Cooperative Research Centre
for National Plant Biosecurity

Final Report

CRC 30133

Urban surveillance for Emergency Plant Pests (EPPs)

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1. Executive Summary

There are two important reasons why pests including Emergency Plant Pests (EPPs) can become established in urban areas and spread to nearby horticultural or agricultural areas. First, urban dwellers usually purchase large quantities of goods and services from a variety of sources and locations, and so are potentially exposed to a wide a range of pests. Second, urban areas have a high density of exotic gardens and other resources that allow newly introduced pests to become established. Surveillance for EPPs in urban areas is therefore an important element of any system that aims to prevent the establishment of pests in rural and agricultural areas.

In this report, we investigate the benefits of a combined program of targeted and passive surveillance for an EPP. We show that a combination of targeted and passive surveillance has kept the European wasp—a major pest of urban areas and horticulture in south-eastern Australia—from establishing a viable population in the greater Perth (Western Australia) metropolitan area for the last 30 years.

Targeted surveillance using non-toxic baits and passive surveillance based on public reporting are complementary techniques that can prevent establishment and spread of European wasps. In Perth, almost all wasp nests are found by the surveillance system, and for a brief period at the end of each summer the city is considered free of wasps. However, hibernating wasp queens are continually imported in goods and associated packing materials. These establish new nests which must be found and eradicated by the end of their first summer.

The program is finely balanced because of the propensity of the European wasp to build huge nests which can seed dozens of 'daughter' colonies in their second summer. To keep ahead of the potentially explosive growth of the wasp population as a whole, the wasp program must find all such nests early in the wasp season before pupating queens leave the nest.

2. Aims

Surveillance programs are often described as being either targeted or passive. Targeted programs involve some sort of systematic program of testing for a pest or disease at selected locations, while passive programs are characterised by ad hoc investigation of syndromes or events that might indicate the presence of the pest or disease. Passive approaches are sometimes augmented with efforts to increase public awareness.

Here we demonstrate that a combination of these two surveillance methods has prevented the European wasp (*Vespula germanica*) from establishing a sustainable population in Western Australia. We provide evidence that the wasp is being continually re-introduced to Perth from reservoir populations in other parts of Australia, but that the combination of targeted and passive surveillance programs is effective in detecting new infestations. Both arms of the surveillance program require funding for their maintenance and continued effectiveness.

A number of stakeholders benefit from pest surveillance programs. Local councils and state agencies responsible for control of weeds and pests in urban areas are beneficiaries. Rural landholders also benefit because the use of targeted and passive surveillance keeps pests from establishing in urban areas and spreading to rural areas.

3. Key findings

3.1. Natural history of the European wasp in Australia

Vespula germanica is a social wasp, forming large colonies, and is native to Europe, north Africa and parts of Turkey. It has also established new populations in the continental United States, South Africa and New Zealand.

In Australia, the wasp was first established in Tasmania in 1959, but it did not reach the mainland until 1977, when it was disseminated amongst several ports by a single ship (Spradberry and Dvorak 2010). It is now well established in South Australia, Victoria, Tasmania, New South Wales and the Australian Capital Territory. In Western Australia (WA), it was first found in Perth in 1977, but was eradicated until further introductions in 1983/84. Since 1984 the wasp has been recorded during every summer in Perth.

The European wasp is mainly a pest in warm climates. In cold climates, colonies produce just one generation of new queens per year which are released prior to the death of the founding queen and nest. In warmer climes, breeding and nest construction continue throughout the year, resulting in massive summer colonies containing many thousands of individuals and hundreds of new queens. As well as being a public nuisance, the sheer size of wasp populations can lead to local reduction in the populations of other insects, including bees, which reduces pollination services and affects horticulture.

For more than 30 years, the Department of Agriculture and Food of Western Australia (DAFWA) has been using a combination of targeted and passive surveillance techniques to detect and destroy wasp nests. During that period, DAFWA has recorded 715 European wasp nests across the south west of the state, largely concentrated around the greater metropolitan Perth area (Figure 1) but also receiving reports spanning 1000 km from Kalbarri to the north, Albany in the south and Kalgoorlie and Eucla in the east. All European wasp nests found since 1977 have been destroyed, and there are now no known nests outside the greater metropolitan Perth area. All substantial rural infestations have been eradicated.

