Western Australia

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PLANTATIONS
Pinus radiata *and* P. pinaster

Insect pests

***Sirex* spp.**
The Forest Products Commission (FPC) in Western Australia conducts an annual monitoring program throughout its estate. Monitoring in WA is now done using static (panel) traps, which are effective in detecting very low numbers of Sirex. The traps are erected in pairs in open areas of plantations that would likely be used as flight paths for the wasp. Last year they were deployed in plantations from Perth to Esperance, as well as Albany town site and a Bunbury sawmill. No Sirex wood wasps (*Sirex noctillio*) were detected in any of the traps in the 2010-11 flight season.

Bark Beetles
Bark beetle distribution and abundance were monitored in conjunction with the Sirex trapping program; numbers were generally low and not causing problems however large numbers were detected in one trap in a plantation north of Perth. This and other plantations were subject to severe drought conditions in 2010-11 resulting in extensive mortality. Build up in bark beetle numbers may have been an indication of increased tree stress levels prior to symptoms becoming apparent.

Five-spined Bark Beetle *(Ips grandicollis)*
Ips were found in all plantation areas over the length of the trapping season, but were not detected in the Albany town site traps. Numbers were highest in the west coastal plantations of Gnangara, McLarty and Myalup as well as the pine mill near Bunbury.

Golden Haired Bark Beetle (*Hylurgus ligniperda*)
Hylurgus distribution and abundance around the Bunbury area was monitored in conjunction with the Sirex trapping program, but numbers were low and not causing problems.

Monterey Pine Aphid *(Essigella californica)*
Although *Essigella* is present it is still not regarded as a problem in WA. Ian Dumbrell (DAFWA) is the WA representative on the *Essigella* biocontrol project steering committee. There have been four releases in winter 2011 of the control agent *Diaeretus essigellae*. Follow up monitoring is yet to be conducted to see if the wasp has become established.

European House Borer (*Hylotrupes bajulus*)
As of September 2010, European house borer (EHB) has been confirmed at 178 sites across 50 suburbs. This includes 11 plantations and 167 urban sites. EHB infestations have been confined to the greater Perth Metropolitan area, except for one confirmed find in Albany.
Of the confirmed sites:

- 164 were in dead, dry pine in the environment, such as logs, branch stubs, stumps and dead wood inclusions.
- 2 were in furniture.

- 6 were in structural and milled timber (2 of these in houses – Albany and Brigadoon).
- 6 were in trap poles (pinewood logs placed to measure existing population densities, and later for verification of eradication from target areas)

Eradication activities will undergo a transition to ongoing management in 2011.
The Department of Agriculture and Food is undertaking consultation with stakeholders to discuss the transition impact and future management strategies. Most importantly, the transition will require increased support from industry, government and communities in carrying out EHB surveillance, and embracing future containment.

Throughout 2011, the EHB Response Program will focus on:
- Extension and improvement of current EHB training for pest controllers.
- Development of a national communication strategy for EHB education and awareness.
- Continued State communication activities to ensure uptake of risk minimisation strategies.
- Development of interstate quarantine regulations for the movement of EHB host materials from Western Australia.

Wingless Grasshopper (*Phaulacridium* sp.)
No unusual activity

Rutherglen Bug (*Nysius vinitor*)
No unusual activity

'Spring' beetle (*Liparetrus jenkinsi*
No unusual activity

Pathogens

Hail damage from summer thunderstorms south of Busselton in *P. radiata* and north of Perth in *P. pinaster* resulted in significant areas infected with *Sphearopsis sapinea* which lead to large numbers of tree deaths. Rapid decline of hail damaged trees was due to multiple infection points.

Abiotic Factors

Drought

Record low rainfalls over the past three years, coupled with prolonged high temperatures have resulted in widespread tree deaths in south-west WA. This has had a significant impact on forestry production, biodiversity, and visual amenity. Additionally, the large scale deterioration of both plantation and native forests has increased the State's bushfire risk for the coming fire season. Forecasts indicate rainfall over the 2011 spring period will be 'average' however this will provide little benefit as the impacts of the dry seasons are expected to continue through the upcoming summer.

