DESCRIPTIVE STUDY OF HOSPITAL DISCHARGES FOR RESPIRATORY DISEASES IN SPRAY ZONE FOR PAINTED APPLE MOTH (AUCKLAND), RELATIVE TO LOCAL AND NATIONAL STATISTICS 1999-2004

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DESCRIPTIVE STUDY OF HOSPITAL DISCHARGES FOR RESPIRATORY DISEASES IN SPRAY ZONE FOR PAINTED APPLE MOTH (AUCKLAND), RELATIVE TO LOCAL AND NATIONAL STATISTICS 1998-2004

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Abbreviations

Btk	*Bacillus thuringiensis* subspecies *kurstaki*
CAU	Census Area Unit
ICD-9	International classification of diseases version 9
ICD-10	International classification of diseases version 10
MAF	Ministry of Agriculture and Forestry
NHI	National Health Index
NIWA	National Institute of Water and Atmospheric Sciences
NZHIS	New Zealand Health Information Service
PM10	Particulate Matter of 10 microns in size or less
TLA	Territorial Local Authority

1 SUMMARY

Aerial application of Foray 48B was conducted over Auckland suburbs from January 2002 to May 2004 to eradicate the exotic pest, the Painted Apple Moth.

A report commissioned by the Ministry of Health in February 2004 recommended that "…further epidemiological studies are carried out, with sufficient statistical power to provide adequate reassurance to exposed communities in the event that no health effects are found."

The present study compared the age-adjusted and sex-adjusted hospitalisation rates for respiratory diseases for all of New Zealand with equivalent rates for the population living within the spray zone, from January 1998 to May 2004.

In the New Zealand population, monthly hospitalisation rates remained steady with a slightly lower-than-usual winter peak in 2000. In the exposed population, there was an increase in hospitalisations beginning in 2001 (one year before spraying began), continuing into 2004.

We compared hospitalisation rates before (1998-2001) and during (2002-mid 2004) the spray programme. There was no difference between before-spray and during-spray monthly discharge rates for influenza/pneumonia, but asthma discharge rates doubled over the period 2002-mid 2004 for boys aged 0 to 4 years old in the exposed population. Similar but less dramatic increases were observed for girls aged 0 to 4 and 5 to 14 (50% and 80% increases, respectively). Overall, the age-adjusted and sex-adjusted monthly hospital discharge rate for asthma conditions increased by 40% between the two time periods (before and during spray-time) for the spray population and decreased 11% for the national population.

The underlying trend in hospital discharges for respiratory diseases and asthma in the spray zone was evident before spraying began and cannot therefore be attributed to this exposure. However, there are several findings pointing to a real increase in asthma discharges that could plausibly be associated with the spray programme.

Comparing the year 2001 with 2004, there was an increase in asthma admissions in residents inside the spray zone, but a decrease in asthma admissions in residents just outside the spray zone. These trends were statistically significant. In sub analyses by ethnicity, the largest increase appeared in the non European exposed group.

Compared to the three-day period just prior to spraying, spray days and the period of three days after spray days showed slightly higher rates of respiratory and asthma admission within the spray zone. Slightly lower rates of asthma admission than during the pre-spray period were observed outside the spray zone. These differences were not statistically significant.

Chance, bias and confounding are possible alternative explanations for the results and we stress that these results do not prove that the observed patterns of respiratory hospital discharges were caused by exposure to the spray.

2 INTRODUCTION

Between 21 January 2002 and 13 May 2004, residential areas of Western Auckland were sprayed with Foray 48B in an effort to eradicate an exotic pest, the Painted Apple Moth.

This study was commissioned by the New Zealand Ministry of Health to examine hospital discharge rates for respiratory conditions among the exposed population compared to local and national rates before and during the spray period.

Specific terms of reference for this report are as follows:

- Assemble NZHIS hospital discharge data for ICD-10 codes corresponding to respiratory disease. Compare rates between the spray zone and nationally. Specifically examine discharges and other data over critical time periods, using before and during spray event (Jan 2002 to May 2004) comparisons as one control measure, and also comparing to non-exposed.
- Include PM10 monitoring data from the most relevant air monitoring station(s) to account for general particulate pollution as a confounding factor, and account for changes in ambient temperatures.

The pesticide Foray 48B contains a gram positive bacterium called *Bacillus thuringiensis kurstaki* (Btk), held in water suspension. Spores and crystal proteins called delta-endotoxin are produced by Btk. The release of these proteins is stimulated by the alkaline environment of the caterpillar gut after ingestion, and results in caterpillar death. Btk does not release endotoxin under acidic conditions such as the mammalian gut, and is therefore considered safe for human exposure.

Information on the toxicology and environmental fate of Foray 48B is beyond the scope of this report. However, the reader can be directed to relevant references for this information (Noble et al. 1992; Bernstein et al. 1999; Capital Health Region Office of the Medical Health Officer Director of Research 1999; Valent Biosciences Corporation 2000; Teschke et al. 2001; Doekes et al. 2004).

Studies of residential populations exposed to Foray 48B from aerial spraying have described a range of possible health effects including respiratory distress, mucous membrane irritation such as sore throat and itchy eyes, gastrointestinal disturbances and neurological symptoms such as dizziness, sleep disturbances, headache, inability to concentrate and increased anxiety (Noble et al. 1992; Aer'Aqua Medicine Ltd 2001; Washington State Department of Health 2001; Pearce et al. 2002; Hales et al. 2004). None of these studies were able to conclusively attribute symptoms to spray exposure.

Noble et al. (1992) examined health records in a community following spraying of *Btk*. No illness or infections were attributed to *Btk* following review of 3500 hospital admissions, 1140 general practice records and 400 *Btk*-positive bacterial cultures from 10 hospitals. *Btk* was isolated from several body sites, including blood, body fluids, eyes, nose and tissue samples. The authors concluded that these were due to previous use of the pesticide Btk. However, it was reported that spray workers "frequently developed symptoms of headache, nose, throat and eye irritation, dry skin and chapped lips" (Noble et al. 1992).

A telephone hotline received over 20,000 calls. Of these, about a thousand were "health related" and of these, "… 247 calls represented complaints from individuals who reported being in the spray zone or exposed to the spray, and who attribute their symptoms to that exposure." (Noble et al. 1992)

Two studies of communities exposed during *Btk* spraying in Canada in 1992 and again in 1994 contain reports of "allergic rhinitis symptoms, exacerbations of asthma, and skin reactions" (Anon 1993; Bender and Peck 1996), cited in (Bernstein et al. 1999). The largest and most detailed study to date was conducted during aerial spraying for control of Gypsy moth in Vancouver Island, 1999 (affected population, 80,000). This study consisted of the following components:

1. Asthmatic Children's Survey
The survey studied the health of children with asthma, both inside and outside the spray areas, for any health changes that could be attributed to the spray.

2. General Population Survey
This telephone survey documented the health of a group of adults inside and outside the spray area both before and after the spray.

3. Laboratory Surveillance
Laboratory analysis was used to find people whose lab specimen was identified as containing *Btk*, to determine the specific type of *Bt* bacteria found in the specimens, and to compare it to the specific type of *Bt* used in Foray 48B. The role of the identified bacteria, if any, in human disease was also assessed.

4. Exposure Assessment Measurements
Air samples were collected in order to determine the air concentrations of *Btk* within the spray area, both inside and outside homes, as well as over time.

5. Doctors' Office Visits
This information were collected and will be studied for any possible links to the spray program. [In the event, it proved impossible to analyse these data, due to inaccuracy in the recording of ICD codes]

6. Emergency Room Visits
This information from local hospitals' emergency rooms was studied and compared to previous years, and analyzed for possible links to the spray.

7. Telephone Health Support Line Data
A telephone support line was available to the community during the spray periods. Self-reports made to the support line were summarized in the context of the larger study. (Anon 1999)

The authors did not show a relationship between aerial spraying of Foray 48B and short-term human health effects. (Anon 1999; Anon 2001a). Following aerial spraying of Foray 48B in a Seattle neighbourhood of 6600 residents, eight people sought healthcare following the event (0.11%), one was seen in an emergency department, and none were hospitalised (Washington State Department of Health 2001). This and other studies have

reached the same conclusion - none of the reported symptoms following spray events are expected to result in hospitalisations.

Several studies have been carried out following aerial spraying with *Btk* products in Auckland in recent years. About 80,000 people were living in the spray zone during aerial spraying for eradication of white spotted tussock moth in the eastern suburbs of Auckland, 1996-7. The implementation of health surveillance was required by government and included:

> "(a) Documentation and investigation of self-reported concerns;
> (b) Health surveillance using sentinel general medical practitioners;
> (c) Review of health data from suitable sources;
> (d) Birth outcomes analysis;
> (e) A register of individuals exposed to the Btk spray." (Aer'aqua 2001)

"Reported concerns were followed up through a process of interview, requests to consent to obtaining relevant information from health care practitioners, review by a panel of medical specialists of recorded concerns and any available medical information, and where appropriate additional personal medical assessments. This process did not identify any significant diseases attributable to the spraying." (Aer'aqua 2001)

Health surveillance using sentinel general medical practitioners included two practices, one located in the centre of the spray zone and one on the periphery. "Each patient was classified according to their street address (at the time of spraying) as either Zone A - residentially exposed to spraying between October 1996 and April 1997 by DC-6 and helicopter; Zone B - residentially exposed to DC-6 spraying between October and December 1996; or Zone C - not residentially exposed to spraying." (Aer'aqua 2001)

The overall conclusions were as follows: "No adverse health patterns were found, once patterns were examined at a population level. The frequency of occurrence of the following was no different from natural variation: early births; small babies; birth defects; consultation rates with sentinel family doctors for asthma, other respiratory problems, headaches, skin or eye symptoms, and autoimmune disorders." (Aer'aqua 2001)

A study conducted on a subset of the Auckland population used symptom questionnaires before and after the Painted Apple Moth spraying programme began in 2002 (Petrie et al. 2003). Unfortunately, cumulative symptom prevalence was recorded for different retrospective time periods (4 weeks vs 3 months), resulting in data that were not directly comparable.

