Gumleaf Skeletonizer (*Uraba lugens*) Outbreak February 2010 - 2012

Update of the severity of the Gumleaf Skeletonizer outbreak in the Warren Region.

Janet Farr and Allan Wills
February 2012

Department of
Environment and Conservation

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Science Division, Department of Environment and Conservation

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Executive Summary

Background

High levels of defoliation in the southern jarrah forest from 2010 were the result of population increases of the insect pest gum-leaf skeletonizer (GLS: *Uraba lugens*) which had formerly outbroken in1983-1993. Vigilance by DEC and FPC officers and continued monitoring for FORESTCHECK enabled a prompt response for recording distribution and population build up such that the period of population increase can be pinpointed to 2006-09.

What has been done?

Since March 2010 GLS distribution and population levels have been documented using road survey; canopy sampling using branch clipping techniques; satellite imagery and GIS; and pheromone trapping. Studies using leaf area index and examining larval growth and mortality have also been initiated.

Findings

Populations of GLS in 2010-2011 defoliated more than 250,000 ha. Populations have decreased overall since 2010-11 from 824 to 608 larvae/kg dry weight of leaf; however the insect is still in outbreak with some areas having increased GLS and some decreased populations. Pheromone trapping has been successful and proves to be a useful future tool in forest health surveillance. A regression is being developed to relate moth numbers caught in pheromone traps to relative larval numbers in the canopy. Furthermore satellite imagery and GIS has a strong correlation with aerial surveillance although fire events can confuse the data.

Pathological elements have been found in populations and suggest jarrah is usually a marginal host for GLS, which restricts its development into a bivoltine population and under normal conditions results in low populations. GLS grows larger on Marri.

Future directions

- Refine relationship between pheromone captures and larval numbers.
- Develop quantification of leaf area index and relate this to GLS population levels.
- Further develop the relationship between defoliation rates, LAI and satellite imagery.
- Investigate possible collaboration with NZ regarding mating disruption and SPLAT technology.

Background

In 2010 high populations of *Uraba lugens* (gum leaf skeletonizer, GLS) became evident in the jarrah forest. Prior to this an outbreak of GLS, had occurred in the southern jarrah forest from 1983-1992 such that at the peak of the infestation 90,000 ha of forest were affected and the epicenter for this outbreak (Wheatley/Donnelly) was similar to that of the current 2010 outbreak (Fig 1; Abbott 1992, Farr 2002, Farr *et al* 2004). Initial details on the start of this current outbreak are included in a preliminary report dated March 2010. This is an update of the current situation since this time.