Although south-west WA has experienced a reduction in rainfall over an extended period, the past three years have seen unprecedented weather conditions that have led to the extensive losses of plantation pine and widespread impacts across the northern jarrah forest. Assessments conducted indicate that the underlying contributory factors to tree deaths in plantations and native forests are the prolonged absence of rain and the associated fall in water tables. There has been a significant decline in soil moisture in the root zone to such an extent that tree survival has been compromised. No amount of rainfall in the current season will ameliorate the impact on the plantation timber currently affected. For water tables to stabilise and recover, several years of above average rainfall is required. In the immediate future, rainfall trends suggest this outcome is unlikely.

Eucalyptus globulus

Notes on WA plantation health data

Data presented herein has been compiled from reports provided to the industry pest management group (IPMG) by industry partners. It is of a general nature and reflects the lack of formal plantation health data collection. It is likely to be an underestimation as some data lacked integrity and not all companies were able to provide data (F. Tovar, IPMG).

WA Regional Summary

Pest and disease levels reported over 2010-11 were moderate. Insect damage levels seemed to be exacerbated by prolonged drought conditions. Many trees failed to recover from spring defoliation of crown tops, displaying generally poor crowns up until the resumption of autumn rains (March-April). Plantations displaying signs of moisture stress and pest induced defoliation included those in areas east of Albany (including Esperance), the southwest coast (Augusta to Bunbury), and the southwest interior (Collie, Boddington, Bridgetown, Boyup Brook and Rocky gully). That is, most growing areas.

Liparetrus beetles, the chrysomelid *Paropsisterna m-fuscum* (yellow belly) and wingless grasshoppers caused most damage to seedlings and young plantings. *Heteronyx* beetles, eucalypt weevils (*Gonipterus* spp.) and chrysomelids (*Paropsisterna variicolis*) continue to be the most frequently reported insect pests in >3 year-old plantations.

The prolonged summer drought conditions and lack of available food also saw large plantation areas affected by "28 parrots" (*Banardius zonarius*) in search of alternative food sources. Snapped crown-tops and bark stripping being commonly observed as the parrots fed on sap.

As was the case last year, it is estimated that 25,000 ha of the WA estate were inspected frequently by foresters, comprising mostly 1- 3 year old plantations. Of these around 8,500 ha were found to have significant problems due to biotic and abiotic problems, with 80 ha having to be replanted and 6,620 ha being treated or managed in some way. The remainder were left untreated (F. Tovar, IPMG).

Insect pests

African Black Beetle: 20 ha east of Albany was severely affected and had to be replanted, with seedlings protected by netting ("socks").

***Catasarcus* sp.:** Approximately 200 ha of plantation were damaged by *Catasarcus* species. Damage was observed on the lower foliage of trees greater than 3 years old. It was found in small areas within plantations in Collie, Boddington, Boyup Brook, Mt Barker and east of Albany.

Eucalyptus weevil *(Gonipterus* spp.): Low levels of damaged were observed throughout the estate. Drought conditions over the summer (and previously low rainfall) meant that many trees did not recover from spring damage. Moderate to severe damage, totalling some 780 ha, was reported in south-western interior areas, (Donnybrook, Bridgetown, Pemberton and Rocky Gully) and north and east of Albany (Mt Barker, Wellstead).

Eucalypt leaf beetles (Chrysomelidae): *Paropsisterna m-fuscum* was observed causing low levels of damage to seedlings throughout the WA estate. A total of 240 ha were reported as damaged, significant damage warranting spray actions occurred over 100 ha in Augusta/Margaret River and a further 40 ha around Boyup Brook. Some 70 ha of older plantations (>3 years) spread from Albany to Denmark were damaged by *Paropsisterna variicolis*.

***Heteronyx* spp:** These beetles continue to cause repeated damage to the tops of trees in young to mid rotation plantations from January to March. Plantations affected are east of Albany from Cheyne Beach to Wellstead and Esperance. Due to the large areas affected, a lack of manpower

and a lack of effective control options, formal surveys for this pest are not currently conducted. It is estimated that around 3,000-5,000 ha are affected yearly.

Spring Beetle (*Liparetrus jenkinsi*): Greater vigilance from foresters has led to fewer incidences of seedling damage by this species when compared to years past. In total 250 ha were damaged in Mt Barker, Rocky Gully, Manjimup and Boyup Brook. Around 30 ha had to be replanted, the remainder were effectively controlled and recovered from damage.