Over the period for which records have been kept (1984–2010), the number of nests found per calendar year ranged between three (recorded in 1986 and 2000) and 122 in 2004, with a mean of 22 nests found per year. In Perth, nests are initiated in spring and reach substantial sizes by late summer.

Critically, if a nest is missed during one summer it may overwinter allow the release of new queens and the re-queening of the original nests with multiple queens. The temperatures in Perth and the sands of the Swan Coastal Plain on which Perth sits (Figure 1) are well suited to nest building. An overwintered nest will generally reach a very large size in the following summer, and produce thousands of new queens. The population of wasps and their colonies can therefore exhibit rapid growth within a single summer.

The European wasp is well established in several parts of eastern Australia. Because the wasp has been present in Perth every year for over 30 years, there is debate over whether the wasp is established or whether infestations are a result of repeated re-introduction from the eastern states. Interstate transport provides the means for a continual trickle of fertilised queens into WA which initiate new infestations. Continual re-introduction means that long-term, sustained freedom from European wasps is unlikely to be achieved. The re-introduction hypothesis is supported by several lines of evidence which we examine in detail below.

3.2. The surveillance and control program

The eradication of infestations from areas outside Perth, and the fact that the infestations in Perth are at very low levels indicate that the European wasp program is a successful containment program. Despite this success, DAFWA had proposed to terminate the nest removal and destruction component of the program in 2011, and responsibility for this role was to be transferred to local government[1]. Although that decision has been reconsidered, it is useful to examine the nature and performance of the program to describe the features that have made it successful in order that managers can maintain or improve upon that success.

Broadly speaking, the current approach has three components: a passive surveillance program, comprising a public awareness sub-program backed up by a well supported call centre; targeted surveillance in high-risk parts of the metropolitan area; and rapid and effective destruction and removal of nests.

Passive surveillance

The DAFWA passive surveillance program is a coordinated program of newspaper and radio advertising, dissemination of brochures and supported by a telephone information service. The public awareness campaign funnels calls to the telephone line of the DAFWA Pest and Disease Information Service (PaDIS). This call centre provides free educational materials, specimen identification and advice on a broad range of pests and diseases that affect industry, civic gardens, households and the community. It is staffed by knowledgeable technicians, and backed by the services of experienced entomologists, horticulturalists and other technical specialists when required. PaDIS acts as a screening process whereby reports of pests suspected of being of biosecurity significance are passed to specialists in the appropriate fields.

Foraging worker European wasps are conspicuous and easily found by the public. The wasps are attracted to proteins and sugars which are readily available in urban environments. Sources include pet food left in suburban gardens, food scraps in garbage bins and food and drink from barbeques and outdoor eating. The nests, however, are built under the ground or in hidden places and are usually only found when foraging worker wasps become conspicuous during the warmer months of the year.

[1] http://www.walga.asn.au/news-publications/media-releases/2011/february-2011/cut-to-wasp-program-risks-wa-health-and-amenity

Because of their stinging habit, affinity for sugary drinks, high visibility and the widespread public education campaign in WA, public reporting of wasp sightings is high. That is, a high proportion of people who think they've seen a European wasp ring the PaDIS call centre. All proven findings are followed up and nests removed. This is a relatively straightforward process, and DAFWA is confident that almost all mature colonies are discovered by the end of each summer. The principal goal is to detect all nests before they have a chance to disseminate new queens. Hence, awareness campaigns are targeted when European wasp numbers are high but prior to the production of queens in late autumn/early winter.

Targeted surveillance

The targeted surveillance program focuses on high-risk locations—primarily freight endpoints for cargo arriving from eastern states, such as rail and road transport depots. Over the 30 year period of the European wasp surveillance program, particular areas have been the focus of targeted surveillance while passive surveillance reports—from members of the public and industrial workers—have come in from many locations across the broader metropolitan area and beyond.

Targeted surveillance uses traps (generally baited with fish) attached to fences, trees or other tall structures. The baits contain no poison. As the traps prevent the wasps from escaping they are used as a detection device. Traps are monitored regularly over the summer/autumn period for the presence of wasps. Baited traps are believed to be most successful in industrial areas where alternative food resources, like pet food, food scraps and soft drink cans, are relatively rare. Although records of the times and locations of traps have not been systematically kept, most are set during summer in several industrial 'hot spots', in particular:

1. The Welshpool/Kewdale light industrial area. This area, about 10 km south-west of the Perth Central Business District, receives much of the freight arriving in Perth from the eastern capital cities. It is regarded as a hot spot for wasps because hibernating queens have been found in goods and packaging material in the area, and because many infestations have been found there in the last three decades.
2. The immediate vicinity of recently detected overwintered nests. Although overwintered nests are destroyed immediately, queens may already have dispersed and established nests nearby. Traps are therefore used to detect any newly established nests within a few kilometres of a newly found overwintered nest. This may be repeated the following summer.

