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Guava moth distribution survey – Part Two

Chhagan A, Hartnett D, Page-Weir N, Anderson R, Kokeny A, Wallis R, Johnston S, Rogers P, Edwards C, Horrocks K, Jamieson L

June 2018



Confidential report for:
New Zealand Feijoa Growers Association

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EXECUTIVE SUMMARY

Guava moth distribution survey – Part Two

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Background

Guava moth, *Coscinoptycha improbana* (Lepidoptera: Carposinidae), was first recorded in New Zealand in 1997. Since its discovery, the pest has become established in both Northland and Auckland (Jamieson et al. 2004). Climate matching data have shown it has the potential to establish in a number of other key fruit growing regions in New Zealand including Waikato, Bay of Plenty, Gisborne, Hawke's Bay and Nelson (Froud & Dentener 2002).

A guava moth distribution survey was conducted by The New Zealand Institute for Plant and Food Research Limited (PFR) from April to July 2017 in Auckland, Waikato, Bay of Plenty, Hawke's Bay, Gisborne and Nelson. Male guava moth numbers were monitored using green delta traps containing guava moth pheromone lures with 1000 µg guava moth sex pheromone (two-component; 95:5 ratio of Z7-11-one-18Hy and Z7-11-one-19Hy, also known as the binary blend) held on white sticky bases. Results of the distribution survey and records from MPI confirmed the presence of guava moth in the Auckland and Waikato regions (Crosby districts: Auckland, Coromandel and Waikato) (Chhagan et al. 2018). No guava moth were recorded from Bay of Plenty, Gisborne, Hawke's Bay or Nelson. The guava moth pheromone lure used in this preliminary trial was the commercially available binary blend, however, past research has indicated that trap catches using a four-component blend (also known as the quaternary blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10, respectively, were significantly higher than trap catches with the two-component blend (Gibb et al. 2006).

This report summarises the results of a distribution survey conducted in 2018 to establish the distribution of guava moth in New Zealand using the four-component blend of the guava moth sex pheromone.

Methodology

Distribution survey

The distribution survey was conducted from February to May 2018 in Auckland, Waikato, Bay of Plenty, Hawke's Bay, Gisborne, Taranaki, Manawatu and Nelson. In Auckland, male guava moth numbers were monitored on 10 properties. Two green delta traps were placed on each property; one trap contained a commercially available two-component (binary blend) guava moth pheromone lure (1000 µg; Z7-11-one-18Hy and Z7-11-one-19Hy at a ratio of 95:5) and the other contained a four-component (quaternary blend) guava moth pheromone lure (1000 µg; Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Traps were placed in the field for 12 weeks and trap catch was assessed every week. Pheromone lures were replaced after 6 weeks.

In areas outside Auckland, male guava moth numbers were monitored using green delta traps containing four-component blend guava moth pheromone lures held on white sticky bases. Trap catch was assessed every 3 weeks. Traps were placed in the field for 12 weeks, and pheromone lures were replaced after 6 weeks.

Ministry for Primary Industries (MPI) records

Guava moth records from 1997 to 2018 were obtained from a number of sources including the MPI Specimen Tracking and Reporting Systems (STARS) Database, Plant Pest Information Network (PPIN) Database and Laboratory Information Management System (LIMS). The data were extracted and provided by the MPI Plant Health and Environment Laboratory in September 2017, and a further update was provided in May 2018.

Results

Distribution survey

Guava moth were recorded from all trial sites in the Auckland region (Crosby district: Auckland) and in Miranda, Thames, Coromandel Town, Whitianga, Patetonga, Hikutaia and Kopu in the Waikato Region (Crosby districts: Coromandel and Waikato). Guava moth was also recorded at one site in the Bay of Plenty region (Papamoa) (Crosby district: Bay of Plenty).

No guava moth were recorded from Gisborne, Hawke's Bay, Taranaki, Manawatu or Nelson.

A number of other moth species were also caught in the traps during the trial. These included *Heterocrossa rubophaga* (Raspberry bud moth), *Heterocrossa eriphylla*, *Heterocrossa exochana*, *Opogona omoscopia* and *Isotenes miserana* (Orange fruit borer) and a recent arrival *Carposina neurophorella*.

MPI records

The majority of guava moth records from 1997 to 2018 were from fruit received from Northland and Auckland. In 2017, two records were also confirmed from the Coromandel (Kuaotunu and Te Kouma).

Guava moth has been found in association with a number of host fruit, including feijoas, macadamias, apples, citrus and summerfruit. In 2018, guava moth was also confirmed from karaka berries in Northland.

Key points

- Results of the distribution survey and records from MPI confirmed the presence of guava moth in the Auckland and Waikato regions (Crosby districts: Auckland, Coromandel and Waikato). Guava moth is now present in all areas of the Auckland region.
- Guava moth was recorded for the first time in the Bay of Plenty. Only one moth was caught on one occasion in Papamoa and this could be a result of high winds or the chance emergence of guava moth adults from infested fruit brought in from guava moth infested areas.

- Guava moth were also recorded from Miranda, Thames, Coromandel Town, Whitianga, Patetonga, Hikutaia and Kopu in the Waikato Region. The presence of guava moth in Patetonga and Hikutaia is of concern due to their proximity to important fruit growing areas in central Waikato and the Bay of Plenty.
- Trap catch was higher with the four-component blend guava moth pheromone lure compared to the two-component blend in Auckland over the trial period. It is recommended that the four-component lure is used for future trial work where possible and that the commercialisation of the four-component blend guava moth pheromone lure is investigated.

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1 INTRODUCTION

Guava moth (GM), *Coscinoptycha improbana* (Lepidoptera: Carposinidae), was first recorded in New Zealand (Ahipara, Northland) in 1997. Guava moth lays its eggs on host fruit, and hatching larvae then burrow directly into the fruit, resulting in rotting, brown areas and frass. This can lead to early fruit drop and inedible fruit. GM has been recorded on a range of hosts including feijoas, plums, guavas, macadamias, citrus and apples. Crop losses of up to 80% have been reported on early season commercial feijoas. Economic costs are difficult to estimate. The domestic feijoa market is valued at approximately NZ\$3.2M per year and economic costs in regions where GM is present are currently estimated at NZ\$0.3M per year. As well as a production pest, GM has the potential to become an export market access issue. Export development is currently a priority for the New Zealand Feijoa Growers Association, and while the value of feijoa exports increased 15% to NZ\$0.5M in the year to June 2016, GM could threaten this growing export sector (I. Turk, pers. comm.). This pest has the potential to affect the production and marketing of a number of other New Zealand horticultural sectors along with home gardens that are also affected by this pest. Currently there is no reliable management system in place for GM. Research is needed to develop a reliable and sustainable Integrated Pest Management (IPM) programme with minimal agrichemical inputs.

Since its discovery in 1997, the pest has become established in both Northland and Auckland (Jamieson et al. 2004) and climate matching data have shown it has the potential to establish in a number of other key fruit growing regions in New Zealand including Waikato, Bay of Plenty, Gisborne, Hawke's Bay and Nelson (Froud & Dentener 2002). The pest is native to Australia, and has been recorded from Eungella in Queensland to Victoria, and Tasmania. It has also been recorded on Norfolk Island and New Caledonia (Mille et al. 2012).

A guava moth distribution survey was conducted by Plant and Food Research (PFR) from April to July 2017 in Auckland, Waikato, Bay of Plenty, Hawke's Bay, Gisborne and Nelson. Male guava moth numbers were monitored using green delta traps containing guava moth pheromone lures with 1000 µg guava moth sex pheromone (two-component blend; 95:5 ratio of Z7-11-one-18Hy and Z7-11-one-19Hy, also known as the binary blend) held on white sticky bases. Results of the distribution survey and records from MPI confirmed the presence of guava moth in the Auckland and Waikato regions (Crosby districts: Auckland, Coromandel and Waikato) (Chhagan et al. 2018). No guava moth were recorded from Bay of Plenty, Gisborne, Hawke's Bay or Nelson. The guava moth pheromone lure used in this preliminary trial was the commercially available two-component blend, however, past research has indicated that trap catches using a four-component (quaternary blend) of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10, respectively, were significantly higher than trap catches with the two-component lure blend (Gibb et al. 2006). After a New Zealand scientist filed a patent with the Intellectual Property Office of New Zealand in 2004, the four-component blend was not accessible for research purposes. However, this patent has since lapsed, allowing the use of this blend for current experimental work.