Wingless Grasshopper: Approximately 170 ha of plantations were reported as suffering Wingless grasshopper damage, mostly in plantation areas next to crops. Area affected included Augusta, Mt Barker, Rocky Gully and sandy coastal areas from Denmark to Wellstead.

Vertebrate pests

Birds: Due to drought conditions and lack of available feed large numbers of Port Lincoln parrots (commonly termed 28s) were observed in plantations. Areas north of Mt Barker and West to Busselton were especially affected with up to 3,200 ha showing signs of moderate to severe damage.

Unusually, Mountain ducks (*Tadorna tadornoides*) have been reported ripping seedlings out of the ground, with 2 ha having to be replanted near Augusta.

Rabbits: Browsing damage to seedlings by rabbits was reported east of Albany. Approximately 30 ha were affected with 10 ha having to be replanted.

Pathogens

***Teratosphaeria spp.* (formerly *Mycosphaerella*):** Though observed throughout the WA estate, plantations in the Denbarker and Mount Barker areas and along the Great Southern Coast (Wellstead to Walpole) are most affected. A total of 870 ha of affected plantations were reported a slight increase from last year.

Abiotic factors

Drought: Drought stressed plantations were observed in all areas of the WA estate. Approximately 150 ha in Mt Barker and Rocky Gully were unambiguously affected by drought with severe symptoms and deaths occurring. It should be noted however that many areas reported as having severe pest damage symptoms were also likely to be suffering drought stress but were not reported as such.

Nutrient Deficiencies: The number of first and second rotation plantations suffering nutrient deficiencies increased significantly. Close to 2,700 Ha of plantation were reported as showing signs of nutrient deficiency mostly of copper (Cu), boron (B) or zinc (Zn). Significant deficiencies were reported in interior areas (Bridgetown, Boyup Brook and Collie) and the sandy plains around Augusta.

Table 1. Area of *E. globulu*s plantation estate monitored and area affected by pests and pathogens in Western Australia in 2010-11*.

PESTS*	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			
African Black Beetle (*Heteronychus arator*)							X					20	*E. globulus*
Catasarcus sp.			X									-	
Eucalypt weevil (*Gonipterus scutellatus)*				X					X			120	*E. globulus*
Heteronyx spp.					X					X		-	*E. globulus*
Chrysomelid beetles			X									100	*E. globulus*
"Spring" beetles (*Liparetrus* spp.)			X				X					130	*E. globulus*
Wingless grasshopper (*Phaulacridium vittatum*)			X									170	*E. globulus*
28 Parrots (*Banardius zonarius*)				X					X			3200	*E. globulus,*
Rabbits		X					X					10	*E. globulus*
PATHOGEN													
Teratosphaeria spp.				X			X					220	*E. globulus*
Abiotic													
Nutrient deficiencies (Copper, Boron, Zn)					X							2650	*E. globulus*
Drought								X				-	*E. globulus*
									TOTALS		**25,000**	**6,620**	

** Data contained in the above table is of a general nature and reflects the lack of a formal pest and pathogen data collection process. It is likely to be an underestimation as a number of companies were unable to collect the necessary data.*

† Area inspected was roughly calculated from the known area of plantings from 2009- 2011 (1-3 years old), as plantations in this age group are known to be frequently inspected. Additionally older plantations that were reported as having damage were also counted. Again this is likely an underestimation

‡ Area Treated was taken to mean that some control or management action had taken place, including replanting (F. Tovar IPMG)

Other *Eucalypus* spp. (*E. cadocalyx, E. maculata* and *E. saligna*)
Insect pests
Leaf blister sawfly (*Phylacteophaga froggatti*)
Leaf blister sawfly has decimated (stress exposed) plantations of *E saligna* and *E. botryoides* in some inland areas. Gum Leaf Skeletoniser (*Uraba lugens*) was also found on *E. rudis* within the plantation boundary. *E. cladocalyx* and *Santalum spicatum* in the same plantation were not affected by these pests.

'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. 2010 spring season was not an unusual season.

Sandalwood (*Santalum spicatum*) plantations
No major insect or fungal problems reported.