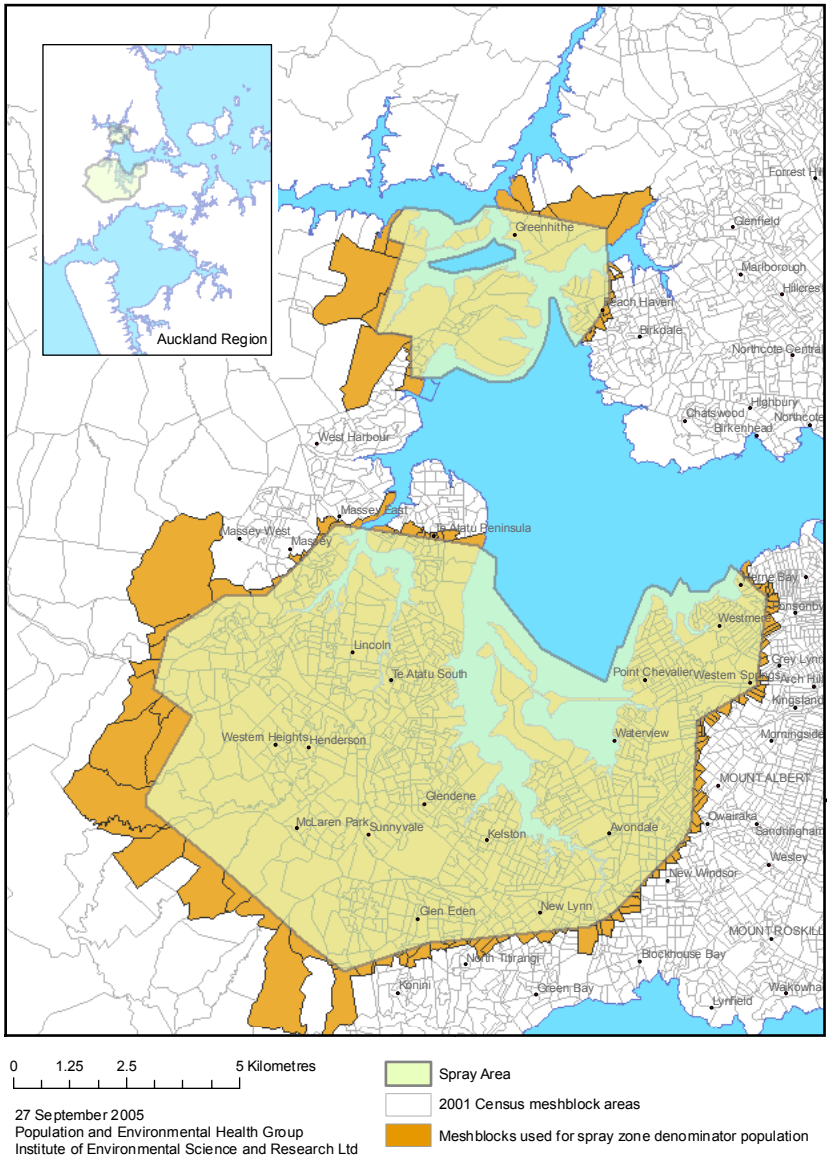
3 METHODS

Identifying the Spray Zone Population (Exposed)

The exposed (numerator) population is based on residential location within the spray zone. The spray zones were supplied as georeferenced digital files by the Ministry of Agriculture and Forestry (MAF) who conducted the spray campaign.

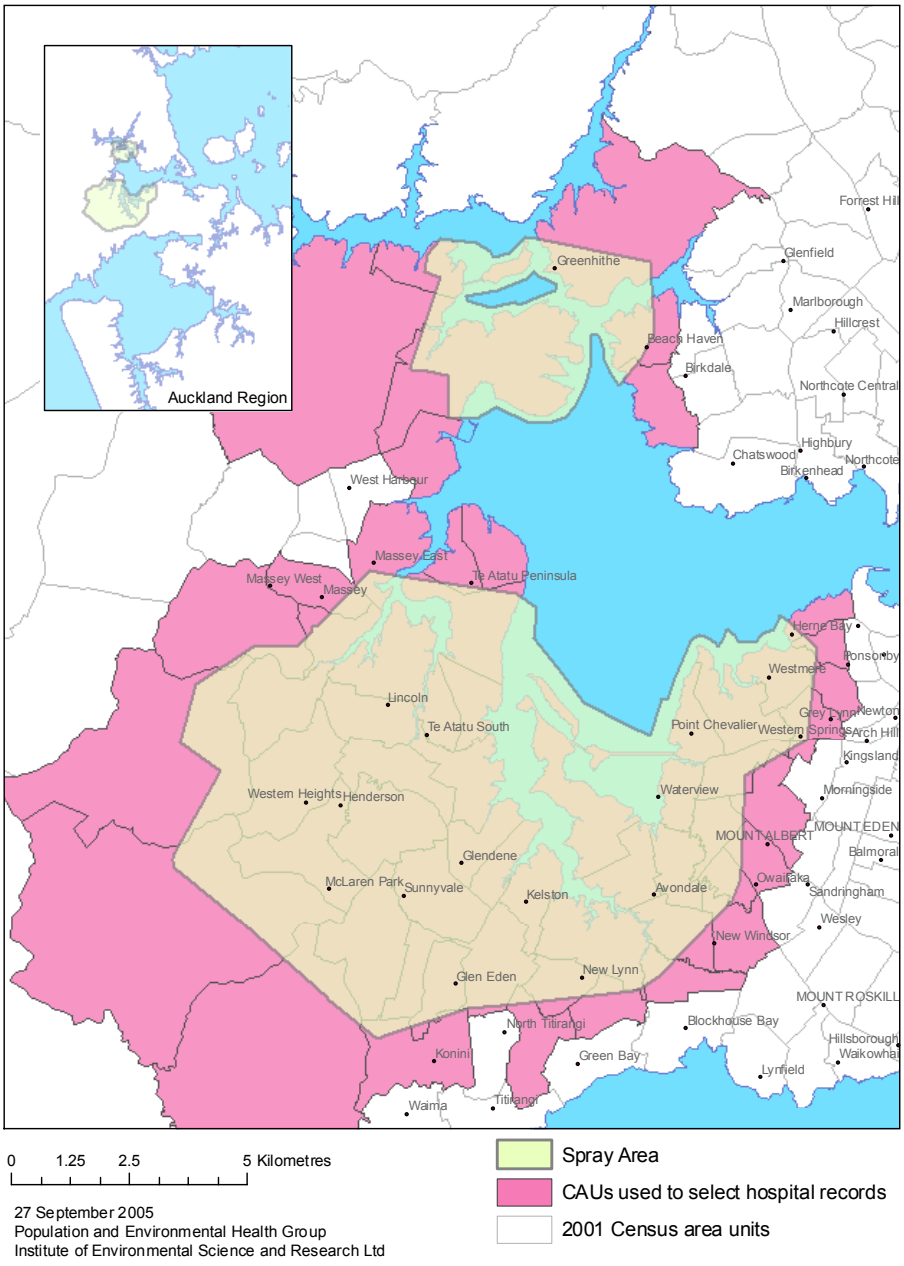
A denominator population of 160,014 people living within the spray zone was estimated from the Statistics New Zealand 2001 usually resident meshblock populations. This estimate was obtained by summing population counts from each meshblock with any part of its area falling within the spray zone boundary (see Figure 1).

Figure 1 Map of the spray area for painted apple moth, 2002-2004, showing meshblocks selected for the denominator population



As multivariate data are not available at the meshblock level of aggregation, the age and sex distributions of the residents were determined from the Census Area Units (CAU), according to the 2001 Census Count published by Statistics New Zealand. The 61 CAUs (with a population of 225,771) used to determine the age and sex distributions were the same ones used to extract the hospital discharge data from NZHIS (see Figure 2 and section 3.1 on numerator data and geocoding of datasets C and D). Population denominator counts by age and sex for previous and subsequent years were assumed to be the same as in the 2001 Census.

Figure 2 Map of the Census Area Units (CAUs) used to select the hospital records for geocoding, determine the age and sex distribution of the residents and compare rates of admission for residents inside and immediately outside the spray zone



Selection of Comparison Groups

Two comparison populations were selected. One comparison group was selected from an urban population adjacent to the spray zone. The national population of New Zealand was selected as a second comparison group to avoid anomalous differences caused by changing hospital discharge thresholds affected by regional factors, minimizing the impact of including possibly exposed individuals from spray drift.

General Population Denominator Dataset

The total population of usual residents (by age and sex) in New Zealand, according to the 2001 census was used. In the case of the asthma rates and influenza/pneumonia national rates, the total population of New Zealand minus the three TLAs, Waitakere, North Shore and Auckland City, was used.