This report summarises the results of a guava moth distribution survey conducted in 2018 to establish the current distribution of guava moth in New Zealand using the four-component blend of the guava moth sex pheromone.

2 METHODOLOGY

2.1 Distribution survey

The guava moth distribution survey was conducted from February to May 2018 in Auckland, Waikato, Bay of Plenty, Hawke's Bay, Gisborne, Taranaki, Manawatu and Nelson (Table 1) (See Appendices 1–7 for trap locations and details). The trial was conducted during this period to coincide with the peak of the feijoa season, and hence, peak GM populations.

In Auckland, male guava moth numbers were monitored on 10 properties. Two green delta traps (Figure 1) were placed on each property; one trap contained a commercially available two-component blend guava moth pheromone lure (1000 µg; Z7-11-one-18Hy and Z7-11-one-19Hy at a ratio of 95:5, also known as the binary blend) and the other contained a four-component blend guava moth pheromone lure (1000 µg; Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10, also known as the quaternary blend) (Table 2). The two-component blend pheromone lures were provided by Etec Crop Solutions and the four-component blend pheromone lures were produced by Plant and Food Research (PFR). Each pheromone lure comprised an orange-coloured rubber septum, which was placed on a white sticky base within the trap (Figure 2). Traps were generally placed in feijoa trees, but where feijoa trees were not present, traps were placed in other guava moth host trees including citrus, apple and macadamia. The two-component and four-component traps were placed approximately 5 m apart at a height of approximately 1.5 m. Trap catch was assessed every week. Traps were placed in the field for 12 weeks, and pheromone lures were replaced after 6 weeks. An additional five traps containing the two-component blend guava moth pheromone lure were placed on a further five sites in Auckland. Trap catch was assessed at irregular intervals for these five sites, but generally every 3–4 weeks.

In areas outside Auckland male guava moth numbers were monitored using green delta traps containing guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10) held on white sticky bases. Traps were placed at a height of approximately 1.5 m and were generally placed in feijoa trees. Where feijoa trees were not present, traps were placed in other guava moth host trees including citrus, summerfruit, guava and macadamia. Trap catch was assessed every 3 weeks. Traps were placed in the field for 12 weeks, and pheromone lures were replaced after 6 weeks.

Table 1. The number of guava moth (*Coscinoptycha improbana*) traps and trap check frequency in each region.

Pheromone	Region	Number of traps	Trap check frequency
Two-component	Auckland	10	Weekly
		5	Every 3-4 weeks
Four-component	Auckland	10	Weekly
	Waikato	50	Every 3 weeks
	Bay of Plenty	21	Every 3 weeks
	Gisborne	20	Every 3 weeks
	Hawke's Bay	20	Every 3 weeks
	Taranaki	3	Every 3 weeks
	Manawatu	1	Every 3 weeks
	Nelson	20	Every 3 weeks
	Total	160	

Table 2. Composition of the guava moth (*Coscinoptycha improbana*) pheromone lures.

	(Z)-7-tricosene	(Z)-7-octadecen-11-one	(Z)-7-nonadecen-11-one	(Z)-7-tricosen-11-one
	Z7-23Hy	Z7-11-one-18Hy	Z7-11-one-19Hy	Z7-11-one-23Hy
Two-component lure (binary)		950µg	50µg	
Four-component lure (quaternary)	650µg	235µg	15µg	100µg

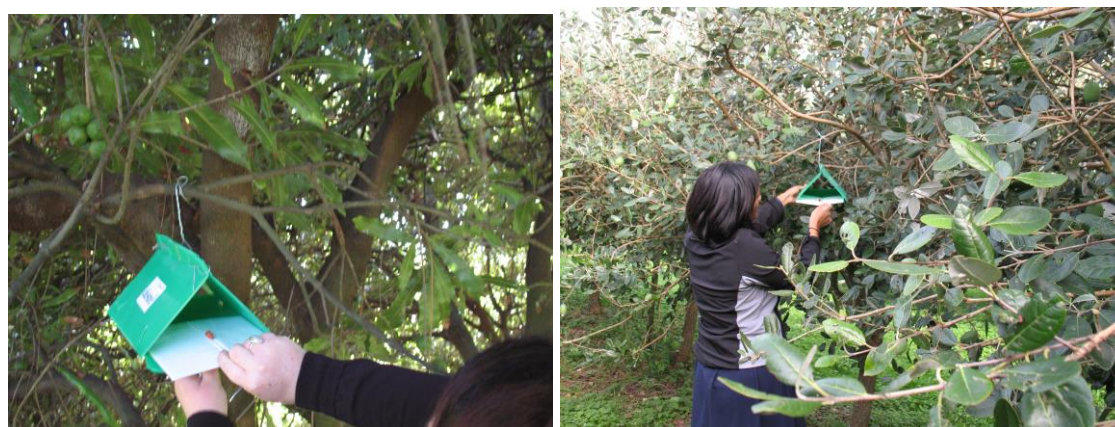


Figure 1. A green delta trap containing a guava moth (*Coscinoptycha improbana*) pheromone lure on a sticky white base, used to monitor guava moth male adults.

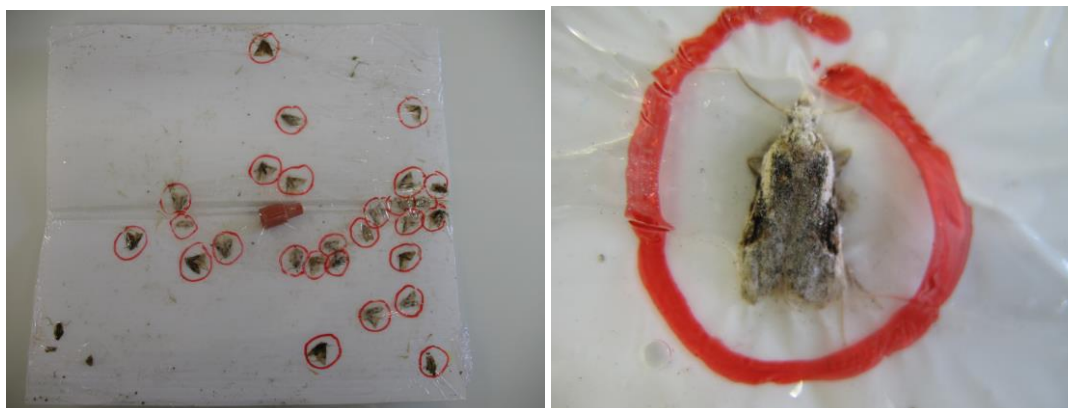


Figure 2. A white sticky base with guava moth (*Coscinoptycha improbana*) male adults (circled with red marker pen).

2.2 Ministry for Primary Industries (MPI) records

Guava moth records from 1997 to 2018 were obtained from a number of sources including the MPI Specimen Tracking and Reporting Systems (STARS) Database, Plant Pest Information Network (PPIN) Database and Laboratory Information Management System (LIMS). These data were extracted and provided by the MPI Plant Health and Environment Laboratory in September 2017 and a further update was provided in May 2018.

3 RESULTS

3.1 Distribution survey

The nationwide guava moth trapping results for 2018 is presented in Figure 3.

Auckland Region

Guava moth were recorded from all of the trial sites in the Auckland region (Crosby District: Auckland). These included new guava moth trap catch records from Oratia, Waiheke Island, Awhitu and Clarks Beach (Figure 4).

Trap catch was higher with the four-component blend guava moth pheromone lure compared to the binary blend over the trial period (Figure 5). This was particularly noticeable at sites with high guava moth populations (Figure 6). Refer to Appendix 1 for site details and total trap catch numbers.

Trap catch using the two-component blend was higher in 2018 compared to 2017 (April and May) in Auckland (Figure 7). A number of factors may have influenced this including temperature and, preferred host plant availability, resulting in higher guava moth populations.

Waikato Region (including Coromandel)

In Waikato and Coromandel, as in 2017, guava moth were recorded from Miranda and Thames. However, guava moth were also recorded from Coromandel Town, Whitianga, Patetonga, Hikutaia and Kopu this season (Figures 8 and 9). These new guava moth trapping records indicate the growing distribution of guava moth in New Zealand. Refer to Appendix 2 for site details and total trap catch numbers.