Managed natural forests

Jarrah forest (*Eucalyptus marginata)*
Insect pests

Jarrah leaf miner (*Perthida glyphopa*) (JLM)
Surveys for jarrah leaf miner (JLM) in October and November 2009 showed that there was northwards spread of JLM outbreak into northern regions of Jarrah forest, but severe browning due to JLM was recorded in the Albany hinterland. A survey of the cutout boundary will be repeated in October & November 2011 (A. Wills, & J. Farr DEC).

Gum leaf skeletonizer (*Uraba lugens*)
An outbreak of gumleaf skeletonizer (GLS) was first observed in Dec-March 2009-10. In the summer season of 2010-2011 population monitoring included a road drive-by survey; branch clipping of 61 sites throughout the jarrah forest including 45 sites originally determined in the 1982-92 outbreak; aerial observation and mapping; trial of the New Zealand pheromone lure system in an outbreak situation. Severe defoliation occurred on 250,000 ha, with > 350,000 ha experiencing severe to moderate defoliation. The mean larval density was measured in December as 824 larvae kg^{-1} dry weight of leaf which was equivalent to a January population of 275 larvae kg^{-1} dry weight of leaf (adjusted for appropriate survival rates), nearly twice the past peak outbreak level in 1986-87. Some areas of forest experienced nearly 100% defoliation. The New Zealand pheromone lure system was successful and will be used in 2011-12 to determine GLS flight periods and develop a more efficient population monitoring system for future outbreaks (a paper will be published in Australian Journal of Forestry in 2011 on the pheromone trial). In addition remote sensing and GIS applications will be investigated to further investigate spatial patterns as related to vegetation, soils, fire history and land management regimes (J. Farr, DEC).

U. lugens defoliation at Easter forest block February 2011 (*left*) and Aerial photograph showing large scale defoliation February 2011 (*right*).

Cerambycid woodborers (*Phoracantha semipunctata*)
Beetle populations responded strongly to the drought-induced collapse of jarrah and marri in the Northern Jarrah Forest by quickly colonizing damaged stems (83% of marri, 84% of jarrah). Destructive sampling of trees exhibiting differing symptomologies confirmed beetles are largely acting as secondary invaders, with minimal damage observed in neighbouring trees maintaining green canopies. A negative relationship was found between woodborer damage in the sapwood and sapwood moisture content. Despite their roles as secondary invaders, consumption of cambial tissues is significant with an average 68% of marri tissue and 33% of jarrah stem tissue consumed in drought-affected trees. Predation may limit the potential for resprouting, particularly in marri. Whole stem dissections of six marri stems resulted in 7, 26, 35, 36, 45, and 108 living larvae per square meter of surface area. Population and damage monitoring of the population is expected to continue. (G. Matusick, MU)

Pathogens

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).

Abiotic factors

Frost

In June/July 2010 large portions of the northern jarrah forest experienced extreme low temperatures (-4 to -6º C) resulting in rapid foliage and shoot mortality marri and jarrah. Damage was restricted to drainage lines, which likely acted as cold-air sinks. Twelve plots (40m fixed-radius)(6 damaged/6 undamaged) were installed in Wandoo National Park (Talbot Brook) to collect baseline damage and track recovery. The hardest hit areas were those pockets of jarrah/marri surrounding Darken Swamp. Trees of all size classes were affected though variation was high on each site. Some marri trees experienced 100% defoliation and shoot loss (47% average), while jarrah was slightly less affected (23% foliage damage). Marri leaves discoloured, dried, and died very quickly. Affected jarrah foliage first turned purple, then eventually died in spring. Most marri trees with complete defoliation reflushed large portions of their crowns. Most affected jarrah trees simply shed their shoots, with minimal evidence of reqprouting. Wandoo was not affected. Research is continuing to determine low temperature tissue thresholds. Preliminary data suggests exponentially more cell damage occurs between -4 and -6 degrees Celsius (G.Matusick, Murdoch University).

