to *P. ramorum.* This project is funded by the CRC National Plant Biosecurity and The Department of Environment, Water, Rivers and Heritage (Supervisors: G. Hardy and D. Huberli, MU, I. Smith DPI Vic.,and D. Rizzo, UCD).

Alexander Rea: Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species. Alex is currently describing five new *Phytophthora* species from the Department of Environment and Conservation's Vegetation Health Service culture collection. This is also including pathogenicity screening and ecological studies. This project is funded by the CRC National Plant Biosecurity (Supervisors G. Hardy, T. Burgess, MU and M. Stukely, DEC).

Papori Barua: Screening *Lambertia* species for susceptibility and resistance to *Phytophthora cinnamomi* to develop a model plant system to examine resistance mechanisms (Supervisors: G. Hardy, J. McComb, MU, and B. Shearer, DEC).

Peter Scott: The potential role of *Phytophthora* species in *Eucalyptus gomphocephela* (Tuart) decline. Peter has isolated a *P. citricola*-like *Phytophthora* from the fine roots and rhizosphere of tuart. Morphological and sequence data indicate that the pathogen is undescribed and he is currently working on describing this organism. He also has field and glasshouse pathogenicity trials in place. Trees in the decline treated with phosphite respond very well in comparison to control treatments further indicating that this new *Phytophthora* species could be playing a role in the decline syndrome (Supervisors G. Hardy, P. Barber, MU, and B. Shearer, DEC).

Honours Theses in progress at Murdoch University (MU)

Mark Gresser: The impact of thinning and burning minesite rehabilitation infested or not infested with *hytophthora cinnamomi* on vegetation health and small mammal communities (Supervisors: M. Craig and G. Hardy, MU).

Tom Phillips: Detection of *Phytophthora cinnamomi* from bulk water and soil samples using real time polymerase chain reaction. (Supervisors: Nari Anderson, P. O'Brien and G. Hardy, MU).

Jayden O'Brien: The persistence and disease cycle of *Phytophthora cinnamomi* in high and low impact 'black gravel' sites in the jarrah forest. (Supervisors: D. Huberli, MU, V. Stokes, Alcoa Australia and G. Hardy, MU).

Managed natural forests

Jarrah forest (*Eucalyptus marginata*)

Diseases

Use of metham sodium to eliminate *Phytophthora* from roading gravel. The introduced pathogen *P. cinnamomi* can be spread to areas of native vegetation by the movement of soil and soil products including gravel. As gravel is widely used in road construction, many contracts for its supply specify that it must be sourced from gravel pits located on dieback-free sites. This will increase transport costs if the only source of dieback-free gravel is at a distance from where it is required. As uninfested gravel is in short supply, preliminary experiments have investigated whether it is possible to kill *P. cinnamomi* by treating gravel with the soil fumigant metham sodium. If this can be done reliably, economically and safely, gravel from infested gravel pits can be treated for use in road construction in areas of native vegetation without the environmental risk of spreading *P. cinnamomi* to uninfested areas. (E. Davison, B. Warton & F. Tay, Curtin University of Technology)