Bay of Plenty Region

Guava moth was recorded for the first time in the Bay of Plenty. Only one moth was caught on one occasion in Papamoa (Figure 10). Refer to Appendix 3 for site details and total trap catch numbers.

Other regions

No guava moth were recorded from Gisborne, Hawke's Bay, Manawatu, Taranaki or Nelson (Figures 11–13). Refer to Appendices 4–7 for site details.

Bycatch in traps

A number of other moth species were also caught in the traps during the trial. These included *Heterocrossa rubophaga* (Raspberry bud moth), *Heterocrossa eriphylla*, *Heterocrossa exochana*, *Opogona omoscopia*, *Isotenes miserana* (Orange fruit borer) and *Carposina neurophorella* (Figure 14).

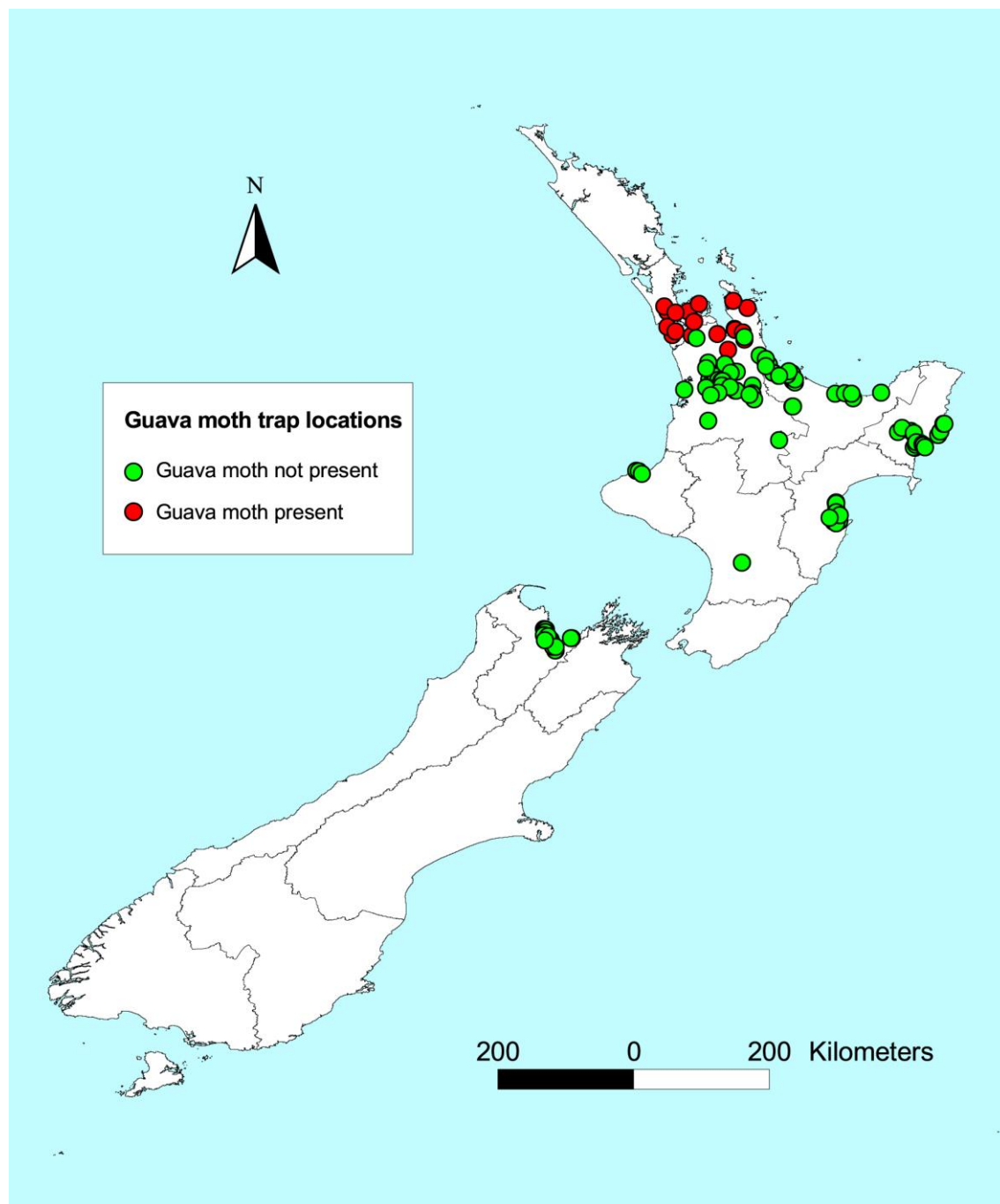


Figure 3. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in New Zealand from February to May 2018.

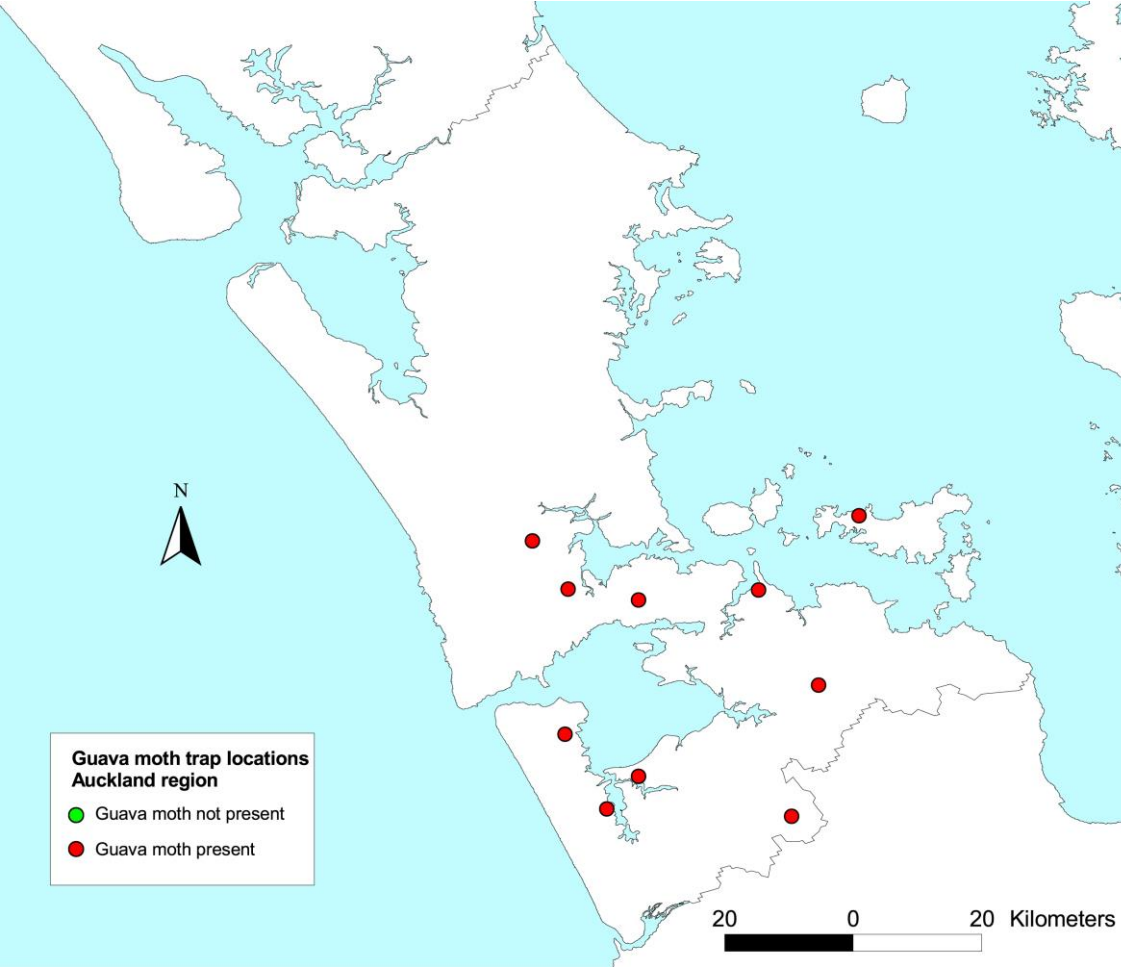


Figure 4. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Auckland region from February to May 2018.

