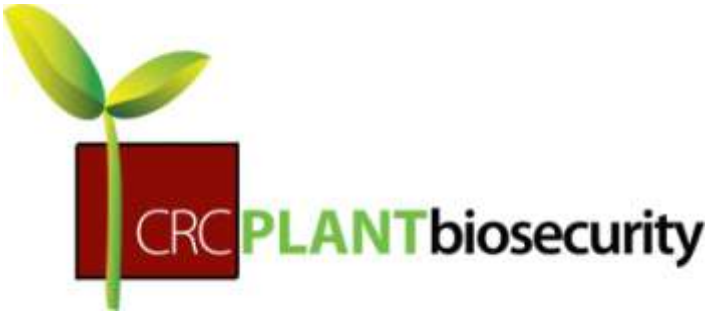


Cooperative Research Centre
for National Plant Biosecurity

Final Report

CRC30039

Trapping to prove area freedom (Fruit fly trapping project)

WA
Dr C.P. Francis De Lima
Ms Shirani Poogoda
SA
Dr Catherine Smallridge
Mr Adam Caldwell

NSW
Dr Olivia Reynolds
Vincent van der Rijt
Scott Clark
Beverley Orchard

March 2011

Project Leader contact details:
Name: Dr CPF De Lima
Address: Department of Agriculture and Food Western Australia, 3 Baron-Hay Court, South Perth, WA 6151

Phone: (08) 9368 3587
Fax: (08) 9368 2958
Email: francis.delima@agric.wa.gov.au

CRCNPB contact details:
Cooperative Research Centre for National Plant Biosecurity
LPO Box 5012
Bruce ACT 5012
Phone: +61 (0)2 6201 2882
Fax: +61 (0)2 6201 5067
Email: info@crcplantbiosecurity.com.au
Web: www.crcplantbiosecurity.com.au

Table of contents

1. Executive summary

Fruit fly area freedom is vital for market access. Since 1990 it has been managed through codes of practice under national and international agreements. The standard practice is based on the deployment of static trapping grids covering orchards, towns and urban areas. The grids are relatively effective when numbers are high, but are an inefficient strategy to detect early fruit fly incursions and are becoming increasingly expensive to deploy and maintain due to the prescribed fixed distances between traps. It is also clear that many traps are currently placed in unsuitable environments for fruit flies to satisfy trap spacing regulations leading to delays in detecting incursions and requiring more expensive eradication efforts.

To better manage fruit fly incursions an improved trapping system is required. This system will deliver a cost effective return on investment while minimising the number of undetected incursions which lead to breeding populations and loss of market access in affected areas for many months or years. The challenge for this project is to develop a science based rationale that will optimise trap placement for the detection of fruit fly and take into account the differing matrices of abiotic and biotic factors that are found within Australia, while giving confidence in the effectiveness of surveillance.

Research was conducted in WA and NSW to determine if new methods termed 'dynamic trapping' would provide an equivalent proof of area freedom at lower cost. The standard trapping method where traps are placed in a grid system 0.4 - 1km apart (static trapping), was tested against a method of strategic trap deployment (dynamic trapping) in hosts at the time when they are most attractive to fruit flies (i.e. when hosts held mature fruit).

The strategy utilised two data types: (1) Trap data was collected over three seasons from fruit fly free areas: free (near 0 flies/trap/fortnight), very low (<2 flies/trap/fortnight) and low (>2 flies/trap/fortnight) for Mediterranean fruit fly (MFF), *Ceratitis capitata* (Wiedemann) in WA; and areas of low numbers (>2 flies/trap/fortnight) in endemic areas for Queensland fruit fly (QFF) *Bactrocera tryoni* (Froggatt) in NSW. (2) Recent historical data from fruit fly free zones in SA was analysed and examined to determine whether there were any factors common to outbreak situations. All trial sites were spatially mapped for host species.

With Mediterranean fruit fly, dynamic trapping methods deploying traps in the most attractive hosts detected fruit fly infestations earlier than static traps in Donnybrook (low fly numbers). The dynamic trapping method required one-third to one-half the number of traps used in a static grid to obtain the equivalent information on detecting itinerant or established fly numbers required for the fruit fly code of practice. This result was consistent over the three seasons with variable population levels. In areas with very low and zero fly density (Manjimup, Pemberton) and in Kununurra with zero fly density, there was no difference in fly detection between the static and dynamic trapping methods.

With Queensland fruit fly, results were variable and inconclusive in three areas (Cootamundra, Junee and Gundagai) which had fly densities >2 flies/trap/fortnight. Similarly, the data for the Tumut orchard was limited and it was difficult to draw any conclusions. In Ganmain, a town of low fruit fly density, dynamic traps were more effective than static traps in capturing *B. tryoni*, in terms of both proportion of traps which detected flies and proportion of flies caught in traps.

Historical South Australian data relating to Mediterranean and Queensland fruit fly detections were combined with modern spatial data with a view to improving the trapping processes. To demonstrate area freedom in Adelaide, a grid of more than 3000 trapping sites is maintained for both Queensland and Mediterranean fruit fly. As new suburbs are developed, the cost associated with maintaining the increasing size of the trapping grid escalates. Although the trapping grid extends across all settled areas, the suitability of environmental patches for fruit fly establishment is likely to vary significantly among those areas. New housing developments have smaller garden areas compared with older established suburbs, and commercial or industrial areas have different vegetation patterns compared with residential areas. The results of this study indicated that, outbreaks (the establishment of breeding populations)

occurred where the immediate surroundings of the property with the trap were characterised by a low proportion of fruit-tree free properties, and a higher proportion of properties with moderate fruit tree densities. The results also showed that while historical data-sets present some problems relating to data consistency among locations, future detection data could be digitised and added to the data-set to expand and improve the analysis. This research has the potential to identify areas of low fruit fly establishment potential where trapping effort could be reduced, thereby saving on monitoring costs in some parts of designated fruit fly free areas.

In conclusion, the project demonstrates that dynamic trapping which targets the hosts most likely to attract fruit flies can considerably reduce monitoring costs. The use of data mining with digital mapping also enables placement of traps in areas attractive to fruit flies thus reducing monitoring costs and ensuring early detection. Early detection reduces the likelihood of establishment of breeding populations and hence reduces costs of eradication.

2.Aims and objectives

Fruit fly species attack a wide range of fruits and vegetables with major impacts on the sustainability of Australia's horticultural industry and market access. Domestic and international markets for fruit fly susceptible crops are estimated to have an average annual value of $4.8 billion in Australia, 25% of which is traded interstate. The average export value of fruit fly susceptible crops is nearly $500 million (National Fruit fly Strategy Action Plan 2010).

Fruit growing regions along the River Murray in South Australia, Victoria and New South Wales as well as the Ord River Irrigation Area in Western Australia are recognised as free from pest fruit flies in Australia and overseas (Sutherst *et al*. 2000; Jessup *et al*. 2007). Growers within these areas can market their produce without pre-harvest or postharvest treatments thereby enjoying considerable cost savings. Where an area is accepted as fruit fly free, continuous monitoring is required to prove that the area remains free of the pest species and for the prompt detection and reporting of invading species as required by national and international protocols (MCOP 2006, QCOP 1996; FAO 1999). Phytosanitary strategies to prevent and detect potentially infested product entering fruit fly free areas and border control measures are enforced (Smith 2000).

Area freedom from fruit flies is based on maintaining several thousand traps in horticultural production areas and adjacent urban zones to monitor for incursions of Mediterranean and Queensland fruit flies and other economic native and exotic species. Currently traps are placed in a grid system (0.4 - 1km apart) and are examined throughout the year - weekly in warmer months and fortnightly in winter. This highly intensive system is very expensive to maintain with the majority of traps returning zero records. While nil records are highly desirable, the grid system is cumbersome, expensive and not accurate although it is the best we have based on current knowledge. Many traps are placed in unattractive hosts because the grid system forces the placement at specified distances. Traps are often not in fruiting hosts for most of the year. Codes of Practice are in place to manage loss of area freedom where there are incursions. Supplementary traps are placed to delineate an outbreak area when flies are detected above the predefined threshold. For example, when a single male fly is found in horticultural area that has traps at 1km intervals, supplementary traps or traps deployed at 400m intervals can be used for further detections. Area freedom is lost when three male Medfly or five male Qfly are found within a fortnight in 1 sq. km area or when one gravid female or one larva is found in a fruit (QCOP 1996, MCOP 2006, Meats and Clift 2005; Jessup *et al.* 2007). The trapping grid in Adelaide commenced in 1960 (Maezler 1990a) and currently number more than 3,500 traps to maintain area freedom (Smith 2000). In Western Australia currently, a trap grid is maintained to detect Qfly and other exotic fruit flies in main metropolitan areas while in the Ord River Irrigation Area (ORIA) trap grids are maintained for Medfly and for species attracted to cue-lure and methyl eugenol.

Australia also has a national trapping grid that covers major ports; these traps are administered by state and territory governments. Such grids also act as early warning systems. More than 25,000 cue-lure, methyl eugenol and capilure traps have been deployed throughout Australia for fruit fly monitoring (Smith 2000). The cost of maintaining these national grids exceeds $12 million annually and is difficult to sustain under shrinking government budgets. With the standard grid, many traps are placed in unattractive hosts because the grid system forces placement at specified distances and traps are often not in fruiting hosts for most of the year. While nil results are highly desirable, inefficiency of the trapping grid can result in delays in detecting incursions. Such delays can lead to establishment of breeding populations which in turn increase time required for their eradication and may increase period of loss of market access by months or years. In the absence of more cost effective methods, future maintenance of area freedom will become prohibitively expensive and potentially be limited to high value crops. In ecological studies done on fruit flies in the south west of WA, De Lima (1998) found that a subset of traps strategically located throughout the year based on climate and host phenology gave the same information on Medfly populations as a fixed trap grid.

This project was conducted over three seasons from 2007 to 2010 to develop methods of reducing costs while maintaining high monitoring efficiency. The strategy was to deploy traps in hosts at the time when

they are most attractive to fruit flies, with the aim of reducing monitoring costs while gaining in efficiency in early detection of the incursive population. The outcome of this project is expected to provide the scientific basis for early detection and eradication of fruit fly populations and therefore more effectively manage area freedom for market access.

3. (a) Key findings. Part One: WA

METHODS & MATERIALS

To test and prove the effectiveness of new methods trial traps were deployed in areas free from Medfly and in areas of low fly density in order to assess effectiveness as an early warning system since detection of two flies/fortnight within a 1sq. km area triggers deployment of supplementary traps in pest free areas (MCOP 2006).

Selection of experimental areas

Experimental areas were selected for trial sites on the basis of fly density (>2, <2 and near 0, flies/trap/fortnight), non-application of chemical treatments for fruit fly control, availability of a range of fruits and access to the site.

Four areas were selected: Donnybrook (33°S, 115°E; 180 km south of Perth), Manjimup (34°S, 116°E; 260 km south of Perth), Pemberton (34°S, 116°E; 280 km south of Perth) and Kununurra (15°S, 128°E; 2220 km north east of Perth). Capilure baited Lynfield traps were used to establish fly densities in southwest towns in a preliminary survey. These areas were known to have Medfly infestations from previous studies. Based on preliminary survey data (Appendix A) fly density in the area surrounding the town centres were found to be as follows: Donnybrook >2 flies/trap/fortnight, Manjimup <2 flies/trap/fortnight and Pemberton near 0 flies/trap/fortnight.

The Ord River Irrigation Area (ORIA) is a Fruit fly exclusion zone (FFEZ) with a trap grid in place for the verification of Area freedom. The grid has a spacing of 400m in the urban area and 1km in the horticultural areas around Kununurra. Besides trapping for Medfly (capilure) the grid has traps for species that respond to cue lure and methyl eugenol. There is a total of 94 capilure traps in this grid, 24 of which are in the town. The static grid utilises fruiting hosts where possible but traps are also placed in other broad-leafed evergreen trees in all high visitor traffic areas such as caravan parks and hotels.

For the deployment of traps, trees with a larger fruit volume and/or canopy were given preference as these were indicated to be better sites for lek formation (Hendrichs and Hendrichs 1990). Traps were placed 1.5-2m high and ~50cm into the canopy.

Town Monitoring

In two southwest towns (Donnybrook and Manjimup) fruit fly populations were monitored in towns throughout the trial period using male and female traps. These indicated the numbers possible in each area when populations were well established and acted as indicators of presence of fly populations. As fly numbers were zero or near zero in Pemberton, the trial trap grid was placed over the town and there were no specifically designated town traps. In Kununurra the existing static grid was used for monitoring the town population.

Orchard trials

Trial traps were set up in a variety of orchards to provide a wide range of conditions to test the two monitoring methods. Some trial sites were large commercial orchards, others were smaller home orchards, some isolated and some with larger orchards in the surrounding area. Trap sites, contained a pair of static and dynamic traps each.

In each area a number of trial sites were chosen based on the selection criteria. Descriptions of sites are given in Appendix B. All trap sites are indicated in maps for each area (Appendix C).

Deployment of traps to compare methods

Static method

Traps were deployed to satisfy the Medfly code of practice (MCOP 2006). Two criteria were important in the selection of hosts for static traps, a distance of at least 400m from the nearest static trap and in an attractive host. Static traps were placed to maintain 25-50m distance from the trees where the dynamic trap was likely to be placed through the year. The choice of host was evergreen fruiting tree, followed by deciduous fruiting tree. Where neither type was found within the required distance, the static trap was placed in a non-host tree. Static traps were moved at some sites if there was an issue with the attractiveness/health of the host or in the review process in an attempt to provide it with a better host.

Dynamic method

The main criterion was to maximise trap efficiency. Traps were placed in most attractive hosts available at the time. Traps were placed in hosts with ripe fruit in preference to trees with unripe fruit. Where more than one type of host with ripe fruit was available at a given time, the type used was that known to be preferred from previous studies. That is, stone fruit was given preference to pome fruit followed by other fruit. For the selection of hosts for dynamic traps where there was no ripe fruit on trees but there was fruit on the ground under trees and green fruit on other trees were still small, traps were left on the previous host until there was mature fruit available. At times there were no fruit available and the trap remained on the previous host until a more suitable host was available. In autumn/winter a majority of traps were moved to citrus as these were the only hosts with fruit and because they were indicated to be overwintering sites from previous studies (De Lima 1998) and a preferred host for lek formation and mating (Hendrichs and Hendrichs 1990; Whittier *et al*. 1992).

Traps and Lures

The male trap used was a locally made Lynfield trap (Cowley *et al.* 2002). The modified version used in WA (Wijesuriya and De Lima 1995; Broughton and De Lima 2002) consists of a one litre clear plastic jar (10cm diameter, 12.4cm high) with an opaque white screw-on lid. Four 2.5 cm diameter entry holes are placed equidistant around the trap 5cm below the top of the jar. The male lure consisted of two cotton dental rolls in a large paper clip loaded with 3ml of Capilure. A 1 cm^2 DDVP pest strip (Killmaster®) was placed in the bottom of the trap as the killing agent.

The female trap Suterra/Chempac Bucket trap (Agrisense/Suterra) used is similar to the Tephri trap (Broughton and De Lima 2002). It consists of a white opaque lid 5.5cm, that fits into a yellow bucket shaped invaginated bottom 12cm high. Assembled the trap is 16.4cm in height and is 14cm in diameter at its widest point. Three 2cm diameter entry holes are placed equidistant around the trap 5.5cm from the top of the trap. There are clear plastic valves inside the entry holes intended to reduce exit of flies that enter. This trap was used with three component Biolure attached to internal walls with a 1cm^2 DDVP pest strip (Killmaster®) placed in the bottom of the trap as the killing agent. This trap used with Biolure proved to be more effective than the plastic McPhail trap in cage studies (unpublished data).

All lures and DDVP pest strips were replaced three monthly throughout the three year trial period. Traps were replaced as needed.

Hosts

Host mapping: Hosts in a 200m radius around each site trap pair was recorded and categorised into groups <6, < 30, <100 and >100. Only hosts larger than 1m were counted and host height was recorded as <2m, <3m or >3m.

Host phenology: Phenology of fruiting hosts around the static/dynamic trap pair (approx. 100m) was recorded at each trap check. Host status was categorised by the number of fruit on hosts. Dimensions of the hosts were recorded when traps were placed and phenology of the hosts were recorded at each collection.

Trap recording periods

Records were made of fly numbers in traps weekly in spring/summer/autumn (October – June) and fortnightly in winter (July - September) in the southwest. Fly numbers were recorded weekly in Kununurra.

Climate records

Daily weather data was obtained for all locations from Bureau of meteorology Patched Point Data base records: Donnybrook 9534 (-33.5731, 115.8233), Kununurra 2056 (-15.7814, 128.710), Manjimup 9573 (-34.2556, 116.1428), Pemberton 9592 (-34.4494, 116.0428).

Statistical methods

For each region, analyses were carried out to compare the numbers of flies and the presence of flies in dynamic and static traps.

A generalized linear mixed model (GLMM) was used to compare the percentage of male traps with male flies present for dynamic and static traps. The fixed model included the effect of trap type, the effect of date of trapping and the interaction between these factors. When flies were trapped earlier in the season in dynamic traps compared to static traps there was a trap type x date interaction. The random model included an effect of site, assumed to have a normal distribution, an effect for traps within sites, also assumed to have a normal distribution, which effectively introduces a constant correlation between all dates, and residual errors, assumed to be binomial. Fixed effects were tested using a Wald statistic. In addition a GLMM was used to compare the percentage of traps with male flies for dynamic and static traps at each date of collection. Fixed and random models were as above except that date effects were excluded.

A linear mixed model (LMM) was used to compare the numbers of male flies in dynamic and static traps. Fly numbers were transformed using a logarithm, $\log_e(\text{count}+1)$, prior to analysis to ensure that the residuals have a normal distribution with common variance at each date. The fixed model included the effect of trap type, the effect of date of trapping and the interaction between these factors. The random model included effects for site and residual errors which were allowed to be correlated between adjacent dates and to have different variances at different dates. Where terms were not significant a simpler model was fitted. Fixed effects were tested using an F statistic. In addition a LMM was used to compare the numbers of male flies in dynamic and static traps at each date of collection. Fixed and random models were as above except that date effects were excluded. Analyses for comparison of trapping method only included data from the period over which flies were caught.
Dynamic traps were placed in different hosts at different times of the year as they were fruiting. As a result the effect of host is confounded with date of inspection. However some attempt was made to examine the effect of host on the performance of dynamic traps. The effect of host on male fly numbers was examined by fitting:

- a GLMM to the presence/absence of flies for each site and date of trapping. In the fixed model the effect of host was examined before and after fitting an overall effect for inspection date. The random model included an effect of site.
- an LMM similar to that described above to $\log_e(\text{count}+1)$. In the fixed model the effect of host was examined before and after fitting an overall effect for inspection date while the random model included effects for site and residual errors which were allowed to be correlated between adjacent dates and to have different variances at different dates.

Static traps were placed in a greater range of hosts in 2010. The number of traps which caught at least one fly over the season was tabulated for each host. Since there were only small numbers of traps in each host no further analysis was carried out.

RESULTS

Summary of trial sites in all study areas

Town monitoring (summer 2007 - winter 2010)

The number of traps deployed in each area varied during the study. Traps placed in the town centres are given in Table 1. Traps from the static grid in Kununurra were used to monitor the population in that area. The number of urban sites studied gives a good understanding of the population pressure or lack of it on orchards studied in each district.

Table 1: Number of traps in urban zones near study sites.

Study area	No. of male (M) and female (F) traps deployed each season		
	2007-08	2008-09	2009-10
Donnybrook	6F, 5M	5F, 5M	5F, 5M
Manjimup	3F, 5M	4F, 5M	4F, 5M
Kununurra	24 M	24 M	24 M

Orchard trial traps (summer 2007 - winter 2010)

Traps placed in orchards to investigate the efficiency of trapping method are given in Table 2. Male traps were deployed at 12 trial sites in southwest towns, with one static and one dynamic male trap at each site. Female traps were deployed at a further three sites in all areas with one static and one dynamic female trap at each site.

As the study progressed, some of the sites were discontinued due to a variety of reasons such as change of property ownership, irrigation issues leading to rundown orchards and owners reorganising orchards removing or pruning trees relevant to the study. Further suitable sites were added to the study where possible (Appendix D).

In Kununurra availability of a range of fruit for the dynamic trap limited trial sites available for trap deployment. Male traps were deployed at nine trial sites and female traps were deployed at three sites.

Table 2: Number of sites for orchard trials to test static and dynamic methods.

Study area	Trap type	No. of orchard trial sites each season		
		2007-08	2008-09	2009-10
Donnybrook	male	22	23	19
	female	5	4	3
Manjimup	male	14	13	12
	female	3	3	3
Pemberton	male	14	15	15
	female	3	3	3
Kununurra	male		9	9
	female		3	3

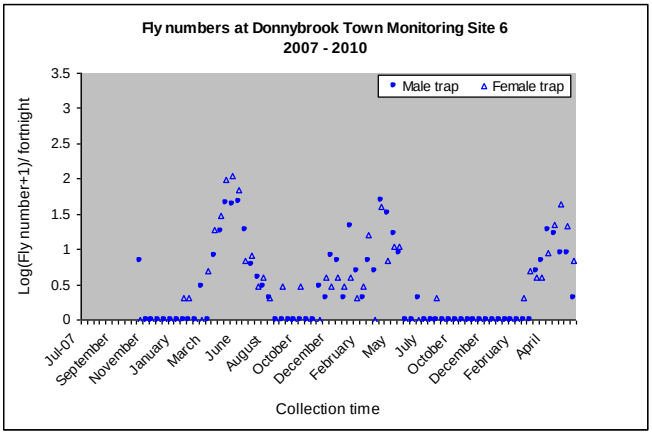
All trial trap placements, including trap placement periods in various hosts throughout the study, are listed in Appendix D for the four areas. Static trap hosts are listed in Tables 1a, 2a, 3a and 4a (Appendix D) and Dynamic trap hosts are listed in Tables 1b, 2b, 3b and 4b (Appendix D).

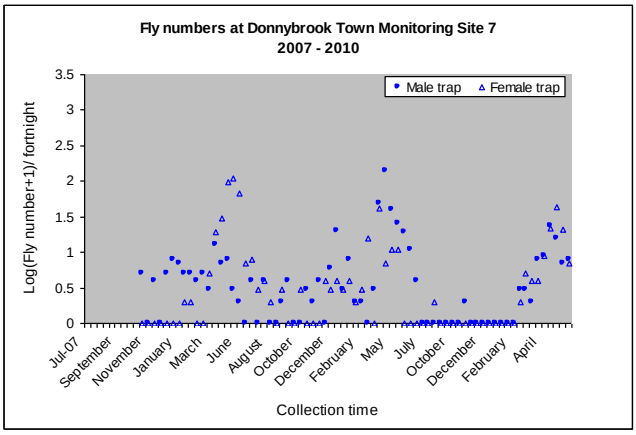
Donnybrook

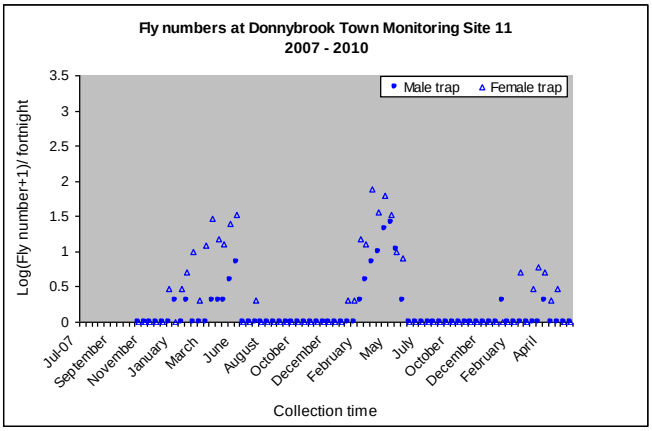
Town monitoring

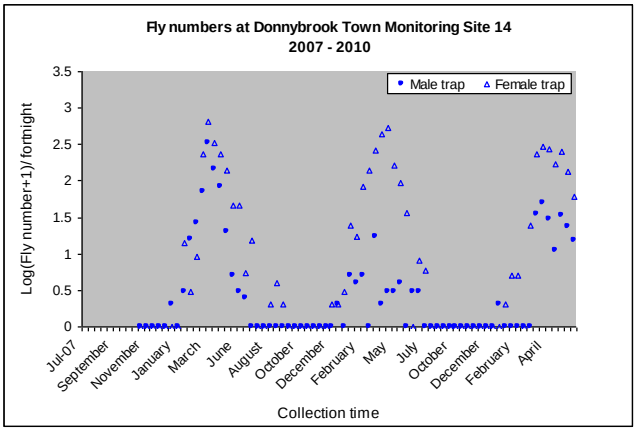
During the winter months, July-September, numbers were lower but were often above two per trap per fortnight at some sites (Figure 1, sites 6, 7). Highest numbers were recorded at most sites (>10 per fortnight) between March and June in all three years (Figure 1). This category was reached earlier and lasted longer at some sites in some seasons (Figure 1, sites 6, 7, 14 & 40).

Figure 1: Fly numbers at Town monitoring sites in Donnybrook









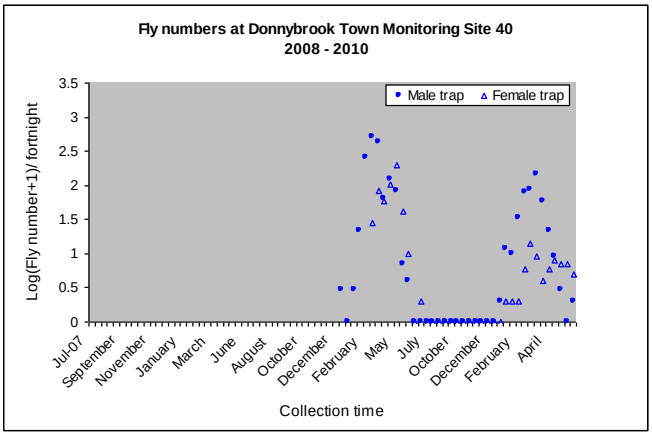


Figure 2: Fly numbers and hosts in which traps were placed at Donnybrook town monitoring site 6

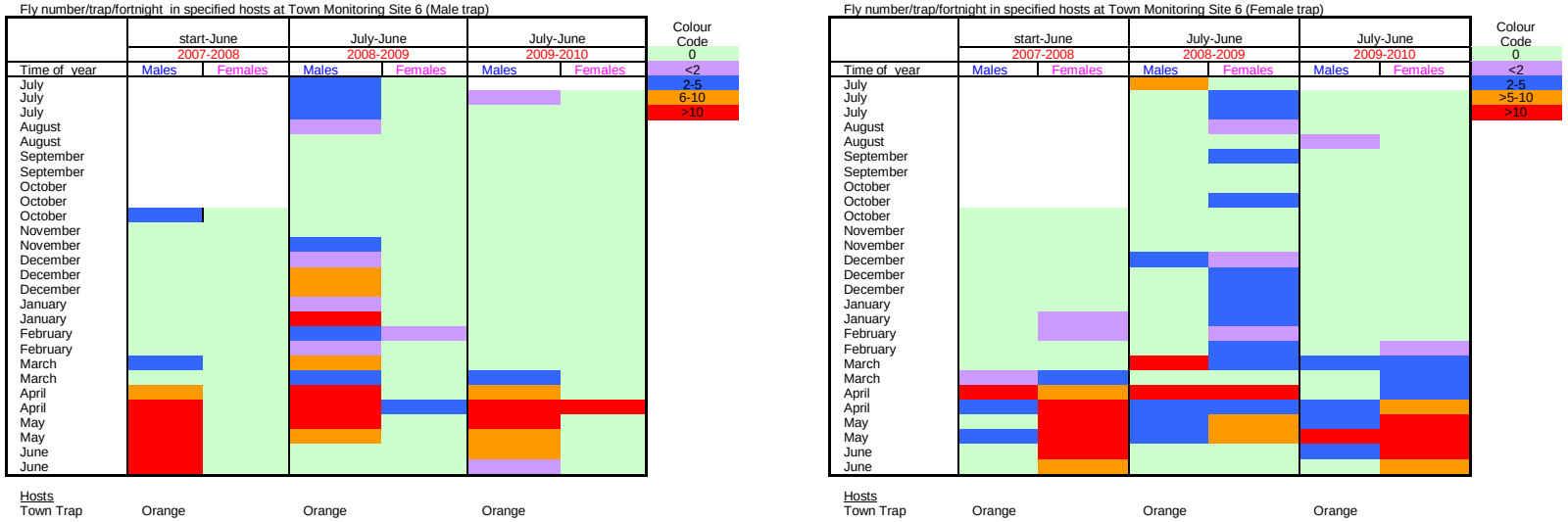


Figure 3: Fly numbers and hosts in which traps were placed at Donnybrook town monitoring site 7

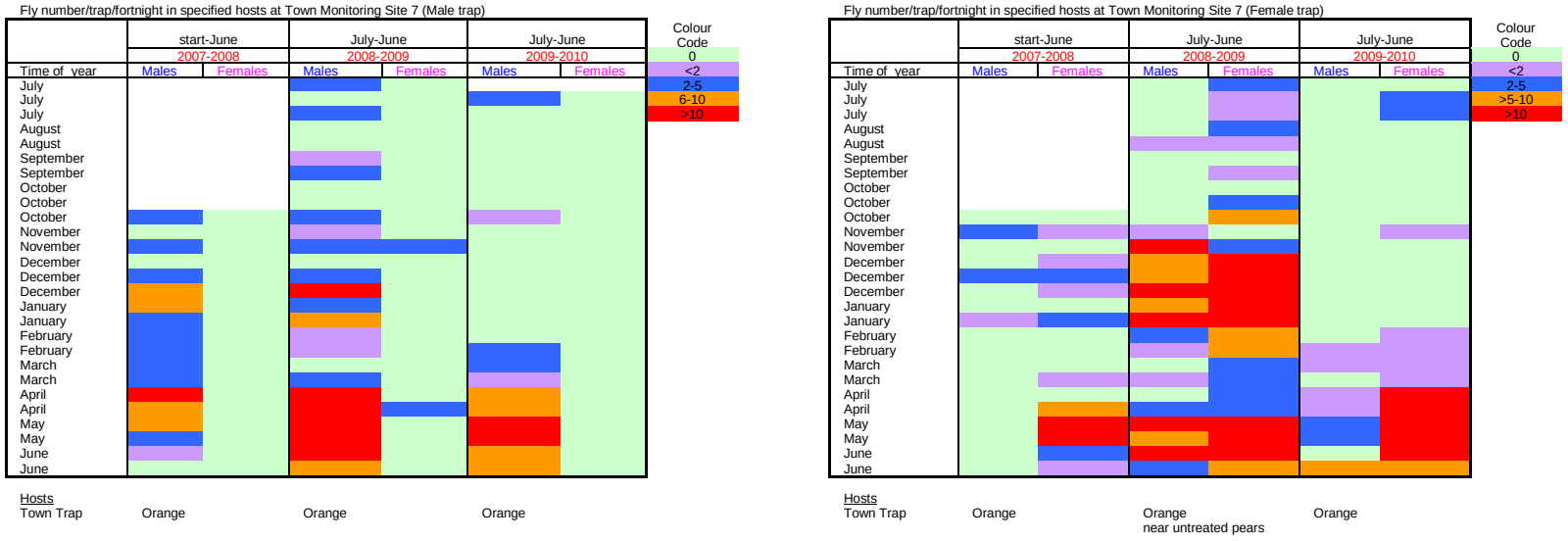


Figure 4: Fly numbers and hosts in which traps were placed at Donnybrook town monitoring site 11

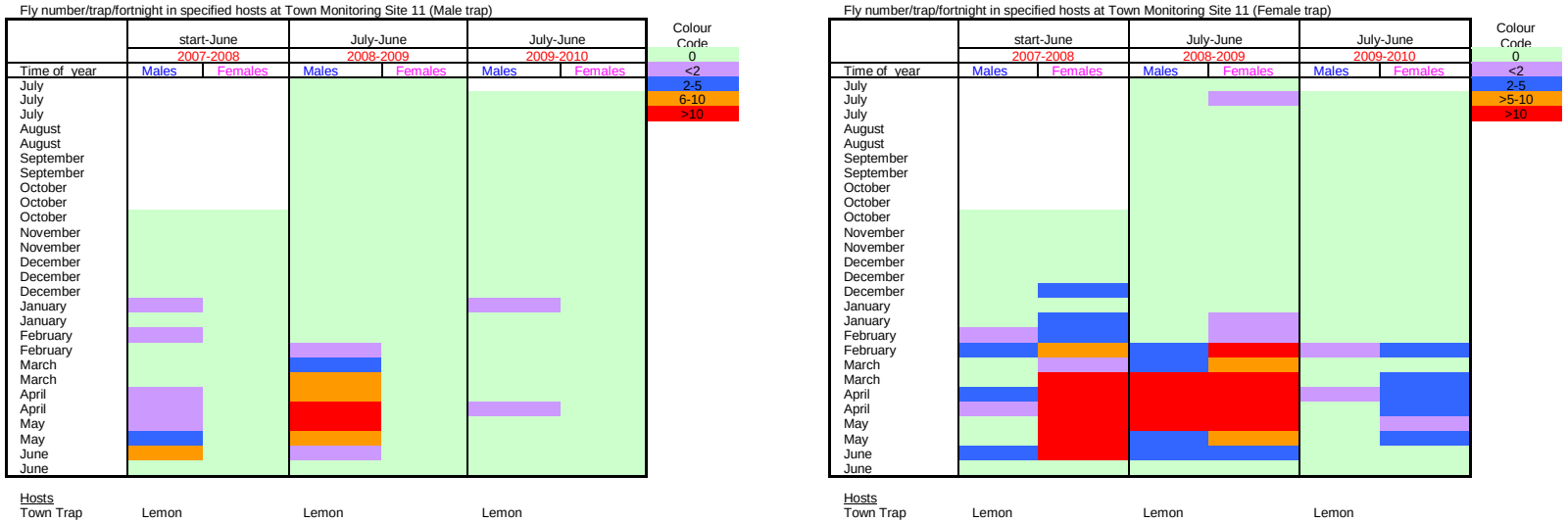


Figure 5: Fly numbers and hosts in which traps were placed at Donnybrook town monitoring site 14

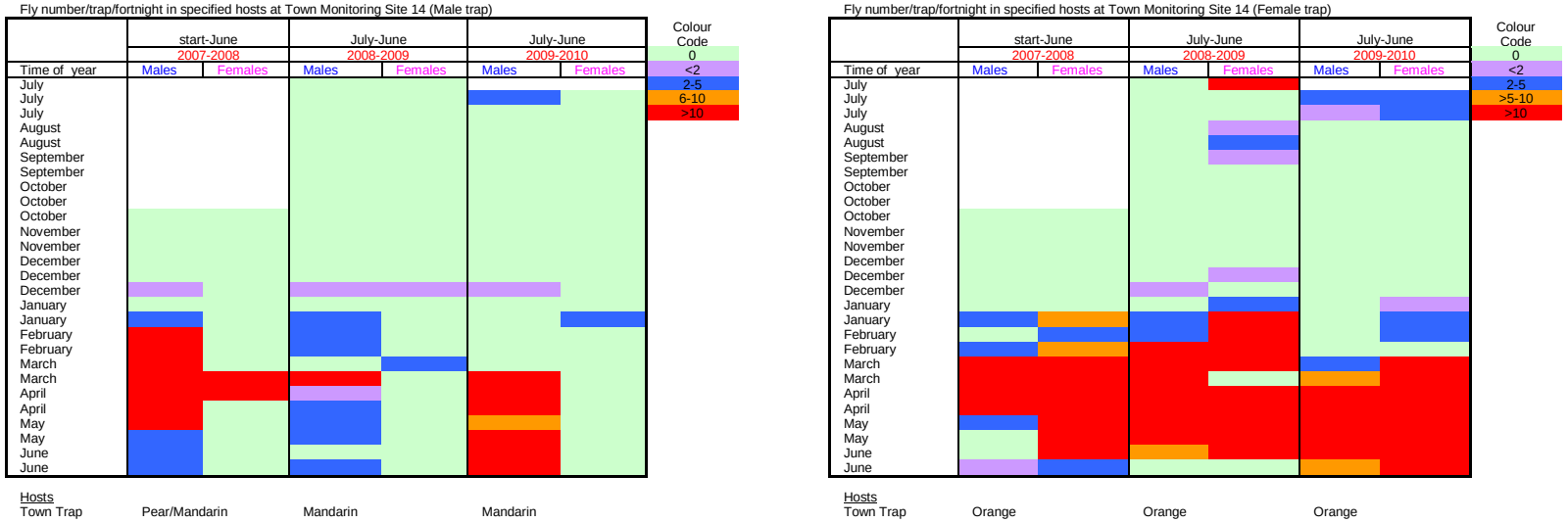
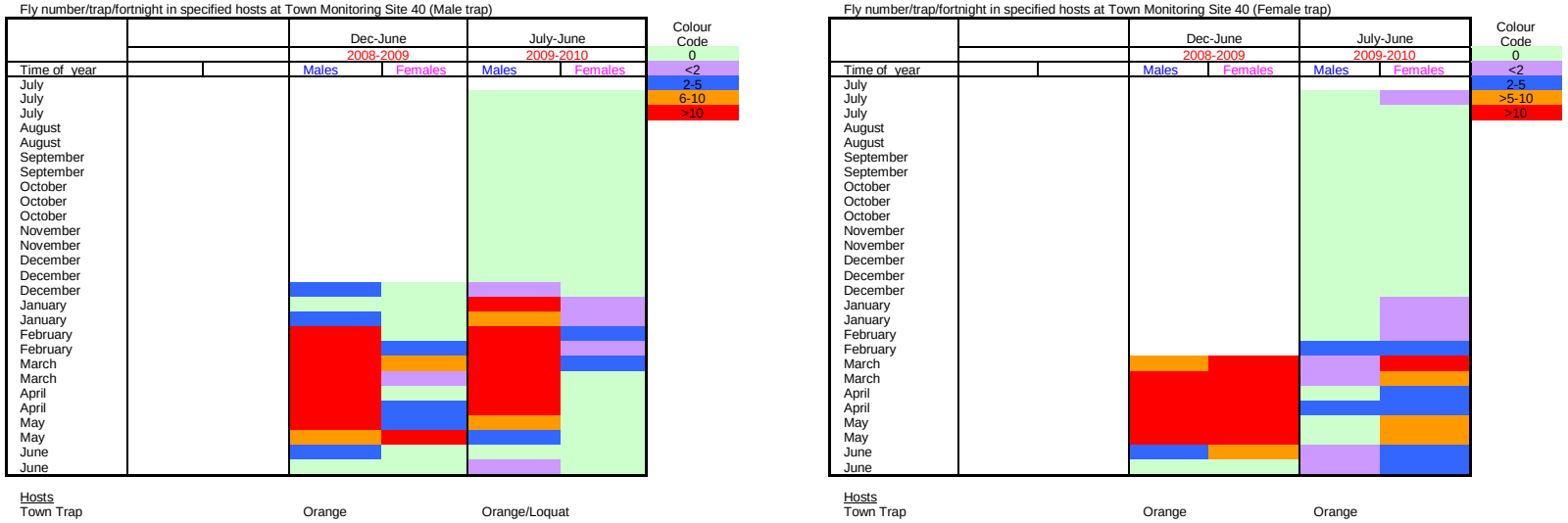


Figure 6: Fly numbers and hosts in which traps were placed at Donnybrook town monitoring site 40



Orchard trial sites

Time of fly capture: static vs dynamic traps

Flies were captured earlier and more frequently in dynamic traps than in static traps at a majority of sites in Donnybrook (Table 3).

In 2008, Dynamic traps captured flies (two or more per fortnight) four or more weeks earlier at seven sites; at two sites both traps captured flies in the same period and at two sites Static traps captured flies earlier than the Dynamic traps.

In 2009, Dynamic traps captured flies (two or more per fortnight) two or more weeks earlier at 14 sites and the Static trap at two sites; both traps triggered the threshold in the same period at four sites.

In 2010, Dynamic traps captured flies (two or more per fortnight) four or more weeks earlier at seven sites and the Static trap did not perform earlier at any site.

Table 3: Time lag in the fly capture by the Dynamic or Static trap at individual sites in Donnybrook

		Number of weeks the Dynamic trap captured two flies or more earlier than Static trap		
Site	Type of trap	2008	2009	2010
1	Male	>10	10	*nc*
2	Male	*nf*	*nf*	*nf*
10	Male	*nc*	Static 2 weeks earlier	*nc*
16	Male	>10	2	>10
18	Male	*nc*	4	>10
23	Male	0	2	8
24	Male	4	2	6
25	Male	8	4	>10
26	Male	4	6	*nf*
27	Male	4	0	4
29	Male	*nc*	>10	*nf*
30	Male	Static 4 weeks earlier	0	*nc*
31	Male	>10	2	
32	Male	Static >10 earlier	>10	*nf*
34	Male		2	*nc*
36	Male	0	2	*nc*
38	Male		>10	*nf*
39	Male		0	>10
21	Female	*nf*	Static 2 weeks earlier	*nf*
22	Female	*nc*	>10	*nf*
33	Female	*nf*	0	*nf*

nf = no flies; *nc* = not captured >2; = no traps at this site

The time lag between the capture of flies in Dynamic and Static traps over the three year period is shown in charts for individual sites at which flies were detected as follows. Earlier capture of two or more flies in the dynamic trap in one or more seasons as shown in Table 3 is evident in Figures at sites 1, 16, 18, 22,

23-29, 31-32, and 34-39. Earlier capture of flies in static traps is seen in Figures at site 10, 21, 30 and 32.

Higher numbers reached at sites where flies were breeding are seen in Figures at sites 16, 23-27, 31, 36/28, 39.

Host phenology and fly population at Donnybrook orchard sites

In Donnybrook large orchards consist of apples, pears, plums, peaches, nectarines, apricots, cherries and grapes. There are small areas of citrus. Within the stone and pome fruit orchards there are small numbers of other fruit trees such as loquats, figs, citrus and mulberry.

While generally the types of fruit in these orchards were similar, varieties and volumes varied. At some sites even though the trees were thriving, fruit set was low and what fruit that did set was taken by birds before ripening. Therefore, sites were categorised according to available fruit volume as well as size/type of the orchard (Table 4). Distance of each site from the town centre is also given. Traps in orchards closer to town captured flies more frequently and were more likely to have infestations where there was host material, unless orchard hygiene was maintained and fruit was harvested in a timely manner.

Frequency of capture at threshold levels

Eleven of the trial sites were non-breeding sites and ten were breeding sites (Table 4). The number of times that flies were captured in each category of fly density (ie: <2 per fortnight; 2-5 per fortnight, >10 per fortnight) is given for the three years of the study.

Over the three seasons, flies were captured in small numbers below the threshold level (< 2 flies per fortnight), between mid July and December. While there were several trial sites at which flies were breeding, flies started appearing in traps later in the year between January - March for example at sites 24-27 compared to a majority of the town trap sites where flies started appearing in traps between October - December (Site 6, 7, 11, 14, 40). Flies were captured at the threshold level from January onwards (Site 23-27). The highest numbers reached at orchard breeding sites (Figure 15-18) were not as high as those at Town sites (Figure 1).

Sites 21, 22 and 33 were small orchards which contained a pair of female traps. Numbers recorded at these sites were small (Figure 12, 13 and 23).

Table 4: Characteristics of orchards trial sites with non-breeding and breeding Medfly populations in Donnybrook

Key Small orchards Large orchards					Capture Frequency Total, Jan-June			Capture Frequency < 2 flies/trap/fortnight Jan-June			Capture Frequency 2-5 flies/trap/fortnight Jan-June			Capture Frequency 6-10 flies/trap/fortnight Jan-June			Capture Frequency >10 flies/trap/fortnight Jan-June		
Site	Type of trap	Fruit volume in 200 m	Distance from town centre	Breeding population	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
1	Male	Moderate/ mostly citrus	5-10	No	7	6	0	5	4		1	2					1		
2	Male	Low	5-10	No	0	0	0												
10	Male	High/ mostly citrus	2-5	No	2	5	1	2	2	1		2			1				
18	Male	Moderate	2-5	No	3	1	5	3		2		1	2			1			
29	Male	High (mostly cherry)	5-10	No	1	2	0	1	1			1							
32	Male	High	> 10	No	5	5	0	4	4		1	1							
34	Male	High	10	No		4	1			1		4							
38	Male	Low-Moderate	10	No		3	0		1			1		1					
18	Male	Moderate	2-5	No	3	1	5	3		2		1	2			1			
21	Female	Moderate	> 10	No	0	3	0		2			1							
22	Female	Low	> 10	No	1	6	0	1	4			1			1				
33	Female	Moderate	2-5	No		8	0		3			4			1				
23	Male	High	2-5	YES	10	14	12	3	2	3	5	5	5	1	2	3	1	5	1
24	Male	High	2-5	YES	15	13	12	1	3	3	1	5	7	3	1	1	10	4	1
25	Male	High	5-10	YES	9	13	2	3	4	1	1	4		2	3	1	3	2	
26	Male	High in 2009	5-10	YES	8	11	0	3	3		4	3		1	3			2	
27	Male	High	5-10	YES	15	16	5	1	2	2	6	3	3	6	3		2	8	
30	Male	High	5-10	YES	13	11	0	2	2		6	3		3	5		2	1	
31	Male	High	10	YES	6	9		1	4		1	2		1	3		3		
28/36	Male	High in 2008, 2009	5-10	YES	16	15	1	1	2	1	7	9		6			2	4	
39	Male	High	5-10	YES		13	9		1	4		3	5		4			5	

Orchard trial sites with breeding populations

Large orchards

Sites 24 and 25 were large commercial orchards. Site 27 was a mixed fruit orchard that previously had organic status but was not run commercially during the trial period. These properties contained a high volume of fruit, more than 50 fruit per tree in many pome and stone fruit. Of these, site 24 was closest to town. Site 25 and 27 were about 8km from the town.

Flies appeared early in the year, February – March (Sites 24, 25 & 27) and numbers multiplied within a week or two of first detection or remained steady at the threshold level at these sites (Figure 15, 16 and 18). There was a succession of pome and stone fruit at all sites. There were early fruiting apricots, cherries and peaches followed by several varieties of plum, pear and apple, with a large variety of fruits such as persimmons, figs and citrus providing a continuous succession of hosts throughout the year. Periodically fruit remained on the ground allowing population build up at these sites. At site 24 there was a smaller range of fruits, but a large volume of plums and apples with a small number of pear and citrus hosts (2 of each, >50 fruit per tree) providing a succession of hosts through the year. Unharvested fruit was often left to rot on the ground thus contributing to the breeding population.

Site 39 was a semi neglected pome fruit orchard more than 5km from town. While it was mainly an apple (>20 fruit per tree) and pear orchard (>50 fruit per tree) a considerable amount of plums were also in the surrounding area (Figure 27). High fly numbers were captured in a pear in 2008, rising sharply two weeks after trap was placed in this tree indicating a breeding population. Fly numbers were much lower in 2010 but appeared at around the same time of the year and remained steady at the threshold level (two or more per fortnight) through the season confirming a breeding population.

Small orchards

Site 16 was a small orchard close to town (<2km). At this site, there were high numbers in traps and larvae were found in peaches indicating a breeding population (Figure 10). However, flies were captured consistently mainly in one host (a peach) in 2009 and 2010. Placement in other peach, plum and apricot trees within 50m of this tree did not capture flies. The orange tree which was adjacent to the peach captured high numbers in June at the end of the 2010 season. Fruit volumes in these trees were high (20-50 per tree). Larvae were found in a peach within 3m of a peach tree containing the trap which had not captured flies in the preceding weeks.

Site 23 was an orchard close to town (<2km) and with adjoining large commercial orchards. There was a large volume of fruit and flies were captured consistently in high numbers (Figure 14).

At some orchards (Site 26, 30, 31, 36/28) fruit set in early hosts was very low in 2010. Consequently fly capture was very low or zero at these sites (Figure 17, 21, 20 and 25).

Site 28 was close to a creek and captured flies throughout the season in 2008. Traps were moved to site 36 in the near vicinity, flies were captured throughout 2009 (Figure 25). At both sites the fruit volume was high (>20 per tree) in stone fruit and pome fruit as well as citrus. However, in 2010 there was only one fly captured in the same pear tree (>50 fruit per tree), possibly related to lower levels of stone fruit in this season (<6 per tree) disrupting flies breeding in 2010. Peaches did not produce fruit and although other stone fruit produced fruit, volume was low in apricots (<6 per tree) and nectarines did not remain on trees to ripen in 2010 (Figure 25). Similarly, at site 26 there was a variety of fruit available. Fruit set was high in 2009 (>50 per tree in stone fruit) and fly numbers went up sharply in March in a peach and fig which were within 5m of the plum it was in previously, indicating a breeding population. However in 2010, fruit set was very low in both stone and pome fruit (<6 per tree) and no flies were captured at this site.

Sites 30 and 31 were smaller orchards, but also in this category in terms of frequency of fly capture and numbers. At both sites numbers of trees were fairly low but fruit production in stone and pome fruits

were moderate at site 30 and high at site 31. In 2010, fruit set was low in stone fruit other than plums and flies were not captured at site 30.

At site 31, fly number increased to a very high level in plums following first detection in 2008 (Figure 21). Larvae were found in a large number of fruit at this site. While in 2008 maintenance was poor at site 31, orchard hygiene improved and numbers dropped significantly in the following year. Presence of a succession of hosts and fruit left on trees and on the ground contributed to the establishment of flies at these sites.

Possible factors affecting fruit set in 2010

A general delay in flowering and fruit set in stone fruit and pome fruit observed in the Donnybrook area in 2010 is indicated in the phenology recorded at sites 23, 25 and 26 as shown in Table 5. Fruiting in apricot, nashi, nectarine, peach and pear was delayed by one or more weeks. The delayed time is given as an estimate due to differences in the dates of phenology recording in the two seasons.

Delay in fruit set was affected by climatic differences in the three seasons (Table 6). Note that the pattern of rainfall was considerably different in the later three months of 2008 where there was a total of 134ml of rainfall compared to 67ml in the same months in 2009. Average temperature was also lower in December of 2008 compared to 2007 and 2009.

Table 5: Delay in fruit set noted at some sites in Donnybrook 2010.

Fruit set at Site 23

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apple	13 Nov	25 Nov	
Apricot	23 Sept	28 Oct	> 1 week
Nashi	5 Nov	25 Nov	
Nectarine	29 Sept	25 Nov	> 4 weeks
Peach	16 Oct	28 Oct	
Pear	5 Nov	25 Nov	
Plum	8 Oct	28 Oct	

Fruit set at Site 25

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apricot	23 Sept	14 Oct	>1 week
Cherry	30 Oct	25 Nov	>1 week
Nectarine	23 Oct	28 Oct	>1 week
Peach	23 Oct	28 Oct	>1 week
Pear	13 Nov	12 Nov	
Plum	16 Oct	14 Oct	

Fruit set at Site 26

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apple	20 Nov	25 Nov	
Apricot	23 Sept	25 Nov	> 4 weeks
Nectarine	23 Oct	28 Oct	
Peach	23 Oct	25 Nov	>1 week
Pear	23 Oct	25 Nov	>1 week
Plum	8 Oct	30 Sept	

Fruit set at Site 27

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apple	13 Nov	12 Nov	
Apricot	23 Sept	14 Oct	>1 week
Cherry	30 Oct	25 Nov	>1 week
Nashi	20 Nov	25 Nov	
Nectarine	8 Oct	28 Oct	> 1 week
Peach	23 Oct	28 Oct	
Pear	16 Oct	12 Nov	> 2 weeks
Plum	8 Oct	28 Oct	
Quince	5 Nov	25 Nov	

Table 6: Climate data Donnybrook

	Total rain (mm)				Av Max temp				Av Min temp			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Jan		0	3.4	1.8		31.5	32.2	32.4		15.3	15.7	15.4
Feb		8.3	18.6	2.8		31.3	30.5	32.1		17.0	15.4	16.7
Mar		9.4	8.4	17.2		28.4	27.7	29.4		14.3	12.9	15.1
Apr		101.4	1	51.5		23.2	26.9	24.3		10.6	11.2	11.4
May		158.2	82.4	70.8		20.8	23.0	20.6		9.6	8.4	7.9
Jun		119.4	257	57		18.5	17.2	17.9		6.2	7.1	5.8
Jul	237	193.7	188.9		17.8	16.5	16.8		8.2	5.5	5.7	
Aug	176.3	26.4	162.5		18.0	18.4	17.6		7.8	4.0	7.3	
Sep	154.4	110	153.2		18.8	19.2	17.0		8.2	7.2	6.9	
Oct	53.2	46.9	16		21.5	22.6	22.8		8.3	9.9	10.1	
Nov	2.8	77.4	50.3		27.9	22.7	25.9		12.1	10.3	11.8	
Dec	32.4	10.3	0.8		26.6	27.8	30.3		12.8	12.3	12.8	

	Temperature range		Temperature range		Temperature range		Temperature range	
	Max	Min	Max	Min	Max	Min	Max	Min
	2007	2007	2008	2008	2009	2009	2010	2010
Jan			39.3	8.0	41.0	8.9	41.5	7.5
Feb			39.8	8.5	37.9	8.3	39.2	8.5
Mar			36.0	5.5	36.2	6.5	39.2	5.2
Apr			31.1	5.5	32.6	5.5	30.0	6.2
May			25.5	2.6	28.1	3.7	26.5	1.8
Jun			21.2	1.4	23.5	0.8	22.7	0.5
Jul	21.5	2.4	20.5	1.8	20.1	0.8		
Aug	23.5	1.6	22.9	0.6	20.2	1.6		
Sep	25.8	2.3	23.6	0.5	21.0	1.8		
Oct	29.4	3.8	33.6	2.5	35.3	3.9		
Nov	38.3	3.9	29.5	6.5	33.8	6.1		
Dec	42.4	3.9	36.6	7.5	38.1	8.2		

Orchard trial sites without breeding populations

Large orchards

Site 32 was comparable in size to site 25 with a similar range and volume of fruits, however, flies were found in smaller numbers, intermittently through the year (Figure 22). As the climate and host availability were very similar to other sites, there is no obvious reason for the non-establishment of a breeding population other than the greater distance from the populations in town. Small numbers of flies reaching these sites may not have been sufficient to establish a breeding population. Site 34 was at a similar distance from town. While there was a large amount of pome and stone fruit there were only limited numbers of early hosts (Figure 24).

Sites 10 and 29 consisted of large volumes of fruit but were restricted in terms of variety (Figure 9 and 19). Majority of hosts in the 200m were avocado and orange with few stone fruit and other fruit. Site 10 contained mostly citrus (>20 per tree), and although there was fruit present throughout the year the volume of stone fruit was limited in all years (<6 per tree, except in 2009 6-10 per tree) and there were other hosts such as loquat (>50 fruit) and mandarin but only single trees. As the stone fruit was likely to be taken by birds before ripening, early season preferred hosts were missing at this site. Site 29 consisted mostly of cherry which had a short fruiting period and at this site there were apples, pears and citrus (> 20 fruit), but the number of trees in the surrounding 200m were few. In 2009 larvae were found in a peach and the tree was removed, no flies were found in 2010. Limited succession of preferred hosts contributed to the lack of establishment of breeding populations at both sites.

Small orchards

Site 2 had a lower fruit volume than most sites because of irrigation issues and low fruit set in pome fruit (<6 per tree) and moderate fruit set in stone fruit with the exception of apricots (Figure 8). Most stone and pome fruit were taken by birds and fly numbers at this site was zero.

At site 1 small numbers were captured, and there were high numbers captured in April 2008 at this site which did not continue further (Figure 7). The level of pome and stone fruit were low.

Site 18 also had small number of detections in April and May when flies are dispersing (Figure 11). Number of hosts was low at this site and the fruit volume was high in stone fruit (plum and pear) in 2008-2009 and in olives in all years. Flies did not appear in high numbers. Fruit set in stone and pome fruit was moderate and low respectively in 2010.

Site 38 is a recently planted citrus and stone fruit orchard (<6 years) with some large fruit trees in the home orchard (Figure 26), about 500m from site 31 (Figure 21). Few flies were captured in a large orange tree in 2009 and none were captured in 2010.

Fly numbers were low at sites 21 and 22 with female traps (Figure 12 and 13), which were also more than 10km from the town centre. At site 22 trees were pruned in 2009 and the pear tree in which flies were captured in 2009 was removed which would have disrupted fly activity at this site. Also with female traps, site 33 (Figure 23) is a well tended and well producing small orchard. At this site there were no flies in 2008, larvae were found in a peach in 2009, fruit was destroyed and hygiene improved and no further flies were detected in 2010.

Donnybrook
Site 1

Ripe fruit at Site 1

Host	Availability of Ripe fruit		
	start-June 2007Nov -2008	July-June 2008-2009	July-June 2009-2010
Apple	Mar-Apr	Mar	
Apricot		Dec-Feb	
Fig	Jan-Mar	Nov; Dec-Mar	Dec-Feb
Grape	Jan-Feb	Jan-Mar	
Grape fruit	…-June	July-June	July-June
Lemon	…Dec; Mar-June	July; Jan; June	Most of year
Lilly pilly	Feb-May	Apr-June	Most of year
Loquat		Oct-Nov	
Mandarin	...-June	Aug-Oct; May-June	July-Oct; May-June
Mulberry	Nov; May-June	Oct-Dec	July; Sept
Nectarine	Mar	Jan	
Olive	Apr -May	Apr-May	Apr
Orange	All year	All year	July-Nov Jan-June
Passion fruit	Intermittent		Dec; Apr
Peach	Jan	Jan-Feb	Jan
Pear	Apr	May	
Persimmon		Mar	
Plum		Dec	Dec
Pomegranate	…-Apr-	Mar	Apr-May

Distance from town centre 5-10 km

Hosts and fruit volume at Site 1

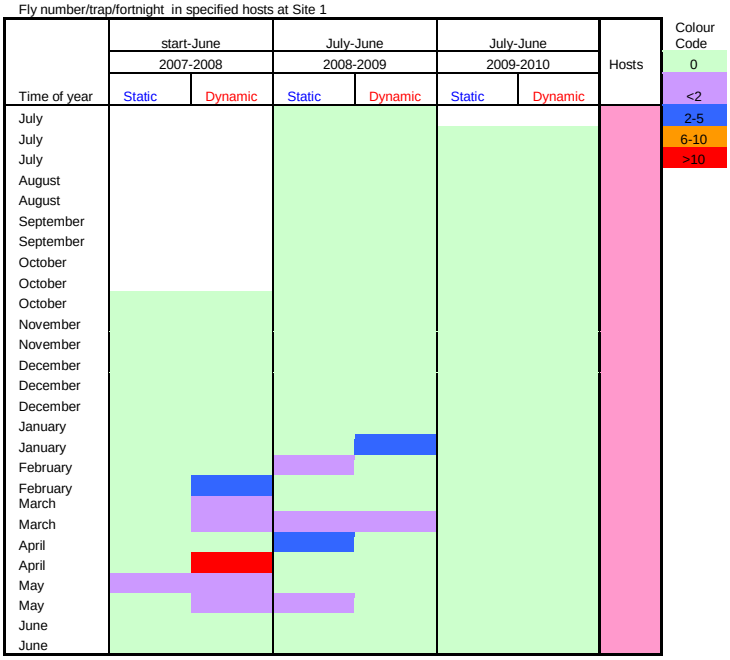
Hosts within 200m radius

Apple < 6,
Orange < 30
Stone fruit (Nectarine, Peach, Plum) < 6 of each
Other fruit (Fig, Grape, Loquat etc) < 6 of each
Citrus (Lemon, Mandarin) < 30
(Pear, Nashi) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	M	L
Pome fruit	L	L	L
Citrus	VH	VH	VH
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 1



Hosts where flies were captured in traps

Static	Orange	Orange	no flies (Nectarine)
Dynamic	Orange	GF	no flies

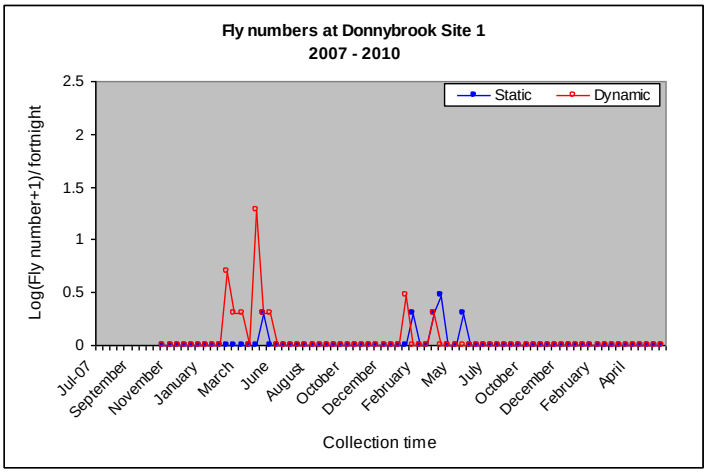


Figure 7: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 1

Donnybrook
Site 2

Ripe fruit at Site 2

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Feijoa	April	Feb	
Fig	Feb-Mar	Feb-Mar	Feb-Mar
Grape	Jan-Feb	Feb-Mar	Feb-Apr
Lemon	Most of year	Most of year	Most of year
Loquat	Oct-Nov	Oct	
Mandarin	Apr-June	May-June	July; May-June
Mulberry	Dec-Jan	Nov-Dec	Nov-Dec
Nectarine		Dec-Feb	
Olive			Apr
Passion fruit		Dec	
Peach		Feb	
Pear			
Plum		Jan-Feb	

Distance from town centre 5-10 km

Hosts and fruit volume at Site 2

Hosts within 200m radius

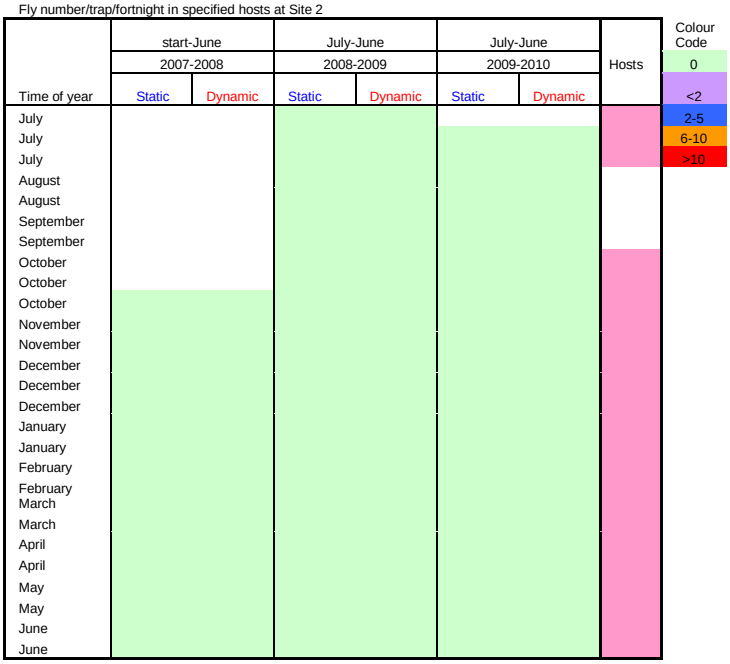
Apple < 6,
Citrus (Lemon, Mandarin, Orange) < 6
Stone fruit (Nectarine, Peach, Plum) < 6 of each
Pear < 6
Other fruit (Fig, Grape, Guava, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	M	M,
Pome fruit	L	L	
Citrus	M	M	H
Other	H	H	H

L in apricot & taken by birds

Fly number/trap/fortnight in specified hosts at Site 2



Hosts where flies were captured in traps

Static	no flies (Loquat)	no flies (Loquat)	no flies (Pear)
Dynamic	no flies	no flies	no flies

No flies

Figure 8: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 2

Donnybrook
Site 10

Ripe fruit at Site 10

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Fig		Feb-Apr	
Grape fruit	….-June	July-Aug	June
Lemon	…-Dec & Mar-June	July-Sept;Oct-Mar;May-June	July-June
Loquat		Oct-Nov	
Mandarin	Nov; Apr-June	July-Oct; Nov-Feb	July-June
Mulberry	Dec	Oct-Dec	Oct-Nov
Nectarine			Dec
Orange	…-Dec	most of year	most of year
Passion fruit	Intermittent		

Distance from town centre 2-5 km

Hosts and fruit volume at Site 10

Hosts within 200m radius

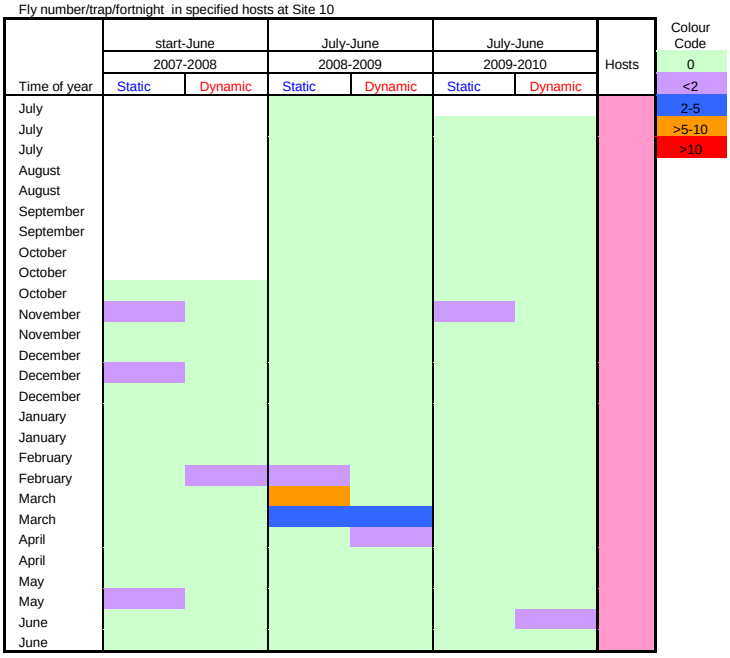
Avocado 100-200
Citrus (Lemon) < 6
Mandarin < 30
Orange < 100
Stone fruit (Apricot, Cherry, Necatine, Peach, Plum) < 6 of each
Other fruit (Fig, Loquat etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	M	L
Pome fruit	L	L	
Citrus	VH	VH	VH
Other	VH	VH	VH

L apricot and peaches & taken by birds

Fly number/trap/fortnight in specified hosts at Site 10



Hosts where flies were captured in traps

Static	Orange	Orange	Orange
Dynamic	Fig	Lemon/GF	Mandarin

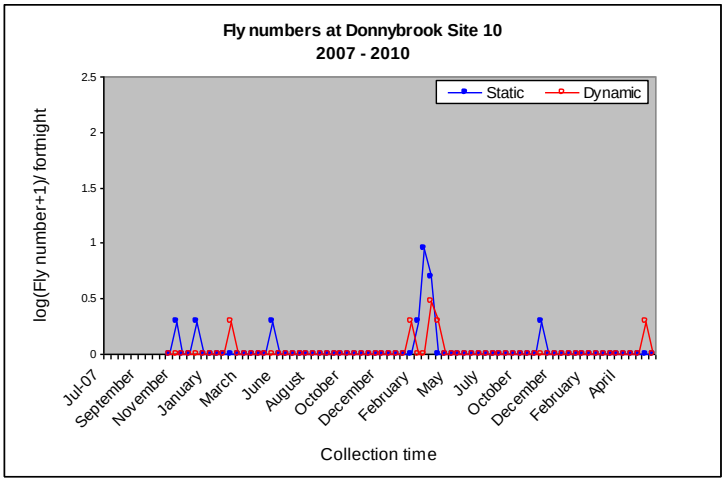


Figure 9: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 10

Donnybrook
Site 16

Ripe fruit at Site 16

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Mar	Mar	Mar
Apricot	Dec	Dec-Jan	Dec
Fig	Dec-Mar	Oct-Dec	July; Sept
Grape	Feb-Apr	Jan	
Grape fruit	Intermittent	Apr-May	Apr
Mulberry	Oct-Feb		
Orange	Feb-Nov		
Peach	Dec-Apr	Dec-Mar	Jan
Pear	Feb	Mar	Feb
Plum	Jan-Feb	Jan-Mar	Feb-Mar

Distance from town centre < 2 km

Hosts and fruit volume at Site 16

Hosts within 200m radius

Apple < 6,
Citrus (Grapefruit, Lemon, Orange) < 30

Pear < 6

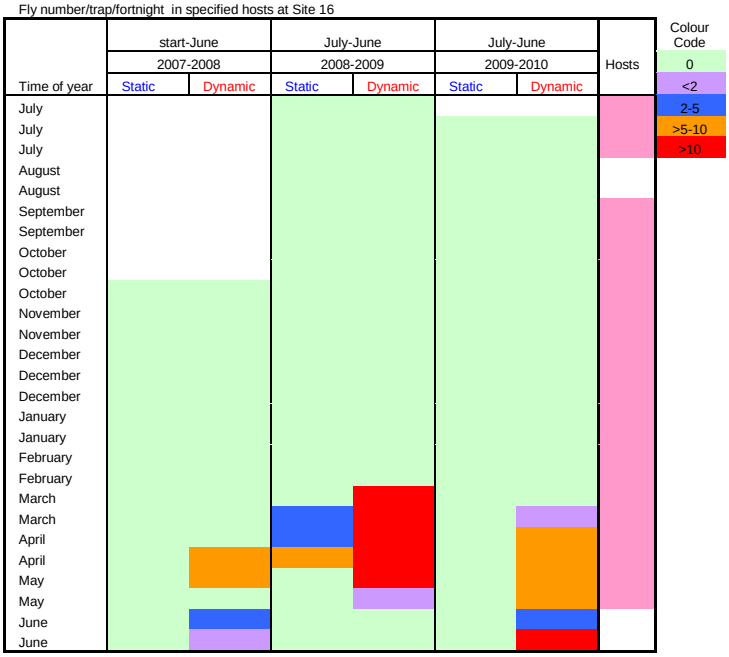
Stone fruit (Apricot, Peach, Plum) < 6 of each

Other fruit (Fig, Grape, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	M	M	M
Citrus	VH	VH	VH
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 16



Hosts where flies were captured in traps

Static	No flies (G F)	Grape fruit	no flies (Peach)
Dynamic	Orange	Peach	Plum/Peach/Orange

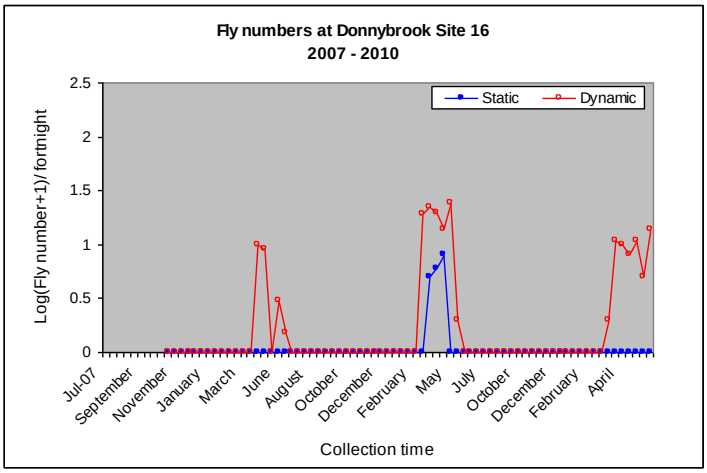


Figure 10: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 16

Donnybrook
Site 18

Ripe fruit at Site 18

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb-May	Mar	
Apricot		Dec-Jan	
Cherry		Dec	
Grape	Jan-Mar		
Grape fruit	Apr-June	July; May-June	July-Sept; April-June
Lemon	…-June	July-Jan	July-Aug; June
Mandarin	May-June	July-Sept; Nov & June	July-Aug; May
Mulberry	…Nov; Feb	Oct-Dec	Oct-Dec
Olive	...-Apr	May-June	Apr-May
Orange	Apr-June	July; Sept-Oct; May-June	July-Sept May-June
Pear	Apr	Mar	
Plum	Jan-Mar	Jan-Mar	Jan

Distance from town centre 5-10 km

Hosts and fruit volume at Site 18

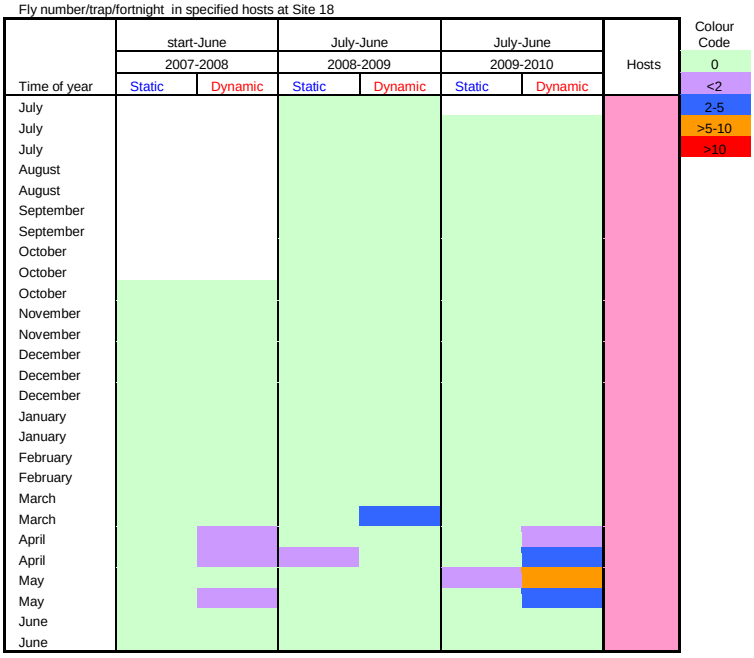
Hosts within 200m radius

Apple < 30,
Citrus (Lemon, Mandarin, Orange) < 30
(Apricot, Cherry, Nectarine) < 6
Pear < 30
Stone fruit (Plum & other) < 30 of each
Other fruit (Fig, Grape, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	M
Pome fruit	H	VH	L
Citrus	M	M	M
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 18



Hosts where flies were captured in traps

Static	no flies (Mulberry/conifer)	conifer	no flies (Mulberry)
Dynamic	Olive/Orange	Pear	Olive