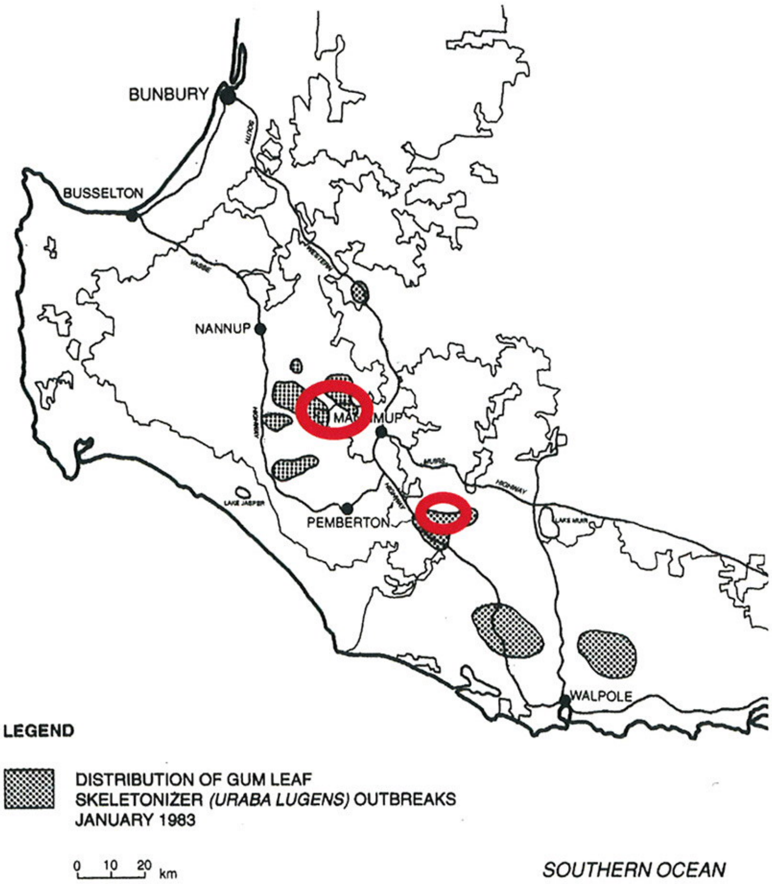


Figure 1 Map of original outbreak of GLS with current 2011 epicenters circled in red.

Nov 2010- Jan 2012

During 2010-2012 the outbreak was investigated as shown below:

1. Road survey (Nov 2010)
2. Branch clipping (Dec 2010, 2011)
3. Aerial survey (Feb 2011)
4. Satellite imaging (GIS)
5. Pheromone trials (Feb-Apr 2011; Jan 2012 -)
6. Digital leaf area index
7. Supplementary larval sampling

Procedures 1-3 enabled assessment of the distribution and intensity of the outbreak and quantified population levels such that comparisons could be made with the prior outbreak. Procedures 4-7 were and are being conducted to follow the phenology of the insect; examine pathological elements within its population; develop an efficient and cost effective monitoring method which can be related to field population levels; and augment the potential for the future use of remote sensing in determining distribution and population levels.

Distribution and population levels

The road survey conducted in Nov 2010 determined that the GLS distribution for 2010 – 11 was much higher as compared with the previous generation in 2009 – 10. Prior to 2009 the FORESTCHECK monitoring program (which includes monitoring for observed presence/absence of known jarrah forest pests), found limited evidence of GLS in the localities of Donnelly and Blackwood Plateau (Table 1). The only incidence of GLS recorded for these localities prior to 2009 was in 2007 where it was observed as present in one grid in low numbers. Furthermore, in 2011 at the current outbreak peak, 5 sites in the Blackwood Plateau had strong evidence of GLS presence despite the sites being outside high population areas. This shows that population levels were starting to increase from 2007 but did not reach outbreak levels until 2009-10. Comparison of the rate of infestation of the GLS sample trees shows that at the end of the first outbreak only 37% of trees had populations of GLS (Table 2; determined through branch clipping). In2009, although isolated forest patches were showing moderate defoliation, only 25% of sample trees were infested (from visible assessment of crowns) compared with 80% in 2010 (determined through branch clipping). Therefore we can be confident that the build up of population levels occurred during 2006-2009.

The aerial survey conducted in Feb 2011 revealed over 250,000 ha affected by high defoliation levels from GLS populations (Fig 1) such that some areas experience 100% defoliation. Branch clipping enabled further verification of the levels of defoliation in relation to GLS population levels. Sites were selected using the original 45 tree locations as established by Abbott for the earlier outbreak and expanded such that 61 tree locations were sampled in Dec 2011 and again in Dec 2012. These locations also feature on Figure 1. Branch clipping quantified GLS populations in relation to kilogram dry weight of leaf. In December 2010 (caused defoliation as seen in Feb 2011) the mean GLS population was 824 larvae/kg dry weight of leaf with a maximum level of 11,433 at site 4 in Wheatley (location: 50 H 406446, 6223308). In December 2011 the mean GLS population had decreased to 608 larvae/kg with a maximum level of 6,037 at site 26 in Dingup (location: 50 H 431728, 6200158).