Frost affected patch in April 2010 (*left*) and an affected jarrah tree in December 2010 (*right*)

Drought

Unprecedented drought-induced deaths in the northern jarrah forest (NJF) observed starting late February 2011. Most damage occurred along the Darling Scarp from northern Perth to Pinjarra and in the western forest. Mortality occurred in overstorey (jarrah/marri) and midstorey (*Banksia grandis/Allocasuarina*) in noticeable patches. An aerial survey of approximately 9% of the NJF resulted in an estimate of 1.6% of the area

severely affected with an additional 5% showing strong crown chlorosis in late May. The rate of progression seemingly slowed through June, however some sites continued to lose canopies through late July. All size and age classes of trees are affected. Most canopies died very quickly (within 5-7 days), losing their shoots and leaves within a month. Drought and more specifically mass conduction failure is thought to be the main cause of death in jarrah and marri due to rapid drying of the inner bark and sapwood. Also, an estimated 50% of the damaged sites were located on notably shallow soils, as evidence by their proximity to granite rock outcrops. Damaged areas were larger and more severe in the Northern section of the forest near Jarrahdale, with smaller, less severe areas to the south (Dwellingup). By late July some jarrah stems not damaged by woodborers were re-hydrated to breast height, while marri stem tissue continues to dry and die. Research is very active on this disturbance event at the moment and will likely continue indefinitely (G.Matusick, Murdoch University).

Canopy mortality centres near Dale (*left*) and strongly chlorotic canopies surrounding mortality centre (*right*). Photos taken May 2011.


Jarrah crown collapse and leaf shed near Dale. Photo taken July 2011.

Karri forest (*Eucalyptus diversicolor*)
Insect pests
No major pest problems reported.

Pathogens
No new major disease problems were reported. Management and survey of *Armillaria* root disease in karri forests continues to command attention.

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

Native plant communities

***Phytophthora* in natural ecosystems**
Previously large-scale aerial photography has been used to map the extent of Phytophthora dieback disease in native forests in the south-west of Western Australia, whereas currently most mapping is undertaken with intensive field survey. Validation of the observations involves routine testing of soil and root samples for the presence of *Phytophthora cinnamomi.* In addition to *P. cinnamomi*, six morpho-species had been identified using this technique: *P. citricola, P. megasperma, P. cryptogea, P. drechsleri, P. nicotianae* and *P. boehmeriae.* In recent years many new *Phytophthora* species have been described world-wide, often with similar morphology to existing species; thus, as

many of the isolates collected in Western Australia have been difficult to identify based on morphology, molecular identification of some of the morpho-species is required. Based on amplification of the internal transcribed spacer (ITS) region of the rDNA, sequence data of over 560 isolates (both recent and historical) have now been compared to that of existing species and undescribed taxa. This work is continuing.

In addition to *Phytophthora multivora*, a further eight new species isolated from WA natural ecosystems have now been described: *P. elongata, P. thermophila, P. gibbosa, P. gregata, P. litoralis, P. arenaria, P. constricta* and *P. fluvialis.* Pathogenicity has so far been tested and confirmed on native plants for *P. multivora*, *P. elongata, P. arenaria* and *P. constricta*. Several additional new WA taxa await formal description.

New records for WA of *Phytophthora* taxa known elsewhere have included: *P. inundata*, *P. niederhauserii*, *P*. taxon asparagi, *P*. taxon personii, *P*. taxon PgChlamydo, *P*. taxon rosacearum-like, *P*. taxon salixsoil and *P*. taxon humicola-like.

A number of unique hybrid Phytophthoras, with significant genetic diversity, have been identified from WA natural and plantation ecosystems: some from soil associated with dead plants, and also many from waterways. Investigations of the hybrids and their origins are progressing. The presence of these hybrids (all recovered from routine soil, root and water samples being tested for *Phytophthora*) shows that they are sufficiently stable and resilient to survive in the harsh WA environment. Also, it raises the possibility of hybrids with significant pathogenic capability arising in the field at any time from interactions between compatible *Phytophthora* species. Movement of infested soil and/or plant material between sites will clearly facilitate these interactions, and should be minimised.