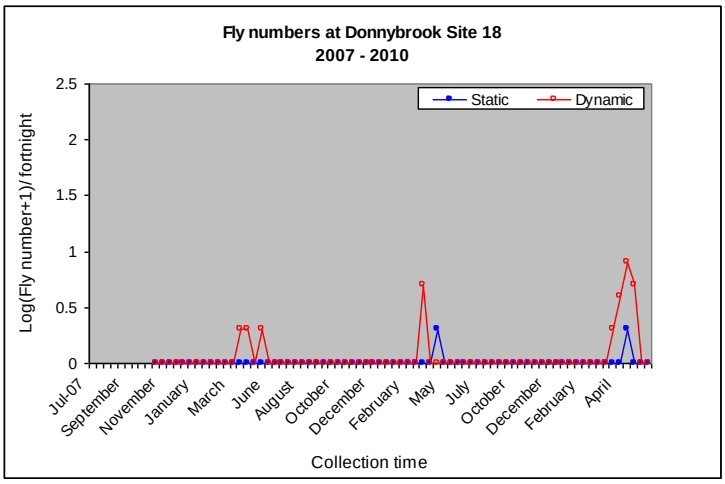


Figure 11: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 18

Donnybrook
Site 21

Ripe fruit at Site 21

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb-May	July; May-June	May
Apricot	Dec	Dec-Jan	
Cumquat	…-June	July-June	July-June
Grape	Jan-Mar	Mar	
Lemon	…-June	July-June	July-June
Mandarin	May-June	July-Mar	Aug-Sept
Mulberry		Oct-Nov	
Orange	April-June	July-Dec; Apr-June	July-Jan June
Passionfruit	Jan-June	July-Aug; Feb-June	Jan-Mar; May
Persimmon	Mar-June	Apr-June	Apr
Plum	Feb-April		

Distance from town centre > 10 km

Hosts and fruit volume at Site 21

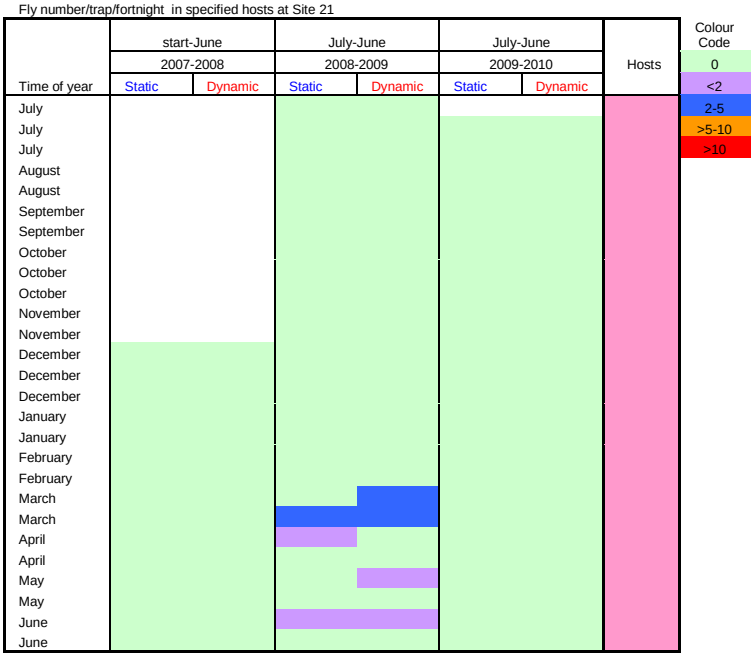
Hosts within 50m radius

Apple, Pear < 6 each
Citrus (Lemon, Mandarin, Orange) < 30
SF (Apricot, Plum) < 6 each
Other fruit (Guava, Mulberry, Persimmon etc) < 6 each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	VH	M, taken by birds
Pome fruit	VH	VH	H
Citrus	VH	VH	VH
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 21



Hosts where flies were captured in traps

Static	no flies (Mandarin)	Orange	no flies (Apple)
Dynamic		Cumquat	no flies

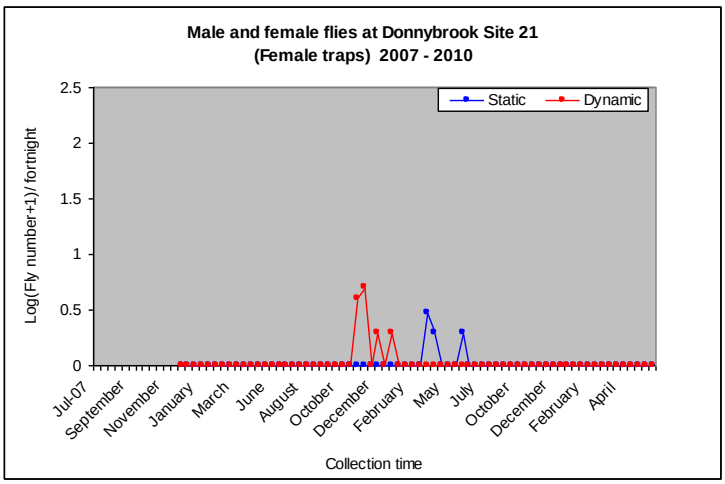


Figure 12: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 21

Donnybrook
Site 22

Ripe fruit at Site 22

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov - 2008	2008-2009	2009-2010
Apple	Feb-May	Mar-Apri	
Fig	Feb-April	Mar-April	Mar-May
Lemon	…-June	July-Oct; Mar-May	July-Apr; June
Loquat	Feb	Oct-Dec	
Mandarin	…-June	July-Mar; JuneJuly-Apr; June	
Nectarine	Feb	Mar-Apr	
Orange			
Pear	Mar-Apr	Mar-May	
Persimmon			
Plum	Jan	Dec-Feb	Dec-Jan

Distance from town centre > 10 km

Hosts and fruit volume at Site 22

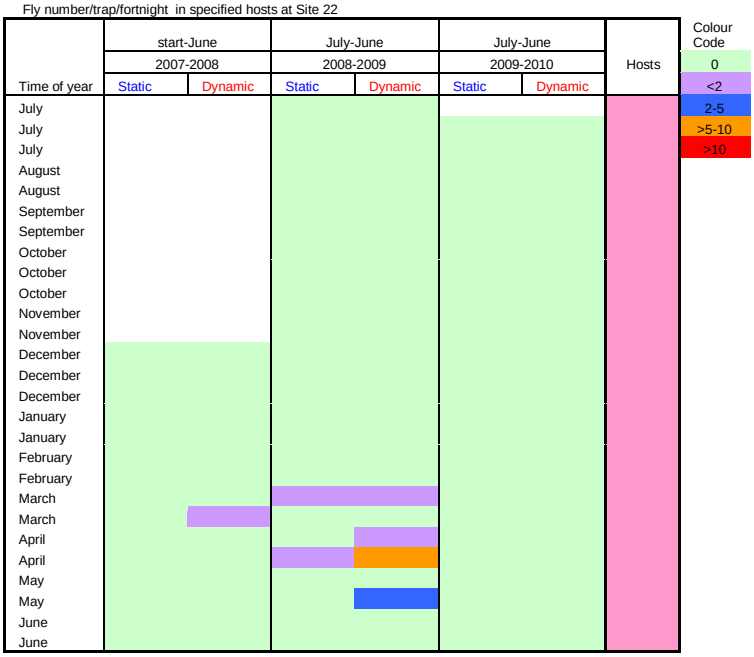
Hosts within 50m radius

Apple, Pear < 6 each
Citrus (Lemon, Mandarin, Orange) < 30
SF (Apricot, Nectarine, Plum) < 6 each
Other fruit (Lilly pilly, Loquat, Olive) < 6 each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH, L nectarine	VH, L nectarine	VH, L nectarine
Pome fruit	H	VH	
Citrus	M	M	M
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 22



Hosts where flies were captured in traps

Static	no flies (Apple/Loquat)	Loquat	no flies (Apple/Loquat)
Dynamic	Fig	Pear	no flies

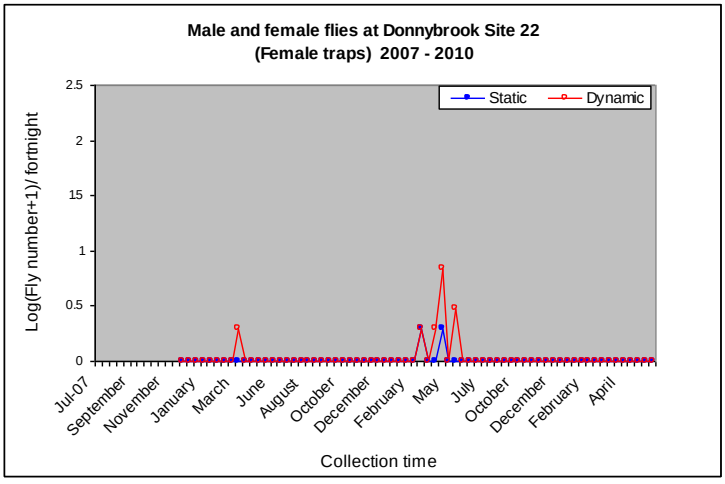


Figure 13: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 22

Donnybrook
Site 23

Ripe fruit at Site 23

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	...-July	Feb-Aug	Mar-May
Apricot		Dec	Oct-Dec
Grapefruit	Mar-Sept	Nov	July-Apr
Lemon	Most of year		
Mandarin	May	May-June	July, May-June
Nashi	Mar-Apr	Mar-Apr	Mar-Apr
Nectarine	Feb	Dec-Mar	Feb-Mar
Olive	…Feb	June	
Orange	...-July	July-Jan	Most of year;
Peach	Mar	Dec-Feb	Feb
Pear	Feb-May	Mar-May	Mar-May
Plum		Dec	Dec-Jan

Distance from town centre 2-5 km

Hosts and fruit volume at Site 23

Hosts within 200m radius

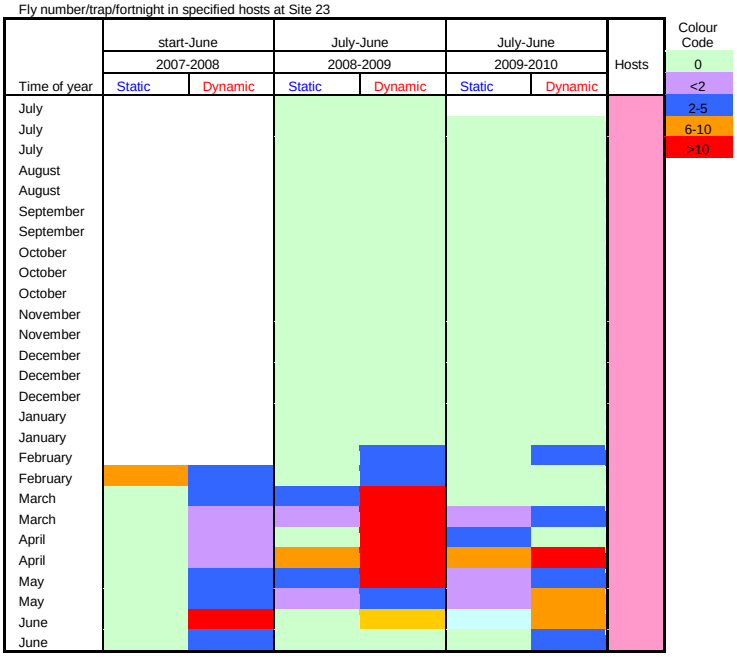
Apple 400-500
Apricot < 100
Citrus (Grapefruit, Lemon, Mandarin, Orange) < 6 of each
Nashi, < 100
Pear < 30
Plums <300-400
SF (Nectarine, Peach)< 100 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	H	H	VH
Other	M	M	M

no nectarines in 2010

Fly number/trap/fortnight in specified hosts at Site 23



Hosts where flies were captured in traps

Static	Orange	Orange	Plum
Dynamic	Nect/Pear/Apple	Nect/Pear/Apple	Pear/apple

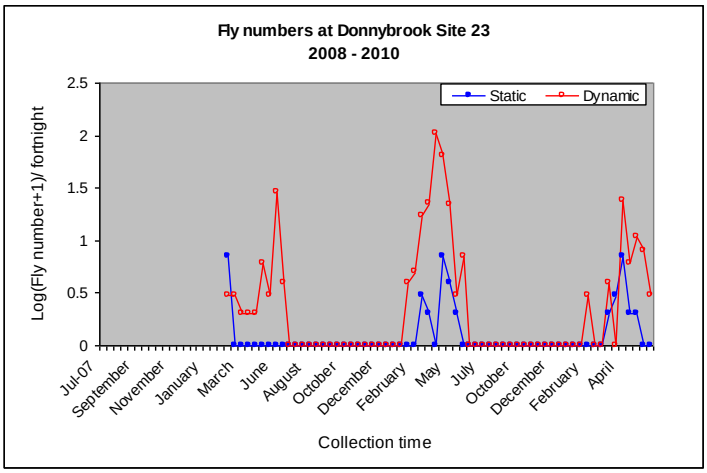


Figure 14: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 23

Donnybrook
Site 24

Ripe fruit at Site 24

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	Mar-July	Mar-June	May
Orange	…-June	July-Oct; Nov-June	July-Feb; May-June
Peach	Mar	Feb-Mar	
Pear	...-May	Mar-June	Mar-May
Plum	...-Apr	Jan-May	Jan-apr

Distance from town centre 2-5 km

Hosts and fruit volume at Site 24

Hosts within 200m radius

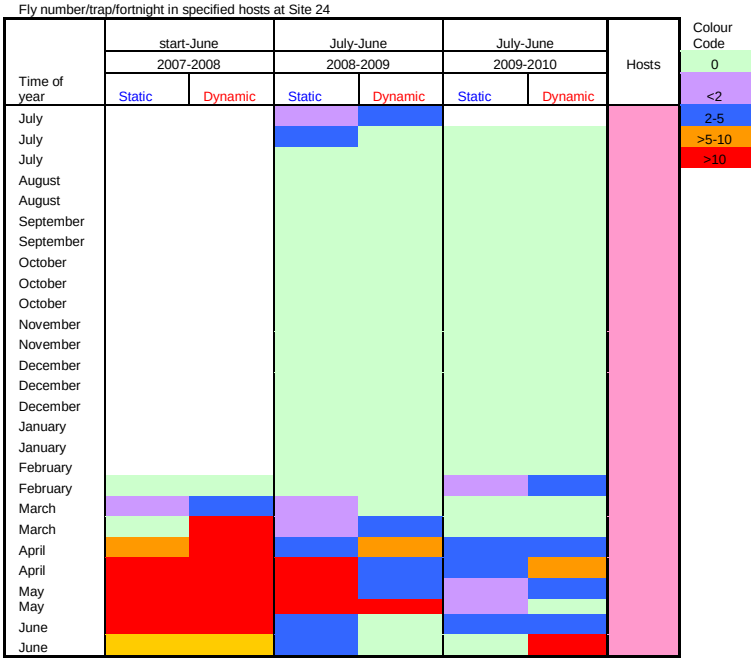
Apple 1-200
Citrus (Orange) < 6
Grape 100=200
Pear < 6
Plums < 200-300
SF (Apricot, Peach) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

no peaches in 2010
other - grapes only

Fly number/trap/fortnight in specified hosts at Site 24



Hosts where flies were captured in traps

Static	Orange	Orange	Plum
Dynamic	Plum/Pear/Apple	Plum/Pear	Plum/Pear

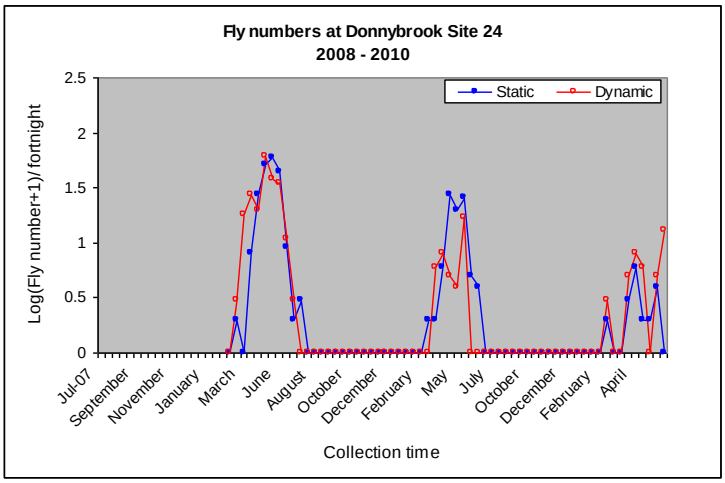


Figure 15: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 24

Donnybrook
Site 25

Ripe fruit at Site 25

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apricot		Dec-Jan	Nov-Dec
Cherry		Nov-Dec	Nov
Cherry guava	...-May	Apr-June	July; Mar-May
Fig	...-Apr	Dec-Apr	Feb-Apr
Grape	...-Apr	Jan-Mar	Feb-Mar
Mandarin	...-June	July-Aug;May-June	July-Sept; May-June
Nectarine	...-Apr	Jan-Mar	Jan
Orange	...-June	July-Feb; June	July-Apr
Peach	...-Feb	Dec-Feb	Jan
Pear	...-May	Apr-May	Mar
Persimmon	...-Apr	Apr-May	Apr
Plum	...-Feb	Jan-Mar	Jan-Feb

Distance from town centre 5-10 km

Hosts and fruit volume at Site 25

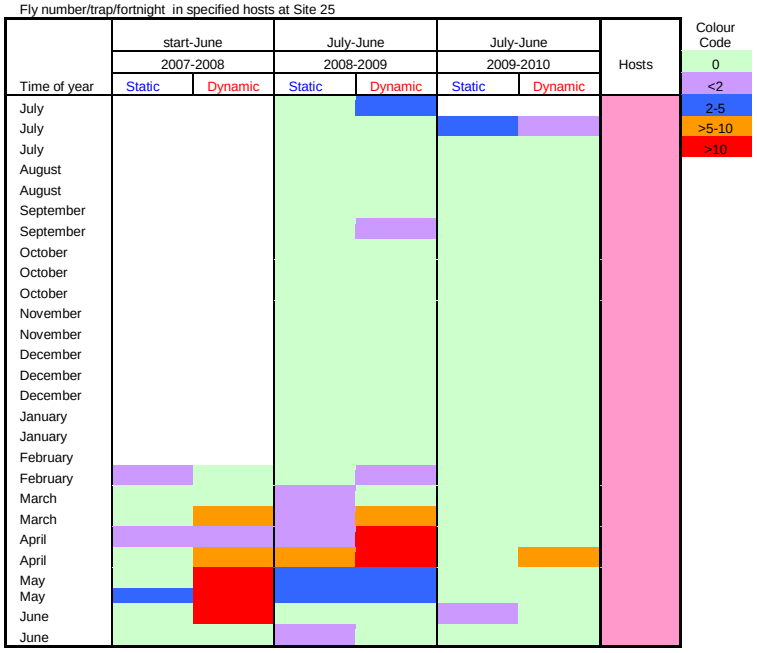
Hosts within 200m radius

Citrus (Orange) 400-500
Pome fruit (Apple & Pear) < 500-600
plums <100
SF (Apricot, Cherry, Nectarine, Peach)< 300-400
Other fruit (Fig, Mulberry etc) < 6 of each type

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 25



Hosts where flies were captured in traps

Static	Orange	Orange	Orange/Plum
Dynamic	Nectarine/Mandarin	Nectarine	Mandarin/Persimmon

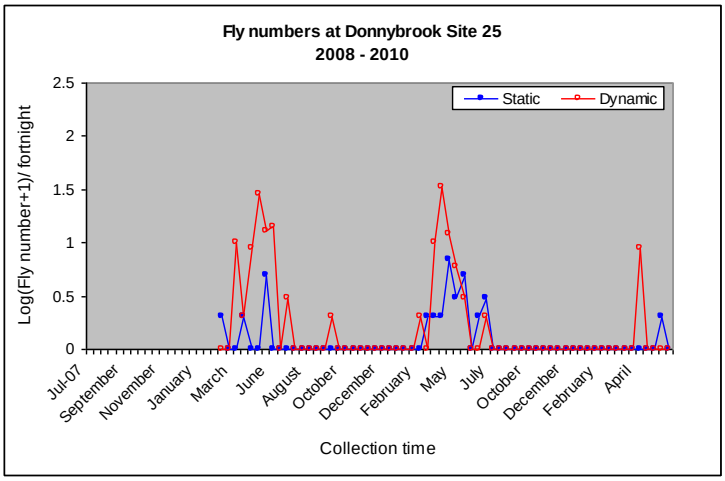


Figure 16: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 25

Donnybrook
Site 26

Ripe fruit at Site 26

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	Feb-08	2008-2009	2009-2010
Apple	Apr-May	Mar	
Apricot		Dec-Jan	
Avocado		Feb	Dec
Feijoa		Apr-May	
Fig	…-Mar	Nov; Jan; Mar	Nov; Jan-Feb
Grape		Mar	
Grape fruit	…-June	July-Apr; June	July-June
Guava		Feb; June	
Lemon	…-June	July-June	July-Oct; Jan-June
Loquat		Oct-Nov	Oct
Mandarin	Apr-June	July-Aug;June	July-Aug; Oct;
Mulberry		Dec	
Nectarine		Feb	
Orange		Feb; May-June	July-Oct; June
Peach	…Feb	Feb-Mar	
Pear		Mar	
Persimmon		Mar	
Plum		Jan-Mar	
Pomegranate	…-May	Mar-Apr; June	May
Tamarillo		Apr-June	July; May-June

Distance from town centre 5-10 km

Hosts and fruit volume at Site 26

Hosts within 200m radius

Citrus (Mandarin, Orange) < 30

Pome fruit (Apple & Pear) <100
SF (Apricot, Nectarine, Plum) < 100

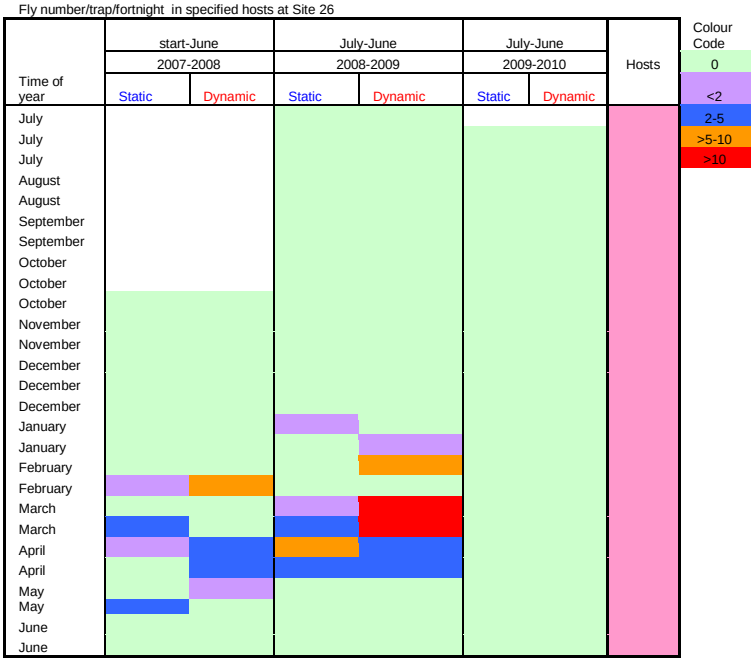
Other fruit (Guava, Fig, Loquat, Mulberry etc) < 6 of each type

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		VH	L
Pome fruit		L	
Citrus	VH	VH	VH
Other	H	H	H

SF removed by birds in 2008 and 2010 before ripening in 2010;
Pome Fruit not set in 2010

Fly number/trap/fortnight in specified hosts at Site 26



Hosts where flies were captured in traps

Static	Grapefruit	Grapefruit	no flies (GF/Orange)
Dynamic	Peach/GF	Plum/Peach/Fig/Orange	no flies

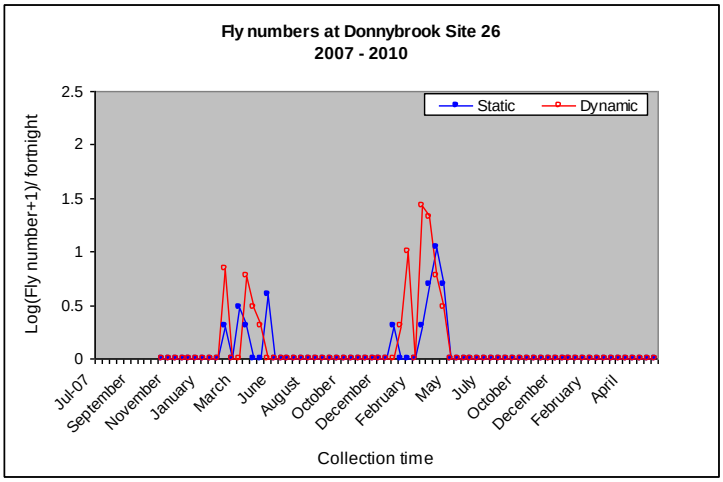


Figure 17: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 26

Donnybrook
Site 27

Ripe fruit at Site 27

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	Feb-08	2008-2009	2009-2010
Apple	...-June	Mar-May	Mar-May
Apricot	May	Dec-Jan	
Cherry		Nov	Nov
Cherry guava	...-May	Apr-May	Apr
Feijoa	April		
Fig	...-Apr	Jan-Apr	Jan-Mar
Grape fruit		July-Apr; May-June	July-Sept; May-June
Guava	May	July-Oct	Aug-Sept
Lemon	Most of year	Most of year	Most of year
Mandarin	Apr-June	July-Sept; May-June	Nov-Dec; May-June
Mango	Apr-June		
Mulberry	...-Mar	Oct-Jan	Nov-Dec
Nashi	...-May	Mar	Mar
Nectarine		Dec & Feb	Dec
Orange	...June	July-Feb; June	July-Jan; May-June
Peach	...-Mar	Dec; Feb-Mar	Feb-Mar
Pear	...-May	Feb; Mar-May	Mar-May
Persimmon	Mar-June	Apr-June	Apr-June
Plum	...-Mar	Jan-Mar	Jan-Feb
Quince	Mar-May	Apr-May	Apr-May

Distance from town centre 5-10 km

Hosts and fruit volume at Site 27

Hosts within 200m radius

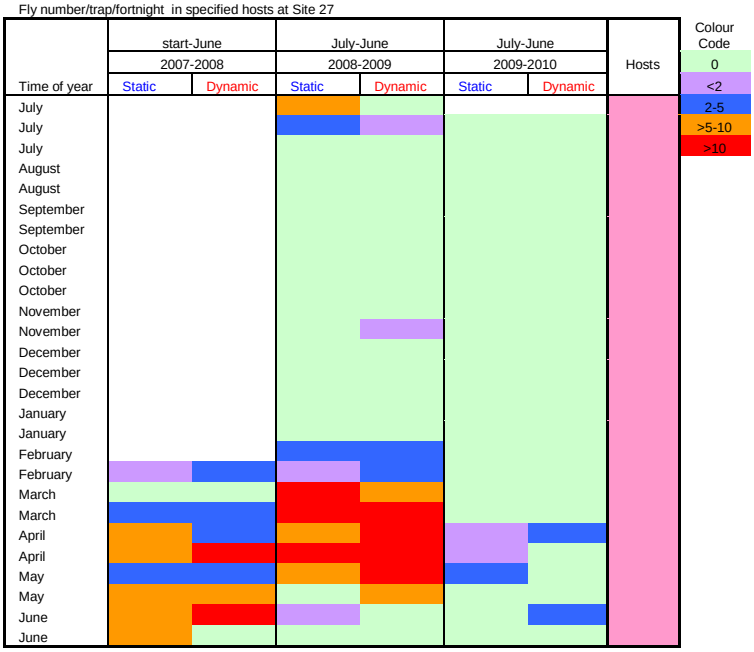
Citrus (Mandarin, Orange) < 30
Pome fruit (Apple & Pear) 100-200
SF (Apricot, Nectarine, Peach, Plum) 100-200
Other fruit (Feijoa, Guava, Loquat, Mango, Mulberry etc)
Fig < 30 < 6 of each type
Grape < 30

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, L apricot
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

no feijoas or mango in 2010

Fly number/trap/fortnight in specified hosts at Site 27



Hosts where flies were captured in traps

Static	Mandarin	Mandarin	Peach
Dynamic	Peach/Apple	Mandarin/Orange/Plum/Peach	Plum/Orange

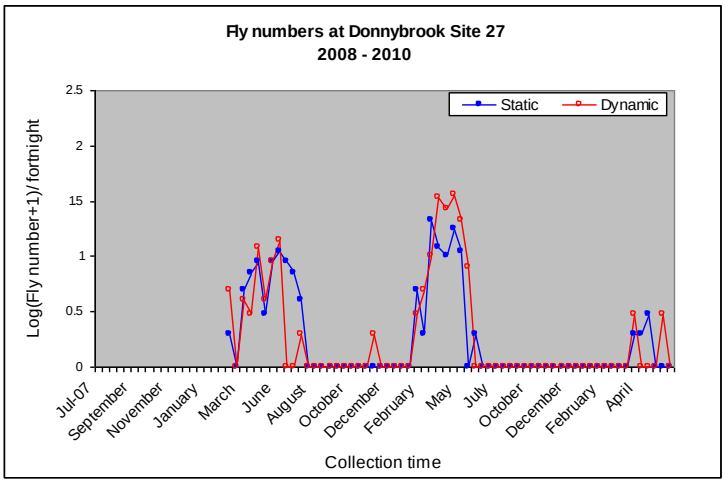


Figure 18: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 27

Donnybrook
Site 29

Ripe fruit at Site 29

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	...-Apr	Mar-June	May-June
Cherry		Nov-Dec	Dec
Fig	...-June	Mar; June	Mar-June
Grape fruit	May-June	July-Dec; Jan-Feb; May-June	July-Dec; May-June
Lemon	July-June	July-June	July-June
Loquat	...-Nov	Oct	
Mandarin	Apr-Oct	May-June	July-June
Mulberry	Mar	Oct	Oct-Nov
Nectarine		Dec	Dec
Orange	...-Apr; May-June	July-June	July-June
Peach	Feb	Dec-Jan; Mar	Dec
Pear	Mar-Apr	Mar-Apr	Mar-Apr
Persimmon	Mar-May	Apr-June	Apr-June

Distance from town centre 5-10 km

Hosts and fruit volume at Site 29

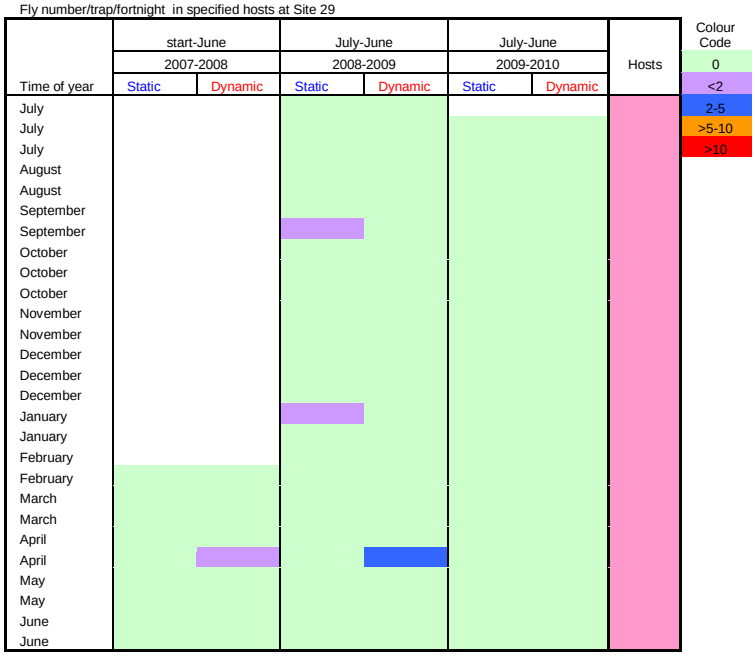
Hosts within 200m radius

Cherry 200-300
Citrus (Lemon, Mandarin, Orange) < 30
Pome fruit (Apple & Pear) < 6
SF (Apricot, Peach)< 30
Other fruit (Loquat, Mulberry etc) < 6 of each type

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 29



Hosts where flies were captured in traps

Static	Orange	Orange	No flies (Cherry)
Dynamic	Pear	Apple	No flies

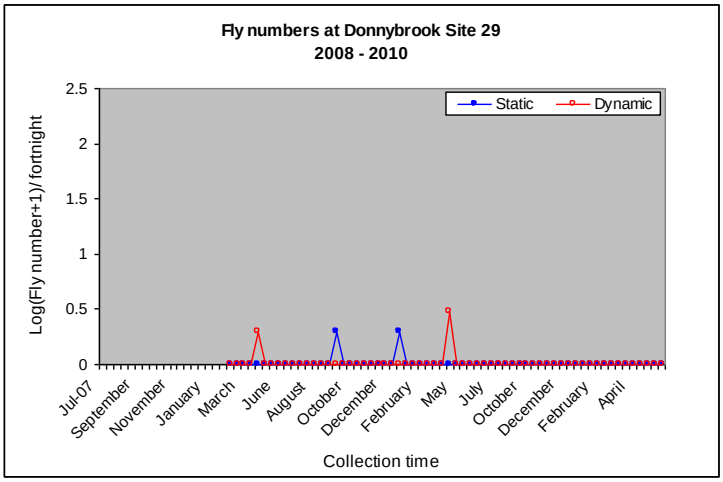


Figure 19: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 29

Donnybrook
Site 30

Ripe fruit at Site 30

Host	Availability of Ripe fruit		
	start-June 2008	July-June 2008-2009	July-June 2009-2010
Apple	April	Mar	
Apricot	Nov		
Avocado			
Cherry		Nov	
Cumquat	…-June	July-June	July-Aug; June
Grape	…-Apr	Feb-Mar	Feb
Grape fruit	Apr-June	July-Feb; June	July-June
Lemon	…June	July-June	July-Apr June
Loquat		Oct-Nov	Oct
Mandarin	Mar-June	July-Sept; June	Aug-Sept; Feb-June
Olive		Apr-May	Apr
Orange	…-June	July-June	July-Nov; May-June
Pear	Mar	Feb-Apr	
Plum		Dec-Jan	Jan

Distance from town centre 5-10 km

Hosts and fruit volume at Site 30

Hosts within 200m radius

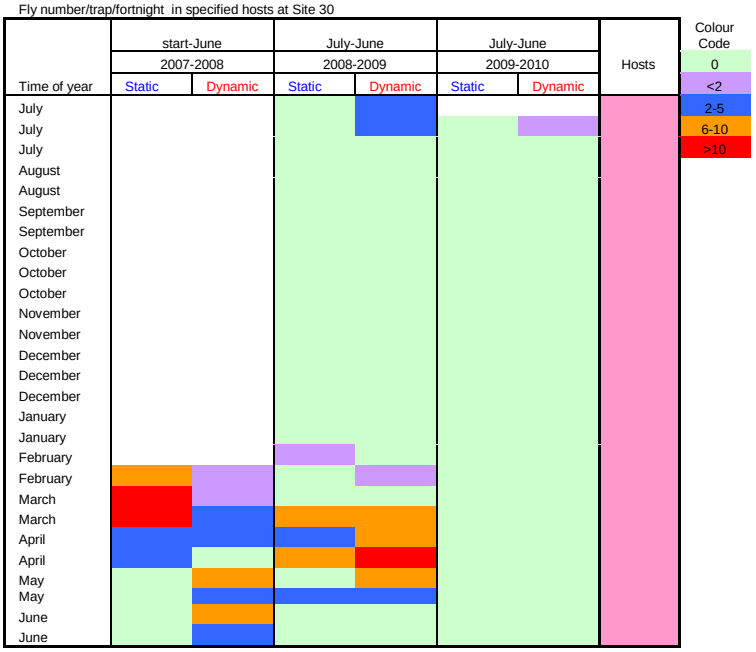
Cherry < 30
Citrus (Lemon, Mandarin, Orange) < 100
Pome fruit (Apple & Pear) 100-200
SF (Apricot, Peach, Plum) 200-300
Other fruit (Loquat, Mulberry, Olive etc) < 6 of each type

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH plums L apricot
Pome fruit	VH	H	M
Citrus	VH	VH	VH
Other	VH	VH	VH

pear taken by birds before ripening in 2010

Fly number/trap/fortnight in specified hosts at Site 30



Hosts where flies were captured in traps

Static	Loquat	Loquat	no flies (Loquat)
Dynamic	Pear/Orange/Mandarin	Mandarin/Pear	Orange

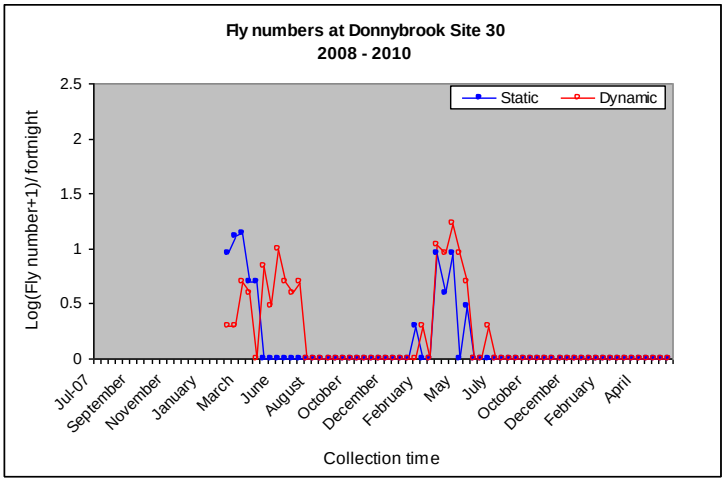


Figure 20: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 30

Donnybrook
Site 31

Ripe fruit at Site 31

Host	Availability of Ripe fruit		
	start-June 2008	July-June 2008-2009	July-June 2009-2010
Apple	...-Jun	Mar-May	Dec; May
Apricot	…-Feb	Dec	
Cherry	Nov-Dec		
Fig	…-Mar	Feb-Apr	Feb=Mar
Grape	Feb-Mar	Feb-Mar	Feb-Mar
Grape fruit	Mar-June	July-Feb; May-June	July-Dec; May-June
Lemon	All year	All year	All year
Lilly pilly		Apr-June	Aug-Sept; Mar-June
Loquat		Oct-Nov	
Mandarin	Feb; Apr-June	July-Nov	July-Sept; May-June
Mango		Apr-June	Mar
Mulberry		Oct-Dec	
Nectarine		Jan	Jan-Feb
Olive	June	Apr-May	
Orange	All year	All year	All year
Peach	Feb-Mar	Jan; Mar	Jan-Mar
Pear	…-Mar	Feb-Mar	
Plum	…-Mar	Dec-Mar	Jan-Feb
Quince	Mar-May	Mar-Apr	May

Distance from town centre = 10 km

Hosts and fruit volume at Site 31

Hosts within 200m radius

Apple < 6,
Citrus (Grapefruit, Lemon, Orange) < 30

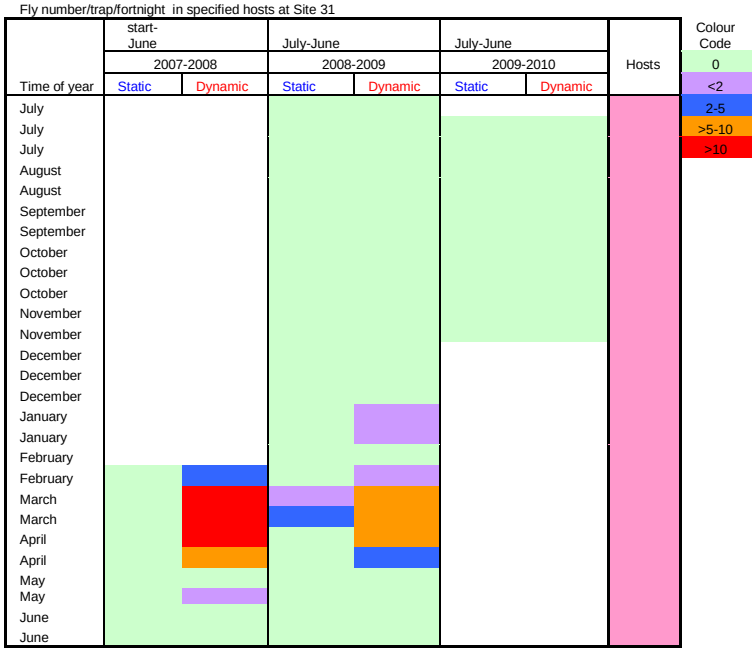
SF (Apricot, Nectarine, Peach, Plum, Quince) < 6 of each

Other fruit (Fig, Grape, Mango, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	L, apricot, plum
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 31



Hosts where flies were captured in traps

Static	no flies (Loquat)	Loquat	no flies (Loquat)
Dynamic	Plum/Apple	Peach/Plum/Apple	

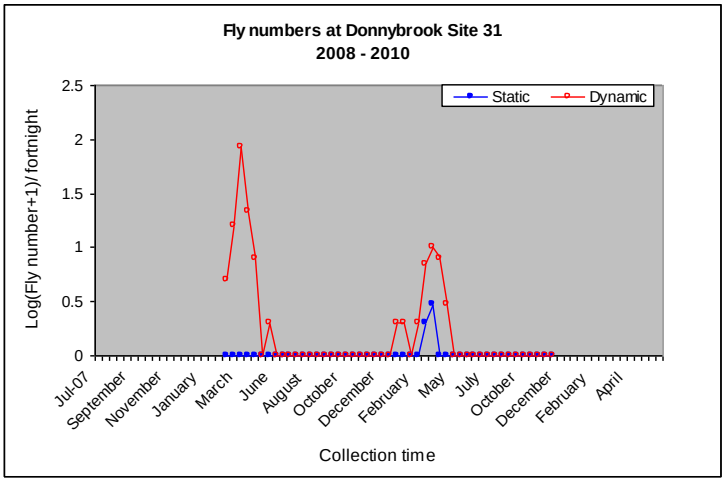


Figure 21: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 31

Donnybrook
Site 32

Ripe fruit at Site 32

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	...-June	Mar-June	Mar-June
Apricot		Dec-Jan	Dec
Cherry		Nov-Dec	Nov-Dec
Fig	…-Mar	Dec & Mar	Dec; Mar-Apr
Grape	Mar-Apr	Feb-Apr	Mar
Lemon	...-June	July-June	July-June
Lilly pilly		Oct-Jan; Apr-June	Mar-June
Loquat		Oct-Dec	Oct-Nov
Mandarin	…June	July-April; June	July-Oct; Jan-June
Mulberry	…-Feb	Dec-Feb	Dec-Feb
Nectarine	Apr		Jan
Orange	Mar-June	July-Oct; Dec-Apr; June	July-Sept; June
Peach	feb-Mar	Dec-Mar	Jan-Mar
Pear	Mar-May	Mar-Apr	Feb
Plum	…-Mar	Dec-Apr	Jan
Prickly pear		July-June	July-Oct; Dec; Mar-June
Quince	…-May	Apr	Apr

Distance from town centre > 10 km

Hosts and fruit volume at Site 32

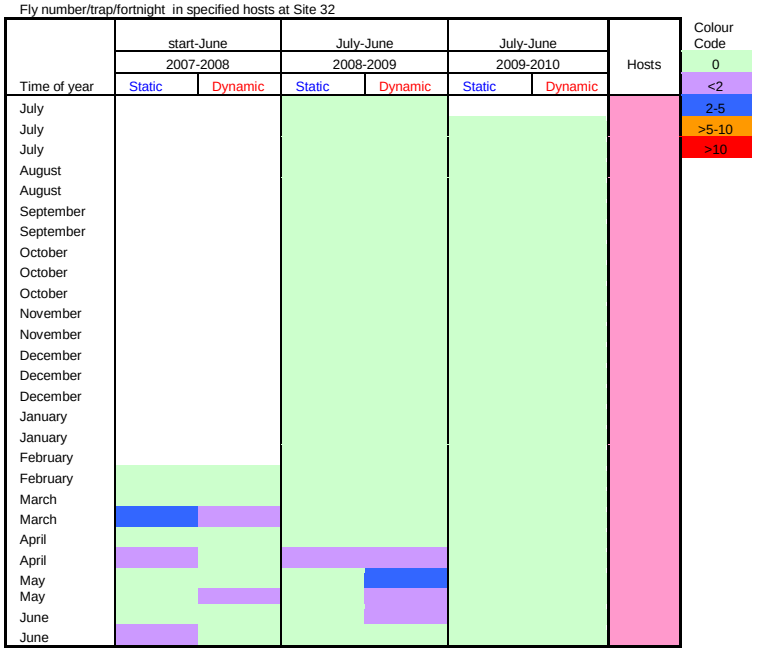
Hosts within 200m radius

Apple 100-200
Apricot 20-300
Other fruit (Fig, Loquat, Prickly pear etc) < 6 of each
Cherry < 100
Pear 200-300
Plums 300-400 (many)
Quince < 30

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 32



Hosts where flies were captured in traps

Static	Loquat	Loquat	No flies (Peach)
Dynamic	Mandarin/Apple	Plum/Apple	No flies

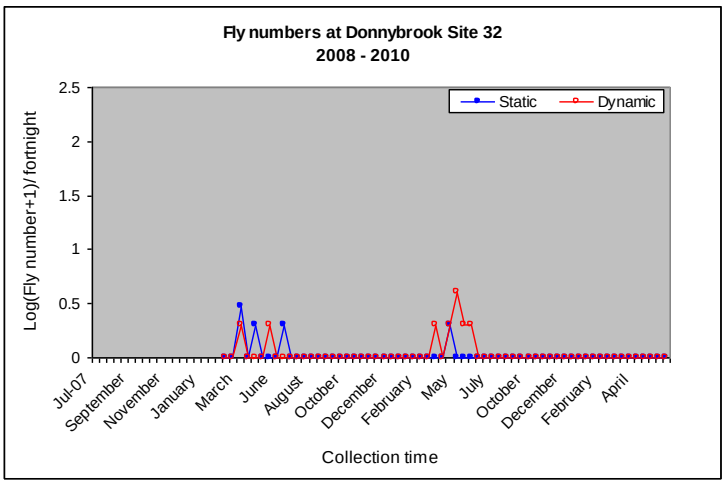


Figure 22: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 32

Donnybrook
Site 33

Ripe fruit at Site 33

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple		Mar-June	July-Aug; Apr-June
Apricot		Dec	
Fig		Mar-Apr	Apr
Grape		Feb-Mar	Mar-Apr
Lemon		July--June	July-Feb; Apr-June
Loquat		Oct-Nov	Nov
Mandarin		July-Aug	Aug-Sept;
Mulberry		Dec-Feb	Dec
Nectarine		Feb	Feb
Olive		May …-Oct; May-June	Apr-June
Orange			July-Sept; May
Peach		Jan-Feb	Dec-Jan
Pear		Mar	Feb
Plum		Jan-Feb	Jan
Quince		Apr-May	April

Distance from town centre 2-5 km

Hosts and fruit volume at Site 33

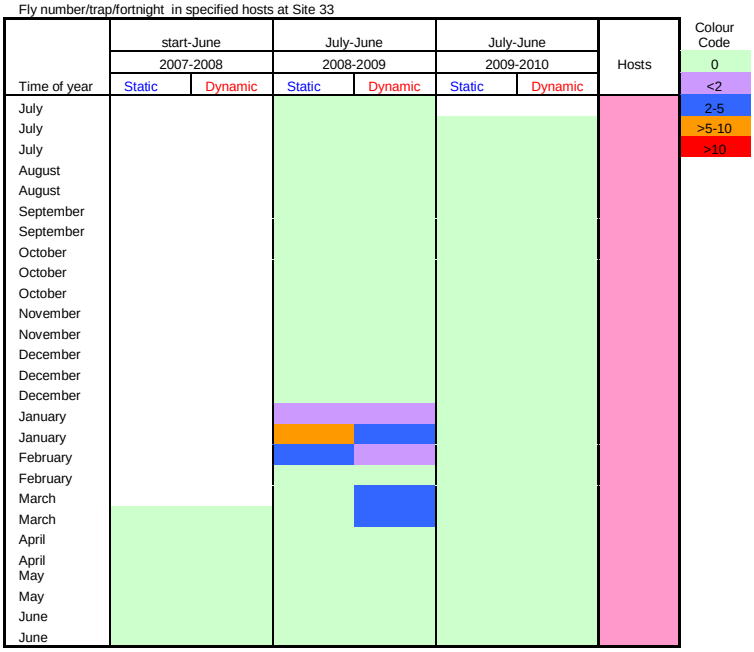
Hosts within 50m radius

Citrus (Lemon, Mandarin, Orange) < 6
SF (Apricot, Cherry, Nectarine, Peach, Plum) < 6 each
Apple, Pear < 6
Other fruit (Fig, Grape, Loquat etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		VH	VH, L apricot
Pome fruit		VH	VH
Citrus		VH	VH
Other		VH	VH

Fly number/trap/fortnight in specified hosts at Site 33



Hosts where flies were captured in traps

Static	no flies (Orange)	Orange	no flies (Orange)
Dynamic	no flies	Plum/Pear/Fig	no flies

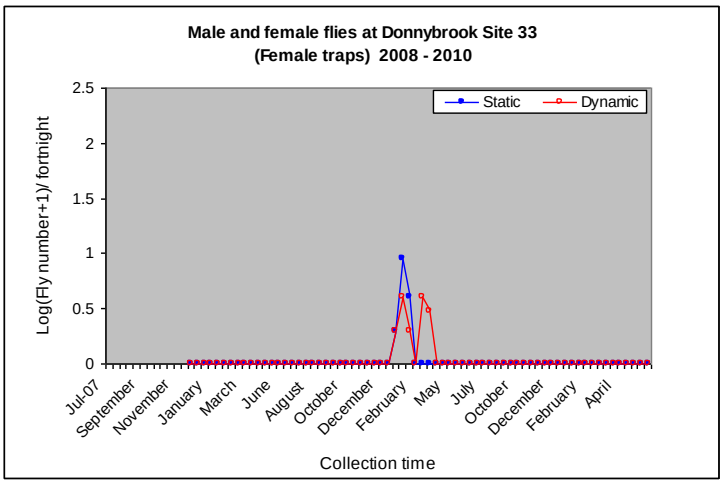


Figure 23: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 33

Donnybrook
Site 34

Ripe fruit at Site 34

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	July-Aug; Jan-Apr	...-July; Mar-June	May
Apricot		Dec-Jan	Dec
Cherry guava		Apr-June	July-Aug; Apr-May
Fig		Sept-Apr	Apr
Guava		July-Aug	June
Lilly pilly		July-Dec	Sept-Dec; Apr-June
Mulberry		Jan-Feb	Dec
Olive		May-June;	July-Sept;Apr-May
Plum		Dec-Jan	Dec-Mar
Prickly pear		Feb-June	July-Oct; Feb-June

Distance from town centre = 10km

Hosts and fruit volume at Site 34

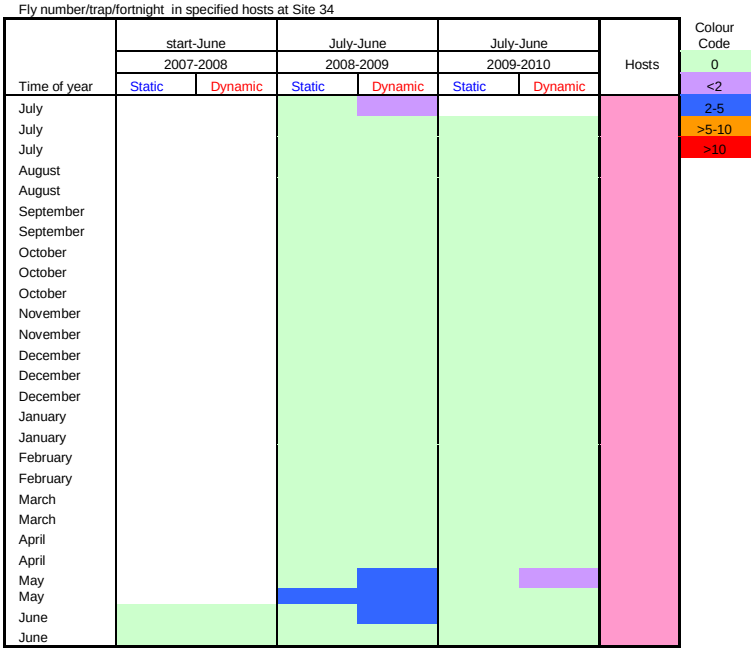
Hosts within 200m radius

Apple 500-600
Apricot < 6
Cherry < 6
Pear < 100
Plums < 30
Other fruit (Feijoa, Fig, Loquat, Lilly pilly etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		VH	VH, L apricot
Pome fruit		VH	VH
Citrus		L	
Other		VH	VH

Fly number/trap/fortnight in specified hosts at Site 34



Hosts where flies were captured in traps

Static	Feijoa	No flies (Apple)
Dynamic	Apple	Apple

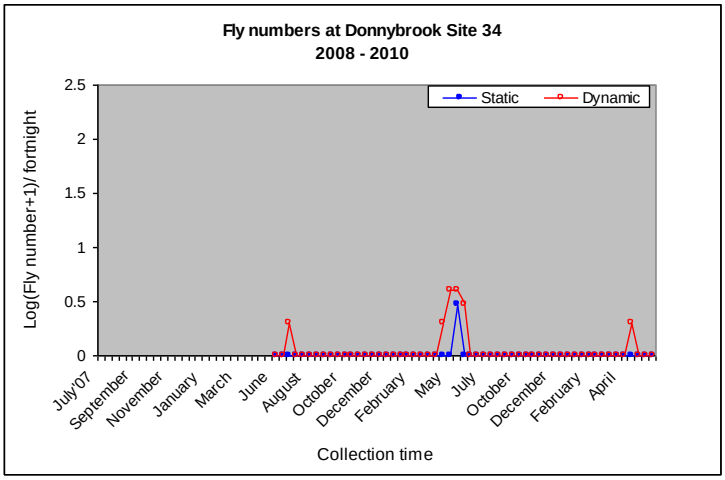


Figure 24: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 34

Donnybrook
Site 36/28

Ripe fruit at Site 28 & 36

Host	Availability of Ripe fruit		
	start-June 2008	July-June 2008-2009	July-June 2009-2010
Apple	Feb-Apr	Mar-Apr	May
Apricot	Apr	Jan	Dec
Grapefruit		…-Mar	July-June
Lemon	…June		
Loquat		Oct-Nov	Oct-Nov
Nashi	Apr-May	Mar-Apr	Feb
Nectarine		Feb-Mar	
Mulberry	Feb-Mar		
Olive	Mar-May		
Orange	…-June	..-June	July-Feb; June
Peach	…-Mar		
Pear	..-June	Feb-Apr	Mar-May
Plum	…-Apr	Feb-Mar	Jan-Feb

Distance from town centre 5-10 km
Traps at site 28 in 2007-2008 were moved to Site 36
about 200m away

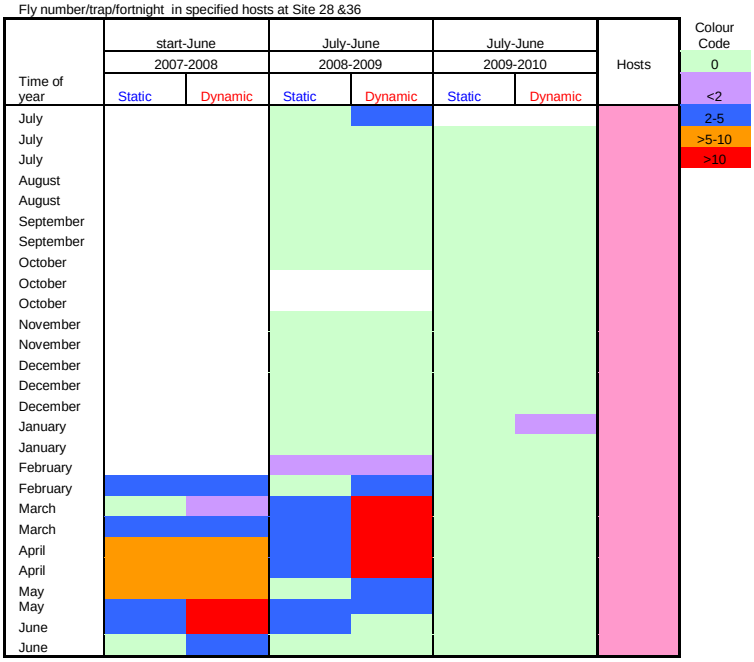
Hosts and fruit volume at Site 36

Hosts within 200m radius
Apple < 100
Apricot < 100
Citrus (Lemon, Orange) < 6 of each
Stone fruit (Nectarine, Peach) < 6 of each
Pear < 100
Plums <100
Other fruit (Fig, Feijoa, Loquat, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	Lapricot, M nectarine
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 28 &36



Hosts where flies were captured in traps

Static	Loquat	Grapefruit	No flies (Apple)
Dynamic	Plum/Pear	Orange/Nectarine/Pear	Pear

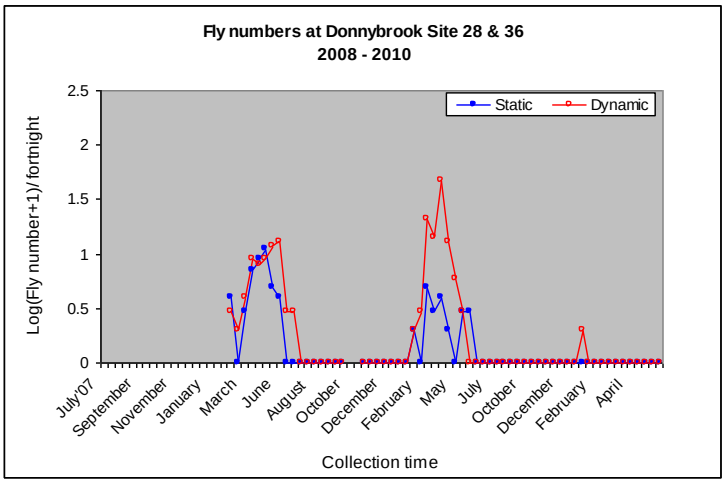


Figure 25: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 28 & 36

Donnybrook
Site 38

Ripe fruit at Site 38

Host	Availability of Ripe fruit		
	start-June 2008	July-June 2008-2009	July-June 2009-2010
Apple		Mar	
Apricot		Dec	
Fig		Feb	Mar
Lemon		…-June	July-June
Lilly pilly		Apr-June	July-Sept; Apr-May
Lime		Dec,Feb; Apr-June	July-Sept
Loquat		Nov-Dec	Oct
Mandarin		Dec; May-June	July-Sept; May
Mulberry		Nov-Dec	Oct-Nov
Nectarine			Jan
Olive		Apr	Mar
Orange		Nov-Mar; June	July-June
Passion fruit		Mar	
Peach		Dec	
Plum		Jan	Jan

Distance from town centre 10 km

Hosts and fruit volume at Site 38

Hosts within 200m radius

Apple < 30,

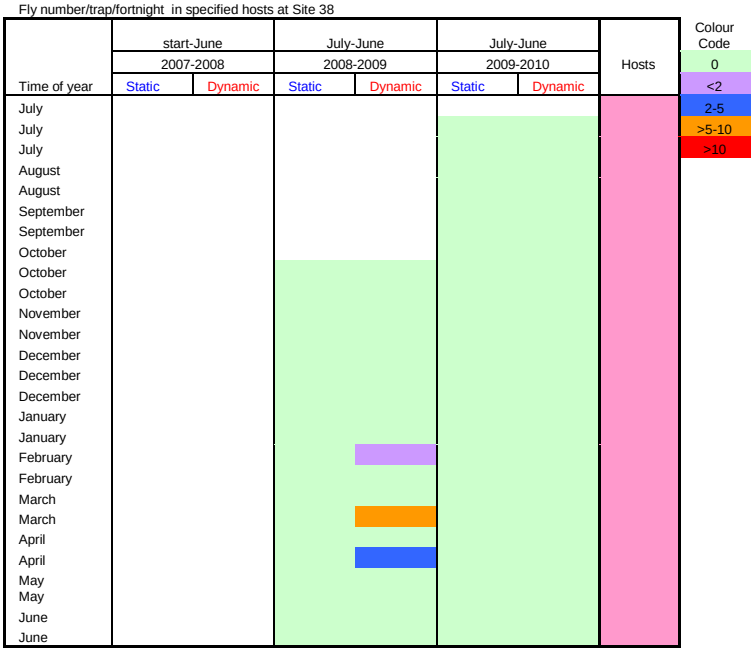
Citrus (Lemon, Mandarin,Orange) < 30 of each
SF (Apricot, Nectarine, Peach, Plum) < 30

Other fruit (Lime, Loquat, Mulberry, etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		L	M
Pome fruit		L	L
Citrus		VH	VH
Other		VH	VH

Fly number/trap/fortnight in specified hosts at Site 38



Hosts where flies were captured in traps

Static	no flies (Orange)	no flies (Orange)
Dynamic	Orange	no flies

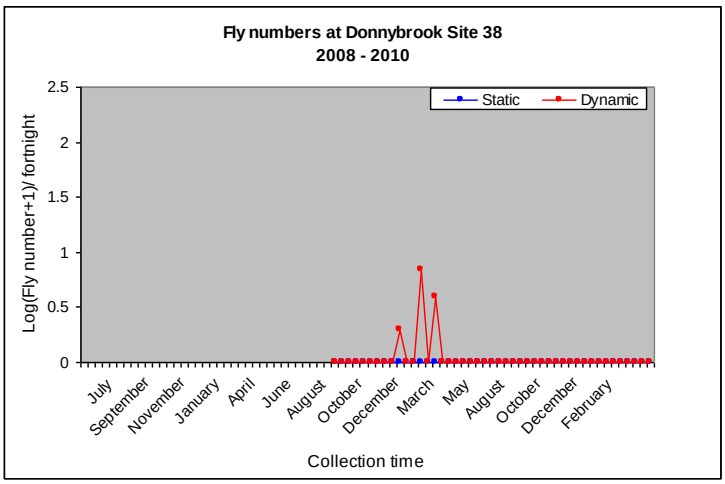


Figure 26: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 38

Donnybrook
Site 39

Ripe fruit at Site 39

Host	Availability of Ripe fruit		
		July-June	July-June
		2008-2009	2009-2010
Apple		Mar-Apr	
Fig		Feb-Apr	Feb-Mar
Grape		Feb-Apr	
Mandarin		…-June	July-June
Mandarin		May-June	July-Aug; May-June
Nectarine		Dec-Jan	Jan
Orange		May-June	July-Dec; May-June
Pear		Mar-Apr	Mar-Apr
Persimmon		Apr	
Plum		Dec-Jan	Dec

Distance from town centre 5-10 km

Hosts and fruit volume at Site 39

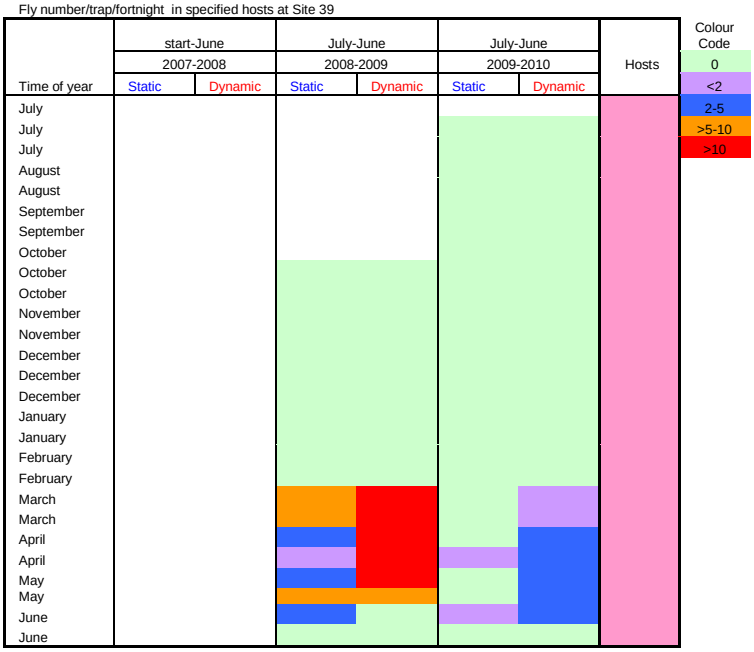
Hosts within 200m radius

Apple < 30
Citrus (Lemon, Orange) < 6 of each
Grape < 30
Nectarine < 6
Pear 200-300
Plum 100-200
Other fruit (Persimmon, Prickly pear etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		M	M
Pome fruit		VH	VH
Citrus		VH	VH
Other		M	M

Fly number/trap/fortnight in specified hosts at Site 39



Hosts where flies were captured in traps

Static	Orange	Plum
Dynamic	Pear	Pear

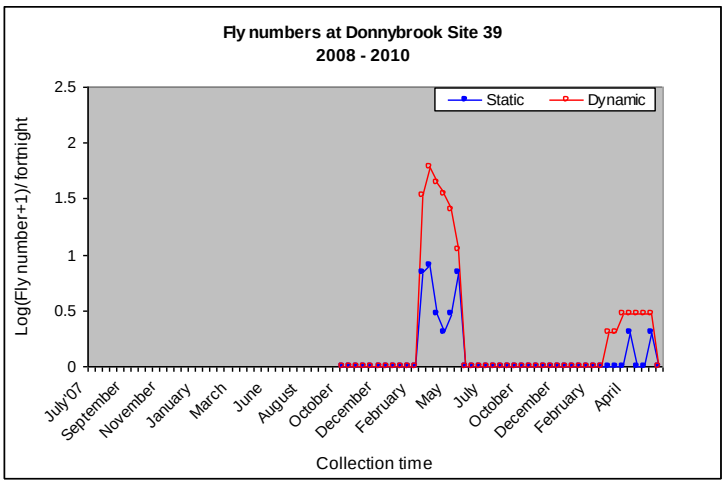


Figure 27: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 39

Statistical analysis of Donnybrook data

Male flies in male traps in 2008

A graph of the percentage of male traps with male flies present at each collection date (Fig 28a) indicates that, in orchards, male flies only started to appear in traps from 21 February 2008 (Date 149011 on the x-axis). On the previous date, and preceding ones, none of the traps had any male flies. On this basis comparisons between dynamic and static traps have only been made using data collected on 21 February 2008 and later.

The effect of trap type on the percentage traps with male flies did not change with date of collection (Trap type x Date interaction: P=0.828). On average over all dates for which flies were present, 34.4% dynamic traps had male flies while only 17.4% static traps had male flies present (P=0.004). There was no effect of date of collection on the percentage of traps with male flies (P=0.770). It should be noted that with dynamic and static traps at only 27 sites you would only expect to detect difference of approximately 20% between dynamic and static traps at each date. Adjusted percentages for each trap type on each collection date are shown in Table 7. Adjustments are required in order to make means comparable between dates because observations were not made at all sites on all dates.

When the percentage of traps with male flies in dynamic and static traps was compared for each collection date the percentage was significantly higher in dynamic traps on only 23 April 2007 (P=0.050), but was close to significance on 28 February 2008 (P=0.056), 5 March 2008 (P=0.074), 7 May 2008 (P=0.099), 21 May 2008 (P=0.089), 28 May 2008 (P=0.071) and 4 June 2008 (P=0.089). On all other dates there was no difference.

There is no evidence in either the combined analysis or the individual analyses at each date that flies are trapped earlier in the season in dynamic traps compared to static.

The effect of trap type on the number of male flies caught did not change with date of collection (Trap type x Date interaction: P=0.638). On average over all dates for which flies were present, there were 0.35 male flies in static traps and 0.70 male flies in dynamic traps (P<0.001). The probability of catching a fly in a dynamic trap is 17.5% higher than it is in a static trap. Since we do not know the number of flies present outside the trap we cannot estimate the absolute probabilities of catching a fly in each trap type.

There was also a significant effect of date on the number of male flies in traps (P<0.001). Adjusted (for site) male fly numbers for each trap type on each collection date are shown in Table 8 and Figure 29a. When the number of male flies in dynamic and static traps was compared for each collection date the number was significantly higher in dynamic traps on 28 February 2008 (P=0.049), 23 April 2008 (P=0.024), 7 May 2008 (P=0.021) and 28 May 2008 (P=0.030). On all other dates there was no difference.

Table 7: Adjusted (for site) percentage of traps with male flies present at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
21-Feb-08	-1.224	-0.981	22.7%	27.3%
28-Feb-08	-0.312	-1.816	42.3%	14.0%
05-Mar-08	-0.941	-3.02	28.1%	4.7%
11-Mar-08	-1.471	-2.276	18.7%	9.3%
19-Mar-08	-0.896	-1.127	29.0%	24.5%
26-Mar-08	-0.409	-0.867	39.9%	29.6%
02-Apr-08	-0.636	-0.867	34.6%	29.6%
08-Apr-08	-0.875	-1.127	29.4%	24.5%
16-Apr-08	-0.409	-0.867	39.9%	29.6%
23-Apr-08	-0.188	-1.778	45.3%	14.5%
29-Apr-08	-0.409	-1.423	39.9%	19.4%
07-May-08	-0.188	-1.423	45.3%	19.4%
15-May-08	-0.409	-0.627	39.9%	34.8%
21-May-08	-0.409	-1.778	39.9%	14.5%
28-May-08	-0.875	-2.999	29.4%	4.8%
04-Jun-08	-0.409	-1.778	39.9%	14.5%
18-Jun-08	-0.875	-1.778	29.4%	14.5%
Standard error of difference (SED)				
Average:		0.827		
Maximum:		1.519		
Minimum:		0.651		

Table 8: Adjusted (for site) numbers of male flies at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
21-Feb-08	0.231	0.359	0.26	0.43
28-Feb-08	0.423	0.122	0.53	0.13
05-Mar-08	0.306	0.092	0.36	0.10
11-Mar-08	0.206	0.107	0.23	0.11
19-Mar-08	0.466	0.303	0.59	0.35
26-Mar-08	0.661	0.367	0.94	0.44
02-Apr-08	0.496	0.284	0.64	0.33
08-Apr-08	0.503	0.360	0.65	0.43
16-Apr-08	0.703	0.521	1.02	0.68
23-Apr-08	0.731	0.255	1.08	0.29
29-Apr-08	0.599	0.315	0.82	0.37
07-May-08	0.923	0.347	1.52	0.42
15-May-08	0.638	0.558	0.89	0.75
21-May-08	0.538	0.278	0.71	0.32
28-May-08	0.631	0.140	0.88	0.15
04-Jun-08	0.748	0.342	1.11	0.41
18-Jun-08	0.325	0.180	0.38	0.20
Standard error of difference (SED)				
Average:		0.143		

Male flies in male traps in 2009

A graph of the percentage of male traps with male flies present at each collection date (Fig 28b) indicates that, in orchards, male flies only started to appear in traps from 15 January 2009 (Date 149340 on the x-axis). On the previous date, and preceding ones, none of the traps had any male flies. On this basis comparisons between dynamic and static traps have only been made using data collected on 15 January 2009 and later.

The effect of trap type (dynamic vs static) on the percentage traps with male flies did not change with date of collection (Trap type x Date interaction: P=0.992). On average over all dates for which flies were present, 33.6% dynamic traps had male flies while only 21.9% static traps had male flies present (P=0.027). There was a significant effect of date of collection on the percentage of traps with male flies (P<0.001). Adjusted percentages for each trap type on each collection date are shown in Table 9. Adjustments are required in order to make means comparable between dates because observations were not made at all sites on all dates. When the percentage of traps with male flies in dynamic and static traps was compared for each collection date the percentage was significantly (almost) higher in dynamic traps on 29 April 2009 (P=0.064), and 13 May 2009 (P=0.052). On all other dates there was no difference.

The effect of trap type on the number of male flies caught changed with date of collection (Trap type x Date interaction: P<0.001). This interaction appears to reflect an increased efficiency of dynamic traps relative to static traps at times of the year when fly numbers in traps are highest over and above there increased efficiency when fly numbers are low. Adjusted male fly numbers for each trap type on each collection date are shown in Table 10 and Figure 29b. On average over all dates for which flies were present, there were 0.32 male flies in static traps and 0.79 male flies in dynamic traps (P<0.001). When the number of male flies in dynamic and static traps was compared for each collection date the number was significantly higher in dynamic traps on 4 March 2009 (P=0.028), 12 March 2009 (P=0.051), 25 March 2009 (P=0.002), 1 April 2009 (P<0.001), 8 April 2009 (P=0.011), 15 April 2009 (P=0.050), 29 April 2009 (P=0.022), 6 May 2009 (P=0.049) and 13 May 2009 (P=0.020). On all other dates there was no difference.

Table 9: Adjusted (for site) percentage of traps with male flies present at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
15-Jan-09	-11.566	-2.197	0.0%	10.0%
21-Jan-09	-2.944	-11.566	5.0%	0.0%
28-Jan-09	-1.735	-11.566	15.0%	0.0%
12-Feb-09	-1.689	-1.689	15.6%	15.6%
18-Feb-09	-1.337	-2.905	20.8%	5.2%
25-Feb-09	-1.689	-2.155	15.6%	10.4%
4-Mar-09	-1.045	-11.61	26.0%	0.0%
12-Mar-09	-0.554	-1.044	36.5%	26.0%
18-Mar-09	-0.420	-0.661	39.7%	34.1%
25-Mar-09	0.758	-0.333	68.1%	41.8%
1-Apr-09	1.306	0.091	78.7%	52.3%
8-Apr-09	-0.121	-0.788	47.0%	31.3%
15-Apr-09	0.303	-0.554	57.5%	36.5%
22-Apr-09	-0.334	-0.120	41.7%	47.0%
29-Apr-09	0.758	-0.554	68.1%	36.5%
6-May-09	-0.334	-1.336	41.7%	20.8%
13-May-09	-0.121	-1.689	47.0%	15.6%
20-May-09	-0.121	-0.554	47.0%	36.5%
27-May-09	-1.337	-1.689	20.8%	15.6%
11-Jun-09	-1.689	-1.689	15.6%	15.6%
25-Jun-09	-11.612	-2.155	0.0%	10.4%
Standard error of difference (SED)*				
Average:		0.825		
Maximum:		1.464		
Minimum:		0.650		

** SED's reported cannot be used to compared greyed transformed means where no traps had male flies*

Table 10: Adjusted (for site) numbers of male flies at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
15-Jan-09	0.000	0.069	0.00	0.07
21-Jan-09	0.035	0.000	0.04	0.00
28-Jan-09	0.124	0.000	0.13	0.00
12-Feb-09	0.143	0.110	0.15	0.12
18-Feb-09	0.217	0.037	0.24	0.04
25-Feb-09	0.145	0.073	0.16	0.08
4-Mar-09	0.240	0.001	0.27	0.00
12-Mar-09	0.515	0.204	0.67	0.23
18-Mar-09	1.008	0.561	1.74	0.75
25-Mar-09	1.289	0.451	2.63	0.57
1-Apr-09	1.362	0.628	2.90	0.87
8-Apr-09	1.092	0.383	1.98	0.47
15-Apr-09	1.231	0.508	2.42	0.66
22-Apr-09	1.026	0.739	1.79	1.09
29-Apr-09	1.159	0.533	2.19	0.70
6-May-09	0.847	0.382	1.33	0.47
13-May-09	0.841	0.226	1.32	0.25
20-May-09	0.710	0.476	1.03	0.61
27-May-09	0.147	0.189	0.16	0.21
11-Jun-09	0.132	0.116	0.14	0.12
25-Jun-09	0.001	0.070	0.00	0.07
Standard error of difference (SED)				
Average:		0.203		

Male flies in male traps (2010)

A graph of the percentage of male traps with male flies present at each collection date (Fig 28c) indicates that, in orchards, male flies only started to appear consistently in traps from early March 2010. On this basis comparisons between dynamic and static traps have only been made using data collected on 3 March and later. Data from 10 March and 17 March was excluded as no male flies were caught on these dates (leaving 15 collection dates).