A hybrid form of surveillance, labelled 'secondary passive' occurs when a nest is found due to public reporting and subsequent trapping detects additional nests. Although the nest is detected by a targeted process, such a discovery relies on the initial reporting through the passive surveillance program and would not have been found by the regular targeted surveillance program. The category 'secondary passive' is somewhat arbitrary, but is useful for discriminating between nests found from the targeted and passive components of the surveillance system.

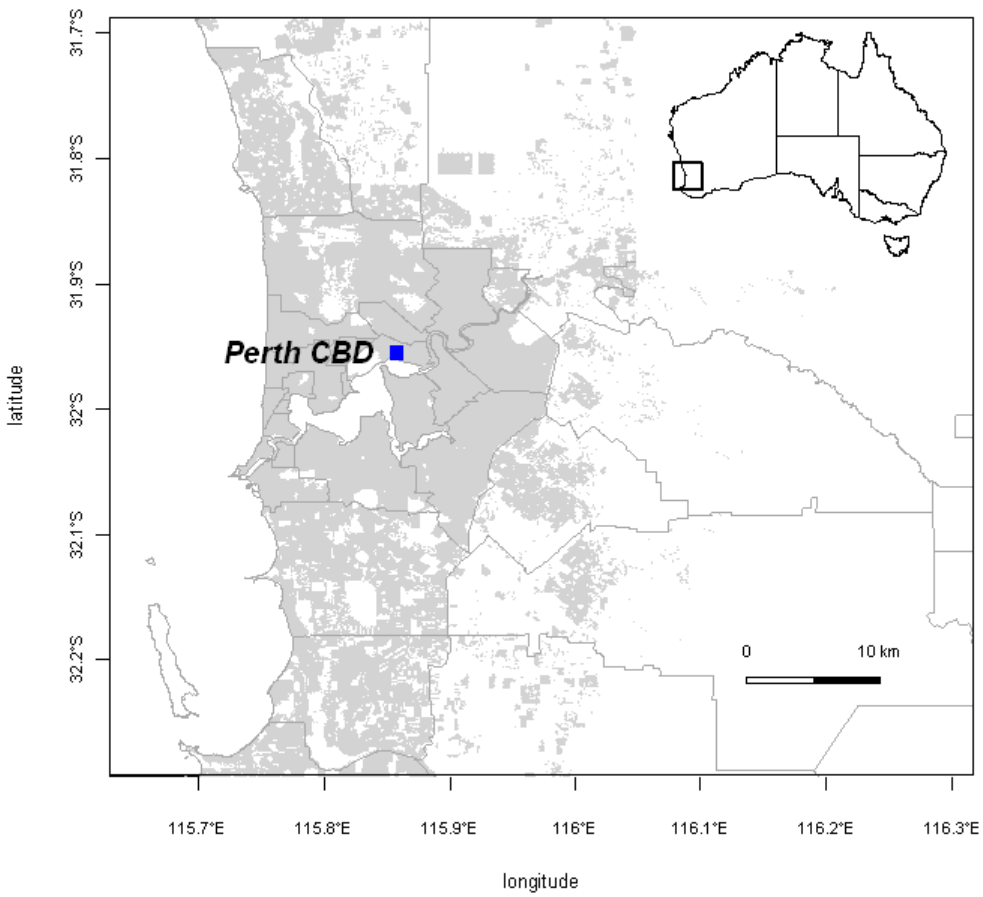

Figure 1. Study area of south western Western Australia showing the Perth Central Business District (CBD) and boundaries of local government areas. Residential, industrial sites and coastal farm infrastructure are shaded. The city sits on a sandy coastal plain. It is separated from rural areas—which sit on a plateau to the east—by the Darling scarp running north-south at about 116.1°E.

3.3. Spatial and temporal distribution of targeted and passive finds

In this report we examine how successful the DAFWA surveillance program has been in preventing the European wasp from establishing in south west WA during six summers: 2005 to 2010 (we shall refer to each summer by a single year so that, for example, 2005 means the summer of 2004 to 2005). During this period, DAFWA entomologists have attributed each nest found to either the targeted or passive program. Here, we present the spatial and temporal distribution of nests partitioned by surveillance type.