3.1 Calculating Respiratory Hospitalisation Rates

Numerator Data

Hospitalisation data for all New Zealand were obtained by age and sex from the New Zealand Health Information Service (NZHIS) for the period 1 January 1990 to 30 May 2004, with the following variables:

- Number of hospital discharges for respiratory diseases (ICD10 J00-J99).
- Number of hospital discharges for asthma (ICD10 J45-J46).
- Number of hospital discharges for diseases of the circulatory system (ICD10 I00-I99).
- date of discharge,
- age,
- sex,
- ethnicity,
- ICD 10 sub code, and
- location of hospital (in Auckland/ out of Auckland).

Separate data sets were provided for the above data due to differences in spatial and temporal resolution.

Dataset A- time period 1st Jan 1999- 31st May 2004, all respiratory discharges (ICD9 codes 460-519) for all of New Zealand.

Dataset B - time period 1st Jan 1999- 31st May 2004, asthma discharges (ICD9 code 493) for all of New Zealand minus the three TLAs where spraying occurred: Waitakere, North Shore, and Auckland City.

Dataset C- time period 1st Jan 2002 - 31st May 2004, all respiratory disease discharges (ICD9 codes 460-519) by diagnostic code for CAUs included in the spray area.

Dataset D - time period 1st Jan 1999 - 30th December 2001, all respiratory disease discharges (ICD9 460-519) by diagnostic code for CAUs included in the spray area.

Clinical codes in the ICD10 system for the later years were converted to ICD9 codes. Hospitalisation totals for asthma (ICD9 code 493) and influenza and pneumonia (ICD9 480-489) among the spray population were calculated separately subsequent to receiving the data the second time from NZHIS, as described below.

Datasets C and D were geocoded as follows:

MAF provided digital boundaries of the spray zones. ESR selected 61 CAUs that fell within, or partly within, the main spray zone and provided these data to NZHIS.

NZHIS selected hospital discharges with residence in these CAUs. NZHIS provided ESR with a list of the addresses for these records, along with a unique identifier. Each record was geocoded to an x,y coordinate and matched to a unique spray zone. The list of records was then returned to NZHIS with additional fields indicating inclusion within the spray zone (or not), and specific spray zone of each record.

Using the unique identifiers, NZHIS matched this information back to the relevant ICD coded records extracted previously and provided records to ESR without the address information but with the spray zone details appended.

Exposed Population – Hospital discharges, identified by geocoding as residing inside the spray zone, were summed by age group, sex and ethnicity as required for analysis. For the years 2002-2004, records falling outside the spray zone, but within the selected 61 CAUs were also identified from geocoding and used in the comparison of admission rates inside and immediately outside the spray zone.

General Population – All respiratory hospitalisations in New Zealand were included as indicated above. In the case of asthma discharges, territorial authorities within the spray zone were excluded from the comparison group. These included Waitakere, North Shore, and Auckland City.

Calculation of rates

Total population monthly discharge rates for all respiratory disease, for asthma and for influenza/pneumonia per 1000 population were calculated by age and sex group for the spray area and for the whole of the New Zealand population, from 1999 to May 2004. All monthly hospitalisation rates were standardised by age and sex based on the total New Zealand population in 2001, with age defined in the following categories: less than 5 years old, 5 to 14 years old, 15 to 44 years, and 45+.

Comparisons carried out

The following descriptive comparisons were made:

- adjusted monthly discharge rates for all respiratory diseases (ICD9 460-519) between spray population and national population by month and by year, January 1, 1999 – May 31, 2004.

- monthly discharge rate for all respiratory diseases (ICD9 codes 460-519) in period before spraying and during spraying by age and sex for exposed and national populations.
- monthly discharge rate for asthma (ICD9 code 493) in period before spraying and during spraying by age and sex for exposed and national populations.
- trends in number of hospital discharges for asthma for the populations resident within the spray zone and just outside the spray zone; these analyses were performed for the whole population and for European and non European ethnic groups.

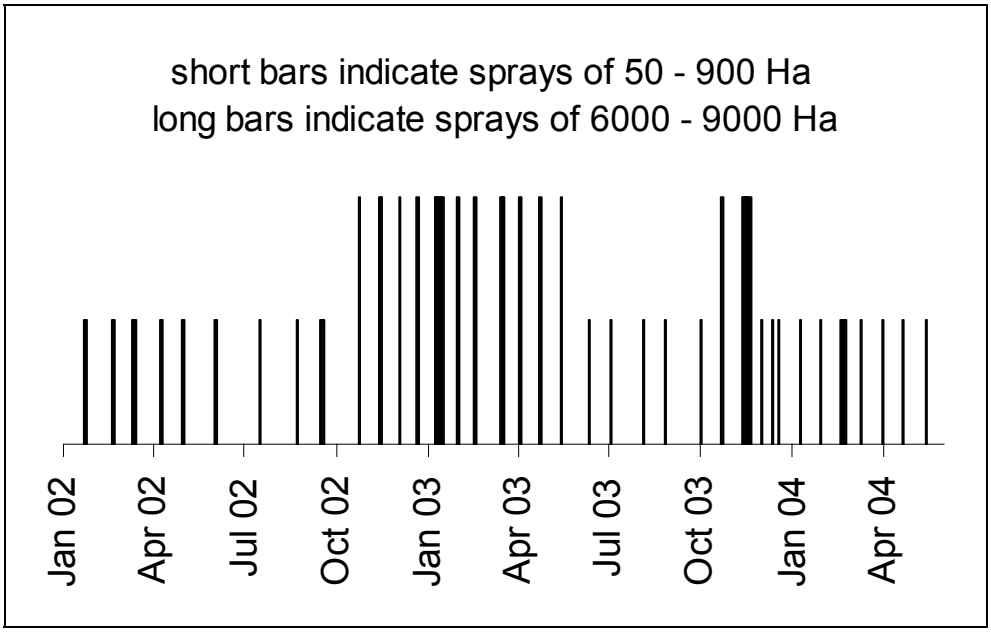
Analysis of short-term effects

In order to investigate potential short-term effects of aerial spraying on hospital discharges, days between 1st January 2002 and 31st May 2004 were classified into four mutually exclusive categories as follows:

1. Prior to spraying: three days before each period of aerial spray
2. All days on which spraying occurred
3. After spraying: three days after completion of each period of aerial spraying
4. Other days

Spraying operations lasted from one day to several days, and were usually two or more weeks apart (Figure 3). The choice of three-day comparison periods minimised overlap between successive periods of spraying. On only one date was there overlap between an after-spray period and the next spray operation; data for this day were not included in the analyses. Although separate spray periods covered different geographic areas and used different volumes of Foray 48B, these differences are not accounted for in this report.

Figure 3 PAM spray operations 2002 – 2004



3.2 Statistical Tests

Annual averages of monthly rates were calculated using arithmetic means of the twelve monthly rates for each year, and the five monthly rates for 2004. The annual mean for 2004 was calculated from the first five months of data only.

Differences in monthly and annual hospitalisation rates between the spray zone and national populations before and during the spray period were calculated using the Mann-Whitney-Wilcoxon two-sample test for the t approximation of a one-sided test. This procedure was performed in SAS using the NPAR1WAY procedure.

For the analysis of short-term effects, rates of discharge per day (not per 1000 population) and Poisson 95% confidence intervals were calculated.

3.3 Monitoring Data

PM_{10} data (particulate matter of 10 microns or less in aerodynamic diameter in micrograms/m^3) were obtained for the years 1998 to 2004 for two residential neighbourhood sites, namely Henderson and Mt. Eden. The Henderson site was chosen as the only monitoring site within the PAM spray zone. The Mt Eden site was chosen as a comparison site as it also used the Partisol sampling method of monitoring.

Ambient monthly air temperature average data for the Henderson site within the Auckland region were downloaded from the NIWA (National Institute of Water and Atmospheric Sciences) website database, Copyright NIWA 2005 Subject to NIWA's Terms and Conditions (http://cliflo.niwa.co.nz/pls/niwp/doc/terms.html). Annual and monthly ambient air temperatures for New Zealand were obtained from the International Research Institute for Climate Prediction, Palisades, New York (http://iri.columbia.edu/iri/index.html).

4 RESULTS

The population within the 61 census area units (225,771), used to determine the age and sex distribution of the spray zone population, was larger than the exposed population according to meshblock analysis (160,014). When analysed according to census area units, the exposed population was more strongly represented by Asian and Pacific people than the national population. Annual analysis by age and ethnicity showed that among the youngest age group (less than 5 years old), Asian people had the lowest discharge rates for respiratory disease, whereas Pacific people had the highest discharge rates.

4.1 Hospitalisation rates in spray zone residents and the national population

Statistically significant differences in hospitalisation rates between the spray zone and national populations were observed. Specifically, monthly hospitalisation rates in the spray zone were lower than those in the New Zealand population for the years 1999 to 2001, when compared as age and sex-adjusted annual averages (see Table 1).

Monthly hospitalisation rates among the exposed group gradually increased over the period under study while national rates remained relatively constant, resulting in statistically significant increases for the spray population compared to national rates in years 2003 and 2004.

Table 1 Annual average of monthly respiratory hospital discharge rates per 1000 population, adjusted for age and sex

Year	Before Spray			During Spray		
	1999	2000	2001	2002	2003	2004 (part)
Spray area population	0.95	0.99	1.25	1.30	1.42*	1.08*
New Zealand National Population	1.34*	1.27*	1.36*	1.34	1.34	1.01
Ratio of Spray area/National rates	0.7	0.8	0.9	1.0	1.1	1.1

**statistically significant difference between annual means for exposed and national populations , using a paired t-test with equal variance at $p<0.05$*

The observed increase in hospitalisation rates among the spray population from 2001 onwards was almost entirely accounted for by the < 15 year age groups, bringing the average monthly hospitalisation rate for that age group almost equal to the national average (see Table 2 below).