Most of the newly-described Phytophthoras (and some of those yet to be described) have been associated with multiple species of dying native plants in WA natural ecosystems, with DEC isolations from indicator plants dating back to the 1980s. Some Phytophthoras are active in a broader range of site conditions than those favouring *P. cinnamomi* (e.g. *P. multivora* in limestone soils). Some species (e.g. *P. arenaria* and *P. constricta*) are believed to be endemic in WA. Most of the new taxa have been associated with dying *Banksia* spp. while *P. elongata*, *P. multivora* and *P. thermophila* have also been isolated from dying *Eucalyptus marginata* (jarrah). *Phytophthora multivora* is pathogenic to bark and cambium of *E. gomphocephala* and *E. marginata* and is believed to be involved in the decline syndrome of both eucalypt species within the tuart woodland. *P. elongata* has also been isolated from dying *Corymbia calophylla* in mining rehabilitation sites. Some taxa appear to have limited distribution, while others like *P. multivora* are widespread.

Land managers are being encouraged to apply the precautionary principle in dealing with all of these soil-borne *Phytophthora* species with the aim of minimising their spread, while management and policy documents are now being updated to include the other *Phytophthora* species in the definition of Phytophthora dieback.
The previously recorded presence in WA natural ecosystems of some *Phytophthora* species other than *P. cinnamomi* (*P. cryptogea, P. nicotianae, P. megasperma, P. boehmeriae*) has been confirmed by DNA sequencing of stored isolates; however, *P. citricola* and *P. drechsleri* (previously believed to be present) are not present among the

isolates tested to date. (T. Burgess, G. Hardy, D. White, A Rea, Murdoch University; J. Webster, J. Ciampini, M. Stukely, DEC).

DEC - Phytophthora Research Projects

Over the past year a number of small to medium scale experiments into the control of *P. cinnamomi* have been conducted by DEC Science Division staff. This has included investigations into the ability of geotextiles to filter *P. cinnamomi* inoculum, the suppressive effect of fire retardants on the infection cycle of *P. cinnamomi* and the use of high intensity phosphite application (HIPA) (i.e. basal stem application) in Jarrah and *Banksia grandis*. In brief, the geotextiles were able to contain *P. cinnamomi* zoospores under neutral hydrologic pressure, fire retardants (Angus ForExpan-S, Phos-Check WD-881) suppress the growth and infective ability of *P. cinnamomi* at their recommended rates for use in bushfire control and HIPA did not provide adequate phosphite tissue concentrations in Jarrah to control of *P. cinnamomi*. Further experiments into the efficacy of fumigants to sterilise *P. cinnamomi* infested soil and an assessment of the effectiveness of current DEC hygiene procedures will be conducted during 2011-2012 (C. Dunne, P. Scott, R, Thavornkanlapachai, DEC).

State NRM - Phytophthora Containment and Eradication Research

In late 2009 a State NRM grant was received to undertake a number of Phytophthora dieback management initiatives. Included in this project were attempts at management scale containment and eradication of *Phytophthora cinnamomi* infestations within the Fitzgerald River and Cape Arid National Parks. To date a <0.5 ha infestation at Cape Arid National Park has been eradicated and a 1 ha infestation within the Fitzgerald River National Park has been contained. The containment and eradication programs used an integrated management approach utilizing catchment hydrological modeling, runoff diversion, root impervious membranes, geotextiles to prevent inoculum movement in overland flows, host destruction including herbicide treatment, fungicide treatment using phosphite, fumigation and perimeter fencing to prevent animal vectoring. Further treatments and monitoring will be undertaken over the current financial year. (C. Dunne, R. Hartley, P. Scott, DEC; B. Dunstan, T. Paap, N. Williams, G. Hardy, Murdoch University).

State NRM - Correlations of plant canker pathogen impacts in Proteaceae with climate and optimizing the canker control management strategy for the south coast of Western Australia.

Currently two declared rare flora, *Banksia verticillata and Lambertia orbifolia ssp. orbifolia* are being severely impacted by canker disease and concern was raised that this may be caused by emerging pathogens in a changing climate. Studies funded by state NRM in 2010 have been conducted on the impact of aerial canker on *Banksia* decline, resulting in the identification of a number of associated fungal species which included *Neofusicoccum australe, N. macroclavatum, Cryptodiaporthe melanocraespeda* and a new genus within the Cryphonectriaceae currently being described (proposed *Cirrhiluteous shearii*).

Transects established in 2010 to monitor the health and survival of three keystone *Banksia* species of the south coast (*Banksia baxteri*, *B. coccinea*, and the rare granite banksia, *B. verticillata*) have identified an increase in canker incidence and forecast a further increase within these Proteaceous spp. in the future climate change scenarios projected for south Western Australia. Increasing canker impact in *B. baxteri* has been significantly correlated with increases in daily humidity, maximum and mean temperatures. For *B. coccinea* positive correlations with minimum temperatures and evaporation have been found.