The temporal sequence (Figure 2) shows the number of nests detected since June 2004 by month of year. As expected, peaks occur in the warmer months of the year and the plot shows that both the targeted and passive methods are responsible for detecting substantial numbers of nests (74 and 52 respectively). A small number of nests are detected by the follow-up lure trapping method (secondary passive, 11 nests). Single over-wintered nests (shown as asterisks) were recorded in September 2008 and December 2009. Over 1200 queens were found in the September 2008 nest, but—presumably because it was detected in spring prior to the release of the queens—it did not give rise to a major infestation in the 2009 summer.

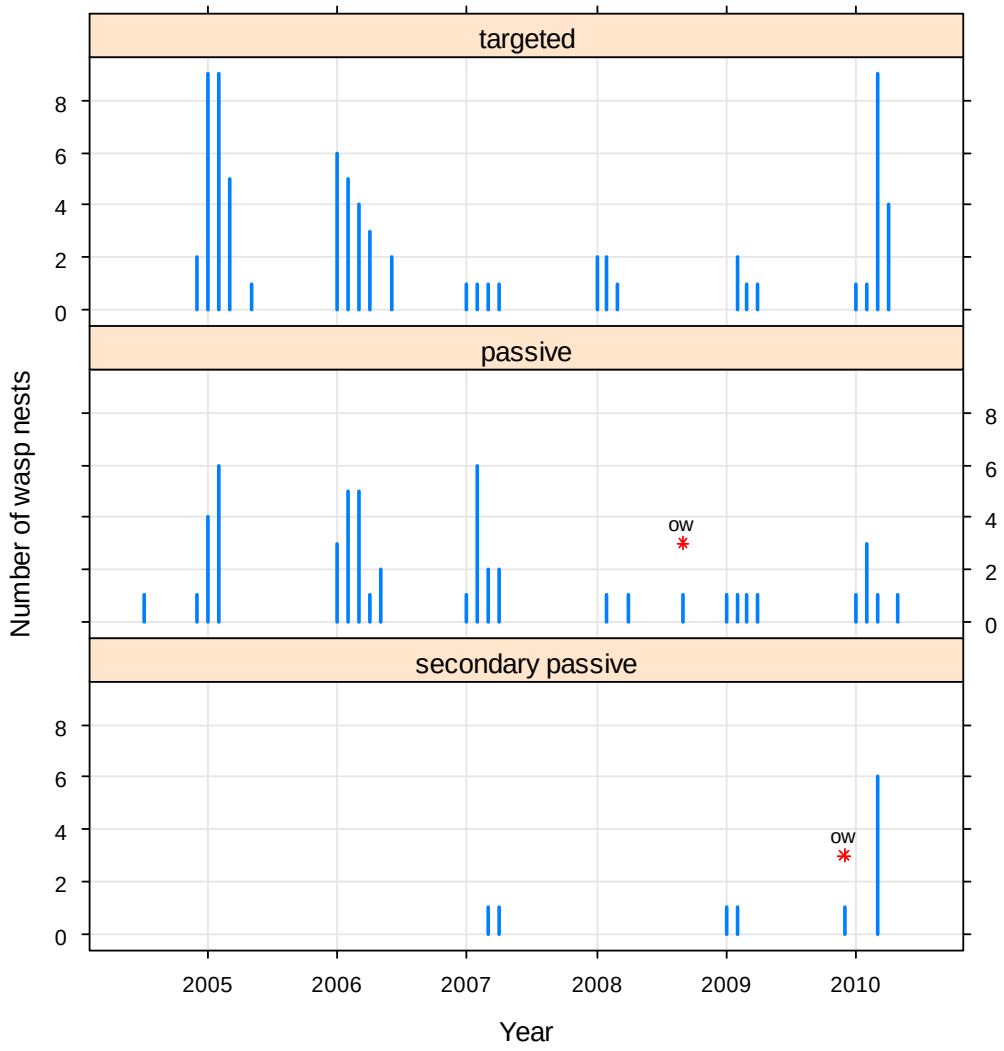

Figure 2. Monthly number of European wasp nests found in south west WA since June 2004, partitioned by surveillance method. Over-wintered nests were detected in September 2008 and December 2009 (asterisks). Tick marks are at January each year.