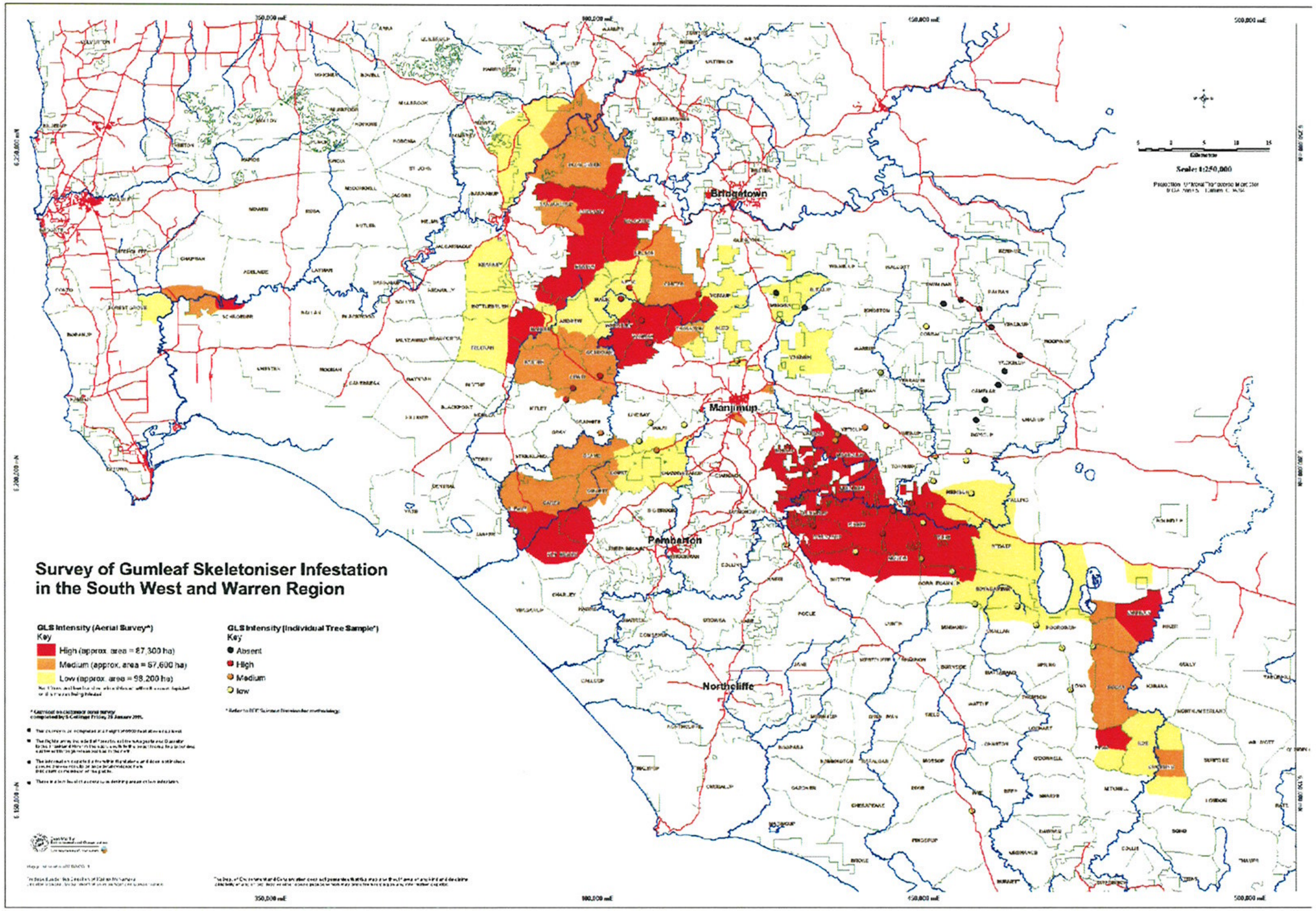
Table 1 GLS observations from Forestcheck (FC) monitoring plots in the Donnelly and Blackwood localities.