The effect of trap type (dynamic vs static) on the percentage traps with male flies did not change with date of collection (Trap type x Date interaction: P=0.933). On average over all dates for which flies were present, 20.7% dynamic traps had male flies while only 7.4% static traps had male flies present (P=0.022). There was an effect of date of collection on the percentage of traps with male flies (P=0.023). Adjusted percentages for each trap type on each collection date are shown in Table 11. Adjustments are required in order to make means comparable between dates because observations were not made at all sites on all dates. When the percentage of traps with male flies in dynamic and static traps was compared for each collection date the percentage was not significantly different on any date.

The effect of trap type on the number of male flies caught did not change with date of collection (Trap type x Date interaction: P=0.218). While there is some indication that dynamic traps became more efficient relative to static traps at times of the year when fly numbers in traps were high there were probably too few flies early in the season when fly numbers were low to detect this interaction between trap type and date. Adjusted male fly numbers for each trap type on each collection date are shown in Table 12 and Figure 29c. On average over all dates for which flies were present, there were 0.07 male flies in static traps and 0.30 male flies in dynamic traps (P=0.027). When the number of male flies in dynamic and static traps was compared for each collection date the number was

significantly higher in dynamic traps on 28 April (P=0.043) and 5 May (P=0.035) and close to significance on 14 April (P=0.082), 22 April (P=0.067) and 26 May (P=0.072). On all other dates there was no difference.

Table 11: Adjusted (for site) percentage of traps with male flies present at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
3/03/2010	-2.833	-2.833	5.6%	5.6%
24/03/2010	-2.079	-2.833	11.1%	5.6%
31/03/2010	-2.833	-17.566	5.6%	0.0%
7/04/2010	-2.079	-2.079	11.1%	11.1%
14/04/2010	-0.956	-2.833	27.8%	5.6%
22/04/2010	-0.693	-1.609	33.3%	16.7%
28/04/2010	-0.693	-1.609	33.3%	16.7%
5/05/2010	-0.956	-2.833	27.8%	5.6%
12/05/2010	-0.956	-1.609	27.8%	16.7%
19/05/2010	-1.253	-2.833	22.2%	5.6%
26/05/2010	-1.253	-2.833	22.2%	5.6%
2/06/2010	-0.956	-2.079	27.8%	11.1%
9/06/2010	-0.956	-2.833	27.8%	5.6%
16/06/2010	-1.609	-17.566	16.7%	0.0%
23/06/2010	-2.079	-17.566	11.1%	0.0%
Standard error of difference (SED)*				
Maximum:		1.126		
Minimum:		0.519		

** SED's reported cannot be used to compared greyed transformed means where no traps had male flies*

Table 12: Adjusted (for site) numbers of male flies at each collection date for Donnybrook. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
3/03/2010	0.063	0.039	0.065	0.040
24/03/2010	0.080	0.039	0.083	0.040
31/03/2010	0.080	0.000	0.083	0.000
7/04/2010	0.105	0.105	0.110	0.110
14/04/2010	0.394	0.063	0.483	0.065
22/04/2010	0.498	0.174	0.645	0.190
28/04/2010	0.741	0.227	1.098	0.255
5/05/2010	0.326	0.039	0.385	0.040
12/05/2010	0.483	0.148	0.621	0.160
19/05/2010	0.339	0.039	0.404	0.040
26/05/2010	0.339	0.039	0.404	0.040
2/06/2010	0.436	0.080	0.546	0.083
9/06/2010	0.212	0.080	0.237	0.083
16/06/2010	0.334	0.000	0.397	0.000
23/06/2010	0.201	0.000	0.223	0.000
Standard error of difference (SED)				
Average:		0.117		

Figure 28: Percentage of traps with male flies present at each collection date for Donnybrook. Note that date is in day number format (148892 is 28 Oct 2007 and 149129 is 18 June 2008; 149340 is 15 Jan 2009).

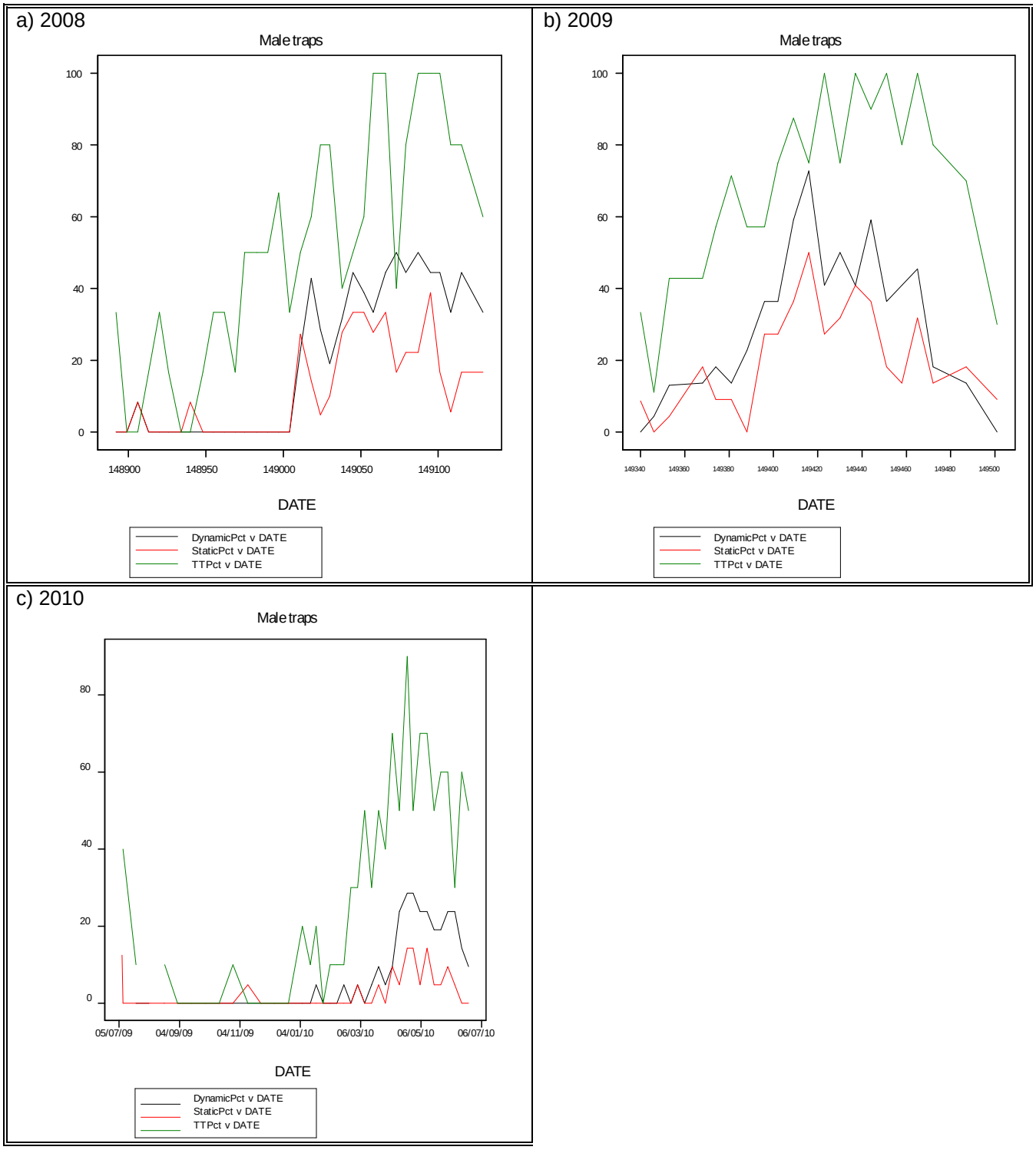
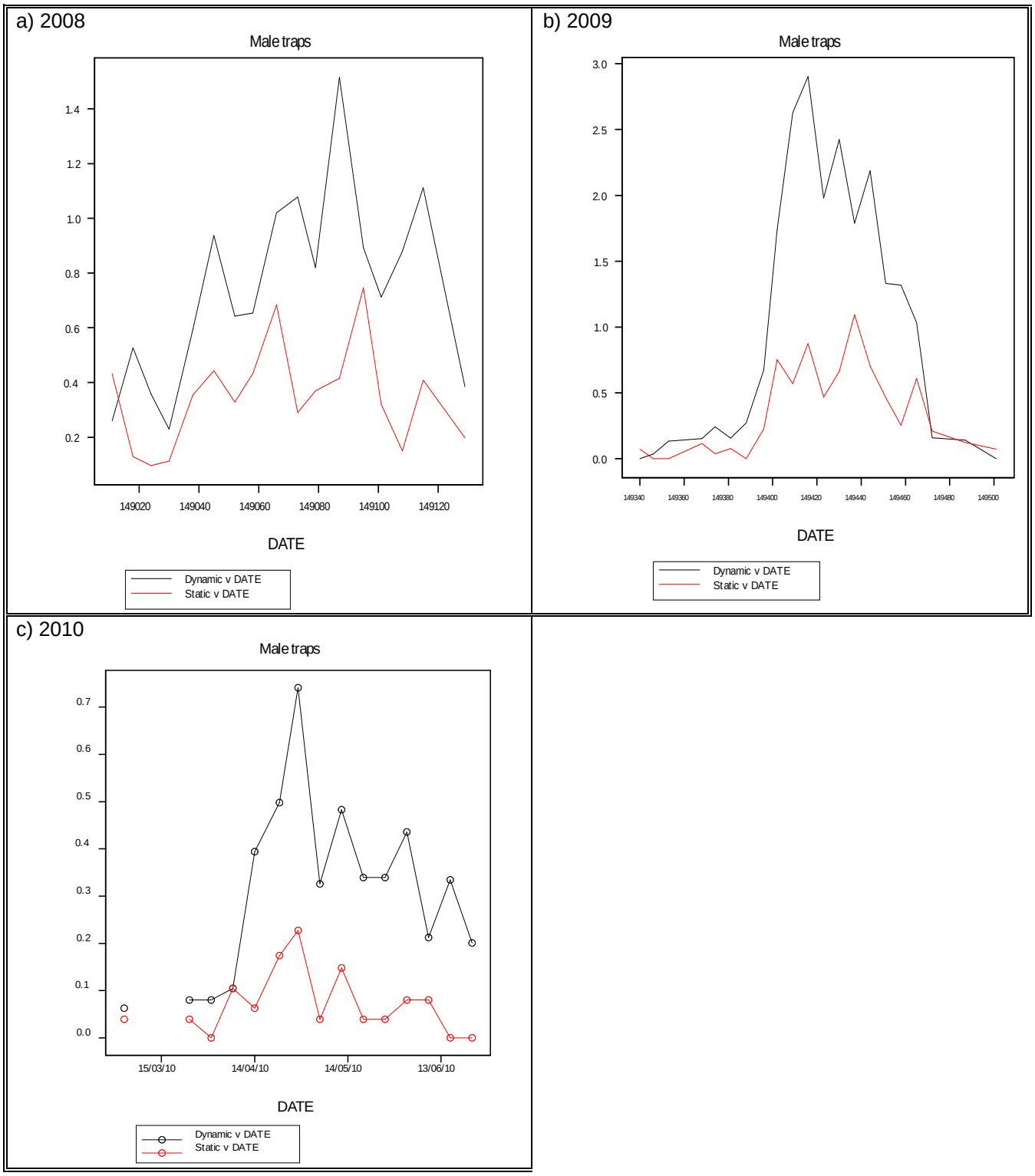


Figure 29: Average number of male flies present at each collection date. Note that date is in day number format (148892 is 28 Oct 2007 and 149129 is 18 June 2008; 149340 is 15 Jan 2009).



Host effect 2007-2008

There was no effect of host on the presence/absence of male flies in traps before or after removing overall effects for date of inspection (P=0.101 and P=0.225, respectively). The proportion of traps with male flies before and after adjustment for date of inspection is shown in Figure 30a.

A graph showing hosts and male fly numbers for each dynamic trap at each site (Figure 31a) indicates there is no clear effect of host on number of flies captured. However, tests of host effects before and after removing overall effects of inspection date are significant (P=0.002 and P<0.001, respectively). Average fly numbers for each host before and after adjustment for inspection date are shown in Table 13 and Figure 32.

Table 13: Numbers of male flies for each host before and after adjustment for overall effect of date of inspection for Donnybrook 2007-2008.

	Transformed mean		Back transformed mean	
Inspection_Date	Before	After	Before	After
Apple	0.631	0.786	0.88	1.19
Dwarf peach	0.866	1.851	1.38	5.36
Grapefruit	0.046	0.036	0.05	0.04
Mandarin	0.540	0.698	0.72	1.01
Nectarine	0.264	0.779	0.30	1.18
Orange	1.086	0.580	1.96	0.79
Peach	0.147	1.443	0.16	3.23
Pear	1.118	1.166	2.06	2.21
Plum	0.722	1.367	1.06	2.93
Standard error of difference (SED)				
Average:	0.397	0.193		

Host effect 2008-2009

There was a significant effect of host on the presence/absence of male flies in traps after removing overall effects for date of inspection (P<0.001). The proportion of traps with male flies after adjustment for date of inspection is shown in Fig 30b.

A graph showing hosts and male fly numbers for each dynamic trap at each site (Figure 31b) indicates that high numbers of male flies are associated with nectarine, peach, pear and plum hosts. Tests of host effects after removing overall effects of inspection date are significant (P<0.001). Average fly numbers for each host after adjustment for inspection date are shown in Table 14 and Figure 33. In general we can say that male traps in stone fruits have the highest numbers of male flies and male traps in citrus fruits have the lowest numbers of male flies; traps in pears have high numbers of male flies while traps in apples and figs have relatively low numbers of male flies. Pairwise comparisons using a 5%LSD based on the standard errors indicate that male traps in peach trees have significantly higher numbers of male flies than those in other fruit trees apart from apricots (due to lack of information); male traps in pear trees have significantly higher numbers of male flies than those in lemon, apple, fig, orange and grapefruit trees; male traps in nectarine and plum trees have significantly higher numbers of male flies than those in orange and grapefruit trees.

Table 14: Numbers of male flies for each host after adjustment for overall effect of data of inspection for Donnybrook 2008-2009.

Inspection Date	Transformed mean	Back transformed mean
Peach	1.418	3.13
Pear	0.971	1.64
Apricot	0.816	1.26
Nectarine	0.662	0.94
Plum	0.623	0.86
Mandarin	0.480	0.62
Lemon	0.429	0.54
Apple	0.375	0.46
Fig	0.311	0.36
Orange	0.066	0.07
Grapefruit	-0.032	0.00
Standard error of difference (SED)		
Average:	0.240	

Host effect 2009-2010

Static traps
In 2010 static male traps were placed in a range of hosts. Table 15 shows the number of static traps in each host which captured at least one fly during the year. Due to the low number of traps in each host there is no difference in the percentage of traps that caught flies in different hosts.

Dynamic traps
There was no effect of host on the presence/absence of male flies in dynamic traps after removing overall effects for date of inspection (P=0.174). The proportion of traps with male flies after adjustment for date of inspection is shown in Fig 30c.

A graph showing hosts and male fly numbers for each dynamic trap at each site (Figure 31c) indicates that high numbers of male flies are associated with olive, orange, peach, pear and plum hosts. Tests of host effects after removing overall effects of inspection date were significant (P=0.024). Average fly numbers for each host after adjustment for inspection date are shown in Table 16 and Figure 34. Pairwise comparisons using a 5%LSD based on the standard errors indicate that male traps in orange, nectarine, peach, persimmon and pear trees had significantly higher numbers of male flies than those in apple and grapefruit trees.

Table 15: No. and % static traps in each host (static) that caught at least one fly during 2009-2010

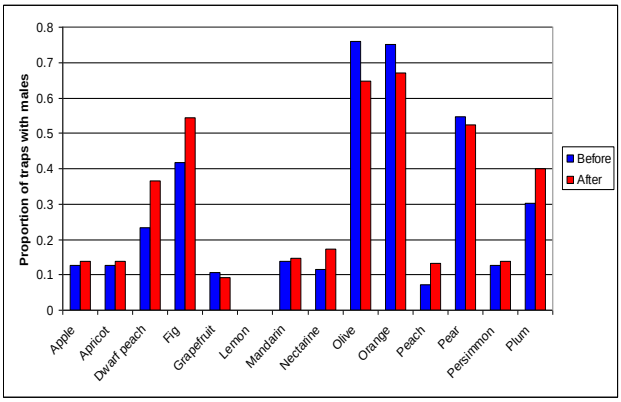
Host	Total no. Traps	No. Traps with flies	%Traps with flies
Apple	2	0	0%
Cherry	1	0	0%
Loquat	1	0	0%
Nectarine	1	0	0%
Orange	2	1	50%
Peach	3	1	33%
Pear	1	0	0%
Plum	7	5	71%

Table 16: Numbers of male flies for each host (dynamic) after adjustment for overall effect of date of inspection for Donnybrook 2009-2010.

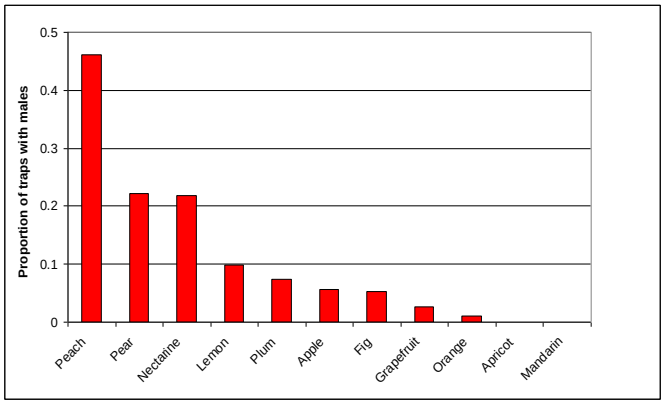
Inspection Date	Transformed mean	Back transformed mean
Orange	1.066	1.90
Nectarine	1.044	1.84
Peach	0.937	1.55
Persimmon	0.781	1.18
Pear	0.761	1.14
Olive	0.504	0.66
Fig	0.392	0.48
Plum	0.370	0.00
Mandarin	0.360	0.43
Apple	-0.136	0.00
Grapefruit	-0.331	0.00
Standard error of difference (SED)		
Average:	0.490	

Figure 30: Effect of host after adjustment for overall effect of date at Donnybrook on proportion of traps with males.

(a) 2008 (*Note that standard errors are not presented as those calculated by Genstat appear to be unreliable)*



b) 2009 (*Note that standard errors are not presented as those calculated by Genstat appear to be unreliable)*



(c) 2010

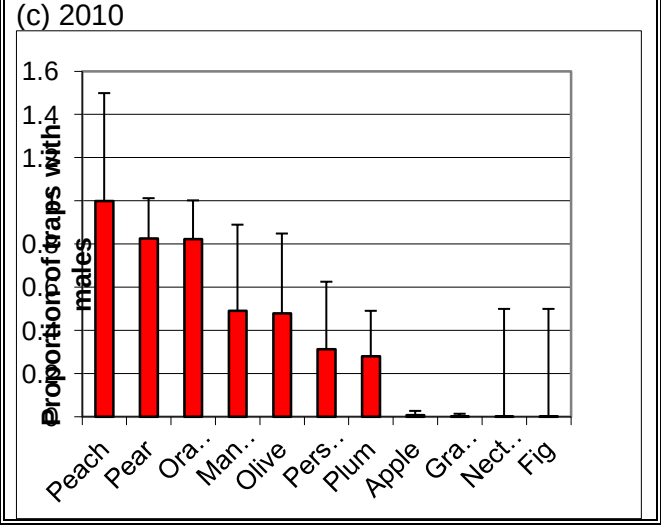


Figure 31: Effect of host after adjustment for overall effect of date at Donnybrook on male fly numbers (with virtual SE bars).

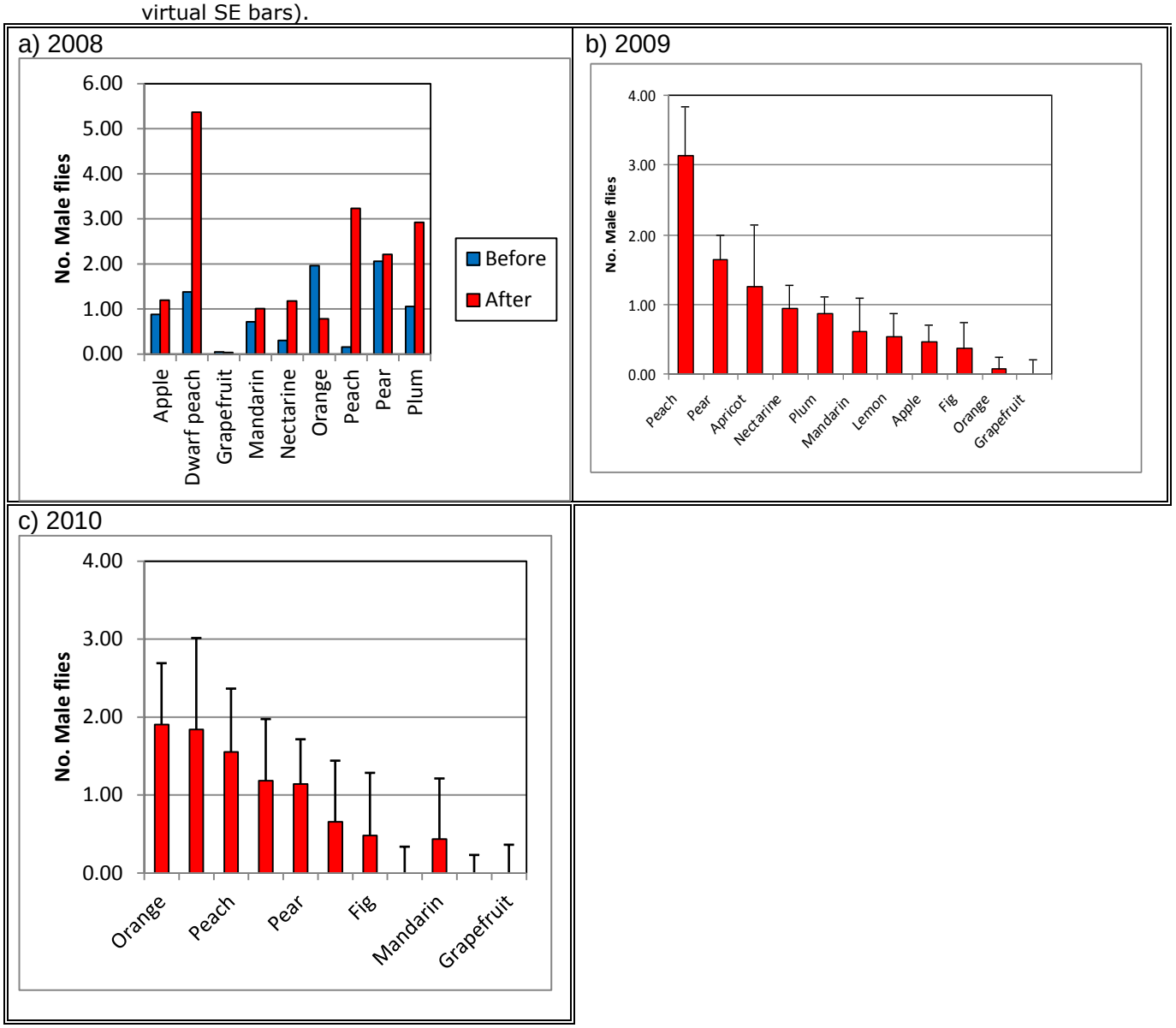


Figure 32: Loge (number of male flies +1) and host (apple: black x; dwarf peach: red circle; grapefruit: green cross; mandarin: blue star; nectarine: pale blue square; orange: pink diamond; peach: blue triangle; pear: orange triangle; plum: green asterisk) for each dynamic trap at each collection date. Note that date is in day number format (148892 is 28 Oct 2007 and 149129 is 18 June 2008)

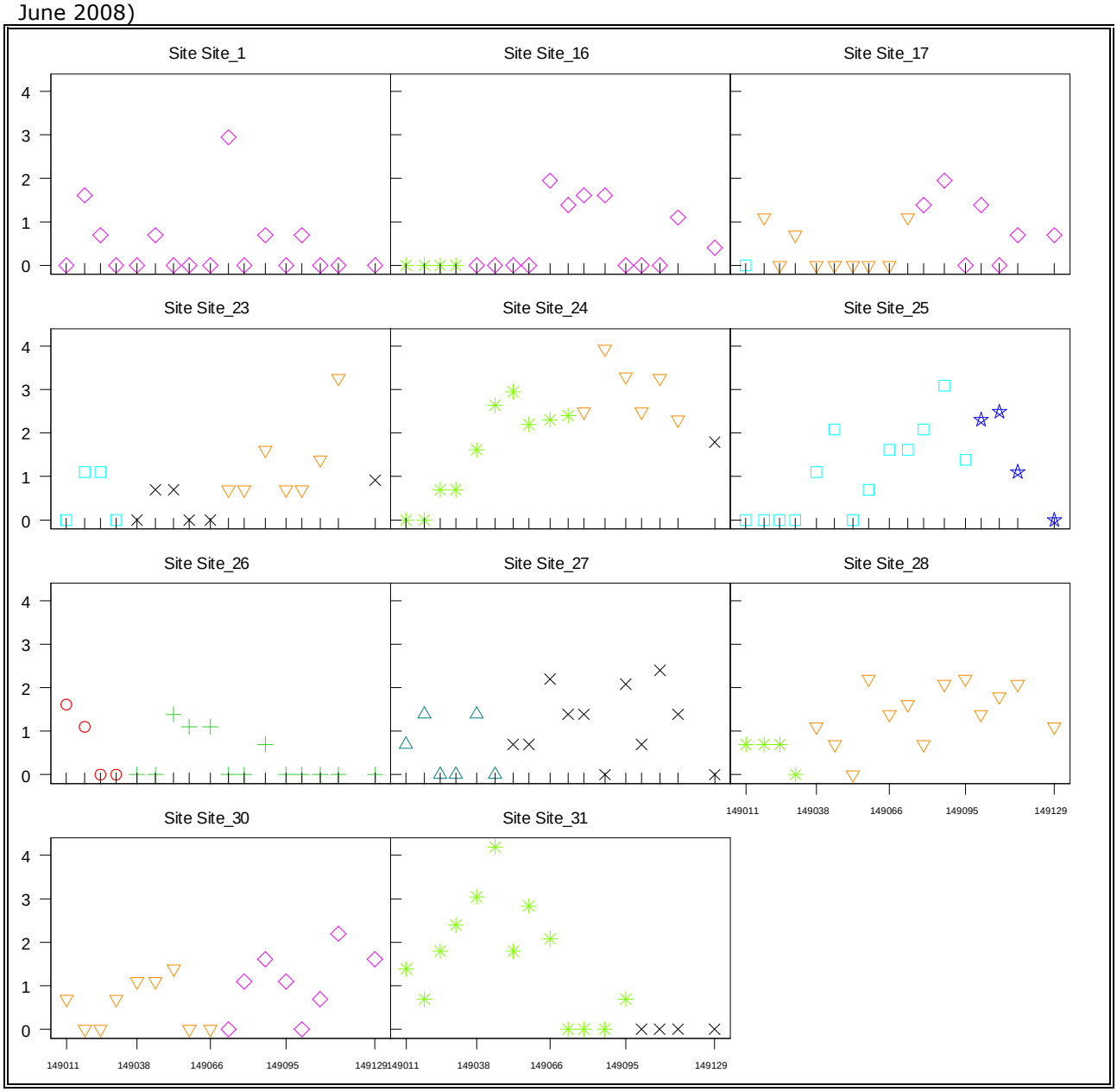


Figure 33: Loge (number of male flies +1) and host (apple: black x; apricot: red O; Figure green +;grapefruit: blue star; lemon: pale blue square; mandarin: pink ◇; nectarine: yellow Δ; orange: orange ▼; peach: green asterisk; pear: aqua x; plum: blue O) for each dynamic trap at each collection date. Note that date is in day number format (149340 is 15 Jan 2009)

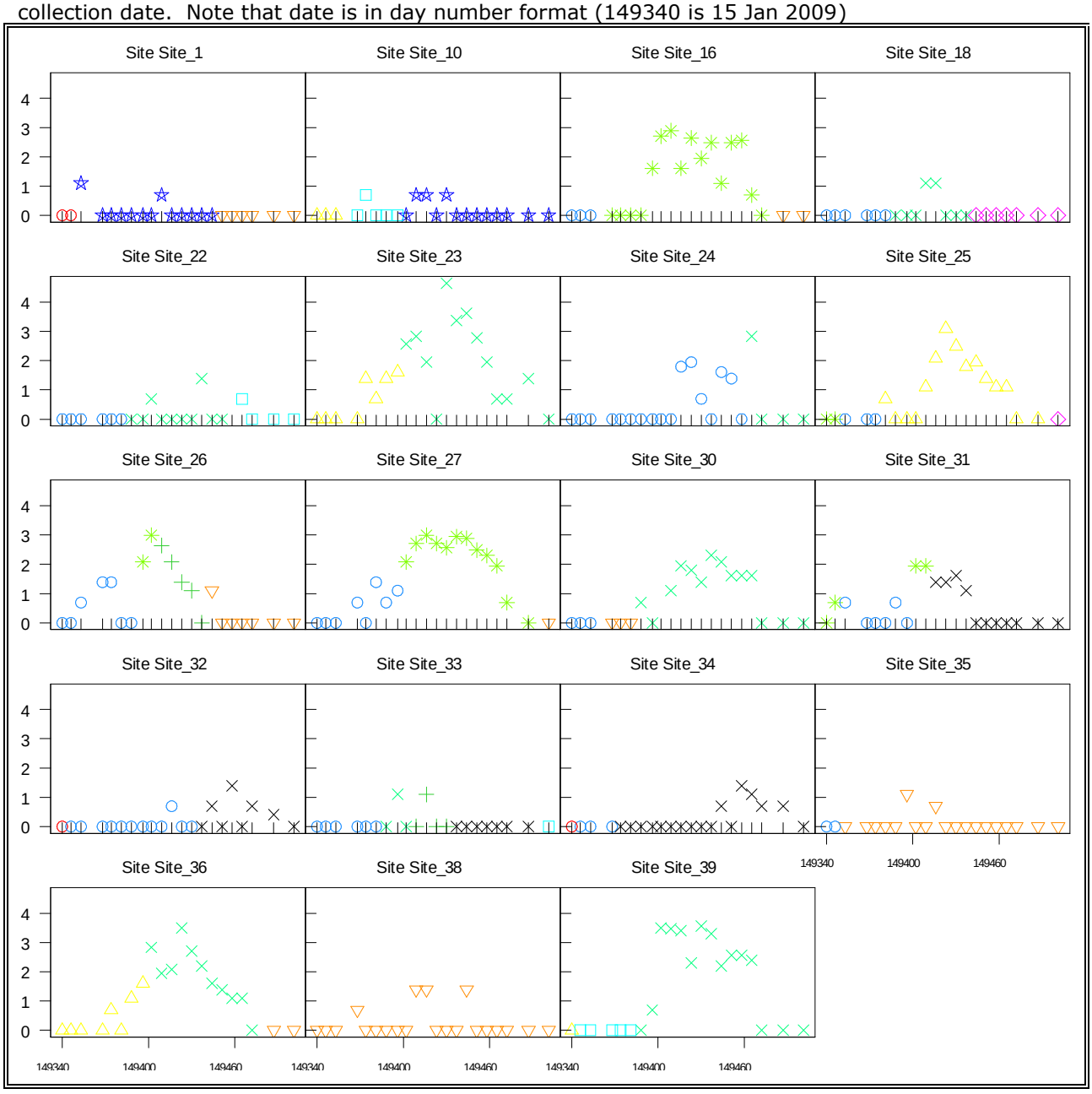
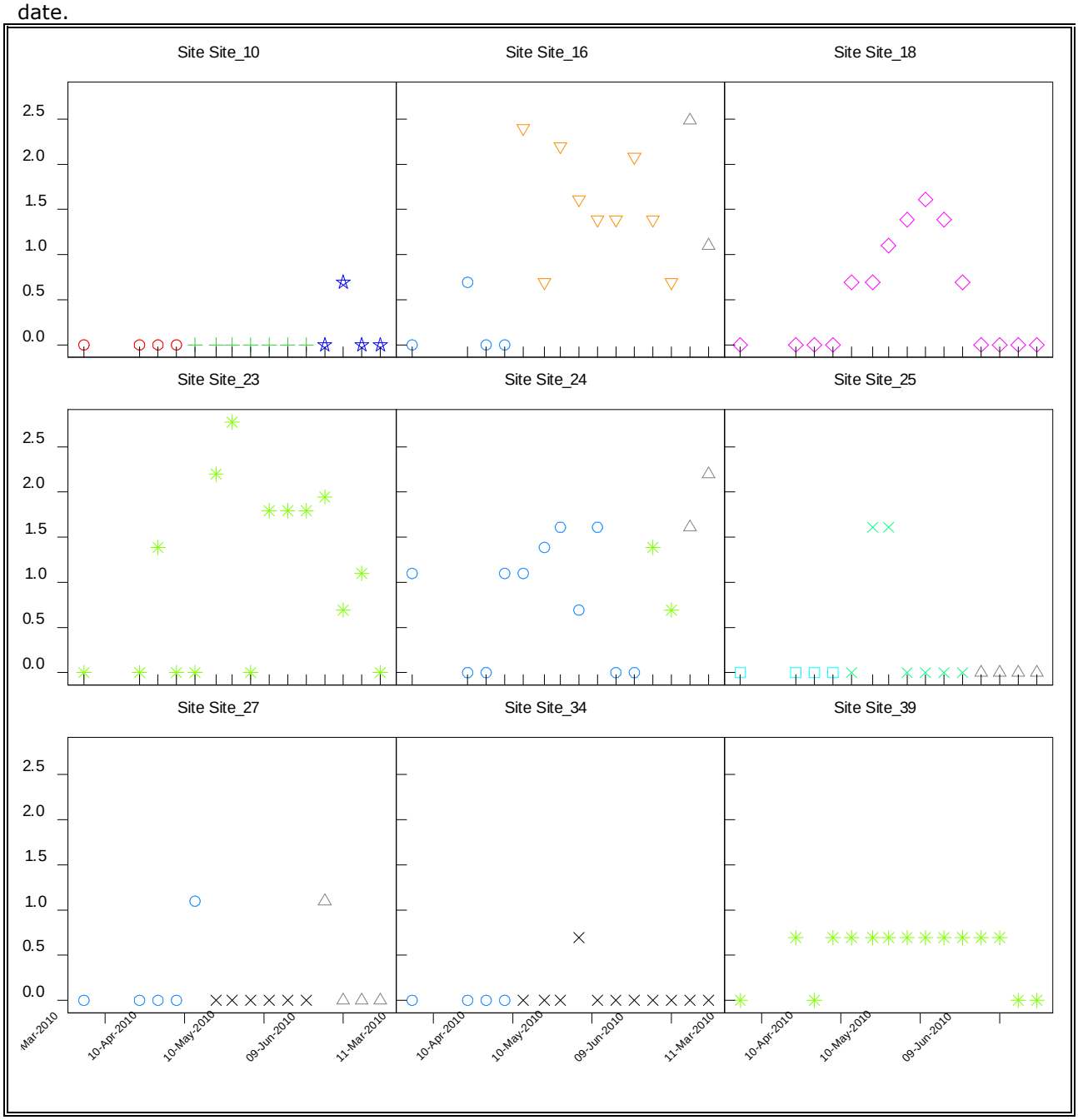


Figure 34: Loge (number of male flies +1) and host (apple: black x; Figure red O; grapefruit: green +;mandarin: blue star; nectarine: pale blue square; olive: pink ◇; orange: grey Δ; peach: orange ▼; pear: green asterisk; persimmon: aqua x; plum: blue O) for each dynamic trap at each collection date.



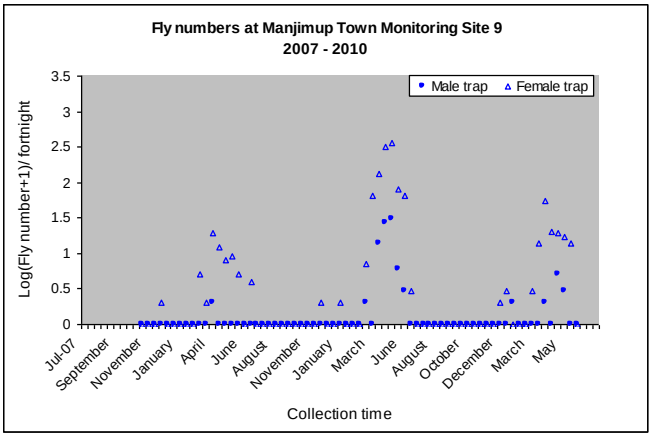
Manjimup

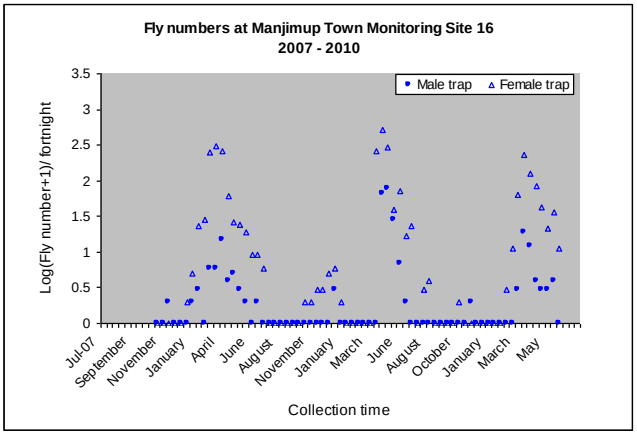
Town Monitoring

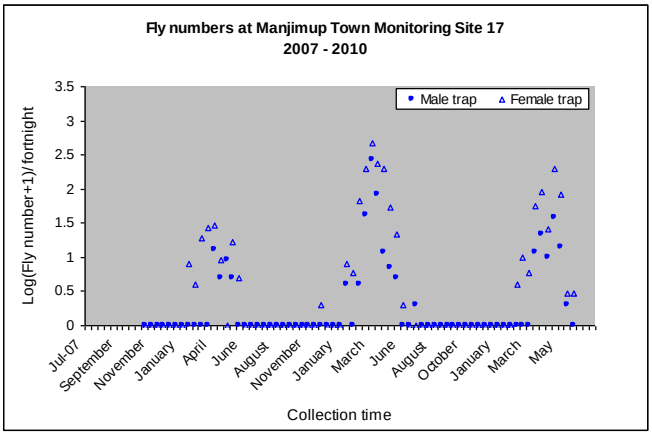
Fly captures were much lower in Manjimup as anticipated by the preliminary survey (Appendix A) but numbers at Town trap sites with established populations were high, reaching about 500 per fortnight at site 16 and site 17, especially in 2009 which was the most favourable season (Figure 35).

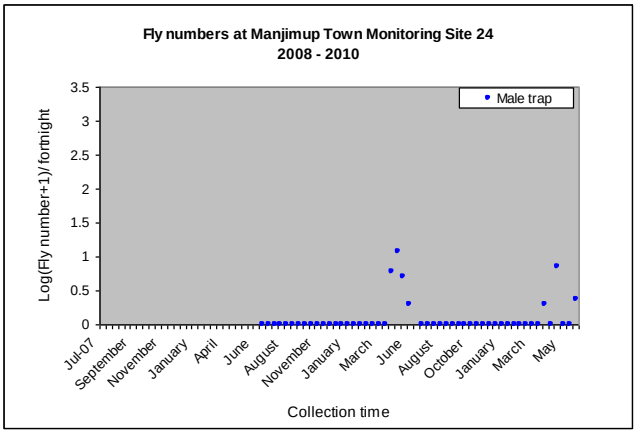
During winter and spring, mid July - January, flies were not captured at the threshold level of more than two flies per fortnight, with the exception of one site which had a small peak in December 2008 followed by numbers as high as in Donnybrook (> 500/ fortnight) in March 2009 which carried over into traps until August that year (Site 16). Generally flies were found in small numbers from late November at levels below the threshold. Highest numbers were recorded at most sites (>10 per fortnight) between late March and early May.

Figure 35: Fly numbers at Town Monitoring sites in Manjimup









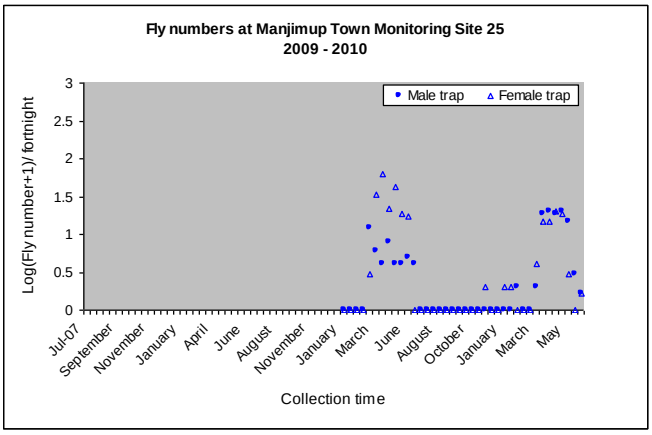
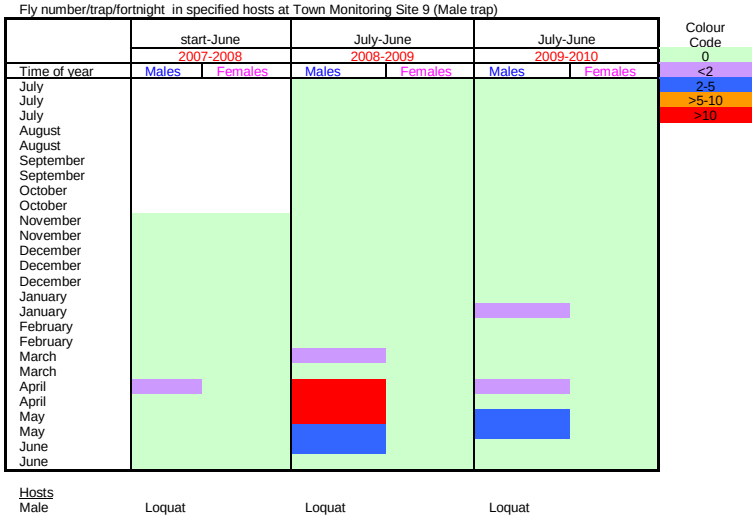


Figure 36: Fly numbers and hosts in which traps were placed at Manjimup town monitoring site 9



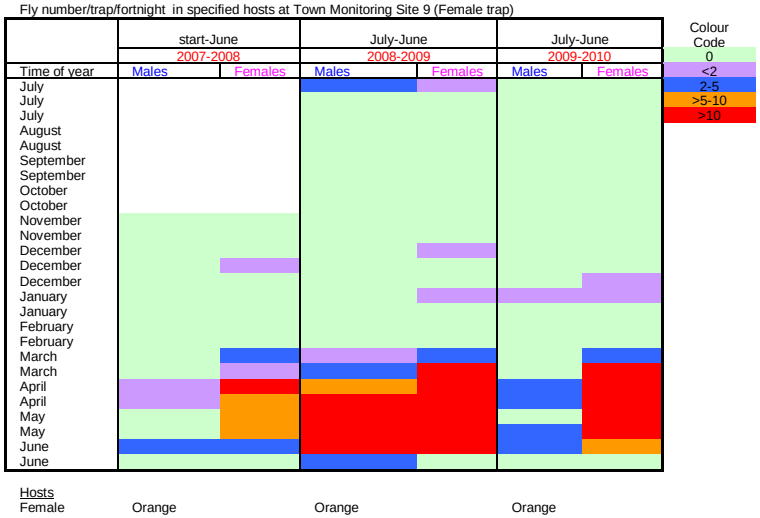
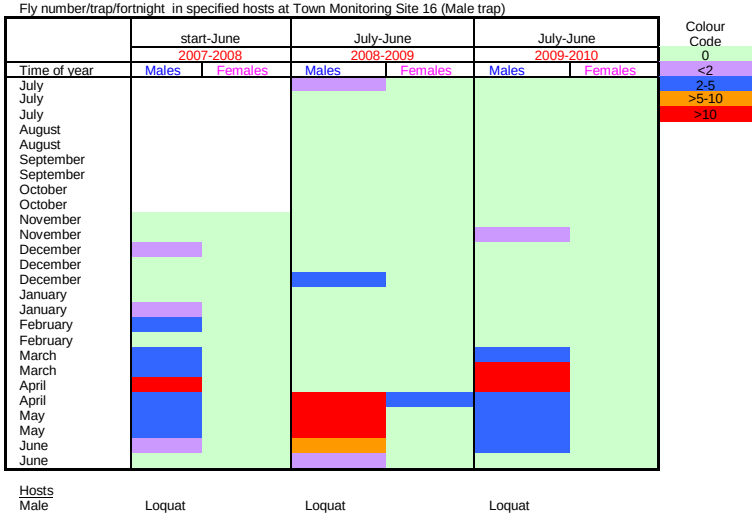


Figure 37: Fly numbers and hosts in which traps were placed at Manjimup town monitoring site 16



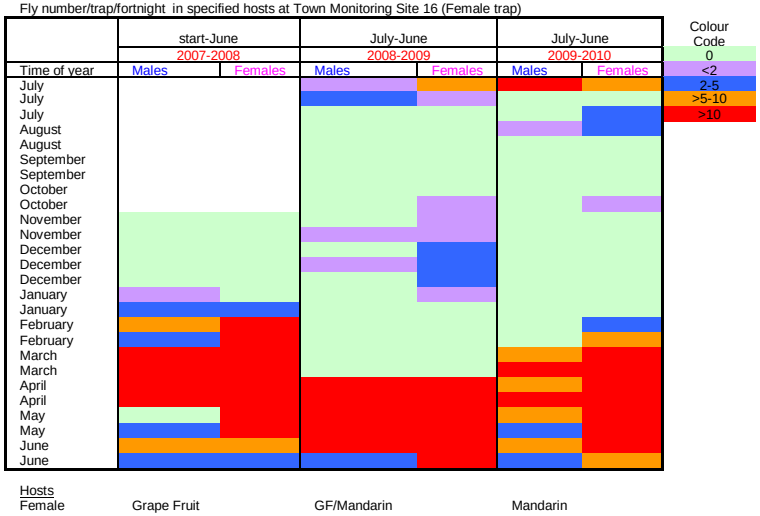
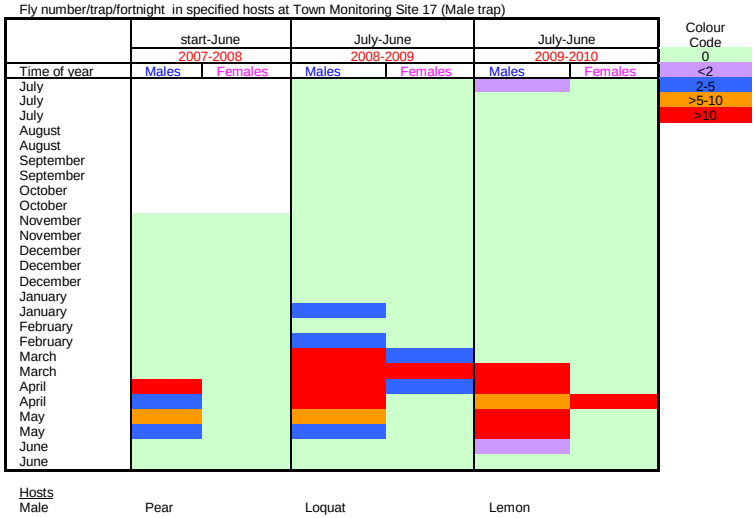


Figure 38: Fly numbers and hosts in which traps were placed at Manjimup town monitoring site 17



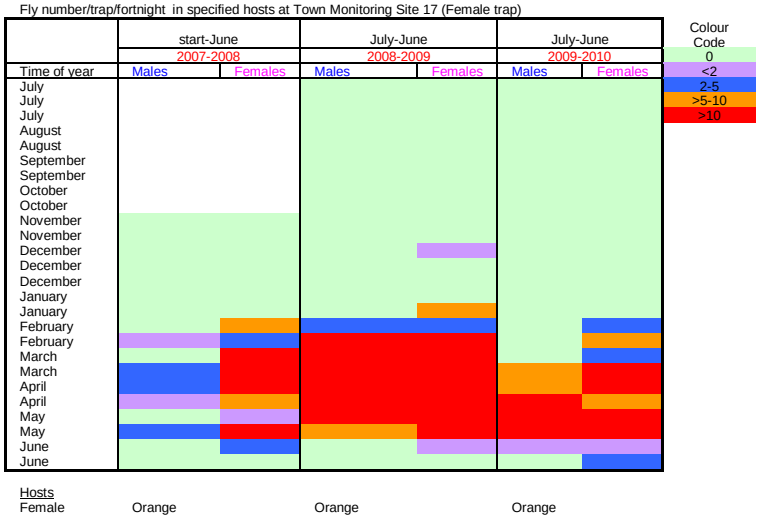


Figure 39: Fly numbers and hosts in which traps were placed at Manjimup town monitoring site 24

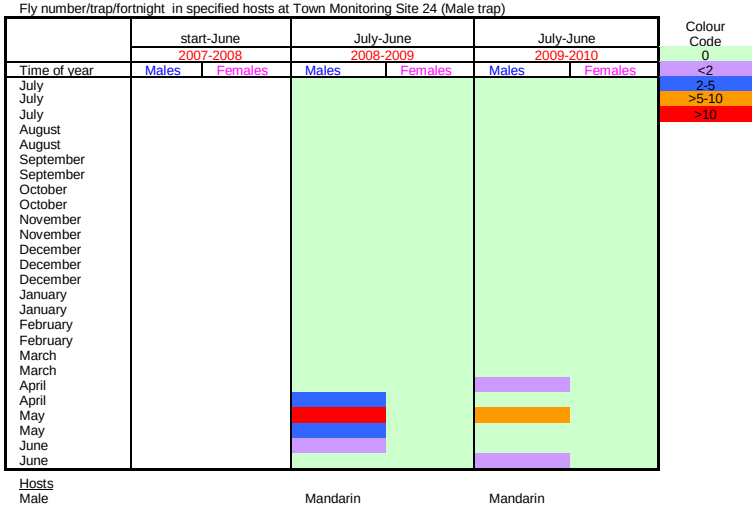
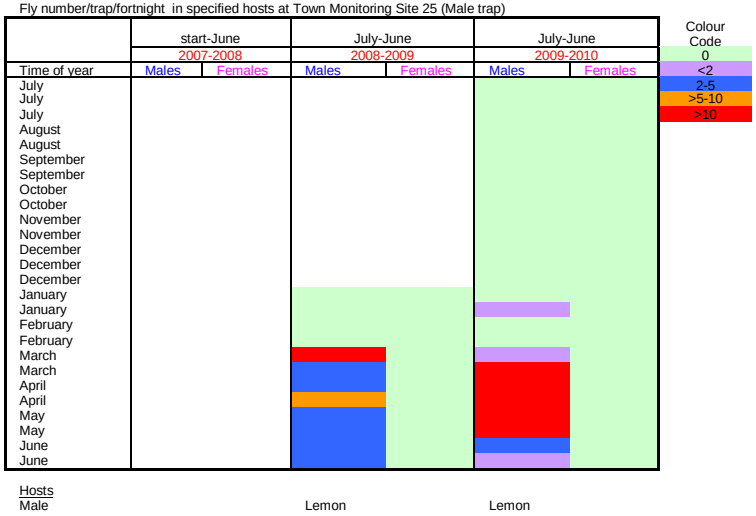


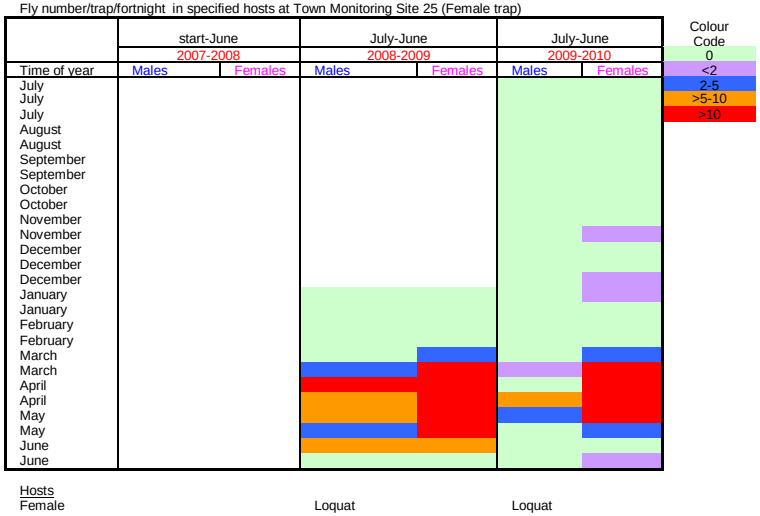
Figure 40: Fly numbers and hosts in which traps were placed at Manjimup town monitoring site 25

Fly number/trap/fortnight in specified hosts at Town Monitoring Site 25 (Male trap)



Hosts
Male — Lemon — Lemon

Fly number/trap/fortnight in specified hosts at Town Monitoring Site 25 (Female trap)



Hosts
Female — Loquat — Loquat

Orchard trial sites

Time of fly capture: static vs dynamic traps

Flies were captured earlier and more frequently in dynamic traps than in static traps at a majority of sites in Manjimup (Table 17).

In 2008, Dynamic traps captured flies (two or more per fortnight) four or more weeks earlier at two sites, at one site both traps captured flies in the same period and at one site Static traps captured flies earlier than the Dynamic traps.

In 2009, Dynamic traps captured flies (two or more per fortnight) two or more weeks earlier at three sites and the Static trap at three sites.

In 2010, more than two flies per fortnight was captured only at one site in Manjimup and this was in a dynamic trap.

Table 17: Time lag in the fly capture by the Dynamic or Static trap at individual sites in Manjimup

		Number of weeks the Dynamic trap captured two flies or more earlier than Static trap		
Site	Type of trap	2008	2009	2010
1	Male	*nf*	*nf*	*nf*
2	Male	*nf*	*nf*	*nf*
3	Male	Static >10	*nf*	*nf*
4	Male	*nf*	*nf*	*nf*
5	Male	*nf*	*nf*	*nf*
7	Male	*nc*	Static >10	*nc*
8	Male	*nf*	*nf*	
11	Male	>10	>10	>10
12	Male	*nf*	>10	*nc*
15	Male	*nc*	*nf*	*nf*
20	Male	*nf*	Static >10	*nf*
22	Male	0	Static >4	*nf*
23	Male	*nc*	*nc*	*nc*
6	Female	*nf*	>10	*nf*
14	Female	*nc*	*nc*	*nf*
21	Female	>4	*nc*	*nc*

nf = no flies; *nc* = not captured >2; = no traps at this site

The time lag between the capture of flies in Dynamic and Static traps over the three year period, in Manjimup is shown for individual sites at which flies were detected (Figure 41-56). Higher numbers reached at sites where flies were breeding are seen in Figures 49 and 55. Earlier capture of two or more flies in the dynamic trap in one or more seasons as shown in Table 17 is also seen in Figures at site numbers 6, 11, 12 and 21. Earlier captures of flies in static traps are seen in Figures at site numbers 3, 7, 20 and 22.

Host phenology and fly population at Manjimup orchard sites

In Manjimup large orchards consist of pome and stone fruit similar to Donnybrook but there fewer citrus orchards. Within these orchards are small numbers of a variety of fruit trees similar to Donnybrook. In the town itself, fruit trees were scattered through many back yards in small numbers. Fly numbers in

Manjimup are generally lower than in Donnybrook and flies are rarely found more than 5km radius from the town centre.

Even though there was a breeding population in town, orchards closer to the town were not treated for fruit fly as fruit fly damage was not perceived to be a major issue. Neglected backyard orchards where trees were densely planted and not pruned (site 16) and fruit was left to rot (site 9) lead to high numbers in the peak population period.

Types and varieties of fruit in these orchards varied and sites were categorised according to available fruit volume as well as size/type of the orchard (Table 18). Distance of each site from the town centre is also given.

Frequency of capture at threshold levels

Fourteen of the trial sites were non-breeding sites and two were breeding sites (Table 18). The number of times that flies were captured in each category of fly density (ie: <2 per fortnight; 2-5 per fortnight, >10 per fortnight) is given for the three years of the study.

Flies were not captured between mid July to mid-February at trial sites in all years.

Flies were captured at the threshold level (>2 flies per trap per fortnight), from mid March to June. Fly numbers recorded at the two sites at which flies may have been breeding were very low (maximum 8 & 12 per fortnight) compared to those at town trap sites (maximum 30, 78, 264 per fortnight). In 2010, when fly numbers were generally low, flies at the threshold level (two or more flies per trap) were captured only at one site (site 11) and that was in a dynamic trap (Figure 49).

Sites 6, 14 and 21 were orchards which contained a pair of female traps. Numbers observed at these sites were small (Figure 46, 51 and 54).

Table 18: Characteristics of orchards trial sites with non-breeding and breeding Medfly populations in Manjimup

Key Small orchards Large orchards					Capture Frequency All, Jan-June			Capture Frequency < 2 flies/trap/fortnight Jan-June			Capture Frequency 2-5 flies/trap/fortnight Jan-June			Capture Frequency 6-10 flies/trap/fortnight Jan-June			Capture Frequency >10 flies/trap/fortnight Jan-June		
Site	Type of trap	Fruit volume in 200 m	Distance from town centre	Breeding population	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
1	Male	High (apple)	2-5	No	0	0	0												
2	Male	Moderate	2-5	No	0	0	0												
3	Male	High	5-10	No	1	0	0				1								
4	Male	High	5-10	No	0	0	0												
5	Male	High	5-10	No	0	0	0												
7	Male	Moderate	<2	No	3	5	1	3		1		2							
8	Male	Moderate/Low	<2	No	0	0	0												
11	Male	Moderate	2-5	YES	5	6	4	3	2	2	2	3	2		1				
12	Male	Low	2-5	No	2	3	0	2	1			2							
15	Male	Moderate (cherry)	2-5	No	1	0	0	1											
20	Male	Low	2-5	No	0	7	0		6			1							
22	Male	High	<2	YES	5	10	0	1	1		3	7		1	1			1	
23	Male	High	5-10	No	1	3	1	1	3	1									
6	Female	High	5-10	No	0	2	0		1			1							
14	Female	Low - Moderate	2-5	No	1	1	0	1	1										
21	Female	High (Avo+Cherry)	2-5	No	6	1	1	3	1	1	3								

Orchard trial sites with breeding populations

Large orchards

Sites 3, 4, 5, 6, 22 and 23 were large commercial orchards. These properties contained a high volume of fruit, more than 20 fruit per tree in both pome and stone fruit. Site 21 was a relatively large orchard that consisted mainly of avocado, cherry and apricot, in the two seasons it was used in this study the fruit volume in apricot was low (<6 fruits per tree). Of these, site 22 was closest to town (<2 km). Site 3-6 and 23 were 8-10km from the town centre.

Of these, site 22 appeared to have a breeding population, that is numbers remained steady at the threshold level for several weeks (Figure 55) in both 2008 and 2009. There was a succession of pome and stone fruit at this site. Early fruiting apricots, plums and apples provided a continuous succession of hosts in the warmer months. In 2010 there were no flies at this site. Periodically fruit remained on the ground allowing population build up. However, there was little fruit available in the latter half of the year and that maybe why a large breeding population did not establish in spite of its proximity to the town centre.

Small orchards

Site 11, was a small orchard that was fairly isolated (<5km from town). At this site, small numbers were captured consistently over the three seasons, suggesting that there is a small breeding population at this site even though the numbers were not very high (Figure 49). Although host numbers were low at this site, trees were well tended and produced well (> 20 fruit per tree) and there was a large variety of fruits such as loquats, and citrus to provide a succession of hosts through the year. Even in 2010, where fruit set was low at some sites, at this site only peaches set less fruit, all other host types produced well.

In 2010, fly numbers at trial sites were extremely low and flies were captured at the threshold level (two or more flies per fortnight) only once at site 11. The shortage of stone fruit is suspected to be the cause as there was no shortage of numbers at breeding sites in the town and the flies reached high numbers at these sites at a similar time of the year as in previous seasons (Figure 36-40). Site 22 in Manjimup was the largest orchard closest to the town, and more than ten flies in a fortnight were captured only at this site on one occasion in 2009. Although numbers increased within four weeks of first detection in 2009, there were no flies in the following season indicating no breeding population, or that the population died out or dispersed in the 2010 season, as there was a massive amount of fruit available at this orchard.

Possible factors affecting fruit set in 2010

Fruiting in apple, nashi, peach and plum was delayed by one or more weeks (Table: 19). The delayed time is given as an estimate due to differences in the dates of phenology recording in the two seasons. At site 11 cherry did not produce fruit however, apple, pear and quince produced fruit at a similar time and fruit volume was high (>20 per tree) in 2010 (Figure 49). Note that the pattern of rainfall was considerably different in the latter three months of 2007 and 2008 where there was a total of 187 and 198ml of rainfall compared to 96ml in the same months in 2009 (Table: 20). Average temperature was also lower in December of 2007 and 2008 compared to 2009.

Table 19: Delay in fruit set noted at some sites in Manjimup 2010.

Fruit set at Site 11

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apple	29-Oct	4-Nov	
Cherry	29-Oct		no cherry
Nashi	29-Oct	2-Dec	> 4 weeks
Peach	9-Oct	4-Nov	> 1 week
Pear	6-Nov	4-Nov	
Plum	9-Oct	4-Nov	> 1 week
Quince	22-Oct	4-Nov	

Fruit set at Site 22

Host	Fruit set		
	July-June 2008-2009	July-June 2009-2010	
Apple	6-Nov	2-Dec	> 1 week
Apricot	15-Oct	4-Nov	
Pear	29-Oct	4-Nov	
Plum	9-Oct	4-Nov	> 1 week

Table 20: Climate data Manjimup

	Total rain (mm)				Av Max temp				Av Min temp			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Jan		2.8	3.2	2.8		28.0	27.9	28.4		13.4	13.8	12.8
Feb		12.2	17.8	1.6		28.9	27.0	29.1		14.8	13.5	14.4
Mar		11	27	13		25.4	24.3	26.3		12.5	11.9	13.9
Apr		145.2	6.4	48.6		21.1	23.2	21.8		10.7	10.6	10.6
May		125.6	95.4	88.2		18.7	20.5	18.0		10.0	8.2	9.0
Jun		136.2	184.8	51.8		16.2	15.0	16.0		7.1	7.5	6.6
Jul	168.6	196.2	199.4		15.6	14.2	14.7		7.5	5.7	6.3	
Aug	152.8	46.2	114.4		15.6	16.2	15.3		8.0	5.2	7.3	
Sep	148.2	104.4	180.7		16.9	16.8	14.9		8.1	7.4	6.6	
Oct	81.8	77	27.8		19.1	19.6	19.8		7.9	9.4	9.4	
Nov	7.6	73	64.2		24.7	19.5	23.6		10.3	9.5	10.7	
Dec	98	48.2	4.6		23.5	23.8	26.3		11.4	11.1	11.2	

	Temperature range		Temperature range		Temperature range		Temperature range	
	Max	Min	Max	Min	Max	Min	Max	Min
	2007	2007	2008	2008	2009	2009	2010	2010
Jan			36.1	9.3	40.2	10.3	40.8	8.6
Feb			38.3	9.6	37.9	8.1	36.8	7.5
Mar			34.8	8.8	36.4	6.7	38.4	7.9
Apr			29.9	6.8	30.4	5.6	27.3	4.9
May			23.5	6.7	26.0	4.4	25.1	5.0
Jun			19.3	4.9	22.3	3.0	20.7	2.2
Jul	19.4	2.9	18.5	2.3	19.2	2.8		
Aug	21.5	2.3	21.1	2.4	18.9	2.4		
Sep	23.0	3.3	22.7	2.2	22.4	3.0		
Oct	27.6	3.7	28.5	5.0	31.0	5.0		
Nov	36.6	5.4	27.6	6.0	32.5	4.6		
Dec	41.1	4.6	32.0	7.6	36.9	7.0		

Orchard trial sites without breeding populations

Large orchards

Site 3, 4, 5, 6 and 23 were large orchards comparable in size to site 22, with a similar volume of fruits (Figure 43-46, 56). Of these, flies were captured once at site 3 and twice at site 6 (Figure 43, 46). Fruit volume was similar (>20 per tree) in pome fruit at all sites, but stone fruit volume was less ('Low' to 'Moderate' at sites 4, 5 and 'Low' for peaches and nectarine at site 23 in 2010), but at some sites a greater range of fruit was available such as feijoa, persimmon (site 4, site 6). There is no obvious reason for the non-establishment of a breeding population other than the small numbers entering the area.

Site 21 consisted of mostly apricot, avocado and cherry, with a small number of other stone and pome fruit. Therefore, the host succession at this site was not favourable to the establishment of a population. Flies were captured at the threshold level in 2008 but not in 2009 or 2010 (Figure 54).

Small orchards

Site 1 and site 2 were small orchards surrounded by large apple orchards, site 1 with a small number of a variety of fruit such as fig, loquat (>20 per tree) and citrus (11-20 fruit per tree) and site 2 with high volumes in all fruit (>20 fruit per tree; even though a large proportion of stone and pome fruit in 2010 was taken by birds) that provided a succession of hosts through the year (Figure 41, 42). No flies were recorded at either site. Site 8 was another orchard at which flies were not captured and that was discontinued in 2010 as the owners gradually removed their orchard (Figure 48).
At site 6 and site 20, small numbers of flies were captured only in 2009 (Figure 46 and 53).

At site 12 the backyard trees were few in number and the fruit volume in pome fruit was <10 per tree, however, flies were captured in both 2008 and 2009 in small numbers (Figure 50). A similar pattern is seen at site 7 (Figure 47) which had some large trees with >20 fruit per tree (apricot, olive) and smaller trees pear, peach, apple that had a high fruit volume except in 2010.

At site 15 which had a variety of stone and pome fruit (>20 per tree) only one fly was captured in 2008 (Figure 52). This site had low numbers of early fruiting stone fruit such as apricot and peach.
Earliest flies of the season were captured at site 14 in female traps in February (Figure 51) but single flies only in 2008 and 2009. Early fruiting apricot and also plums at site 14 were large trees with low fruit volume (<6 per tree) with the exception of 2009 when they produced a higher volume of fruit (11-20 per tree). Even in other seasons, where flies had triggered the threshold intermittently and there was a large volume of fruit available, a breeding population did not establish at these orchards.