Figure 3 shows nest locations that have reliable geographical coordinates for the period of the study. The distribution of European wasp nests has expanded and contracted in different parts of the greater Perth metropolitan area during that period. The total number of nests found was higher in the first two study years (2005 and 2006), following a particularly bad year (2004), during which a large overwintered nest was discovered in the foothills of the Darling scarp (east-northeastern part of the map).

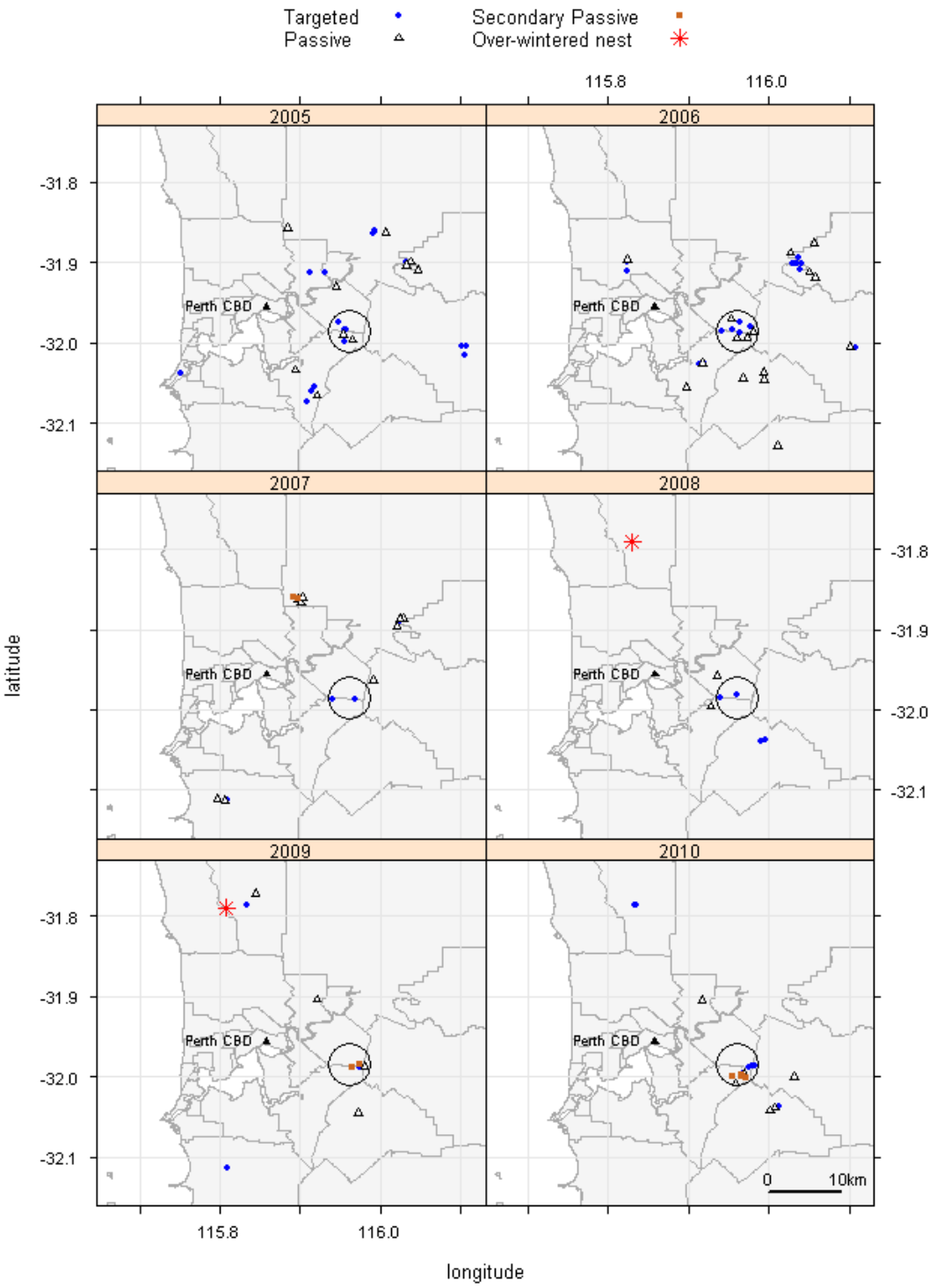

Figure 3. The distribution of European wasp nests found in the greater Perth metropolitan area south west WA since June 2004. An open circle in each map shows a 3 km radius of the Welshpool area, within which lure trapping frequently occurs.