Table 2 Average monthly respiratory hospitalisation rate per 1000 population by age and sex, before spraying (1999 – 2002) and during spraying (2002-mid 2004)

Sex	Age Group (Years)	Exposed Population			National Population		
		Rate before spray (number)	Rate during spray (number)	% Change	Rate before spray (number)	Rate during spray (number)	% Change
Female	0 - 4	2.70 (17)	3.81 (24)	+41*	4.23 (559)	4.22 (558)	<1
	5 - 14	0.70 (8)	1.02 (12)	+46*	0.96 (269)	0.80 (224)	-17*
	15 - 44	0.50 (19)	0.54 (21)	+8	0.62 (512)	0.57 (476)	-8
	45+	1.44 (35)	1.75 (43)	+21	1.52 (1023)	1.55 (1040)	+2
Male	0 - 4	3.41 (23)	5.46 (36)	+60*	5.77 (801)	5.76 (799)	-
	5 - 14	0.74 (9)	0.88 (11)	+18	1.02 (302)	0.87 (256)	-15*
	15 - 44	0.51 (19)	0.51 (19)	-	0.52 (410)	0.48 (377)	-8
	45+	1.80 (39)	2.03 (44)	+13	1.75 (1055)	1.78 (1073)	+2
Weighted Average		1.06	1.31	+24	1.32	1.29	-3

**=statistically significant difference between pre-spray monthly hospitalisation rate and during-spray monthly hospitalisation rate using the Wilcoxon nonparametric test at 0.05 level of significance*

The relative increase in discharges from the spray zone can be seen to occur by 2001, a full year before spraying for Painted Apple Moth began, as shown in Figure 4 below. There were significant changes in the relative difference between hospital discharge rates in the spray population and the national population. Differences with regard to diagnostic code are examined below.

Figure 4 Age and sex-adjusted monthly respiratory hospitalisation rates per 1000 population for New Zealand and Auckland spray zone, 1999 to mid 2004

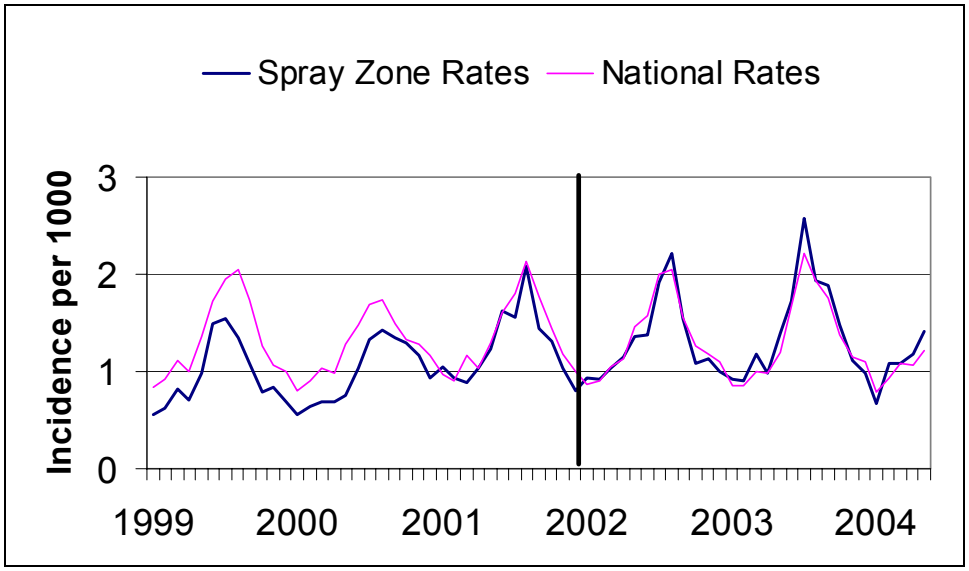


Table 3 Average monthly asthma hospitalisation rate per 1000 population for each age and sex group, before spraying (1999 – 2002) and during spraying (2002-mid 2004)

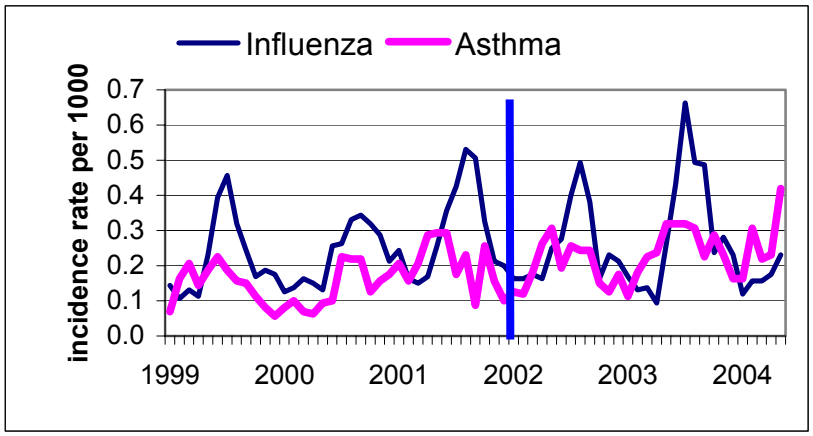
Sex	Age Group (Years)	Exposed Population			National Population minus exposed population[1]		
		Rate before spray (number)	Rate during spray (number)	% Change	Rate before spray (number)	Rate during spray (number)	% Change
Female	0 - 4	0.53 (4)	0.78 (5)	*+47*	0.66 (71)	0.66 (71)	*0*
	5 - 14	0.18 (2)	0.32 (4)	*+78**	0.22 (51)	0.16 (37)	*-28**
	15 - 44	0.14 (6)	0.17 (6)	*+29*	0.16 (110)	0.14 (90)	*-18*
	45+	0.14 (4)	0.16 (3)	*+8*	0.13 (73)	0.10 (58)	*-20*
Male	0 - 4	0.65 (5)	1.34 (12)	*+106**	1.05 (119)	0.90 (102)	*-14*
	5 - 14	0.20 (3)	0.30 (5)	*+53*	0.27 (67)	0.20 (49)	*-27**
	15 - 44	0.09 (3)	0.09 (4)	*+2*	0.08 (50)	0.06 (41)	*-18*
	45+	0.07 (2)	0.06 (2)	*-11*	0.06 (31)	0.05 (26)	*-14*
Weighted Average		0.16	0.23	*+42**	0.19	0.16	*-17*

[1] National population includes all TLAs except Waitakere, North Shore and Auckland City
**=statistically significant difference between pre-spray monthly hospitalisation rate and during-spray monthly hospitalisation rate using the Wilcoxon nonparametric test at 0.05 level of significance*

Monthly asthma discharge rates doubled over the period 2002-mid 2004 for boys aged 0 to 4 years old in the exposed population but decreased in the national population. A statistically significant increase was also observed for girls aged 5 to 14 (see Table 3 above). Overall, the age-adjusted and sex-adjusted monthly hospital discharge rate for asthma conditions (ICD10 codes J45, J46) increased by 42% between the two time periods (before and during spray-time) among the exposed group, but decreased by 17% among the comparison group. The decrease among the control group was not statistically significant.

Monthly discharge rates for asthma and pneumonia/influenza for the exposed population are shown in Figure 5 below. The influenza epidemic that began in 2001 in Auckland is clearly visible. There was no statistically significant difference between before-spray and during-spray monthly discharge rates for influenza/pneumonia in the exposed population.

Figure 5 Age and sex-adjusted monthly asthma and influenza/pneumonia hospitalisation rates per 1000 population for the Auckland spray zone, 1999 to mid-2004



4.2 Local trends in hospitalisations

Between January 2001 and June 2004, there was a decreasing trend in asthma admissions in residents just outside the spray zone, but a significant increasing trend in asthma admissions in residents inside the spray zone (Table 4). In sub analyses by ethnicity, the largest increase appeared in the non European exposed group.

Table 4 Trend in daily asthma hospitalisations comparing base year (2001) to later years (2002 - 2004) for residents within the spray zone and those residing in CAUs bordering the spray zone (Poisson model)

	Trend in admissions per day, compared to 2001	Standard Error	p-value	95% Confidence interval
All ethnicities				
		Outside spray zone		
2002	-0.26	0.08	0.002	-0.42 to -0.10
2003	-0.14	0.08	0.077	-0.30 to 0.02
2004	-0.38	0.12	0.001	-0.60 to -0.15
		Inside spray zone		
2002	-0.03	0.07	0.692	-0.17 to 0.11
2003	0.18	0.07	0.01	0.04 to 0.31
2004	0.27	0.08	0.001	0.10 to 0.44
Non European				
		Outside spray zone		
2002	-0.24	0.12	0.043	-0.47 to -0.01
2003	-0.01	0.11	0.956	-0.22 to 0.21
2004	-0.11	0.15	0.465	-0.40 to 0.18
		Inside spray zone		
2002	0.07	0.09	0.422	-0.10 to 0.25
2003	0.21	0.09	0.013	0.05 to 0.38
2004	0.39	0.10	0.000	0.18 to 0.60
European				
		Outside spray zone		
2002	-0.28	0.12	0.017	-0.51 to -0.05
2003	-0.30	0.12	0.012	-0.53 to -0.07
2004	-0.74	0.19	0.000	-1.11 to -0.37
		Inside spray zone		
2002	-0.21	0.12	0.079	-0.45 to 0.02
2003	0.11	0.11	0.313	-0.11 to 0.33
2004	0.04	0.15	0.789	-0.25 to 0.33