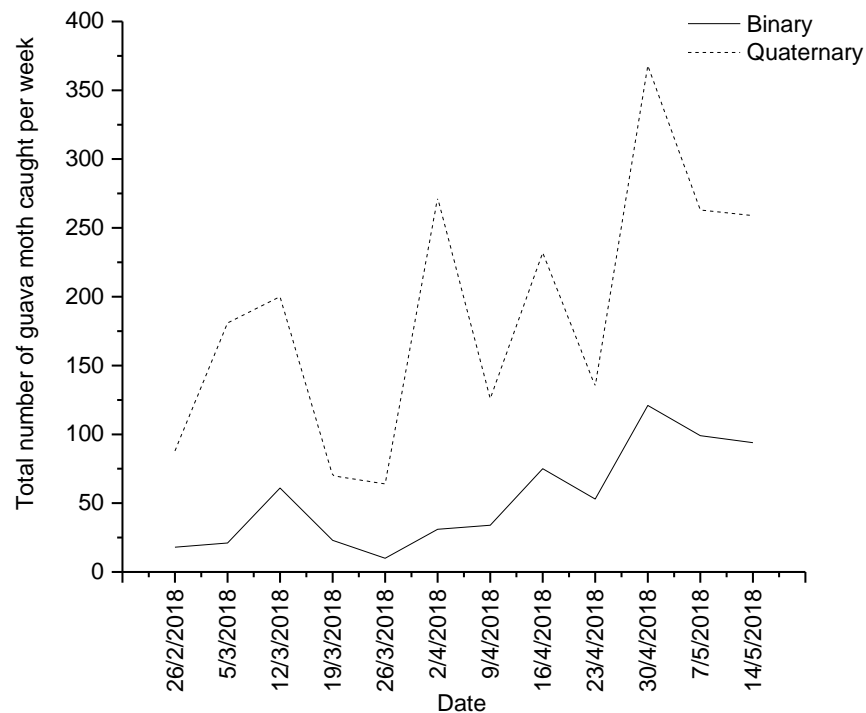


Figure 5. The total number of guava moth (*Coscinoptycha improbana*) males caught per week using the two-component and four-component guava moth pheromone blend lures at nine sites in the Auckland region from February to May 2018.

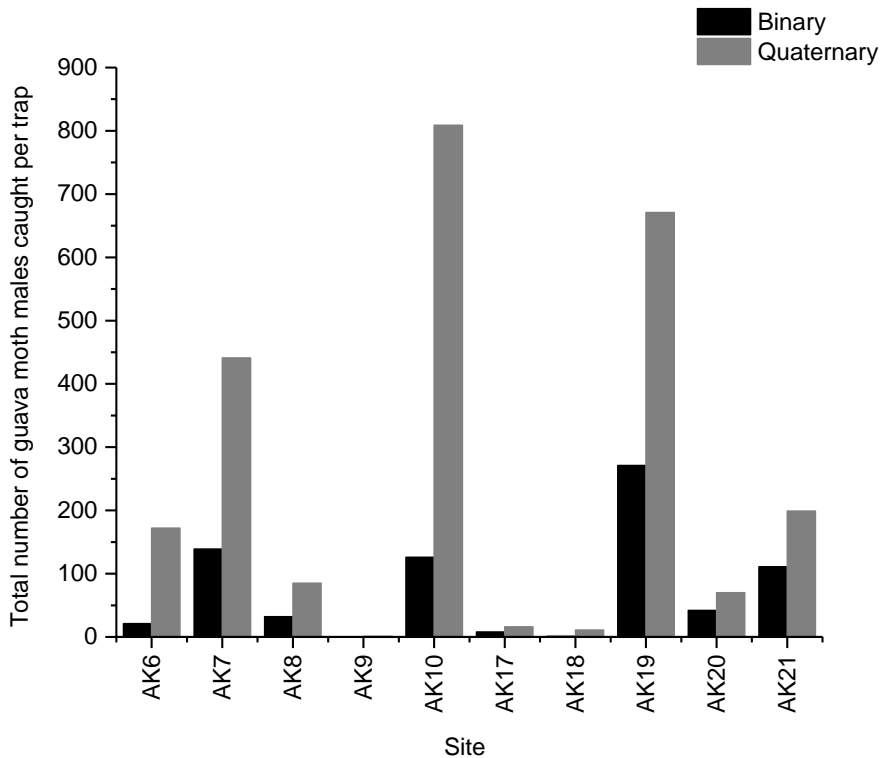


Figure 6. The total number of guava moth (*Coscinoptycha improbana*) males caught per site using the two-component and four-component guava moth pheromone blend lures over 12 weeks from February to May 2018 at 10 sites in the Auckland region.

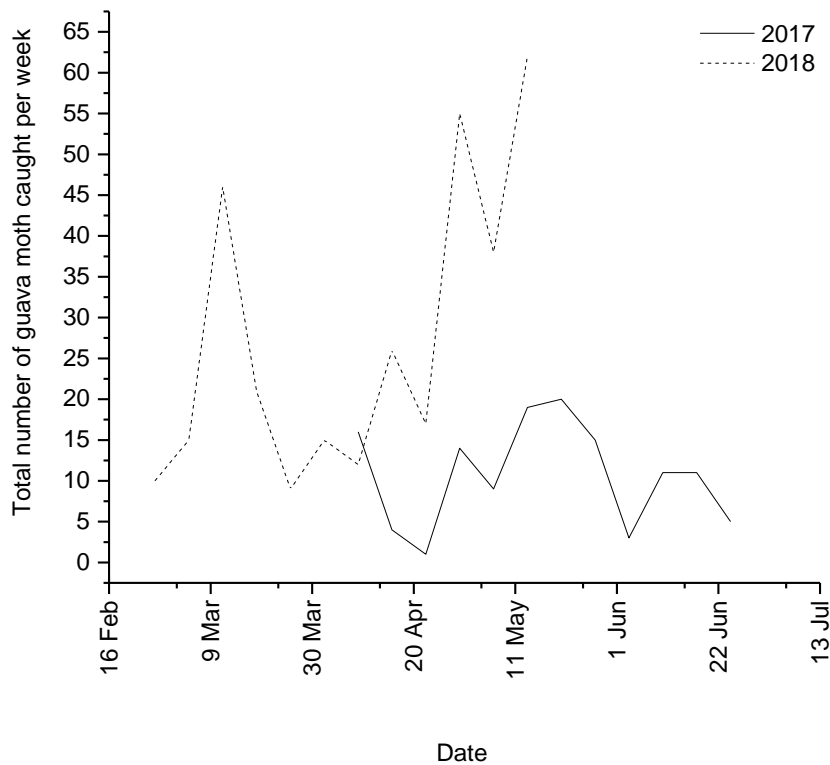


Figure 7. The total number of guava moth (*Coscinoptycha improbana*) males caught per week using the two-component guava moth pheromone blend lures at six sites in the Auckland region from April to June 2017 and February to May 2018.

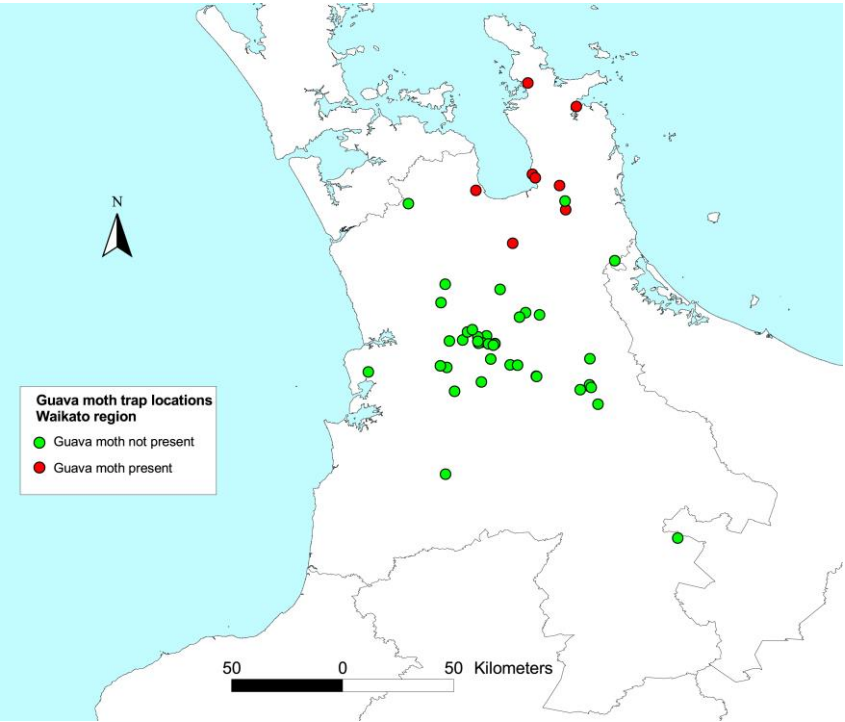


Figure 8. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Waikato region from February to May 2018.