For all years, concentrations of nests are evident within a 3 km radius of Welshpool, where freight and road transport depots and other large-lot industrial parcels occur, and trapping is carried out every year. However, the high number of nests found in that area is not

particularly clear because the nests are close together and the points on the map overlap. Figure 4 depicts the same data as a density map for the six year study period. It clearly shows a high density cluster near the Welshpool freight area and a lower density cluster at Darlington in the foothills of the Darling scarp (due mostly to finds in the 2005 and 2006 summers).

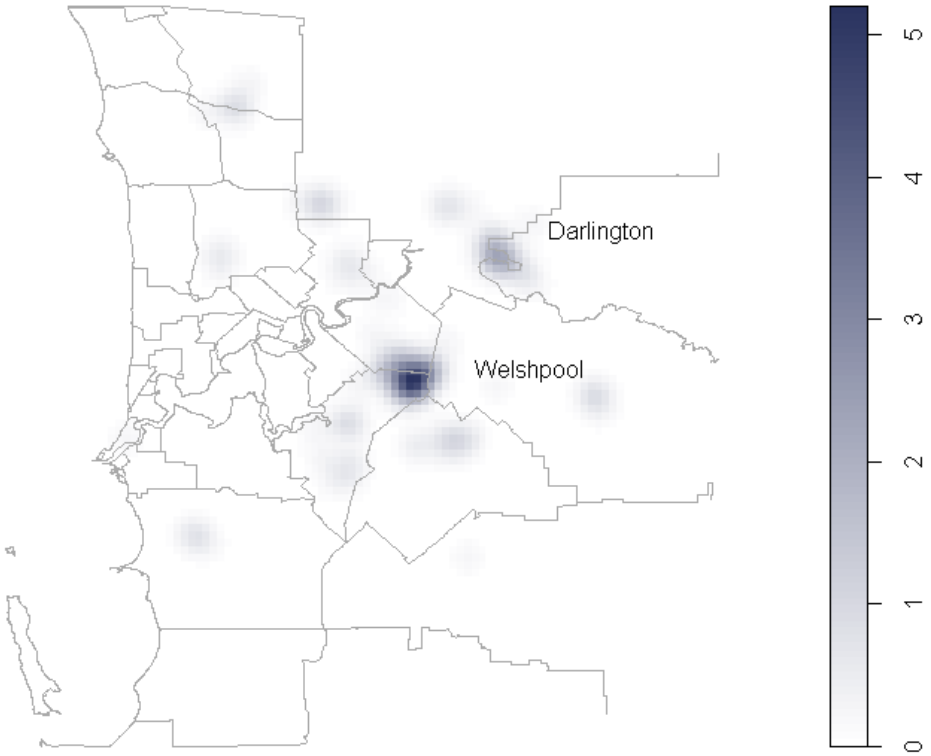

Figure 4. Density of European wasp nests (per square kilometer) found in WA since June 2004. Density was estimated using the R package spatstat *(Baddley and Turner 2005). An isotropic Gaussian kernel-smoother was used with a bandwidth of 1 km.*

3.4. Costs and benefits of the program

Costs

Estimating costs of the targeted program involves accounting for dedicated staff time. However, attributing costs to passive surveillance is difficult because it is conducted as part of a general service to rural and urban landholders. Baseline estimates of 'Passive costs' in Table 1 were derived by attributing approximately 8.5% of the annual salary and operating costs for PaDIS to the European wasp program (this proportion being the proportion of enquiries concerning wasps received by the PaDIS telephone system). The operating costs for PaDIS include educational programs and awareness raising, training of PaDIS staff, Information Technology and communications and other incidentals used by PaDIS. The

baseline estimates were added to the laboratory costs for entomologists—mainly for identification of specimens—to give an annual total of 'Passive costs' shown in Table 1. 'Targeted costs' were estimated by partitioning salary and operating costs for all 'wasp' activities carried out by DAFWA's Entomology Branch.

Table 1. Direct costs of the DAFWA European wasp program. Each financial year encompasses one summer period ("wasp summer").