4.3 Short-term effects

Rates of discharge per day and Poisson 95% confidence intervals were calculated for exposure categories and local sub-populations as shown in the following tables:

Table 5 Daily respiratory and asthma hospitalisation rates before, during and after spraying for residents within the spray zone and those residing in CAUs bordering the spray zone

Respiratory admissions		Resident outside spray zone			Resident in spray zone		
	Number of days meeting definition	Number of admissions	Rate/day	95%CI	Number of admissions	Rate/day	95%CI
3 days before spray	116	413	3.56	3.23-3.92	704	6.07	5.63-6.53
During spray	82	275	3.35	2.97-3.77	532	6.49	5.95-7.06
3 days after spray	116	409	3.52	3.19-3.88	736	6.34	5.89-6.82
All other days	567	2351	4.14	3.98-4.32	4096	7.22	7.00-7.45

Asthma admissions		Resident outside spray zone			Resident in spray zone		
	Number of days meeting definition	Number of admissions	Rate/day[1]	95% CI	Number of admissions	Rate/day	95%CI
3 days before spray	116	81	0.70	0.55-0.87	119	1.02	0.85-1.22
During spray	82	42	0.51	0.37-0.69	100	1.22	0.99-1.48
3 days after spray	116	76	0.65	0.52-0.82	134	1.16	0.97-1.37
All other days	567	439	0.77	0.70-0.85	707	1.24	1.15-1.34

Compared to the 3-day periods just prior to spraying, days on which spraying occurred and the following three days showed:

- slightly higher rates of admission for respiratory disease, inside the spray zone
- slightly lower rates of admission for asthma, outside the spray zone
- slightly higher rates of admission for asthma, inside the spray zone

None of these differences were statistically significant at the 95% level.

There were 32 (736-704) more admissions for respiratory diseases in the three days following spraying compared to the three days prior to spraying, inside the spray zone. Based on the rate in the three days prior to spraying (inside the spray zone), there were 34

[1] Comparisons valid within but not between columns, since the rate is per day, not per 1000 population.

more discharges for respiratory diseases during spraying than expected (6.07 hospitalisations per day * 82 days = 498 expected, 532 observed), and roughly half of these (N=16) were asthma admissions.

The highest rates of daily admission were observed in the final category of "all other days", (that is, neither during nor within 3 days of spraying). Comparisons between the final category of "all other days" and the other categories are confounded by seasonal and long-term time trends (lower temperature and higher PM_{10} on those days, see Table 7) and so are not informative. The choice of comparison categories that are adjacent in time avoids this problem.

3.3 Air Monitoring Data

The possibility of a correlation between hospitalisation rates and local air quality was examined, with particular attention to the 2001 increase in respiratory hospitalisations among residents in the spray zone. However, this was largely uninformative as the highest annual PM10 average was recorded in 1999 for both sites. The corresponding relative increase in respiratory discharges was isolated to this year, and not connected to the increasing trend that began in 2001.

Monthly PM10 concentrations for the Henderson site are shown in Figure 6 below. Note the lack of air monitoring data available for the first half of 2002 (Henderson), and all of 2002 (Mt Eden).

Figure 6 Monthly average PM_{10} concentrations in Auckland, 1998-2004

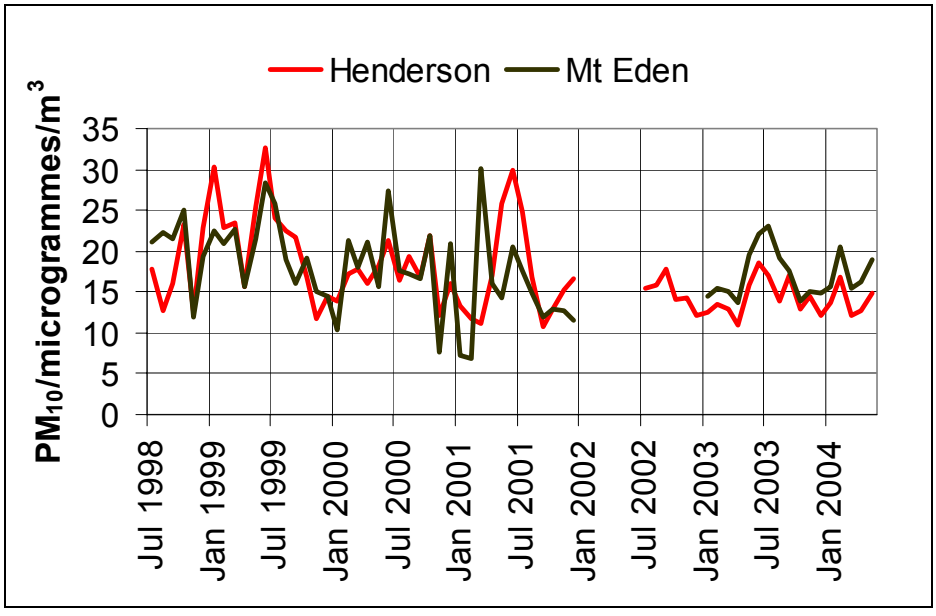
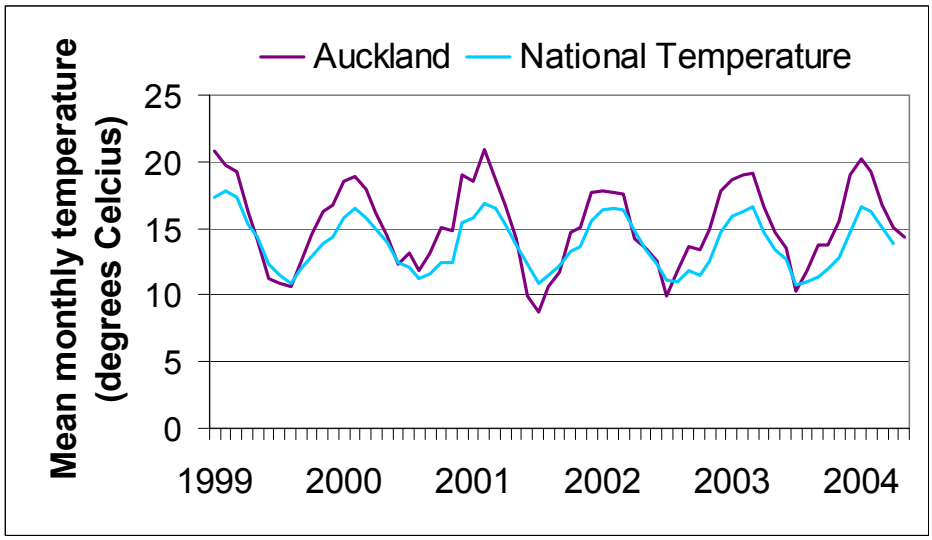


Figure 7 Mean monthly ambient temperature in Auckland and all of New Zealand, 1999-mid 2004



Mean monthly temperatures in Auckland followed a seasonal trend that showed a lower-than-normal summer peak in 2001/2002 (Figure 7 above).

Data sources: NIWA (National Institute of Water and Atmospheric Sciences), New Zealand (http://cliflo.niwa.co.nz/pls/niwp/doc/terms.html) International Research Institute for Climate Prediction, Palisades, New York. (http://iri.columbia.edu/iri/index.html)

The averages of ambient PM10 and daily maximum temperature within short-term exposure categories were as follows (Table 6).

Table 6 Ambient PM10 and daily maximum temperature within the spray zone before during and after spray events

Time Period	Ambient PM_{10} ($\mu g/m^3$)	Daily maximum temperature (°C)
3 days before spray	15.1	19.1
During spray	16.8	20.2
3 days after spray	17.2	20.0
Other days	17.3	18.2

Compared to the 3-day periods just prior to spraying, days on which spraying occurred and the following three days showed slightly higher ambient PM10 and slightly higher maximum temperatures.

Summary of results

National comparisons

Statistically significant differences in respiratory hospitalisation rates between the spray zone and national populations were observed. However, an increase in respiratory admissions from the spray zone began in 2001, a full year before spraying started.

There was no difference between before-spray and during-spray monthly discharge rates for influenza/pneumonia in the exposed population. The age-adjusted and sex-adjusted monthly hospital discharge rate for asthma conditions increased by 42% between 1998-2001 and 2002-2004 among the exposed group but decreased among the national comparison group.

Local comparisons

Comparing the year 2001 with 2004, there was an increase in asthma admissions in residents inside the spray zone, but a decrease in asthma admissions in residents just outside the spray zone. These trends were statistically significant. In sub analyses by ethnicity, the largest increase appeared in the non European exposed group.

Short-term effects

Compared to the three-day period just prior to spraying, spray days and the period of three days after spray days showed slightly higher rates of respiratory and asthma admission within the spray zone. Slightly lower rates of asthma admission than during the pre-spray period were observed outside the spray zone. These differences were not statistically significant.

5 DISCUSSION

The scope of this report is limited to respiratory conditions of sufficient severity to require admission to hospital. Potential effects of Foray 48B exposure on non respiratory diseases or milder respiratory symptoms not leading to hospital admission are not considered.

Asthma discharge rates by month doubled over the period 2002-mid 2004 for boys aged 0 to 4 years old in the exposed population but decreased in the national population. Similar but less distinct increases were observed for boys aged 5 to 14 and girls aged 0 to 4 and 5 to 14. The underlying upward trend in hospital discharges for respiratory diseases and asthma in the spray zone was evident before spraying began and cannot therefore be attributed to the spray. For certain regions, changes in reporting of hospital discharges are known to have occurred between 1995/1996 and 2000/2001. This may partly explain the increasing trends in the spray zone compared to the general population, but cannot readily explain the results of local comparisons.