Ranking of effectiveness of the fungicides tebuconazole (Tebuconazole®), fenarimol (Rubigan®), thiabendazole (Tecto®) and prochloraz (Sportak®) showed that prochloraz was most effective in containing lesions of *Neofusicoccum* and *Cryptodiaporthe* while fenarimol most effective against the putative *Cirrhiluteous* pathogen. (C. Crane, S. Barrett, B. Shearer, C. Dunn, DEC).

Urban and rural

Pathogens and Declines

Norfolk Pines

Recently the health of Norfolk pines in the Perth urban area has declined. There is a lot of dieback of all but the current year's needles and many young trees die. There are often visible cankers on the stems and branches. *Neofusicoccum parvum* is routinely isolated from these cankers and its pathogenicity proven. This is interesting and *N. parvum*, while common elsewhere in Australia, has not been isolated previously in Western Australia even though there have been extensive surveys in natural ecosystems (H. Golzar, T. Burgess, MU). Results from this project have been published – see Golzar H, Burgess TI (2011) *Neofusicoccum parvum,* a causal agent associated with cankers and decline of Norfolk Island pine in Australia. Australasian Plant Pathology 40: 484-489

Pathogens of boabs

Surveys for fungi associated with boab (*Adansonia gregorii*) are underway in both South Africa and Western Australia. In this study, seven new species of the Botryosphaeriaceae are described from baobab (*Adansonia gibbosa*) and surrounding endemic tree species growing in the Kimberley region of northwestern Australia. Members of the Botryosphaeriaceae were predominant endophytes isolated from apparently healthy sapwood and bark of endemic trees; others were isolated from dying branches. Phylogenetic analyses of ITS and EF1-α sequence data revealed seven new species: *Dothiorella longicollis*, *Fusicoccum ramosum Lasiodiplodia margaritacea*, *Neoscytalidium novaehollandiae*, *Pseudofusicoccum adansoniae*, *P. ardesiacum* and *P. kimberleyense*. The most commonly isolates species was *Lasiodiplodia theobromae*. A pathogenicity test has shown that this species is highly pathogenic to boabs Many of the new species found on Boabs have also been found causing cankers on mangoes in the Ord Region Irrigation Area (Monique Sakalidis, T. Burgess, G. Hardy, Murdoch University; M. Wingfield, Tree Pathology Cooperative Program (TPCP) South Africa).

Results from this project have been published – see Sakalidis ML, Hardy GESJ, Burgess TI (2011a) Endophytes and potential pathogens of the baobab species *Adansonia gregorii*; a focus on the Botryosphaeriaceae Fungal Ecology 4: 1-14 and Sakalidis ML, Ray JD, Lanoiselet V, Hardy GESJ, Burgess TI (2011b) Pathogenic Botryosphaeriaceae associated with *Mangifera indica* in the Kimberley Region of Western Australia. European Journal of Forest Pathology 130: 379-391.

***Tetratosphaeria* on marri**

Several new *Teratosphaeria* species were described from marri. *Corymbia* species are generally not severely affected by *Teratosphaeria* (formally *Mycosphaerella*) leaf diseases and few fungal leaf pathogens have been described from *C. calophylla*. Two new species of *Teratosphaeria* from *C. calophylla*, *Teratosphaeria calophylla sp. nov* and *T. rubidae sp. nov* have been described. In addition, a new epitype was designated for *T. australiensis*. *Tetratosphaeria callophylla* causes a leaf blight which can be severe, but to date its distribution appears to be limited to Kings Park (T. Burgess, Murdoch University). The results of this project have been published – see Taylor K, Andjic V, Barber PA, Hardy GESJ, Burgess TI (2011) New species of *Teratosphaeria* associated with leaf diseases on *Corymbia calophylla* (marri). Mycological Progress: DOI: 10.1007/s11557-11011-10738-11551.