FC Location	*Year*	*No. sites with GLS*
Donnelly	2001	0
Blackwood	2005	0
Donnelly	2007	1
Blackwood	2011	5

Table 2 Summary of outbreak infestation rate history for GLS

Year	*No. Sample Trees*	*No trees infested*	*% Trees infested*	*Note*
1987	45	32	71	Outbreak peak (1982-96)
1995	45	17	37	Non outbreak period
2009	47	12	25	New outbreak start
2010	61	49	80	Very severe defoliation
2011	61	48	79	Less apparent damage than in 2010-11

Figure 1 Aerial survey of Jarrah forest affected by GLS defoliation conducted in Feb 2011



Sampling was conducted in December because this period represented the stage in the insect's life cycle when feeding rates increased and had maximum impact on the host plant. Population estimates for the first outbreak were done in January when larval numbers would be declining as the insect was advancing to the pupal stage and also mortality impacts were maximized. Therefore January sample levels were an underestimate of GLS populations at that time and were less useful for comparisons with impacts on canopy and for use relating to remote sensing and GIS applications. To enable comparison with the prior population levels the current data were therefore converted to estimated levels for January using known survival rates for this insect. Adjusted larval population levels were 275 and 201 larvae/kg respectively for 2010 and 2011, compared with 155 larvae/kg in 1987. The resultant population graph is displayed in Figure 2. This demonstrates that the current population outbreak exceeds that experienced in 1986-1989; and even though there has been a decrease for the 2011 – 12 population, levels are still much higher than those experienced in the earlier outbreak.