Manjimup
Site 1

Ripe fruit at Site 1

Host	Availability of Ripe fruit		
	start-June 2007Nov - 2008	July-June 2008-2009	July-June 2009-2010
Apple	Mar-May	Mar-June	April-May
Apricot	Dec-Jan		Jan
Fig	Dec-Jan; Feb-May	Oct-Jan; Feb-May	Dec-Jan; Apr
Lemon	…-June	July-June	July-June
Loquat		Nov-Dec	Dec
Mandarin	…-June	July-Nov; Jan-June	July-Nov;Dec-Jan; May-June
Nectarine	Feb	Oc & Feb	
Orange	…-June	July-Mar; May-June	July-Sept; June
Passion fruit		Feb-April	April
Pear	Mar-Apr	Mar-May	Apr
Persimmon	Apr-June	Apr-June	Apr-June
Prickly pear		July-June	July-June

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 1

Hosts within 200m radius
Apple 500-600
Citrus (Lemon, Mandarin) < 6
Peach < 30
Apricot < 6
Other fruit (Fig, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	M	M	L
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	M	M	H

Fly number/trap/fortnight in specified hosts at Site 1

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Evergreen)	no flies (Loquat)	no flies (Loquat)
Dynamic	no flies	no flies	Pear

No flies

Figure 41: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 1

Manjimup
Site 2

Ripe fruit at Site 2

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb	Mar	Mar-Apr
Cherry	No-Dec	Dec	Dec
Fig	Jan-May	Oct-May	Jan-May
Lemon	All year	All year	All year
Lilly pilly	Nov; May-June	July-Oct; May-June	July-Sept; May-June
Mulberry	Nov-Feb	Oct-Dec	Nov-Jan
Olive	Mar-May	Apr-June	April
Orange	Nov-Dec; Mar-June	July-Aug; Dec; May-June	July-Sept; May-June
Passion fruit	..-Dec;Feb-Apr;June	Aug-Oct; Mar-Apr	Aug-Apr
Plum	Nov-Jan	Dec-Jan	Jan
Prickly pear		Jul-Dec;Mar-June	Aug-Aug; Oct-Jan; Mar-June

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 2

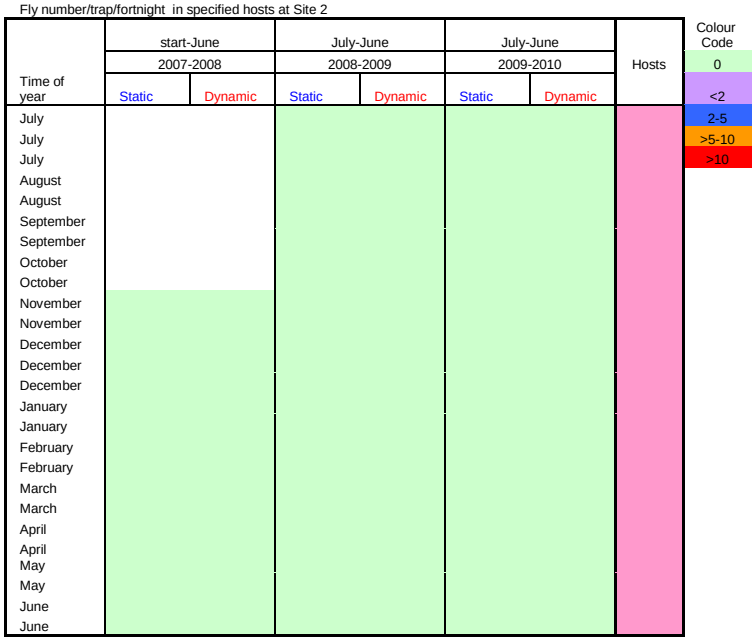
Hosts within 200m radius

Apple 100-200
Citrus (Lemon, Mandarin) < 6
Cherry < 6
Other fruit (Fig, Grape etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH removed by birds
Pome fruit	VH	VH	VH removed by birds
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 2



Colour Code

0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Evergreen)	no flies (Lemon)	no flies (Fig)
Dynamic	no flies	no flies	no flies

No flies

Figure 42: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 2

Manjimup
Site 3

Ripe fruit at Site 3

Host	Availability of Ripe fruit		
	start-June 2007Nov -2008	July-June 2008-2009	July-June 2009-2010
Apple	Mar-June	Mar-June	Apr-May
Apricot	Dec-Jan	Jan	Jan
Cherry	Nov-Jan	Dec-Jan	Dec-Jan
Fig		Nov-June	Apr-May
Lemon	…-June	Jan-June	Jan-June
Nectarine	Jan-Mar	Feb-Mar	Jan-Mar
Peach	Feb-Mar	Jan	Jan
Pear	Mar	Apr	May
Persimmon	Apr-June		
Plum	Feb	Feb	Feb-Mar
Pomegranate	Feb; May	May	May

Distance from town centre 5-10 km

Hosts and fruit volume at Manjimup Site 3

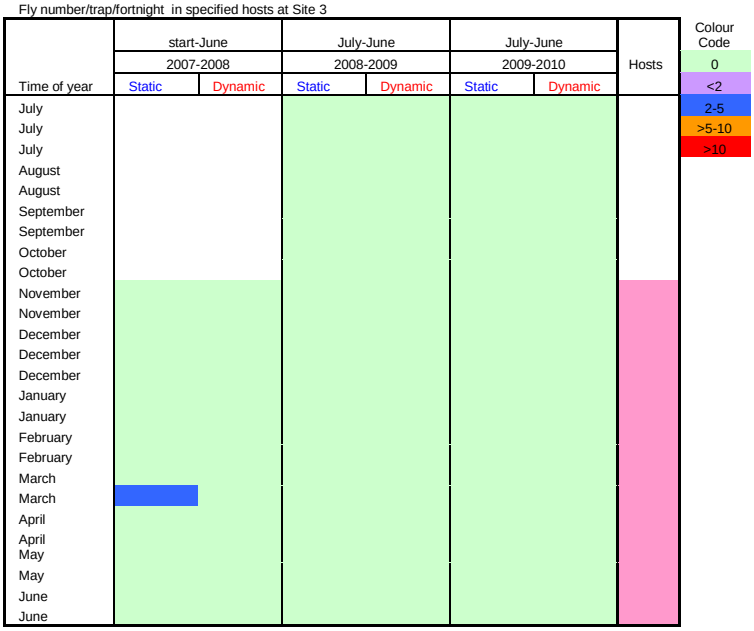
Hosts within 200m radius

Apple 500-600
Apricot < 100
Cherry 400-500
Lemon < 6
Grape 100-200
Nectarine < 100
Peach < 100
Plum < 100
Other fruit (Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 3



Hosts where flies were captured in traps

Static	Lemon	no flies (Lemon)	no flies (Pear)
Dynamic	no flies	no flies	no flies

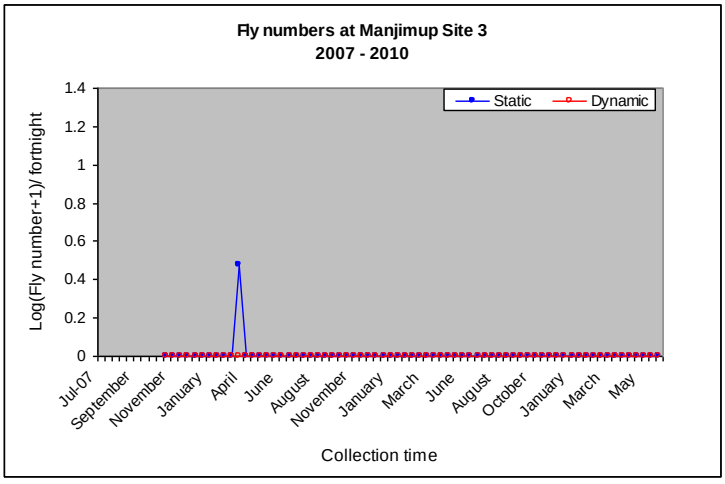


Figure 43: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 3

Manjimup
Site 4

Ripe fruit at Site 4

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Apr-May	Mar-May	Mar-Apr
Feijoa	Apr-May	May-June	May
Fig	Dec-Apr	Nov-May	Apr
Lemon	…-June	July-June	July-June
Lilly pilly	Mar-June	July-Oct; Apr;	Aug; Dec; Apr-June
Mulberry	…-Feb	Jan-Feb	Dec-Feb
Nashi	Mar-Apr	Mar-Apr	Mar-Apr
Nectarine		Jan-Feb	
Olive	Feb	Aug; Apr-June	Apr-June
Orange	…-June	July-Jan; May-June	July-Dec; May-June
Persimmon	Mar-June	July; Apr-June	Apr-June

Distance from town centre 5-10 km

Hosts and fruit volume at Manjimup Site 4

Hosts within 200m radius

Apple < 100-200
Avocado < 400-500
Orange < 6
Nashi < 30
(Plum & Nectarine) < 6
Other fruit (Feijoa, Fig, Olive, Loquat etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	M	M
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Loquats removed by birds before ripening

Fly number/trap/fortnight in specified hosts at Site 4

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code

0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Avocado)	no flies (Avocado)	no flies (Avocado)
Dynamic	no flies	no flies	no flies

No flies

Figure 44: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 4

Manjimup
Site 5

Ripe fruit at Site 5

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb-May	July; Mar-June	July; April
Kiwi fruit	April	July	
Lemon	…-June	July-June	July-June
Lime	Nov-Dec		
Mandarin	…-May	July-June	July-June
Orange	…-Apr; June	July-Feb; June	July-June
Peach	Mar	Mar	Mar

Distance from town centre 5-10 km

Hosts and fruit volume at Manjimup Site 5

Hosts within 200m radius

Apple < 600-700
Citrus (Orange, Mandarin) < 6
SF (Peach) < 6
Other fruit (Grape etc) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	L	L
Pome fruit	VH	VH	VH
Citrus	H	H	H
Other	H	H	

Fly number/trap/fortnight in specified hosts at Site 5

	start-June		July-June		July-June			Colour Code
	2007-2008		2008-2009		2009-2010		Hosts	0
Time of year	Static	Dynamic	Static	Dynamic	Static	Dynamic		<2
July								2-5
July								>5-10
July								>10
August								
August								
September								
September								
October								
October								
November								
November								
December								
December								
December								
January								
January								
February								
February								
March								
March								
April								
April								
May								
May								
June								
June								

Hosts where flies were captured in traps

Static	no flies (Apple)	no flies (Avpple)	no flies (Avpple)
Dynamic	no flies	no flies	no flies

No flies

Figure 45: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 5

Manjimup
Site 6

Ripe fruit at Site 6

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Apr-June	July; Mar-June	Apr-May
Apricot	Dec-Jan		Jan
Avocado		Dec-June	July-June
Cherry		Dec	Dec-Jan
Feijoa	Apr-May	May	Apr
Fig	Dec; Feb-Apr	Jan; Mar-May	Apr-May
Grape	Feb-Mar	Jan-Mar	Mar
Lemon	Nov-June	July-June	July-June
Mandarin		Nov-Mar; May-June	July-June
Mulberry	Dec-Feb	Jan-Feb	Jan-Feb
Nectarine	Jan-Feb		
Olive		Apr-June	Apr-May
Orange	…-June	July-June	July-June
Peach	Dec-Mar	Jan	Mar
Persimmon	May	Apr-June	Apr-May
Plum	Dec-Feb	Jan-Feb	Jan-Mar
Quince	…-May	Apr-June	Apr

Distance from town centre 5-10 km

Hosts and fruit volume at Manjimup Site 6

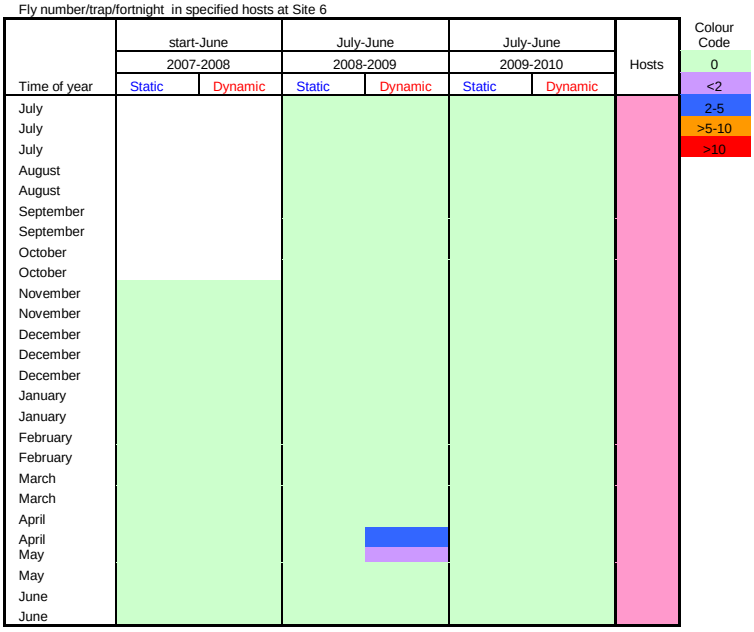
Hosts within 200m radius

Apple < 200-300
Citrus < 6
Peach, Plum < 30
SF (Apricot, Nectarine) < 6 of each
Other fruit (Fig, Grape,Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, M on apricot and Nectarine
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 6



Hosts where flies were captured in traps

Static	no flies (Plum/Olive)	no flies (Olive)	no flies (Olive)
Dynamic	no flies	Fig	no flies

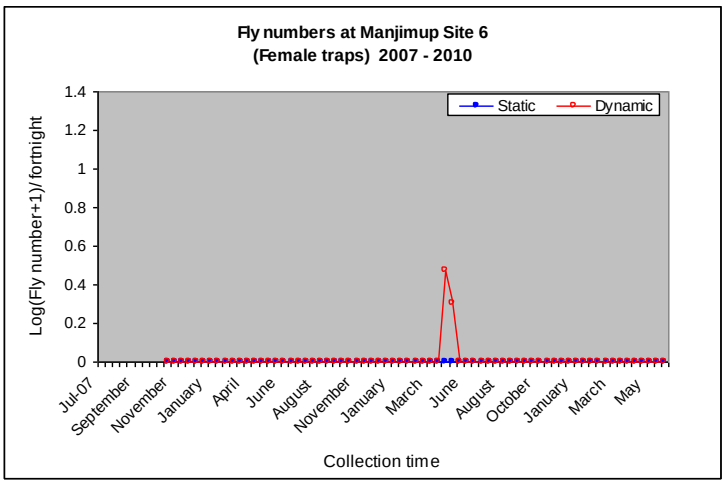


Figure 46: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 6

Manjimup
Site 7

Ripe fruit at Site 7

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Apr-May	Mar-June	Apr
Apricot	Dec-Jan	Jan	Jan
Cherry	Nov-Dec	Nov	Dec
Fig	Feb-Apr	Mar-May	Mar
Grape	Feb-Mar	Feb-Mar	Mar
Grape fruit		May-June	June
Lemon	…-June	July-Nov; Jan-June	July-June
Mulberry	Dec-Mar	Jan-Mar	Jan-Feb
Nectarine	Feb	Feb	
Olive	Mar-Apr	Apr-June	Apr-May
Orange	…Dec; May-June	Jlu-Nov; May-June	July-Nov; Apr-June
Peach	Feb	Feb-Mar	
Pear	Mar-Apr	Feb; Apr	Apr
Plum	Jan-Mar	Jan-Mar	Feb-Mar

Distance from town centre < 2 km

Hosts and fruit volume at Manjimup Site 7

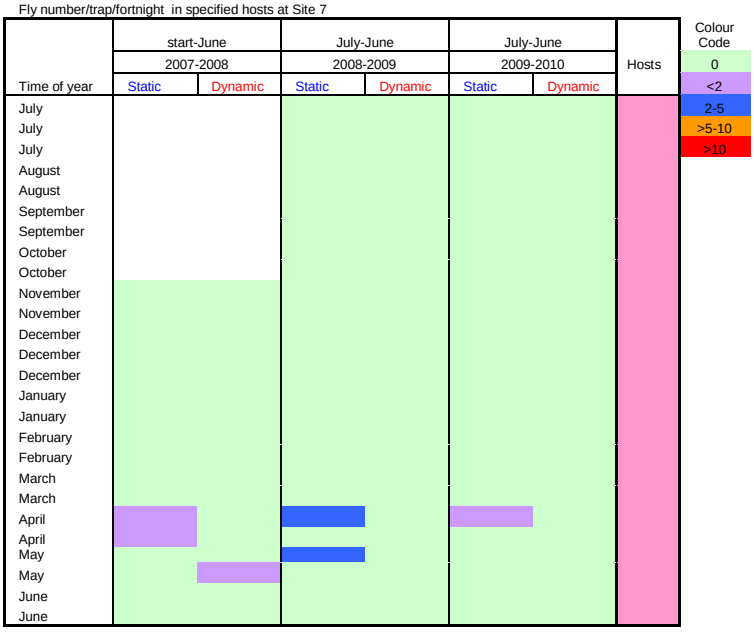
Hosts within 200m radius

Apple < 100
Lemon < 6
Mandarin < 100
SF (Cherry, Apricot,Nectarine, Peach) < 6 of each
Other fruit (Avocado, Fig, Persimmon) < 6 of each
Orange <30
Olive < 100
Pear < 6
Plum < 30

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, L nectarine and peach i
Pome fruit	VH	VH	VH
Citrus	H	H	H
Other	L; VH olives, others	L; VH olives	L; VH olives

Fly number/trap/fortnight in specified hosts at Site 7



Hosts where flies were captured in traps

Static	Apricot	Olive	Apricot
Dynamic	Orange	no flies	no flies

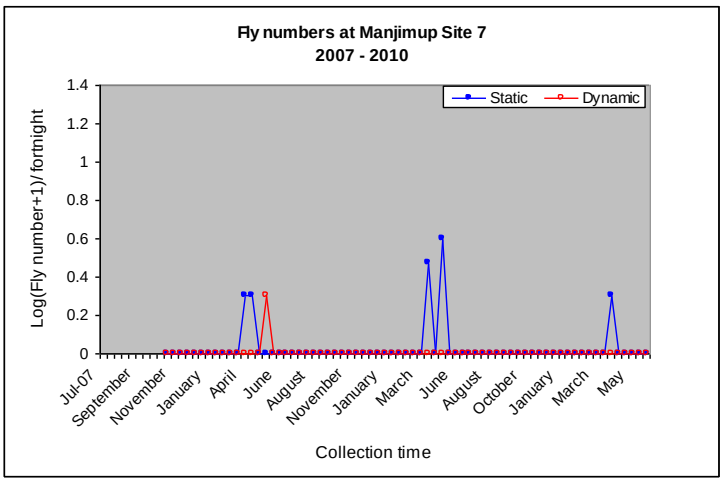


Figure 47: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 7

Manjimup
Site 8

Ripe fruit at Site 8

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Cherry	Dec		
Fig	Mar-Apr	Mar-May	
Lemon		Set; Apr-May	
Mandarin	Dec; Apr-June	July-Sept; June	July-Aug
Mulberry		Nov-Jan	
Nectarine	Feb		
Orange	June	July-Sept; May-June	July-Aug
Peach	Dec-Mar		
Plum	Jan-Apr	Jan-Feb	

Distance from town centre < 2 km

Hosts and fruit volume at Manjimup Site 8

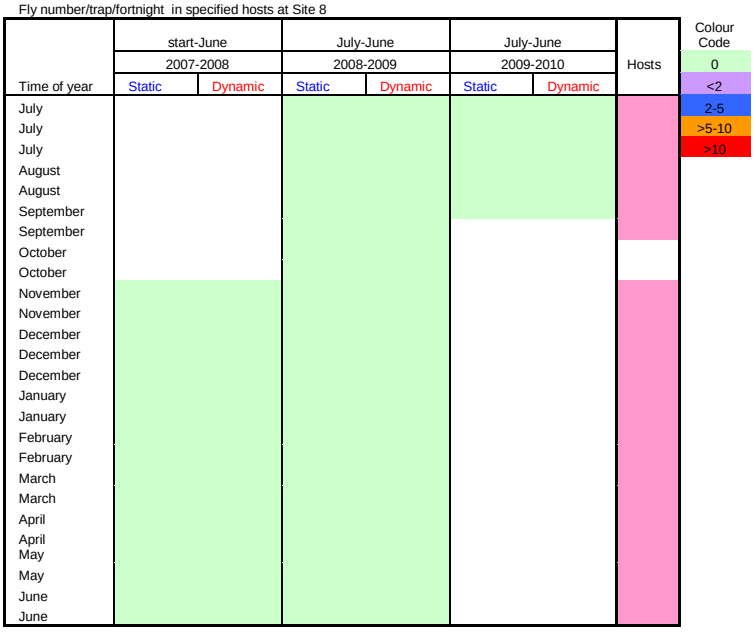
Hosts within 200m radius

Apple < 30
Lemon < 30
Mandarin < 30
Orange <30
Plum < 30
SF (Cherry, Apricot,Nectarine, Peach) < 6 of each
Other fruit (Fig, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	H	
Pome fruit			
Citrus	M	M	M
Other	L	L	

Fly number/trap/fortnight in specified hosts at Site 8



Hosts where flies were captured in traps

Static	no flies (Plum)	no flies (Mulberry)	no flies (Mulberry)
Dynamic	no flies	no flies	no flies

No flies

Figure 48: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 8

Manjimup
Site 11

Ripe fruit at Site 11

Host	Availability of Ripe fruit		
	start-June 2007 Nov - 2008	July-June 2008-2009	July-June 2009-2010
Apple	Mar-May	Mar-May	Apr-May
Fig	Jan; Mar-May	Dec-Jan; Mar-May	Jan & Apr
Grape	Dec		
Lemon	…-June	July-June	July-June
Loquat	Nov-Jan	Oct-Dec	Nov-Dec
Mandarin	..-Nov; Jan	July-June	July; Oct-June
Nashi	Mar-Apr	Mar-Apr	Mar-Apr
Olive		May-June	May
Orange	…-June	July-June	July-June
Passion fruit	Feb-May	Apr-June	Feb
Peach	Feb-Apr	Apr	Mar-Apr
Pear	Mar-Apr	Mar-Apr	Apr
Plum	Jan-Mar	Dec-Apr	Jan-Apr
Quince	Feb-May	Mar-June	Dec; Apr-May

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 11

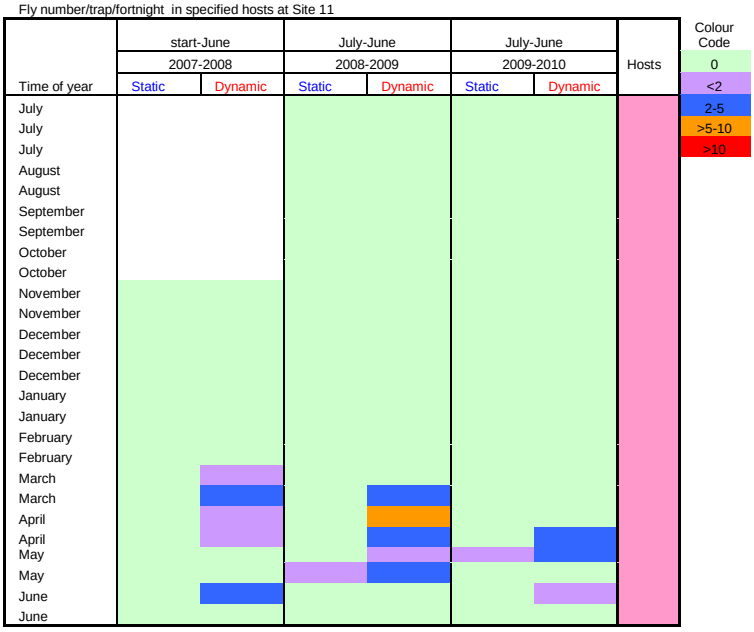
Hosts within 200m radius

Apple < 6
Citrus < 6
SF (Apricot,Nectarine, Peach, Plum) < 6 of each
Other fruit (Avocado, Fig, Grape etc) < 6 of each
Loquat < 6
(Nashi, Pear, Quince) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, < peach
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 11



Hosts where flies were captured in traps

Static	no flies (Peach)	Loquat	Cherry
Dynamic	Peach/Apple	Peach/Apple	Apple

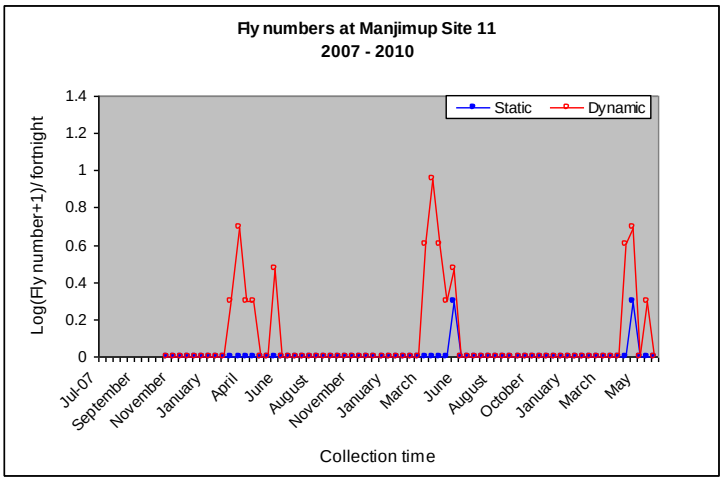


Figure 49: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 11

Manjimup
Site 12

Ripe fruit at Site 12

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007 Nov -2008	2008-2009	2009-2010
Fig	Mar-Apr	Nov; Mar	Feb
Grape	Feb-Mar	Mar	Mar-Apr
Lemon	…-June	July-June	July-June
Mandarin	Nov-Jan; May-June	July-June	July-June
Mulberry	Dec	Dec-Feb; June	Dec-Jan
Nashi	Mar-Apr	Mar-Apr	Mar-Apr
Olive	Mar-May	Apr-June	Apr-May
Orange	…-June	July-June	July-June
Passion fruit		Oct-Nov; Feb-June	Aug-Feb
Peach	Mar	Mar	
Quince		Mar	May

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 12

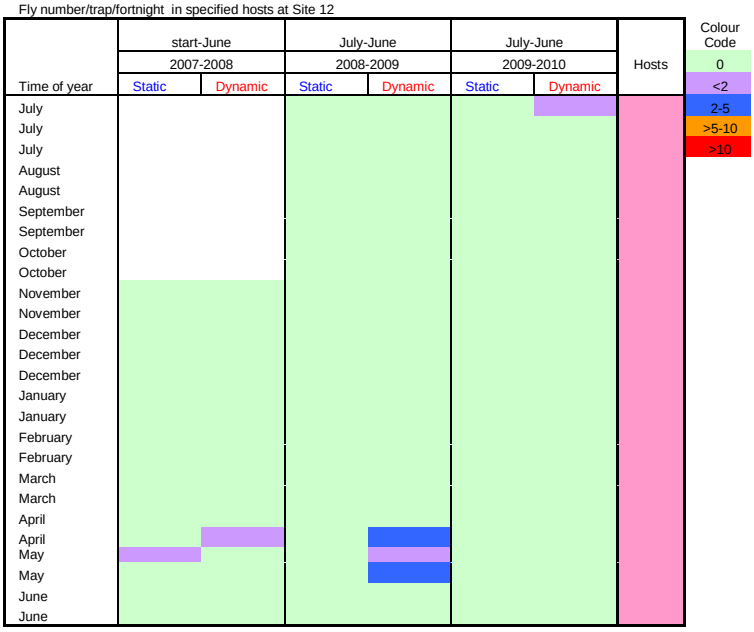
Hosts within 200m radius

Apple < 30
Citrus < 6
Olive < 30
Plum < 6
(Nashi, Pear, Quince) < 6
Other fruit (Grape, Passion fruit etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	M	M	L
Pome fruit	M	M	VH
Citrus	H	H	VH
Other	L	M	L

Fly number/trap/fortnight in specified hosts at Site 12



Hosts where flies were captured in traps

Static	Olive	no flies (Olive)	no flies (Olive)
Dynamic	Nashi	Lemon/Nashi	Lemon

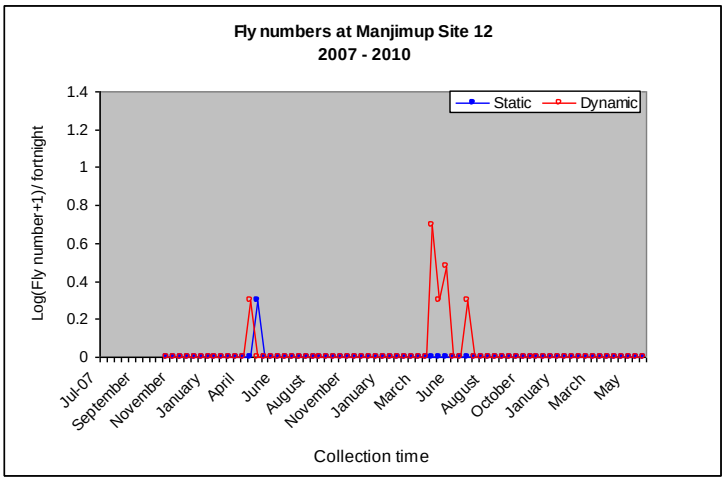


Figure 50: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 12

Manjimup
Site 14

Ripe fruit at Site 14

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb	Mar-Apr	Apr-June
Apricot	Jan	Jan	Jan
Cherry	Nov	Dec	
Lemon	May-Jun	July-Dec; Apr-June	July-June
Loquat	Nov-Dec	Nov-Dec	
Mandarin	…-June	July-June	July-June
Mulberry	Dec-Feb	Dec-Feb	Dec-Feb
Nectarine	Feb		
Passion fruit		Mar-Apr	Apr
Peach			Mar-Apr
Plum	Dec-Jan	Jan-Feb	Feb

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 14

Hosts within 200m radius

Apple, Pear < 6

Cherry < 6
Citrus < 6

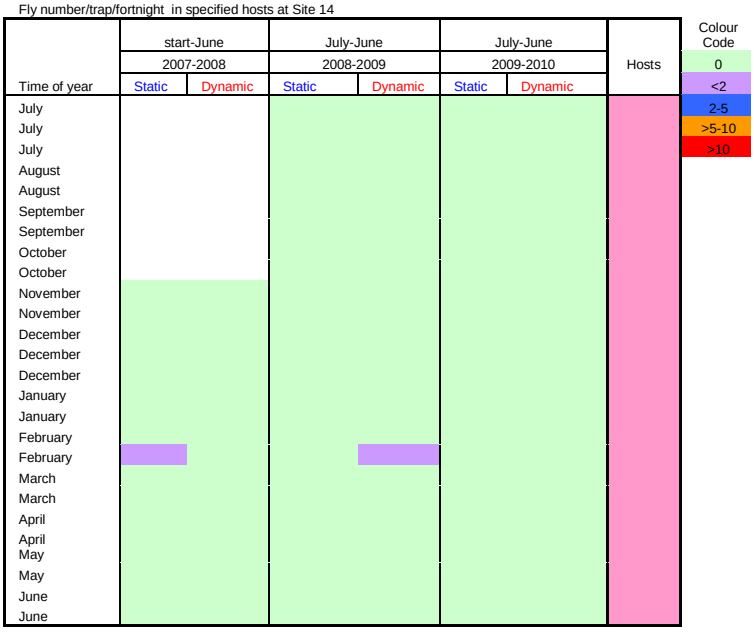
SF (Apricot, Nectarine, Peach, Plum) < 6 of each

Other fruit (Mulberry, Passionfruit etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	H	L
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	M	H	H

Fly number/trap/fortnight in specified hosts at Site 14



Hosts where flies were captured in traps

Static	Apricot	no flies (Loquat)	no flies (Apple)
Dynamic	no flies	Nectarine	no flies

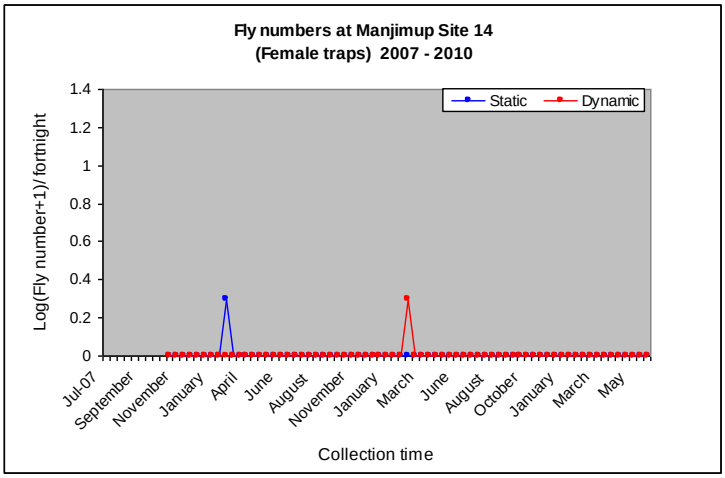


Figure 51: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 14

Manjimup
Site 15

Ripe fruit at Site 15

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007 Nov -2008	2008-2009	2009-2010
Apricot		Jan	Jan
Grape	Feb-Mar	Feb	Mar-Apr
Lemon	…-Jan; Mar	Jan	July-Dec; Mar-May
Lime		July-Mar	
Nectarine	Jan	Jan-Feb	Feb
Olive	Apr	Apr	Apr
Peach	Feb	Dec	
Pear	Feb	Mar-Apr	Apr
Plum	Nov-Feb	Jan-Mar	Jan-Feb

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 15

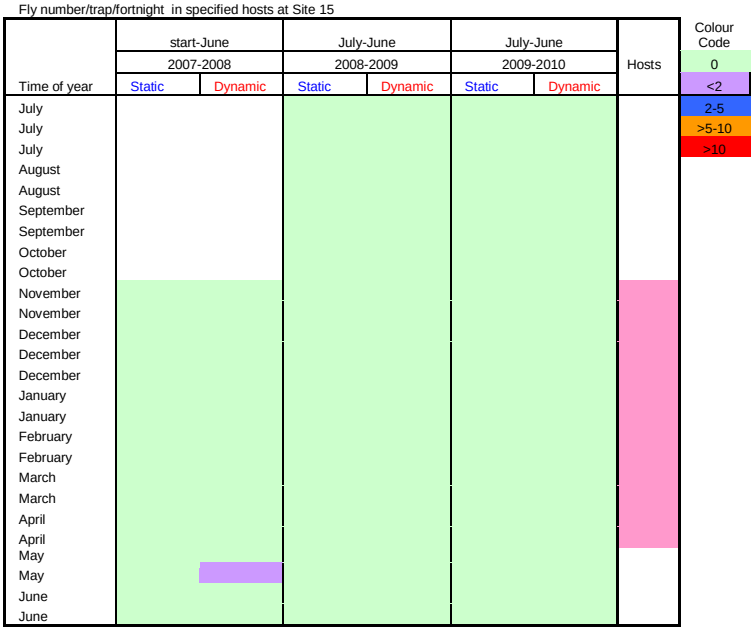
Hosts within 200m radius

Apple < 30
Cherry<100
Citrus < 6
Loquat < 6
Pear < 6
SF (Apricot, Nectarine, Peach, Plum) < 6 of each
Other fruit (Olive, Grape etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH, L apricot	VH, L apricot	VH, L apricot & peach
Pome fruit	VH	VH	H
Citrus	M	L	L
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 15



Hosts where flies were captured in traps

Static	no flies (Plum)	no flies (Photinia)	no flies (Apricot)
Dynamic	Lime	no flies	no flies

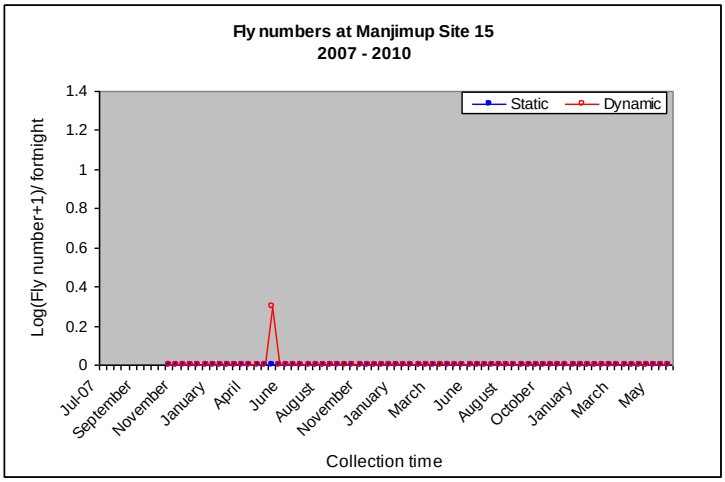


Figure 52: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 15

Manjimup
Site 20

Ripe fruit at Site 20

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007 Nov -2008	2008-2009	2009-2010
Apple		Mar-Apr	Apr
Fig	Apr-June	Mar-May	Mar-May
Lemon	…-June	July-June	July-June
Nectarine		Jan-Feb	Feb
Orange	…-June	July-June	July-June
Peach	Mar	Mar	Mar
Plum	Jan-Feb	Feb-Mar	Jan

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 20

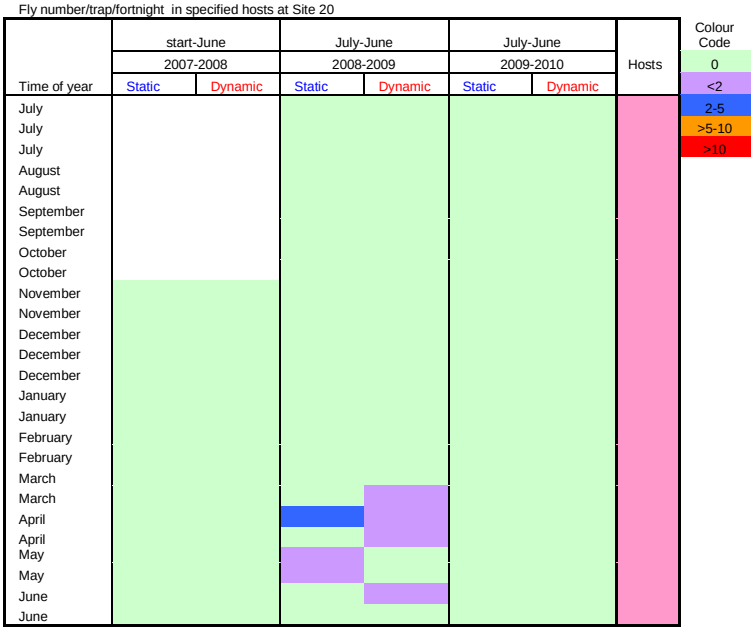
Hosts within 200m radius

Apple < 6
Citrus < 6
SF (Nectarine, Peach, Plum) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	H	H	M
Pome fruit	M	VH	L
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 20



Hosts where flies were captured in traps

Static	no flies (Orange)	Orange	no flies (Orange)
Dynamic	Lime	Peach/Fig	no flies

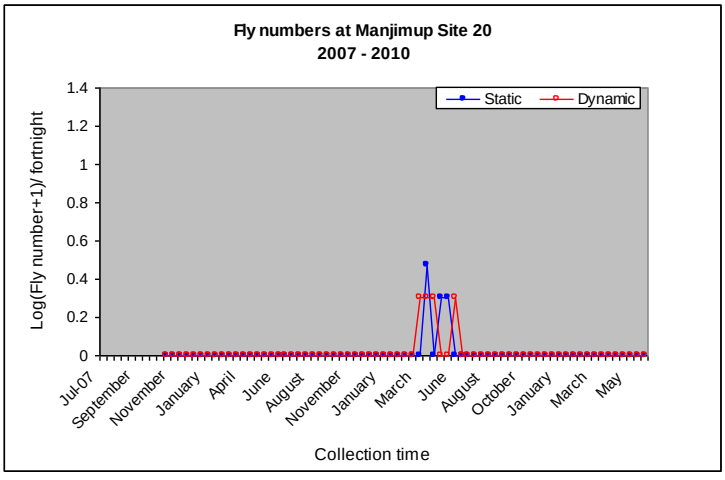


Figure 53: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 20

Manjimup
Site 21

Ripe fruit at Site 21

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apricot		Jan	
Cherry		Dec-Jan	Dec-Jan
Grape fruit	Feb-April; June	July-June	July-Mar; May-June
Pear	Mar-Apr	Mar	Apr
Plum	Feb-Mar	Jan-Feb	Jan-Mar
Quince	…-May	Mar-May	Apr

Distance from town centre 2-5 km

Hosts and fruit volume at Manjimup Site 21

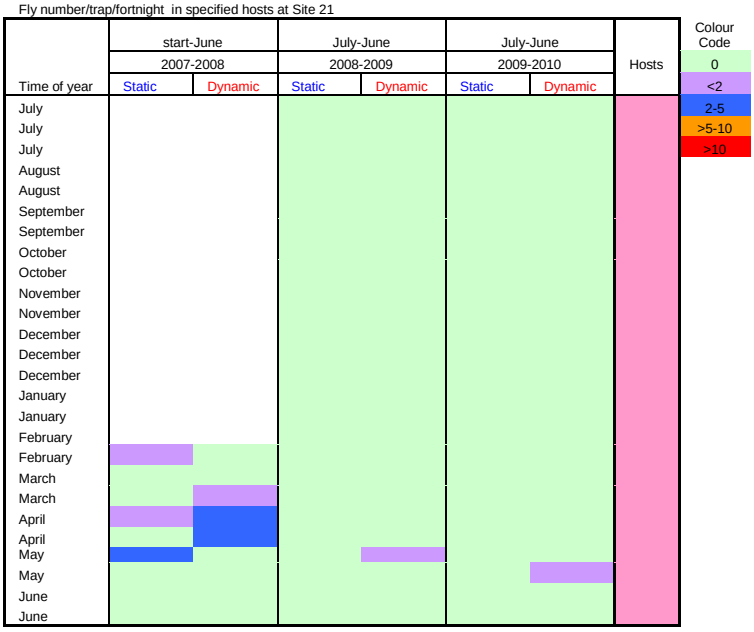
Hosts within 200m radius

Apricot < 30
Avocado < 600-700
Citrus < 6
SF (Pear, Plum, Quince) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH cherry & plum, L apricot	VH cherry & plum, L apricot	VH cherry & plum, L apricot
Pome fruit	VH	VH	VH
Citrus	M	M	M
Other			

Fly number/trap/fortnight in specified hosts at Site 21



Hosts where flies were captured in traps

Static	Avocado	Avocado	no flies (Apricot)
Dynamic	Pear	Quince	Quince

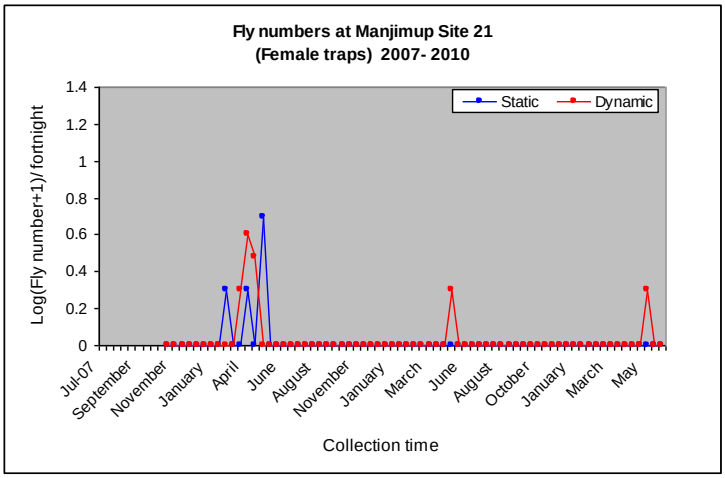


Figure 54: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 21

Manjimup
Site 22

Ripe fruit at Site 22

Host	Availability of Ripe fruit		
	start-June 2008	July-June 2008-2009	July-June 2009-2010
Apple	…-June	July; Mar-May	Mar-May
Apricot		Jan	Jan-Feb
Fig	Mar-Apr	Mar-June	Apr
Lemon	…-June	July-June	July-June
Passion fruit	Mar-June	Aug-Oct; Apr;	
Pear	Feb-Apr	Mar-Apr	Mar
Plum	…-Apr	Jan-Mar	Mar-Apr

Distance from town centre < 2 km

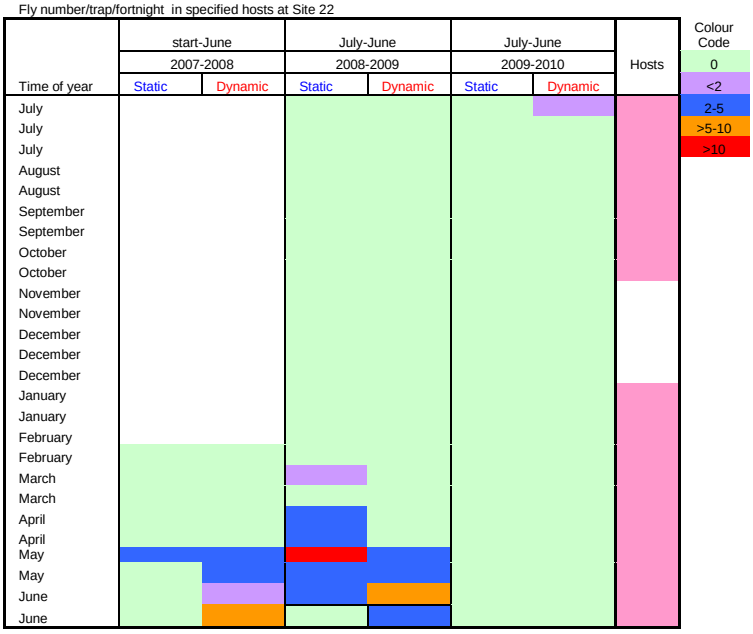
Hosts and fruit volume at Manjimup Site 22

Hosts within 200m radius
Apple < 600
Apricot < 300
Citrus < 6
Pear < 200
Plum < 200

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	M	M	H
Other	L	L	L

Fly number/trap/fortnight in specified hosts at Site 22



Hosts where flies were captured in traps

Static	Apple	Apple	no flies (Appke)
Dynamic	Apple	Apple	Apple

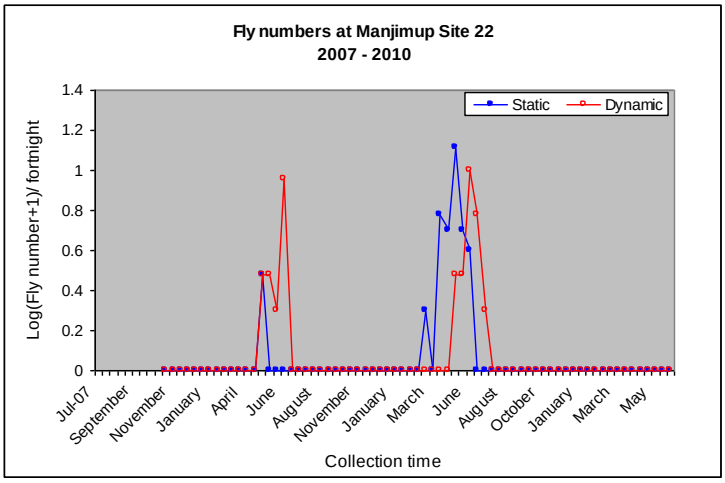


Figure 55: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 22

Manjimup
Site 23

Ripe fruit at Site 23

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple	Mar-June	July; Mar-June	Apr
Fig	Mar-May	Dec;Apr-May	Apr
Lemon	…-June	July-June	July-June
Mandarin	…-June	July-June	July-June
Nectarine	..-Mar	Jan-Mar	
Peach	…-Mar	Jan-Mar	
Plum		Jan-Apr	Feb-Apr
Pomegranate	…-May	Jan; Apr-June	Apr-May

Distance from town centre 5-10 km

Hosts and fruit volume at Manjimup Site 23

Hosts within 200m radius

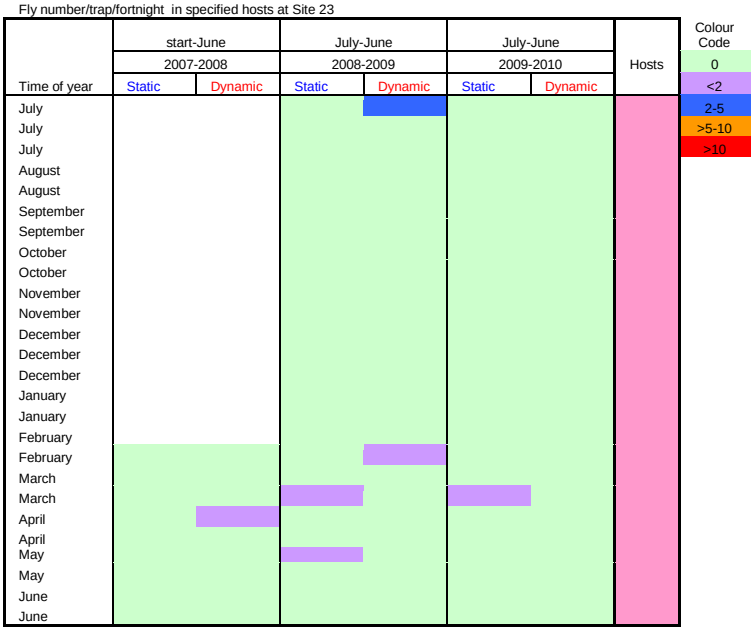
Apple < 1500
Cherry < 6
Citrus < 6
Nectarine < 30
Peach, Plum <6
Other fruit (Fig, Pomegranate etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH for plums only in 2010
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	M	M	M

other SF taken by birds in 2010

Fly number/trap/fortnight in specified hosts at Site 23



Hosts where flies were captured in traps

Static	no flies (Apple)	Apple	Apple
Dynamic	Mandarin	Mandarin/Peach	no flies

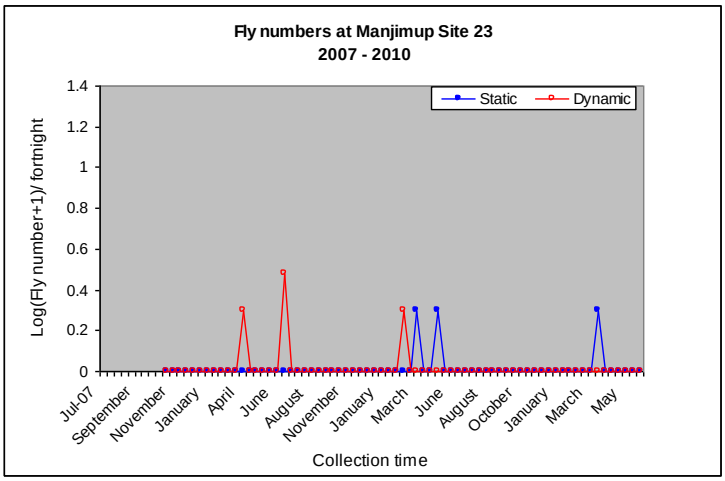


Figure 56: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 23

Statistical analysis of Manjimup data

Male flies in male traps in 2008

A graph of the percentage of male traps with male flies present at each collection date (Fig 57a) indicates that, in orchards, male flies only started to appear in traps from 13 March 2008 (Date 149032 on the x-axis). On the previous date, and preceding ones, none of the traps had any male flies. On this basis comparisons between dynamic and static traps have only been made using data collected on 13 March 2008 and later. Site 18 has also been excluded because it was removed after 27 March and no flies were caught at this site in March. In addition all data from 24 March 2008 has been removed as no flies were caught in any traps on this date.

The effect of trap type on the percentage traps with male flies did not change with date of collection (Trap type x Date interaction: P=1.000). On average over all dates for which flies were present, 4.56% dynamic traps had male flies while only 0.04% static traps had male flies present (P=0.781). There was no effect of date of collection on the percentage of traps with male flies (P=0.983). Percentages for each trap type on each collection date are shown in Table 21.

When the percentage of traps with male flies in dynamic and static traps was compared for each collection date there was no difference for any date.

The effect of trap type on the number of male flies caught did not change with date of collection (Trap type x Date interaction: P=0.914). On average over all dates for which flies were present, there were 0.087 male flies in dynamic traps and 0.030 male flies in static traps (P=0.337). The probability of catching a fly in a dynamic trap is 5.3% higher than it is in a static trap.

There was no effect of date on the number of male flies in traps (P=0.721). Adjusted (for site) male fly numbers for each trap type on each collection date are shown in Table 21 and Figure 58a. When the number of male flies in dynamic and static traps was compared for each collection date the number was not significantly higher in dynamic traps except on 21 May 2008 (P=0.082) when it was close to significance.

Table 21: Adjusted (for site) percentage of traps with male flies present at each collection date for Manjimup.

Inspection_Date	Dynamic	Static
13/03/2008	7.7%	0.0%
19/03/2008	7.7%	7.7%
27/03/2008	7.7%	0.0%
02/04/2008	7.7%	0.0%
10/04/2008	7.7%	7.7%
16/04/2008	15.4%	7.7%
01/05/2008	0.0%	15.4%
08/05/2008	7.7%	7.7%
15/05/2008	7.7%	0.0%
21/05/2008	23.1%	0.0%
29/05/2008	7.7%	0.0%
05/06/2008	15.4%	7.7%
19/06/2008	7.7%	0.0%

Table 22: Adjusted (for site) numbers of male flies at each collection date for Manjimup. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
13-Mar-08	0.053	0.000	0.05	0.00
19-Mar-08	0.085	0.085	0.09	0.09
27-Mar-08	0.085	0.000	0.09	0.00
02-Apr-08	0.053	0.000	0.05	0.00
10-Apr-08	0.053	0.053	0.05	0.05
16-Apr-08	0.107	0.053	0.11	0.05
01-May-08	0.000	0.107	0.00	0.11
08-May-08	0.085	0.053	0.09	0.05
15-May-08	0.053	0.000	0.05	0.00
21-May-08	0.160	0.000	0.17	0.00
29-May-08	0.053	0.000	0.05	0.00
05-Jun-08	0.107	0.053	0.11	0.05
19-Jun-08	0.169	0.000	0.18	0.00
Standard error of difference (SED)				
Average:		0.088		

Male flies in male traps in 2009

A graph of the percentage of male traps with male flies present at each collection date (Fig 57b) indicates that, in orchards, male flies only started to appear in traps from 19 February 2009 (Date 149375 on the x-axis). On the previous date, and preceding ones, none of the traps had any male flies (apart from one male fly caught at site 23 on 3 July 2008. On this basis comparisons between dynamic and static traps have only been made using data collected on 19 February 2009 and later.

The effect of trap type on the percentage traps with male flies did not change with date of collection (Trap type x Date interaction: P=1.000). On average over all dates for which flies were present, 8.5% dynamic traps had male flies while only 6.8% static traps had male flies present (P=0.751). There was no effect of date of collection on the percentage of traps with male flies (P=0.955). Percentages for each trap type on each collection date are shown in Table 23.

When the percentage of traps with male flies in dynamic and static traps was compared for each collection date there was no difference for any date.

The effect of trap type on the number of male flies caught did not change with date of collection (Trap type x Date interaction: P=0.588). On average over all dates for which flies were present, there were 0.095 male flies in dynamic traps and 0.083 male flies in static traps (P=0.814). The effect of date on the number of male flies in traps was close to significance (P=0.054). Adjusted male fly numbers for each trap type on each collection date are shown in Table 24 and Figure 58b. When the number of male flies in dynamic and static traps was compared for each collection date the number was not significantly higher in dynamic traps.

There is not sufficient information to examine the effect of host on the efficiency of dynamic male traps.

Table 23: Adjusted (for site) percentage of traps with male flies present at each collection date for Manjimup.

Inspection Date	Dynamic	Static
19-Feb-09	0.0%	0.0%
26-Feb-09	7.7%	0.0%
4-Mar-09	0.0%	0.0%
11-Mar-09	0.0%	0.0%
18-Mar-09	0.0%	7.7%
25-Mar-09	7.7%	0.0%
1-Apr-09	7.7%	7.7%
8-Apr-09	15.4%	15.4%
16-Apr-09	7.7%	15.4%
22-Apr-09	23.1%	0.0%
29-Apr-09	7.7%	7.7%
6-May-09	15.4%	30.8%
13-May-09	7.7%	7.7%
20-May-09	15.4%	15.4%
27-May-09	7.7%	7.7%
3-Jun-09	7.7%	7.7%
10-Jun-09	15.4%	0.0%
24-Jun-09	7.7%	0.0%

Table 24: Adjusted (for site) numbers of male flies at each collection date for Manjimup. Note that SEDs can only be applied on the transformed scale

	Transformed mean		Back transformed mean	
Inspection_Date	Dynamic	Static	Dynamic	Static
19-Feb-09	0.000	0.000	0.00	0.00
26-Feb-09	0.053	0.000	0.05	0.00
4-Mar-09	0.000	0.000	0.00	0.00
11-Mar-09	0.000	0.000	0.00	0.00
18-Mar-09	0.000	0.053	0.00	0.05
25-Mar-09	0.053	0.000	0.05	0.00
1-Apr-09	0.107	0.053	0.11	0.05
8-Apr-09	0.203	0.191	0.23	0.21
16-Apr-09	0.085	0.169	0.09	0.18
22-Apr-09	0.262	0.000	0.30	0.00
29-Apr-09	0.053	0.124	0.05	0.13
6-May-09	0.107	0.363	0.11	0.44
13-May-09	0.085	0.150	0.09	0.16
20-May-09	0.169	0.177	0.18	0.19
27-May-09	0.085	0.053	0.09	0.05
3-Jun-09	0.169	0.107	0.18	0.11
10-Jun-09	0.107	0.000	0.11	0.00
24-Jun-09	0.096	0.000	0.10	0.00
Standard error of difference (SED)				
Average:		0.114		

Male flies in male traps (2010)

A graph of the percentage of male traps with male flies present at each collection date (Fig 57c) indicates that, in orchards, male flies only started to appear in traps from 18 March 2010 when one static trap out of the 15 male static traps had male flies present. At all dates at least 13 of the 15 traps had no male

flies. On the basis that there were insufficient traps with male flies, no analysis of percentage of male traps with male flies present has been carried out to compare static and dynamic traps. For the same reason no analysis of male fly numbers was carried out. Figure 58c shows the average number of male flies in each trap type on each date of inspection. On two inspection dates the average numbers of male flies in dynamic traps was higher than in static traps on any inspection date.

There is not sufficient information to examine the effect of host on the efficiency of dynamic male traps.

Figure 57: Percentage of traps with male flies present at each collection date for Manjimup. Note that date is in day number format (148892 is 28 Oct 2007 and 149129 is 18 June 2008; 149340 is 15 Jan 2009).

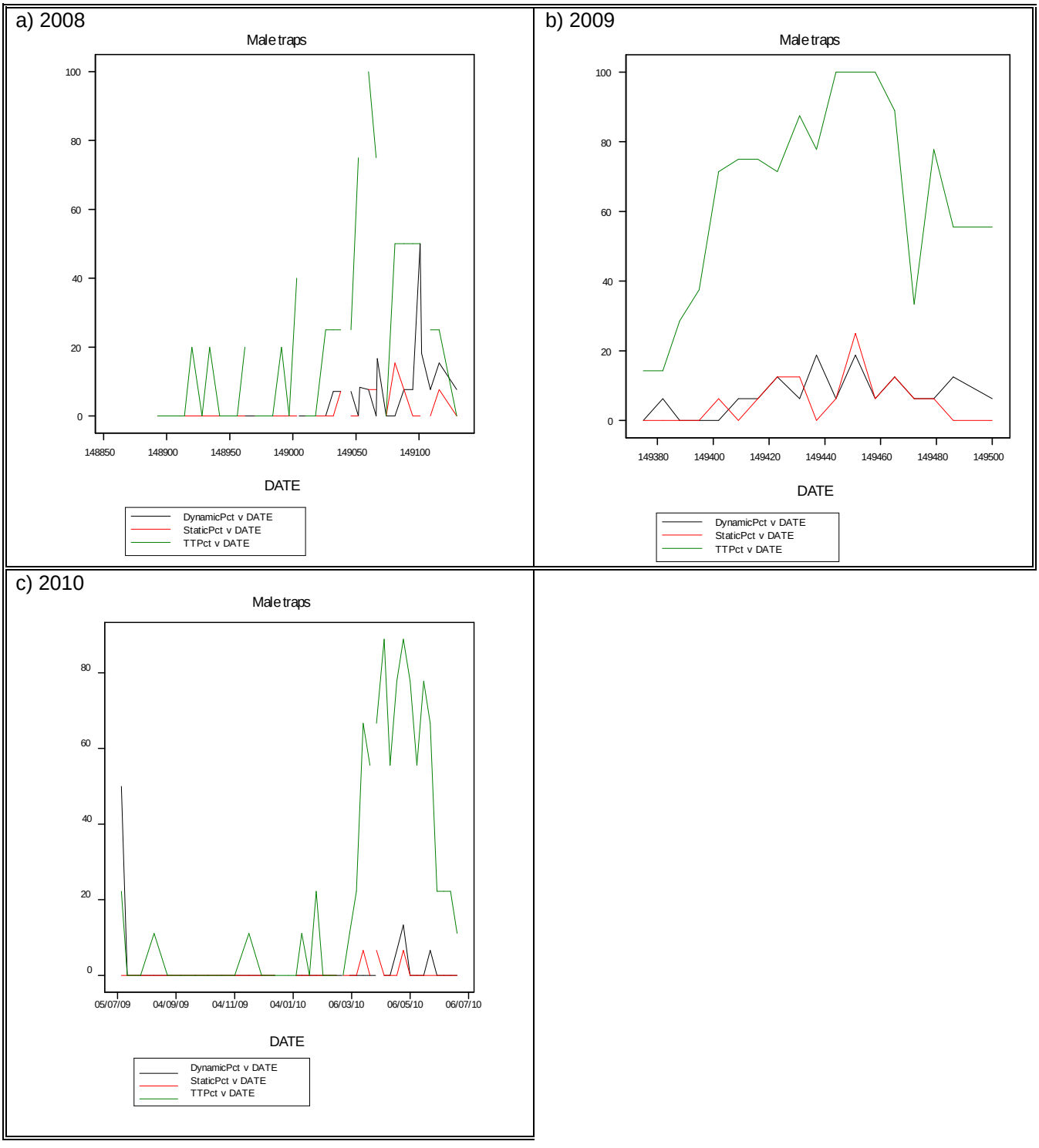
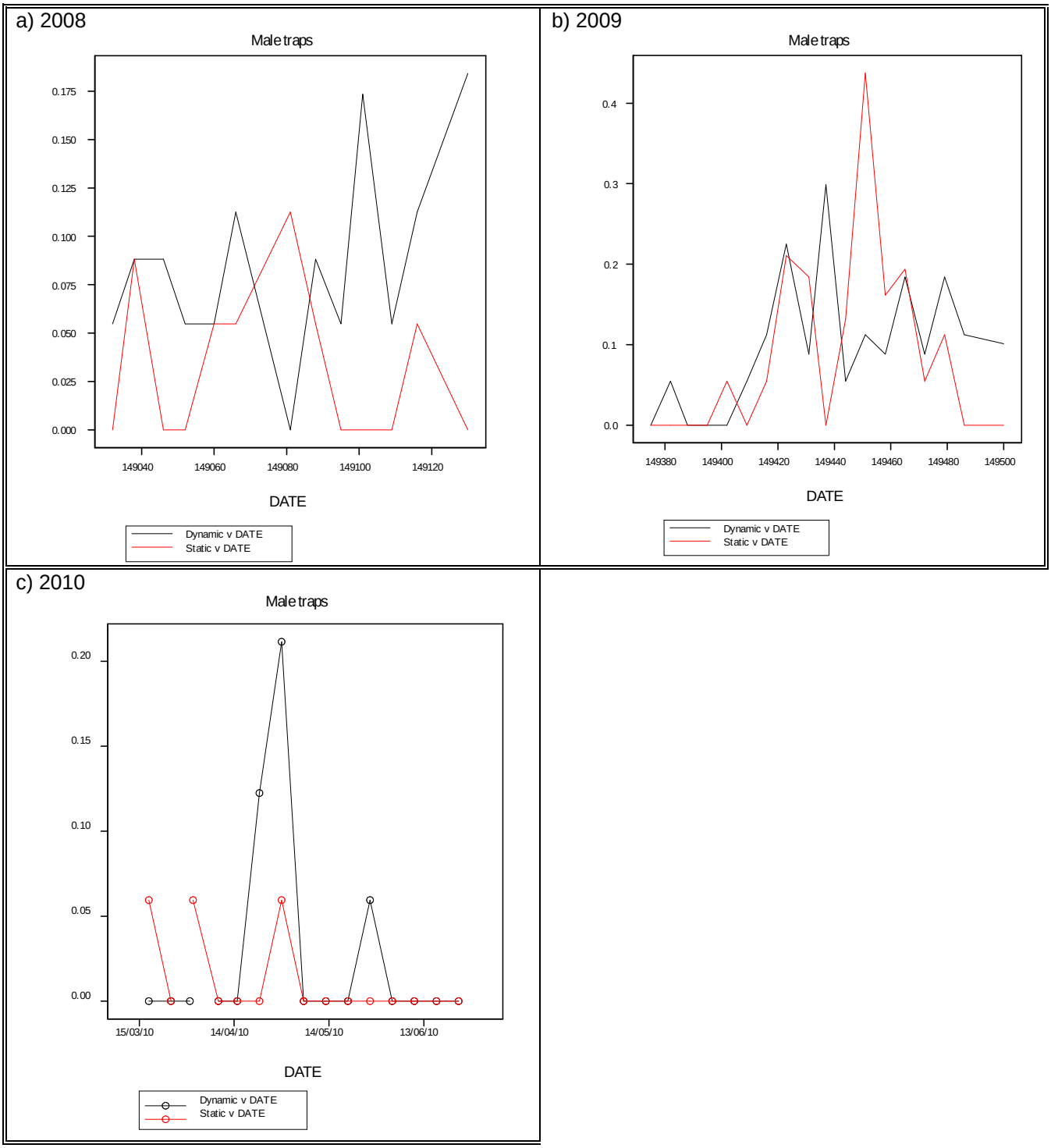


Figure 58: Average number of male flies present at each collection date in Manjimup. Note that date is in day number format (148892 is 28 Oct 2007 and 149129 is 18 June 2008; 149340 is 15 Jan 2009).



Pemberton

Time of fly capture: static vs dynamic traps

In 2008, flies were not captured at the threshold level (two or more per trap per fortnight) in Pemberton (Table 25).

Few flies were captured in 2009 and 2010 and usually less than two flies per fortnight except in traps at site 6 and on a single occasion at site 7 (Table 25).

With the small number of detections no preference was indicated for either static or dynamic traps.

Table 25: Time lag in the fly capture between the Static and Dynamic traps in Pemberton

		Number of weeks the Dynamic trap captured two flies or more		
Site	Type of trap	2008	2009	2010
1	Male	nc	nc	nc
2	Male	nf	nf	nf
5	Male	nc	nf	nf
7	Male	nf	Static >10	nf
8	Male	nf	nf	nf
9	Male	nf	nf	nf
10	Male	nf	nf	nf
11	Male	nf	nf	nf
12	Male	nf	nc	nf
14	Male	nf	nf	nf
15	Male	nf	nf	nf
16	Male	nf	nf	nf
17	Male	nf	nf	nf
18	Male		nf	nf
19	Male		nf	nf
4	Female	nf	nf	nf
6	Female	nf	6	nc
13	Female	nf	nf	nf

nf = no flies; nc = not captured >2; = no traps at this site

Table 26: Characteristics of orchards trial sites with non-breeding and breeding Medfly populations in Pemberton

Key Small orchards Large orchards					Capture Frequency All, Jan-June			Capture Frequency < 2 flies/trap/fortnight Jan-June			Capture Frequency 2-5 flies/trap/fortnight Jan-June			Capture Frequency 6-10 flies/trap/fortnight Jan-June			Capture Frequency >10 flies/trap/fortnight Jan-June		
Site	Type of trap	Fruit volume in 200 m	Distance from town centre	Breeding population	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
1	Male	High	<2	No	1	1	1	1	1	1									
2	Male	Low	2-5	No	0	0	0												
5	Male	Moderate	<2	No	0	0	0												
7	Male	Moderate	<2	No	0	3	0		2			1							
8	Male	Moderate	2-5	No	0	0	0												
9	Male	High	<2	No	0	0	0												
10	Male	Moderate	2-5	No	0	0	0												
11	Male	High	<2	No	0	0	0												
12	Male	Moderate	5-10	No	0	0	0												
14	Male	Moderate	<2	No	0	0	0												
15	Male	Low	2-5	No	0	0	0												
16	Male	Moderate	>10	No	0	0	0												
17	Male	High	2-5	No	0	0	0												
18	Male	Moderate	>10	No	0	0	0												
19	Male	Moderate	>10	No	0	0	0												
4	Female	Moderate	2-5	No	0	0	0												
6	Female	Moderate	<2	YES	0	8	2			2		3			3			2	
13	Female	Low	<2	No	0	0	0												

Host phenology and fly population at Pemberton orchard sites
Pemberton is the southern most town in which this trial was located. Properties in this area were not treated for fruit fly. Fly numbers were near zero, only two flies were captured in the town, in the preliminary survey (Appendix A). Large orchards within the 10km radius of the town were mostly monocultures of apples. Some orchards had or two or three fruits such as apples, avocado and kiwi fruit. Within the town there were mixed fruit orchards in most backyards.

All fly detections were within a 2km radius of the town centre. At site 7 flies were captured only in 2009 in a loquat tree (Figure 64). A peach tree, which was found with larvae in fruit, had been removed prior to this detection at site 7. Site 7 and site 6 were 400-500 m apart. Distance of each site from the town centre is given in Table 26 and sites have been categorised according to size and type of orchard.

Frequency of capture at threshold levels
Eighteen of the trial sites were non-breeding sites and one was a breeding site (Table 26). The number of times that flies were captured in each category of fly density (ie: <2 per fortnight; 2-5 per fortnight, >10 per fortnight) is given for the three years of the study.

Flies were not captured between mid July - mid December at trial sites in all years.

Flies were captured at the threshold level (>2 flies per trap per fortnight), from mid March to June in 2009. A maximum of 63 flies per fortnight was recorded at site 6 (Figure 63). In 2010, flies were not captured at the threshold level. Single fly captures were recorded in the static and dynamic traps at site 6 on two separate occasions and once in the dynamic traps at site 1 in 2010.

Site 1 was very close to the main highway and single flies were captured in all three years indicating that flies entered the area intermittently even though they did not establish.

Sites 4, 6 and 13 were orchards which contained a pair of female traps. Flies were not captured at sites 4 and 13 (Figure 61 and 70).

Orchard Trial sites with breeding populations

Large orchards
None.

Small orchards
At site 6 flies were found in 2009 March – June (Figure 63) and a survey of dropped fruit at this site found infested mandarins. These flies may have overwintered to emerge in the next season but the population did not expand in 2010, possibly due to lower fruit volume at this site in 2010. Introduction of supplementary traps (eight male, eight female) in April – July 2010 did not capture any further flies. A number of fruit trees at site 6, were removed in June 2010.

Orchard Trial sites without breeding populations

Large orchards
Site 16 -19 were large orchards with high volumes of fruit (>20 per tree) of one or more types and they also contained small numbers of a variety of other fruit trees (Figure 73-76). At all sites there is a gap in host succession in the latter months of the year.

Small orchards
Sites 1, 5 and 12 show small numbers that were captured in town but continuous populations were not found, even in the presence of considerable volume and variety of fruit (Figure 59, 62 and 69).

In Pemberton also the pattern of rainfall was different in 2008 in that August was drier and more rain was received from September to November. In 2007 and 2009 the total rainfall in the last three months of the year was similar (164ml and 142ml) but in 2008, 347ml was received in the same period (Table 27).

In 2009 December was very dry as also observed in Donnybrook and Manjimup. In 2008 November maximum temperature was also lower, up to 5°C lower in Average maximum temperature compared to Donnybrook. These differences would have contributed to the variability in patterns of fruit set observed through the seasons. Manjimup and Pemberton show a similar pattern of variability in rainfall in the period 2007-2010.

Table 27: Climate data for Pemberton

	Total rain (mm)				Av Max temp				Av Min temp			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Jan		8.7	6.1	4.2		26.8	26.8	27.5		13.8	14.3	12.9
Feb		13.1	14.8	3.6		28.4	26.4	28.1		15.3	13.8	14.7
Mar		14.1	36.7	17.1		25.2	24.2	26.2		13.0	12.5	14.4
Apr		155.1	17.4	51.7		21.6	23.0	21.8		11.3	11.3	10.7
May		185.6	123	101.2		19.2	20.8	18.4		11.1	8.2	9.4
Jun		173.4	278.6	76.5		17.1	15.7	16.7		8.6	8.4	7.4
Jul	223.5	268.2	236.2		16.5	14.9	15.5		8.4	6.7	7.1	
Aug	223.5	72	154.5		16.4	16.7	16.0		8.9	5.6	8.2	
Sep	204.3	158.2	259.4		17.2	17.1	15.5		8.9	7.9	7.5	
Oct	85.1	96.4	38.1		18.9	19.7	19.5		8.8	10.0	9.9	
Nov	12.7	177.4	96.6		23.8	19.5	22.7		10.9	10.0	11.1	
Dec	66.1	74.3	7.8		23.0	23.0	25.2		11.9	11.7	11.5	

	Temperature range		Temperature range		Temperature range		Temperature range	
	Max	Min	Max	Min	Max	Min	Max	Min
	2007	2007	2008	2008	2009	2009	2010	2010
Jan			35.1	9.8	38.9	10.6	38.9	8.9
Feb			37.9	9.4	36.7	8.4	36.0	7.1
Mar			33.5	9.5	35.9	6.4	38.0	8.5
Apr			29.7	6.9	29.1	5.4	26.6	5.6
May			24.2	7.5	26.3	3.3	25.0	4.5
Jun			20.4	5.0	22.1	4.0	20.6	2.6
Jul	20.0	1.5	19.5	3.0	19.8	3.9		
Aug	21.5	4.5	22.0	1.3	19.0	4.0		
Sep	23.5	3.6	23.0	3.0	23.0	3.3		
Oct	27.2	5.0	28.3	5.1	31.2	5.9		
Nov	35.0	6.0	26.5	5.5	32.4	6.0		
Dec	40.4	6.6	31.2	7.7	35.1	7.1		

Male flies in male traps (2007-2010)

No statistical analysis has been carried out at Pemberton as very few male flies were caught.