Peppermint dieback

Agonis flexuosa, commonly known as the Western Australian peppermint, is a tree native to the south-west of Western Australia, and severe dieback symptoms have been recently observed in some areas. A species of fungus was believed to be the causal agent. For this project, fungi were collected, isolated, identified and tested for pathogenicity to determine the causal agent of the decline of *A. flexuosa* in natural ecosystems in Western Australia. Fungi were isolated from symptomatic and asymptomatic material collected from *A. flexuosa*, cultured, and then identified using molecular taxonomy, microscopy and vegetative compatibility trials. Pathogenicity trials using *A. flexuosa* seedlings were carried out to prove Koch's Postulate. All isolates caused lesions in the seedlings, and there is no significant difference between lesions caused by isolates from symptomatic and asymptomatic material. This suggests that the causal agent could be an endophytic fungus which has become a pathogen (N. Dakin, BioGENIUS student, T. Burgess, D. White, G. Hardy, Murdoch University). A student on the diversity of Neofusicoccum australe suggests that this latent pathogen is endemic to Western Australia. Its involvement in the decline of the peppermint must be associated with host stress (N. Dakin, BioGENIUS student, M. Sakalidis, T. Burgess, D. White, G. Hardy, Murdoch University). Results from this project have been published – see Sakalidis ML, Hardy GESJ, Burgess TI (2011a) Class III endophytes, clandestine movement amongst hosts and habitats and their potential for disease; a focus on *Neofusicoccum australe*. Australasian Plant Pathlogy 40: 510-521 and Dakin N, White D, Hardy GESJ, Burgess TI (2010) The opportunistic pathogen, *Neofusicoccum australe*, is responsible for crown dieback of peppermint (*Agonis flexuosa*) in Western Australia. Australasian Plant Pathlogy 39: 202-206.

Mundulla Yellows

Monitoring the occurrence and symptom development of Mundulla Yellows (MY) in WA continues. Symptomatic eucalypts (both planted trees and remnant native trees) have been recorded and monitored in several additional locations. Spread of symptoms within affected sites appears generally to be slow, and diseased and apparently-healthy trees can grow alongside each other. 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 inland 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).

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 14,395 ha was mapped to assist the planning of roading and timber harvesting operations undertaken by the FPC, while FPC also arranged significant areas of mapping by private contractors. This included 4988 ha of previous mapping that was checked for further spread. Mapping and hygiene planning were undertaken on a further 1,147 ha for the Parks and Visitor Services, Nature Conservation Service and Sustainable Forest Management Service of DEC, and 1,777 ha for external parties. Training programs were carried out in disease mapping and hygiene management (G.Strelein, DEC).

In the year to 30th June 2011, a total of 1,936 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 *Phytophthora* in the DEC culture collection, from a range of WA locations and ecosystems. This has led to the discovery of an unexpectedly large number of new *Phytophthora* taxa (nine of which have now been formally described), as well as new records for WA of several *Phytophthora* taxa known from elsewhere, and also a swarm of *Phytophthora* hybrids (see details under *Phytophthora* in natural ecosystems). While the pathogenicity of many of the new taxa is still to be fully investigated, the precautionary principle should be applied by managers to ensure that the spread of all of these soil-borne Phytophthoras to new areas is minimised. Hygiene practices should be applied in the same way as for *P. cinnamomi*. (M. Stukely, DEC).

Forest health monitoring

An automated annual monitoring program is continuing to be developed to identify changes in satellite reflectance information over time and correlate this with known or past causes of changes in forest health and vigour. This information is then used to classify the changes, with levels of confidence, to causal factors. Those with unknown or low levels of confidence or changes in magnitude are then targeted for further investigation including field checks to confirm causes and recalibrate the annual data updates. The system includes spatial modeling algorithms to incorporate both known datasets (harvesting, fire, mining) and surrogate datasets (landform, soils, vegetation) that can be correlated with possible causes and inform the decisions on causes that as yet have no spatial history to guide classification (G. Strelein, 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 late 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. Six Post-Doctoral fellows and a Manager have been appointed within the centre. The focus of this centre will initially be the decline of tuart and wandoo, however, student projects under the centre have been initiated investigating the decline of other iconic WA species including *E. marginata, Corymbia calophylla, E. rudis, Agonis flexuosa and C. ficifolia.* Further information about the Centre can be found at www.treehealth.murdoch.edu.au (G. Hardy, Murdoch University).