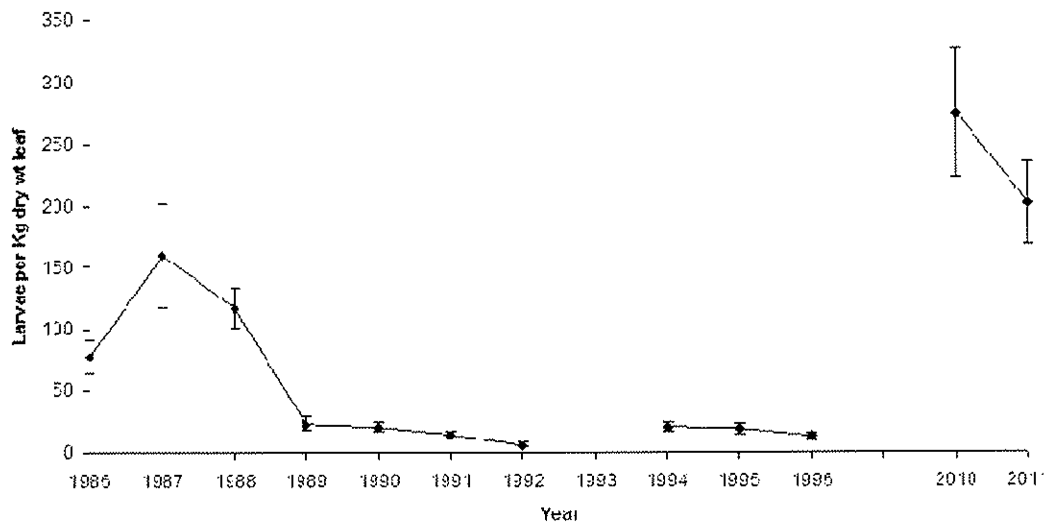
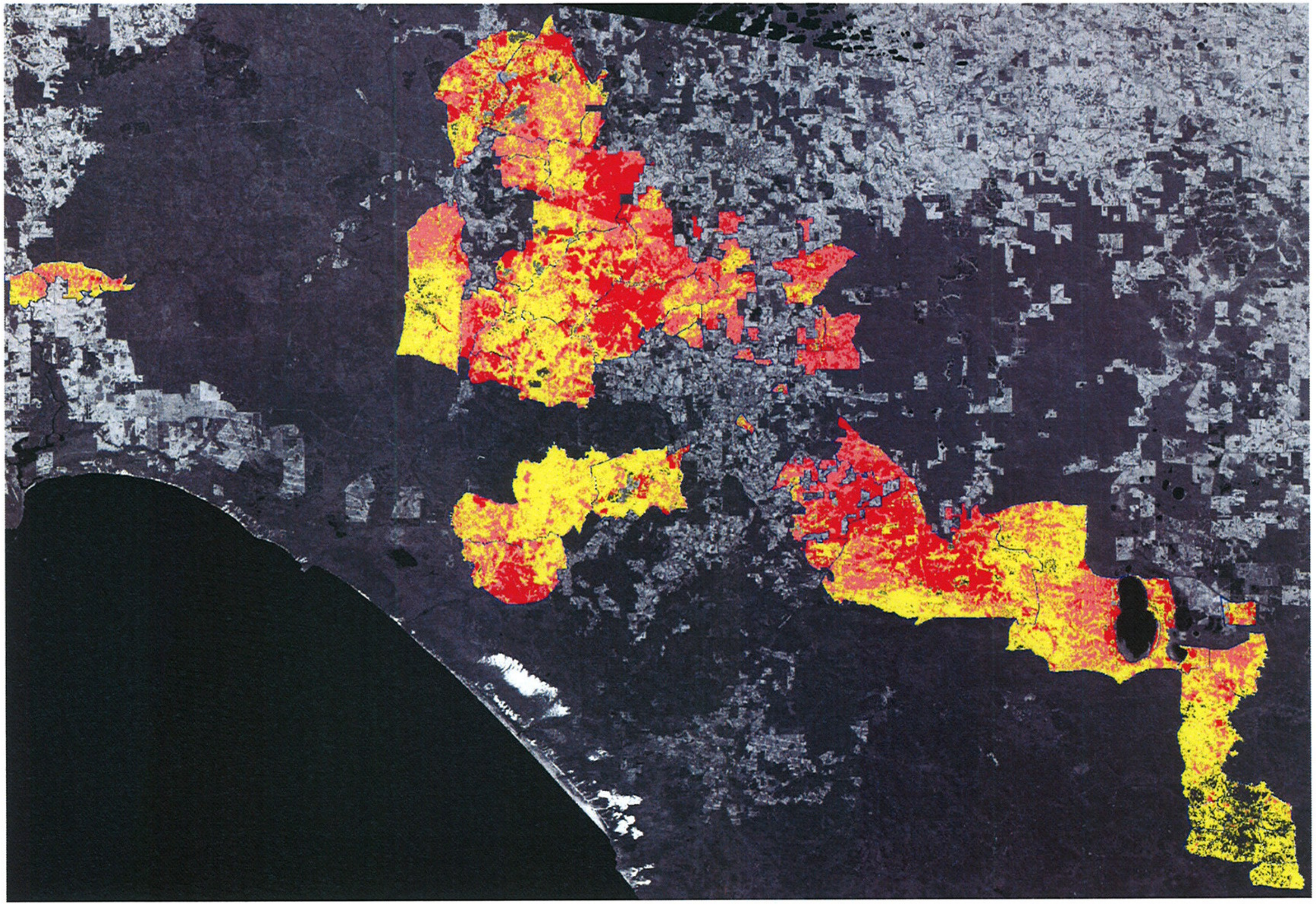


Figure 2 Population of GLS in the southern Jarrah forest (± SE) as measured from canopy samples taken in January of the respective year from 1986-1996 (Farr unpublished data) and for the current outbreak 2010 - 2011. Data for 2010 and 2011 adjusted to January survival levels for comparison.