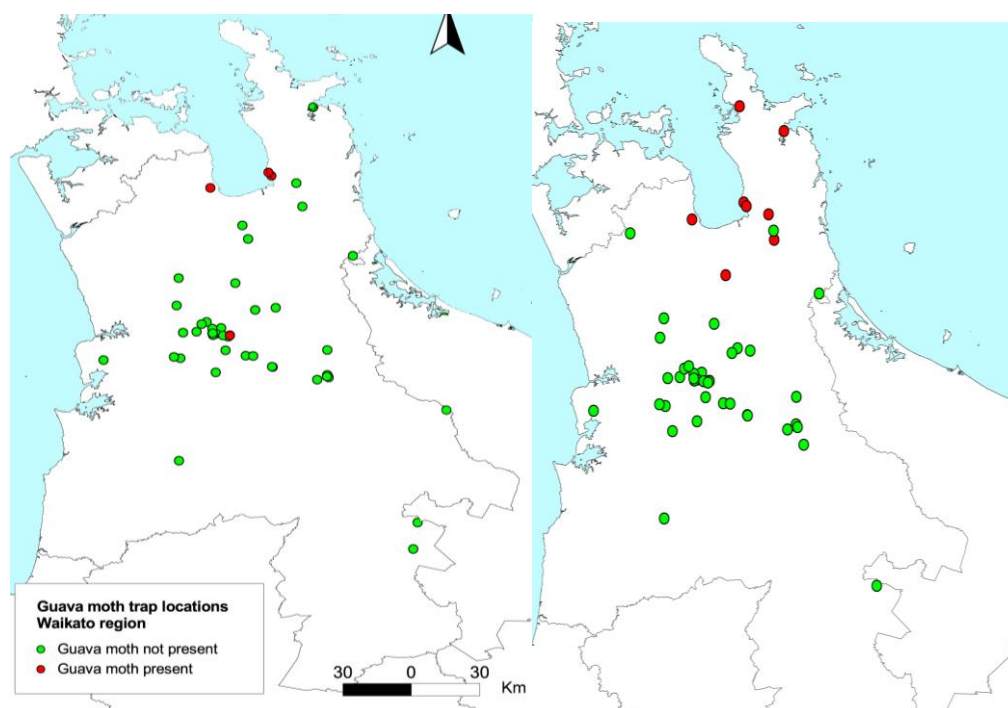


Figure 9. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Waikato region from April to July 2017 using the two-component guava moth pheromone lure (left) and February to May 2018 using the four-component guava moth pheromone lure (right).

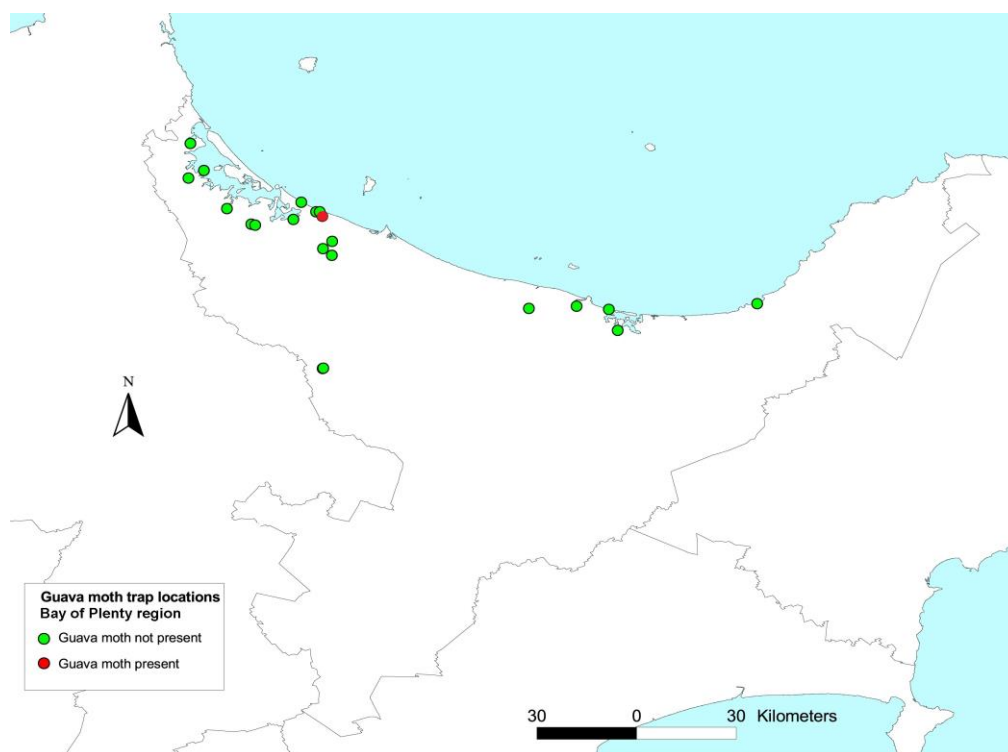


Figure 10. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Bay of Plenty region from February to May 2018.

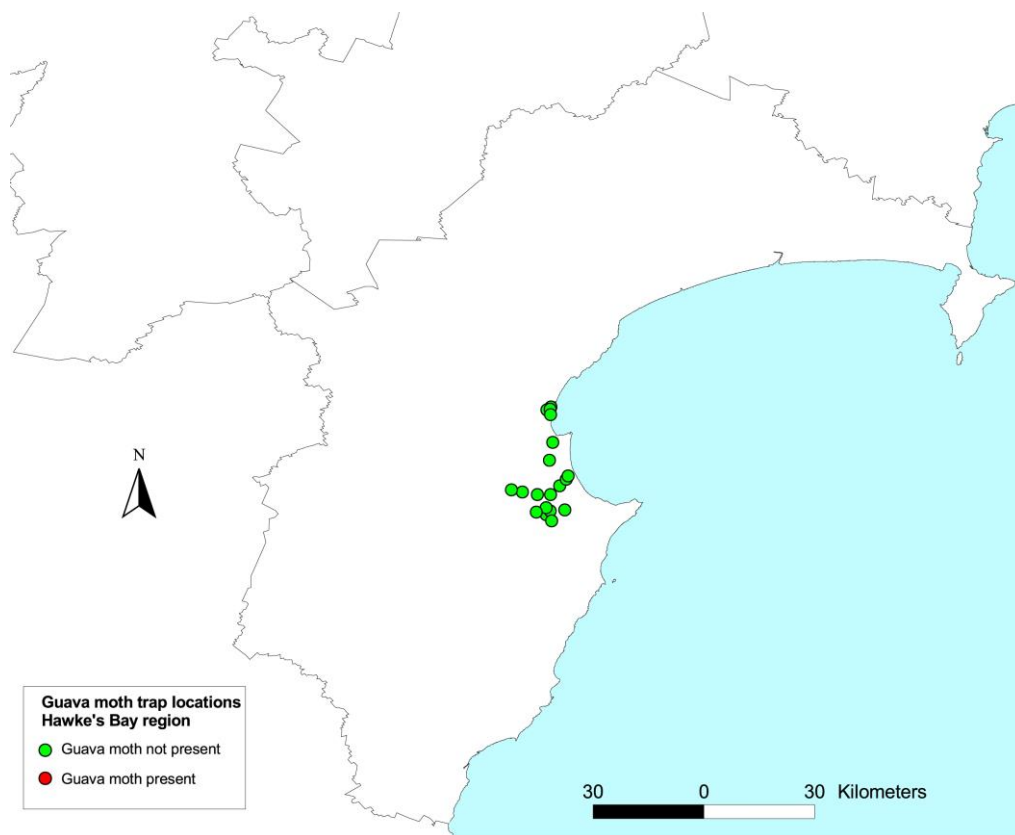


Figure 11. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Hawkes Bay region from February to May 2018.