Financial Year	"Wasp summer"	Passive costs ($)	No. nests	Cost per nest ($)	Targeted costs ($)	No. nests	Cost per nest ($)
2005-06	2006	18 518	16	1 157	28 363	20	1 418
2006-07	2007	24 240	13	1 865	32 252	4	8 063
2007-08	2008	21 370	2	10 685	31 525	5	6 305
2008-09	2009	26 768	7	3 824	32 258	4	8 065
2009-10	2010	25 676	13	1 975	33 364	15	2 224
Total		116 572	51	2 286	157 762	48	3 287

Neither the passive nor the targeted costs in Table 1 include additional costs for the treatment of European wasp nests and the laboratory analysis of the nests. This is because the focus of this report is on investigating the contribution that each type of surveillance method makes to the control of European wasps and these costs are not influenced by the surveillance method used to discover the nest. Nevertheless, an indicative estimate of control and analysis costs may be useful. These costs are directly related to the number of nests found in any one year. A generous allowance of 0.5 day per nest, and a salary cost of $100,000, yields a cost of $4,000 for the 16 'passive' nests, and $5,000 for the 20 'targeted' nests in the busy summer of 2006. Total costs for treatment and laboratory analysis in the 'quiet' years would be expected to be less, all else being equal, than this conservative estimate for 2006, although the cost per nest would increase in quiet years because of changes in the ratio of fixed and variable costs.

Benefits

The benefits of urban freedom from the deleterious effects of the European wasp are likely to be substantial although many, varied and difficult to quantify (Fowler 1983). In other countries, and other parts of Australia, European wasps have significant negative impacts on horticulture, apiculture, tourism and, particularly, outdoor social activities (Spradberry and Dvorak 2010). With the favourable climate—the nuisance value—which lasts just a few weeks in Europe (Spradberry and Dvorak 2010), is likely to last many months in Perth and other coastal parts of south west WA. In the United States northwest, foraging wasps spoil fruit and can intimidate pickers and grape growers (Spradberry and Dvorak 2010). These impacts may be cause for concern: Perth's adjacent Swan Valley has many wineries and vineyards. A surveillance program similar to the one implemented in WA could be employed

in other Australian states. However, the spatial extent of the existing distribution in the eastern states means the program would require substantial initial cost to reduce infestations down to manageable levels.

3.5. Discussion

Both the historical eradications from rural areas and the evidence presented here for 2005–2010 shows that DAFWA has a highly successful program. The rarity of overwintered nests—despite the ease with which the wasps survive Perth's mild winters—suggests that almost all nests are discovered every year and destroyed.

Both the pattern over time and the geographical spread of the recorded nests support the assumption of high public responsiveness: if public engagement was moderate to low an exponential rate of wasp abundance would be expected from uncontrolled over-wintering nests. There is no indication of an exponential increase in Figure 2 and no sustained radial growth is evident from the maps (Figures 3 and 4).

The targeted and passive programs are complementary. Targeted surveillance using baited traps is cost-effective in industrial areas for two reasons. First, alternative food resources are rare and so wasps are attracted to baits. Second, there are not many barbeques or picnics in such areas, so reporting via the passive surveillance system is less likely.

In areas where there are people and picnics, passive reporting is most efficient. Although the chance that an individual will report wasps is probably low, there are many eyes in a city, so collectively, the likelihood that a nest will be reported is high. The geographical extent of the passive network is also much greater than the coverage achievable using traps from the targeted approach.

All but two of the nests depicted in Figure 3 were judged by entomologists as being 'new'—meaning that they were established and detected within a single spring/summer. The sparse spatial distribution depicted in Figure 3, with a concentration around Welshpool, suggests that imported queens are responsible for most of these new nests; nests spawned by local queens would have a strongly clustered distribution. Direct observation of a single hibernating queen in imported freight is highly unlikely and yet several have been found in the Welshpool area. It is therefore reasonable to conclude that many queens are imported annually and that some survive to seed new nests. As long as European wasps are not efficiently controlled elsewhere, and Perth continues to receive freight, a constant trickle of new infestations can be expected and the city is never likely to be completely free of wasps.

Containment however, is feasible, but must be vigorously pursued. Although wasp control activities are concentrated in the Perth summer and distributed across many DAFWA staff, they constitute less than one full-time salary per year for the period 2005–2010; noting a formal cost-benefit analysis was considered beyond the scope of this work.