Satellite imagery and GIS

The use of satellite imagery and GIS technology has revealed strong correlation with the visual aerial survey assessment (Figure 3). However inconsistencies occur in areas, for example, subject to fire which can appear as high infestation areas due to canopy loss. Therefore ground truthing is important to verify such images. We are currently working to refine the remote sensing applications such that these can be related to values such as leaf area index and ultimately larval population levels. The 2011-12 results are as yet not finalized and therefore are not displayed here

Figure 3 GIS imagery for the GLS outbreak area in January 2011. Red areas represent very high defoliation; Pink, moderate-high defoliation; Yellow, moderate – low defoliation.



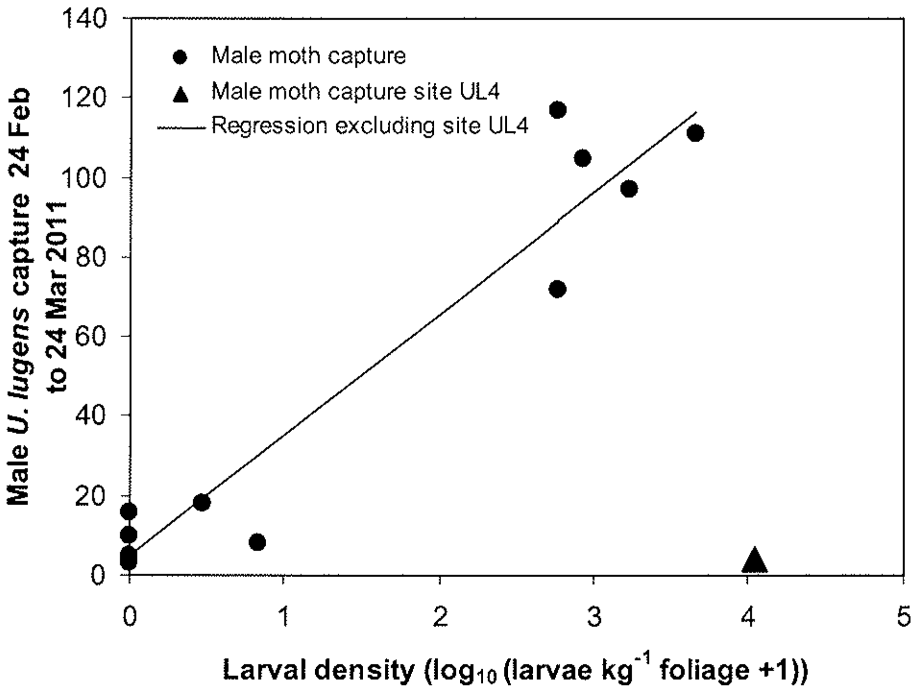
Leaf area index

It is anticipated to use leaf area index as a quantitative measure of GLS damage in the forest. This ultimately will be compared with quantitative measures of larval/moth populations and GIS images. With a regression of the leaf index against GLS population levels a threshold population level beyond which defoliation is significant in the forest could be developed enabling interfacing with remote sensing to establish a predictive tool for GLS outbreaks. To date we have digitally photographed canopies for a range of GLS affected locations including some FORESTCHECK sites, all of which have measures of GLS population levels.

Pheromone trapping

A pheromone was developed for GLS in New Zealand and is now distributed by Etec Crop Solutions (Auckland NZ). The pheromone, known as Desire®, was developed using GLS populations derived from eastern Australia following an introduction of the pest into NZ. Since GLS in Western Australia behaves slightly differently and the NZ pheromone was developed to monitor an introduced insect in amenity trees mainly located in parks and gardens rather than forests, it was necessary to test its effectiveness in WA conditions. This was done successfully in 2010-11 and subsequently we have submitted a paper to Australian Journal of Forestry which has been accepted for publication (Farr and Wills 2012). Moth captures were significantly correlated to larval populations as established from branch clipping ($R^2 = 0.9$, $p<0.001$). Problems were evident in areas with thick understory where the number of male moths captured did not correspond to the larval population, however in other plots the relationship was strong (Fig 4).