Pemberton
Site 1

Ripe fruit at Site 1

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	April-June	July-Aug; Apr-June	July; June
Apricot	Dec	Jan	
Cherry guava		Apr-May;	July; Apr-May
Fig	Mar-May	Dec; Mar-May	Apr-May
Grape	Mar-Apr	Mar	Apr
Kiwi fruit	May-June	June	June
Lemon	…-June	July-June	July-June
Loquat	…-Nov	Dec	
Mandarin	Nov; Apr; June	July-Aug: May-June	July-Aug;
Nectarine		Jan-Feb	Jan
Orange	Nov-Apr	July-Sept; May-June	July-Sept; June
Passion fruit	Mar-Apr	Apr-May	Apr
Peach	Mar	Mar	Mar
Pear	Mar	Mar-May	Mar-Apr
Persimmon	Mar-May	Apr-June	July; Apr-June
Plum	Jan-Feb	Jan-Feb	Feb
Rspberry		Dec-Jan	Dec-Jan

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 1

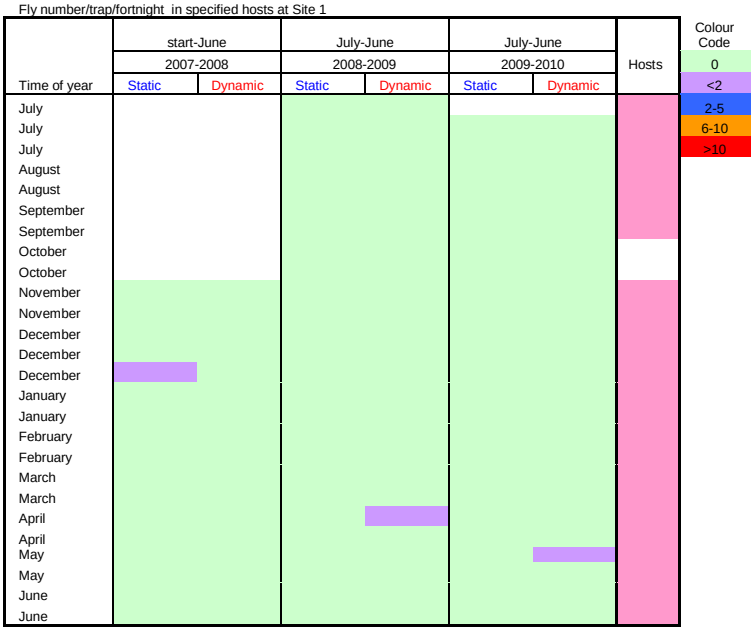
Hosts within 200m radius

Apple < 6
Citrus (Lemon, Mandarin, Orange) < 6 of each
Pear < 6
SF (Apricot, Cherry, Nectarine, Peach, Plum) < 30
Other fruit (Fig, Kiwi fruit, Loquat, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	H	H	M
Pome fruit	VH	VH	VH
Citrus	H	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 1



Hosts where flies were captured in traps

Static	Evergreen	no flies (Evergreen)	no flies (Chestnut)
Dynamic	no flies	Pear	Pear

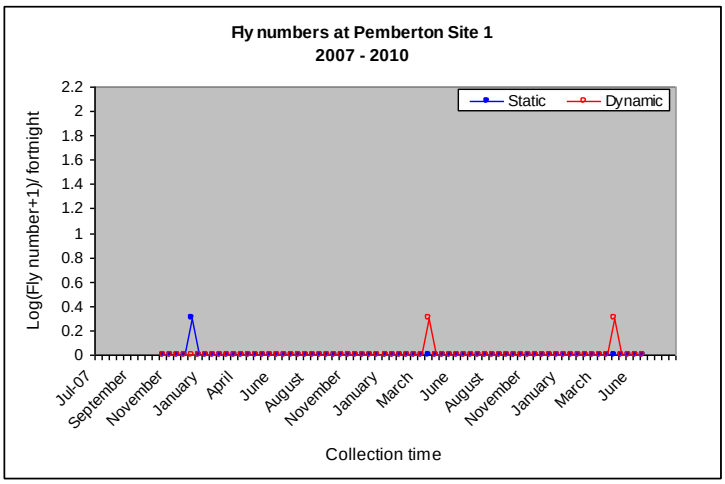


Figure 59: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 1

Pemberton
Site 2

Ripe fruit at Site 2

Host	Availability of Ripe fruit		
	start-June 2007Nov -2008	July-June 2008-2009	July-June 2009-2010
Lemon	…-June	July-June	July-June
Nectarine	Jan-Feb	Dec	Jan; Mar
Orange	…-June	July-June	July-June
Passion fruit	…-May	Aug; Feb-May	Oct; Jan
Peach	Mar	Mar	Mar
Plum	Jan-Feb	Jan-Mar	Feb

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 2

Hosts within 200m radius
- Apple < 6
- Citrus(Lemon, Orange) < 6 of each
- Peach < 30
- SF (Apricot, Nectarine, Plum) < 6
- Other fruit(Loquat, Passion fruit etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, M in peach
Pome fruit			
Citrus	VH	VH	VH
Other	VH	VH	L

Fly number/trap/fortnight in specified hosts at Site 2

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
- 0
- <2
- 2-5
- 6-10
- >10

Hosts where flies were captured in traps

Static	no flies (Evergreen)	no flies (Evergreen)	no flies (Peach)
Dynamic	no flies	no flies	no flies

No flies

Figure 60: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 2

Pemberton
Site 4

Ripe fruit at Site 4

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Mar-June		
Grape	Feb		
Lemon	…-June	July-June	July-June
Mandarin	…-June	July-June	July-June
Mulberry	Nov-Feb	Dec-Feb	Dec
Nectarine	Feb		Feb
Peach	Jan	Feb	
Plum	Jan-Feb	Jan-Feb	Jan-Feb

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 4

Hosts within 200m radius

Apple, Pear < 6

Citrus (Lemon, Mandarin) < 6

SF (Apricot, Grape, Mulberry, Nectarine, Peach) < 6 of each

Avocado < 30

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH, no peahces
Pome fruit	VH	H taken by birds	H taken by birds
Citrus	VH	VH	removed
Other	M avo	H avo	H avo

Fly number/trap/fortnight in specified hosts at Site 4

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code

0
<2
2-5
6-10
>10

Hosts where flies were captured in traps

Static	no flies (Lemon)	no flies (Lemon)	no flies (Lemon)
Dynamic	no flies	no flies	Mandarin

No flies

Figure 61: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 4

Pemberton
Site 5

Ripe fruit at Site 5

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Mar	Apr-June	May
Apricot	Dec-Jan	Jan	
Lemon	…-June	July-June	July-June
Nectarine	Dec-Apr	Dec-Feb	Dec
Persimmon	April	Apr-May	Apr
Plum	Dec-Jan	Jan	Jan

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 5

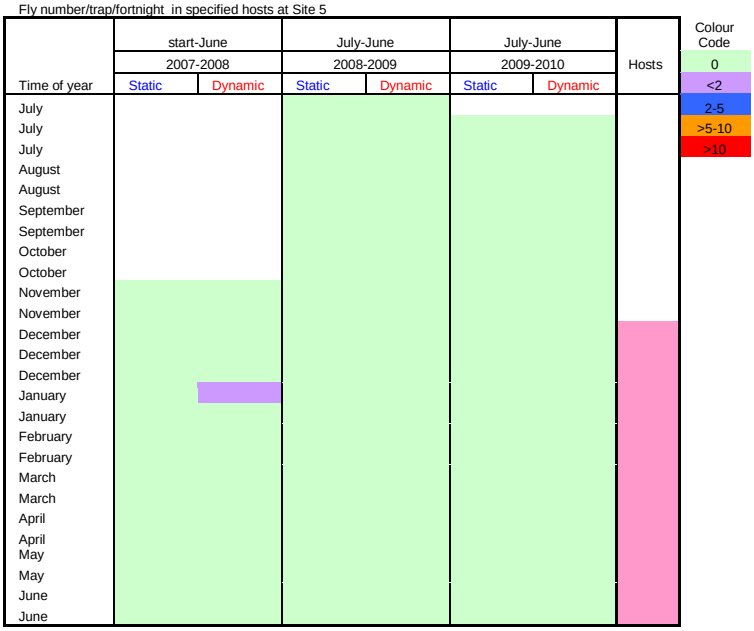
Hosts within 200m radius

Apple < 30
Citrus(Lemon, Mandarin, Orange) < 6 of each
Peach < 30
Plum < 30
SF (Apricot, Nectarine, Plum) < 6 of each
Other fruit (Grape, Fig, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH plum, Lother	VH plum, Lother	VH plum, Lother
Pome fruit	VH	VH	VH
Citrus	H	H	H
Other	M	M	H

Fly number/trap/fortnight in specified hosts at Site 5



Hosts where flies were captured in traps

Static	no flies (Lemon)	no flies (Lemon)	no flies (Plum)
Dynamic	Apricot	no flies	no flies

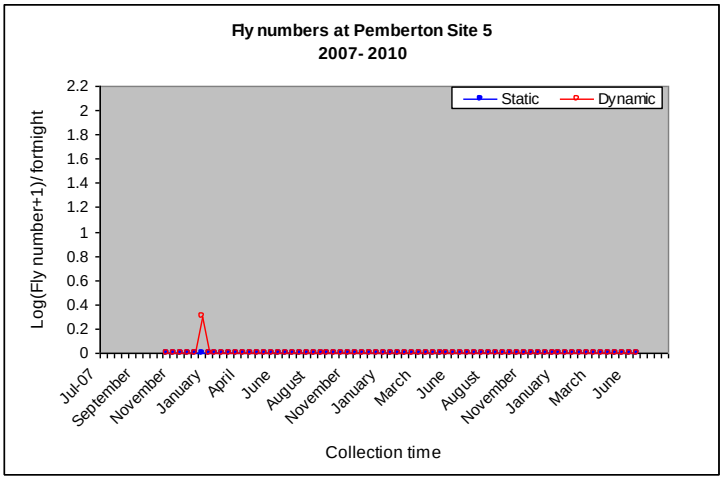


Figure 62: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 5

Pemberton
Site 6

Ripe fruit at Site 6

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	May	Apr-May	May
Apricot	Dec	Jan	Jan
Kiwi fruit	Jun	July-Aug; June	
Lemon	…-June	July-June	July-June
Mandarin	…-June	July-June	July-June
Mulberry	Nov-Feb	Oct-Dec	Nov-Dec
Orange	…-June	July-June	July-June
Pear	Mar	Mar	Feb
Plum	Dec-Jan	Jan-Feb	Jan

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 6

Hosts within 200m radius

Citrus (Lemon, Mandarin, Orange) < 6

Kiwi fruit < 6

Pear < 6

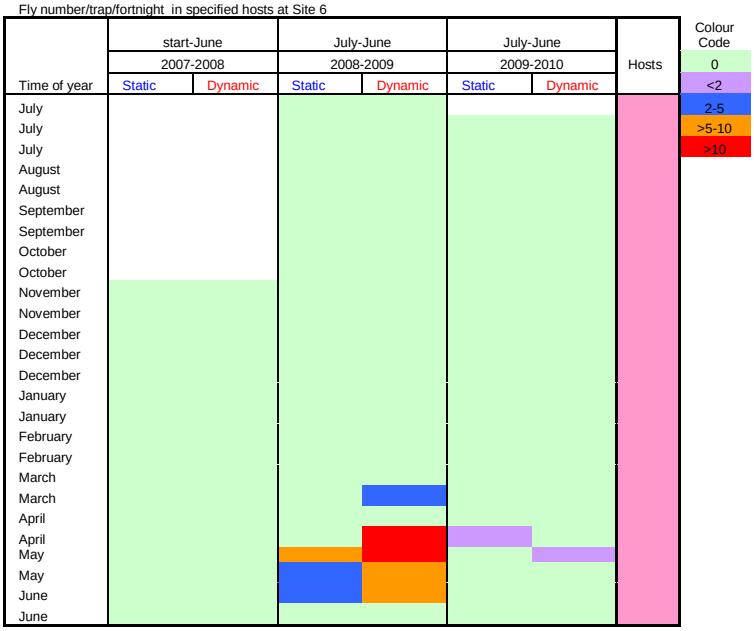
SF (Apricot, Nectarine, Peach, Plum) < 6 of each

Other fruit (Fig, Grape,Kiwi fruit, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L, M apricot	M	H, L apricot
Pome fruit	H	H	H
Citrus	VH	VH	M
Other	VH	VH	

Fly number/trap/fortnight in specified hosts at Site 6



Hosts where flies were captured in traps

Static	no flies (Apple)	Mandarin	Apple
Dynamic	no flies	Mandarin	Mandarin

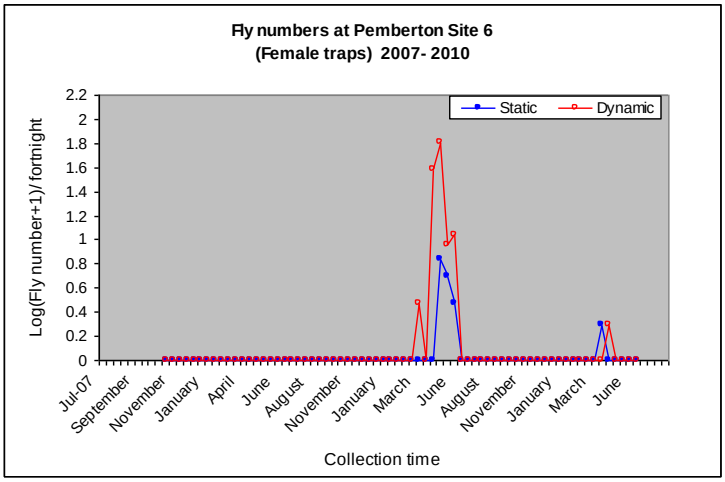


Figure 63: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 6

Pemberton
Site 7

Ripe fruit at Site 7

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apricot		Dec	
Fig	Dec-April	Nov-Jan; Mar-May	Apr-May
Grape	Mar	Feb-Apr	Mar
Lemon	…-June	July-June	July-June
Lilly pilly		Aug-Nov; Apr-June	Apr-June
Loquat	…-Nov	Nov-Dec	Nov-Dec
Orange	…-June	July-Oct	
Peach	Mar-May	Mar	Mar-Apr
Pear	Mar	Apr	April
Plum	Jan	Jan-Feb	Feb-Mar

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 7

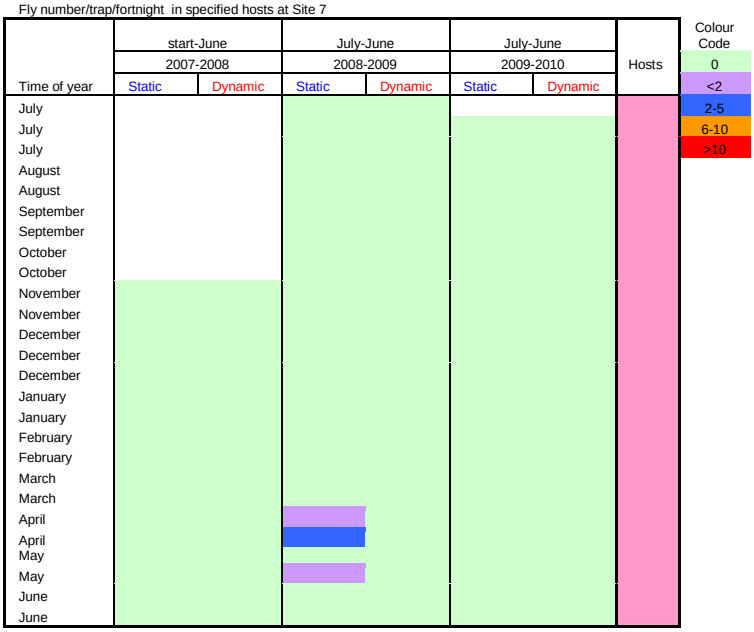
Hosts within 200m radius

- Apple < 30
- Citrus (Lemon, Orange) < 30 of each
- Mandarin < 6
- Peach < 30
- Pear < 6
- Plum < 30
- SF (Cherry, other) < 6 of each
- Other fruit (Grape, Fig, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH, L in apricot	VH, L in apricot	VH, L in apricot
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 7



Hosts where flies were captured in traps

Static	no flies (Plum)	Loquat	no flies (Apple)
Dynamic	no flies	no flies	no flies

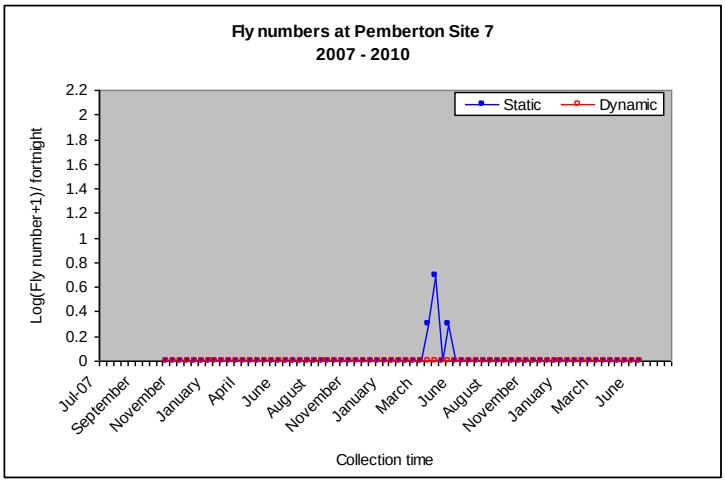


Figure 64: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 7

Pemberton
Site 8

Ripe fruit at Site 8

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Apr-May	Mar-June	May-June
Blackberry	Feb-June	Jan-June	Feb-May
Citron	…-June	July-June	July-June
Fig	Feb-Apr	Nov-Jan; Mar-May	Dec-Jan; Mar-May
Lemon	Apr	Apr-May	July-Dec; Apr
Loquat		Nov-Dec	Nov
Nectarine		Feb	
Peach	Feb	Mar-June	
Plum	Dec; Feb	Dec; Feb-Mar	Jan

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 8

Hosts within 200m radius

Apple < 30

Citrus < 6

Peach < 30
SF (Apricot, Nectarine, Plum) < 6 of each

Other fruit (Fig, Loquat etc)< 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L	L, H in plum	L, H in plum
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH fig, M loquat

Fly number/trap/fortnight in specified hosts at Site 8

Hosts where flies were captured in traps

Static	no flies (Nectarine)	no flies (Loquat)	no flies (Nectarine)
Dynamic	no flies	no flies	no flies

No flies

Figure 65: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 8

Pemberton
Site 9

Ripe fruit at Site 9

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Apr-May	Mar-June	
Apricot	Dec	Dec	
Choko	July	June	
Fig	Dec; Feb-May	July; Nov-Dec; Mar-June	Dec-Jan; Mar-June
Grapefruit	…-June	June-July	June-May
Kiwi fruit	Apr; June	July-Aug	May-June
Lemon	…-June	June-July	June-July
Loquat	Dec-Jan	Oct	Nov
Mulberry	December	October	November
Nectarine	Feb	Jan	
Olive		May-June	May
Orange	May-June	July-Sept	
Passion fruit	Feb-Apr	Feb-Apr	Apr
Peach	Dec-Jan	Jan	
Plum	Dec-Mar	Jan-Mar	Jan
Pomegranate	Apr-May	Apr-May	May-June

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 9

Hosts within 200m radius

Apple < 6

Citrus (Grapefruit, Lemon, Orange) < 6 of each

Pear < 6

SF (Apricot, Peach, Plum, other) < 6 of each

Other fruit (Fig, Grape, Kiwi fruit, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	M	VH	M, removed by birds
Pome fruit	M	VH	M, removed by birds
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 9

Hosts where flies were captured in traps

Static	no flies (Lemon)	no flies (Lemon)	no flies (Apple)
Dynamic	no flies	no flies	no flies

No flies

Figure 66: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 9

Pemberton
Site 10

Ripe fruit at Site 10

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Mar	May-June	Apr-June
Apricot	Dec	Jan	
Blueberry		Jan-Feb	Jan-Feb
Fig	Dfeb-Apr	Nov; Mar-Apr	Apr
Grape	Feb-Mar	Mar-Apr	Mar-Apr
Kiwi fruit	Mar-June	July; June	June
Lemon	…-June	June-July	June-July
Mandarin	May-June	July-Aug; June	July; June
Nectarine			
Olive			
Orange	Nov-Dec; May-June	July-Oct; May-June	July-Oct; June
Peach	Dec; Feb-Mar	Mar	Mar
Persimmon	Mar-Apr	Apr-May	Apr-May
Plum	Jan-Feb	Jan-Mar	Jan-Mar

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 10

Hosts within 200m radius
- Apple < 6
- Citrus (Lemon, Mandarin, Orange) < 6 of each
- Pear < 6
- SF (Apricot, Cherry, Nectarine, Peach, Plum) < 6 of each
- Other fruit (Fig, Grape, Kiwi fruit, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	H peach & plum, L apr & nect
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 10

Hosts where flies were captured in traps

Static	no flies (Eucalypt)	no flies (Eucalypt)	no flies (Agonis)
Dynamic	no flies	no flies	no flies

No flies

Figure 67: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 10

Pemberton
Site 11

Ripe fruit at Site 11

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007 Nov -2008	2008-2009	2009-2010
Apple	Apr-May	Apr-June	Mar-May
Apricot	Dec-Jan	Jan	
Cherry guava	Apr-May	Apr-June	Apr-May
Feijoa	Apr	Apr	
Fig	Mar-May	Nov-Dec; Mar-May	Apr-June
Grape			Mar
Kiwi fruit	Apr; June	July-Aug; June	Aug; May-June
Lemon	…-June	June-July	June-July
Loquat	…-Dec	Nov-Dec; Mar-May	Nov
Olive	Mar-June	July-Oct	
Nectarine	Jan	Jan-Mar	Feb
Orange	…-June	June-July	June-July
Passion fruit	Jan-Mar	Feb-Apr	Oct-Dec; Jan; Mar
Peach	Mar	Mar	Apr
Pear		Mar	Mar
Persimmon	Apr-May	Apr-June	Apr-June
Plum	Jan-Feb	Jan-Mar	Feb

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 11

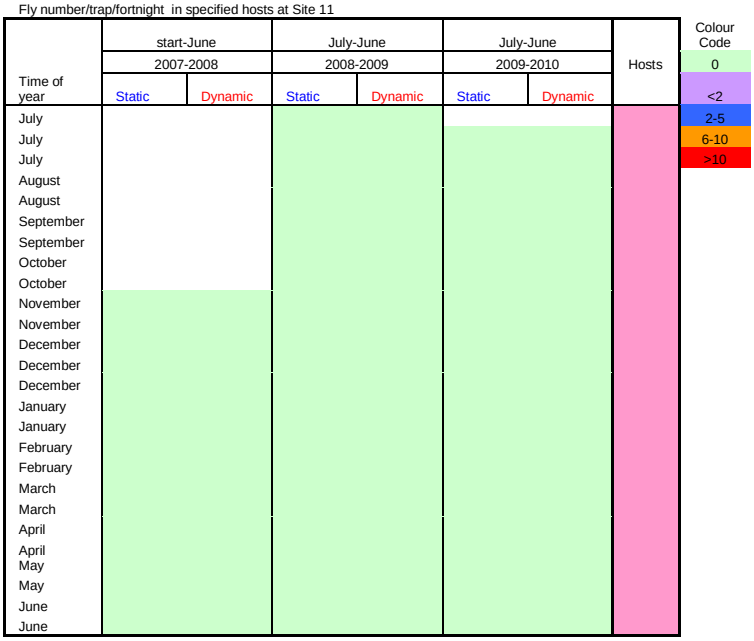
Hosts within 200m radius

Apple < 30
Citrus (Grapefruit, Lemon, Mandarin, Orange) < 6 of each
Kiwi fruit < 30
Pear < 6
SF (Apricot, Cherry, Nectarine, Peach, Plum) < 6 of each
Other fruit (Fig, Grape, Kiwi fruit, Loquat, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH	VH	VH
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 11



Hosts where flies were captured in traps

Static	no flies (Orange)	no flies (Orange)	no flies (Apple)
Dynamic	no flies	no flies	no flies

No flies

Figure 68: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 11

Pemberton
Site 12

Ripe fruit at Site 12

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb-May	Mar-June	July; Mar & June
Apricot	Dec	Jan	Dec
Fig	Dec; Feb-May	Dec; Mar-May	Mar-May
Grape	Mar	Mar-June	
Lemon	…-June	July-June	July-June
Loquat	…-Jan; Mar	Nov-Dec	Dec
Mandarin	June	July-Aug; June	July; June
Mulberry	Dec	Nov-Dec	Dec
Nectarine		Feb	feb
Olive		Apr-June	Mar-June
Orange	Nov-Jan; Mar; May-June	July-Sept; June	July-June
Passion fruit		July; Apr	Mar
Peach	Mar	Mar-June	Mar
Persimmon	Mar-May	Apr-May	Apr-May
Plum	Jan-Feb	Jan-Mar	Jan-Mar
Pomegranate	Jan; Mar-May	July; Apr; Feb-June	Apr-May
Raspberry		Dec-Jan	Dec-Jan
Tamarillo	Mar-June		

Distance from town centre 5-10 km

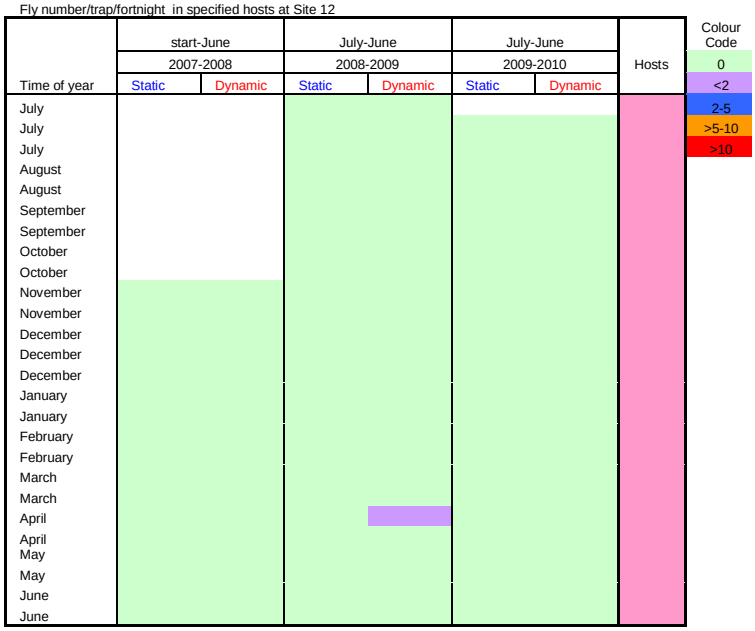
Hosts and fruit volume at Pemberton Site 12

Hosts within 200m radius
- Apple < 30
- Citrus (Lemon, Orange) < 6 of each
- SF (Apricot, Cherry, Nectarine, Peach, Plum) < 6 of each
- Other fruit (Feijoa, Fig, Grape, Loquat, Olive, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	VH, L apricot	VH, L apricot	VH, L apricot
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 12



Hosts where flies were captured in traps

Static	no flies (Wattle)	no flies (Feijoa)	no flies (Feijoa)
Dynamic	no flies	Apple	no flies

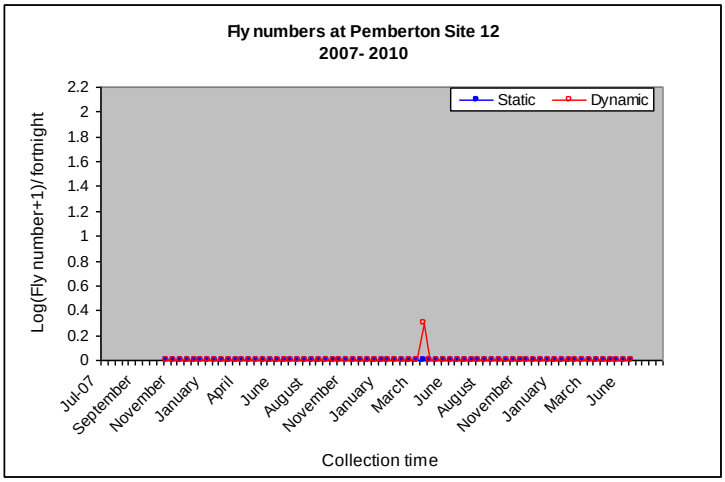


Figure 69: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 12

Pemberton
Site 13

Ripe fruit at Site 13

Host	Availability of Ripe fruit		
	start-June 2007Nov -2008	July-June 2008-2009	July-June 2009-2010
Apple	Jan	Feb	Mar
Apricot	Dec-Jan	Jan	
Fig	Mar-May	Dec-Jan; Mar-June	Apr-June
Lemon	Nov-Dec; Apr-May	July-Nov; Apr-June	July-Jan; June
Mandarin	…-Feb; June	July-Sept	
Mulberry	Dec-Jan	Dec	Jan
Nashi	Feb	Mar	
Nectarine	Jan-Feb	Jan-Mar	
Peach	Jan	Feb-Mar	
Persimmon	April--May	April	Apr-May
Plum	Nov; Jan	Jan-Feb	Feb

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 13

Hosts within 200m radius

Apple < 30
Citrus (Lemon, Mandarin, Orange) < 6
Pear < 6
Plum < 30
SF (Apricot, Cherry, Nectarine,Quince) < 6 of each
Other fruit (Fig, Mulberry, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	M	H	M
Pome fruit	M	M	L
Citrus	H	H	H
Other	VH	VH	VH

most fruit taken by birds

Fly number/trap/fortnight in specified hosts at Site 13

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
6-10
>10

Hosts where flies were captured in traps

Static	no flies (Fig)	no flies (Evergreen)	no flies (Apple)
Dynamic	no flies	no flies	no flies

No flies

Figure 70: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 13

Pemberton
Site 14

Ripe fruit at Site 14

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Apple	Feb	Mar	Jan
Apricot	Dec		
Fig	Mar-Apr	Dec; Mar-May	Apr-May
Grape		Oct-Feb	
Lemon	…-June	July-June	July-June
Loquat	…-Nov	Oct-Nov	Nov
Orange	…-June	July-Dec; May-June	July-June
Passion fruit	Jan-Mar	Oct; Jan-Feb	
Peach	Mar	Mar	
Pear	Feb	Mar	Apr
Persimmon	Apr-June	Apr-June	
Plum	Jan	Jan-Feb	

Distance from town centre < 2 km

Hosts and fruit volume at Pemberton Site 14

Hosts within 200m radius

Apple < 6

Citrus (Lemon, Orange) < 6 of each

SF (Apricot, Peach, Plum, other) < 6 of each
Other fruit (Fig, Grape, Loquat, Persimmon etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	H	VH	M, removed by birds
Pome fruit	VH	VH	VH
Citrus	VH	VH	VH
Other	H	H	H

Fly number/trap/fortnight in specified hosts at Site 14

Hosts where flies were captured in traps

Static	no flies (Avocado)	no flies (Avocado)	no flies (Avocado)
Dynamic	no flies	no flies	no flies

No flies

Figure 71: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 14

Pemberton
Site 15

Ripe fruit at Site 15

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007 Nov -2008	2008-2009	2009-2010
Cumquat	Nov-Apr	Aug-Jun	July-Oct
Red currant	Nov-Apr	Nov-Dec	Dec
Fig	Mar-Apr	Apr-June	Apr-May
Lemon	…-June	July-June	July-June
Loquat	…-Nov	Nov-Dec	Nov
Mandarin	…-Jan; Mar-May	July-June	July-June
Mulberry	Nov	Oct	Nov
Olive		Apr-May	Apr-May
Orange	…-June	July-June	July-June
Passion fruit	April-June	July-Aug	
Quince	Jan	Feb	Apr
Raspberry		Jan	Dec

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 15

Hosts within 200m radius

Citrus (Cumquat, Lemon, Mandarin, Orange)< 6
Grape < 30
Pome fruit (Apple, Pear, Quince) < 6 of each
SF(Apricot, Nectarine, Plum) < 6 of each
Other (Fig, Loquat, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	L,	L	L
Pome fruit	L	L	L
Citrus	VH	VH	VH
Other	VH	VH	VH

taken by birds most stone fruit all years

Fly number/trap/fortnight in specified hosts at Site 15

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code

0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Loquat)	no flies (Loquat)	no flies (Nectarine)
Dynamic	no flies	no flies	no flies

No flies

Figure 72: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 15

Pemberton
Site 16

Ripe fruit at Site 16

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Fig	Apr	Jan; Apr-May	Apr
Mulberry		Oct-Dec	Nov
Orange	….-Apr	July-Oct	
Persimmon	Apr-May	July & Oct; Apr-June	Apr-June
Tangelo		…-June	July-June

Distance from town centre > 10 km

Hosts and fruit volume at Pemberton Site 16

Hosts within 200m radius

Avocado < 300-400

Citrus (Tangelo, Lemon)< 100

Other (Mango, Mulberry etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit			
Pome fruit			
Citrus	VH	VH	VH
Other	VH	VH	VH

Fly number/trap/fortnight in specified hosts at Site 16

	start-June		July-June		July-June		Hosts	Colour Code
	2007-2008		2008-2009		2009-2010			0
Time of year	Static	Dynamic	Static	Dynamic	Static	Dynamic		<2
July								2-5
July								6-10
July								>10
August								
August								
September								
September								
October								
October								
November								
November								
December								
December								
December								
January								
January								
February								
February								
March								
March								
April								
April								
May								
May								
June								
June								

Hosts where flies were captured in traps

Static	no flies (Avocado)	no flies (Avocado)	no flies (Avocado)
Dynamic	no flies	no flies	no flies

No flies

Figure 73: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 16

Pemberton
Site 17

Ripe fruit at Site 17

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Berries		Dec-May	Dec-Mar
Blueberry		Jan-Feb	Jan-Apr
Fig	June	Apr-June	May
Lemon		...-June	July-June
Mulberry		Dec-May	Dec-Jan
Nashi		Mar	
Olive		Apr-June	May-June
Peach		Feb	
Pear		Apr	
Plum		Jan-Mar	
Quince		Mar-Apr	Apr

Distance from town centre 2-5 km

Hosts and fruit volume at Pemberton Site 17

Hosts within 200m radius

Avocado < 300-400
Berries (Blueberry, Raspberry) < 200-300
Citrus (Orange, Lemon)< 30
Pome fruit (Nashi, Pear, Quince) < 6 of each
SF(Apricot, Peach, Plum) < 6 of each
Other fruit (Fig, Kiwi fruit, Olive etc) < 6 of each

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		M	L & taken by birds
Pome fruit		M	M
Citrus	VH	VH	VH
Other		VH berries	VH berries

Fly number/trap/fortnight in specified hosts at Site 17

Hosts where flies were captured in traps

Static	no flies (Lemon)	no flies (Avocado)	no flies (Quince)
Dynamic	no flies	no flies	no flies

No flies

Figure 74: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 17

Pemberton
Site 18

Ripe fruit at Site 18

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple		Apr-June	Apr-June
Apricot		Feb	Jan
Lemon		..-June	July-June
Nectarine		Feb-Mar	Feb
Olive		Apr-May	May
Orange		…-Sept; Feb-Mar; May-June	July-Aug; Dec & June
Peach		Mar	Dec-Mar
Pear		Apr	May
Plum		Jan-Mar	Jan-Mar

Distance from town centre > 10 km

Hosts and fruit volume at Pemberton Site 18

Hosts within 200m radius

Citrus (Lemon, Orange) < 3

Olive< 100-200

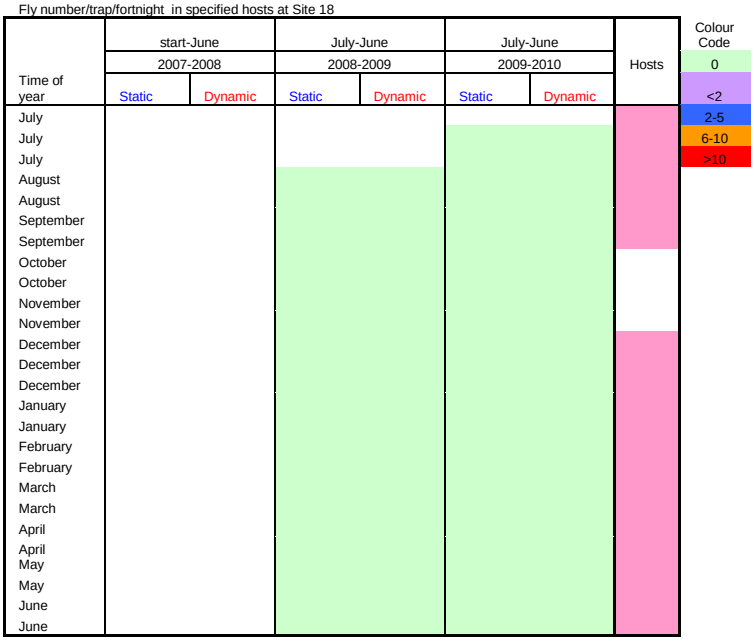
Pome fruit (Apple, Pear) < 30
SF (Apricot, Nectarine, Peach, Plum) < 30

Other fruit (Feijoa) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit		VH	VH
Pome fruit		VH	VH
Citrus		H	H
Other		VH olives	VH olives

Fly number/trap/fortnight in specified hosts at Site 18



Colour Code

0
<2
2-5
6-10
>10

Hosts where flies were captured in traps

Static	no flies (Olive)	no flies (Olive)
Dynamic	no flies	no flies

No flies

Figure 75: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 18

Pemberton
Site 19

Ripe fruit at Site 19

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2008	2008-2009	2009-2010
Apple		Apr-June	Apr
Apricot			Jan
Feijoa		June	
Grapefruit		July-Sept	July-Oct; June
Kiwi fruit		…-Aug	Aug-Sept; June
Lemon		Sept; Apr-June	July-Dec; May
Peach			
Nashi		Mar-May	Apr-May
Nectarine		Mar-May	Jan
Orange		…-Oct	May-June
Pear		Apr-June	Apr
Plum		Jan	Jan
Pomegranate		Feb	Apr
Quince		Mar	May

Distance from town centre > 10 km

Hosts and fruit volume at Pemberton Site 19

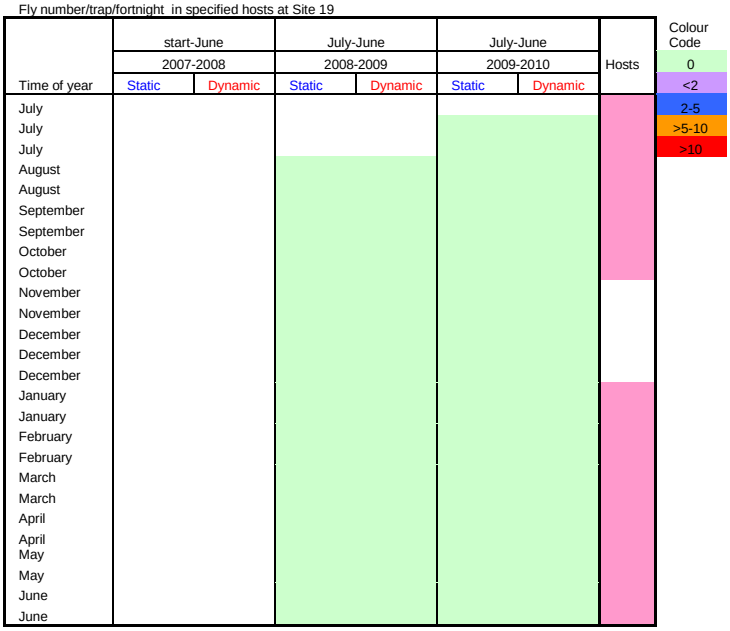
Hosts within 200m radius

Avocado < 200
Blackberry < 100
Citrus (Grapefruit, Lemon, Mandarin, Orange) < 6 of each
Kiwi fruit < 200
Passion fruit < 100
Pome fruit (Nashi, Pear) < 200
Olive< 100-200
SF (Apricot, Nectarine, Peach, Plum) < 100
Other fruit (Feijoa, Mulberry, Olive etc) < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2009	2010
Stone fruit	H	H	H
Pome fruit	M	M	M
Citrus	M	M	M
Other	VH kiwi fruit	VH kiwi fruit	VH kiwi fruit

Fly number/trap/fortnight in specified hosts at Site 19



Hosts where flies were captured in traps

Static	no flies (Avocado)	no flies (Nashi)
Dynamic	no flies	no flies

No flies

Figure 76: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 19

Kununurra

Town monitoring (June 2008 - June 2010)

In the centre of town in Kununurra the following Medfly had been intercepted in the static trap grid, without any further captures indicating that the flies had been itinerant flies possibly brought in with fruit by tourists. During this period no flies were captured in the remaining 91 traps of the ORIA static grid.

Table 28: Flies intercepted in the static grid in the ORIA

Date	No. of male Medfly	Trap Number	Host	Address	Lat/Long
2/07/2008	1	KU0042CAP	mango	Poinciana St	S 15.78004 E 128.73328
16/07/2008	1	KU0044CAP	lemon	Town Caravan Park	S 15.77753 E 128.73779
27/08/2008	1	KU0092CAP	mango	Poinsettia Way	S 15.76333 E 128.74648
3/09/2008	1	KU0092CAP	mango	Poinsettia Way	S 15.76333 E 128.74648

Trial sites (June 2008 - June 2010)

The nature of the trapping sites and distance from town are given in Table 29.

From September 2008 – June 2010 no Medflies were captured in the static grid or the trial traps. No *C. capitata* were captured in Kununurra in any of the trial traps in the two years; nine male trap sites and three female trap sites within the current static grid demonstrated a result equal to that of the fixed trap grid of 40 traps.

Table 29: Characteristics of orchards trial sites in Kununurra

Key Small orchards Large orchards					Capture Frequency of *C. capitata*, July-June	
Site	Type of trap	Fruit volume in 200 m	Distance from town centre	Breeding population	2008 - 2009	2009 - 2010
1	Male	High	5-10	No	0	0
2	Male	Low	5-10	No	0	0
4	Male	Moderate	5-10	No	0	0
5	Male	Moderate	2-5	No	0	0
6	Male	High	5-10	No	0	0
8	Male	High	> 10	No	0	0
10	Male	Moderate	5-10	No	0	0
11	Male	Low	5-10	No	0	0
12	Male	Moderate	5-10	No	0	0
3	Female	Moderate	< 2	No	0	0
7	Female	Moderate	5-10	No	0	0
9	Female	Moderate	> 10	No	0	0
13	Female	Low	2-5	No	0	0

Host phenology and fly population at Kununurra orchard sites

In Kununurra large orchards consist of mango. There are smaller areas planted to papaya, grapefruit, and mixed tropical fruits such as carambola, custard apple, guava, jack fruit, star fruit etc. (Figure 77-89).

While *C. capitata* were not captured, small numbers of some native *Bactrocera* species were found in traps.

Kununurra
Site 1

Fruiting phenology at Site 1

Host	Availability of Ripe fruit		
	Start	July-June	July-June
	Jun-08	2008-2009	2009-2010
Banana	June	June & Nov	June-Dec; May
Cashew		Aug-Nov	Sept-Oct
Ixora		July-Aug; Feb & June	July-Aug; Nov-Feb; June
Lime		Feb-June	July-Aug; Oct; Mar-June
Mango		Dec	Nov-Dec
Mulberry		Aug-Dec; Jan-Mar; May	July; Sept-Oct; Jan
Papaya		June; Aug-Sept;Nov-June	July-June

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 1

Hosts within 200m radius

Banana 200-300
Cashew <30
Ixora < 30
Lime < 6
Mango <100
Papaya < 100

Fly density NIL
Fruit Biomass HIGH

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Banana		VH	VH
Citrus		VH	M
Mango		VH	VH
Papaya		VH	VH
Other		H	Medium - High

Fly number/trap/fortnight in specified hosts at Site 1

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 77: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 1

Kununurra
Site 2

Fruiting phenology at Site 2

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Custard apple	June	July-Aug	
Grape		April	Aug-Sept; March
Grapefruit	June	July-Aug; Feb-June	July; Sept; Nov-June
Mango		Dec	Nov
Papaya			…-Jan; Mar-June
Passion fruit	July	Oct-Nov	
Sapodilla			Nov-Dec; May
Sapote		Nov	Nov

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 2

Hosts within 200m radius

Avocado < 6
Carambola < 6
Custard apple < 6
Grape < 100
Grapefruit 200-300
Lime < 6
Mango < 100
Papaya 100-200
Passionfruit < 6
Sapodilla < 6
Sapote < 6
Star apple < 6
Tamarind < 6
Tangelo < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		VH	VH
Mango		VH	VH
Papaya		H	H
Other		L, H sapodilla	L, M sapodilla

Fly number/trap/fortnight in specified hosts at Site 2

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango/Papaya)
Dynamic	no flies	no flies

No flies

Figure 78: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 2

Kununurra
Site 3

Fruiting phenology at Site 3

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Carambola		Aug	
Cashew			Nov
Ixora	June	July-Sept; Dec-Jan; May	July-Sept
Mango		Nov-Dec	Sept-Nov
Sapodilla	June	Mar-Apr	Mar-May

Distance from town centre < 2 km

Hosts and fruit volume at Kununurra Site 3

Hosts within 200m radius

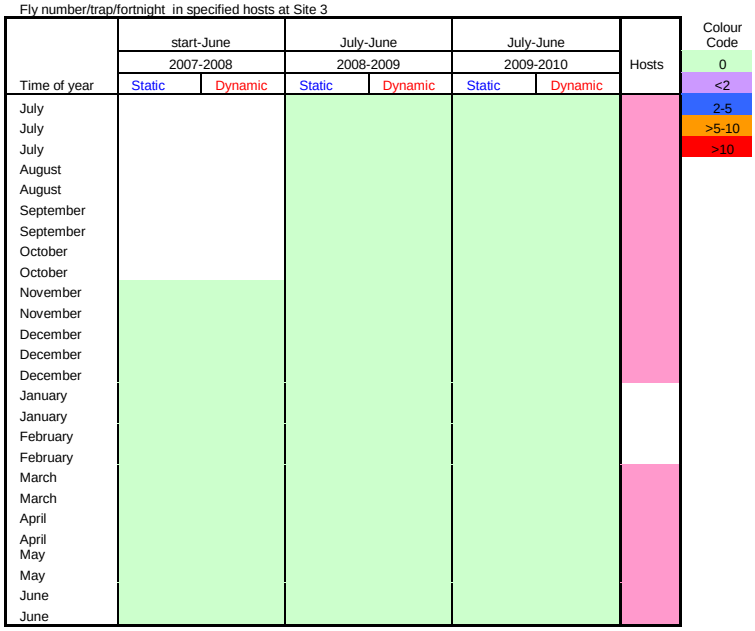
Carambola < 6
Cashew < 6
Ixora < 30
Mango < 30
Sapodilla < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Mango		M	M
Other		L; M sapodilla	L; M sapodilla

removed by people before ripening

Fly number/trap/fortnight in specified hosts at Site 3



Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 79: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 3

Kununurra
Site 4

Fruiting phenology at Site 4

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Custard apple			Oct
Grapefruit			May-June
Guava		Apr-June	Mar-June
Mango		Nov-Dec	Nov-Dec
Star apple		July-Oct	

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 4

Hosts within 200m radius

Cahsew < 6
Custard apple < 6
Grapefruit < 6
Guava <6
Lime, Indian < 6
Mango 300-400
Sapodilla < 6
Star apple < 6
Tangelo < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		L	L,
Mango		VH	VH
Guava		L, removed by birds	L, removed by birds
Other		L	L

Fly number/trap/fortnight in specified hosts at Site 4

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 80: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 4

Kununurra
Site 5

Fruiting phenology at Site 5

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Avocado			Jan-Mar
Carambola	Jun	July-Sept; Apr-June	July-Sept; Mar-June
Grapefruit			…-Jan; Mar-June
Guava		Jly-Sept; Nov-Dec; Mar-June	July-Nov; Jan-Feb;
Lemon	June	Aug; Oct-Nov; Mar-May	Aug-Oct; June
Lime	June	July-Nov; Mar-June	July; Nov-Mar; June
Mango		Oct-Dec; Mar	Nov
Mulberry		July-June	Sept-Nov; June
Orange		July-Aug; Oct-Dec	July-Saug; Dec
Papaya			
Sapodilla		Nov-Dec; Mar; May-June	Sept-Nov; Jan-Feb
Sapote		Oct	

Distance from town centre 2-5 km

Hosts and fruit volume at Kununurra Site 5

Hosts within 200m radius

Avocado < 6
Carambola < 6
Grapefruit < 6
Guava < 2
Lemon < 6
Lime < 6
Mango 300-400
Mulberry <6
Orange < 6
Papaya < 6
Sapodilla < 6
Sapote < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		H; L GF, Orange	H; L GF, Orange
Mango		VH	VH
Papaya		L	L
Other		VH	VH

Fly number/trap/fortnight in specified hosts at Site 5

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 81: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 5

Kununurra
Site 6

Fruiting phenology at Site 6

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov - 2008	2008-2009	2009-2010
Custard apple		Mar	July; Sept-Nov
Guava	June	July-Nov; Feb-June	July; Sept-Nov; May
Jack fruit		Sept-Nov; Jan	Sept-Jan
Lime		July; Nov-Jan; Mar	Oct;
Mango		Nov-Dec	Nov
Mulberry		Aug; Dec-Jan	Oct-Nov
Orange		May-June	
Papaya	June	July; Jan-June	July; Sept-Dec; Mar-June
Soursop		Nov-Mar	Jan

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 6

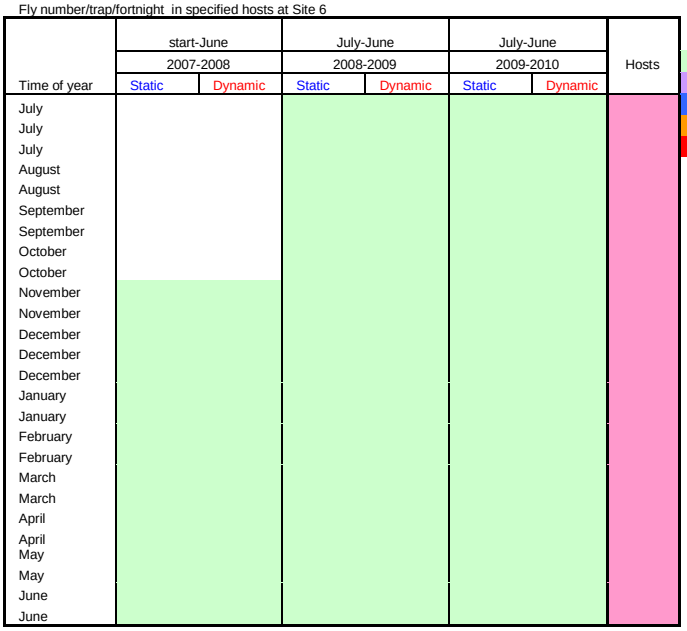
Hosts within 200m radius

Citrus (Lemon, Lime, Orange) < 6
Custard apple < 6
Guava < 6
Jack fruit < 6
Mango 900-1000
Mulberry < 6
Orange Jasamine <6
Papaya < 100
Sapote < 6
Soursop < 6
Star apple < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		L	L
Mango		H	H
Papaya		H	H
Guava		H	L
Other		L; H jack fruit	L; H jack fruit

Fly number/trap/fortnight in specified hosts at Site 6



Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 82: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 6

Kununurra
Site 7

Fruiting phenology at Site 7

Host	Availability of Ripe fruit		
	start-June	July-June	Discontinued
	2007Nov -2008	2008-2009	Moved to Site 13
Custard apple			
Jack fruit			
Lemon		Aug-Sept; Nov-Dec; Mar-June	
Mango		Nov-Dec	
Sapote			
Star apple		Aug	

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 7

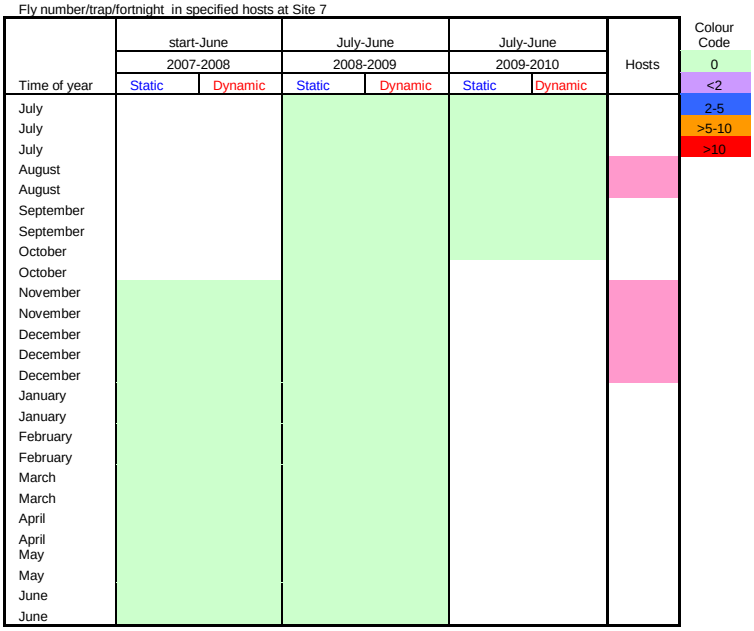
Hosts within 200m radius

Custard apple < 6
Jack fruit < 6
Lemon < 6
Mango 100-200
Sapote < 6
Star apple < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		H	H
Mango		M	M
Other		L	L

Fly number/trap/fortnight in specified hosts at Site 7



Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 83: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 7

Kununurra
Site 8

Fruiting phenology at Site 8

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Avocado		Mar	
		July-Sept; Nov; Feb;Apr-June July-Oct;	
Carambola	June		
Grapefruit			Dec; May-June
Lime		July-Nov; Mar-June	July-Nov; June
Sandalwood	June	July-June	July-June
Sapodilla	June	Mar-May	Aug-Dec; May-June
Star apple	June		Sept-Oct; June

Distance from town centre > 10 km

Hosts and fruit volume at Kununurra Site 8

Hosts within 200m radius

Avocado
Carambola < 6
Grapefruit <200-300
Lime < 6
Persimmon < 6
Sandalwood > 1000
Sapodilla < 6
Star apple < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		VH	VH
Mango		H	H
Papaya		H	H
Guava		H	L
Other		H	M

Fly number/trap/fortnight in specified hosts at Site 8

Hosts where flies were captured in traps

Static	no flies (Grapefruit)	
Dynamic	no flies	no flies

No flies

Figure 84: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 8

Kununurra
Site 9

Fruiting phenology at Site 9

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Avocado		Mar	Feb
Banana		May	
Calamondin		July-June	Nov; June
Carambola		Feb-Aug; Jan-June	July; Nov-Mar;
Custard apple			
Guava		Mar	Feb-Mar
Jack fruit		Oct-Nov; Jan-Feb	Oct-Feb
Lemon		Sept; Nov; Jan-June	
Mandarin	June	Aug; Nov; Feb-June	July; June
Mango		Nov-Dec	Nov
Mulberry		Dec-Jan	Sept
Sapodilla		Dec; Mar-May	Oct; Jan-Feb
Sapote, white			Nov
Soursop			Nov-Mar
Star apple		Nov-Dec	Sept-Oct
Tamarind		July-Jan; Apr; June	July-Jan

Distance from town centre > 10 km

Hosts and fruit volume at Kununurra Site 9

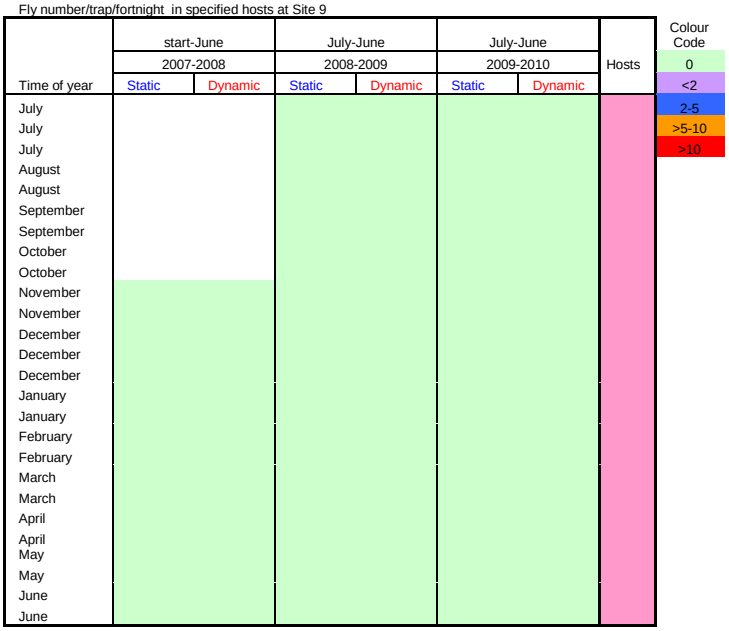
Hosts within 200m radius

Avocado < 6
Banana < 6
Carambola < 6
Custard apple < 6
Guava < 30
Jack fruit < 6
Lemon <6
Mandarin < 30
Mango < 30
Mulberry < 6
Sapodilla < 6
Star apple < 6
Tamarind < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		M	M
Mango		VH	VH
Guava		L	L
Other		M	M

Fly number/trap/fortnight in specified hosts at Site 9



Colour Code

0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango/Calamondin)
Dynamic	no flies	no flies

No flies

Figure 85: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 9

Kununurra
Site 10

Fruiting phenology at Site 10

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Cashew			Aug-Oct
Cumquat		July-Oct	Sept-Mar; June
Custard apple		Aug-Sept	Oct
Guava		Feb; Apr-June	Sept; Jan; Mar; June
Ixora		Aug; Dec-Jan; May-June	July; Oct; Jan-Feb
Jack fruit		Aug; Oct-Nov	Sept-Jan; Mar
Lemon	June	July-Sept; Nov;Jan-June	July; Dec-June
Lime	June	July-June	July-June
Mango		Nov-Dec	Oct-Nov
Papaya	June	July-June	July
Tangelo		Feb; May	

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 10

Hosts within 200m radius

Cashew < 6
Cumquat < 6
Custard apple < 6
Grapefruit < 100
Guava < 6
Ixora < 30
Jack fruit < 6
Lemon < 6
Lime < 6
Mango 800-900
Papaya 300-400
Tangelo < 100

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		Vh	VH
Mango		VH	VH
Papaya		H	H
Guava		H	L
Other		L	L

Fly number/trap/fortnight in specified hosts at Site 10

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code

0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango/Cumquat)
Dynamic	no flies	no flies

No flies

Figure 86: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 10

Kununurra
Site 11

Fruiting phenology at Site 11

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Carambola	June	July-Sept; Dec-June	July-Aug; Nov; June
Grapefruit	June	July-aug; Nov-Dec; Feb-June	July-June
Ixora	June	Aug-Nov	July-Dec
Jackfruit		Oct-Nov	Oct-Dec
Lime		July-Nov; Apr	Oct-June
Mango		Nov-Dec	Nov
Orange			June

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 11

Hosts within 200m radius

Carambola < 6
Grapefruit < 100
Ixora < 6
Jackfruit < 6
Lime < 6
Mango > 1000
Orange < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		VH; L orange	VH; L orange
Mango		VH	VH
Other		M	M

Fly number/trap/fortnight in specified hosts at Site 11

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 87: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 11

Kununurra
Site 12

Fruiting phenology at Site 12

Host	Availability of Ripe fruit		
	start-June	July-June	July-June
	2007Nov -2008	2008-2009	2009-2010
Custard apple			Sept-Oct
Guava		Nov-Apr	Mar; Oct
Ixora		July-Aug; Dec; May-June	July-Sept
Lemon	June	Mar-May	Feb-Mar
Lime		Nov-Dec	Nov
Mango		Nov-Dec	Nov
Mulberry			Sept-Nov
Sapote			
Star apple			
Water apple		Aug-Sept	July; Oct; Mar

Distance from town centre 5-10 km

Hosts and fruit volume at Kununurra Site 12

Hosts within 200m radius

Custard apple < 6
Guava < 6
Ixora < 6
Lemon < 6
Lime < 6
Mango 100-200
Mulberry < 6
Sapote < 6
Star apple < 6
Water apple < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Citrus		H	L
Mango		VH	VH
Other		L, eaten by horses	L, eaten by horses

Fly number/trap/fortnight in specified hosts at Site 12

Time of year	start-June 2007-2008 Static	start-June 2007-2008 Dynamic	July-June 2008-2009 Static	July-June 2008-2009 Dynamic	July-June 2009-2010 Static	July-June 2009-2010 Dynamic	Hosts
July							
July							
July							
August							
August							
September							
September							
October							
October							
November							
November							
December							
December							
December							
January							
January							
February							
February							
March							
March							
April							
April							
May							
May							
June							
June							

Colour Code
0
<2
2-5
>5-10
>10

Hosts where flies were captured in traps

Static	no flies (Mango)	no flies (Mango)
Dynamic	no flies	no flies

No flies

Figure 88: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 12

Kununurra
Site 13

Fruiting phenology at Site 13

Host	Availability of Ripe fruit		
		commenced Oct 2009	July-June
	Traps moved from site 7		2009-2010
Barbado cherry			Jan
Carambola			June
Lilly pilly (type of)			Oct
Longan			Oct; Mar
Mango			Oct-Nov
Miracle fruit			Oct-Nov
Passionfruit wild			Oct-June
Sapodilla			Oct-Feb
Water apple			Oct; Jan; Mar

Distance from town centre 2-5 km

Hosts and fruit volume at Kununurra Site 13

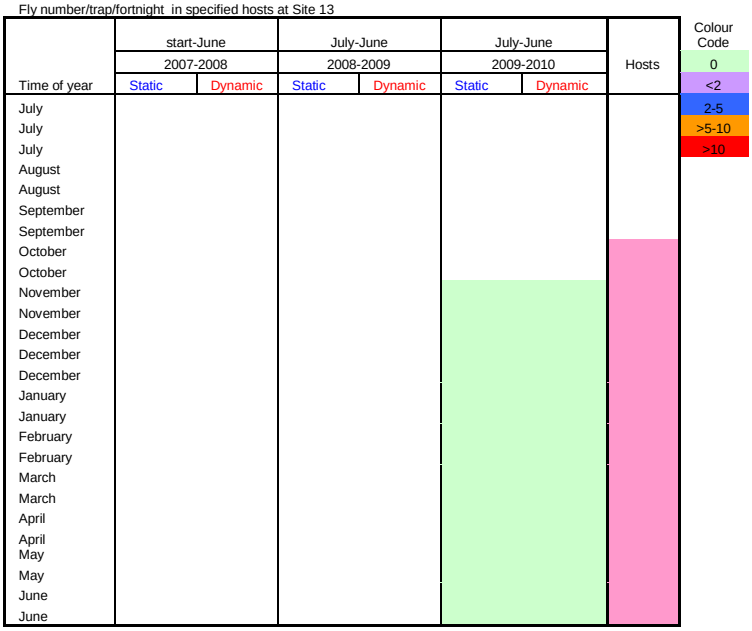
Hosts within 200m radius

Barbado cherry < 6
Carambola < 6
Dragon fruit < 6
Longan < 6
Lillly pilly (type of) < 6
Mango < 30
Miracle fruit < 6
Passionfruit wild < 6
Sapodilla < 100
Star apple < 6
Water apple < 6

(Fruit volume: L < 6, M 6-10, H 11-20, VH >20)

Fruit category	2008	2008-2009	2009-2010
Water apple passion fruit, sapodilla		VH	VH
Mango		L	L
Longan, carambola,, cherry , lilly pilly		L	L
Miracke fruit		M	L

Fly number/trap/fortnight in specified hosts at Site 13



Hosts where flies were captured in traps

Static — no flies (Sapodilla)

Dynamic — no flies

No flies

Figure 89: Fly numbers, hosts, ripe fruit and fruit volume within 200m of site 13

DISCUSSION

General Discussion

In the field, under Western Australian conditions, development of Medfly from egg to adult takes 28-34 days in summer and 60 - 115 days in winter depending on temperature. The lower thresholds for development of Medfly in Western Australia (De Lima 2008) are 9.3 °C for eggs to hatch; 11.1°C for larvae to develop though three instars and pupate in soil; 8.4 °C for pupae to develop to adults; and 12.8 °C for egg maturation in adults (pre-oviposition) requiring an accumulation of 298 day degrees (DD) above these thresholds for development. Other threshold values for Medfly (Tassan *et al.* 1982) used in California are: egg-larvae 9.7°C, pupa 9.7°C and pre-oviposition 16.6 °C requiring an accumulation of 376 DD for development and from these figures the Medfly life cycle in California is estimated to be 31-38 days in summer and winter 120-186 days.

Carey (1984) conducted a number of laboratory studies at 25 °C and found that Medfly larval development times varied with type of host fruit, ranging from more than one week on mango and tomato, to three weeks in quince. Moreover, survival as larvae and pupae were higher for larvae developing in certain hosts. Mean development times for eggs was 49.2 hrs; pupae 11.5-13.5 days; adult to egg laying 1-3 days; adding to a total of about 16 days for development under optimal conditions. Carey (1984) concluded that four factors contributed to the success of Medfly: 1) multiple overlapping generations, 2) high net reproduction while young, 3) high larval fitness in certain hosts, and 4) lack of diapause. Temperature is a major factor that affects survival, flight thresholds, fecundity, and mortality of adults. Fletcher (1986) found that *B. tryoni* resorbed their eggs during winter and that ovarian development did not proceed normally in the absence of protein. High temperatures 36-38°C for more than a week lead to high mortality in all immature stages and exposure to adverse temperatures in one life stage resulted in higher mortality in subsequent life stages (Meats 1984). Further, the range of temperature faced by earlier life stages influenced tolerance of maxima in adults in that when the minimum is 30°C or more, survival at a given maximum temperature was lower (Meats 1984).

In Greece, Medfly surviving as larvae develop in fruit during winter, pupate in late winter, emerge in small numbers in the following spring to repopulate the area under favourable conditions (Papadopoulos *et al.* 2001a). However, adults exposed to natural conditions within field cages did not survive over winter, all pupae exposed to outdoor temperature also died, while most larvae in fruit also died, close to 40% emerged to pupate and produce adults in the spring (Papadopoulos *et al.* 1996; 1998). In WA some towns (e.g. Pemberton) are too cold for over wintering of Medfly, in other areas this species over winters in all stages – as adults sheltering in canopy of non-deciduous trees, larvae in fruit and pupae in soil underneath hosts (De Lima 1998; 2008). Papadopoulos *et al.* (2001a) considered carryover of the population to be related to the biomass of fruit available for survival during the stressful periods and the early hosts available for the first generations of the new season. However in many areas in Manjimup and in Pemberton, Medfly did not persist even when the supply of attractive hosts was abundant.

Dispersal is essential to survival avoiding overcrowding and depletion of host fruit for egg laying. The post teneral dispersive phase in Medfly is considered to be small with 80% of released flies being captured within a 300m radius (Wong *et al.* 1982; Plant and Cunningham 1991). Maezler (1990a) analysed Medfly and Qfly outbreaks in Adelaide from 1948 to 1987 and found that the majority of sites infested with larvae in any season were within a radius of 0.8km. Meats *et al.* (2003) examined 75 infestations of *C. capitata* and 286 infestations of *B. tryoni* in normally fly-free areas in Australia and found the radius of occurrence of both adult male flies and infested fruit was almost always less than 1km. Carey (1996) found that Medfly captures from 1975-1994 in California followed a pattern of spread that was not concentric from the point of introduction and was more related to the topography of the area and/or host distribution. In the absence of hosts *C. capitata* has been found to travel a distance of 2 km (Fimiani 1979) and migratory movement of over 18km have been observed by Steiner *et al.* (1962). Where small numbers of flies disperse over a larger area their ability to reproduce is adversely affected leading to the 'Allee effect' – a reduced ability to find mates, hosts and survive (Carey 1996; Meats *et al.* 2003). The availability of adult food such as plant exudates, pollen, bacteria on fruit (Hendrichs & Hendrichs 1990) may also govern fly numbers and their movement from one area to

another. Lek formation for mating where males congregate on host trees, and attempt to attract females by releasing sex pheromones, has been observed in some *Bactrocera* species such as *B. tryoni* (Tychsen 1977). Lek formation has been observed with *C. capitata* in coffee trees, on under surfaces of leaves or on fruit, in Guatemala (Prokopy and Hendrichs 1979) and in orange trees in Carnarvon, Western Australia (Supasatian 1986). Citrus was found to be a preferred site for lek formation and mating for *C. capitata* by Whittier *et al.* (1992) in a mixed fruit orchard in Hawaii. Kanneshiro (1993) states that only four trees constituted major lek sites in this orchard with 118 mixed fruit trees. While Whittier *et al.* (1992) observed that mating took place in trees with and without ripe fruit, work in a mixed fruit orchard in Egypt showed that while flies were found in small numbers on non-hosts, the greatest number of leks and mating pairs were found on fruiting citrus trees (Hendrichs and Hendrichs 1990). Choice of lek site was a combination of host status of the plant and environmental factors (Whittier *et al.* 1992). Host succession is observed by Maezler (1990b) in studies of larval finds in Adelaide from 1948-49 &1985-86: larvae started in early apricots in December and continued in peaches through to April, also observed in other fruits such as Cumquats and Mandarins in summer-autumn and few only in feijoa and orange in late autumn and winter. In Greece, a seasonal pattern of infestation starting in Apricots, then peaches in spring and moving to other fruits in summer, then to peach, figs and apples in autumn was demonstrated by Papadopoulos *et al.* (2001a). While flies survived as larvae in apples, placement of traps in early fruiting apricots in the area captured flies earlier in the season than traps placed in apple trees (Papadopoulos *et al.* 2001b).

In the findings of this report, Medfly mates on hosts with fruit, and larvae that pupate under late season host trees which emerge as adults to start a new generation are captured in early season hosts that provide fruit for oviposition. As movement of flies through a succession of fruiting hosts has been demonstrated, placement of traps in favoured fruiting hosts appears to be a highly significant factor in improving the probability of early detection of flies emerging in or migrating into the area.

Discussion of findings in this study

Donnybrook

The dynamic trapping method was more effective in the early detection of flies at the threshold level (two or more flies per trap per fortnight) in all years. Dynamic traps captured more flies on more occasions than the static trap 2008-2009 and on all seven sites at which flies were captured in 2010. The strategic movement of traps used in the dynamic method proved to be an advantage both when the general population in the area was high and when it was low. This advantage was clear even when a large proportion of static traps were placed in stone or pome fruit trees (2010) which were indicated to be preferred hosts in 2009.

Although there was high variability in fly numbers across sites and over the seasons, statistical analyses confirmed a significant advantage in the dynamic trapping method in all three years both in terms of percentage of traps in the area that captured flies and in terms of average numbers captured.

The relative abundance of flies was affected by the variability of fruit set (time/volume) in early fruiting stone fruit hosts, and therefore host succession, in the different seasons. The low fly numbers recorded in 2010 at some trial sites which had recorded high fly numbers in the previous season, is consistent with observations of dispersal of *C. capitata* in the absence of suitable hosts by previous authors (Fimiani 1979; Fletcher 1989; Papadopoulos *et al.* 2001a). Other factors such as orchard hygiene contributed to population variability.

At well established breeding sites in the town centre (Donnybrook sites 6, 7) in the more favourable season of 2009 where fruit was available earlier, fly numbers were high very early in the summer, whereas in the most unfavourable fruiting season of 2010 fly numbers were lower and reached the highest category (>10 per fortnight) later in the season. Thus, the pattern of fly capture varied from season to season. At trial sites with low fly numbers, the first detection of two flies per fortnight did not always indicate a breeding population as seen at several sites in Donnybrook (sites 18, 21, 34). At sites where there was a breeding population, numbers increased from one category to the next (or more) in 2-4 weeks and remained high for several weeks. In the season where overall population levels were very

low (2010), fly numbers at breeding sites were also low but stayed in the category of two or more flies per fortnight for 2-3 months (Donnybrook Site 39).

In 2010, when fly numbers were generally low, dynamic traps captured flies earlier at all orchard sites where flies appeared in Donnybrook, thereby suggesting that strategic movement of traps to fruiting hosts throughout the season may be of greater benefit when fly numbers are lower. Low efficiency of the capilure trap is indicated by release-recapture studies (Cunningham and Couey 1986; Lance and Gates 1994) and in the many larval finds in fruit prior to detection of the population in static grid traps in both Adelaide (Maezler 1990b; Maezler *et al.* 2004) and in the establishment of large outbreaks prior to detection in traps in California (Carey 1996). The attraction of the trap may be even lower when competing with other attractive odours as indicated in the literature by authors such as Kanneshiro (1993) and Katsoyannos *et al.* (1998). Strategic movement of the trap may compensate to some extent for the low efficiency of the lure.

Manjimup

The dynamic trapping method was more effective in the early detection of flies at the threshold level (two or more flies per trap per fortnight) in all years. Dynamic traps captured more flies on more occasions than the static trap. Fly captures in Manjimup were lower than in Donnybrook. Consequently, even though statistical analyses indicated a similar trend to that observed in Donnybrook in both 2008 and 2009, the difference between the static and dynamic trapping methods were not statistically significant. In 2010, flies were captured at only four trial sites and at the threshold level at only one site. Therefore, the numbers were insufficient for analysis of the difference between the two trapping methods.

The variability in fly number across sites and over the seasons was observed also in this area. Climatic differences resulted in variability of fruit set (time/volume) in early fruiting stone fruit hosts, and therefore host succession, as in Donnybrook. Sites such as Manjimup site 22 had large a amount of fruit and a possible breeding populations in 2009, however the population level was not high and there was a gap in host succession in the latter part of the year. Therefore, dispersal of emerging flies early in the season in search of hosts and mates may have resulted in dilution or extinction of the population.

The lack of establishment of flies even where there is large volume of fruit and a succession of hosts are available around the year maybe due to the cooler winters in Manjimup as indicated by the Average maximum temperature that is up to 3°C lower than in Donnybrook in summer. Flies appeared later in the season than in Donnybrook at all trial sites except for single flies at site 14.

As indicated by the delay in fly capture in traps and development of high numbers compared to Donnybrook, a longer time is taken for the accumulation of day degrees required for completion of the life cycle (De Lima 2008; MCOP 2006). Hence, the less favourable climate coupled with lower numbers in the periphery of the town would explain the lower fly numbers at orchard sites.

In those sites that were more than 5km away from the town centre two or more flies were captured only twice (Table 18). At one of these sites (site 3) fruit from other orchards are packed and captured flies may have come from other fruit as there were no other detections throughout the three years. Therefore, these orchards >5km from the Manjimup town centre, maybe classified as Areas of Low Pest prevalence or pest free areas under current criteria (MCOP 2006) as fly captures did not exceed two flies/trap/fortnight.

Pemberton

There was no difference between the static and dynamic trapping methods in the early detection of flies at the threshold level. Frequency of fly capture was insufficient for statistical analysis.

Single fly observations in Pemberton on several occasions over the years indicated that flies do enter this area in low numbers. Flies did not establish even in the presence of a considerable volume of host material and under favourable climatic conditions, suggesting also that the population may have been below levels necessary for establishment. Similar cases are described by Maezler *et al.* (2004) where

many trap captures of *B. tryoni* and *C. capitata* in Adelaide at levels below the outbreak thresholds did not result in outbreaks; they are thought to be dispersing males from numerous introductions.

Two sites captured flies at the threshold level (two or more per fortnight) and flies were found to be breeding at one site. However, only two single flies were captured in the following season at the breeding site. In addition to the lack of fruit in apricots that act as early hosts, lower temperatures which require a longer period to accumulate the necessary day degrees to complete the generations (De Lima 2008) may have reduced the chances of re-establishment of a population in the next season. The type and numbers of hosts at breeding and non-breeding sites were similar. No flies were captured in commercial or smaller orchards outside of the 2km radius, indicating this area can be classified as a pest free area for *C. capitata* under current criteria (MCOP 2006).

Kununurra

No Medfly captured in trial traps in the two years. Town traps also did not capture flies at the threshold level (two per trap per fortnight). In town traps there were four single fly captures, over a period of four months, at two sites in 2008 which did not establish. The dynamic trapping method produced a result similar to that of the static grid.

Establishment of Areas of Low Pest Prevalence

There are areas in which a pest species is present at very low levels and can be maintained at low-levels. Establishment of 'Areas of low pest prevalence' follow the COP which complies with the draft standards prescribed in FAO (2005). Accepted pest levels must be verified continually as for 'Pest free' areas and control measures must be in place to keep numbers at acceptable levels.

The methods developed in this study prove area freedom. However, they have also been tested in areas of low pest prevalence (ALPP) and have proved effective. It is therefore useful to extend dynamic trapping methods as suitable for consideration in proving ALPP in the further development of the fruit fly codes of practice for market access. Since fewer numbers of traps are required to prove ALPP the costs of such a trapping regime may be affordable for growers.

CONCLUSIONS

The dynamic trapping method was demonstrated to be more efficient in the capture of *C. capitata* than the static trapping method in Donnybrook and of equal efficiency in Manjimup, Pemberton and Kununurra.

Donnybrook*:* Dynamic traps captured significantly more flies than static traps in all three years that flies were trapped. In 2008 the ratio of male flies captured by static traps compared to dynamic traps was 0.50 (static: 0.35 vs dynamic: 0.70), in 2009 the same ratio was 0.40 (static: 0.32 vs dynamic: 0.79) and in 2010, when fly numbers were much lower, the same ratio was 0.23 (static: 0.07 vs dynamic: 0.30). In other words the number of dynamic traps required for every static trap to catch the same total number of flies was 0.50 in 2008, 0.40 in 2009 and 0.23 in 2010.

Flies were captured earlier in dynamic traps in 2008, 2009 and 2010.

Manjimup*:* There was no significant difference in the number of flies caught in dynamic and static traps in 2008 or 2009 or 2010 due to the low fly numbers recorded at Manjimup.

Flies were captured earlier in dynamic traps at more sites in 2008 and 2010.

Pemberton*:* Fly numbers captured within the 2km radius of the town centre were insufficient for analysis. As flies were not captured outside of the 2km radius, this area can be classified as a pest free area for *C. capitata* under current criteria (MCOP 2006).

Kununurra*:* The dynamic trapping method produced a result similar to that of the static grid.

RECOMMENDATIONS

Use of the dynamic method is more efficient than the existing static trapping procedures.

Fewer traps are required when using the dynamic method. The results show that 23 – 50% of the traps used in a static grid are sufficient to give the same confidence of detecting a Medfly incursion when the dynamic method is employed. A conservative decrease in the number of traps to 50% of that currently employed in proving area freedom is recommended.

Traps should be placed in citrus in winter and thereafter moved to apricots or early peaches, then nectarines, plums and later peaches, followed by apples, pears, olives, figs and loquats, moving back to citrus in June. In trap deployment, the selection of host type should follow the preferred host type available in a given season, with larger trees with high fruit volume given preference.

APPENDICES

Appendix A: Preliminary survey (winter/spring 2007)

Traps were maintained in town centres for seven months during winter/spring 2007. The results are given in Appendix A. Results show >2 flies/trap/fortnight in Donnybrook, <2 flies/trap/fortnight in Manjimup and near 0 flies/trap/fortnight in Pemberton. This data justifies the selection of area for the study.

Table 1: Preliminary survey in Southwest towns: 24 May 2007 – 4 October 2007

Area	Traps	Collections	Host	Fly number in Male traps	Fly number in Female traps
Donnybrook	5 male 5 female	8 8	Apple Apple Orange Pear (M) Orange (F) Plum	52 19 25 3 970	15 3 3 48 35
Manjimup	8 male 8 female	6 6	Apple Apple Loquat (M)/ Lemon (F) Loquat (F) Orange (M) Olive (M)/ Orange (M) Orange Pear (M) Orange (F) Plum	0 0 0 4 0 1 0 1	0 0 0 0 3 0 0 0
Pemberton	6 male 6 female	6 6	Apple Apple Orange Orange Pear (M) Orange (F) Plum	0 0 0 0 1 0	0 0 1 0 0 0

Appendix B: Site Descriptions

Donnybrook

Site 1: Home orchard with a neighboring small citrus and avocado orchard. The property itself contained a small number of large apricots and plums which were not prolific producers. Oranges produced well and a variety of other more recently planted fruit trees came into production in the latter seasons. Birds tended to get the stone fruit prior to ripening.

Site 2: Home orchard that is about 500m from a large stone fruit orchard. While peaches, apricots, plums, mulberry and olive were large trees, others were small numbers of more recent plantings. Again the fruit set was not prolific on stone fruit and birds tended to remove fruit. Some fruit was bagged on this property, especially peaches in the 3rd season.

Site 3: Small home orchard, well maintained, close to town and well maintained commercial orchards. This site contained a small number of a variety of fruit trees, some of which produced well. These trees were suffering water stress and some trees died and consequently traps were moved to another site.

Site 4: Small home orchard, well maintained, that is less than 500m from a large citrus orchard. This site contained a small number of a variety of fruit trees which produced well. These trees were severely pruned in 2008 and consequently traps were moved to another site.

Site 5: Small home orchard, well maintained, that is less than 500m from a large citrus orchard. This site contained a small number of a variety of fruit trees. The stone fruit trees did not produce well and fruit was lost to birds before ripening. Traps were moved to another site due to lack of fruit.

Site 6 (TM): Town traps in a row of older orange trees on the north edge of town, adjacent to a newer subdivision. There is a commercial orchard nearby. Fruit is not harvested & left to rot under trees.

Site 7 (TM): Town traps in older orange trees on the edge of a commercial pome orchard on the north side of town. Good producers but fruit left to rot on ground including from the adjacent apple trees.

Site 8: A well tended small home orchard. The orchard consists of a variety of stone and pome fruit with a few citrus and a variety of other fruit trees. As the trees were planted in close proximity the static trap needed to be placed in a non-host tree. Male traps were moved to another site and replaced with female traps which could be placed less than 25m apart (renamed site 33).