In local comparisons of data for the year 2001 with later years, there was an increase in asthma admissions in residents inside the spray zone, but a decrease in asthma admissions in residents just outside the spray zone. These trends were statistically significant.

There was limited evidence of a weak short term effect of exposure on respiratory admissions. Compared to the three-day period just prior to spraying, spray days and the period of three days after spray days showed slightly higher rates of respiratory and asthma admission within the spray zone. Slightly lower rates of asthma admission than during the pre-spray period were observed outside the spray zone. These differences were not statistically significant.

It should be stressed that these findings do not prove that the observed patterns of respiratory hospital discharges were caused by exposure to the spray. It is important to consider alternative explanations for the results. These are considered below under the headings of chance, bias and confounding.

5.1 Chance

There were no statistically significant differences between the number of discharges on the three-day periods just prior to spraying, compared with days on which spraying occurred or compared with the following three days. Therefore, the observed differences in discharge rates between these periods could be due to chance. However, the post-spray increase in asthma discharges in residents inside the spray zone (Tables 3 and 5) was highly significant and can be reasonably assumed not to be solely due to chance.

5.2 Bias

Numerator data (individually geocoded hospitalisation records) were aggregated to the spray zone boundary. The denominator population were meshblock counts with age, sex and ethnicity derived from nearby CAUs. As the spray zone was smaller than the meshblocks, the rate created underestimated the true hospitalisation incidence. However this is likely to be negligible (less than 10%) based on a comparison of land area and associated population within the two areas. The comparison of local trends did not require

use of population estimates as they are based on admissions per day, not admissions per 1000 population.

The observed increase in asthma admissions within the spray zone could be at least partly explained by a lower threshold of concern among residents for attending hospital with asthma. The percentage of presenting patients who are admitted to hospital may vary according to local factors such as access to alternative facilities, emergency room clinician characteristics, and availability of hospital beds. A study published in 1990 on admission variation in New Zealand concluded that there was not enough evidence to support the idea that admission practices varied over time (Mitchell et al. 1990). Alternatively, the increase in respiratory and asthma discharges observed among the spray population relative to the national population may have been partly due to a change in the reporting of respiratory disease admissions. There is evidence that in some regions, patients presenting to Accident and Emergency were more likely to appear in the hospital discharge data in 2001 than in 1996 (see Appendix L). This might partly explain the observed difference between asthma trends in the spray zone and nationally, but is unlikely to explain the local difference in asthma trends between people living in the spray zone and those living in CAUs adjacent to, but outside, the spray zone.

Exposure misclassification was inevitable without detailed air sampling of Btk and time-use surveys of the exposed population. For example, some residents within the spray zone would have been away from home during the day or for extended periods of time during the spray period. Sensitive individuals were offered temporary relocation during spray periods. People outside the spray zone may have been exposed. Those living or working in areas adjacent to the spray zone were likely to have experienced at least some exposure from spray drift. This was not measured at the time of the spraying and the extent to which it occurred is difficult to estimate. Concurrent community spray campaigns in Hamilton and Auckland means that the national comparison group also included a number of exposed individuals from Hamilton.

Some people resident outside the zone would have travelled into the spray zone during spraying operations. Many children resident outside the spray zone are likely to have been exposed because they attended schools within the spray area. Likewise, time spent indoors is likely to have an effect (according to one study, indoor exposures were initially lower than outdoors, but lasted for longer (Teschke et al. 2001).

Crude measurement of exposure is likely to lessen the effect of a true exposure/response relationship. Analysis of short-term effects avoids, to some extent, the problem of exposure misclassification by place of residence. On the other hand, the classification of short-term exposure to the spray is not straightforward, because the different episodes of spraying were not uniform in time, space, or volume of Foray 48B used. A further difficulty is that the plausible lag times between spraying and putative health effects are uncertain. Nevertheless, we consider that the approach used is reasonable as an initial exploratory analysis.

5.3 Confounding

Possible confounding by ethnicity was examined: the exposed population had greater representation from Asian and Pacific people than the national population. National percentages of both Pacific and Asian peoples are six percent, whereas among the exposed

population, each ethnicity accounted for thirteen percent of the total. Overall, the difference from the national population is not expected to be noticeable.

Air monitoring data showed that the monthly average PM10 concentration decreased over the spray period. Temperature comparisons indicated a colder year than usual for Auckland in 2002, and this may have had some effect on the prevalence of respiratory disease in the exposed population. Although air pollution levels as indicated by PM10 concentrations in the Auckland region do not explain the increase in hospitalisation rates for respiratory conditions, it is possible that the 2001 hospitalisation increase was related to the increase in PM10 that year. However, hospitalisation rates were lower in 1999 when there were a greater number of air quality exceedences than in 2001.

The analysis of short-term changes in hospital discharges a few days before, during and after sprays avoids confounding by factors that change only slowly over time. However, these results may still be confounded by factors that change from day to day, such as the weather, air pollution, respiratory infections, day of the week, and public holidays.

Higher ambient PM_{10} in the days during and following spraying could explain the small excesses of discharges observed in these periods. Warmer maximum temperatures, on the other hand, would be expected to reduce the number of discharges, especially on the following few days. Accordingly, the possibility that the observed short-term differences are explained, at least in part, by confounding cannot be excluded. It is also possible that confounding could be obscuring a real short-term effect. Confounding by weather, air pollution, day of the week, and public holiday effects can best be controlled using time series methods. These analyses are beyond the scope of this project.

6 CONCLUSION

This was the first community-based study of hospital discharge data in response to long-term aerial application of a biological insecticide. The exposed population was assumed to be those in residence directly under the spray areas.

The underlying trend in hospital discharges for respiratory diseases and asthma in the spray zone was evident before spraying began and cannot therefore be attributed to the spray. Analysis of whether this trend continued past the cessation of aerial spraying is outside of the scope of this report (comparison of hospitalisation before and during the spraying). However, there are several findings indicating a real increase in asthma discharges that could plausibly be associated with the spray programme. Chance, bias and confounding are possible alternative explanations for the results observed in this report. These findings do not prove that the observed patterns of respiratory hospital discharges were caused by exposure to the spray.

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APPENDICES

APPENDIX A Report Distribution

Copies of this report have been made and distributed to:

Sally Gilbert, New Zealand Ministry of Health

APPENDIX B CAUs used for exposed population analysis

2001 CAU identifier	CAU Name	TLA Name
509100	Greenhithe	North Shore City
510010	Beachhaven North	North Shore City
510020	Beachhaven South	North Shore City
510700	Henderson North	Waitakere City
510800	Henderson South	Waitakere City
511001	Tangutu	Waitakere City
511002	Woodglen	Waitakere City
511100	Glen Eden East	Waitakere City
511300	New Lynn North	Waitakere City
511401	Fruitvale	Waitakere City
511402	Rewarewa	Waitakere City
511601	Glendene North	Waitakere City
511602	Glendene South	Waitakere City
511700	Kelston Central	Waitakere City
511800	Sunnyvale	Waitakere City
511902	Crum Park	Waitakere City
512201	Matipo	Waitakere City
512202	Durham Green	Waitakere City
512300	Te Atatu Central	Waitakere City
512401	Edmonton	Waitakere City
512402	Wakeling	Waitakere City
512500	Mcleod	Waitakere City
512600	Konini	Waitakere City
512901	Parrs Park	Waitakere City
512902	Otimai	Waitakere City
513010	Sturges South	Waitakere City
513020	Opanuku	Waitakere City
513100	Swanson	Waitakere City
513210	Ranui North	Waitakere City
513220	Sturges North	Waitakere City
513301	Kingdale	Waitakere City
513302	Fairdene	Waitakere City
513410	Whenuapai West	Waitakere City
513420	Herald	Waitakere City
513430	Hobsonville	Waitakere City
513522	Lucken Point	Waitakere City
513530	Royal Heights	Waitakere City
513620	Birdwood	Waitakere City
513631	Waimumu North	Waitakere City
513632	Waimumu South	Waitakere City
514401	Roberton	Auckland City
514402	Glenavon	Auckland City
514500	New Windsor	Auckland City
514600	Avondale South	Auckland City
514801	Rosebank	Auckland City
514802	Avondale West	Auckland City
514900	Waterview	Auckland City
515001	Point Chevalier West	Auckland City
515002	Point Chevalier East	Auckland City
515003	Point Chevalier South	Auckland City
515100	Westmere	Auckland City
515201	Herne Bay	Auckland City
515301	Ponsonby West	Auckland City
515410	Grey Lynn West	Auckland City
515431	Surrey Crescent	Auckland City
515432	St Lukes North	Auckland City
517800	Mt Albert Central	Auckland City
517901	Springleigh	Auckland City
517902	Owairaka West	Auckland City
517903	Owairaka East	Auckland City
617900	Inlet-Waitemata Harbour	Area Outside Territorial Authority

APPENDIX C Time lag between exposure and symptom reporting

Estimate of time lag between exposure and symptom reporting following application of Foray 48B

Estimates of the time-lag between exposure to Foray 48B and the reporting of adverse health outcomes depends on the differentiation between outcomes and whether they represent chronic diseases or acute reactions.