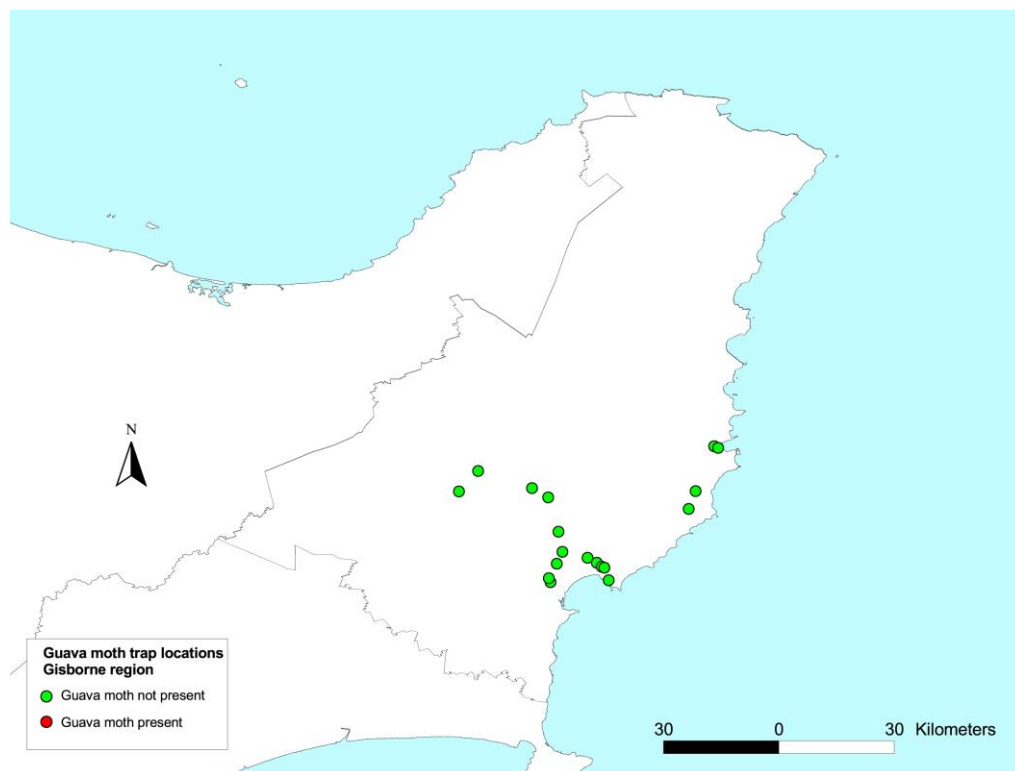


Figure 12. Guava moth (*Coscinoptycha improbana*) trap locations and presence absence of guava moth at each trap location in the Gisborne region from February to May 2018.

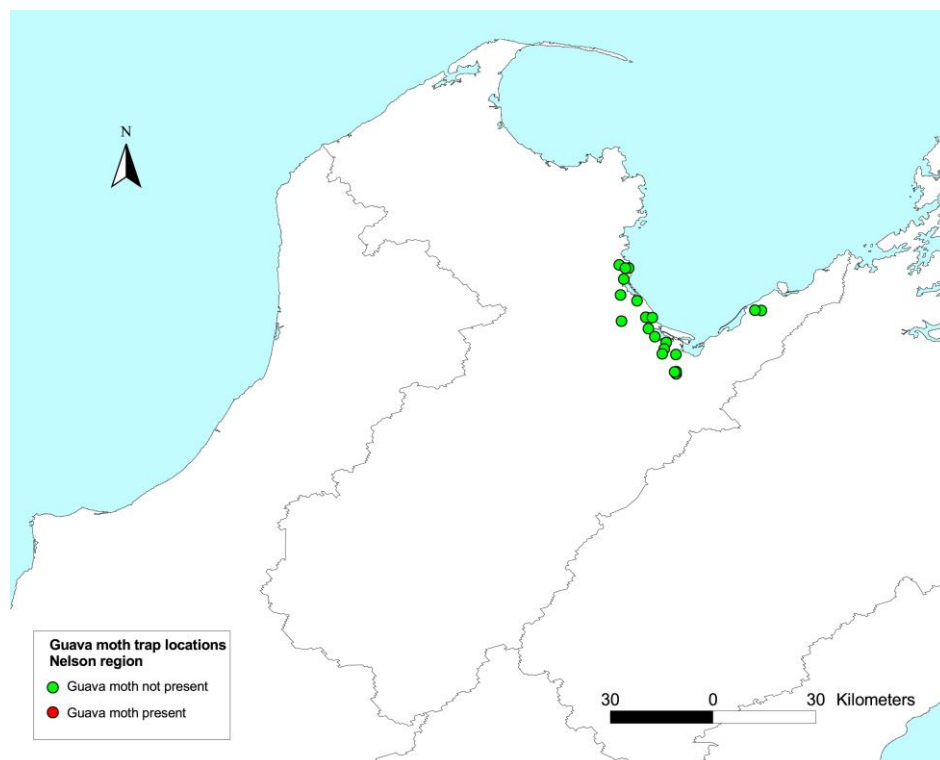


Figure 13. Guava moth (*Coscinoptycha improbana*) trap locations and presence/absence of guava moth at each trap location in the Nelson region from February to May 2018.



Heterocrossa eriphylla



Heterocrossa exochana



Carposina neurophylla



Isotenes miserana

Figure 14. Other Lepidoptera caught in the guava moth traps using the guava moth pheromone blend lures in the Auckland region from February to May 2018.

3.2 Ministry for Primary Industries (MPI) Records

The majority of guava moth records from 1997 to 2018 were from fruit received from Northland and Auckland (Table 3). In 2017, two records were also confirmed from the Coromandel (Kuaotunu and Te Kouma).

Guava moth has been found in association with a number of host fruit, including feijoas, macadamias, apples, citrus and summerfruit (Table 4). In 2017 and 2018, guava moth was also confirmed from persimmon and karaka berries, respectively.

Table 3. Ministry of Primary Industries (MPI) and AsureQuality Guava Moth (*Coscinoptycha improbana*) records from 1997 to 2018 by location.

Location	Number of records
Northland	57
Auckland	57
Coromandel	2
Total	116

Table 4. Ministry of Primary Industries (MPI) and AsureQuality Guava Moth (*Coscinoptycha improbana*) records from 1997 to 2018 by host.

Family	Common name	Scientific name	Number of records
Corynocarpaceae	Karaka	<i>Corynocarpus laevigatus</i>	1
Ebenaceae	Persimmon	<i>Diospyros kaki</i>	1
Myrtaceae	Feijoa	<i>Acca sellowiana</i>	19
Myrtaceae	Guava	<i>Psidium guajava</i> <i>Psidium</i> sp.	6
Myrtaceae	Lillypilly	<i>Syzygium australe</i>	1
Proteaceae	Macadamia	<i>Macadamia integrifolia</i>	8
Rosaceae	Apple	<i>Malus domestica</i> <i>Malus sylvestris</i> <i>Malus</i> sp.	4
Rosaceae	Loquat	<i>Eriobotrya japonica</i>	1
Rosaceae	Nashi Pear	<i>Pyrus pyrifolia</i>	1
Rosaceae	Peach	<i>Prunus persica</i>	10
Rosaceae		<i>Prunus</i> sp.	3
Rosaceae	Plum	<i>Prunus domestica</i>	13
Rosaceae	Apricot	<i>Prunus armeniaca</i>	1
Ruatceae	Citrus (unspecified)	<i>Citrus</i> sp.	8
Ruatceae	Grapefruit	<i>Citrus paradisi</i>	1
Ruatceae	Lemon	<i>Citrus limon</i>	11
Ruatceae	Mandarin	<i>Citrus reticulata</i>	10
Ruatceae	Orange	<i>Citrus sinensis</i>	9
Ruatceae	Tangelo	<i>Citrus tangelo</i>	3
Not specified			5
Total			116

4 DISCUSSION

Results of the distribution survey and records from MPI confirmed the presence of guava moth in the Auckland and Waikato regions (Crosby districts: Auckland, Coromandel and Waikato). Guava moth were recorded from all trial sites in the Auckland region. These included six sites which were used in the 2017 distribution survey (Taupaki, Henderson, Half Moon Bay, Clevedon, Pukekohe, Waiuku), and four new sites in Greenlane, Waiheke Island, Clarks Beach and Awhitu. Guava moth were also recorded from traps in Oratia, Warkworth and Mangawhai. This is particularly significant as it highlights that guava moth is widely distributed in Auckland.