Site 9: An organic home orchard, well maintained, with large orchard in the surrounding area. This site contained small numbers of a variety of fruit trees other than stone and pome fruit. Some stone fruit trees produced well and some trees were netted. Traps were moved to another site due to request by owner.

Site 10: Large orchard with well tended oranges that were producing well. The stone fruit and other fruit trees were in the home orchard adjacent to the oranges. While the Apricots were large they were not prolific producers.

Site 11 (TM): In town, the traps are in large lemon trees in a front yard. There are fruit trees scattered throughout neighbouring properties in small numbers.

Site 12 (TM): In town, the trap was in large loquat tree in a front yard. There are fruit trees scattered throughout neighbouring properties in small numbers. The tree was pruned and traps were moved elsewhere.

Site 13 (TM): In town, the trap was initially placed in an orange in a front yard and moved to the rear at request of owner. There was a small home orchard at rear and nectarine with larvae in fruit on the neighbouring property. The trap was moved elsewhere due to request by new tenant.

Site 14 (TM): In town, an established neglected mixed orchard on large block. The citrus & large pear trees produce plenty of fruit which manage to ripen on the trees before rotting on the ground. The stone fruit that sets is taken by the birds before it can ripen.

Site 15: Small home orchard, well maintained. This site contained a small number of a variety of fruit trees and scattered fruit trees were present on neighbouring properties. The stone fruit trees did not produce well and most fruit was lost to birds before ripening. Traps were moved to another site due to lack of fruit.

Site 16: Home orchard with a number of large stone fruit and citrus trees and a variety of other fruits less than ten years old. A large proportion of the stone fruit and citrus produced well and often there was fruit on the ground.

Site 17: A large home orchard with a number of large citrus, pear and stone fruit trees and a variety of other fruits less than ten years old. Larger trees produced well and often there was fruit on the ground. Traps were moved elsewhere due to request by owner.

Site 18: A home orchard with large plum, pear and olive trees and other more recently planted trees less than ten years old. The pear tree and the plums did not produce much fruit in the 2010, whereas fruit was abundant in 2009. The olive was prolific all both years.

Site 19: Large commercial orchard with mostly apple and several types of stone fruit in adjacent blocks, with a variety of other fruit trees less than 10 years old. Apples and stone fruit produced well and there was fruit on the ground. However, the grower was found to bait the perimeter of the orchard fortnightly, therefore, traps were removed from this property.

Site 20: Small home orchard with large apple, loquat, pear trees and some citrus trees. There was a section more recently planted stone fruit and olives. The stone fruit did not produce well and some trees were suffering from water stress. Therefore, traps were moved elsewhere.

Site 21: Small mixed home orchard back yard in small town of Kirup, south of Donnybrook. There are fruit trees in neighbouring properties. Pome, citrus and persimmon produce well. The stone fruit trees next door are younger trees and any fruit that sets is taken by the birds before it can ripen.

Site 22: Also a small mixed home orchard in back yard of home in Kirup. Has a large plum tree which produced a large crop in all three years. The plums were not harvested and there were too many for the birds so ripened on tree and rotted on the ground.

Site 23: Large home orchard with a considerable amount of all types of stone fruit, apple and nashi that were well tended and well producing and a not well cared for small citrus orchard. Often fruit was on the ground. This site was surrounded by large well tended commercial stone fruit orchards and poorly managed home orchards with a large quantity of stone and pome fruit.

Site 24: Commercial orchard with a plum and apple orchard in adjacent blocks, with a couple of citrus trees & large prolific pears (which were not harvested). Apples, pears and citrus produced well. The plums did not set a very large crop in 2010 and were not harvested leaving fruit to rot on trees & the ground.

Site 25: Large commercial orchard that is well managed but with fruit on the ground periodically. This site contains a range of stone and pome fruit. It is isolated but for two other nearby properties (site 26 and 27) close to 500m. Fruit set was high in all years.

Site 26: Small semi neglected home orchard on a property north of Donnybrook, with a variety of well established fruit trees surrounded by pasture. The stone fruit set fruit in abundance in 2009 but not in 2008 or 2010 and fruit was taken by the birds before they ripened in later years.

Site 27: Large established ex organic orchard on a property north of Donnybrook. Most trees under large net which is in bad condition, ripped with trees growing through the top. There is a big variety of large fruit and nut trees. Although neglected this orchard produces a large volume of fruit, some of which does not get harvested. Some birds get into netted area & clean up some of the fruit but a lot ripens on the trees & rots on the ground. Due to the variety of trees grown there is fruit around all year.

Site 28: A home orchard with a variety of stone and pome fruit, with large lilly pilly, loquat and pear trees. A lot of fruit was not harvested and was left to rot under trees. Neighbouring properties also contained a lot of fruit trees.

Site 29: Small cherry and macadamia orchard with a variety of other fruit trees, located north of Donnybrook. Few persimmons under net, other stone and pome fruit netted individually while fruiting. Property surrounded by bushlands and other small properties.

Site 30: Fruit trees scattered amongst garden on this property north of Donnybrook. Apricot and pear did not set much fruit in 2010 season but the pear produced well in 2009. Most of the plums got eaten by birds. Citrus was often left to rot on the ground.

Site 31: Another property North of Donnybrook with a well established home orchard with a variety of fruit trees. Stone fruit did not produce very well in 2010 season whereas they had produced in abundance in 2008 and 2009; with the birds getting most of the fruit in 2010. Large Lilly pilly, quince, apple and citrus had heavy crops in 2010 with fruit ripening on trees and fall to the ground to rot.

Site 32: Large mixed commercial orchard on the South West Highway, south of Donnybrook. The orchard consists mostly of a variety of stone fruit with apples and a few citrus trees. There is a pear orchard across the road. Apricots did not set as much fruit in 2010 as they had in 2008 and 2009. Fruit is left on the ground after harvest.

Site 33: A well tended small home orchard. The orchard consists of a variety of stone and pome fruit with a few citrus and a variety of other fruit trees.

Site 34: Organic apple and plum orchard located south of Donnybrook on the South West Highway. There is also a variety of single fruit trees located around the house and sheds. This is a well maintained property with fruit being harvested for sale. Numerous ducks, geese and chickens help clean up fallen fruit.

Site 35: Large orchard under net but now converted to cattle farm also on South West Highway, south of Donnybrook. There are some remaining plum trees and fruit trees around the house and sheds. Fig netted while fruiting. Citrus produce plenty of fruit but stone fruit had very little fruit this past season, the birds got them all.

Site 36: There was a variety of large fruit trees on this property north of Donnybrook. Apricots did not set much fruit in 2010 as they had in 2009, but there was a good crop of nectarines which the birds enjoyed. Apple, citrus and pear produced well in both years. Citrus rots on ground but birds and rodents clean up the fallen apples.

Site 37: A small home orchard with a variety of fruit trees. The stone fruit did not produce well, although some trees were netted, others lost fruit to birds. As the site was fairly isolated and the fruit biomass was low, traps were moved elsewhere.

Site 38: Organic property located north of Donnybrook, with small citrus orchard with a variety of other fruit trees. Stone fruit trees had very little fruit in both 2009 and 2010. Most fallen fruit (except citrus) is cleaned up by a variety of ducks, geese and chickens.

Site 39: Neglected orchard mostly pome fruit with a small number of other fruits, located north of Donnybrook. Large pear tree had a lot of fruit in both 2009 and 2010. Most stone fruit taken by birds while still green. Citrus and pome fruit ripen on trees unharvested then rot on the ground.

Site 40 (TM): Town traps on South West Highway, few fruit trees in front and back yards. Other fruit trees in neighbouring properties.

Manjimup

General comment: 2010 season, due to a colder wetter spring stone fruit in particular plums did not set as much fruit as previous seasons.

Site 1: Rural cattle property with an established home orchard just south of Manjimup. Neighbouring property is a large apple orchard. Fruit trees are maintained and produce well. Most fruit at the home orchard is lost to birds, some fruit manages to ripen on the tree for harvesting.

Sites 2-6: Are along Seven Day Road, south of Manjimup.
Site 2: Rural cattle property with an established home orchard just south of Manjimup. Some large fruit trees, apple, plum and figs. Plums and apples were taken by birds earlier than usual this season, not getting a chance to ripen. Trees well maintained.

Site 3: Large commercial mixed orchard, mostly stone and pome fruit. Variety of fruit close to packing shed. Due to size of orchard and amount of fruit produced the birds have little impact at this site. Trees well maintained but fruit is left on ground to rot after harvesting.
Site 4: Large commercial mixed fruit and nut orchard. Variety of fruit close to packing shed and house. All well established and maintained. Not all fruit is harvested or taken by birds and fruit is left to rot on trees and ground. There was very little stone fruit this past season.

Site 5: A small home orchard surrounded by a large commercial apple orchard. All trees maintained and pruned but fruit left to rot on the ground. Kiwi fruit and lime too heavily pruned last season and did not bear fruit this year.

Site 6: A good sized home orchard behind packing shed on a large commercial apple orchard. There is a large variety of well established fruit trees including stone fruit. Unlike most other sites in 2010 there was a very heavy fruit set at this site. Some fruit even managed to ripen on the trees without being taken by birds. There were plums rotting on the tree and ground.

Site 7: A well established home orchard located close to Manjimup. Most fruit trees a reasonable size with a few younger trees. Smaller stone fruit trees did not set many fruit this season but larger trees produced well for the birds. Well maintained, including picking up some of the fallen fruit.

Site 8: A well established home orchard located close to Manjimup. Most fruit trees produced well in 2008 and 2009. However, stone fruit trees were gradually removed by owners over the year and by mid-2010 mostly citrus remained on this property.

Site 9 (TM): In town, established semi neglected backyard orchard with mature trees.
Parrots get most of fruit except citrus which rots on the ground. Other fruit birds drop also rots on ground.

Site 10 (TM): In town, in a front yard with several other mature trees in close proximity. Lower branches of trees were pruned, hence trap was moved elsewhere.

Site 11: A large well established home orchard located 2km East of Manjimup surrounded by farmland and forest. Fruit trees on this property always seem to produce plenty of fruit. Some trees are partially netted while fruiting as parrots frequent this property. Owners make other efforts to keep numbers of parrots down so trees are not stripped of fruit and some manage to ripen. Also normally plenty of fruit on ground rotting.

Site 12: Fruit trees scattered around this property in newer subdivision close to town. Trees are under 10 years of age with a variety of citrus, stone and pome fruit. Not much stone fruit set but nashi and citrus produce well. Trees are maintained and nashi is in chicken pen so they clean up the fallen fruit.

Site 13 (TM): In town, in a backyard with several other trees in close proximity. Access was over a fence at this site and lemon tree developed scale and mould. Trap was moved to another site.

Site 14: This site is a home orchard in the chicken yard on the eastern outskirts of town. Most fruit trees a reasonable size with a few younger trees. Smaller stone fruit trees had very little fruit this season. Birds get most of stone fruit before it ripens. Only citrus left to rot on ground as chickens and ducks clean up pome fruit that birds drop to ground.

Site 15: On the outskirts of town neighbouring properties. One property has about 30 Cherry trees with a few other stone fruit, the other a variety of fruit trees. Cherry trees are neglected and do not produce much fruit. Stone fruit on other property better maintained and have produced well over the past three seasons. Very good plum set this year, ripening for harvest and falling to ground to rot. Parrots are getting some of fruit and pears often partially netted to get through to harvest.

Site 16 (TM): In town, mature fruit trees, planted close together and rarely pruned. There was fruit on ground all year around, mostly citrus but also plums and apples in season. This site had the highest fruit fly numbers in this location each season.

Site 17 (TM): On the outskirts of town, a small mature neglected mixed fruit orchard. There is a commercial apple orchard less than 500m away. A very large pear tree which always produced lots of fruit had fruit on the ground in season. An early fruiting peach tree which had more fruit in first two seasons, along with citrus and a large olive tree made up the rest of the orchard.

Site 18: A small home orchard with a variety of well established trees. The plums produced well and there was fruit on the ground but other trees did not produce much fruit in the 2008. Therefore, traps were moved to another site.

Site 19: In a backyard behind a hotel about 500m from large orchards. Trees produced well, however, variety and numbers were limited therefore traps were moved to a more appropriate site.

Site 20: A home orchard on small acreage surrounded by pasture. Mixed mature fruit trees well maintained, regularly pruned. Stone and pome fruit trees were netted when in fruit. Trees were kept smaller but had good crops of fruit.

Site 21: A small cherry, apricot and avocado orchard with a row of mixed fruit trees. The cherries and avocados had plenty of fruit each season. The apricots did not crop well and had very little fruit in 2010. The pear, plums and quince trees were large mature trees which fruited well, with fruit on the ground in season.

Site 22: Located in a large commercial mixed orchard with mature trellised stone and pome fruit well maintained. There was always a good crop of fruit in season with plenty of fruit on ground at harvest time. A small group of younger trees, citrus, fig, persimmon and passion fruit was nearby.

Site 23: Located in a large commercial apple orchard, with a row of mature mixed fruits. Plums, peaches and mandarin always had a good crop of fruit which ripened in the trees, unharvested and left to rot on the ground.

Site 24 (TM): On the eastern side of town newer subdivision. Citrus trees on a large corner block.

Pemberton

Site 1: In town, neighbouring properties with established variety of fruit trees. Stone fruit, pome fruit, citrus, figs, persimmons, kiwi fruit and vines. Some trees in neighbouring property were netted. Good fruit set on most trees. Birds did get some of the fruit.

Site 2: In town on the edge of the forest, neighbouring properties with a small number of established stone fruit and citrus trees. All fruit trees had good fruit set and stone fruit were partially netted while fruiting.

Site 3: In town on the edge of the forest, about 500m from a berry farm, a backyard orchard. These were mature trees which were planted quite close together. As the static trap needed to be on a non-host, traps were moved to an alternate site.

Site 4: In town on the edge of the forest, a few fruit trees with adjoining small avocado orchard. Good fruit set on stone and pome fruit. Birds got most of the stone fruit before ripening. Apples were netted when in fruit. Some fruit trees removed in the past year.

Site 5: In town, neighbouring properties with established variety of fruit trees.
Good fruit set as most trees at least ten years old. The stone fruit was mostly taken by birds before ripe. Apples stayed on the trees longer.

Site 6: In town, small home orchard mostly neglected with a couple of fruit trees in neighbouring properties. Most of the stone and pome fruit were taken by birds before ripening. Some citrus on trees all year around, left to rot under trees.

Site 7: In town, established variety of fruit trees including very large lilly pilly and loquat trees. Good fruit set with some loss of fruit to the birds. Trees well maintained.

Site 8: In town on the edge of the forest, home orchard with large fig, citrus and apple trees, younger stone fruit. Larger trees cropped well and held most of their fruit. Birds got most of the stone fruit before it ripened.

Site 9: Pemberton Camp School. Close to town adjoining the forest this site has a large variety of older fruit trees and vines. Good fruit set but most stone fruit taken by birds before ripe (except avocado, citrus & kiwi fruit). Trees well maintained.

Site 10: Large well established fruit trees in this home orchard on property surrounded by farmland (pasture). The trees produce very well, some even being harvested before the birds get it. Some apples netted while fruiting.

Site 11: Large well established fruit trees in this home orchard on three adjoining properties surround by farmland (pasture). Some attempts to net some of the apples and stone fruit, trees a little neglected. Most trees producing plenty of fruit, but a lot are consumed by the birds, or if citrus rot on the ground.

Site 12: Home orchard on property surround by farmland (pasture). Large variety of fruit trees many well established with a few younger trees. Most of the stone fruit is eaten by birds before it ripens. Some apples remain till harvest. There is always some citrus around. Trees well maintained.

Site 13: Semi neglected home orchard on rural cattle property. Most of the fruit trees are under ten years of age except big fig and mulberry trees. With the exception of the older trees most did not set a lot of fruit and the birds get it long before it gets a chance to ripen.

Site 14: A small home orchard of large well established fruit trees in chicken pen, on a rural Farm Stay property surrounded by forest and farm land. Most trees produce plenty of fruit, the birds getting a lot of it. No fruit except citrus left to rot on the ground.

Site 15: A good variety of younger fruit trees on a rural lifestyle block surrounded by forest and farm land. Trees well maintained but low producers and any fruit set is soon taken by the birds (except citrus).

Site 16: This farm is approx. 10km out of town. This property has a large avocado orchard with a few other fruit trees, a small netted persimmon orchard and a row of large tangelo trees. Large fig tree is also netted. Due to the netting most fruit is able to be harvested, birds were not interested in the fruit not under net (avocados and tangelos). Some fruit left to rot on the ground.

Site 17: A large variety of berries along with other fruit trees including large well established citrus, fig, mulberry and quince trees. Stone and pome fruit pruned very heavily in past season so bore little or no fruit in 2010. Surprisingly the birds have little impact on this property. Well maintained.

Site 18: Just down the road from site 16 this home orchard is set amongst an orchard of olives and macadamias. Although only a young orchard it produces a good amount of fruit, stone and pome are under permanent net with citrus outside netted area. A few ducks and bantams are in the netted area so clean up any fruit on the ground. Although no one lives permanently on the property it is well maintained.

Site 19: This property is 2km down the road from site 18. Few fruit trees set amongst producing and maintained avocados and neglected Nashi and Kiwi fruit orchards. The surrounding area is forest and neighbouring macadamia orchard. Nashi do not produce much fruit but kiwi vines are loaded and so overgrown that only little birds have access to the fruit. Some stone fruit trees have temporary nets while in fruit otherwise parrots take it all. Not much stone fruit set this year due to weather and heavy pruning.

Kununurra

Site 1: Semi-neglected property which belongs to a religious broadcasting group, where bananas are a commercial crop. There is mostly bush around this site but sandalwood is being planted around it. Bananas are over watered but producing reasonably well, mango and papaya are producing well.

Site 2: Well maintained orchard with high producing grapefruit, mango, and papaya. Guava was mostly taken by birds before ripening. Custard apple, star apple did not produce well and were heavily infested with mealy bugs. Neighbouring property on one side had a lot of fruit, mostly mango, other side was pasture.

Site 3: This site was a small urban block with scattered fruit trees in neighbouring properties. Some trees were not well watered. Main site used for dynamic traps were well watered but fruit production was low due to shade. Mango and sapodilla at this site were prolific producers. The cashew production was reasonable but the ixora did not produce well as it was pruned as a hedge and the carambola production was low due to shade.

Site 4: Neglected property with small acreage blocks on two sides, bush on other two sides. Main purpose of this site was native seed gathering and processing. Bauhinia and gum trees were interspersed with fruit trees which led to high numbers of birds and shade. Therefore, fruit production was low and loss to birds was high. Old established mangos produced well, but some trees such as tangelo and lime were lost due to lack of water.

Site 5: Backyard with a variety of fruit that were prolific producers except for papaya and sapote. The large commercial mango orchard on one side was well maintained and high producing.

Site 6: Backyard with small numbers of a variety of large established fruit trees that produced well but lost a lot of fruit to birds. This site had a well maintained, high producing mango orchard on one side and a papaya orchard on the other.

Site 7: Backyard orchard adjacent to a neglected and poorly producing mango orchard. Due to irrigation issues some trees were lost and traps were moved to site 13.

Site 8: This site was a small experimental orchard on the edge of a citrus orchard and across from a very large sandalwood plantation. Overall, well watered but fruit was left to rot under trees, other than the citrus which was an economic concern. Carambola were high producing but were removed in 2009, production in sapodilla was also good but moderate in star apple. Sandalwood produced a lot of fruit in which Aquilonis were breeding.

Site 9: Experimental planting orchard behind Research station offices, adjacent to river and pasture. Well producing carambola, guava, lemon, mango, sapodilla, sapote and tamarind.

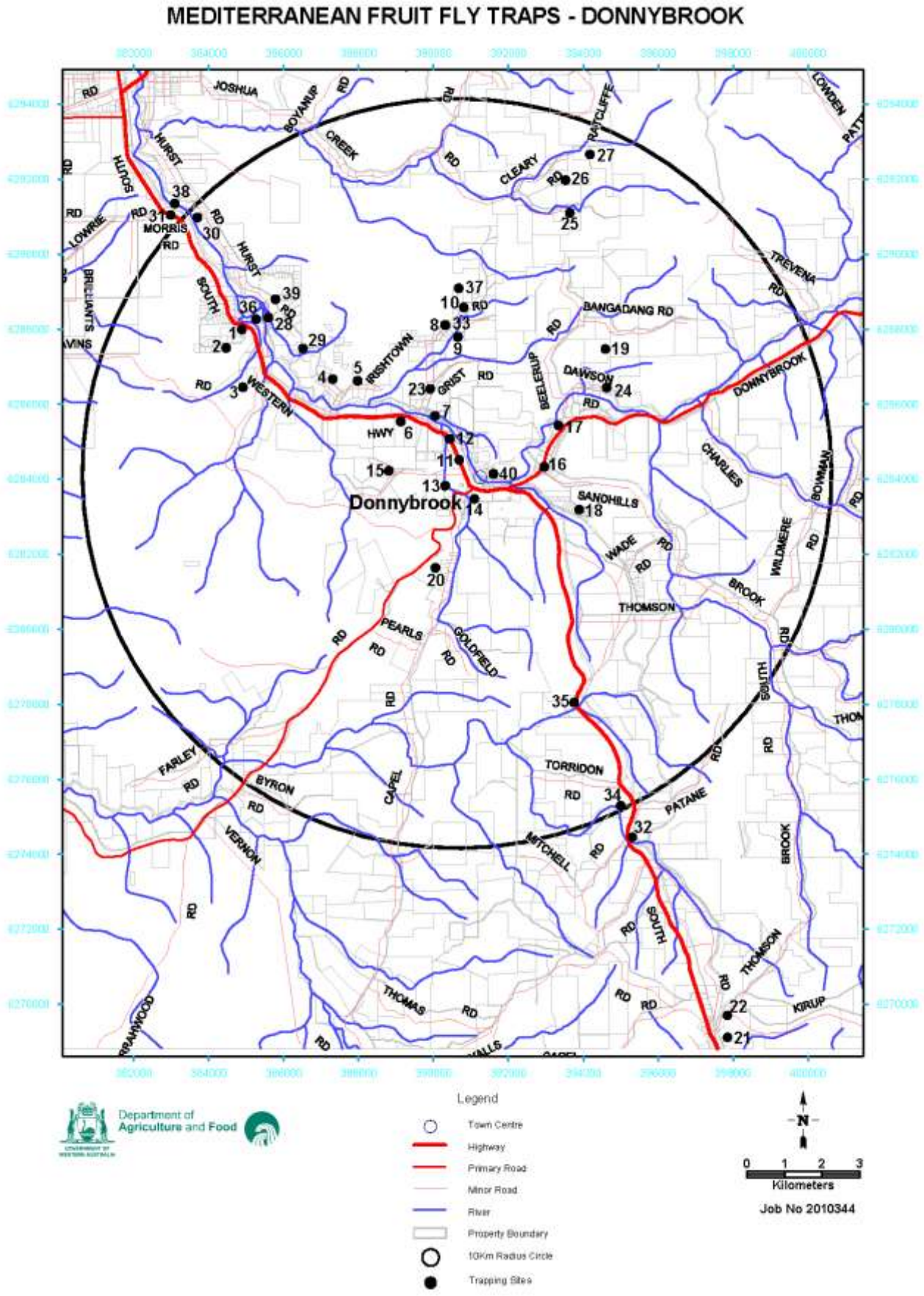
Site 10: Special rural block adjacent river and with neglected orchards on two sides with predominantly mango. The site itself contained well established, mature trees, well maintained and high producing cashew, jack fruit, lemon, lime, mango and papaya.

Site 11: Home orchard adjacent to well maintained mango orchard with high producing carmbola, jackfruit, mango, and neglected grape fruit trees with unharvested fruit remaining on trees. Well maintained neighbouring mango orchard with moderate volume of fruit due to pruning.

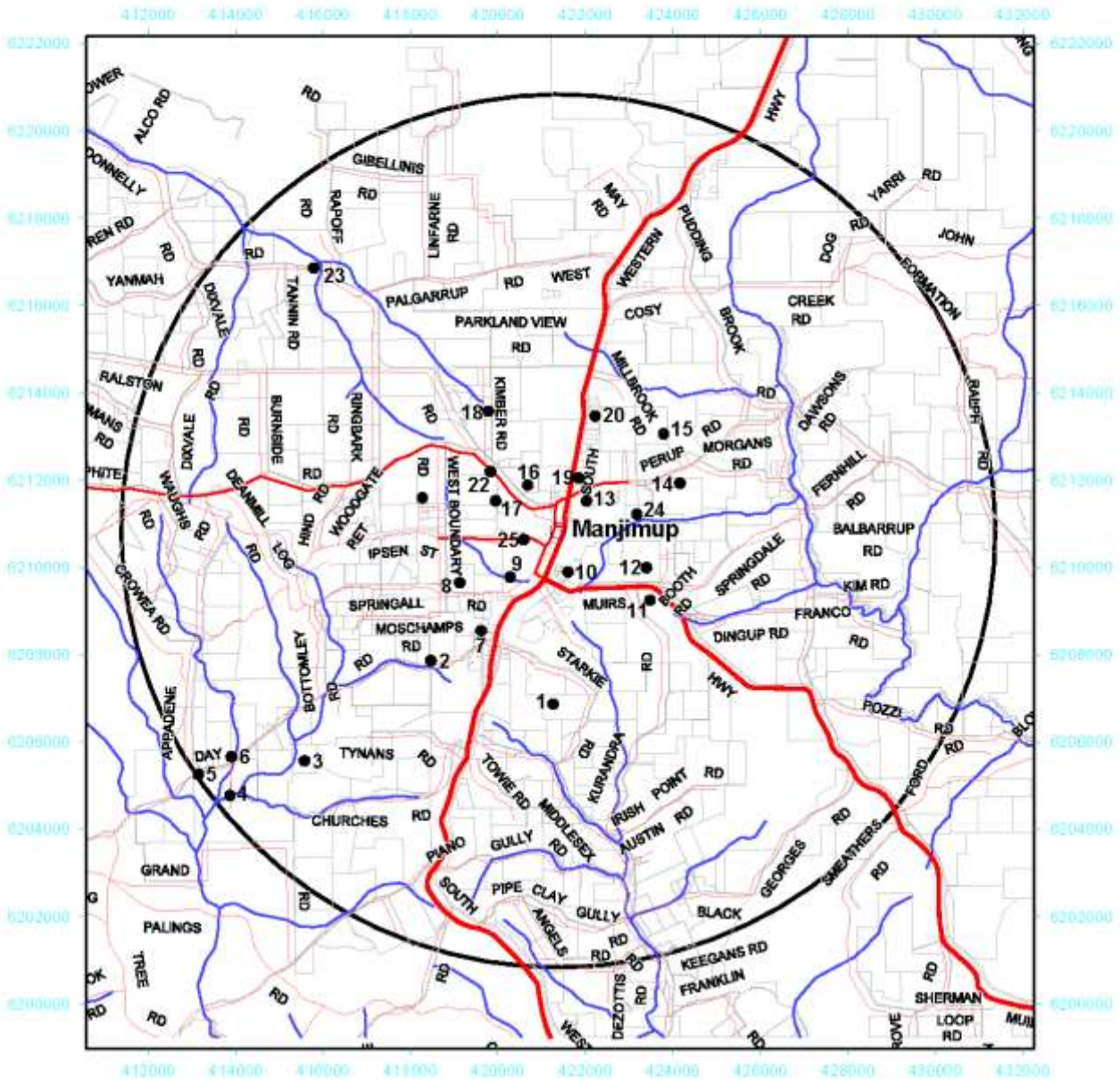
Site 12: Well maintained and high producing mango orchard of four to five different types, with other fruit trees in a paddock with horses. Horses ate all they could reach of the fruit and a lot of the remaining fruit was taken by birds. There were plantings of chia (grain) on one side and pumpkins on another.

Site 13: Semi-neglected small acreage with high producing sapodilla and water apple trees. Wild passion fruit was also taking over other trees at this site and producing well. Mango did not produce well due to lack of water.

APPENDIX C: Maps



MEDITERRANEAN FRUIT FLY TRAPS - MANJIMUP



Department of Agriculture and Food

Legend

- Town Centre
- Highway
- Primary Road
- Minor Road
- River
- Property Boundary
- 10Km Radius Circle
- Trapping Sites

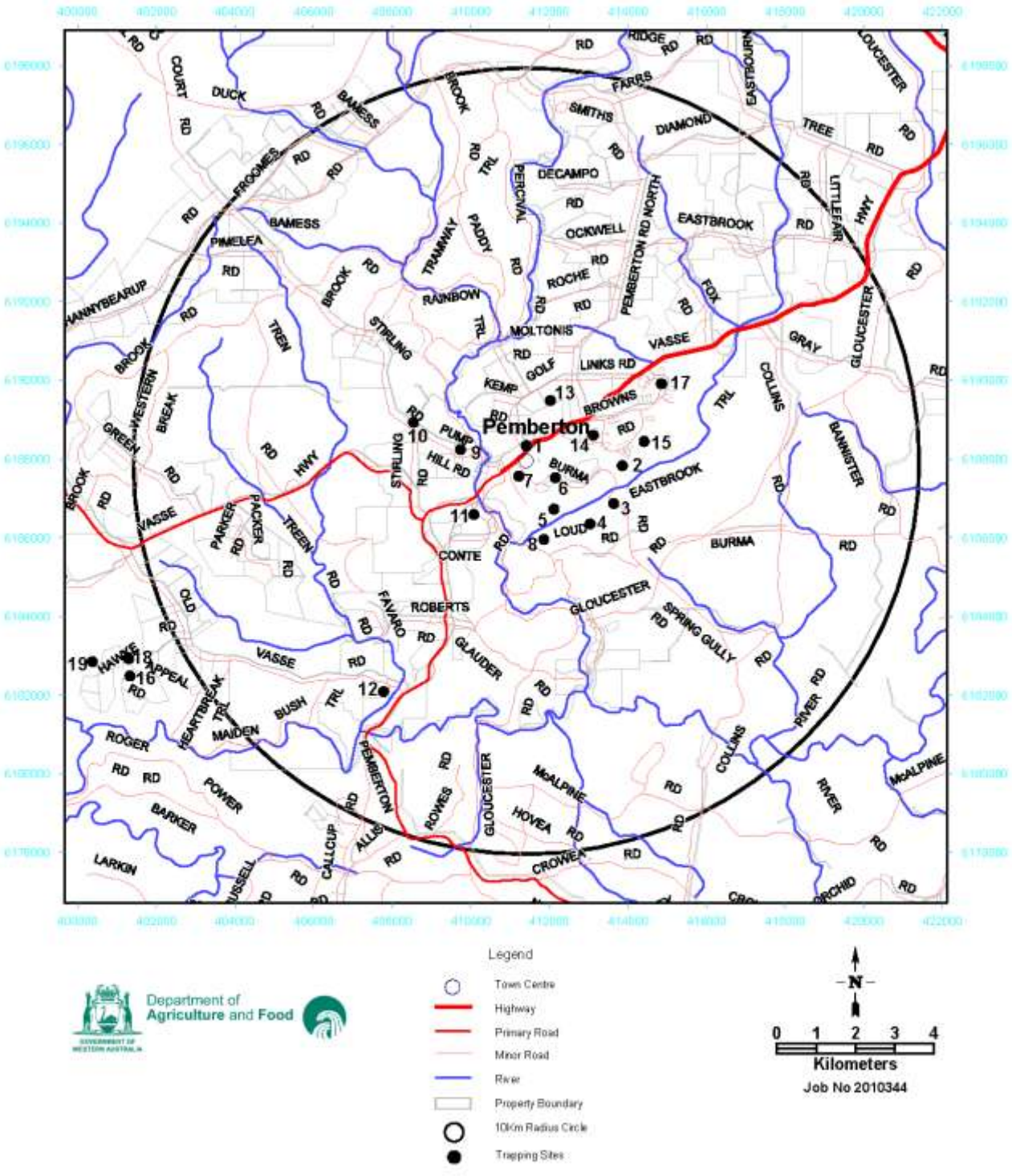
N

0 1 2 3 4

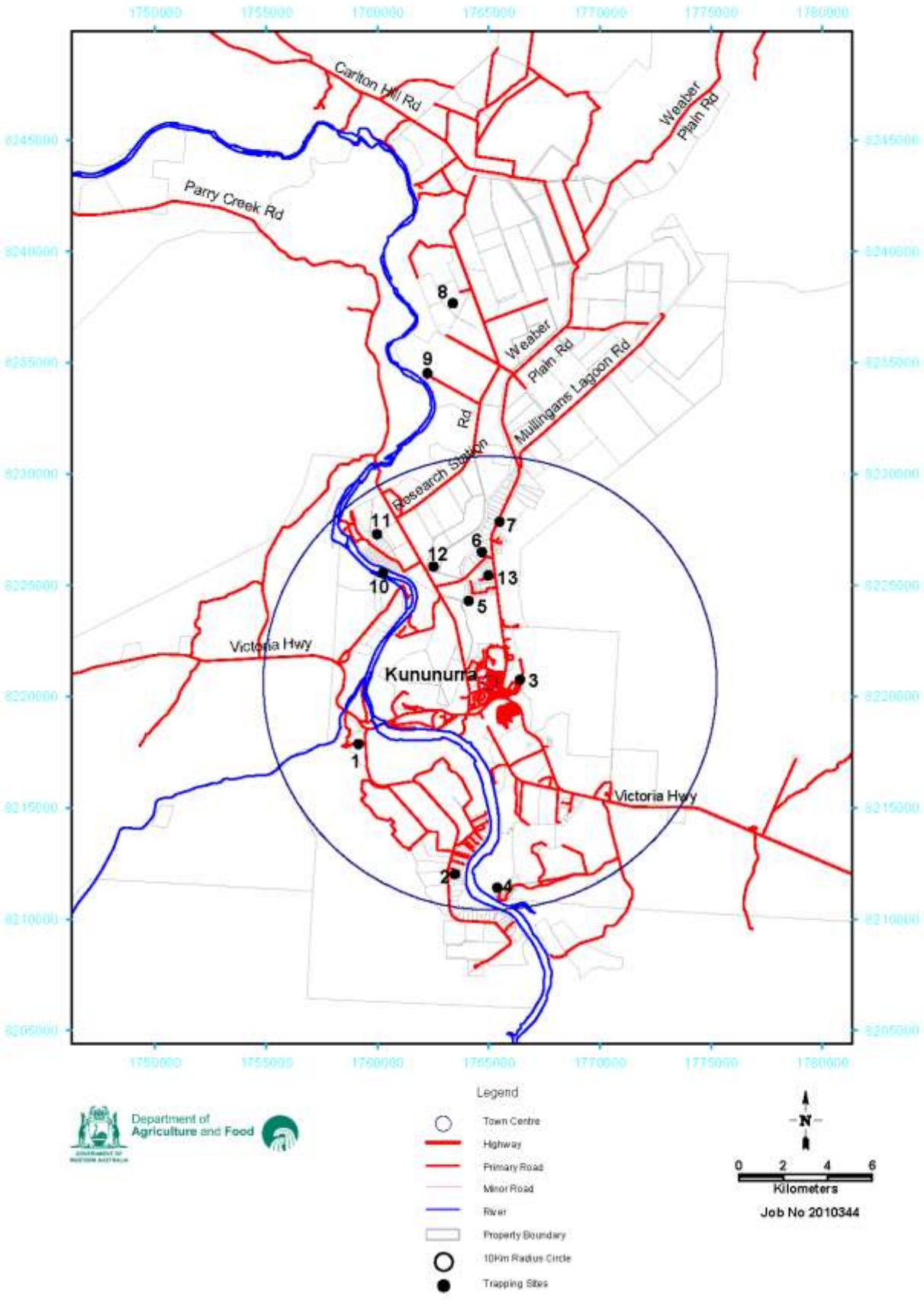
Kilometers

Job No 2010344

MEDITERRANEAN FRUIT FLY TRAPS - PEMBERTON



MEDITERRANEAN FRUIT FLY TRAPS - KUNUNURRA



Appendix D: Trap deployment over the trial period

Table 1a: Donnybrook – Placement of Town Monitoring traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details		
6 M Marginata Rd	Orange (TT) 115 48.483 33 33.802 17/09/07 – 23/06/10		
6 F Marginata Rd	Orange (TT) 115 48.517 33 33.802 17/09/07 - 23/06/10		
7 M Irish town Rd	Orange (TT) 115 48.805 33 33.725 17/09/07 -24/06/10		
7 F Irish town Rd	Orange (TT) 115 48.805 33 33.721 17/09/07 - 21/01/09	Orange (TT) 115 48.820 33 33.737 21/01/09 - 23/06/10	
11M 31 Collins St	Lemon (TT) 115 49.449 33 34.592 1/11//07 - 23/06/10		
11F 31 Collins St	Lemon (TT) 115 49.449 33 34.595 1/11//07 - 23/06/10		
12M 1 Emarald St	Orange (TT) 115 49.229 33 34.286 1/11/07 - 26/03/08		
13M 13 Emarald St	Orange 115 49.300 33 34.625 28/11/07 - 24/01/08	Nectarine 115 49.311 33 34.644 24/01/08 - 29/04/08	Orange (2) 115 49.267 33 34.631 29/04/08 - 19/11/08
14 M Hunter & Steere St	Pear (TT) 115 49.432 33 34.910 17/09/07 - 28/05/08	Mandarin (TT) 115 43.460 33 34.900 28/05/08 - 23/06/10	
14 F Hunter & Steere St	Orange (TT) 115 43.446 33 34.903 17/09/07 - 23/06/10		
40 M 'Plants for Sale' 134 SW Hwy	Orange (TT) 115 49.705 33 34.702 23/12/08 - 23/06/10		
40 F 'Plants for Sale' 134 SW Hwy	Orange (TT) 115 49.686 33 34.733 18/03/09 - 23/06/10		

Table 1b: Donnybrook – Placement of Static traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details			Notes
1 Marshall Rd	Tree Lucerne 115 45.594 33 32.516 17/09/07 - 1/11/07	Orange 115 45.586 33 32.513 1/11/07 - 25/11/09	Nectarine 115 45.588 33 32.510 25/11/09 - 23/06/10	
2 Marshall Rd	Eucalypt 115 45.271 33 32.770 17/09/07 – 6/12/07	Loquat 115 45.249 33 32.746 6/12/07 – 25/11/09	Pear 115 45.254 33 32.706 25/11/09 - 23/06/10	
3 Billinghurst Rd	Evergreen 115 45.650 33 33.224 17/09/07 – 21/03/08			Discontinued - death of some trees
4 Gemmell Rd	Evergreen 115 47.213 33 33.253 17/09/07 – 6/12/07	Mulberry 115 47.209 33 33.253 6/12//07 – 15/05/08	Eucalypt 115 47.221 33 33.256 15/05/08 -10/12/08	Discontinued - severe pruning of trees
5 31 Bendall Rd	Melaleuca 115 47.549 33 33.175 17/09/07 – 6/12/07	Eucalyptus 115 47.549 33 33.182 6/12/07 – 11/03/08		Discontinued – poor fruiting hosts
8 8 Nash Place	Eucalypt 115 48.822 33 32.640 17/09/07 – 22/11/07	Evergreen 115 48.815 33 32.645 22/11//07 – 19/03/08		Discontinued – changed to female trap site
9 4 Hickman Rd	Melaleuca 115 49.051 33 32.570 17/09/07 - 6/12/07	Persimmon 115 49.051 33 32.568 6/12/07 – 7/05/08	Olive 115 49.055 33 32.538 7/05/08 – 2/07/08	Discontinued – at request of owner
10 2 Miller Rd	Orange 115 49.365 33 32.346 17/09/07 - 23/06/10			
15 15 Morgan Road	Bottle brush 115 48.302 33 34.606 17/09/07 – 28/11/07	Eucalypt (near small peach, olive, mandarin) 115 48.299 33 34.622 28/11/07 - 23/06/10		Discontinued – poor fruiting hosts
16 21 Preston Rd	Grapefruit 115 50.820 33 34.506 17/09/07 - 25/11/09	Peach 115 50.824 33 34.472 25/11/09 - 23/06/10		
17 127 Preston Road	Orange 115 51.100 33 33.983 17/09/07 - 08/10/08			Discontinued – at request of owner
18 18 Hacket Road	Mulberry 115 51.016 33 35.071 17/09/07 – 7/06/08	conifer 115 51.016 33 35.072 7/06/08 – 25/11/09	Plum 115 50.983 33 35.031 25/11/09 - 23/06/10	
19 F Bremer Road	Apple 115 51.597 33 32.872 25/10/07 – 14/02/08			Discontinued – regular perimeter baiting by grower
20 F 120 Upper Capel Road	Loquat 115 49.159 33 35.954 25/10/07 – 4/03/09			Discontinued – death of some hosts

21 F SW Hwy, Kirup opp old school	Apple 115 53.743 33 42.900 25/10//07 -14/02/08	Mandarin 115 53.788 33 42.902 14/02/08 – 18/02/09	Orange 115 53.756 33 42.902 18/02/09 – 26/11/09	2nd Apple 115 53.700 33 42.904 25/11/09 - 23/06/10
22 F SW Hwy, Kirup nr Pie shop	Apple 115 53.599 33 42.522 28/11/07 – 24/01/08	Loquat 115 53.602 33 42.507 24/01/08 – 25/11/09	Apple 115 53.599 33 42.522 28/11/07 - 23/06/10	
23 45 Irish Twon Rd	Orange 115 48.781 33 33.461 14/02/08 – 10/12/08	2nd Orange 115 48.791 33 33.449 10/12/08 – 25/11/09	Plum 115 48.807 33 33.487 25/11/09 - 23/06/10	
24 opp 85 Bremer Road	Orange 115 51.741 33 33.356 14/02/08 – 25/11/09	Plum 115 51.726 33 33.357 25/11/09 - 23/06/10		
25 1100 Joshua Creek Rd	Orange 115 51.260 33 30.816 14/02/08 - 25/11/09	Plum 115 51.274 33 30.815 25/11/09 - 23/06/10		
26 116 Warburton Rd	Grapefruit 115 51.200 33 30.376 14/02/08 - 25/11/09	Plum 115 51.204 33 30.395 25/11/09 -- 23/06/10		
27 586 Warburton Rd	Mandarin 115 51.495 33 29.960 14/02/08 – 25/11/09	Peach 115 51.505 33 29.997 25/11/09 - 23/06/10		
28 Geraldine Rd, opp Argyle Rd	Loquat 115 45.997 33 32.937 14/02/08 – 15/10/08			Discontinued – at request of owner
29 845 Hurst Rd	Orange 115 46.599 33 32.400 14/02/08 – 25/11/09	Cherry 115 46.587 33 32.447 25/11/09 - 23/06/10		
30 691 Hooker Rd	Loquat 115 44.945 33 30.829 14/02/08 - 23/06/10			
31 Cnr Hurst & Gwindinup	Loquat 115 44.688 33 30.450 14/02/08 – 25/11/09	Quince 115 44.697 33 30.457 25/11/09 - 23/06/10		
32 20033 Sw Hwy	Loquat 115 53.082 33 40.996 14/02/08 – 25/11/09	Peach 115 53.016 33 40.987 25/11/09 - 23/06/10		
33 F 8 Nash Place	Orange 115 48.807 33 32.647 14/02/08 - 23/06/10			
34 1974 SW Hwy	Feijoa 115 52.168 33 39.511 04/06/08 – 25/11/09	Apple 115 52.124 33 39.505 25/11/09 - 23/06/10		
35 19374 SW Hwy	Acacia 115 51.097 33 37.981 23/10/08 - 25/11/09	Plum 115 51.133 33 37.872 25/11/09 - 23/06/10		

36 87 Geraldine's Rd	Loquat 115 45.918 33 32.210 30/10/08 – 26/11/08	Grapefruit 115 45.926 33 32.215 26/11/08 – 25/11/09	Apple 115 45.899 33 32.262 25/11/09 - 23/06/10	
37 26 Hickman Place	Eucalypt 115 49.075 33 32.422 29/10/08 – 28/01/09			Discontinued – poor fruiting hosts
38 Lot 2 Hurst Rd	Orange 115 51.275 33 30.842 12/11/08 - 23/06/10			
39 Cnr Hurst & Argyle	Orange 115 46.232 33 32.254 12/11/08 – 25/11/09	Plum 115 46.228 33 32.249 25/11/09 - 23/06/10		

Table 1c: Donnybrook – Placement of Dynamic traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details						
1 Barnes	Orange 115 45 594 33 32 516 21/09/07 - 28/11/07	Apricot 115 45 599 33 32 489 28/11/07 - 31/01/08 8/01/09 - 21/01/09	Orange 115 45 599 33 32 485 31/01/08 - 11/12/08 29/04/09 - 25/11/09 26/05/10 - 23/06/10	Plum 115 45 592 33 32 497 11/12/08 - 8/01/09 25/11/09 - 10/02/10	Grapefruit 115 45 585 33 32 490 21/01/09 - 29/04/09 10/02/10 - 26/05/10		
2 Donald	Loquat 115 45 249 33 32 746 21/09/07 - 28/11/07	Apricot 115 45 260 33 32 713 28/11/07 - 11/03/08 6/12/07 Orchard 25/11/09 - 10/02/10	Lemon 115 45 261 33 32 730 11/03/08 - 21/05/08 16/07/08 - 10/12/08 30/05/09 - 25/11/09 14/04/10 - 26/05/10	Mandarin 115 45 272 33 32 726 21/5/08 - 16/07/08 26/05/10 - 23/06/10	Peach 115 45 250 33 32 722 10/12/08 - 25/02/09	Fig 115 45 248 33 32 729 25/02/09 - 30/05/09 10/02/10 - 14/04/10	
10 'Little Paddocks'	Grapefruit 115 49 390 33 32 374 21/09/07 - 28/11/07 19/03/08 - 15/05/08 12/03/09 -26/11/09 07/04/10 - 26/05/10	Apricot 115 49 387 33 32 376 28/11/07 - 21/02/08 26/11/09 -10/02/10	Fig 115 49 392 33 32 375 21/02/08 - 19/03/08 10/2/10 - 7/04/10	Mandarin 115 49 887 33 32 363 15/05/08 – 28/05/08 26/05/10 - 23/06/10	Loquat 115 49 887 33 32 363 28/05/08 - 10/12/08	Nectarine 115 49 385 33 32 376 10/12/08 - 4/02/09	Lemon 115 49 387 33 32 381 4/02/09 - 12/03/09
16 King	Plum 115 50 845 33 34 494 21/09/07 - 28/11/07 31/01/08 -11/03/08 10/02/10 - 7/04/10	Peach 115 50 858 33 34 469 28/11/07 - 31/01/08 18/02/09 - 27/05/09 07/04/10 - 9/06/10	Orange 115 50 859 33 34 469 11/03/08 - 10/12/08 27/05/09 - 25/11/09 9/06/10 - 23/06/10	Apricot 115 50 851 33 34 469 10/12/08 - 7/01/09	Plum 115 50 855 33 34 494 7/01/09 - 4/02/09	Peach 115 50 824 33 34 472 04/02/09 - 18/02/09	Peach 115 50 849 33 34 487 25/11/09 - 10/02/10
18 'Bird In Hand' formerly 2nd House	Lemon 115 50 984 33 35 036 21/09/07 - 20/11/07	Plum 115 50 973 33 35 029 20/11/07 - 14/02/08 7/01/09 - 25/02/09	Pear 115 50 970 33 35 080 14/02/08 - 11/03/08 25/02/09 - 22/04/09	Olive 115 50 953 33 35 023 11/3/08 - 8/05/08 10/02/10 - 23/06/10	Orange 115 50 959 33 35 032 8/05/08 - 10/12/08	Mulberry 115 50 945 33 35 039 10/12/08 - 7/01/09 25/11/09 - 10/02/10	Mandarin 115 50 966 33 35 037 22/04/09 - 25/11/09
21 F Old School	Cumquat 115 53 745 33 42 903 30/11/07 -19/03/08 10/12/08 - 25/11/09 14/04/10 - 23/06/10	Apple 115 53 743 33 42 900 19/03/08 - 14/08/08	Lemon 115 53 751 33 42 902 14/08/08 – 10/12/08	Persimmon 115 53 753 33 42 908 25/11/09 - 14/04/10			

22 F Pie Shop	Plum 115 53 586 33 42 509 30/11/07 -31/01/08 15/01/09 – 25/02/09	Nectarine 115 53 586 33 42 509 31/01/08 - 19/03/08	Fig 115 53 600 33 42 521 19/03/08 - 15/05/08 10/02/10 - 5/05/10	Lemon 115 53 601 33 42 522 15/05/08 - 10/12/08 13/05/09 - 26/11/09 5/05/10 - 23/06/10	Prunus 115 53 586 33 42 521 10/12/08 – 15/01/09	Plum 115 53 592 33 42 511 26/11/09 - 10/02/10	Pear 115 53 591 33 42 517 25/02/09 - 13/05/09
23 Giancono	Nectarine 115 48 745 33 33.513 14/02/08 -11/03/08 14/01/09 - 12/03/09	Apple 115 48 813 33 33.488 11/03/08 - 08/04/08	Pear 115 48 767 33 33.506 8/04/08 - 28/05/08 12/03/09 - 25/06/09 10/02/10 - 23/06/10	Apple 2 115 48 742 33 33.526 28/05/08 - 16/07/08 25/06/09 - 2/09/09	Lemon 115 48 763 33 33 509 16/07/08 - 10/12/08 2/09/09 - 25/11/09	Apricot 115 48 771 33 33 503 10/12/08 - 23/12/08 25/11/09 - 10/02/10	Nectarine 115 48 756 33 33.480 23/12/08 - 14/01/09
24 Dawson	Plum 115 51 741 33 33 384 14/02/08 - 23/04/08 11/12/08 - 12/02/09 25/11/09 - 26/05/10	Pear 115 51 752 33 33.384 23/04/08 - 18/06/08 13/05/09 - 22/07/09 26/05/10 - 9/06/10	Apple 115 51 750 33 33.379 18/06/08 - 16/07/08	Orange 115 51 813 33 33 398 16/07/08 - 11/12/08 22/07/09 - 25/11/09 9/06/10 - 23/06/10	Plum 115 51 740 33 33.382 12/02/09 – 13/05/09		
25 Ronzio	Nectarine 115 51 271 33 30.850 14/02/08 - 14/05/08 18/02/09 - 11/06/09 10/02/10 - 7/04/10	Mandarin 115 51 277 33 30.838 14/05/08 - 13/08/08 11/06/09 - 25/11/09	Orange 115 51 282 33 30 831 13/08/08 - 19/11/08 26/05/10 - 23/06/10	Peach 115 51 275 33 30 842 19/11/08 - 21/01/09	Plum 115 51 296 33 30 819 21/01/09 - 18/02/09	Apricot 115 51 322 33 30 788 25/11/09 - 10/12/10	Persimmon 115 51 291 33 30 795 07/04/10 - 26/05/10
26 Webster	Dwarf Peach 115 51 166 33 30 361 14/02/08 - 11/03/08 10/02/10 -17/03/10	Grapefruit 115 51 166 33 30 360 11/03/08 - 13/08/08 17/03/10 - 14/04/10	Orange 115 51 235 33 30 432 13/08/08 - 11/12/08 22/04/09 - 25/11/09 14/04/10 - 23/06/10	Apricot 115 51 223 33 30 418 11/12/08 - 7/01/09 25/11/09 - 10/02/10	Plum 115 51 233 33 30 410 7/01/09 - 4/03/09 21/01/09 - 22/04/09	Peach 115 51 228 33 30 415 4/03/09 - 18/03/09	Fig 115 51 230 33 30 413 18/03/08 - 22/04/09
27 Sophia Hills	Peach 115 51 497 33 29 993 14/02/08 - 11/03/08 10/12/08 - 7/01/09	Peach 115 51 464 33 29 995 11/03/08 -26/03/08 11/03/09 - 11/06/09	Apple 115 51 482 33 29 980 26/03/08 - 18/0608 14/04/10 - 26/05/10	Mandarin 115 51 515 33 29 988 18/06/08 - 16/07/08	Orange 115 51 516 33 29 979 16/07/08 - 10/12/08 11/06/09 - 25/11/09 26/05/10 - 23/0610	Plum 115 51 468 33 29 973 7/01/09 - 12/02/09 25/11/09 - 17/02/10	Plum 115 51 466 33 29 969 12/02/09 – 11/03/09 17/02/10 -14/04/10
29 'Kamere'	Apple 115 44 610 33 30 422 14/02/08 - 19/03/08 25/03/09 - 25/06/09 22/04/10 - 23/06/10	Pear 115 44 614 33 30 443 19/03/08 - 23/04/08 25/02/09 - 25/03/09 10/02/10 - 22/04/10	Mandarin 115 44 614 33 30 424 23/04/08 - 15/05/08 18/06/08 - 20/11/08 25/06/09 - 25/11/09	Persimmon 115 44 605 33 30 419 15/05/08 - 18/06/08	Peach 115 44 698 33 30 427 20/11/08 - 17/12/08	Peach 115 44 614 33 30 428 17/12/09 - 25/02/09 25/11/09 -10/02/10	

30 'Kintail'	Pear 115 44 981 33 30 874 14/02/08 - 2/04/08 25/02/09 - 25/06/09 17/02/10 - 17/03/10	Orange 115 44 977 33 30 857 02/04/08 - 21/05/08 25/06/09 - 25/11/09	Mandarin 115 44 980 33 30 865 21/05/08 - 19/11/08 17/03/10 - 23/06/10	Orange 2 115 44 915 33 30 860 19/11/08 - 7/01/09 28/01/09 - 25/02/09	Plum 115 44 980 33 30 852 7/01/09 - 28/01/09 25/11/09 - 17/02/10		
31 Birch	Plum 115 44 698 33 30 432 14/02/08 - 23/04/08 21/01/09 - 12/03/09	Apple 115 44 699 33 30 429 23/04/08 -19/06/08 25/03/09 - 25/06/09	Mandarin 115 44 700 33 30 426 19/06/08 - 13/11/08	Orange 115 44 700 33 30 428 13/11/08 - 10/12/08	Peach 115 44 693 33 30 428 10/12/08 - 21/01//09	Peach 115 44 702 33 30 436 12/03/09 - 25/03/09	
32 Wherrett	Plum 115 53 090 33 41 022 14/02/08 - 19/03/08 14/01/09 - 16/04/09 10/02/10 - 17/03/10	Mandarin 115 53 077 33 41 001 19/03/08 - 29/04/08 13/11/08 - 10/12/08 17/03/10 - 7/04/10	Apple 115 53 075 33 40 998 29/04//08 - 16/07/08 16/04/09 - 25/06/09 07/04/10 - 23/06/10	Orange 115 53 076 33 40 998 16/07/08 - 13/11/08 25/06/09 - 25/11/09	Peach 115 53 022 33 41 029 10/12/08 - 7/01/09 25/11/09 - 10/02/10	Apricot 115 53 035 33 41 013 7/01/09 - 14/01/09	
33 F Ashbourne	Fig 115 48 795 33 32 653 19/03/08 -28/05/08 18/03/09 - 15/04/09	Lemon 115 48 806 33 32 647 28/05/08 - 10/12/08 11/06/09 - 25/11/09	Apricot 115 48 797 33 32 644 10/12/08 - 23/12/08	Plum 115 48 801 33 32 644 23/12/08 - 12/02/09	Plum 115 48 788 33 32 652 12/02/09 - 25/02/09	Pear 116 48 798 33 32 646 25/02/09 - 18/03/09 17/02/10 - 17/03/10	Apple 115 48 801 33 32 650 15/4/09 - 11/06/09 17/03/10 - 23/06/10
	Peach 115 48 799 33 32 646 25/11/09 - 17/02/10						
34 Robb	Apple 115 52 151 33 39 504 4/06/08 - 16/07/08 25/06/09 - 19/08/09 07/04/10 - 23/06/10	Lilly Pilly 115 52 174 33 39 477 16/07/08 - 10/12/08 19/08/09 - 25/11/09	Apricot 115 52 165 33 39 479 10/12/08 - 15/01/09 25/11/09 - 10/02/10	Plum 115 52 154 33 39 476 15/01/09 - 12/02/09 10/02/10 - 7/04/10	Apple 115 52 158 33 39 483 16/07/08 – 30/07/08 12/02/09 - 25/06/09		
35 Dittman	Lemon 115 51 090 33 37 879 23/10/08 - 10/12/08	Apricot 115 51 088 33 37 879 10/12/08 - 8/01/09 25/11/09 - 10/02/10	Plum 115 51 107 33 37 875 08/01/09 - 21/01/09	Orange 115 51 101 33 37 875 21/01/09 - 25/11/09 10/02/10 - 23/06/10			
36 Tim & Lyn	Orange 115 45 918 33 32 210 30/10/08 - 10/12/08 27/05/09 - 25/11/09 14/04/10 - 23/06/10	Apricot 115 45 934 33 32 244 10/12/08 - 7/01/09 25/11/09 -10/02/10	Nectarine 115 45 924 33 32 241 7/01/09 - 12/03/09	Pear 115 45 960 33 32 260 12/03/09 - 27/05/09 10/02/10 - 14/04/10			

38 'Jenoshua'	Loquat 115 44 570 33 30 162 12/11/08 - 10/12/08	Apricot 115 44 596 33 30 166 10/12/08 - 7/01/09 25/11/09 - 10/02/10	Orange 115 44 595 33 30 165 7/01/09 - 25/11/09 10/02/10 - 23/06/10				
39 Gibbs	Lemon 115 46 236 33 32 280 12/11/08 - 10/12/09 15/01/09 - 25/02/09 25/06/09 - 25/11/09	Nectarine 115 46 220 33 32 280 10/12/08 - 15/01/09 25/11/09 - 10/02/10	Pear 115 46 210 33 32 278 25/02/09 - 25/06/09 10/02/10 - 23/06/10				

3	Lemon 115 456 660 33 32 304 21/09/07 - 28/11/07	Fig 115 45 676 33 32 203 28/11/07 - 21/02/08	Discontinued				
4	Lemon 115 47 210 33 33 278 21/09/07 26/03/08 - 28/11/07	Peach 115 47 215 33 33 271 28/11/07 - 10/12/08	Discontinued				
5	Mandarin 115 47 549 33 33 585 21/09/07 - 28/11/07 21/02/08 - 11/03/08	Nectarine 115 47 549 33 33 580 28/11/07 - 6/12/07	Apricot 115 47 540 33 33 575 6/12/07 - 21/02/08	Discontinued			
8	Orange 115 49 807 33 32 651 21/09/07 - 28/11/07	Apricot 115 49 798 33 32 632 28/11/07 - 21/02/08	Pear 115 48 802 33 32 640 21/02/08 - 19/03/08	Changed to female trap site			
9	Lemon 115 49 072 33 32 539 21/09/07 - 28/11/07	Peach 115 49 084 33 32 524 28/11/07 - 21/02/08	Plum 115 49 084 33 32 522 21/02/08 - 26/03/08	Apple 115 49 074 33 32 555 26/03/08 - 4/06/08	Mandarin 115 49 076 33 32 541 4/06/08 - 2/07/08	Discontinued	
15	Lemon 115 48 302 33 34 606 21/09/07 - 28/11/08 21/02/08 - 11/03/08	Nectarine 115 48 302 33 34 606 28/11/08 - 21/02/08	Discontinued				

17	Orange 115 51 110 33 33 957 21/09/07 -28/11/07	Nectarine 115 51 112 33 33 969 28/11/07 - 21/02/08	Pear 115 51 081 33 33 951 21/02/08 - 26/03/08	Pear 115 51 080 33 33 956 26/03/08 - 17/04/08	Orange 115 51 105 33 33 961 17/04/08 - 8/10/08	Discontinued	
19 F	Apricot 115 51 568 33 32 867 25/10/07- 6/12/07	Peach 115 51 565 33 32 865 6/12/07 - 10/01/08	Nectarine 115 51 562 33 32 864 10/01/08 - 14/02/08	Nectarine 115 51 561 33 32 861 14/02/08 -21/02/08	Discontinued		
28 Castledine	Plum 115 45 998 33 32 351 14/02/08 - 11/03/08	Pear 115 46 008 33 32 367 11/03/08 - 28/0508	Pear 115 46 017 33 32 350 28/05/08 - 18/06/08	Orange 115 45 986 33 32 320 18/06/08 - 15/10/08	Discontinued		
20 F 'Southernwood'	Lemon 115 49 170 33 35 942 25/10/07 – 25/02/09	Apple 115 49 180 33 35 980 25/02/09 - 4/03/09	Discontinued				
37 Wunnenber	Lemon 115 49 107 33 32 423 29/10/08 - 10/12/08	Peach 115 49 105 33 32 421 10/12/08 - 28/01/09	Discontinued				

Table 2a: Manjimup – Placement of Town Monitoring traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details			Notes
9 M	Loquat (TT) 116 08.220 34 15.090 17/09/07 – 24/06/10			
9 F	Orange (TT) 116 08.236 34 15.084 17/09/07 – 24/06/10			
10	Loquat (TT) 116 08.759 34 14.765 17/09/07 – 20/02/08			Discontinued 20/2/08 - pruned
16 M	Loquat (TT) 116 08.469 34 14.013 17/09/07 – 24/06/10			
16 F	Lemon (TT) 116 08.456 34 14.016 17/09/07 – 27/03/08	Grapefruit (TT) 116 08.455 34 14.019 27/3/08 – 22/01/09	Mandarin (TT) 116 08.465 34 14.005 22/01/09 – 24/06/10	
17 M	Olive (TT) 116 07.795 34 14.229 17/09/07 – 30/11/07	Pear (TT) 116 07.795 34 14.230 30/11/07 – 13/06/08	Lemon (TT) 116 07.992 34 14.214 13/06/08 – 24/06/10	
24 M	Mandarin (TT) 116 09.441 34 14.388 31/7/08 – 24/06/10			
25 M	Lemon (TT) 116 08.574 34 14.514 22/1/09 – 24/06/10			
25 F	Loquat (TT) 116 08.550 34 14.500 22/01/09 – 24/06/10			

Table 2b: Manjimup – Placement of Static traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details			Notes
1 Starkies Rd	Almond 116 08.474 34 16.190 17/09/07 - 17/01/08	Evergreen 116 08.479 34 16.182 17/01/08 - 17/07/08	Loquat 116 08.443 34 16.211 17/07/08 - 24/06/10	
2 311 Seven Day Rd	Evergreen 116 06.800 34 15.997 17/09/07 - 6/12/07	Fig 116 06.808 34 15.997 6/12/07 - 19/06/09 2/12/09 - 24/06/10	Lemon 116 06.802 34 15.997 19/6/08 - 2/12/09	
3 Guadaninos Seven Day Rd	Lemon 116 04.554 34 16.879 17/09/07 - 2/12/09	Pear 116 04.556 34 16.879 2/12/09 - 24/06/10		
4 Fontanini's Seven Day Rd	Avocado 116 03.588 34 17.562 17/09/07 – 2/12/08	Apple 116 03.694 34 17.354 2/12/09 - 24/06/10		
5 313 Seven Day Rd	Apple 116 03.422 34 17.367 17/09/07 - 22/04/09	Apple 116 03.419 34 17.373 22/04/09 - 24/06/10		
6 F Jim Walker Seven Day Rd	Plum 116 03.732 34 17.108 17/09/07 - 1/05/08	Olive 116 03.821 34 17.059 1/05/08 - 2/12/09	Cherry 116 03.821 34 17.062 2/12/09 - 24/06/10	
7 Becker Road	Apricot 116 07.807 34 15.316 17/09/07 - 19/06/08 2/12/09 - 24/06/10	Olive 116 07.803 34 15.316 19/6/08 - 2/12/09		
8 S & K Read	Plum 116 07.455 34 15.155 17/09/07 - 1/05/08	Native 116 07.461 34 15.154 1/05/08 - 31/07/08	Mulberry 116 07.515 34 15.164 31/07/08 - 9/09/09	Discontinued – trees removed
11 Ansell Kurundra Rd	Peach 116 09.976 34 15.169 17/09/07 - 19/06/08	Loquat 116 09.986 34 15.194 19/06/08 - 2/12/09	Cherry 116 09.986 34 15.197 2/12/09 - 24/06/10	
12 Aldersea Drv	Almond 116 09.679 34 14.680 17/09/07 - 17/11/08	Olive 116 09.690 34 14.685 17/11/08 - 24/06/10		
13 M	Lemon (TT) 116 09.035 34 14.177 17/09/07 - 17/07/08			Discontinued - scale
14 F Perup Road	Apricot 116 09.962 34 13.872 17/09/07 - 19/06/08	Loquat 116 09.959 34 13.874 19/06/08 - 2/12/09	Apple 116 09.959 34 13.878 2/12/09 - 24/06/10	
15 Carinoglen Rd	Plum 116 09.769 34 13.530 17/09/07 - 1/05/08	Chestnut 116 09.760 34 13.519 1/05/08 - 17/07/08	Photinia / evergreen 116 09.744 34 13.518 17/07/08 - 2/12/09	Apricot 116 09.784 34 13.524 2/12/09 - 24/06/10
17 F	Orange 116 07.985 34 14.236 26/10/07 - 24/06/10			

18	Orange 116 07.707 34 14. 024 17/09/07 - 27/03/08			Discontinued 27/3/2008 -poor fruiting hosts
19 F	Lemon 116 09.126 34 13. 605 17/09/07 - 27/03/08			Discontinued 27/3/08 - limited hosts moved to 21
20 Speak & Bendotti	Native 116 09.381 34 13.161 17/09/07 - 17/11/07	Orange 116 09.384 34 13.1543 17/11/07 - 24/06/10		
21 F Parkland View	Avocado 116 06.740 34 14.219 14/02/08 - 2/12/09	Apricot on trellis 116 06.713 34 14.221 2/12/09 - 24/06/10		
22 Opposite Kimber St	Apple 116 06.764 34 13.546 14/02/08 - 24/06/10			
23 Danrobe Park	Apple 116 05.066 34 11.244 14/02/08 - 24/06/10			

Table 2c: Manjimup – Placement of Dynamic traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details						
1	Mandarin 116 08 474 34 16 170 17/09/07 - 27/03/08 27/05/09 - 2/12/09 13/05/10 - 24/06/10	Fig 116 08 463 34 16 193 27/03/08 - 19/06/08	Orange 116 08.479 34 16.181 19/06/08 - 10/12/08	Nectarine 116 08.480 34 16.181 10/12/08 - 4/03/09 2/12/09 - 4/03/10	Pear 116 08.480 34 16.170 4/03/09 - 27/05/09 4/03/10 - 13/05/10		
2	Mulberry 116 06 808 34 15 972 17/09/07 - 20/02/08 24/09/09 - 2/12/09	Apple 116 06.813 34 15 980 20/02/08 - 3/04/08 18/03/09 - 22/04/09	Orange 116 06 818 34 15 974 3/04/08 - 10/12/08 27/05/09 - 24/09/09 29/04/10 - 24/06/10	Plum 116 06.814 34 15 979 10/12/08 - 11/03/09 2/12/09 - 28/01/10	Fig 116 06.808 34 15.970 22/04/09 - 27/05/09 28/01/10 - 29/04/10		
3	Lemon 116 04 549 34 16 921 17/09/07 - 30/11/07 19/06/08 - 10/12/08 10/06/09 - 2/12/09 10/06/10 - 24/06/10	Apricot 116 04 553 34 16 902 30/11/07 - 28/02/08 2/12/09 - 28/01/10	Peach 116 04 544 34 16 935 28/02/08 - 3/04/08	Apple 116 04 544 34 16 950 03/04/08 - 29/04/08 25/03/10 - 6/05/10	Persimmon 116 04 522 34 16 916 29/04/08 -19/06/08	Nectarine 116 04.549 34 16.925 10/12/08 - 18/03/09 28/01/10 - 25/03/10	Fig 116 04.588 34 16.952 18/03/09 - 10/06/09 6/05/10 - 10/06/10
4	Orange 116 03 573 34 17 523 17/09/07 - 6/12/07 19/06/08 - 10/12/08 22/10/09 - 02/12/09	Nectarine 116 03 575 34 17 516 6/12/07 - 20/02/08 10/12/08 - 11/03/09 02/12/09 - 18/02/10	Fig 116 03 592 34 17 504 20/02/08 - 29/04/08 11/03/09 - 20/05/09 18/02/10 - 29/04/10	Lilly Pilly 116 03 575 34 17 512 29/04/08 - 19/06/08 20/05/09 - 22/10/09 29/04/10 - 24/06/10			
5	Orange 116 03 447 24 17 366 17/09/07 - 1/04/09 24/09/09 - 11/02/10 6/05/10 - 24/06/10	Apple 116 03.461 34 17.374 1/04/09 - 24/09/09 11/02/10 - 6/05/10					
6F	Orange 116 03 715 34 17 093 17/09/07 - 30/11/07 27/03/08 - 10/12/08 27/05/09 - 2/12/09 10/06/10 - 24/06/10	Apricot 116 03 718 34 17 095 30/11/07 - 20/02/08 2/12/09 - 28/01/10	Plum 116 03 717 34 17 033 20/02/08 - 27/03/08 10/12/08 - 18/03/09	Plum 116 03 726 34 17 107 28/01/10 - 9/04/10	Fig 116 03.726 34 17.107 18/03/09 - 27/05/09 9/04/10 - 10/06/10		
7	Lemon 116 07 811 34 15 299 17/09/07 - 30/11/07	Plum 116 07 792 34 15 291 30/11/07 - 27/03/08 10/12/08 - 22/01/09 2/12/09 - 11/03/10	Fig 116 07 792 34 15 289 27/03/08 - 1/05/08 1/04/09 - 20/05/09 11/03/10 - 22/04/10	Orange 116 07 787 34 15 298 1/05/08 - 10/12/08 20/05/09 - 2/12/09 22/04/10 - 24/06/10	Plum 116 07.788 34 15.292 22/01/09 - 1/04/09		

11	Orange 116 10 000 34 15 183 17/09/07 - 30/11/07 19/06/08 - 10/12/08 10/06/09 - 2/12/09 10/06/10 - 24/06/10	Peach 116 10 009 34 15 180 30/11/07 - 29/04/08 10/12/08 - 1/04/09 2/12/09 - 9/04/10	Apple 116 10 008 34 15 181 29/04/08 - 19/06/08 1/04/09 - 10/06/09 9/04/10 - 10/06/10				
12	Lemon 116 09 711 34 14 694 17/09/07 - 30/11/07 29/04/08 - 10/12/08 6/05/09 - 2/12/09 29/04/10 -24/06/10	Peach 116 09 718 34 14 694 30/11/07 - 27/03/08 10/12/08 - 1/04/09 2/12/09 - 28/01/10	Nashi 116 09 717 34 14 692 27/03/08 - 29/04/08 1/04/09 - 6/05/09 28/01/10 - 29/04/10				
14F	Mandarin 116 09 964 34 13 867 17/09/07 - 30/11/07 27/03/08 - 10/12/08 13/05/09 - 2/12/09 15/04/10 - 24/06/10	Peach 116 09 959 34 13 878 30/11/07 - 27/03/08 10/12/08 - 20/02/09 2/12/09 - 15/04/10	Apple 116 09.959 34 13.875 11/03/09 - 13/05/09	Nectarine 116 09.959 34 13.866 20/02/09 - 11/03/09			
15	Lemon 116 09 767 34 13 547 17/09/07 - 30/11/07 6/05/09 - 2/12/09 29/04/10 - 24/06/10	Plum 116 09 775 34 13 567 30/11/07 - 20/02/08 10/12/08 - 18/03/09 2/12/09 - 18/02/10	Pear 116 09 763 34 13 554 20/02/08 - 27/03/08 18/03/09 - 6/05/09 18/02/10 - 29/04/10	Lime 116 09 763 34 13 554 27/03/08 - 10/12/08			
20	Orange 116 09 392 34 13 140 17/09/07 - 30/11/07 19/06/08 - 10/12/08 10/06/09 - 2/12/09 10/06/10 - 24/06/10	Peach 116 09 387 34 13 135 30/11/07 - 27/03/08 10/12/08 - 1/04/09 2/12/09 - 31/03/10	Fig 116 09 397 34 13 145 27/03/08 - 19/06/08 1/04/09 - 10/06/09 31/03/10 - 10/06/10				
21F	Pear 116 06 742 34 14 246 14/02/08 - 29/04/08 11/03/10 - 6/05/10	Quince 116 06 738 34 14 237 29/04/08 - 19/06/08 25/03/09 - 20/05/09 6/05/10 - 24/06/10	Grapefruit 116 06 744 34 14 233 19/06/08 - 10/12/08 20/05/09 - 2/12/09	Plum 116 06 735 34 14 233 10/12/08 - 25/03/09 2/12/09 - 11/03/10			
22	Plum 116 07 720 34 13 612 14/02/08 - 27/03/08 10/12/08 - 22/01/09 20/02/09 - 18/03/09 2/12/09 - 22/04/10	Apple 116 07 745 34 13 637 27/03/08 - 19/06/08 18/03/09 - 15/07/09 22/04/10 - 3/06/10	Apple 116 07 741 34 13 646 19/06/08 - 17/07/08	Lemon 116 07.792 34 13.580 17/07/08 - 10/12/08 15/07/09 - 2/12/09 3/06/10 - 24/06/10	Apricot 116 07.727 34 13.592 22/01/09 - 20/02/09		

23	Plum 116 05 120 34 11 235 14/02/08 - 27/03/08 10/12/08 - 22/01/09 18/03/09 - 20/05/09 2/12/09 - 15/04/10	Mandarin 116 05.119 34 11.250 27/03/08 - 10/12/08 20/05/09 - 2/12/09 15/04/10 -24/06/10	Peach 116 05.121 34 11.343 22/01/09 - 18/03/09				
8	Mandarin 116 07 495 34 15 152 17/09/07 - 30/11/07	Peach 116 07 468 34 15 172 30/11/07 - 20/02/08	Nectarine 116 07 468 34 15 172 20/02/08 - 27/03/08	Mandarin 2 116 07 478 34 15 173 27/03/08 - 10/12/08 27/05/09 - 9/09/09	Fig 116 07.472 34 15.173 11/03/08 - 10/12/08 11/03/09 - 27/05/09	Plum 116 07.459 34 15.178 10/12/08 - 11/03/09	
18	Lemon 116 07 713 34 13 020 20/09/07 - 30/11/07	Plum 116 07 713 34 13 990 30/11/07 - 27/03/08	Discontinued				
19 F	Lemon 116 09 083 34 13 610 20/09/07 - 20/02/08	Apple 116 09 121 34 13 613 20/02/08 - 24/03/08	Discontinued				