Our arguments are strengthened by recent experience. After the data for this study was analysed, the DAFWA wasp program temporarily ceased and there is now (April 2011) a large infestation in Perth, much of it centred near a single overwintered nest discovered south-west of Welshpool in the City of Gosnells (within Perth's greater metropolitan area). More than 65 nests have been found in 2011, and a concerted and relatively expensive

effort is underway to find all nests before the 2011 winter—prior to the release of new queens. Despite the current effort, there is an increased probability of nests surviving undetected and releasing queens increasing the importance of a heightened surveillance system over the coming spring/summer season if the outbreak is to be contained.

3.6. References

Davis, PR and PL Wilson (1991) *Report on European Wasps in Western Australia with Special Reference to the 1990–91 Season*. Department of Agriculture, Western Australia.

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4. Implications for stakeholders

Passive surveillance programs are sometimes difficult to evaluate. Here, we have shown that a passive surveillance program can augment a targeted program, and ensure that (almost) all pests are found within a targeted area. The dual-approach of the program in WA also demonstrates the value of early intervention in pest control activities to reduce labour and keep costs down.

Administration by a single authority seems to be a key component of the success of the European wasp program. DAFWA entomologists target surveillance to recent and historical hot spots, and modify surveillance according to a range of local conditions. If the program is to be run by local councils, they will need to coordinate their public awareness programs and liaise with one another to choose lure sites. A wasp program requires some specialist entomological services, and it might be difficult to justify employment of an entomologist for each of several authorities; in DAFWA, the costs associated with employing entomologists are distributed across a range of programs—targeting both urban and rural pests.

The maps and time series shown here were produced after processing the raw data. The data have been kept by DAFWA in a variety of formats over the 30 year history of the European wasp program. Our computer programs converted dates, times and locations into consistent formats so that the data could be mapped and plotted. Geolocation was crucial. Most nest sites had been identified by street address—though some had been recorded with a GPS device (Global Positioning System)—and it was necessary to convert street addresses to longitudes and latitudes for mapping. The consistent use of GPS devices would speed the analysis of important data sets such as this one.

5. Abbreviations/glossary

ABBREVIATION	FULL TITLE
CRCNPB	Cooperative Research Centre for National Plant Biosecurity
EPP	Emergency plant pest
DAFWA	Department of Agriculture and Food of Western Australia
PaDIS	Pest and Disease Information Service
CBD	Central Business District
GPS	Global Positioning System
DAFF	Department of Agriculture, Fisheries and Forestry

6. Plain English website summary

The lead author of this report works for the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). Any summary of findings for the CRCNPB must be approved by the Executive Director of ABARES.

CRC project no:	CRC 30133
Project title:	Urban surveillance for EPPs
Project leader:	Greg Hood, ABARES
Project team:	Philip Tennant, Peter Davis, Marc Widmer and Greg Hood
Research outcomes:	This project looked at the contribution that passive and targeted (or active) surveillance can make to the on-ground management of Emergency Plant Pests (EPPs). EPPs can become established in urban areas and spread to nearby horticultural or agricultural districts. Surveillance for EPPs in urban areas is an important element of any system that aims to prevent the establishment of pests in rural and agricultural areas. The benefits of a combined program of targeted and passive surveillance for an EPP was investigated. A combination of targeted and passive surveillance has kept the European wasp—a major pest of urban areas and horticulture in south-eastern Australia—from establishing a viable population in Western Australia for the last 30 years. Targeted surveillance using lures and passive approaches relying on public reporting are complementary techniques that can prevent establishment and spread of European wasps.
Research implications:	This project illustrated that a multi-pronged surveillance approach may be needed to control the spread of EPPs—in this case study, infestations of the European Wasp in Western Australia (WA). For more than 30 years the Department of

	Agriculture and Food of Western Australia (DAFWA) has been using a combination of passive and targeted surveillance techniques to detect and then destroy wasp nests to control the European wasp. A major challenge for the surveillance program is that if a nest is missed during one summer it may overwinter allowing the release of new queens. The population of wasps and their colonies can therefore exhibit explosive growth within a single summer. Additionally, with hibernating wasp queens being continually imported into WA from rail or road transport freight there is an ongoing need for this cost effective surveillance program to continue. Standard use of GPS devices (in Personal Digital Assistants or other hardware) would reduce the time required for data cleaning and manipulation and facilitate faster, more prompt analysis of surveillance data sets.
Research publications:	TBA
Acknowledgements:	Thanks to Darryl Hardie and Fred Ramsden from DAFWA and the staff from the Pest and Disease Information Service (PaDIS).