Guava moth was recorded for the first time in the Bay of Plenty. Only one moth was caught on one occasion in Papamoa and this could be a result of high winds or the chance emergence of guava moth adults from infested fruit brought in from guava moth infested areas. A number of pheromone traps have been placed in the area to confirm whether the moth caught in late-May was a one-off chance incident or whether guava moth is in fact now present in the region.

Guava moth were also recorded from Miranda, Thames, Coromandel Town, Whitianga, Patetonga, Hikutaia and Kopu in the Waikato Region. The trap catches in Whitianga, Patetonga, Hikutaia and Kopu are particularly noteworthy as no guava moth were caught in traps at these same locations in the 2017 distribution survey. Whether this was a result of the guava moth lure used in the surveys (2017= two-component and 2018= four-component), or a sign of the increasing distribution of guava moth, is unknown. Only one moth was caught in each of the traps in Kopu and Patetonga during the trial in 2018 and this, as with the catch in Papamoa, could also be a result of high winds or the chance emergence of guava moth adults from infested fruit brought in from guava moth infested areas. In 2017, a single moth was caught in a trap in Matangi however, no guava moth were caught in the same location in the 2018 distribution survey. It is likely this was also a random trap catch. Nonetheless, the presence of guava moth in Papamoa, Patetonga and Hikutaia is of concern due to their proximity to important fruit growing areas in central Waikato and the Bay of Plenty.

Trap catch was higher with the four-component blend guava moth pheromone lure compared to the two-component blend in Auckland over the trial period. This was especially noticeable at sites with high guava moth populations. It is also worth noting that at one site in Auckland, guava moth was only caught in the four-component blend trap and not in the two-component blend trap. It is recommended that the four-component lure is used for future trial work where possible and that the commercialisation of the four-component blend guava moth pheromone lure is investigated.

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APPENDIX 1. LOCATION OF GUAVA MOTH TRAPS IN THE AUCKLAND REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (two-component blend; 95:5 ratio of Z7-11-one-18Hy and Z7-11-one-19Hy and four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Pheromone Lure Blend	Total no. of GM
Henderson	-36.8843929	174.6380483	Feijoa	1	AK6A	Two-component	21
Henderson	-36.8843929	174.6380483	Feijoa	2	AK6B	Four-component	172
Half Moon Bay	-36.8858254	174.9043902	Feijoa	3	AK7A	Two-component	139
Half Moon Bay	-36.8858254	174.9043902	Feijoa	4	AK7B	Four-component	441
Clevedon	-37.0186013	174.9882221	Feijoa	5	AK8A	Two-component	32
Clevedon	-37.0186013	174.9882221	Feijoa	6	AK8B	Four-component	85
Pukekohe	-37.2022454	174.950505	Feijoa	7	AK9A	Two-component	0
Pukekohe	-37.2022454	174.950505	Feijoa	8	AK9B	Four-component	1
Waiuku	-37.1919653	174.6924345	Macadamia	9	AK10A	Two-component	126
Waiuku	-37.1919653	174.6924345	Macadamia	10	AK10B	Four-component	809
Taupaki	-36.8170662	174.5884788	Feijoa	11	AK17A	Two-component	8
Taupaki	-36.8170662	174.5884788	Feijoa	12	AK17B	Four-component	16
Awhitu	-37.087829	174.63388	Feijoa	13	AK18A	Two-component	1
Awhitu	-37.087829	174.63388	Lemon	14	AK18B	Four-component	11
Clarks Beach	-37.146373	174.736842	Feijoa	15	AK19A	Two-component	271
Clarks Beach	-37.146373	174.736842	Feijoa	16	AK19B	Four-component	671
Greenlane	-36.899809	174.736842	Feijoa	17	AK20A	Two-component	42
Greenlane	-36.899809	174.736842	Feijoa	18	AK20B	Four-component	70
Waiheke Island	-36.781659	175.044975	Apple	19	AK21A	Two-component	111*
Waiheke Island	-36.781659	175.044975	Apple	20	AK21B	Four-component	199*
Oratia	-36.9341854	174.6066	Feijoa	21	AK23A	Two-component	2*
Oratia	-36.935897	174.6062	Feijoa	22	AK24A	Two-component	3*
Warkworth	-36.3784937	174.7581	Feijoa	23	AK26A	Two-component	12*
Warkworth	-36.41906	174.6515	Feijoa	24	AK27A	Two-component	6*
Mangawhai	-36.0850685	174.5661	Feijoa	25	AK28A	Two-component	13*

*Traps checked every 3-4 weeks

APPENDIX 2. LOCATION OF GUAVA MOTH TRAPS IN THE WAIKATO REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10)

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Miranda	-37.1784462	175.2932729	Feijoa	26	WO1	1
Waihi	-37.463663	175.8550324	Feijoa	27	WO2	0
Motumaoho	-37.673926	175.493892	Feijoa	28	WO3	0
Huntly	-37.5587337	175.1682617	Feijoa	29	WO4	0
Huntly	-37.5587337	175.1682617	Red guava	30	WO5	0
					WO6	No trap
Hamilton	-37.1784462	175.2932729	Feijoa	31	WO7	0
Hamilton	-37.463663	175.8550324	Feijoa	32	WO8	0
Hamilton	-37.5587337	175.1682617	Feijoa	33	WO9	0
Hamilton	-37.5587337	175.1682617	Feijoa	34	WO10	0
Hamilton	-37.6746346	175.1602829	Feijoa	35	WO11	0
Hamilton	-37.7685009	175.3355948	Feijoa	36	WO12	0
Hamilton	-37.7885142	175.1851256	Feijoa	37	WO13	0
Hamilton	-37.7914194	175.3020581	Feijoa	38	WO14	0
Hamilton	-37.7939461	175.3155181	Feijoa	39	WO15	0
Hamilton	-37.7986418	175.3029506	Feijoa	40	WO16	0
Matangi	-37.7717462	175.3003216	Feijoa	41	WO17	0
Ngahinapouri	-37.7850527	175.2388273	Feijoa	42	WO18	0
Te Pahu	-37.7530685	175.2580471	Feijoa	43	WO19	0
Patetonga	-37.7435101	175.2777797	Macadamia	44	WO20	1
					WO21	No trap
Morrinsville	-37.7991913	175.3700344	Feijoa	45	WO22	0
Morrinsville	-37.8967745	175.1746361	Feijoa	46	WO23	0
Morrinsville	-37.8903695	175.1488177	Feijoa	47	WO24	0
Raglan	-37.3934544	175.4422362	Feijoa	48	WO25	0
Matangi	-37.3364889	175.4186497	Feijoa	49	WO26	0
Matangi	-37.6837079	175.5506349	Feijoa	50	WO27	0
Matangi	-37.5795117	175.3910024	Feijoa	51	WO28	0
Matamata	-37.6927753	175.4696537	Feijoa	52	WO29	0

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
					WO30	No trap
Cambridge	-37.9321144	175.536654	Feijoa	53	WO31	0
Cambridge	-37.8855813	175.4318652	Feijoa	54	WO32	0
Cambridge	-37.9330456	175.5389228	Feijoa	55	WO33	0
Cambridge	-37.8624495	175.3524066	Feijoa	56	WO34	0
Cambridge	-37.8870445	175.4611744	Feijoa	57	WO35	0
Ohaupo	-37.9558231	175.3142435	Feijoa	58	WO36	0
					WO37	No trap
Tirau	-37.9740333	175.7532376	Feijoa	59	WO38	0
Tirau	-37.9667567	175.7536138	Feijoa	60	WO39	0
Tirau	-37.9778100	175.7600799	Feijoa	61	WO40	0
Puatruru	-38.045425	175.786496	Feijoa	62	WO41	0
Tirau	-37.9861741	175.7145885	Feijoa	63	WO42	0
Whitianga	-36.8383376	175.698971	Feijoa	64	WO43	2
Hikutaia	-37.2571362	175.6562583	Feijoa	65	WO44	2
Thames	-37.1129475	175.5217015	Feijoa	66	WO45	1
Thames	-37.1280191	175.5335999	Feijoa	67	WO46	44
Kopu	-37.1586054	175.6315069	Feijoa	68	WO47	1
					WO48	No trap
Te Kuiti	-38.3288867	175.1696542	Feijoa	69	WO49	0
Taupo	-38.5884062	176.11006	Feijoa	70	WO50	0
Pokeno	-37.231933	175.018872	Feijoa	71	WO51	0
Thames	-37.221086	175.654138	Macadamia	72	WO52	0
Ngaruawahia	-37.63389	175.15082	Feijoa	73	WO53	0
Pirongia	-37.992781	175.206292	Feijoa	74	WO54	0
Coromandel	-36.742618	175.502782	Feijoa	75	WO55	151*

*Trap setup in late April and only checked once in mid-May.