Acute reactions have been estimated to occur with the following time estimates:

1. Immediately following exposure, to one month post-event (Morrissey 2004)
2. Within 36 hours of spray event for passive surveillance reports (Washington State Department of Health Environmental Health Programs, Report of Health Surveillance Activities "Aerial Spraying for Asian Gypsy Moth – May 2000, Seattle, WA) http://www.doh.wa.gov/ehp/ts/Pest/AsianGypsyMothReport.doc
3. Two to three days after the spray event for development of severe influenza-like symptoms (case reports from 'Assessment of the potential health impacts of the 'Painted Apple Moth' aerial spraying programme, Auckland', NZ MoH February 2004 http://www.moh.govt.nz/moh.nsf/wpg_Index/Publications-Publications+by+subject#P
4. Immediately after spraying until three or four days later for chronic chest infection and cough (case reports from 'Assessment of the potential health impacts of the 'Painted Apple Moth' aerial spraying programme, Auckland', NZ MoH February 2004 http://www.moh.govt.nz/moh.nsf/wpg_Index/Publications-Publications+by+subject#P
5. Two weeks post-spray event for coughing that lasted for two weeks (case reports from 'Assessment of the potential health impacts of the 'Painted Apple Moth' aerial spraying programme, Auckland', NZ MoH February 2004 http://www.moh.govt.nz/moh.nsf/wpg_Index/Publications-Publications+by+subject#P

Chronic outcomes following exposure to Foray 48B have included the following estimates of time-lag between exposure and reporting of adverse effects:

1. Three months may not be long enough for symptoms of irritated throat, difficulty concentrating, sleep problems, stomach discomfort, itchy nose, dizziness, diarrhea and gas discomfort that were increased over a 3-month period following spraying in Auckland, but the authors suggest that the follow-up period may have been too short. (Petrie, Thomas and Broadbent 2003, Symptom complaints following aerial spraying with biological insecticide Foray 48B, NZMed J 116(1170);7pp.
2. At least one year post-event for symptoms, according to spray events in Auckland eastern suburbs. Symptom reporting peaked in May of 1997, and continued throughout the remainder of the year. Reports were still coming in through passive surveillance as of February 1998. The lag-time indicated from the data in this research was at least one year post-event, while the study authors chose the 17 months following the end of exposure for follow-up of chronic symptoms (Aer'Aqua Medicine Ltd).

Raw data for Table 2, spray population
Monthly hospitalisation totals for all respiratory discharges by age group and sex among spray population

Sex	Year / Month / Age gp	1999 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	6	9	5	8	17	12	23	31	29	6	6	6
F	5 - 14	5	6	9	7	14	5	10	6	5	6	9	3
F	15 - 44	10	14	18	12	14	34	34	24	18	20	18	11
F	45+	23	20	27	21	28	61	47	38	35	35	19	29
M	0 - 4	11	13	16	11	23	27	30	36	26	16	18	10
M	5 - 14	5	8	6	16	10	11	10	8	5	5	9	5
M	15 - 44	8	8	24	10	14	24	25	27	12	9	20	13
M	45+	22	22	27	27	37	64	68	44	42	28	34	33

Sex	Year / Month / Age gp	2000 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	8	8	7	6	15	19	27	29	20	19	13	17
F	5 - 14	4	6	8	8	7	4	13	13	16	11	13	6
F	15 - 44	10	14	16	20	9	19	22	16	28	24	15	14
F	45+	25	21	32	21	18	44	32	47	35	46	44	38
M	0 - 4	6	9	6	10	13	25	45	31	37	27	26	11
M	5 - 14	6	5	3	3	11	13	12	23	14	9	8	12
M	15 - 44	8	17	19	18	20	8	14	17	15	21	27	22
M	45+	22	22	18	25	28	32	47	52	50	49	41	30

Sex	Year / Month / Age gp	2001 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	10	13	17	18	22	22	39	66	26	12	13	7
F	5 - 14	13	8	10	8	6	14	9	9	3	13	10	2
F	15 - 44	14	19	12	17	45	39	20	21	18	25	19	17
F	45+	47	32	28	28	29	52	58	68	46	44	29	21
M	0 - 4	18	15	18	26	21	30	37	69	47	24	16	14
M	5 - 14	9	12	8	5	9	15	7	8	8	17	14	8
M	15 - 44	19	18	20	21	22	30	28	34	31	23	19	16
M	45+	38	32	29	41	43	57	52	58	52	51	44	43

Raw data for Table 2, spray population
Monthly hospitalisation totals for all respiratory discharges by age group and sex among spray population

	Year	2002											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	12	16	11	13	19	25	42	51	34	24	16	18
F	5 - 14	8	6	8	16	12	18	9	20	12	7	7	8
F	15 - 44	25	22	24	14	22	21	24	23	20	14	16	18
F	45+	26	24	34	37	48	34	55	95	51	40	39	43
M	0 - 4	14	13	22	33	37	48	72	65	39	28	32	16
M	5 - 14	5	11	10	10	16	10	12	7	13	7	9	8
M	15 - 44	12	17	16	24	24	19	23	35	19	14	17	4
M	45+	47	37	41	37	40	46	70	57	59	38	45	45

	Year	2003											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	10	10	15	18	25	24	54	64	48	24	23	16
F	5 - 14	9	8	16	15	17	16	20	17	17	14	11	11
F	15 - 44	15	9	17	17	26	37	36	30	22	34	12	17
F	45+	41	33	42	29	51	53	83	53	48	43	41	31
M	0 - 4	18	22	32	21	31	43	74	73	60	34	30	30
M	5 - 14	4	9	9	9	14	15	14	18	16	15	10	11
M	15 - 44	11	19	18	16	17	31	42	13	18	20	20	7
M	45+	40	35	40	33	41	56	88	41	72	52	32	35

	Year	2004				
	Month	1	2	3	4	5
Sex	Age gp					
F	0 - 4	8	19	15	12	29
F	5 - 14	4	13	5	12	16
F	15 - 44	12	16	22	20	25
F	45+	27	25	41	35	38
M	0 - 4	17	33	31	33	56
M	5 - 14	5	16	11	9	17
M	15 - 44	12	22	17	28	14
M	45+	22	29	30	39	30

Raw data for Table 2, national population
Monthly hospitalisation totals for all respiratory discharges by age group and sex among national population

Sex	Year / Month / Age gp	1999 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	231	353	414	324	501	671	856	1223	984	565	365	318
F	5 - 14	214	251	321	270	349	341	301	341	288	268	228	168
F	15 - 44	308	410	485	476	625	791	687	604	515	452	453	389
F	45+	665	625	757	675	965	1446	1743	1559	1464	988	869	907
M	0 - 4	393	529	612	498	787	937	1193	1628	1293	819	542	523
M	5 - 14	212	309	345	291	388	347	326	383	331	281	269	231
M	15 - 44	306	316	416	377	469	559	540	418	355	378	327	292
M	45+	773	655	823	838	1009	1343	1636	1488	1290	996	904	909

Sex	Year / Month / Age gp	2000 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	243	279	364	330	465	766	1114	1002	610	508	438	429
F	5 - 14	148	241	261	244	343	283	253	340	282	210	290	274
F	15 - 44	314	394	463	469	557	603	538	531	552	503	500	404
F	45+	698	595	700	719	866	1014	1103	1252	1210	1195	1081	980
M	0 - 4	353	511	525	536	731	994	1536	1285	923	705	686	619
M	5 - 14	159	269	293	275	384	363	279	365	298	258	294	306
M	15 - 44	276	338	413	321	403	448	372	468	463	378	404	366
M	45+	790	747	837	776	1036	1052	1142	1267	1254	1208	1081	994

Sex	Year / Month / Age gp	2001 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	284	277	418	368	470	557	880	1275	942	535	431	344
F	5 - 14	202	203	313	192	322	352	296	327	245	267	262	183
F	15 - 44	431	408	542	452	578	762	678	672	560	525	393	413
F	45+	855	657	825	804	883	1254	1504	1630	1386	1243	945	783
M	0 - 4	416	492	626	508	715	869	1154	1581	1331	844	628	496
M	5 - 14	205	224	308	257	360	457	339	343	278	267	315	251
M	15 - 44	308	364	457	394	468	556	541	563	523	429	422	330
M	45+	923	748	850	913	1020	1208	1341	1581	1339	1289	990	943

Raw data for Table 2, national population
Monthly hospitalisation totals for all respiratory discharges by age group and sex among national population

Sex	Year / Month / Age gp	2002 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	216	292	382	400	620	734	1067	1200	796	502	506	409
F	5 - 14	152	196	233	247	316	298	263	328	259	202	204	174
F	15 - 44	374	407	416	479	578	601	681	654	513	387	439	393
F	45+	742	691	837	893	1028	1216	1523	1579	1260	1123	936	961
M	0 - 4	352	417	582	556	905	1077	1507	1633	1069	805	744	604
M	5 - 14	161	216	277	264	341	312	358	376	293	245	240	250
M	15 - 44	347	364	344	417	460	457	506	505	427	337	351	297
M	45+	890	784	852	944	1175	1195	1550	1414	1201	1127	994	1038

Sex	Year / Month / Age gp	2003 1	2	3	4	5	6	7	8	9	10	11	12
F	0 - 4	226	310	364	307	433	733	1095	1114	979	597	513	435
F	5 - 14	143	176	192	183	242	326	331	289	241	223	224	177
F	15 - 44	349	325	397	449	562	729	777	553	512	440	360	400
F	45+	842	701	818	777	962	1347	1900	1554	1440	1216	916	875
M	0 - 4	315	433	550	500	645	993	1315	1532	1298	890	755	684
M	5 - 14	144	200	208	230	270	361	355	327	262	243	221	182
M	15 - 44	296	254	309	330	399	495	631	408	403	370	332	292
M	45+	884	765	879	892	986	1294	1839	1454	1406	1188	949	1052