Table 3a: Pemberton – Placement of Static traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details		
1 104 Brockman St	Evergreen (Burnt Apr 09) 116 02.330 34 26.543 17/09/07 - 30/04/09	Chestnut 116 02.317 34 26.548 30/04/09 - 3/12/09	Nectarine 116 02.314 34 26.560 3/12/09 - 24/06/10
2 837 ForestryGlen Rd	Evergreen 116 02.893 34 26.760 17/09/07 – 3/12/09	Peach 116 02.916 34 26.786 3/12/09 - 24/06/10	
3 Abott Rd	Eucalypt 116 02.678 34 26.014 17/09/07 - 30/04/08	Discontinued	
4 F Cnr Abott/Robinson	Lemon 116 02.551 34 27 067 17/09/07 - 24/06/10		
5 Kariholm Christian home	Eucalypt 116 02.348 34 27.009 17/09/07 - 29/11/07	Lemon 116 02.414 34 26.983 29/11/07 - 3/12/09	Plum 116 02.381 34 26.945 3/12/09 - 24/06/10
6 F 34 Lefroy St	Mandarin 116 02.358 34 26.778 17/09/07 - 29/11/07 19/06/08 - 3/12/09	Apple 116 02.358 34 26.765 29/11/07 - 19/06/08 3/12/09 - 24/06/10	
7 13 Jamieson St	Ornamental plum 116 02.203 34 26.808 17/09/07 - 21/02/08	Loquat 116 02.149 34 26.792 21/02/08 - 3/12/09	Apple 116 02.149 34 26.780 3/12/09 - 24/06/10
8 226 Dickinson Rd	Nectarine 116 02.058 34 27.046 17/09/07 - 21/02/08 3/12/09 - 24/06/10	Loquat 116 02.000 34 27.062 21/02/08 - 3/12/09	
9 Camp School Swimming pool Rd	Lemon 116 01.749 34 26.689 17/09/07 - 3/12/09	Apple 116 01.739 34 26.665 3/12/09 - 24/06/10	
10 Pump Hill Rd	Pine 116 02.748 34 26.482 17/09/07 – 29/11/07	Agonis 116 02.780 34 26.456 29/11/07 - 24/06/10	
11 Conte Road	Orange 116 01.350 34 27.351 17/09/07 – 3/12/09	Apple 116 01.350 34 27.351 3/12/09 - 24/06/10	
12 Vass Hwy, Cnr Broad way	Wattle 116 00.520 34 27.556 17/09/07 - 21/02/08	Feijoa 116 00.492 34 27.550 21/02/08 - 24/06/10	
13 F Mt View SW Hwy	Fig 116 02.427 34 26.305 17/09/07 - 19/06/08	Rubber tree 116 02.427 34 26.303 19/06/08 – 3/12/09	Apple 116 01.429 34 26.305 3/12/09 - 24/06/10

14 Pemberton Farm Chalets	Avocado 116 03.014 34 26.353 17/09/07 - 24/06/10		
15 4 Clarrie Jones Place	Loquat 116 03.059 34 26.362 17/09/07 – 2/12/09	Nectarine 116 03.078 34 26.368 2/12/09 - 24/06/10	
16 'Swamp Willow' 179 Hawke Rd	Avocado 115 55.672 34 29.440 28/03/08 - 24/06/10		
17 Lavender Berry Farm Browns Road	Lemon 116 04.311 34 25.994 30/04/08 – 2/12/09	Quince 116 04.324 34 26.001 2/12/09 - 24/06/10	
18 Hawk Road	Olive 115 55.251 34 29.707 01/08/08 - 24/06/10		
19 Hawke Brook Chalets	Avocado 115 54.857 34 29.821 1/08/08 – 2/12/09	Old Nashi 115 54.791 34 29.859 2/12/09 - 24/06/10	

Table 3b: Pemberton – Placement of Dynamic traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details						
1	Lemon 116 02 342 34 26 563 21/09/07 - 29/11/07 19/06/08 - 18/12/08 14/05/09 - 3/12/09	Peach 116 02 338 34 26 558 29/11/07 - 21/02/08	Pear 116 02 335 34 26 570 21/02/08 - 29/04/08 19/03/09 - 14/05/09 12/03/10 - 25/06/10	Persimmon 116 02 329 34 26 574 29/04/08 – 19/06/08	Nectarine 116 02.314 34 26.560 18/12/08 - 5/02/09	Nectarine 2 116 02.324 34 26.570 5/02/09 - 19/03/09 3/12/09 - 12/03/10	
2	Lemon 116 02.870 34 26.765 21/09/07 - 29/11/07 5/11/09 - 3/12/09 9/04/10 - 25/06/10	Peach 116 02 877 34 26 781 29/11/07 - 28/03/08 04/12/08 - 2/04/09 25/3/10 - 9/04/10	Orange 116 02 888 34 26 782 28/03/08 - 4/12/08 02/04/09 - 5/11/09	Nectarine 116 02 871 34 26 768 3/12/09 - 25/03/10			
4 F	Mandarin 116 02 542 34 27 072 21/09/07 - 29/11/07 21/02/08 - 4/12/08 02/04/09 - 5/11/09	Apricot 116 02 536 34 27 073 29/11/07 - 21/02/08 5/11/09 - 28/01/10	Plum 116 02.538 34 27.071 04/12/08 - 2/04/09 28/01/10 - 28/05/10	Avocado 116 02 530 34 27 070 28/05/10 - 25/06/10			
5	Lemon 116 02 348 34 27 009 21/09/07 - 29/11/07 29/04/08 - 18/12/08 16/07/09 - 3/12/09 21/05/10 - 25/06/10	Apricot 116 02 359 34 27 014 29/11/07 - 21/02/08 18/12/08 - 19/03/09 3/12/09 - 28/01/10	Apple 116 02 366 34 26 983 21/02/08 - 29/04/08 19/03/09 - 16/07/09 28/01/10 - 21/05/10				
6 F	Orange 116 02 358 34 26 778 21/09/07 - 29/11/07	Mulberry 116 02 361 34 26 803 29/11/07 - 21/02/08 04/12/08 - 18/12/08	Pear 116 02 368 34 26 807 21/02/08 – 28/03/08 25/02/10 - 12/03/10	Mandarin 116 02 380 34 26 802 28/03/08 - 4/12/08 05/03/09 - 3/12/09 12/03/10 - 25/06/10	Plum 116 02 362 34 26 805 18/12/08 - 5/03/09 3/12/09 - 25/02/10		
7	Lemon 116 02 191 34 26 755 21/09/07 - 29/11/07 29/04/08 - 4/12/08 7/05/09 - 3/12/09 4/06/10 - 25/06/10	Peach 116 02 188 34 26 757 29/11/07 - 17/01/08 21/02/08 - 29/04/08 04/12/08 - 2/04/09 3/12/09 - 23/04/10	Plum 116 02 203 34 26 774 17/01/08 - 21/02/08	Pear 116 02.199 34 26.762 2/04/09 - 7/05/09 23/04/10 - 4/06/10			
8	Citron 116 02 039 34 27 072 21/09/07 - 29/11/07 19/06/08 - 4/12/08 16/07/09 - 3/12/09	Peach 116 02 057 34 27 076 29/11/07 - 28/03/08 04/12/08 - 19/03/09 3/12/09 - 12/03/10	Apple 116 02 050 34 27 073 28/03/08 - 19/06/08 19/03/09 - 16/07/09 12/03/10 - 25/06/10				

9	Lemon 116 01 749 34 26 689 21/09/07 - 29/11/07	Apricot 116 01 736 34 26 700 29/11/07 - 21/02/08	Plum 116 01 738 34 26 696 21/02/08 - 29/04/08 18/12/08 - 5/02/09 3/12/09 - 25/02/10	Fig 116 01 725 34 26 699 29/04/08 - 19/06/09 19/03/09 - 4/06/09 25/02/10 - 28/05/10	Grapefruit 116 01 749 34 26 679 19/06/08 -18/12/08 04/06/09 - 3/12/09 28/05/10 - 25/06/10	Peach 116 01.737 34 26.696 05/02/09 - 19/03/09	
10	Lemon 116 00 735 34 26 475 21/09/07 - 29/11/07 22/10/09 - 3/12/09	Peach 116 00 745 34 26 475 29/11/07 - 28/03/08 18/12/08 - 2/04/09 03/12/09 - 9/04/10	Apple 116 00 740 34 26 477 28/03/08 - 29/04/08 02/04/09 - 23/06/09 9/04/10 - 25/06/10	Kiwifruit 116 00 752 34 26 471 29/04/08 - 19/06/08	Orange 116 00 732 34 26 475 19/06/08 - 18/12/08 23/06/09 - 22/10/09		
11	Orange 116 01 368 34 27 361 21/09/07 - 29/11/07 28/03/08 - 4/12/08 30/07/09 - 3/12/09	Peach 116 01 340 34 27 389 29/11/07 - 28/03/08 04/12/08 - 19/03/09 3/12/09 - 23/04/10	Apple 116 01.344 34 27.369 19/03/09 - 30/07/09 23/04/10 - 25/06/10				
12	Orange 116 00 520 34 27 556 21/09/07 - 29/11/07	Apricot 116 00 508 34 27 564 29/11/07 - 10/01/08 18/12/08 - 5/02/09 3/12/09 - 28/01/10	Plum 116 00 503 34 27 570 10/01/08 - 28/03/08 05/02/09 - 19/03/09 28/01/10 - 9/04/10	Apple 116 00 508 34 27 572 28/03/08 – 29/04/08 9/04/10 – 7/05/10	Apple 2 116 00 511 34 27 576 29/04/08 - 19/06/08 19/03/09 - 7/05/09	Lemon 116 00 500 34 27 573 19/06/08 - 18/12/08 7/05/09 - 3/12/09 7/05/10 - 25/06/10	
13 F	Orange 116 02 396 34 26 330 21/09/07 - 29/11/07 21/02/08 - 30/04/08 19/06/08 - 18/12/08 12/06/09 - 3/12/09	Apricot 116 02 397 34 26 329 29/11/07 - 21/02/08 18/12/08 - 5/02/09	Nectarine 116 02 397 34 26 329 3/12/09 - 9/04/10	Fig 116 02 396 34 26 328 30/04/08 - 19/06/08 19/03/09 - 12/06/09 9/04/10 - 25/06/10	Peach 116 02.410 34 26.321 05/02/09 - 19/03/09		
14	Lemon 116 02 959 34 26 390 21/09/07 - 29/11/07 28/05/09 - 3/12/09	Peach 116 02 965 34 26 408 29/11/07 - 28/03/08 04/12/08 - 19/03/09 3/12/09 - 12/03/10	Fig 116 02 984 34 26 410 28/03/08 - 19/06/08 19/03/09 - 28/05/09 12/03/10 - 21/05/10	Orange 116 02 958 34 26 392 19/06/08 - 4/12/08 21/05/10 - 25/06/10			
15	Sour orange 116 03 073 34 26 342 21/09/07 - 29/11/07 21/02/08 - 18/12/08 05/03/09 - 2/12/09 12/02/10 - 25/06/10	Peach 116 03 011 34 26 349 29/11/07 - 21/02/08 18/12/08 - 5/03/09 2/12/09 - 12/02/10					

16	Tangelo 115 55.633 34 29.464 28/03/08 - 18/12/08 28/05/09 - 2/12/09 7/05/10 - 25/06/10	Fig 115 55.600 34 29.491 18/12/08 - 28/05/09 2/12/09 - 7/05/10					
17	Lemon 116 04 364 34 25 999 29/04/08 - 4/12/08 30/04/09 - 2/12/09 25/02/10 - 25/06/10	Peach 116 04.357 34 25.997 04/12/08 - 19/03/09	Pear 116 04.367 34 25.991 19/03/09 - 30/04/09 17/12/09 - 25/02/10	Apricot 116 04 360 34 26 001 2/12/09 - 17/12/09			
18	Lemon 115 55 212 34 29 731 01/08/08 - 18/12/08 16/07/09 - 2/12/09	Nectarine 115 55.195 34 29.705 18/12/08 - 5/02/09 2/12/09 - 11/02/10	Plum 115 55.207 34 29.711 05/02/09 - 19/03/09 11/02/10 - 9/04/10	Apple 115 55.188 34 29.695 19/03/09 - 16/07/09 9/04/10 - 25/06/10			
19	Kiwi fruit 115 54 763 34 29 808 1/08/08 - 25/09/08 23/06/09 - 2/12/09 7/05/10 - 25/06/10	Lemon 115 54 749 34 29 822 25/09/08 - 18/12/08	Nectarine 115 54.730 34 29.773 18/12/08 - 5/03/09 2/12/09 - 11/02/10	Pear 115 54.730 34 29.763 05/03/09 - 23/06/09 11/02/10 - 7/05/10			
3	Lemon 116 02.719 34 27.000 21/09/07 - 29/11/07 28/03/08 - 30/04/08	Peach 116 02.710 34 26.997 29/11/07 - 17/01/08 21/02/08 - 28/03/08	Nectarine 116 02.710 34 26.990 17/01/08 - 21/02/08	Discontinued			

Table 4a: Kununurra – Placement of Static traps in hosts at trial sites 2007-2010.

Site	Placement details		
1 Packsaddle Road	Mango 15 47.811 128 41.287 24/06/08 - 9/06/10		
2 ORIA Orchards	Mango 15 50.835 128 43.187 24/06/08 - 6/10/09	Papaya 06/10/09 - 9/06/10	
3 Wilga Place nr Barringtonia St.	Mango 15 46.427 128 45.065 24/06/08 - 9/06/10		
4 454 Lower Crossing Falls Road	Mango 15 51.263 128 44.849 24/06/08 - 9/06/10		
5 Whimbrel Rd off Weaber Plain Rd	Mango 15 44.166 128 43.723 24/06/08 - 9/06/10		
6 427 Mills Road	Mango 15 43.408 128 44.048 24/06/08 - 9/06/10		
7 Cherabin Rd	Mango 15 42.377 128 44.167 24/06/08 - 30/09/09		Discontinued – death of dynamic hosts due to poor irrigation 30/9/2009
8 Oolrui Rd, off Weaber Plain Rd	Grapefruit 15 37.267 128 42.768 24/06/08 - 9/06/10		
9 DAFWA	Mango 15 39.178 128 42.318 24/06/08 - 6/10/09	Calamondin 15 39.186 128 42.314 06/10/09 - 9/06/10	
10 River Farm Rd	Mango 15 43.626 128 41.586 24/06/08 - 9/06/10		
11 Freshwater Fruits	Mango 15 43.134 128 41.262 24/06/08 - 9/06/10		
12 Inness's	Mango 15 43.714 128 42.753 24/06/ - 9/06/08		
13 Kestrel Rd	Sapodilla 15.72.921 128.73.486 06/10/ 09 - 9/06/10		

Table 4b: Kununurra – Placement of Dynamic traps in hosts 2008-2010 (Lat/Long and time period in each host)

Site	Placement details				
1	Papaya 15 47.824 128 41.312 24/06/08 – 20/01/09 10/02/09 – 8/02/10	Ixora 15 47.755 128 41.320 20/01/09 – 8/02/09	Lime 15 47.811 128 41.358 8/02/10 – 9/06/10		
2	Grapefruit 15 50.859 128 43.862 24/06/2008 – 6/11/08 29/01/09 – 2/07/09	Custard Apple 15 50.867 128 43.865 6/11/08 – 2/12/08	Mango 15 50.859 128 43.862 2/12/08 – 20/01/09	Guava 15 50.856 128 43.868 2/07/09 – 9/06/10	
3	Carambola 15 46.441 128 45.104 24/06/08 -11/11/08 03/02/09 – 10/03/09	Mango 15 46.440 128 45.104 11/11/08 -16/12/08 29/09/09 - 8/12/09	Ixora 15 46.435 128 45.106 16/12/08 – 3/02/09	Sapodilla 15 46 439 128 45 105 10/03/09 – 29/09/09 8/12/09 – 9/06/10	
4	Tangelo 15 51.300 128 44.838 24/06/08 – 15/09/08 31/03/09 – 9/06/09	Custard Apple 15 51.288 128 44.839 15/09/08 – 30/09/08	Guava 15 51.284 128 44.894 30/09/08 – 6/11/08 16/12/08 – 31/03/09 9/06/09 – 29/09/09 16/11/09 – 25/05/10	Mango 15 51.305 128 44.836 6/11/08 – 16/12/08 29/9/09 – 16/11/09	Grapefruit 15 51 300 128 44 838 25/05/10 – 9/06/10
5	Sapodilla 15 44.200 128 43.727 24/06/08 – 6/11/08 16/12/08 – 17/03/09 29/09/09 – 9/06/10	Mango 15 44.198 128 43.723 6/11/08 – 16/12/08	Guava 15 44 199 128 43 725 17/03/09 – 29/09/09		
6	Lime 15 43.359 128 44.085 24/06/08 – 6/11/08 9/12/08 – 10/03/09	Mango 15 43.342 128 44.089 6/11/08 – 9/12/08	Custard Apple 15 43 356 128 44 071 10/03/09 – 31/03/09	Guava 15 43 352 128 44 060 31/03/09 – 9/06/10	
7	Lemon 15 42.406 128 44.168 24/06/08 – 18/11/08 16/12/08 – 2/07/09	Mango 15 42.386 128 44.160 18/11/08 – 16/12/08 2/07/09 – 29/09/09	Discontinued		

8	Carambola 15 37.294 128 42.778 24/06/08 - 11/11/08 9/12/08 - 10/03/09 02/07/09 - 27/10/09	Star Apple 15 37.296 128 42.782 11/11/08 - 9/12/08	Lime 15 37 304 128 42 776 10/03/09 - 2/07/09 27/12/09 - 25/05/10	Sapodilla 15 37 294 128 42 778 25/05/10 - 9/06/10	
9	Calamondin 15 39.186 128 42.314 24/06/08 -11/11/08 23/12/08 - 17/0709	Mango 15 39.165 128 42.325 11/11/08 - 23/12/08	Sapodilla 15 39.197 128 42.295 17/07/09 - 9/06/10		
10	Lemon 15 43.676 128 41.662 24/06/08 - 6/11/08 9/12/08 - 2/07/09 1/12/09 - 9/06/10	Mango 15 43.667 128 41.568 6/11/08 - 9/12/08 29/09/09 - 1/12/09	Guava 128 41.568 128 41.580 02/07/09 - 29/09/09		
11	Grapefruit 15 43.173 128 41.244 24/06/08 - 6/11/08 9/12/08 - 24/02/09 10/03/09 - 2/07/09	Mango 15 43.181 128 41.265 6/11/08 - 9/12/08 29/09/09 - 1/12/09	Carambola 15 43 180 128 41 261 24/02/09 - 10/03/09 02/07/09 - 29/09/09	Lime 15 43.212 128 41.292 1/12/09 - 9/06/10	
12	Lemon 15 43.710 128 42.696 24/06/08 - 6/11/08 9/12/08 - 2/07/09	Custard Apple 15 43.708 128 42.703 6/11/08 - 9/12/08 29/09/09 - 1/12/09	Guava 15 43.709 128 42.718 2/07/09 - 29/09/09 1/12/09 - 9/06/10		
13	Water Apple 15.72.969 128.73.508 06/10/09 - 9/06/10				

3. (b) Key findings. Part Two: NSW

INTRODUCTION

The Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) is a polyphagous fruit fly, attacking most commercially grown fruit fruiting vegetables in Australia including tomatoes, chillies, capsicums, eggplant, stone, pome and citrus fruits. This species is endemic to tropical and subtropical coastal eastern Australia (May 1963; Zalucki *et al*. 1984), but is now also broadly distributed in temperate eastern Australia (Bateman 1967; Fletcher 1979; O'Loughlin *et al*. 1984). The exception is the Fruit Fly Exclusion Zone (FFEZ), a pest free area where populations are actively suppressed, thus allowing the horticultural industry within that zone to export fresh commodities to fruit fly-sensitive domestic and international markets. The FFEZ encompasses some of our major horticultural production zones including Sunraysia, the Mid Murray and the Goulburn Valley in Victoria, the Murrumbidgee Irrigation Area (MIA) of New South Wales and the Riverland of South Australia.

This trial was conducted from 2008 to 2010 in New South Wales (NSW) to develop trapping methods that would ultimately reduce costs while maintaining high monitoring efficiency for *B. tryoni*. The strategy involved deploying traps in fruiting hosts, when the crop is the most attractive to fruit flies, with the aim of reducing monitoring costs while aiding in improved early detection of the incursive population.

MATERIALS AND METHODS

Eight towns in the New South Wales Risk Reduction Zone (RRZ) were monitored during spring 2008 using cue-lure baited Lynfield traps to establish pest densities of the Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae). Three towns, Junee (34.87904 °S, 147.58094 °E), Cootamundra (34.64879°S, 148.01491°E) & Gundagai (35° 4' 0 S, 148° 5' 60 E), were selected for continued trapping as they were deemed to have the lowest pest densities of all towns monitored (Table 30). In late 2008, we identified a town, Ganmain (34.79564 °S, 147.04920 °E), in the Risk Reduction Zone, which had been under a spray program for some years, although this had recently ceased and therefore *B. tryoni* numbers were very low. Subsequently, traps were deployed in Ganmain and trapping ceased in Gundagai (Table 30). In late 2009, an abandoned stone fruit orchard was identified near Tumut (35.25650 °S, 148.23265 °E) and trapping ceased in Junee (Table 30). Trap lures were changed every six months in all towns and orchards.

Two methods of trap deployment were employed, static and dynamic and trap numbers varied (Table 30) depending upon town area (Table 31). Static traps were deployed as per the current static grid for *B. tryoni* for regional towns in the Fruit Fly Exclusion Zone (FFEZ), based on a 400m spacing in a broadleaf evergreen, either a fruit tree (fruiting or non-fruiting) or a non-host tree. Dynamic traps followed the same 400m grid spacing but were always placed in a fruiting host tree. Static traps were placed in an overlaying grid, offset by 200m from the nearest static trap (example; see Figure 90).

Table 30. The towns, trapping periods and number of traps used in this study.

Town/Orchard	Trapping period	Number of static traps	Number of dynamic traps
Gundagai	21 January - 23 October 2008	15	15
Cootamundra	15 January 2008 - 17 May 2010	15	15
Junee	15 January 2008 - 7 October 2009	15	15
Ganmain	3 November 2008 - 17 May 2010	12	12
Tumut (orchard)	5 November 2009 - 10 February 2010	4	2

Traps were strategically placed within the tree canopy for both trap types to maximise the chance of trapping fruit flies. The traps were placed towards the south east in summer and the north west in winter (A. Jessup unpub. data 2002).

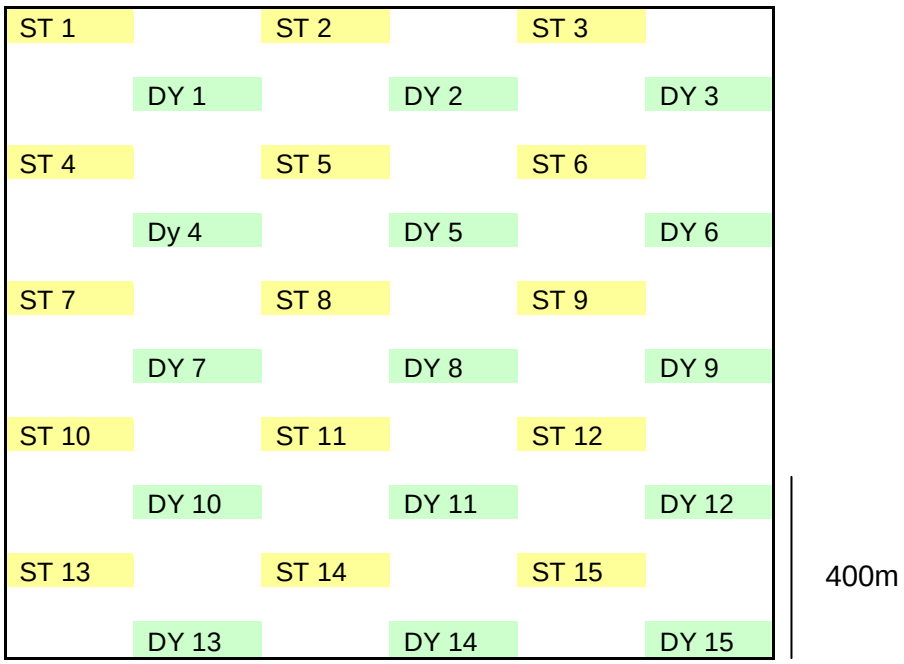


Figure 90. Illustrative example of the placement of static and dynamic traps in each town.

Traps were monitored on a weekly basis from November to May and on a fortnightly basis from June to the end of October as per the Queensland fruit fly Code of Practice.

Host trees were fully mapped for Cootamundra and Ganmain. In Gundagai and Junee, host phenology was recorded for each town by using a number of indicator trees (including all trees in which traps were located) for each fruit type present in the town. The tree descriptors used in the analyses are shown below.

Tree descriptor	**Trees included**
Tree class	Pome, Citrus, Stone, Berry, Fig, Loquat, Olive, Non-host
Tree type	Peach, Apricot, Nectarine, Plum, Prunus plum, Apple, crab apple, Cumquat, Lemon, Valencia orange, Navel orange, Pomegranate, Feijoa, Loquat, Olive, Mulberry, Ash
Tree stage	Mature fruit, immature fruit, flowering, leaves only
Mature fruit	Yes/No

Temperature data was obtained for the region (Wagga Wagga) from the Bureau of Meteorology and is shown in appendix 1.

Statistical Analyses

Generalised linear mixed models (GLMMs) were fitted to a) the proportion of traps which had *B. tryoni* present (irrespective of number of flies present), b) the total proportion of *B. tryoni* trapped on a date and c) the proportion of the catch for a matched pair of traps. Time collectives (time) in models were either, season (defined as Au=autumn (weekly trap checks (tc)), Wi=winter (fortnightly tc), Su=summer (weekly tc) and Sp=spring (fortnightly and then weekly tc) effects or period (defined as On=November to May (weekly tc) and Off = June to October (fortnightly tc). In models for a) and b) fixed effects included time, trap type, time by year, time by trap type and time by year by trap type while date was fitted as a random effect. Date and date by trap type were also included as fixed effects for c) with trap included as a random effect. In all models the error distribution was assumed to be Binomial, dispersion was estimated and the logit link function used. The GLMM was fitted using the method of Schall. The significance of fixed effects was assessed using Wald statistics.

a) The proportion of traps which had flies present (presence/absence analysis)

The data are presented as percentages eg. if eight of the 15 dynamic traps at a date had flies (irrespective of number) the data is presented as 53.3%.

b) The proportion of the total B. tryoni trapped on a date

The data are presented as percentages of the total fly catch across all traps present (numbers varied at sites).

c) The proportion of the catch for a matched pair of traps

Pairs of traps, dynamic and static were matched in each town (i.e. Dynamic 1 & Static 1, Dynamic 2 & Static 2 and so forth). Data are percentages of trap pair captures on a date.

The number of flies captured and effect of host tree - data are transformed log_e(fly count+1)

A linear mixed model (LMM) was fitted which included time, type, time by year, time by type and time by year by type as fixed effects while random effects included date, the interaction of date and trap type and trap. Residual variances were fitted for each year/time combination with a correlation structure fitted to traps over dates within a time. A further LMM was fitted to these data to determine the effect of the trapping tree. In addition to time and year effects, the effect of host was examined both before and after fitting an overall effect for inspection date.

All urban towns

To determine if there were any 'winter hosts' that help perpetuate the adult *B. tryoni* population, data (ln(fly count+1)) for the OFF season for two calendar years was collated across sites (Cootamundra, Ganmain, Gundagai and Junee). A linear mixed model was fitted to the data which included year, site, trap type, tree class, tree type within tree class and tree stage. All interactions, of these main effects were also fitted. All terms were fitted as random effects to determine relative sources of variation in the data. The significance of the random effects was assessed in a step-wise manner by comparing twice the change in the log-likelihood (2Δlogl) with a Chi-square distribution on one degree of freedom.

RESULTS & DISCUSSION

The Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) was trapped in all towns. The duration of trapping in each town, town/orchard area and the fly density in each town is shown in Table 31. During ON periods flies were trapped and collected every week while in OFF periods traps were checked fortnightly.

Table 31. The duration of each trial, the town area and *B. tryoni* density overall and during both weekly (ON) and fortnightly (OFF) trapping periods.

Town/Orchard	Duration of trial	Town area (km^2)	Fly density (flies/trap/week) * Averaged across duration of trial	Fly density (flies/trap/week ON period (weekly trap checks)	OFF period (fortnightly trap checks)
Cootamundra	15 January 2008 - 17 May 2010	4.72	5.3	7.3	1.4
Junee	15 January 2008 - 7 October 2010	2.82	4.9	7.9	1.2
Gundagai	21 January - 23 October 2008	0.63	4.2	7.7	0.9
Ganmain	3 November 2008 - 17 May 2010	1.38	0.05	0.07	0
Tumut (orchard)	5 November 2009 - 10 February 2010	0.3	0.03	0.03	N/A

* Equals: [Total for ON period (Average flies/trap/week for ON period x Number of ON weeks) + Total for OFF period (Average Flies/trap/week (flies per fortnight/2) for OFF period x Number of OFF weeks (fortnights *2))]/Total weeks (Total number of weeks over whole trial).

The fly density in each town for dynamic and static traps is shown in Table 32.

Table 32. Fly density in each trapping town for dynamic and static traps.

	Dynamic traps			Static traps		
Town/Orchard	**Fly density (flies/trap/week)**			**Fly density (flies/trap/week)**		
	ON period (weekly trap checks)	**OFF period (fortnightly trap checks)**	*** Averaged across duration of trial**	**ON period (weekly trap checks)**	**OFF period (fortnightly trap checks)**	*** Averaged across duration of trial**
Cootamundra	8.80	1.47	6.28	5.83	1.20	4.23
Junee	6.65	1.05	4.16	9.09	1.26	5.61
Gundagai	6.83	0.65	3.66	8.55	1.12	4.74
Ganmain	0.10	0	0.07	0.03	0	0.02
Tumut (orchard)	0.08	N/A	0.08	0	N/A	0

* Equals: [Total for ON period (Average flies/trap/week for ON period x Number of ON weeks) + Total for OFF period (Average Flies/trap/week (flies per fortnight/2) for OFF period x Number of OFF weeks (fortnights *2))]/Total weeks (Total number of weeks over whole trial).

Female *B. tryoni* have also been trapped in Cootamundra and Junee although very rarely and were included in the analyses. The native non-economic Newman fly, *Dacus newmani* (Perkins) was also trapped on occasion in all towns although they were not included in the analyses. The selection of Ganmain, a town in the Risk Reduction Zone which has very low *B. tryoni* numbers, met the requirements of a location that mimics the FFEZ as closely as possible.

Host phenology was recorded in all urban towns, but since these trees are located in people's backyards and not used for commercial purposes, management varies greatly and hence host phenology varied greatly from tree to tree and town to town.

Cootamundra

A total of 19234 flies were recorded over the duration of the trial at Cootamundra with fly density shown in Tables 31 and 32. There was a total of 101 collection dates over the duration of the trial (excluding weeks when traps where not checked for logistical reasons). During this time, flies were trapped every week (ON) or fortnight (OFF) with zero flies caught on one occasion during the ON season (11/11/08).

The proportion of traps which had flies present (presence/absence analysis)

Calendar seasons (Summer, autumn, winter, spring)

There was a significant effect of trap type ($F(1,95.0)=4.32$, $P=0.040$) across the seasons with the percentage of dynamic traps with flies higher (58.3%) than the percentage of static traps with flies (53.8%). There was also a significant effect of season ($F(3,83.6)=6.75$, $P<0.001$), and a significant year x season interaction ($F(6,85.9)=4.24$, $P<0.001$). The percentage of traps that captured *B. tryoni* each calendar season is shown in Table 33.

Table 33. The proportion of traps that captured *B. tryoni* each calendar season over the duration of the trial in Cootamundra.

Season/Year	**Logit**	**SE**	**Significance**	**Percentage of traps with *B. tryoni***
Summer 1 2008	2.492	0.6089	e	92.40
Summer 2 2009	0.07	0.4119	abc	51.70
Summer 3 2010	1.848	0.4238	de	86.40
Autumn 1 2008	1.326	0.4054	cde	79.00
Autumn 2 2009	0.025	0.4214	abc	50.60
Autumn 3 2010	1.241	0.4692	cde	77.60
Winter 1 2008	-0.851	0.6178	a	29.90
Winter 2 2009	-0.677	0.6100	ab	33.70
Spring 1 2008	-0.928	0.5110	a	28.30
Spring 2 2009	0.692	0.5019	bcd	66.60

LSD = 1.4086

Weekly (ON) and fortnightly (OFF) trap checks

There was a significant effect of trap type (F(1,93.7)=4.52, P=0.036), averaged across ON/OFF seasons with a higher percentage of flies trapped in dynamic traps (61.6%) compared with static traps (53.7%). There was a significant effect of period (F(1,87.6)=4.47, P=0.037) with 69.1% traps containing flies in the ON period and 49.0% during the OFF period. There was also a significant period x trap type interaction (trap types in ON/OFF periods) (F(1,93.9)=6.12, P=0.015; Table 34), with a greater reduction in percentage of traps with flies for static traps compared to dynamic traps in the OFF season (-14.28%) than in the ON season (-1.46%).

Table 34. The proportion of static and dynamic traps that trapped flies in weekly and fortnightly monitoring trials over the duration of the trial in Cootamundra.

Period (ON/OFF)	**Logit**	**SE**	**Significance**	**Percentage of traps with *B. tryoni***
ON (Weekly trapping) Dynamic	0.9524	0.1895	c	72.16
ON (Weekly trapping) Static	0.881	0.1892	bc	70.70
OFF (Fortnightly trapping) Dynamic	0.228	0.3601	ab	55.68
OFF (Fortnightly trapping) Static	-0.3473	0.3605	a	41.40

LSD 0.6801

There was also a significant period x year interaction (F(3,89.5)=7.93, P<0.001; Table 35).

Table 35. The proportion of traps that captured *B. tryoni* each ON/OFF period each year, over the duration of the trial in Cootamundra.

Frequency of trap monitoring	**Logit**	**SE**	**Significance**	**Percentage of traps with *B. tryoni***
ON (Jan-May) 2008	1.7056	0.1209	d	84.63
OFF (June-October) 2008	-0.4407	0.1390	a	39.16
ON (Nov) 2008 - (May) 2009	-0.2547	0.0820	a	43.67
OFF (June-October) 2009	0.3214	0.1345	b	57.97
ON (Nov) 2009 – (May) 2010	1.2992	0.0980	c	78.57

LSD 0.3283

The proportion of the total B. tryoni trapped on a date

Calendar seasons

There was a significant effect of trap type on the proportion of *B. tryoni* trapped (F(1,178.0)=282.60 P<0.001) with 55.6% of flies caught at each trap check trapped in dynamic traps and 44.4% in static traps.

There was a significant trap type x season (F(6,178.0)=3.36, P=0.004) interaction with the total number of flies caught in dynamic traps greater than the number caught in static traps for Spring (58.2% vs. 41.8%), Summer (58.0% vs. 42.0%), and Autumn (56.8% vs. 43.2%) but not in winter (47.6% vs. 53.4% NS at P=0.05). There was also a significant trap type x season x year interaction (F(12,178.0)=14.94, P<0.001), with a significantly higher number of flies caught in dynamic than static traps during Summer 2008 and Autumn 2008.

ON/OFF periods

Similarly, for ON/OFF periods there was a significant effect of trap type (F(1,188.0)=282.60, P<0.001), with the proportion of total flies trapped greater in dynamic traps (56.6%) than static traps (43.4%).

There was a significant period x trap type (F(1,188.0)=6.72, P=0.051) and year x period x trap (F(3,188.0)=29.87, P<0.001) interaction. The proportion of the total fly number was greater for dynamic

traps for the ON 2008 (67% vs. 33%), OFF 2008 (55% vs. 45%) and OFF 2009 (55% vs. 45%) seasons but in the ON 2008-2009 (53% vs. 47%) and ON 2009-2010 (51% vs. 49%) seasons proportions of total fly numbers did not differ significantly between trap types, although they were still higher in dynamic traps.

The proportion of the catch for a matched pair of traps

Calendar season

There was a significant effect of trap type ($F(1,28.0)=6.95, P=0.014$) with a higher proportion of the catch in the dynamic trap (54.95%) as opposed to the static trap (45.05%). There was a significant trap type x season ($F(6,2221.9)=2.37$, $P=0.027$) and trap type x year x season interaction ($F(12,2223.1)=8.52$, $P<0.001$; Table 36). A significantly higher proportion of flies were caught in dynamic traps compared with static traps; Summer 2008 (65.0% vs. 35.1%), Autumn 2008 (66.7% vs. 33.3%), Spring 2008 (58.4% vs. 41.6%) and Spring 2009 (58.4% vs. 41.6%).

Table 36. The proportion of traps that captured *B. tryoni* each calendar season over the duration of the trial in Cootamundra.

Season/Year	Logit	SE	Significance	Percentage of *B. tryoni* trapped for matched trap pairs.
Summer 2008 Dynamic	0.706	0.0668	fg	66.95
Summer 2008 Static	-0.706	0.0668	ab	33.04
Summer 2009 Dynamic	0.2225	0.0986	def	55.54
Summer 2009 Static	-0.2225	0.0986	bcd	44.46
Summer 2010Dynamic	0.0393	0.0694	de	50.98
Summer 2010 Static	-0.0393	0.0694	de	49.02
Autumn 2008 Dynamic	0.7486	0.0694	g	67.89
Autumn 2008 Static	-0.7486	0.0694	a	32.11
Autumn 2009 Dynamic	-0.0525	0.1332	de	48.69
Autumn 2009 Static	0.0525	0.1332	de	51.31
Autumn 2010 Dynamic	0.1243	0.1261	de	53.10
Autumn 2010 Static	-0.1243	0.1261	cd	46.90
Winter 2008 Dynamic	-0.113	0.2764	cd	47.18
Winter 2008 Static	0.113	0.2764	de	52.82
Winter 2009 Dynamic	-0.076	0.346	d	48.10
Winter 2009 Static	0.076	0.346	de	51.90
Spring 2008 Dynamic	0.4395	0.2492	efg	60.81
Spring 2008 Static	-0.4395	0.2492	abc	39.19
Spring 2009 Dynamic	0.2248	0.1336	def	55.60
Spring 2009 Static	-0.2248	0.1336	bcd	44.40

The number of flies present - data are transformed $\log_e(count+1)$

All preceding analyses have considered proportions. The actual number of flies caught is now considered.

A natural log transformation of the fly count plus one is taken to ensure that residuals had a normal distribution with common variance at each date and to overcome difficulties with zero counts. Since trap counts are taken weekly (ON) or fortnightly (OFF) we consider only the ON/OFF period analysis.

ON/OFF period

There is a significant effect of period ($F(1,96.8)=7.14$, $P=0.009$), with ON period fly numbers (1.22 flies/trap/week; reconverted 2.37 flies/trap/week) being significantly higher than OFF season fly numbers (0.36 flies/trap/week; reconverted 0.44 flies/trap/week). However, there was a significant period x year ($F(3,104.2)=8.52$, $P<0.001$) and trap type x period x year ($F(3,286.9)=3.11$, $P=0.028$) interaction with a larger numbers of flies during the ON 2008/2009 period trapped in dynamic traps (6.5 flies/trap/week) compared to static traps (3.5 flies/trap/week).

Effects of host tree on trapped B. tryoni

The effect of host tree was also examined. The data set is complex in the relationships between trap type, date and host with partial confounding between tree class, tree type and tree stage and date/trap.

Since date may also include effects of climate (temperature, humidity, wind) as well as the effect of a host tree at that time models examined the different effects of fitting host before or after the effect of fitting date with models looked at both the seasonal and period level.

As changes in recording occur (ON=weekly vs. OFF=fortnightly) results for the period analysis are preferable and since date includes important effects of climate, results from the model with date fitted as a fixed effect are discussed.

ON/OFF period
There was a significant effect of date ($F(100,87.7)=19.91$, $P<0.001$) and there are also effects (random) of tree class in particular periods in particular years as well as an effect of tree type in a particular year in the model with date fitted as fixed and host tree attributes as random effects.

In the period analysis with host fitted as fixed and date as a random effect, there was a significant effect of tree stage ($F(4,815.6)=5.38$ $P<0.001$), tree class ($F(6,58.9)=4.78$, $P<0.001$) and tree type ($F(11,53.1)=2.00$, $P=0.046$). This analysis though is fitting means for tree class and tree stage averaged across tree type and across date and period, which ignores the fact that tree classes and tree stages are not always present. When predictions are made averaged only across the days when a pair of tree classes is present we cannot detect any significant differences. Likewise if we estimate means for tree stage only for the dates on which they are present we do not detect any difference in ln(count+1) for any tree stage.

Junee

A total of 13178 flies were recorded over the duration of the trial at Junee with fly density shown in Tables 31 and 32. There was a total of 90 collection dates over the duration of the trial (excluding weeks when traps where not checked for logistical reasons). During this time, flies were trapped every week (ON) and fortnight (OFF) with zero flies caught on only one occasion (26/11/2008).

The proportion of traps which had flies present (presence/absence analysis)

Calendar seasons (Summer, autumn, winter, spring)
There was a significant effect of season ($F(3,59.1)=8.66$, $P<0.001$) and a year x season interaction ($F(4,61.3)=10.54$, $P<0.001$). The percentage of traps that captured *B. tryoni* each calendar season is shown in Table 37.

Table 37. The proportion of traps that captured *B. tryoni* each calendar season, each year, over the duration of the trial in Junee.

Season/Year	Logit	SE	Significance	Percentage of traps with *B. tryoni*
Summer 2008	2.8104	0.5379	e	94.32
Summer 2009	0.3943	0.3534	bc	59.73
Autumn 2008	1.9184	0.3771	de	87.2
Autumn 2009	-0.318	0.3276	ab	42.12
Winter 2008	-0.8944	0.4731	ab	29.02
Winter 2009	-0.7778	0.5045	ab	31.48
Spring 2008	-1.3026	0.4307	a	21.37
Spring 2009	1.2138	0.7175	cd	77.1

There was also a significant season x trap type interaction ($F(3,60.9)=3.23$, $P=0.029$; Table 38). There was no overall type of trap effect and the season by type interaction did not identify any differences between trap types within a season. However, during the peak times of summer and autumn, the percentage of dynamic traps with flies did not differ significantly between these two seasons but the percentage of static traps with flies was greater in summer than in autumn.

Table 38. The proportion of dynamic and static traps that captured *B. tryoni* each calendar season over the duration of the trial in Junee.

	Logit	**SE**	**Significance**	**Percentage of traps with *B. tryoni***
Summer dynamic	1.2314	0.3338	de	77.41
Summer static	1.9734	0.3466	e	87.80
Autumn dynamic	0.7175	0.2643	bcd	67.21
Autumn static	0.8829	0.2656	cd	70.74
Winter dynamic	-0.7322	0.3661	a	32.47
Winter static	-0.9401	0.3688	a	28.09
Spring dynamic	-0.0042	0.4428	abc	49.89
Spring static	-0.0847	0.4426	ab	47.88

Weekly (ON) and fortnightly (OFF) trap checks

There a significant effect of period ($F(1,60.7)=6.82$, $P=0.011$), with a higher percentage of traps with flies in the ON period (71.88%) than the OFF period (40.89%). There was also a significant period x year interaction ($F(2,63.8)=19.59$, $P<0.001$; Table 39), mainly due to the high fly capture rate in the ON period of 2008 (90.1%). The capture rate (percentage of traps with flies) in 2008 OFF, 2008/2009 ON and 2009 OFF do not differ significantly. No trap type effects were identified.

Table 39. The proportion of traps that captured *B. tryoni* each ON/OFF period each year, over the duration of the trial in Junee.

Frequency of trap monitoring	**Logit**	**SE**	**Significance**	**Percentage of traps with *B. tryoni***
ON (Jan-May) 2008	2.2082	0.3308	a	90.10
OFF (June-October) 2008	-0.3309	0.2393	b	41.80
ON (Nov) 2008 - (May) 2009	-0.6209	0.4068	b	34.96
OFF (June-October) 2009	-0.1162	0.4436	b	47.10

The proportion of the total B. tryoni trapped

Calendar seasons

There was a significant effect of trap type ($F(1,122.0)=132.19$, $P<0.001$), with a greater percentage of total flies captured in static traps (57.05%) compared with dynamic traps (42.95%). There was a significant season x trap type interaction ($F(3,122.0)=2.71$, $P=0.048$) with static traps in summer (60.66%) capturing more flies than dynamic traps in summer (39.34%); static traps in autumn (61.1%) capturing more flies than dynamic traps in autumn (38.9%) and static traps in spring (57.63%) capturing more flies than dynamic traps in spring DY (42.37%). There was also a significant year x season x trap type interaction ($F(4,122.0)=8.65$, $P<0.001$; Table 40, Figure 91).

Table 40. The proportion of the total number of *B. tryoni* trapped.

Frequency of trap monitoring	Logit	SE	Significance	Percentage of total *B. tryoni* trapped
Dynamic Summer 2008	-0.2622	0.0571	ab	43.48
Static Summer 2008	0.2622	0.0571	bc	56.52
Dynamic Autumn 2008	-0.2424	0.0641	ab	43.97
Static Autumn 2008	0.2424	0.0641	bc	56.03
Dynamic Winter 2008	0.5478	0.284	c	63.36
Static Winter 2008	-0.5478	0.284	a	36.64
Dynamic Spring 2008	-0.2713	0.1821	ab	43.26
Static Spring 2008	0.2713	0.1821	bc	56.74
Dynamic Summer 2009	-0.6041	0.1109	a	35.34
Static Summer 2009	0.6041	0.1109	c	64.66
Dynamic Autumn 2009	-0.6608	0.1952	a	34.06
Static Autumn 2009	0.6608	0.1952	c	65.94
Dynamic Winter 2009	-0.4353	0.3049	a	39.29
Static Winter 2009	0.4353	0.3049	c	60.71
Dynamic Spring 2009	-0.3442	0.2003	a	41.48
Static Spring 2009	0.3442	0.2003	c	58.52

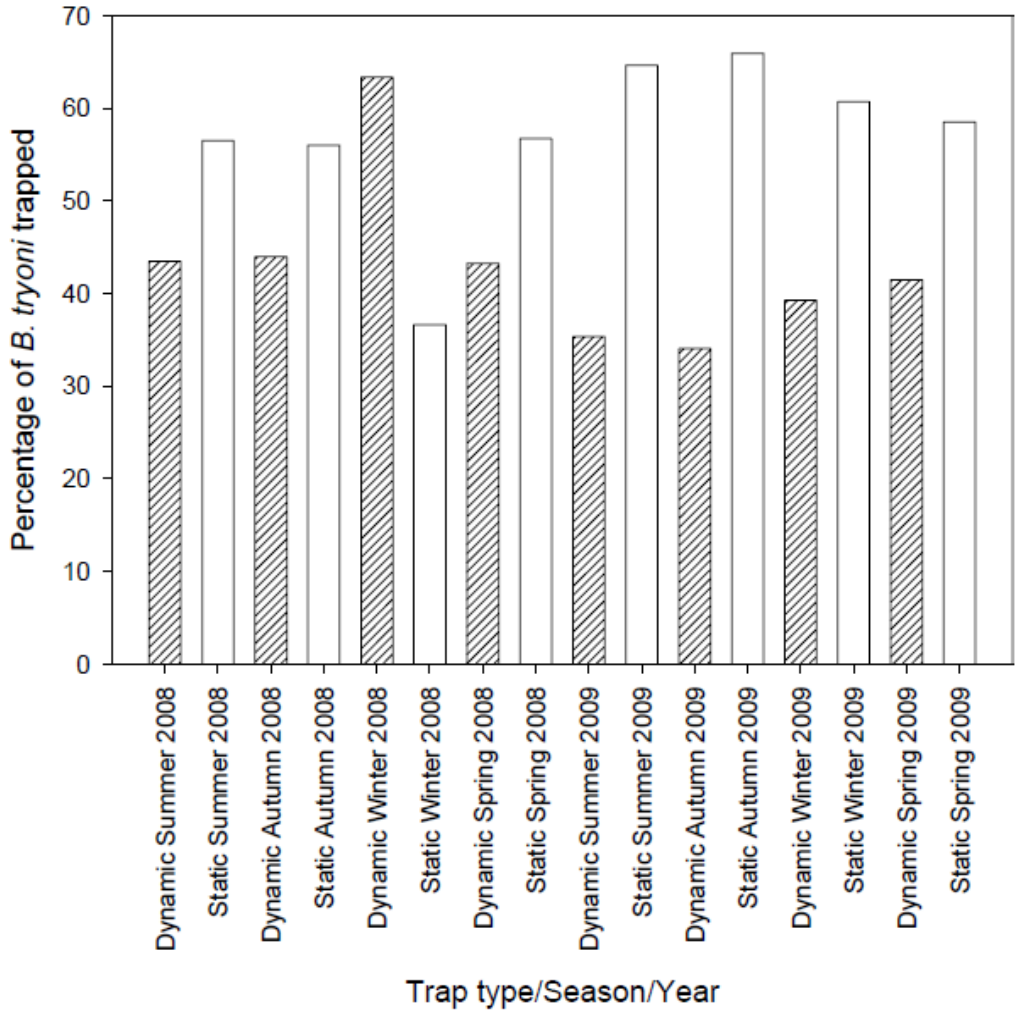


Figure 91. The proportion of the total number of *B. tryoni* trapped.

Weekly (ON) and fortnightly (OFF) trap checks

There was a significant effect of trap type ($F(1,130.0)=126.69$; $P<0.001$) with a higher percentage of *B. tryoni* caught in static (57.81%) compared with dynamic traps (42.19%). There was also a significant year x period x trap type interaction ($F(2,130.0)=13.42$, $P<0.001$; Table 41), with the 2008 and 2009 ON periods capturing higher numbers of flies in static traps than dynamic traps 56.30% vs. 43.70% (2008) and 64.81% vs. 35.19% (2009) and similarly in the 2009 OFF season static trap capturing more flies than dynamic traps (59.19% and 40.81% respectively).

Table 41. The proportion of *B. tryoni* caught in dynamic and static traps during weekly (ON) and fortnightly (OFF) trapping periods each year.

Frequency of trap monitoring	Static/dynamic	Logit	SE	Significance	Percentage of total *B. tryoni* trapped
ON (Jan-May) 2008	Dynamic	-0.2535	0.0435	ab	43.70
ON (Jan-May) 2008	Static	0.2535	0.0435	cde	56.30
OFF (June-October) 2008	Dynamic	-0.0244	0.1564	bc	49.39
OFF (June-October) 2008	Static	0.0244	0.1564	cd	50.61
ON (Nov) 2008 - (May) 2009	Dynamic	-0.6106	0.0976	a	35.19
ON (Nov) 2008 - (May) 2009	Static	0.6106	0.0976	e	64.81
OFF (June-October) 2009	Dynamic	-0.3718	0.1707	ab	40.81
OFF (June-October) 2009	Static	0.3718	0.1707	de	59.19

The proportion of the catch for a matched pair of traps

Calendar season

There was a significant year x season x trap type interaction ($F(4,1340.6)=11.18$, $P<0.001$; Table 42), with a significantly greater proportion of flies trapped in static traps as opposed to dynamic in Summer, Autumn, Winter, and Spring 2009 but in Winter 2008 there were a significantly greater proportion trapped in dynamic as opposed to static traps.

Table 42. The proportion of the total number of *B. tryoni* trapped.

Frequency of trap monitoring	Logit	SE	Significance	Percentage of *B. tryoni* trapped for matched trap pairs.
Dynamic Summer 2008	-0.0921	0.2548	abcd	47.77
Static Summer 2008	0.0921	0.2548	bcde	52.30
Dynamic Summer 2009	-0.7068	0.2884	ab	33.03
Static Summer 2009	0.7068	0.2884	de	66.97
Dynamic Autumn 2008	-0.1005	0.2579	abcd	47.49
Static Autumn 2008	0.1005	0.2579	bcde	52.51
Dynamic Autumn 2009	-0.8562	0.3584	a	29.81
Static Autumn 2009	0.8562	0.3584	e	70.19
Dynamic Winter 2008	0.7421	0.4575	de	67.74
Static Winter 2008	-0.7421	0.4575	ab	32.26
Dynamic Winter 2009	-0.8431	0.4704	a	30.09
Static Winter 2009	0.8431	0.4704	e	69.91
Dynamic Spring 2008	-0.2788	0.3489	abc	43.07
Static Spring 2008	0.2788	0.3489	cde	56.93
Dynamic Spring 2009	-0.637	0.3646	ab	34.59
Static Spring 2009	0.637	0.3646	de	65.41

ON/OFF period

There was s significant period x year x trap type interaction ($F(2,1343.1)=19.32$, $P<0.001$), with a greater percentage of flies trapped in static compared to dynamic traps for the ON season 2009 and OFF season 2009 (67% and 33% respectively for both seasons). There was no significant difference for the ON 2008 (52% and 48% respectively) or OFF 2008 (49% and 51% respectively) periods.

The number of flies present - data are transformed $log_e(count+1)$

ON/OFF period

There was a significant year x period interaction (F(2,80.3)=26.64, P<0.001; Table 43), with the 2008 ON period having significantly higher numbers of *B. tryoni* trapped than 2008/2009 ON, 2008 OFF or 2009 OFF.

Table 43. The number of *B. tryoni* caught each year per trapping period (weekly (ON) and fortnightly (OFF)).

Frequency of trap monitoring	Ln(count+1)	SE	Significance	Number of *B. tryoni* trapped
ON (Jan-May) 2008	2.0003	0.1596	a	6.391
OFF (June-October) 2008	0.6038	0.1778	b	0.829
ON (Nov) 2008 - (May) 2009	0.6214	0.1102	b	0.862
OFF (June-October) 2009	0.6824	0.1992	b	0.979

Effects of host tree on trapped B.tryoni

When we considered the effect of host with date (F(69,59)=16.26, P<0.001) fitted as a fixed effect, neither tree class nor tree stage were significant at 5%.

When host attributes (tree class, tree stage and tree type within tree class) are fitted as fixed effects but date as a random effect, there was a significant effect of tree class (F(7,29.5)=2.36, P=0.015) and tree stage (F(4,8.2)=6.14, P=0.048). Fig has a higher ln(count+1) than stone fruit, citrus or non hosts. It should be noted that Fig was only present in the data between 15/1/2008 and 29/4/2008 and is represented by either two or three trees during this time. The significance of tree stage was examined by predicting ln(count+1) for those dates in which a pair of tree stages were present, for example Immature fruit and Fruit are present for 12 dates while Immature Fruit and Leaf are present for 42 dates. When only the dates present were used there was no difference between tree stages.

Gundagai

A total of 4888 flies were recorded over the duration of the trial at Gundagai with fly density shown in Tables 31 and 32. There was a total of 29 collection dates over the duration of the trial (excluding weeks when traps where not checked for logistical reasons). During this time, flies were trapped at every trap check date.

The proportion of traps which had flies present (presence/absence analysis)

Calendar season

The only significant effect was season (F(3,23.2)=9.85, P<0.001) with Summer 2008 and Autumn 2008 had a higher percentage of traps with flies (86.56 and 89.33% respectively) than Spring 2008 (61.31%) which was in turn greater than Winter 2008 (27.84%).

Weekly (ON) and fortnightly (OFF) trap checks

Similarly to calendar season, the only significant effect was period (F(1,24.9)=24.78, P<0.001), with a greater percentage of traps capturing *B. tryoni* during the ON period (88.39%) compared with the OFF period (40.43%).

The proportion of the total B. tryoni trapped on a date

Calendar season

There was a significant effect of trap type (F(1,50.0)=20.30, P<0.001), with a greater percentage of total *B. tryoni* captured in static traps (56.20%) compared to dynamic traps (43.80 %).

Weekly (ON) and fortnightly (OFF) trap checks

There was a significant effect of trap type (F(1,52.0)=147.85, P<0.001), with a greater percentage of flies trapped in static (59.37%) as opposed to dynamic (40.63%) traps. There was also a significant period x trap type interaction (F(1,52.0)=24.09, P<0.001; Table 44). The main difference occurs during the OFF season, suggesting that during this colder period, *B. tryoni* may be selecting their overwintering

sites and fruiting trees may not necessarily be required to provide this. This is however not evident throughout all of the towns.

Table 44. The proportion of total *B. tryoni* trapped in dynamic and static traps during the ON (weekly trapping) and OFF (fortnightly trapping) periods.

Period	Trap type	Logit	SE	Significance	Percentage of total *B. tryoni* trapped (%)
ON	DY	-0.2143	0.2197	ab	44.66
ON	ST	0.2143	0.2197	bc	55.34
OFF	DY	-0.5441	0.2197	a	36.72
OFF	ST	0.5441	0.2197	c	63.28

The proportion of the catch for a matched pair of traps

Calendar season

There was a significant effect of trap type (F(1,27.4)=7.84,P=0.009), with a higher proportion of flies trapped in static traps (63.86%) compared with dynamic traps (36.16%). There was also a significant season x trap type interaction (F(6,699.6)=2.61, P=0.020), with no difference between trap types for summer but significant differences in autumn (dynamic traps 40.09%, static traps 59.91%), winter (dynamic traps 25.73%, static traps 74.27%) and Spring (dynamic traps 34.83%, static traps 65.17%).

Weekly (ON) and fortnightly (OFF) trap checks

There is a significant effect of trap type (F(1,27.5)=8.21, P=0.008), with a higher proportion of flies trapped in static traps (62.68%) compared with dynamic traps (37.32%). There was also a significant period x trap type interaction (F(2,707.6)=4.49, P=0.013), with differences between trap types greater in the OFF period (dynamic traps, DY 32.46% and static traps, 67.54 %) than in the ON period (dynamic traps, 42.45% and static traps, 57.55%).

The number of flies present - data are transformed $\log_e$(count+1)

Weekly (ON) and fortnightly (OFF) trap checks

There was a significant effect of period (F(1,28.5)=18.64, P<0.001), with 3.65 flies/trap caught each week during the ON period, while only 0.77 flies/trap were caught each fortnight during the OFF season.

Effects of host tree on trapped B.tryoni

When date (F(28.0,46.7)=13.25, P<0.001) was fitted as a fixed effect, there was no effect of host (tree class, tree type or tree stage; P>0.05).

There was no main effect of host tree when host attributes (tree class, tree stage and tree type within tree class) were fitted as fixed effects but there was a significant random effect of date (F(28.0, 46.7)=13.25 P<0.001). There was a significant effect of period x tree class when fitted as a fixed effect (F(4,151.4)=7.98, P<0.001), with stone fruit more attractive than citrus, non host and pome fruit during the OFF season but not during the ON season.

Ganmain

A total of 95 flies were recorded over the duration of the trial at Ganmain with fly density shown in Tables 31 and 32. There was a total of 69 collection dates over the duration of the trial (excluding weeks when traps where not checked for logistical reasons). During this time, there were 46 collection dates when zero flies were present.

There were no flies recorded in either winter 2009 or spring 2008 or 2009. Thus there were no flies recorded in the OFF season. Of the 95 flies trapped, 71 were recorded in autumn 2009. Of these 71 flies 54 were caught in DY traps and 17 in ST traps. Of the 54 caught in DY traps, one third was caught in a single trap. With these limitations in mind we examine the percentage of traps which had flies present.

The proportion of traps which had flies present (presence/absence analysis)

Calendar seasons (summer, autumn, winter, spring)

There was a significant effect of trap type ($F(1,54.9)=20.23$, $P<0.001$), with flies trapped in an average of 3.49% of dynamic traps and 1.35% of static traps. There was also a significant effect of season ($F(1,37.5)=11.31$, $P=0.002$) and a year x season interaction ($F(2,57.1)=13.68$, $P<0.001$). Autumn 2009 had a greater percentage of traps with flies (17.95%) compared to less than 3% of traps in summer 2008 (2.20%), summer 2009 (0.78%) and autumn 2008 (0.72%).

Weekly (ON) trap checks

There was a significant effect of trap type ($F(1,6.64)=44.6$, $P=0.013$), with the percentage of traps with flies in the 2009 ON period higher in dynamic traps (7.1%) compared to static traps (2.90%) and similarly in the 2008 ON period fly numbers were 1.87% (dynamic) and 0.74% (static) respectively. There was also a significant effect of period ($F(1,20.34)=52.4$, $P<0.001$), with a lower percentage of traps with flies during the 2008 ON period (1.19%) compared with the 2009 ON period (4.78%).

The proportion of the total B. tryoni trapped on a date

Calendar seasons

There was a significant effect of trap type ($F(1,38.0)=26.15$, $P<0.001$), with 76.84% of the total catch caught in dynamic traps compared to 23.16% caught in static traps.

The proportion of the catch for a matched pair of traps

Calendar season

If we consider the pairing of traps we have seven dates in summer 2008 when trap pair totals are not all zero, however of these seven dates, there are only three dates were more than one pair of traps have non zero totals (four dates where only one pair of traps have non zero totals). In this season only 17 flies in total were trapped. In autumn 2008 there are only three dates when trap pair totals are non zero and there is only ever one pair of traps at each time (three flies). Summer 2009 has only two dates with trap pairs having flies and one of these dates refers to only one trap pair, while the other has three trap pairs (four flies). Autumn 2009 (71 flies) has 11 dates with non zero trap pairs. Of these 11 dates, three dates have only one pair of traps with flies, the other dates have from two to eight trap pairs with flies.

When trap pair totals are considered for these seasons, there was a significant date x trap type interaction ($F(9,54.4)=5.99$, $P<0.001$), with dynamic trap 7 (Lemon tree) in summer 2008 capturing 66.7% of the total flies trapped in dynamic traps that season; while in autumn 2009, dynamic trap 4 (Navel orange) caught 33.3% of the total flies trapped in dynamic traps that season.

However, due to low numbers of paired traps recording fly capture on the same date, this data is unreliable.

Earliest trap catches

In summer 2008/09, the first fly detection was on the 8/12/08 with one fly in a dynamic trap (trap 7), then on the 15/12/08, one fly was trapped in a static trap (trap 9), then on the 22/12/08 one fly was trapped in each of two dynamic traps (traps 5 & 7).

In summer 2009/10, the first detection was on 9/2/2010 with one fly caught in a dynamic trap (trap 1), and one fly caught in each of two static traps (traps 2 & 5). Dynamic trap 5 also recorded a single fly on 23/2/2010.

Effects of host tree on trapped B. tryoni

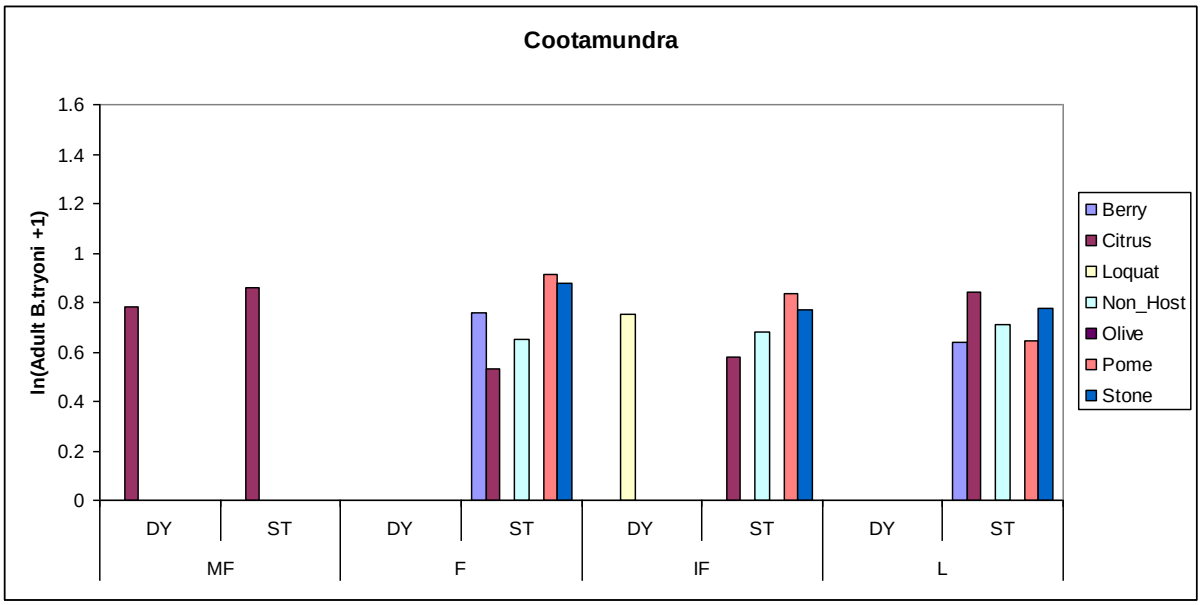
No statistical conclusions can be drawn about tree class, tree type or tree stage for Ganmain as the number of active traps was very low. In summer 2008 only four dynamic and two static traps caught any flies, in summer 09, two dynamic and two static traps caught flies, in autumn 2008, two dynamic and one static caught flies. In addition, during autumn 2009, ten dynamic and nine static traps were active with 54 flies caught in dynamic traps and 71 in static traps during this season. Dynamic trap number four located in a navel orange caught one-third of all flies caught in dynamic traps.

Urban Towns

Areas with >0 fly numbers, even in the OFF period (June – October) proves that an established population is present and that winter temperatures have a marginal effect on numbers. We wanted to determine if there were any 'winter hosts' that help perpetuate the adult *B. tryoni* population and if so, whether they could be used as sentinels in area-free zones. We were unable to show this.

During the OFF period, there was a significant effect of site ($2\Delta logl=26.884$ $P<0.001$), site x year x tree stage ($2\Delta logl=10.364$ $P=0.001$), trap type x tree class x tree stage ($2\Delta logl=26.462$ $P<0.001$; Figure 92) and a site x trap type x tree class interaction ($2\Delta logl=19.024$ $P<0.001$, Figure 93).

Averaged across all the towns, there were higher catches in static traps for mature fruit in citrus but lower catches in static traps for immature fruit in citrus (Figure 92 shows each town individually). However, no differences were shown for dynamic traps.



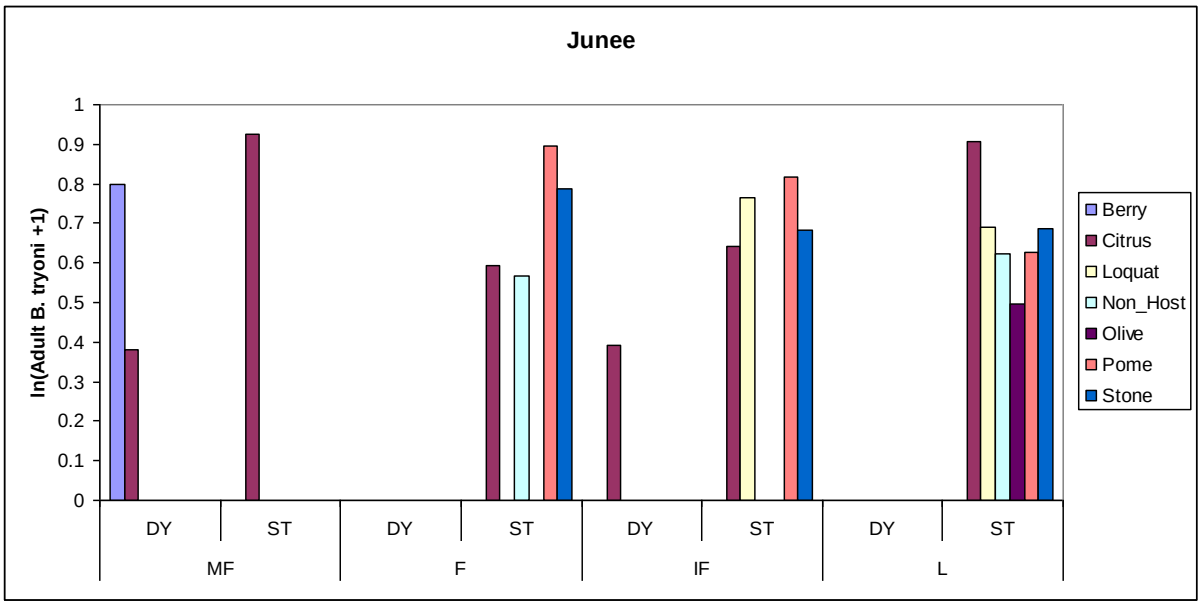


Figure 92. The number of adult *B. tryoni* trapped (ln(fly count + 1)) during the OFF period (June-October) in static (ST) and dynamic (DY) traps for the tree stages, mature fruit (MF), immature fruit (IF), flowering & leaves (F) and leaves only (L) for each urban town for the duration of the trial.

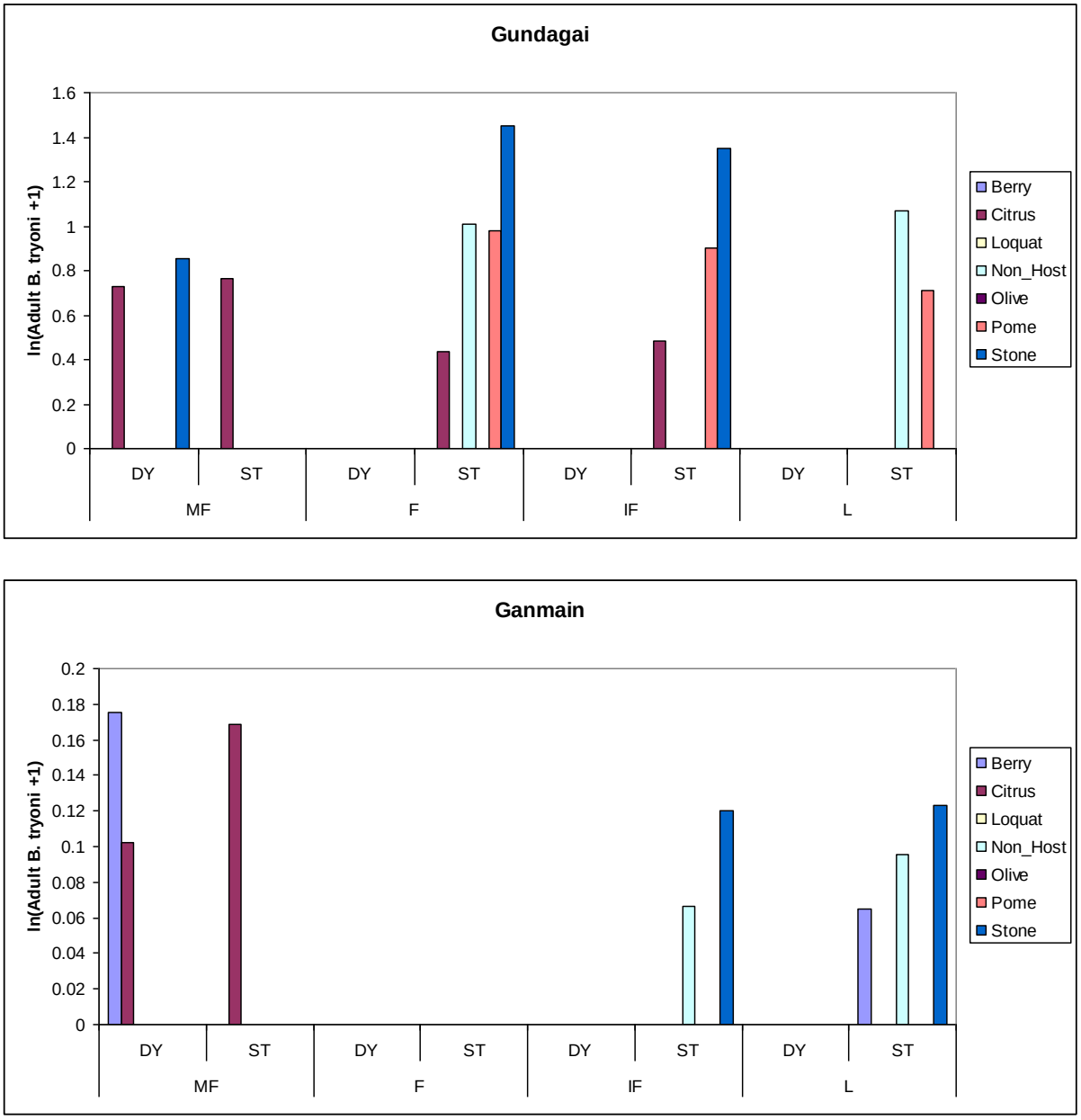
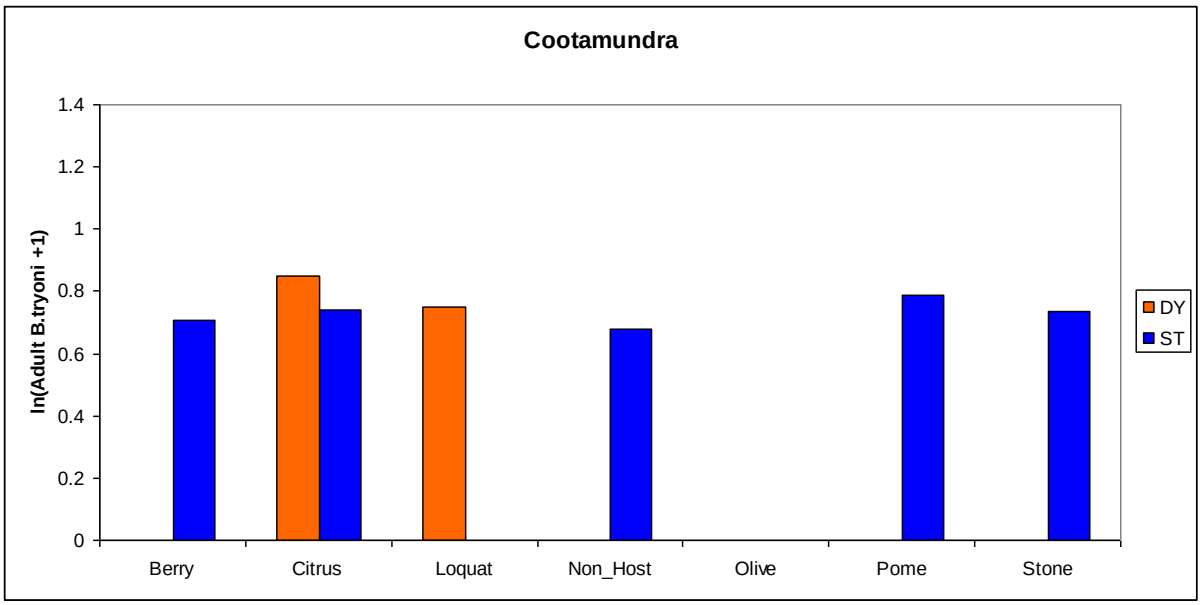
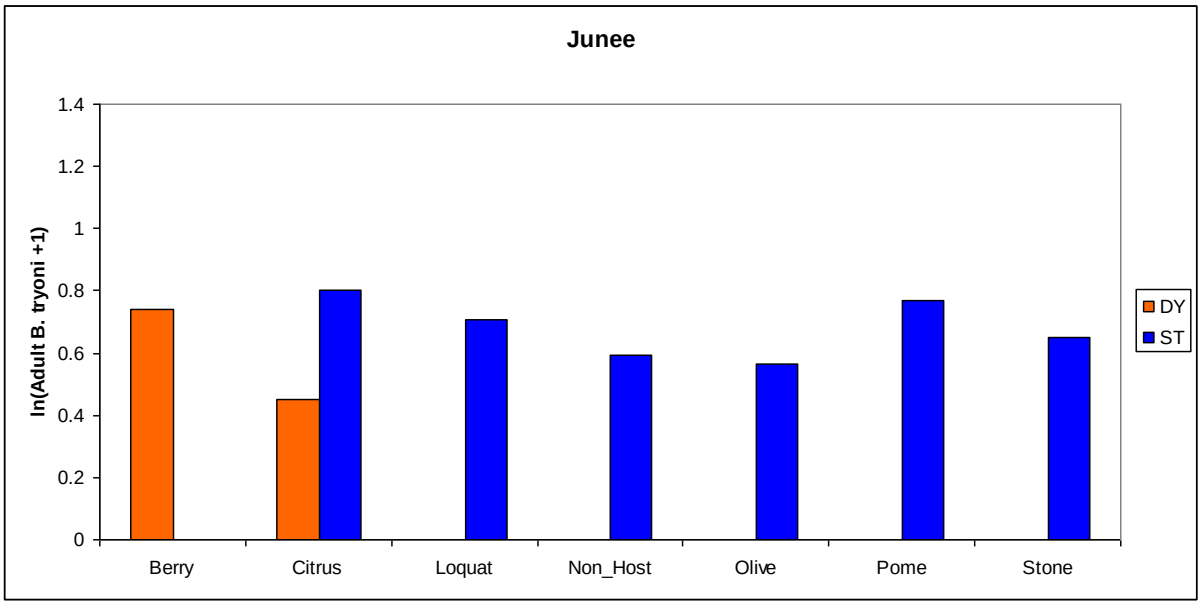


Figure 92 continued. The number of adult *B. tryoni* trapped (ln(fly count + 1)) during the OFF period (June-October) in static (ST) and dynamic (DY) traps for the tree stages, mature fruit (MF), immature fruit (IF), flowering & leaves (F) and leaves only (L) for each urban town for the duration of the trial.