Figure 4 Regression of male moth captures using pheromone lures against larval populations as sampled in December 2010. Regression does not include site UL4 where thick understory interfered with the pheromone plume reducing trap effectiveness.



In the GLS season 2011-2012 we have been refining the above regression and hope to relate the results to digital canopy imaging using leaf area index. In addition a costing of branch clipping against pheromone trapping indicates monitoring using pheromone traps is an efficient proposition for future health surveillance (Table 3). Branch clipping generates very useful population data and is an essential step in our research of this pest; however it has serious safety issues, requires the use of a cherry picker and therefore training for national accreditation, and requires the time of 4 people. Pheromone trapping, once protocols have been established, will be achievable using one person and the corresponding vehicle expenses plus trap costs. It is evident from our recent work, delta traps in which the pheromone is deployed in the field will last 2 seasons, after which they will require replacement. The other ongoing cost for this operation is the pheromone, for which each dose is deployed in an individual sealed packet, which has a finite storage time.

Table 3 Costing for GLS population monitoring using branch clipping and pheromone trapping.

Item	*Branch Clipping*	*Pheromone Trapping*
National accreditation	$3,000	
Cherry Picker hire	$4,000	
Traps/ Pheromones		$800
Cool Room	$900	
Vehicle	$450 (500 km x 0.9)	$270 (300km x 0.9)
Persons	4 (employed 2 casuals)	1.5
Time (Includes field + processing)	6 weeks (dependant on number of sample points)	6 weeks (duration of flight season)
Total (excl persons/ time)	$5,350 ($8350 including national accreditation)	$1,700

In addition to population monitoring, pheromone trapping was used to test whether a second generation of GLS occurred in the southern jarrah forest. Results for this are still inconclusive and some aspects regarding GLS phenology will be mentioned in the section below.

Supplementary larval sampling

Additional larval samples were taken periodically from jarrah coupes along Tamm Road. This was done to examine pathology, early instar mortality and compare growth rates on jarrah with those on marri. Several mortality/pathological factors were apparent. The parasitoids *Euplectrus* and *Cotesisa* are both present in the population, although in very low numbers (precise infestation rates yet to be determined). Other, as yet unidentifiable, pathological agents causing larval mortality are also present including the disease causing brown flaccid larvae as observed at the end of the initial outbreak and suggestions of starvation. Our data on growth rates on jarrah compared with marri suggest larvae grow larger on marri. Earlier work (Farr 2002) showed jarrah is not a good host for GLS and current observations on the fringe of the outbreak in the southern forest suggest that during non outbreak periods survival of GLS on jarrah is marginal, resulting in small larvae. Observations in NZ suggested larvae of a similar biological development period (i.e. stadium) were substantially larger. This suggests that under normal non-outbreak years jarrah is a substandard host for GLS, producing small undernourished larvae with a slow growth rate. Given that climatic conditions are also marginal to produce a bivoltine population might explain the unusual phenology of this insect in WA.

Future directions

- Calibrate relationship between larvae in canopy and moths caught in pheromone traps
  Object: cost effective surveillance monitoring targeting known GLS hot spots
- Establish a relationship between population levels and canopy defoliation (LAI and changes in cover as revealed by satellite imagery)
  Object: determination of a GLS threshold for defoliation impact
- Application of GIS re impacts and attack prone areas

In addition to above NZ has developed a mating disruption technique for brown apple moth in orchards using a gel impregnated with pheromone which can be deployed using aircraft to target areas (program named SPLAT). Given there is now a pheromone for GLS it may be possible to target GLS hot spots with "SPLAT" technology to dampen GLS populations during outbreak periods. This would require collaboration with NZ to test the effectiveness and perhaps refine this procedure for WA conditions.

Aknowledgements
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