APPENDIX 3. LOCATION OF GUAVA MOTH TRAPS IN THE BAY OF PLENTY REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10)

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Te Puke	-37.8045056	176.2955586	Loquat	76	BOP1	0
Te Puke	-37.8227855	176.319623	Macadamia	77	BOP2	0
Papamoa	-37.701458	176.276795	Feijoa	78	BOP3	1
Papamoa	-37.7132657	176.2936779	Feijoa	79	BOP4	0
Papamoa	-37.7011380	176.2868588	Feijoa	80	BOP5	0
Tauranga	-37.7361683	176.1016278	Feijoa	81	BOP6	0
Te Puke	-37.783547	176.320864	Feijoa	82	BOP7	0
Welcome Bay	-37.7227857	176.2153902	Feijoa	83	BOP8	0
Mt Maunganui	-37.6742068	176.2367458	Feijoa	84	BOP9	0
Katikati	-37.5853206	175.973521	Macadamia	85	BOP10	0
Katiakti	-37.5093141	175.9362653	Feijoa	86	BOP11	0
Te Puna	-37.6920980	176.0353767	Feijoa	87	BOP12	0
Opotiki	-37.9588912	177.471059	Macadamia	88	BOP13	0
Opotiki	-38.0331555	177.0935743	Macadamia	89	BOP14	0
Whakatane	-37.9722270	176.8527949	Feijoa	90	BOP15	0
Whakatane	-37.9653316	176.9826263	Feijoa	91	BOP16	0
Ohope	-37.9745756	177.0693717	Feijoa	92	BOP17	0
Rotorua	-38.1403839	176.2949747	Feijoa	93	BOP18	0
Rotorua	-38.1388708	176.2962647	Feijoa	94	BOP19	0
Pyes Pa	-37.738373	176.111937	Feijoa	95	BOP20	0
Katikati	-37.6065722	175.9310373	Feijoa	96	BOP21	0

APPENDIX 4. LOCATION OF GUAVA MOTH TRAPS IN THE HAWKE'S BAY REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Havelock North	-39.6733273	176.8607414	Lime	97	HB1	0
Bay view	-39.4103693	176.871907	Orange	98	HB2	0
Bay view	-39.41791	176.862416	Feijoa	99	HB3	0
Bay view	-39.4161194	176.870276	Lime	100	HB4	0
Havelock North	-39.6638031	176.8706973	Citrus	101	HB5	0
Hastings	-39.6182786	176.8028402	Orange	102	HB6	0
Hastings	-39.624323	176.839173	Feijoa	103	HB7	0
Havelock North	-39.6612027	176.9058411	Feijoa	104	HB8	0
Havelock North	-39.6561835	176.8602436	Feijoa	105	HB9	0
Longlands	-39.6667166	176.836961	Plum	106	HB10	0
Hastings	-39.6240271	176.8710909	Plum	107	HB11	0
Hastings	-39.6031381	176.8932536	Citrus	108	HB12	0
Clive	-39.5870726	176.9099908	Plum	109	HB13	0
Onekawa	-39.4969933	176.8763582	Not recorded	110	HB14	0
Bay view	-39.4290623	176.8716474	Feijoa	111	HB15	0
Hastings	-39.624323	176.839173	Plum	112	HB16	0
Taradale	-39.5400009	176.8682018	Feijoa	113	HB17	0
Havelock North	-39.6882165	176.8737986	Feijoa	114	HB18	0
Clive	-39.5790289	176.9140656	Plum	115	HB19	0
Hastings	-39.612569	176.7763414	Lime	116	HB20	0

APPENDIX 5. LOCATION OF GUAVA MOTH TRAPS IN THE GISBORNE REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Ormond	-38.57004	177.924565	Feijoa	117	GB1	0
Waerengahika	-38.476291	177.691372	Feijoa	118	GB2	0
Hexton	-38.631476	177.992257	Feijoa	119	GB3	0
Makaraka	-38.476345	177.691372	Feijoa	120	GB4	0
Manutuke	-38.688755	177.905872	Feijoa	121	GB5	0
Manutuke	-38.67945	177.9015998	Feijoa	122	GB6	0
Manutuke	-38.6794500	177.9015998	Feijoa	123	GB7	0
Patutahi	-38.645555	177.920214	Macadamia	124	GB8	0
Te Karaka	-38.4679906	177.862755	Feijoa	125	GB9	0
Otoko	-38.4280259	177.7367574	Feijoa	126	GB10	0
Te Karaka	-38.490212	177.900446	Feijoa	127	GB11	0
Waerengahika	-38.61739	177.933975	Feijoa	128	GB12	0
Mangapapa	-38.642765	178.014053	Feijoa	129	GB13	0
Gisborne	-38.652233	178.025411	Feijoa	130	GB14	0
Whataupoko	-38.654696	178.031559	Feijoa	131	GB15	0
Gisborne	-38.6840578	178.0421124	Feijoa	132	GB16	0
Tolaga Bay	-38.5171283	178.229069	Feijoa	133	GB17	0
Tolaga Bay	-38.4754592	178.2450231	Citrus	134	GB18	0
Tolaga Bay	-38.3699743	178.2882325	Feijoa	135	GB19	0
Tolaga Bay	-38.373545	178.298023	Citrus	136	GB20	0

APPENDIX 6. LOCATION OF GUAVA MOTH TRAPS IN THE NELSON REGION AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Riwaka	-41.0915474	172.9967568	Feijoa	137	NN1	0
Motueka	-41.0998522	173.0210192	Feijoa	138	NN2	0
Motueka	-41.0996893	173.0127618	Citrus	139	NN3	0
Tasman	-41.2292857	173.066206	Feijoa	140	NN4	0
Ruby Bay	-41.2297642	173.0834745	Feijoa	141	NN5	0
Mahana	-41.2586019	173.0728414	Feijoa	142	NN6	0
Redwood Valley	-41.2801696	173.0900405	Feijoa	143	NN7	0
Appleby	-41.2948839	173.1199088	Feijoa	144	NN8	0
Appleby	-41.3119110	173.1149017	Feijoa	145	NN9	0
Wakapuaka	-41.2111116	173.3694611	Feijoa	146	NN10	0
Wakapuaka	-41.2103761	173.3528724	Feijoa	147	NN11	0
Tasman	-41.3777693	173.1460643	Macadamia	148	NN12	0
Tasman	-41.3717942	173.1463926	Feijoa	149	NN13	0
Tasman	-41.3724944	173.1419583	Feijoa	150	NN14	0
Motueka	-41.1283963	173.0082176	Feijoa	151	NN15	0
Lower Moutere	-41.1704032	172.999873	Feijoa	152	NN16	0
Tasman	-41.1858095	173.0431404	Citrus	153	NN17	0
Appleby	-41.3247935	173.1098238	Feijoa	154	NN18	0
Hope	-41.3269826	173.1450873	Feijoa	155	NN19	0
Upper Motuere	-41.2389206	173.0029348	Feijoa	156	NN20	0

APPENDIX 7. LOCATION OF GUAVA MOTH TRAPS IN THE MANUWATU AND TARANAKI REGIONS AND THE TOTAL NUMBER OF GUAVA MOTH MALES CAUGHT PER TRAP FROM FEBRUARY TO MAY 2018

Guava moth pheromone lures with 1000 µg guava moth sex pheromone (four-component blend of Z7-23Hy, Z7-11-one-18Hy, Z7-11-one-19Hy, and Z7-11-one-23Hy at a ratio of 65:23.5:1.5:10).

Location	Latitude	Longitude	Host tree	Unique Trap No.	Site/Trap No.	Total no. of GM
Manawatu						
Feilding	-40.210146	175.619293	Feijoa	157	MA1	0
Taranaki						
Waitara	-8.9932442	174.224023	Feijoa	158	TA1	0
Waitara	-39.00157	174.256946	Feijoa	159	TA2	0
Waitara	-39.031436	174.288913	Feijoa	160	TA3	0



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