Figure 93 indicates that at Gundagai catches for stone fruit were higher in static traps, than all other trap type/tree class combinations. No sentinel treeclass or treetype was able to be detected.

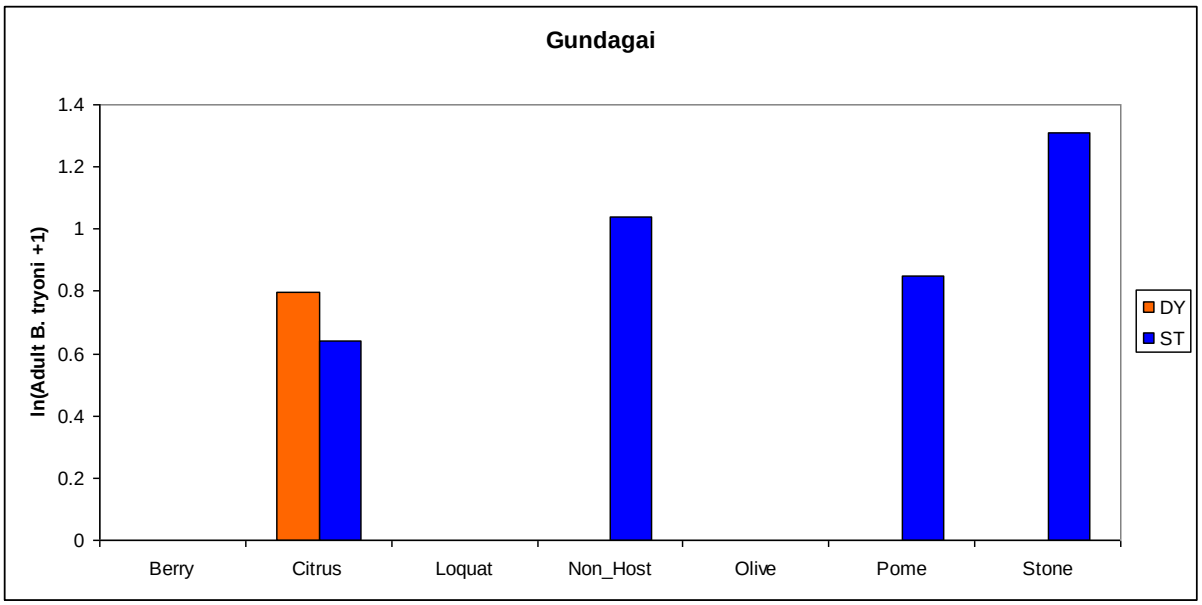


SE = 0.205336

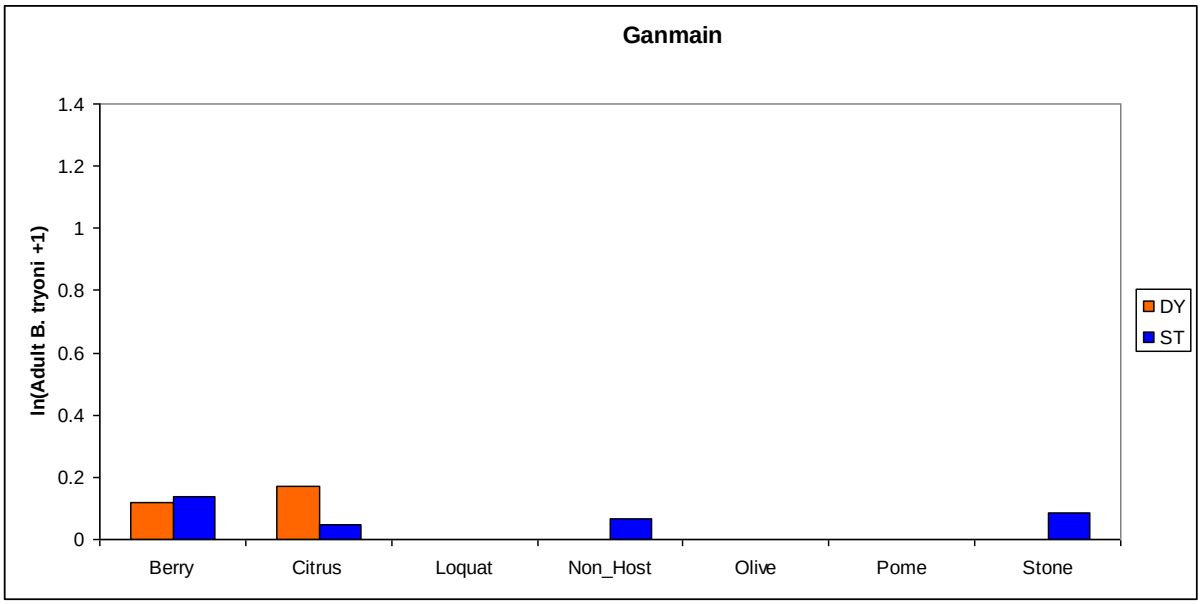


SE = 0.198743

Figure 93. The number of adult *B. tryoni* trapped (ln(fly count + 1)) during the OFF period (June-October) in static (ST) and dynamic (DY) traps for each of the tree classes in each urban town for the duration of the trial.



SE = 0.235529



SE = 0.246379

Figure 93 continued. The number of adult *B. tryoni* trapped (ln(fly count + 1)) during the OFF period (June-October) in static (ST) and dynamic (DY) traps for each of the tree classes in each urban town for the duration of the trial.

Tumut Orchard

A total of two flies were recorded over the duration of the trial at Tumut orchard with fly density shown in Tables 31 and 32. There was a total of 13 collection dates over the duration of the trial (excluding weeks when traps where not checked for logistical reasons), with only two weeks recording trap captures (Table 45). With only two flies in total caught over the whole trial there was insufficient data to analyse.

Table 45. The capture of *B. tryoni* in cue-lure baited traps in an abandoned orchard near Tumut, NSW.

Season	Date	Dy 1	Dy 2	St 1	St 2	St 3	St 4
Spring	5/11/09	0	0	0	0	0	0
Spring	12/11/09	0	0	0	0	0	0
Spring	18/11/09	0	0	0	0	0	0
Spring	25/11/09	0	0	0	0	0	0
Summer	2/12/09	0	0	0	0	0	0
Summer	9/12/09	0	0	0	0	0	0
Summer	16/12/09	0	0	0	0	0	0
Summer	23/12/09	0	0	0	0	0	0
Summer	11/1/10	0	Fallen trap	0	0	0	0
Summer	19/1/10	0	0	0	0	0	0
Summer	27/1/10	0	0	0	0	0	0
Summer	4/2/10	*1	0	0	0	0	0
Summer	10/2/10	0	* 1	0	0	0	0
Total		1	1	0	0	0	

*Peach (mature fruit)
Where Dy = Dynamic trap and St = Static trap.

Climatic Data

Throughout the trial, minimum temperatures were frequently below 0°C (Appendix 1) during the colder periods. Notably average temperatures were frequently below the *B. tryoni* flight threshold of 16°C (Meats and Fay 2000) during the OFF periods (Appendix 1). However, adult *B. tryoni* were trapped in most towns, with the exception of Ganmain, for the entire year with only a few exceptions (see Results above). It appears that, although there are reduced fly numbers trapped during colder periods, the flies are able to still respond to traps, albeit in low numbers during this time.

SUMMARY

Cootamundra, Junee and Gundagai all had relatively high fly densities (5.3, 4.9, 4.2 respectively) averaged across both trap types, throughout the duration of the trial. However, there was not a consistent trend among these towns in terms of fly recapture in both static and dynamic traps.

Cootamundra

In general, Cootamundra caught significantly more flies in dynamic as opposed to static traps.

When a fly was trapped in a calendar season, significantly more dynamic traps captured flies, than static traps. When a fly was trapped in an ON/OFF period, there was significantly less static traps that caught flies compared to dynamic traps during the OFF season than in the ON period. This suggests that dynamic traps were more effective at trapping flies in the OFF season, or cooler times of the year (June – October), than static traps.

The proportion of flies trapped at any given trap check date during a calendar season were higher in dynamic traps than static traps (in any winter there was no difference, nor in autumn 2009), although this was only significant for summer 2008 and autumn 2008. So, although more dynamic traps captured flies than static traps, effectively similar numbers of flies were trapped in both trap types, except in summer 2008 and autumn 2008 when dynamic traps captured significantly more flies. The proportion of flies trapped at any given trap check date during the ON/OFF periods were also higher in dynamic traps than static traps, although not significant for ON 2008-2009 and ON 2009-2010. Once again this suggests that during the cooler months, dynamic traps are trapping more flies than static traps.

When a direct comparison was made of one dynamic trap with one static trap (i.e. paired traps), the proportion of flies trapped at any given trap check date during a calendar season, there was a higher proportion of flies trapped in dynamic compared with static traps (significant for summer, autumn and spring 2008 and spring 2009); summer 2009 & 2010 and autumn 2010 displayed the opposite trend although they did not differ significantly.

When we consider actual numbers of flies (preceding considered proportions) during the ON/OFF period, there were a larger number of flies trapped in dynamic traps as opposed to static traps, although this was only significant for the ON/OFF 2009 period.

There were no notable effects of host tree on *B. tryoni* trapped.

Junee

In general, Junee caught significantly more flies in static as opposed to dynamic traps.

When a fly was trapped in a calendar season, there was no overall effect of trap type within a season. Similarly, when a fly was trapped in an ON/OFF period there were no trap type effects.

The proportion of flies trapped at any given trap check date during a calendar season were higher in static traps than dynamic traps, although this was only significant for all the calendar seasons in 2009. The one exception was winter 2008, when a significantly higher proportion of flies were trapped in dynamic as opposed to static traps.

Similarly, when a direct comparison was made of one dynamic trap with one static trap (i.e. paired traps) during a calendar season, there were a greater proportion of flies trapped in static traps as opposed to dynamic traps. The only exception, was winter 2008 when there was a greater proportion trapped in dynamic traps. When a paired trap analyses was made, the proportion of flies trapped during the ON/OFF periods were higher in static traps compared with dynamic traps during the ON and OFF periods, but only for 2009, not 2008.

When we consider actual numbers of flies (preceding considered proportions) during the ON/OFF period, there were no trap type effects.

In Junee, traps placed in fig trees trapped more flies than those traps placed in stone fruit, citrus or non-hosts, although fig was only used as a trap tree from 15 January 2008 until 29 April 2008.

Gundagai

In general, Gundagai caught significantly more flies in static as opposed to dynamic traps.

When a fly was trapped in a calendar season, there was no overall effect of trap type within a season. Similarly, when a fly was trapped in an ON/OFF period there were no trap type effects.

The proportion of flies trapped at any given trap check date during a calendar season were significantly higher in static traps than dynamic traps. The proportion of flies trapped at any given trap check date during the ON/OFF periods were also higher in static traps than dynamic traps for ON and OFF periods. This suggests that during the colder (OFF period), *B. tryoni* are overwintering (or selecting their overwintering sites) and fruiting trees may not be preferred at this time (however, see effect of host tree below).

When a direct comparison was made of one dynamic trap with one static trap (i.e. paired traps) during a calendar season, there was a significantly greater proportion of flies trapped in static traps as opposed to dynamic traps in all calendar seasons, except summer. When a paired trap analyses was made, the proportion of flies trapped during the ON/OFF periods were higher in static traps compared with dynamic traps, but this difference was greater during the OFF period than the ON period.

When we consider actual numbers of flies (preceding considered proportions) during the ON/OFF period, there were no trap type effects.

In Gundagai, traps placed in stone fruit were more attractive than citrus, pome and non-host trees, but only during the OFF season, not the ON season. It is generally perceived that stone fruit is more attractive than the other three tree classes mentioned, however why this would only be significant during the OFF season is difficult to explain.

Ganmain

Ganmain, had a relatively low trap catch density (0.05) (averaged over the duration of the trial and both trap types). It could therefore be argued that this is more conducive to that which we might see in an outbreak situation in the FFEZ. In general, Ganmain caught significantly more flies in dynamic as opposed to static traps.

During the calendar seasons, the proportion of traps which had flies present were significantly higher for dynamic than static traps. Similarly, during the ON period (as no flies were trapped during OFF periods), significantly more flies were trapped in dynamic as opposed to static traps during both 2008 ON and 2009 ON periods.

The proportion of flies trapped at any given trap check date during a calendar season were significantly higher in dynamic traps than static traps.

There is no evidence that flies are trapped earlier in the season in dynamic traps compared to static traps.

All Urban Towns

Areas with >0 fly numbers, even in the OFF period (June – October) proves that an established population is present and that winter temperatures have a marginal effect on numbers. However, from our results we were unable to determine if there were any 'winter hosts' that would assist in perpetuating the adult *B. tryoni* population.

During the OFF period, there was a significant effect of site ($2\Delta\text{logl}=26.884$ $P<0.001$), site x year x tree stage ($2\Delta\text{logl}=10.364$ $P=0.001$), trap type x tree class x tree stage ($2\Delta\text{logl}=26.462$ $P<0.001$; Figure 92) and a site x trap type x tree class interaction ($2\Delta\text{logl}=19.024$ $P<0.001$, Figure 93).

Tumut Orchard

The orchard scenario (Tumut) involved a short period of trapping in an abandoned orchard where fruiting trees where in limited supply. This is not indicative of a typical commercial orchard, however the only two flies that were trapped were caught in dynamic traps in fruiting trees.

Climatic Data

Throughout the trial, minimum temperatures were frequently below 0°C, however, adult *B. tryoni* were trapped in most towns, with the exception of Ganmain, for the entire year with only a few exceptions (see Results above). Although there are reduced fly numbers trapped during colder periods, the flies are able to still respond to traps, albeit in low numbers during this time.

CONCLUSIONS

In temperate parts of its range, *B. tryoni* populations show distinct seasonal peaks driven by changing seasonal climates (Fletcher 1975, 1979), especially temperature, rainfall and environmental moisture (Dominiak *et al*. 2003; Fletcher 1975, 1979). However, increasingly, we are seeing flies moving throughout the entire season (results of this study).

If we first consider the three towns which have a similar *B. tryoni* population density, while Cootamundra caught significantly more flies in dynamic as opposed to static taps, both Junee and Gundagai showed the reverse trend, although this was only significant for Junee. Therefore, it seems likely that there are factors other than those we have considered in this study influencing trap catches. Certainly, there are a number of ecological factors to consider, in terms of fly response to traps, which largely remain unknown, including flight distance and trap efficiency (including factors which may influence this including temperature, humidity, local fly density etc). The issue of tree descriptor also greatly complicates the analyses and we need to clarify host preference in terms of adult male fly attractancy. Data mining might be able to assist here.

If we consider Ganmain, an urban centre with low fly density, dynamic traps were more effective in both the proportion of traps which captured flies and the overall proportion of flies trapped, than static traps. Although, early season detections occurred in dynamic traps in both years, in 2009 static traps also trapped the first flies.

Little can be drawn from the Tumut orchard due to the very low number of flies trapped and the limited time in which this trial ran.

Ultimately, we need to consider management questions of whether maintaining traps in fruiting trees year round is practical despite the possibility that a reduction in trap number may be required and whether this outweighs any additional costs associated with the maintenance of the traps.

RECOMMENDATIONS

- To trial the use of dynamic traps in the Fruit Fly Exclusion Zone (FFEZ), in urban centres where fly numbers are low in the event of an outbreak. There are obvious difficulties
- in doing this, and these need to be overcome, including the current Code of Practice, AQIS auditing requirements and implications for trade.
- To assess the cost effectiveness of maintaining traps in fruiting trees with a reduction in number of traps, compared with the current static grid.

APPENDICES

Appendix 1

The maximum temperature data for the trapping regions for the duration of the trial.

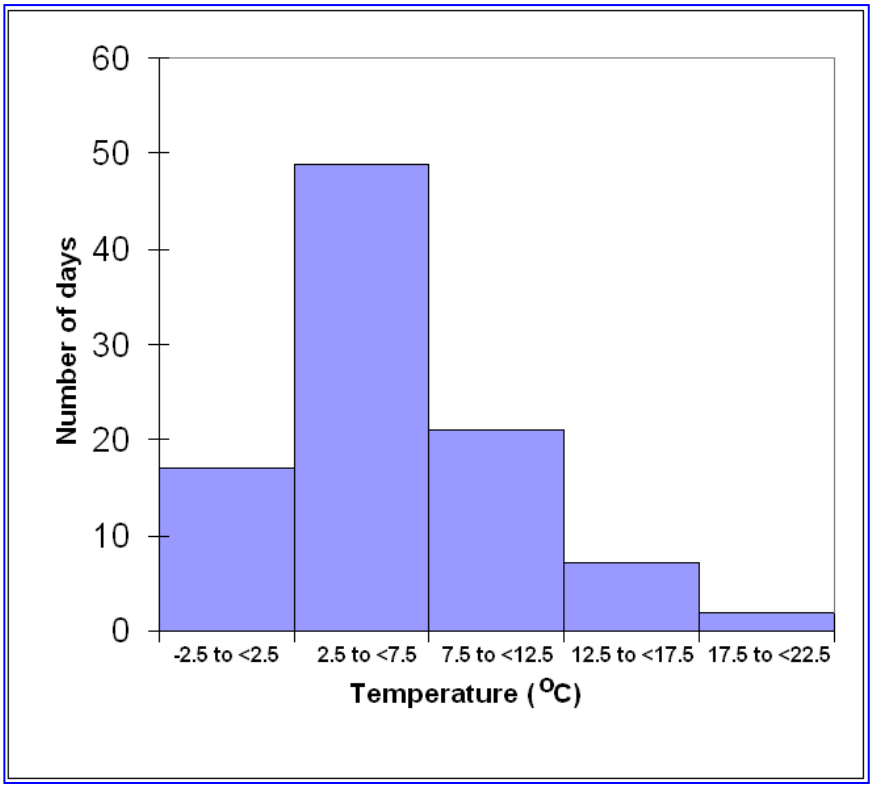
Period	ON/OFF dates		Temperature °C
ON	1/11/08-31/5/09	Average of max	27.2
		Max of max	43.2
		Min of max	11.7
	1/11/09-21/5/10	Average of max	28.4
		Max of max	41.9
		Min of max	13.9
OFF	28/7/08-31/10/08	Average of max	18.9
		Max of max	33.5
		Min of max	4.8
	1/6/09-31/10/09	Average of max	16.8
		Max of max	34
		Min of max	7.2

The minimum temperature data for the trapping regions for the duration of the trial.

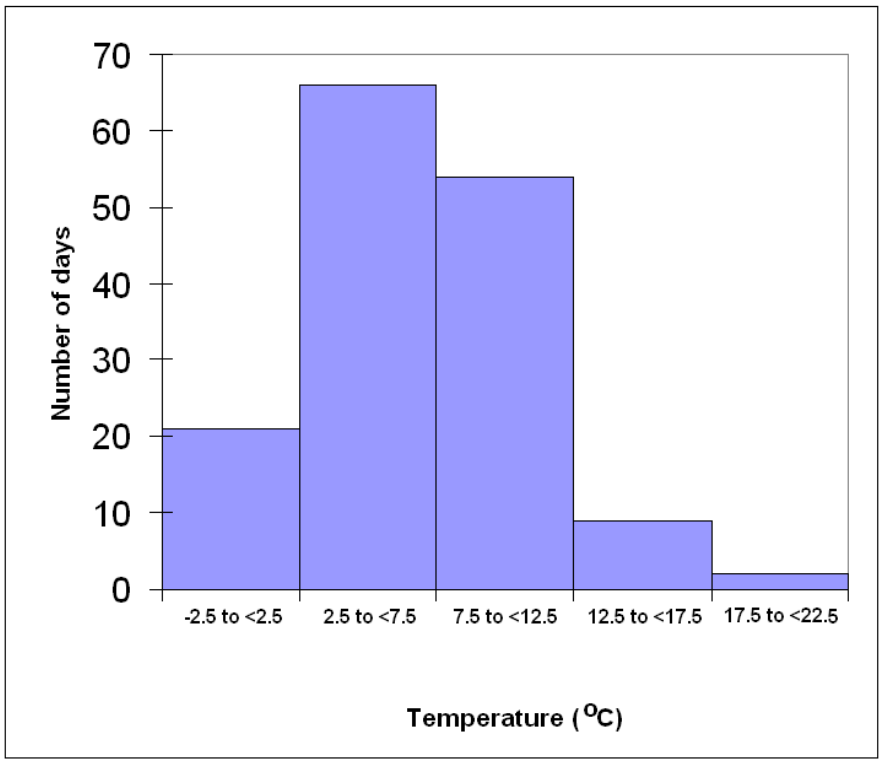
Period	ON/OFF dates		Temperature °C
ON	1/11/08-31/5/09	Average of min	12.3
		Max of min	28.3
		Min of min	1.8
	1/11/09-21/5/10	Average of min	13.5
		Max of min	24.8
		Min of min	0.2
OFF	28/7/08-31/10/08	Average of min	3.9
		Max of min	17.9
		Min of min	-3.2
	1/6/09-31/10/09	Average of min	4.6
		Max of min	17.3
		Min of min	-2.4

Appendix 1 continued.

A histogram of the temperature during the OFF period (June-October) for 2008.



A histogram of the temperature during the OFF period (June-October) for 2009.



3. (c) Key findings. Part Three: SA

INTRODUCTION

South Australia is a recognized fruit fly free area by some export markets (eg, USA http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/DesignatedPestFreeAreas.pdf). Area freedom is demonstrated by the absence of flies in the Cue-lure and Capilure trapping grid deployed in backyards on a 400m spacing throughout the capital city of Adelaide (>3000 trap locations) and in various other smaller cities in the state. Historically, the detection of a single fruit fly (Queensland fruit fly *Bactrocera tryoni* or Mediterranean fruit fly *Ceratitis capitata*) triggered the installation of further traps in the area around the detection and a search of fruit in local backyards for any evidence of larval infestations (hygiene). If larvae were detected, more male flies (4 for *B. tryoni*, or 2 for *C. capitata*) or a (gravid, mated) female fly were trapped nearby within two weeks, an outbreak was declared and eradication operations commenced.

The trapping grid in South Australia is maintained according to the Code of Practice for Management of Queensland Fruit Fly. The location of traps is guided by section 2.5 of the Code:
2.5 Location of traps
To optimise catch, traps should be hung, wherever possible, in host trees that are bearing fruit, and moved to other fruiting host trees when the crop falls or is harvested. If fruiting trees are not available, large broadleaved trees are to be preferred.

This study was part of a much broader project which involved experimental trials in fruit fly endemic areas of New South Wales (Queensland fruit fly) and Western Australia (Mediterranean fruit fly), looking at the relative efficacy of traps installed in fruiting hosts and non-fruiting host trees. The aim of the overall project was to determine whether the trap location directive in the Code of Practice, relating to moving traps into fruiting host trees as the crop falls or is harvested, would be supported by evidence from trapping trials. Supplementary work from data-mining was to further investigate the relationships between fruiting hosts and fruit fly detections. As a data-mining project, this study could not be used to experimentally compare trapping efficiency in host-bearing and non host-bearing trees, as, according to the Code, traps were not located in non host-bearing trees unless there were no host-bearing trees available. In addition, the detection of flies in the trapping grid would be significantly influenced by the nature (location and size) of each individual introduction, rather than representing a capture within a widely distributed population as is the case in endemic areas. However, this study fits within the broader objectives of the examining the relationship between fruiting trees and fruit fly captures, specifically whether the captures represent only detections, or whether they became part of an outbreak.

The aim of this project was to compare the characteristics of areas where detections resulted in the declaration of an outbreak with those where detections progressed no further. Information from Geographic Information Systems of the areas around the detection was included in the analysis, along with information collected about fruit trees in the areas.

MATERIALS AND METHODS

In South Australia, Mediterranean fruit fly are more often detected as larvae than as flies in traps, therefore the information required for this mining project was more limited for this species. Queensland fruit fly detections were more numerous. It was not possible to use the data from all of the detections as the information available was variable in quality and completeness. Hand-written hygiene notes (presence of fruit and fruiting trees in each property in a radius of 200m around the detection) were digitised for twenty-five sites, then examined for suitability for further analysis. A sub-set of 10 detections, five that were part of an outbreak and five that were non-outbreak areas, were sent to PIRSA's SIS unit for matching with spatial data. The data were then examined statistically to determine whether there were any factors common to outbreak situations.

Annual summary reports (Season Indexes) produced by Primary Industries and Resources South Australia (PIRSA), Plant Health Operations (PHO) were examined with data available from the 2001/2002 season. The summaries provided information on the number and location of Queensland fruit fly

detections for each year. A list of detections which were either single detections or were part of an outbreak was developed.

The relevant hygiene data regarding the presence of fruiting hosts within a 400m radius of a Queensland fruit fly detection was located within the hardcopy archives. These data packages consisted of a coversheet showing a map of the detection area superimposed with a circle showing the 200m radius, and a list of locations where additional traps were installed. The coversheet was followed by a group of hand-written datasheets which had been created by teams of hygiene staff. Hygiene staff attempted to visit every property in the detection area and listed fruit trees present in each back yard. A small proportion of properties were inaccessible to hygiene teams resulting in some data gaps. In some years more than others, hygiene data also included the presence or absence of fruit on trees and a qualitative assessment of their level of ripeness. Data from detections at twenty-five locations were keyed into excel spreadsheets to capture the type and number of fruit trees on each property and, where possible, the fruiting condition status of trees present (0 = no fruit, 1 = green, 2 = semi-ripe, 3= ripe, 4 = fruit present). These were examined and a subset of ten sites was selected on the basis of completeness of information available for further analysis using Geographic Information Systems (GIS) data relating to the topography of the areas (Appendix 1). In the final analysis, the fruiting condition data were too inconsistent to use, so trees were classified as fruit trees (all fruit trees including those that were not fruiting) and fruiting trees (those where fruiting condition was between 1 – 4).

GIS Methodology

The subset of detections (Table 46) subjected to further analysis using GIS sought to determine whether certain topographical features within 200 metres of the detection property contributed to the spread of the Queensland fruit fly. Using GIS tools the following were investigated for each detection:

- Surface Areas
- Land Use proportion
- Fruit tree densities

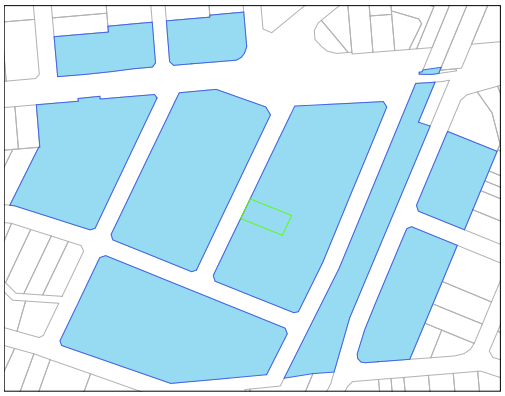
Table 46: Detection properties analysed.

DETECTION SUBURB	OUTBREAK TYPE
Clapham	Non-Outbreak
Colonel Light Gardens	Outbreak
Daw Park	Outbreak
Hazelwood Park	Non-Outbreak
Kensington Park	Non-Outbreak
Magill	Outbreak
Melrose Park	Outbreak
Pooraka	Non-Outbreak
Thebarton	Outbreak
Tusmore	Non-Outbreak

Surface Areas

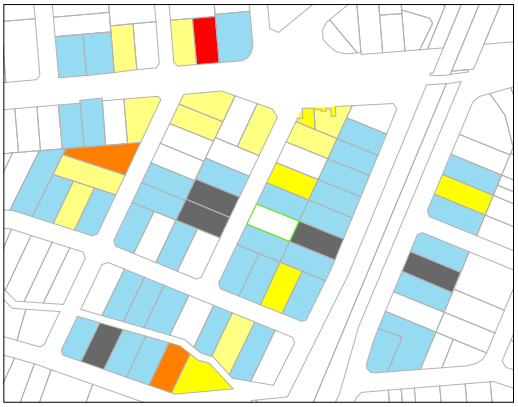
Surface areas were captured based on aerial imagery. Areas captured were tagged hard surface (e.g. roads, roofing, etc), vegetation (i.e. grass and trees) or water and the proportion calculated for each detection. Imagery supplied by DEH

Land use



Land use is a subset of the South Australian Government's land valuation data layer. Each land parcel within 200 metres of the detection property was categorised as residential or non-residential based on the attribute 'LAND_USE_CODE'. The following query was applied to select residential parcels: LAND_USE_CODE > 1000 AND LAND_USE_CODE < 1500 The number of residential properties in an area, the total area of all the land parcels (Ha) and percentage of residential properties was calculated.
Source: DTEI LSG

Fruit Tree Densities



Fruit tree data collected for properties within 200m of the detection property was joined to the State Government's land valuation data layer with the following attributes calculated:

- Number of fruit trees in area
- Number and percentage properties with fruit trees
- Average number of fruit trees / property with fruit trees.
- Number of fruiting trees in area
- Number and percentage properties with fruiting trees
- Average number of fruiting trees / property with fruit trees
- Number of properties with no access.
- Straight line distance of property from detection property

Source: DTEI LSG
See Appendix 2 for details of the above parameter calculations.

RESULTS

GIS Analysis

The topography of land parcels within 200 metres of ten fruit fly detection areas were analysed to determine whether landscape characteristics were associated with detections being an 'Outbreak' (Table 46).

Surface area analysis

Surface analysis data are presented in Table 47. There was a significant difference in the size of the survey areas examine for Outbreak vs Non-outbreak areas (T-Test PASW (equal variances confirmed by Levene's test of equality of variances F=0.298, p=0.600); t=-3.522, df = 8, sig (2-tailed) = 0.008). This, however, is an artefact of the data that were available to examine. The outbreak data tended to be more complete and extend to or beyond the edges of the 200m circle, whereas data for non-outbreak detections tended to be less extensive. The percent of the survey area which was identified as Hard Surface was the same across the categories of Outbreak and Non-outbreak (Independent Samples Mann-Whitney U Test, sig = 0.175, PASW). The results were essentially the same for the percent of the survey area which was vegetated as these were mirrors of each other.

Table 47: Surface data showing total survey area, hard surface area, vegetated area and areas of water for each Non-outbreak and Outbreak detection area.

	OUTBREAK TYPE	Survey Area (Ha)	Hard Surface Area (Ha)	Vegetated Area (Ha)	Water Area (Ha)
CLAPHAM	Non-Outbreak	9.66	5.04 (52.16%)	4.62 (47.84%)	0 (0%)
HAZELWOOD PARK	Non-Outbreak	11.76	6.29 (53.4%)	5.48 (46.6%)	0 (0%)
KENSINGTON PARK	Non-Outbreak	13.81	6.89 (49.86%)	6.93 (50.14%)	0 (0%)
POORAKA	Non-Outbreak	10.74	6.19 (57.64%)	4.55 (42.36%)	0 (0%)
TUSMORE	Non-Outbreak	11.45	5.02 (43.8%)	6.44 (56.2%)	0 (0%)
AVERAGE NON-OUTBREAK		11.48	5.89 (51.37%)	5.60 (48.63%)	0 (0%)
COLONEL LIGHT GARDENS	Outbreak	13.36	7.42 (55.5%)	5.94 (44.5%)	0 (0%)
DAW PARK	Outbreak	15.18	8.73 (57.55%)	6.44 (42.45%)	0 (0%)
MAGILL	Outbreak	14.75	7.04 (47.73%)	7.71 (52.27%)	0 (0%)
MELROSE PARK	Outbreak	13.25	7.8 (58.82%)	5.45 (41.18%)	0 (0%)
THEBARTON	Outbreak	14.93	9.65 (64.64%)	5.28 (35.36%)	0 (0%)
AVERAGE OUTBREAK		14.29	8.13 (56.85%)	6.16 (43.15%)	0 (0%)
AVERAGE ALL		12.89	7.01 (54.11%)	5.88 (45.89%)	0 (0%)

Land use analysis

The proportion of the surveyed area that was designated "residential allotment" was the same across the categories of Non-outbreak (83.92%) and Outbreak area (88.52%) (Independent Samples Mann Whitney U test, sig = 0.754, PASW) (Table 48).

Table 48: Land use data, including number of properties in the survey area, the area (Ha) which were allotments, the number of residential properties and the area (Ha) and percent of total survey area (%) which was designated residential.

	OUTBREAK TYPE	Number of Properties	Area - Allotments (Ha)	Number of Residential Properties	Area - Residential Allotments (Ha)
CLAPHAM	Non-Outbreak	81	6.96	77	6.09 (87.35%)
HAZELWOOD PARK	Non-Outbreak	108	9.53	106	9.07 (95.21%)
KENSINGTON PARK	Non-Outbreak	76	11.54	54	5.13 (44.47%)
POORAKA	Non-Outbreak	115	8.41	107	7.78 (92.57%)
TUSMORE	Non-Outbreak	102	8.87	102	8.87 (100%)
AVERAGE NON-OUTBREAK		96.4	9.06	89.2	7.39 (83.92%)
COLONEL LIGHT GARDENS	Outbreak	143	10.74	136	9.87 (91.91%)
DAW PARK	Outbreak	149	12.71	143	12.28 (96.61%)
MAGILL	Outbreak	144	11.31	138	10.38 (91.8%)
MELROSE PARK	Outbreak	131	11.62	116	8.63 (74.26%)
THEBARTON	Outbreak	137	9.06	128	7.97 (88.02%)
AVERAGE OUTBREAK		140.8	11.09	132.2	9.83 (88.52%)
AVERAGE ALL		118.6	10.08	110.7	8.61 (86.22%)

Fruit tree density analysis

General tree density patterns.

Combining the data from all sites, the proportion of properties with a range of fruit and fruiting tree densities is illustrated in Figure 94. Under both Outbreak and Non-outbreak conditions, the majority of properties held no fruit (Figure 94a) or fruiting (Figure 94b) trees. Overall, the results for fruit tree density (Figure 94a) in Outbreak and Non-outbreak areas were very similar within each tree density category, except that Outbreak areas tended to have slightly more properties with the lower fruit tree densities, and Non-outbreak areas tended to have more properties with higher fruit tree densities. In spatial terms, this suggests that fruit tree distribution was more homogeneous in Outbreak areas than it was in Non – outbreak areas. The data for fruiting trees (Figure 94b) were similar.

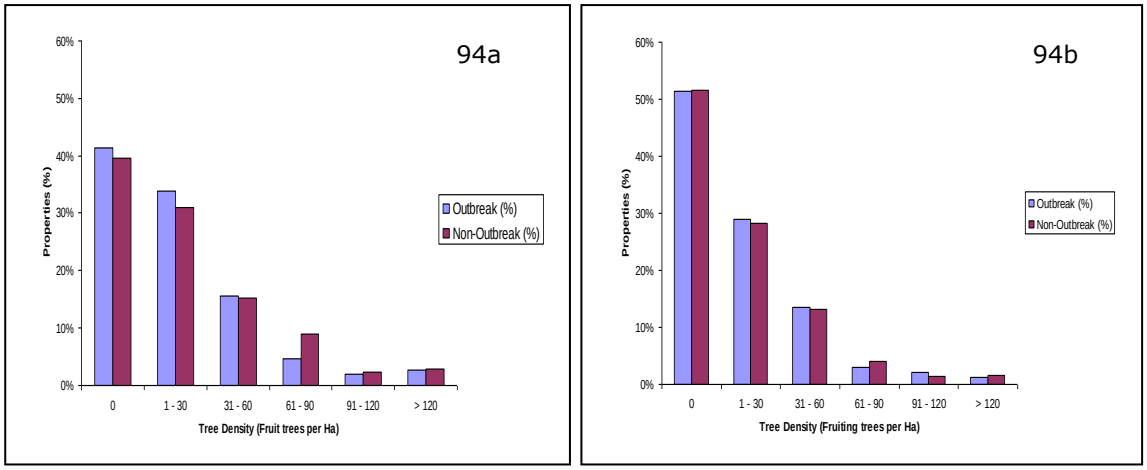


Figure 94: Fruit Tree (94a) and Fruiting Tree (94b) densities: Percentage of properties for Outbreak and Non-Outbreak detections based on tree density per hectare (Ha).

Density in trees per property

Fruit tree density data in terms of fruit and fruiting trees per property are presented in Table 49. There was no significant difference in the distribution of percent properties with fruit trees (p=0.251) or fruiting trees (p=0.465) across the categories of Non-outbreak or Outbreak area (Independent Samples, Mann Whitney U test, PASW). There was also no significant difference in the average number of fruit trees per property (T-Test PASW (equal variances confirmed by Levene's test of equality of variances F=2.881, p=0.128); t=2.020, df = 8, sig (2-tailed) = 0.078) and the average number of fruiting trees per property (T-Test PASW (equal variances confirmed by Levene's test of equality of variances F=3.060, p=0.118); t=1.542, df = 8, sig (2-tailed) = 0.162).

Table 49: Fruit and fruiting tree per property for Outbreak and Non-outbreak areas.

	OUTBREAK TYPE	Properties with Fruit Trees	Average Fruit Trees per Property	Properties with Fruiting Trees	Average Fruiting Trees per Property
CLAPHAM	Non-Outbreak	43 (53.09%)	3.37	34 (41.98%)	2.65
HAZELWOOD PARK	Non-Outbreak	65 (60.19%)	3.23	60 (55.56%)	2.83
KENSINGTON PARK	Non-Outbreak	33 (43.42%)	3.89	27 (35.53%)	3
POORAKA	Non-Outbreak	54 (46.96%)	4.09	36 (31.3%)	3.36
TUSMORE	Non-Outbreak	62 (60.78%)	3.71	49 (48.04%)	3.67
AVERAGE NON-OUTBREAK		51.4 (52.89%)	3.658	128.4	3.102
COLONEL	Outbreak	78 (54.55%)	1.88	60 (41.96%)	2.07

LIGHT GARDENS					
DAW PARK	Outbreak	87 (58.39%)	2.57	67 (44.97%)	1.9
MAGILL	Outbreak	92 (63.89%)	4.22	77 (53.47%)	3.51
MELROSE PARK	Outbreak	80 (61.07%)	2.08	69 (52.67%)	2.25
THEBARTON	Outbreak	66 (48.18%)	3.03	61 (44.53%)	3.02
AVERAGE OUTBREAK		80.6 (57.22%)	2.756	172	2.55
AVERAGE ALL		66 (55.05%)	3.207	150.2	2.826

Density in trees per hectare.

Fruit tree density data in terms of fruit and fruiting trees *per hectare* are presented in Table 50. There was no significant difference in the average number of fruit trees per hectare (T-Test PASW (equal variances not assumed as indicated by Levene's test of equality for variances F=12.029, p=0.008); t=0.876, df = 4.356, sig (2-tailed) = 0.426) and the average number of fruiting trees per hectare (T-Test PASW (equal variances not assumed as indicated by Levene's test for equality of variances F=14.261, p=0.005); t=-0.115, df = 5.180, sig (2-tailed) = 0.913) between Outbreak and Non-outbreak areas.

Table 50: Fruit tree and fruiting tree density per hectare for Outbreak and Non-outbreak areas.

	OUTBREAK TYPE	**Fruit Tree Density per Ha**	**Fruiting Tree Density per Ha**
CLAPHAM	Non-Outbreak	24.49	15.50
HAZELWOOD PARK	Non-Outbreak	23.10	19.22
KENSINGTON PARK	Non-Outbreak	25.91	15.80
POORAKA	Non-Outbreak	28.06	15.45
TUSMORE	Non-Outbreak	27.64	21.36
AVERAGE NON-OUTBREAK		25.84	17.46
COLONEL LIGHT GARDENS	Outbreak	11.70	11.02
DAW PARK	Outbreak	18.21	13.05
MAGILL	Outbreak	35.87	24.36
MELROSE PARK	Outbreak	15.49	14.63
THEBARTON	Outbreak	28.10	26.18
AVERAGE OUTBREAK		21.88	17.85
AVERAGE ALL		23.86	17.66

Distance from detection property analysis.

The fruit tree density (trees per hectare) per property data were divided into two zones, "inner" and "outer", based on the distance of their mid-point from the mid-point of the detection property. Properties that were within 100m of the detection property were categorised as inner properties, and those that were from 100m – 200m from the detection property were deemed outer properties.

A graphical representation of the results (Figure 95) appeared to show that in the inner zone of Outbreak detections, there was a smaller proportion of properties with zero fruit trees (36.7%) than in the outer zone (44.8%). This was the reverse in Non-outbreak detections, where the inner zone had 44.5% of properties with zero fruit trees and the outer zone had 34.6%. The difference between inner and outer zones was statistically significant for the Outbreak data (p=0.047), but not for the Non-outbreak data (p=0.251; Mann Whitney U, SPSS14.0).

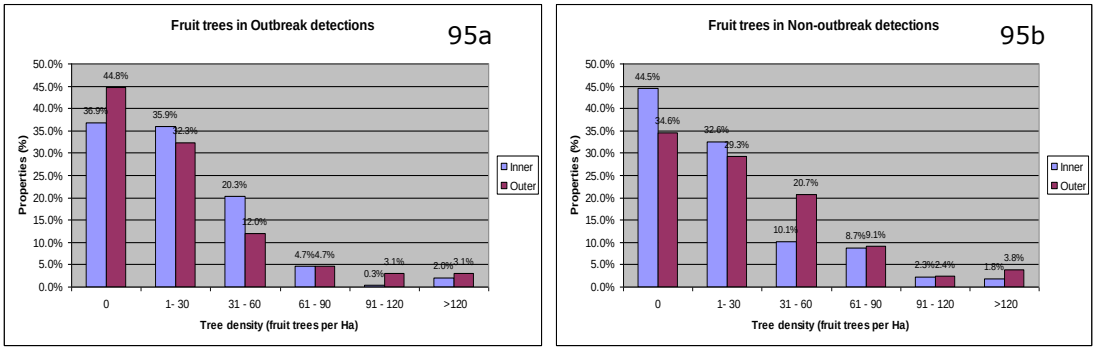


Figure 95: The proportions of properties in Outbreak detections (95a) and Non-outbreak detections (95b) with a range of fruit tree densities in each of two categories based on proximity to the detection property: Inner = properties that were within 100m of the detection property; Outer = properties from 100m – 200m from the detection property.

Furthermore, while the proportions of properties with a low density of fruit trees (1 – 30 trees per Ha) were similar for inner and outer zones of both Outbreak and Non-outbreak detections (range 29.3 – 35.9%), a reversal of frequencies between Outbreak and Non-outbreak detections was seen again for the proportion of properties with moderate fruit tree densities (31 – 60 trees per Ha). In this fruit tree density range, the inner zone of Outbreak detections had a higher proportion of properties (20.3%) compared to the outer zone (12.0%), whereas in the Non-break detections, there was a lower proportion of properties in the inner zone with a moderate fruit tree density (10.1%) compared to the outer zone (20.7%). For this fruit tree density range, the difference between inner and outer zones was statistically significant for both the Outbreak data (p=0.047), and for the Non-outbreak data (p=0.016; Mann Whitney U, SPSS14.0).

These data coarsely describe a spatial difference between the Outbreak and Non-outbreak detections examined in this study. In Outbreaks, the zone close to the detection tended to be characterised by a low proportion of properties with no fruit trees, and a higher proportion of properties with moderate fruit tree densities. In Non-outbreak detections, the reverse was true, and the inner area tended to contain a higher proportion of properties with zero fruit trees, and a lower proportion of properties with moderate fruit tree densities.

DISCUSSION

The results do not clearly identify any topological factors (i.e. surface analysis results) that relate to outbreaks specifically. The surface area and land use statistics calculated for each area may not be detailed enough to determine whether they contribute to the detection developing into an outbreak. Surface area was aggregated into hard surface, vegetated surface and water, and land use was divided into Residential and Non-residential with the proportions of each calculated for each detection. These aggregated units are arbitrary and may conceal relationships between sub units (such as grass, bushes, and trees for vegetated surface) and the establishment of fruit fly.

The first pass of data-mining analysis yielded no significant relationships of fruit tree and fruiting tree density with Outbreak and Non-outbreak detections, with overall around 50% of properties containing no fruit or fruiting trees and around 15% of properties with moderate fruit tree densities (31 – 60 trees per Ha). However, when the data were divided into two zones based on the proximity of the property in relation to the detection site, some interesting relationships emerged. It was apparent that Outbreaks were characterised by lower frequencies of properties with zero fruit trees in the zone closest to the detection property (36.9% vs 50%), and higher proportions (20.3% vs 15%) of properties with moderate fruit tree densities. The converse was true for Non-outbreak areas. This indicates that in this study, Outbreaks (the establishment of a breeding population) occurred where the immediate surroundings of the property with the trap were characterised by a low proportion of fruit-tree free properties, and a higher proportion of properties with moderate fruit tree densities. It is interesting to note that these relationships were not apparent when the data were considered at the 200m scale, suggesting that for young establishing populations, the environment within a 100m radius may be more important than a wider area. The reason for this is may be related to adult dispersal behaviour. Queensland fruit fly have a high dispersal capacity (Meats and Edgerton 2008; Meats *et al.* 2003) relative to, for example Mediterranean fruit fly (Meats *et al.* 2006). Little is known about what triggers dispersal in this species, but it is likely that if host availability is apparently low, the insects may be more likely to disperse. Dispersal may result in a lower likelihood of establishment due to a resultant lower insect density (the Allee effect (Keitt *et al.* 2001; Moller and Legendre 2001)), but where that dispersal leads to enough individuals finding the same suitable patch, invasion success may increase.
The analysis of fruit fly detections using GIS has produced interesting results however there are known limitations in the analytical approach adopted for this project regarding both data and methodology.

Data Limitations

All reasonable attempts were made to acquire the best available digital information from authoritative sources. Wherever necessary, data were corrected, reprocessed or value-added. Some of the most common limitations with the data sources include:

- **Currency** – Data is often not perfectly up-to-date or unavailable. For example, parcel data at the time of each detection was unavailable.
- **Spatial inaccuracy** – Spatial data is often captured at a particular geographic scale. Great care needs to be taken to identify errors that can be introduced by using these data at larger scales.
- **Inappropriateness** – Geographic data is often captured for a specific purpose. Care needs to be taken that the data is appropriate to use in each case.
- **Abstraction** – Geographic data is often collected in discrete layers representing a single theme. Often these themes can be quite abstract in nature and absolute definitions vary among data users. An example relevant to this project is the interpretation of hard surface. What constitutes a hard surface?

Methodology Limitations

The method chosen for this study has limitations. An appreciation of the following aspects of the GIS processes adopted is useful in interpreting the results:

- **Snapshot in time** – Large GIS datasets were employed in the project. Most have different currency dates, although efforts were made so that, where possible, information was of similar currency to the date of the detection. Many of the data layers are dynamic and have changed

since that time. The advantage of the methodology applied is that the analysis processes can be readily re-run on refreshed data.

- **Subjective criteria** – The criteria used in the project are very subjective. Any adjustments to these criteria could produce different results.

APPENDICES

Appendix 1: List of detections examined.

Hygiene data only

Location	Detection tree	Date
27 Birman Ct Flagstaff Hill	Native	19/11/2001
86 Richmond Rd Hawthorn	Native	7/03/2002
36 Barnett St Salisbury	Apricot	5/11/2002
10 Rodney Ave Ingle Farm	Ornamental	6/12/2002
36 Barnett St Salisbury	Apricot	5/11/2002
15 Edgecumbe Tce Rosslyn Park	Orange	16/04/2002
5 Sarah St Marleston	Lemon	7/01/2005
152 Raglan Ave South Plympton	Unknown	4/05/2003
6 Milton St Warradale	Native	20/03/2002
2 Gangara Ave Warradale	Apple	20/03/2002
77 Wilton Av Warradale	Cherry	10/05/2002
58 Moules Rd Rostrevor	Fiddlewood	16/03/2002
88 Bowker St Warradale	Lemon	20/03/2002
5 Russell Road Athlestone	Orange	4/05/2002
41 Main St Lockleys	Orange	1/05/2002

Hygiene data and GIS examination

Location	Detection tree	Date
26 Knightsbridge Rd Hazelwood Park	Oleander	3/12/2003
21 Stirling St Tusmore	Prunus	16/12/2003
11 Holden St Kensington Park	Unknown	30/12/2003
9 Alberta St Clapham	Hibiscus	22/01/2004
3 Adaluma St Pooraka	Nectarine	29/01/2004
32 Ormond Ave Daw Park	Unknown	5/02/2008
2 Day Ave Melrose Park	Unknown	22/02/2008
8 Light Place Col. Light Gardens	Unknown	14/02/2008
31 Douglas St Magill	Native	25/04/2002
14 Randolph St Thebarton	Orange	14/03/2002

Appendix 2: Description of methods for calculating GIS data.

SURFACE CALCULATIONS

FIELDS CREATED	TYPE	DESCRIPTION
HARD_AREA_HA	Double	Total Area of Hard surface in Hectares – roads, houses, footpaths, driveways, tennis courts, swimming pools, sheds
PERC_HARD	Double	Total area of Hard Surface divided by total clip area (200 metre buffer) *HARD_AREA_HA / CLIP_AREA_HA*
VEG_AREA_HA	Double	Total Area of Vegetated surface in Hectares – Trees, grass, gardens, parks
PERC_VEG	Double	Total area of Vegetated Surface divided by total clip area (200 metre buffer) *VEG_AREA_HA / CLIP_AREA_HA*
WATER_AREA_HA	Double	Total Area of Water in Hectares – streams, lakes, rivers
PERC_WATER	Double	Total area of Water divided by total clip area (200 metre buffer) *WATER_AREA_HA / CLIP_AREA_HA*

LANDUSE CALCULATIONS

FIELDS CREATED	TYPE	DESCRIPTION
AREA_HA	Double	Total Area in hectares of each individual property within the clip area
LAND_DESC	Text (20)	'RESIDENTIAL' or 'NON-RESIDENTIAL' Land Use
INFESTED_PROPERTY	Text (100)	Address of 'Infested Property'
PROP_AREA_HA	Double	Total area of all allotments within the clip area Sum of *AREA_HA*
NO_RES	Double	Total Number of Residential properties within clip area
RES_AREA_HA	Double	Total Area of Residential properties within each 'Infested Property' clip area Sum of *AREA_HA* where *LAND_DESC = RESIDENTIAL*
PERC_RES	Double	Percentage of Area of Residential Properties vs Area of all properties ***RES_AREA_HA / PROP_AREA_HA * 100***

FRUIT TREE CALCULATIONS

FIELD	TYPE	DESCRIPTION
TREES	Double	Number of trees from SARDI spreadsheet converted from text to numeric fields
AREA_HA	Double	Total Area in hectares of each individual property within the clip area
TREE_DENSITY	Double	Density of fruit trees per parcel *TREES / AREA_HA*
FRUIT_DENSITY	Double	Density of fruiting trees per parcel Fruiting trees are trees where "Condition = 1-4". *NO_CONDITION_ 1-4 / AREA_HA*
TOTAL_TREES	Double	Total Number of Fruit Trees for each clip area Sum of *TREES*
TREE_PROPERTIES	Double	Total number of properties with Fruit Trees Sum of properties where *TREES > 0*
AVERAGE_TREES_PER_PROP	Double	Average number of trees per property *TOTAL_TREES / TREE_PROPERTIES*
FRUITING_PROP	Double	Total number of properties with fruiting trees (Condition 1-4) in each clip area
NO_FRUITING	Double	Total number of fruiting trees (Condition 1-4) in each clip area
PERC_PROP_FRUITING	Double	Percentage of properties with fruiting trees *FRUITING_PROP / TOTAL_PROPERTIES*
AVE_FRUITING	Double	Average Number of Fruiting Trees per property *NO_FRUITING / FRUITING_PROP*
PERC_PROP_TREES	Double	Percentage of properties with fruit trees *TREE_PROPERTIES / TOTAL_PROPERTIES*

3. (d) Acknowledgments

This project was jointly funded by Cooperative Research Centre for Biosecurity (CRC NPB Ltd) and Horticulture Australia Limited (HAL).

Mrs. Jane Speijers (DAFWA) provided invaluable guidance in the planning stages and carried out the statistical analyses for this project in WA. The following DAFWA staff assisted with field work in Western Australia at various stages of the project: Ms Mirjana Banovic, Ms Helen Collie, Ms Linda Fernihough, Ms Emma Mansfield, Ms Sandra Wellington and Ms Candice Wong with work in the south west; Ms Natalie Bort and Ms Jessica Paterson with work in Kununurra.

David Heaven, Manager of Primary Industries and Resources South Australia's Plant Health Operations provided the fruit fly detection data. Ann Frodsham and Jo-Anne Ragless carried out the digitisation of the handwritten data. Catherine Smallridge of SARDI and Adam Caldwell of PIRSA Spatial Information Services contributed to the analysis of data in this project.

3. (e) References

Bateman M A. 1967. Adaptations to temperature in geographic races of the Queensland fruit fly, *Dacus (Strumeta) tryoni.* Aust. J. Zool., 15, 1141-1161.

Broughton, S., and De Lima, F. 2002. Field evaluation of attractants for monitoring *Ceratitis capitata* (Diptera: Tephritidae) under a range of climatic conditions and population levels in Western Australia. J. Econ. Entomol. 95 (2): 507-512.

Carey, J.R. 1984. Host-specific demographic studies of the Mediterranean fruit fly *Ceratitis capitata*. 9, 261-270.

Carey, J.R. 1996. The incipient Mediterranean fruit fly population in California: implications for invasion biology. Ecology.78, 1690-1696.

Cowley, J. M., Page, F.D., Nimmo, P.R. and Cowley, D.R. 1990. Comparison of the effectiveness of two traps for *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) and implications for quarantine surveillance systems. J. Aust. Ent. Soc. 29, 171-176.

Cuningham, R.T. and Couey, H.M. 1986. Mediterranean fruit fly (Diptera: Tephritidae): distance/response curves to Trimedlure to measure trapping efficiency. Environ. Ent. 15, 71-74.

De Lima, C.P.F. 1998. Management of the Mediterranean fruit fly in apple and pear orchards. (Project No. AP 95045). Final Report for the Horticultural Research and Development Corporation and Agriculture Western Australia.

De Lima, C.P.F. 2008. Area Wide Management of Mediterranean Fruit Fly in Australia. Smietz, J. (eds.) In Proc. VIIIth IS on Modelling in Fruit Research. Acta Hort. 803, 51-59.

Dominiak B C, Gilmour A R, Kerruish B and Whitehead D. 2003. Detecting low populations of Queensland fruit fly, *Bactrocera tryoni* (Froggatt) with McPhail and Lynfield traps. General and Applied Entomology, 32, 49-53.

FAO (1999) Requirements for the establishment of pest free places of production and pest free production sites, *ISPM*, No. 10, Rome.

FAO (2005) Requirements for the establishment of areas of low pest prevalence*. ISPM*, No. 22 *,* Rome.

Fimiani, P. 1979. Deplacements and dispersion of med fly adults (*Ceratitis capitata* Wied.) around Flegreo [in Italy]. Bollettino del Laboratorio di Entomologia Agraria di Portici. 275-284.

Fletcher B S. 1975. Temperature-regulated changes in the ovaries of overwintering females of the Queensland fruit fly, *Dacus tryoni*. Aust. J. Zool., 23, 91-102.

Fletcher B S. 1979. The overwintering survival of adults of the Queensland fruit fly, *Dacus tryoni*, under natural conditions. *Australian Journal of Zoology*, 27, 403-411. Fletcher, B.S. 1986. The Overwintering strategy of the Queensland Fruit Fly, *Dacus tryoni*. II Intern. Symp. Fruit flies / Crete, 375-381.

Fletcher, B.S. 1989. Ecology; movements of Tephritid fruit flies, In Robinson , A.S. & Hooper, G. (eds), Fruit flies; their biology, natural enemies and control. World Crop Pests, 3(B), 209-219, Elsevier, Amsterdam.

Hendrichs, J. and Hendrichs, M.A. 1990. Mediterranean fruit fly (Diptera: Tephritidae) in nature: location and diel pattern of feeding and other activities on fruiting and non-fruiting hosts and honhosts. Ann Entomol Soc Am. 83(3):632-641.

Jessup, A.J., Dominiak, B., Woods, B., De Lima, C.P.F., Tomkin, A., and Smallridge, C.J. 2007. Area-Wide management of fruit flies in Australia. In: Vreysen, M.J.B., Robinson, A.S., Hendrichs, J. (Eds), Area-Wide control of insect pests: from Research to Field Implementation. Springer, Dordrecht, Netherlands, pp. 685-697.

Kanneshiro, K. (1993) Introduction, colonization, and establishment of exotic insect populations: frut flies in Hawaii and California. American Entomologist. 39 (spring): 23-29.

Katsoyannos, B. I., Heath, R. R., Kouloussis, N. A. and Carey, J. R. 1998. Seasonal and annual occurrence of fruit flies (Diptera: Tephritidae) on Chios Island, Greece: differences between two neighbouring citrus orchards. Ann. Entomol. Soc. Am. 91 (1): 43-51.

Keitt T. H., Lewis M. A. & Holt R. D. (2001) Allee Effects, invasion pinning, and species' borders. The American Naturalist. 157, 203-16.

Lance, D. R. and Gates, D.B. 1994. Sensitivity of detection trapping systems for Mediterranean fruit flies (Diptera: Tephritidae) in Southern California. J. Econ. Entomol. 87, 1377-1383.

Maezler, D.A., 1990a. Fruit fly outbreaks in Adelaide SA., From 1948-49 to 1986-87. I. Demarcation, Frequency and Temporal Patterns of Outbreaks. Aust. J. Zool. 38, 439-452.

Maezler, D.A., 1990b. Fruit fly outbreaks in Adelaide SA., From 1948-49 to 1985-86. II. The Phenology of both pestilent species. Aust. J. Zool. 38, 555-572.

Maezler, D.A., 2004. Factors supporting the non-persistence of fruit fly populations in South Australia. Aust. J. Expt. Agric.. 44, 109-126.

May A W S. 1963. An investigation of fruit flies (Trypertidae: Diptera) in Queensland. 1. Introduction, species, pest status and distribution. Queensland Journal of Agricultural Science, 20, 1-82.

MCOP draft (2006) National Code of Practice for the Management of Mediterranean Fruit Fly (Draft) 2006.

Meats, A. 1984. Thermal constraints to successful development of the Queensland fruit fly in regimes of constant and fluctuating temperature. Entomol. Exp. Appl. 36, 55-59.

Meats A & Fay HAC. 2000. Distribution of mating frequency among males of the Queensland fruit fly, *Bactrocera tryoni* (Froggatt), in relation to temperature, acclimation and chance. General and Applied Entomology 29, 27–30.

Meats, A.W., and Clift, A.D. 2005 Zero catch criteria for declaring eradications of tephritid fruit flies: the probabilities. Aust. J. Expt. Agric. 45, 1335-1340.

Meats, A.W., Clift, A.D., and Robson, M.K. 2003. Incipient founder populations of Mediterranean and Queensland fruit flies in Australia: the relation of trap catch to infestation radius and models for quarantine radius. Aust. J. Expt. Agric. 43, 397-406.

Meats A. & Edgerton J. E. 2008. Short- and long-range dispersal of the Queensland fruit fly *Bactrocera tryoni* and its relevance to invasive potential, sterile insect technique and surveillance trapping. Aust. J. Expt. Agric. 48, 1237-45.

Meats A., Smallridge C. J. & Dominiak B. C. 2006. Dispersion theory and the sterile insect technique: application to two species of fruit fly. Entomol. Exp. Appl. 119, 247-54.

Moller A. P. & Legendre S. 2001. Allee effect, sexual selection and demographic stochasticity. *OIKOS* 92, 27-34.

National Fruit Fly Strategy Action Plan. 2010 *www.planthealthaustralia.com.au/.../national-fruit-fly-strategy*.

O'Loughlin G T, East R A and Meats A. 1984. Survival, development rates and generation times of the Queensland fruit fly*, Dacus tryoni*, in a marginally favourable climate: experiments in Victoria. Aust. J. Zool., 32, 353-361.

Papadopoulos, N.T., Carey, J.R., Katsoyannos, B.I. and Kouloussis, N.A. 1996. Overwintering of the Mediterranean fruit fly (Diptera: Tephritidae) in Northern Greece. Ann Entomol Soc Am. 89(4):526-34.

Papadopoulos, N.T., Katsoyannos, B.I. and Carey, J.R. 1998. Temporal changes in the composition of the overwintering larval population of the Mediterranean fruit fly (Diptera: Tephritidae) in Northern Greece. Ann Entomol Soc Am. 91(4):430-4.

Papadopoulos, N.T., Katsoyannos, B.I., Carey, J.R. and Kouloussis, N.A. 2001(a). Seasonal and annual occurrence of the Mediterranean fruit fly (Diptera: Tephritidae) in northern Greece. Ann Entomol Soc Am. 94:41-50.

Papadopoulos, N.T., Katsoyannos, B.I., Kouloussis N.A., Hendrichs, J.R., Carey JR, and Heath, R.R.2001(b). Early detection and Population Monitoring of *Ceratitis capitata* (Diptera: Tephritidae) in a Mixed-Fruit Orchard in northern Greece. J. Econ. Entomol. 94(4): 971-978.

Plant, R.E., and Cunnigham, R.T. 1991 Analyses of the dispersal of sterile Mediteranean fruit flies 9Diptera: Tephritidae) released from a point source. Environ Entomol. 20, 1493-1503.

Prokopy, R.J. and Hendrichs, J. 1979. Mating behaviour of Ceratits capitata on a field caged host tree. Ent. Soc. Amer. 72, 642-648.

QCOP (1996) National Code of Practice for the Management of Queensland Fruit Fly. The Standing Committee on Agriculture and Resource Management

Smith, E.S.C. 2000. Internal and External fruit fly quarantine in Australia. 171-177. In Price, N.S. and Seeruthun I. (eds.) Proceedings, Symposium: Indian Ocean Commision Regional Fruit Fly Sympposium, 5-9 June 2000,Flie en Flae Mauritius. Indian Ocean Commission Mauritius.

Steiner, L.F., Mitchell, W.C. and Baumhover, A.H. 1962. Progress of fruit fly control by irradiation sterilization in Hawaii and Mariana Islands. International Journal of Applied Radiation and Isotopes. 13, 427-434.

Supasatian, C. 1986. The mating behaviour of the Mediterranean fruit fly *Ceratitis capitata* (Wied): Behavioural changes with laboratory rearing. MSc thesis, University of Western Australia, 165 p.

Sutherst, R.W., Collyer, B. S. and Yonow, T. 2000. The vulnerability of Australian horticulture to the Queensland fruit fly, *Bactrocera (Dacus) tryoni*, under climate change. Aust. J. Agric. Res. 51, 467-480.

Tassan, R.L. Hagen, K.S. and Cheng, A. 1982. Mediterranean fruit fly life cycle estimationd for the Californaia eradication program. CEC/IOBC Symposium/ Athens/ Nov. 1982.

Tychsen, P.H. 1977. Mating behaviour of the Queensland fruit fly, *Dacus tryoni* (Dipteera:tephritidae) in field cages. J. Aust. Ent. Soc. 16, 459=465.

Whittier, T.S., Kaneshiro, K.Y. and Prescott, L.D. 1992. Mating behavior of Mediterranean fruit flies (Diptera: Tephritidae) in a natural environment. Ann. Entomol. Soc. Am. 85(2), 214-218.

Wijesuriya, S.R. and De Lima, C.P.F. 1995. Comparison of Two Types of Traps and Lure Dispensers for *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). J. Aust. Ent. Soc. 34, 273-275.

Wong, T.T.Y., Whitehand, L.C., Kobayashi, R.M., Ohinata, R.M., Tanaka, N. and Harris, E.J. 1982. Mediterranean fruit fly: Dispersal of wild and irradiated and untreated laboratory reared males. Environ. Ent. 11, 339-343.

Zalucki M P, Drew R A I and Hooper G H S. 1984. Ecological studies of eastern Australian 1878 fruit flies (Diptera: Tephritidae) in their endemic habitat. II. The spatial pattern of abundance. Oecologia, 64, 273-279.

4. Implications for stakeholders

The work described in this report is an important contribution to development of new and better methods of proving area freedom and early detection of fruit flies and to reduce the extent of outbreak areas for market access. In areas of low fly density strategic placement of traps in fruiting hosts increased the chance of detection of flies and the likelihood of capturing flies earlier. The greater effectiveness of this trapping method will reduce costs and benefit the industry in terms of minimising the number of undetected incursions leading to outbreaks and loss of market access in affected areas.

The methods developed in this study prove area freedom. However, they have also been tested in areas of low pest prevalence (ALPP) and have proved effective. It is therefore useful to extend dynamic trapping methods as suitable for consideration in proving ALPP in the further development of the fruit fly codes of practice for market access. Since fewer numbers of traps are required to prove ALPP the costs of such a trapping regime may be affordable for growers.

- Adopting the dynamic trapping methods is based on good scientific principles and will benefit industry in reducing monitoring costs as well as in eradication costs through early detection of breeding populations.
- Environmental impacts of trap deployment and eradication of fruit fly outbreaks will be reduced.
- The results of this work are expected to satisfy Quarantine requirements of overseas countries for trap placement in terms of early and effective detection of fruit fly incursions into area free zones.
- The results obtained in this project provide the scientific basis for quantifying Areas of Low Pest Prevalence thus enabling places that lose Area Freedom, or those places that cannot achieve area freedom to seek more favourable consideration for market access based on diminished fruit fly risk to trade.

5. Recommendations

Based on the results of this project the following recommendations are made:

- To review trap deployment strategies in area free zones with a view to adopting dynamic trapping methods to reduce costs and aid early detection.
- To review the advantage of classifying areas under active control as Areas of Low Pest Prevalence for market access, and develop appropriate methodology.
- To fund R&D projects on further development and verification of area freedom methods in area free zones.
- To adopt the techniques developed in this project in future area wide management programs.
- To conduct a cost / benefit analyses of maintaining traps in fruiting trees with a reduction in number of traps, compared with the current static grid.
- Adopt spatial analyses in the future with improved data-sets designed to capture more accurately the host environment existing under both non-outbreak and outbreak situations.

6. Abreviations/glossary

ABBREVIATION	FULL TITLE
CRCNPB	Cooperative Research Centre for National Plant Biosecurity
DAFWA	Department of Agriculture and Food Western Australia
DDVP	Dichlorvos
FFEZ	Fruit fly exclusion zone
I&I NSW	Industry & Investment NSW
ORIA	Ord River Irrigation Area
RRZ	Risk reduction zone

7. Plain English website summary

CRC project no:	CRC30039
Project title:	Trapping for area freedom
Project leader:	Dr Francis De Lima
Project team:	Dr Francis De Lima, Ms Shirani Poogoda, Dr Olivia Reynolds, Dr Catherine Smallridge
Research outcomes:	Fruit fly area freedom is vital for market access. Since 1990 it has been managed through codes of practice under national and international agreements. The standard practice is based on the deployment of static trapping grids covering orchards, towns and urban areas. The grids are relatively effective when numbers are high, but are an inefficient strategy to detect early fruit fly incursions and are becoming increasingly expensive to deploy and maintain due to the prescribed fixed distances between traps. The aim of this project was to develop a science based rationale that will optimise trap placement for the detection of fruit fly. The strategy is to deploy traps in hosts at the time when they are most attractive to fruit flies, with the aim of gaining in efficiency in early detection of the incursive population. More effective and earlier detection will minimise the number of undetected incursions which lead to breeding populations, thereby reducing eradication costs and more effectively managing area freedom for market access. Research was conducted in WA and NSW to determine if new methods termed 'dynamic trapping' would provide an equivalent proof of area freedom at lower cost. The standard trapping method where traps are placed in a grid system 0.4 - 1km apart (static trapping), was tested against a method of strategic trap deployment (dynamic trapping) in hosts at the time hosts held mature fruit whenever possible. The dynamic trapping method was demonstrated to be more effective in the capture of *C. capitata* than the static trapping method in Donnybrook. The dynamic method detected fruit fly infestations earlier than the static method in Donnybrook (with low fly numbers) and required one-third to one-half the number of traps used in a static grid to obtain the equivalent information on detecting itinerant or established fly numbers required for the fruit fly code of practice. This result was consistent over the three seasons where population level was quite different in each season. In areas with very low fly density (Manjimup, Pemberton) and in the area free region of Kununurra, there was no difference in fly detection between the static and dynamic trapping methods. With Queensland fruit fly (*Bactrocera tryoni*), results were variable and inconclusive in three areas (Cootamundra, Junee and Gundagai) which had low-high fly densities. Similarly, the data for the Tumut orchard was limited and it is difficult to

	draw any conclusions. However, in Ganmain, a town of low fruit fly density, dynamic traps were more effective than static traps in capturing *B. tryoni*, in terms of both proportion of traps which detected flies and proportion of flies caught in traps. Data mining research in South Australia showed how archival trapping data can be combined with modern spatial data mapping methods to improve the trapping processes. While historical data-sets present some problems relating to data consistency among locations, future detection data could be digitised and added to the data-set to expand and improve the analysis. This research has the potential to identify areas of low fruit fly establishment potential where trapping effort could be reduced, thereby saving on monitoring costs in some parts of designated fruit fly free areas. The results of this study indicated that the establishment of a breeding population occurred where the immediate surroundings of the property with the trap were characterised by a low proportion of fruit-tree free properties, and a higher proportion of properties with moderate fruit tree densities.
Research implications:	The most critical implication of this study is that strategic placement of traps in hosts at times when they are most attractive leads to a greater likelihood of detecting flies and likelihood of earlier detection. With the dynamic trapping method therefore, fewer traps can be used to achieve a detection level similar to that of the current static method without sacrificing efficiency. The number of traps can be reduced by 50 percent where suitable hosts are available. In trap deployment, the selection of host type should follow the preferred host type available in a given season, with larger trees with high fruit volume given preference. Results in WA indicated that traps should be placed in citrus in winter and thereafter moved to apricots or early peaches, then nectarines, plums and later peaches, followed by apples, pears, olives, figs and loquats, moving back to citrus in June. The results obtained in this project also provide the scientific basis for quantifying Areas of Low Pest Prevalence thus enabling places that lose Area Freedom, or those places that cannot achieve area freedom to seek more favourable consideration for market access based on diminished fruit fly risk to trade. Since fewer numbers of traps are required to prove ALPP the costs of such a trapping regime may be affordable for growers. With Queensland fruit fly, further research in the Fruit Fly Exclusion Zone is recommended. An assessment of cost effectiveness of the dynamic trapping method (with reduced number of traps) compared with the current static grid system is needed to quantify the cost benefit.

	Recommendations arising from this study are: • To review trap deployment strategies in area free zones with a view to adopting dynamic trapping methods to reduce costs and aid early detection. • To review the advantage of adopting dynamic trapping methods in classifying areas under active control as Areas of Low Pest Prevalence for market access, and develop appropriate methodology. • To fund R&D projects on further development and verification of area freedom methods in area free zones. • To adopt the techniques developed in this project in future area wide management programs.
Research publications:	In preparation.
Acknowledgments:	This project was jointly funded by Cooperative Research Centre for Biosecurity (CRC NPB Ltd) and Horticulture Australia Limited (HAL). Mrs. Jane Speijers (DAFWA) provided invaluable guidance in the planning stages and carried out the statistical analyses for this project in WA. The following DAFWA staff assisted with field work in Western Australia at various stages of the project: Ms Mirjana Banovic, Ms Helen Collie, Ms Linda Fernihough, Ms Emma Mansfield, Ms Sandra Wellington and Ms Candice Wong, Ms Natalie Bort and Ms Jessica Paterson. David Heaven, Manager of Primary Industries and Resources South Australia's Plant Health Operations provided the fruit fly detection data. Ann Frodsham and Jo-Anne Ragless carried out the digitisation of the handwritten data. Catherine Smallridge of SARDI and Adam Caldwell of PIRSA Spatial Information Services contributed to the analysis of data in this project.