Sex	Year / Month / Age gp	2004 1	2	3	4	5
F	0 - 4	223	395	374	397	551	754
F	5 - 14	117	186	198	170	215	238
F	15 - 44	309	380	485	413	428	495
F	45+	728	660	880	869	898	1089
M	0 - 4	376	563	592	617	849	1111
M	5 - 14	133	262	243	197	261	272
M	15 - 44	245	270	355	360	373	379
M	45+	810	760	888	937	963	1078

APPENDIX F Supplementary data for Table 2, spray population

Supplementary data for Table 2, spray population
Monthly hospitalisation number average, minimum, maximum and standard deviation

		Before Spray (1999 to 2001)				During Spray (2002 to May 2004)			
Sex	Age gp	Average	Min	Max	Stddev	Average	Min	Max	Stdev
F	0 - 4	16.97	5	66	12.02	22.53	8	64	14.59
F	5 - 14	8.31	2	16	3.60	11.72	4	20	4.63
F	15 - 44	19.44	9	45	8.10	20.64	9	37	6.98
F	45+	35.22	18	68	12.72	40.90	24	95	15.61
M	0 - 4	22.72	6	69	13.17	35.97	13	74	18.02
M	5 - 14	9.36	3	23	4.28	11.14	4	18	3.78
M	15 - 44	18.92	8	34	6.90	18.87	4	42	7.88
M	45+	39.00	18	68	12.93	41.31	22	88	14.36

APPENDIX G Supplementary data for Table 2, national population

Supplementary data for Table 2, national population
Monthly hospitalisation number average, minimum, maximum and standard deviation

		Before Spray (1999 to 2001)				After Spray (2002 to May 2004)			
Sex	Age gp	Average	Min	Max	Stddev	Average	Min	Max	Stdev
F	0 - 4	559.28	231	1275	290.52	574.88	216	1200	289.40
F	5 - 14	268.69	148	352	54.98	231.02	117	331	58.09
F	15 - 44	512.14	308	791	114.20	494.42	309	777	121.77
F	45+	1023.47	595	1743	316.42	1067.63	660	1900	317.79
M	0 - 4	800.50	353	1628	356.18	833.89	315	1633	369.42
M	5 - 14	301.67	159	457	59.99	267.20	133	376	65.07
M	15 - 44	409.94	276	563	81.31	391.33	245	631	86.46
M	45+	1055.36	655	1636	249.18	1105.51	760	1839	263.19

Raw data for Table 3, spray population
Monthly hospitalisation totals for asthma diagnosis discharges by age group and sex among spray population

	Year	1999											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	1	5	3	3	4	0	1	2	6	1	2	2
F	5 - 14	2	3	5	1	3	1	3	1	3	4	2	0
F	15 - 44	0	1	6	5	6	11	8	6	5	5	4	0
F	45+	3	4	6	3	4	7	2	3	2	5	0	2
M	0 - 4	3	4	2	5	4	3	0	2	4	1	1	3
M	5 - 14	0	5	3	2	1	0	4	4	1	2	2	1
M	15 - 44	1	2	7	1	4	10	6	3	1	0	2	1
M	45+	1	2	1	3	4	4	6	4	2	0	0	0

	Year	2000											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	4	2	4	0	4	1	3	3	5	4	0	8
F	5 - 14	1	3	1	0	2	1	1	5	1	1	5	1
F	15 - 44	3	3	2	3	2	7	7	6	9	8	3	3
F	45+	3	1	4	1	3	2	4	3	2	2	5	4
M	0 - 4	1	4	0	1	1	3	13	7	5	1	6	2
M	5 - 14	0	1	0	1	0	1	3	6	5	2	1	6
M	15 - 44	1	2	0	4	3	1	4	4	3	2	4	2
M	45+	0	0	0	0	0	0	1	1	5	0	1	2

	Year	2001											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	2	6	5	12	7	3	4	2	1	3	4	3
F	5 - 14	4	1	4	2	3	2	4	2	0	4	0	0
F	15 - 44	4	2	5	4	10	7	6	10	5	12	8	5
F	45+	4	5	1	4	3	9	6	6	3	6	3	2
M	0 - 4	5	6	9	13	9	11	2	7	2	10	2	4
M	5 - 14	5	3	4	2	5	4	2	4	1	3	5	1
M	15 - 44	5	1	4	4	9	10	4	5	2	2	2	1
M	45+	4	1	1	5	1	1	0	1	0	1	1	0

Raw data for Table 3, spray population
Monthly hospitalisation totals for asthma diagnosis discharges by age group and sex among spray population

	Year	2002											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	3	3	5	2	8	5	2	3	6	5	1	4
F	5 - 14	1	0	0	4	2	3	4	6	3	4	0	2
F	15 - 44	6	6	6	7	9	7	12	6	7	3	2	7
F	45+	3	2	1	8	6	2	7	9	7	3	2	5
M	0 - 4	2	4	9	12	12	6	4	8	7	5	8	4
M	5 - 14	1	3	2	1	5	4	4	2	3	3	4	3
M	15 - 44	3	0	3	6	5	4	7	5	4	1	1	1
M	45+	1	1	3	2	2	0	1	0	2	0	2	2

	Year	2003											
	Month	1	2	3	4	5	6	7	8	9	10	11	12
Sex	Age gp												
F	0 - 4	2	3	3	7	7	4	6	11	5	5	7	4
F	5 - 14	0	3	7	8	5	2	7	7	3	4	5	5
F	15 - 44	3	2	6	7	12	17	10	12	5	13	3	4
F	45+	4	3	5	3	3	1	8	6	4	2	2	1
M	0 - 4	6	8	8	6	10	10	11	10	9	9	12	9
M	5 - 14	2	2	2	5	7	5	5	2	6	7	4	3
M	15 - 44	0	6	2	2	3	9	3	1	1	5	1	0
M	45+	1	2	3	0	4	3	1	0	3	1	3	0

	Year	2004				
	Month	1	2	3	4	5
Sex	Age gp					
F	0 - 4	1	10	5	2	13
F	5 - 14	3	5	3	5	8
F	15 - 44	2	4	6	6	8
F	45+	2	2	3	1	5
M	0 - 4	13	15	9	11	22
M	5 - 14	2	8	5	4	7
M	15 - 44	3	5	4	8	3
M	45+	0	0	0	0	1

APPENDIX I Raw data for Table 3, national population

Raw data for Table 3, national population
Monthly hospitalisation totals for asthma diagnosis discharges by age group and sex among national population

	Year Age group	1999	2000	2001	2002	2003	2004 (part)
Female	0 - 4	1002	746	818	839	900	342
	5 - 14	646	602	577	495	490	140
	15 - 44	1494	1281	1185	1199	1239	340
	45+	1087	786	750	817	870	168
Male	0 - 4	1660	1231	1400	1220	1327	472
	5 - 14	843	786	787	641	651	195
	15 - 44	665	572	563	544	566	151
	45+	419	357	326	379	352	89

APPENDIX JSupplementary data for Table 3, spray population

Supplementary data for Table 3, spray population
Average number of monthly asthma hospitalisations, minimum and maximum

		Before Spray (1999 to 2001)				After Spray (2002 to May 2004)			
Sex	Age gp	Average	Min	Max	Stdev	Average	Min	Max	Stdev
F	0 - 4	3.33	0	12	2.44	5.15	1	13	2.92
F	5 - 14	2.11	0	5	1.55	3.96	0	8	2.37
F	15 - 44	5.31	0	12	2.96	6.51	2	17	3.67
F	45+	3.53	0	9	1.89	3.56	1	9	2.35
M	0 - 4	4.33	0	13	3.53	9.92	2	22	3.94
M	5 - 14	2.50	0	6	1.86	4.09	1	8	1.91
M	15 - 44	3.25	0	10	2.57	3.56	0	9	2.42
M	45+	1.47	0	6	1.73	1.09	0	4	1.23

APPENDIX K Supplementary data for Table 2, national population

Supplementary data for Table 2, national population
Average number of monthly asthma hospitalisations, minimum and maximum

Data available from NZHIS, not specifically requested for this project

APPENDIX L Comment from NZHIS on report

Received by Lou Gallagher of ESR from Chris Lewis NZHIS on July 27, 2005 with regard to Painted Apple Moth Hospitalisation report written for the Ministry of Health

From 1996/97 to 2000/01 the number of discharges from the Intensive Care/A&E specialty increased by over 650%.

In 1996/97 Intensive Care/A&E discharges made up 1% of total discharges, compared to 6% in 2000/01.

There was also a disproportionate growth in the percentage from the Intensive Care/A&E cases that were daypatients, increasing from 34.2% in 1996/97 to 70.8% in 2000/01. Analysis of this data suggests that these new daypatient discharges from the Intensive Care/A&E specialty would previously have been classified as attendances at an Accident & Emergency clinic. Accident & Emergency clinic attendances are not reported to the National Minimum Dataset (NMDS) and do not appear in national hospital discharge statistics.

This apparent change in classification of events occurred primarily in the Northland, Waitemata, Auckland, Counties-Manukau, Waikato and Canterbury DHBs. These six DHBs accounted for 94.8% of total Intensive Care/A&E discharges in 2000/01, compared with only 56.2% of all discharges, and 78.2% of total Intensive Care/A&E specialty discharges in 1996/97.

This reporting issue causes some difficulties when interpreting hospitalisation numbers over time, particularly if the conditions being examined are likely to be treated at A&E.