EVALUATION OF THE “SAFER SUMMER” ROAD SAFETY CAMPAIGN

Final Report

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Executive summary

This report describes the aspects and road safety outcomes of a New Zealand-wide traffic enforcement campaign, carried out by New Zealand Police and supported by the wider New Zealand road safety sector. The campaign focussed on reducing speeding and involved the introduction of a reduced speed enforcement threshold and increased traffic enforcement intensity over a two-month summer period. The campaign, publicised as “Safer Summer”, was announced by a media launch event, and was accompanied by speed-related advertisements and extensive coverage in printed, online, and social media. The aims of the initiative were to decrease the prevalence of low-level speed violations and higher-end speeding in order to reduce the risk of crashes, injury and death. The campaign was implemented from 1 December 2013 until 31 January 2014. The purpose of this report is to evaluate the effects of the initiatives in terms of reductions in speeding and the risk of crashes and injury.

A quasi-experimental study design was used to evaluate the differences in speeding, crashes and injuries. Speed survey data was analysed with binary logistic regression models. Crash and injury data were analysed by incorporating Poisson and negative binomial regression techniques. The results of these analyses indicated that the intervention was associated with a significant 36% reduction in vehicles exceeding the speed limit by 1–10km/h, alongside a significant 45% decrease for speeding in excess of 10km/h. Speeding rates were also observed to revert to pre-intervention levels after the reduced enforcement threshold was ceased. Analysis of crash and injury data revealed possible reductions in the risk of fatal, serious and minor crash risk and injuries during the campaign period. Decreases in fatal crashes (22%), serious injury crashes (8%), and minor injury crashes (16%) were present during the intervention; however, there was insufficient evidence in the data to detect a significant effect.

Crashes and casualties occur as a result of a wide range of factors; the aim of the intervention was to reduce some of this risk by reducing driving speeds. Given the fact that the duration of the campaign was limited to a two-month period, the outcomes of the intervention are considered promising, but inconclusive. Although the campaign had a significant and substantial effect on reducing speeding behaviour, the duration of observation period was likely not sufficient to reflect the full effect of this reduction on the risk of serious crashes and injuries. Previous research has strongly established the relationship between the risk of serious crashes and speed; this provides sufficient indication that over a greater intervention period, significant reductions in crashes and injuries would be realised.

Overall, the combined efforts of a reduced speed enforcement threshold, enforcement intensity, and public awareness effectively reduced driving speeds and speed violations over the high-risk holiday period. While the 26% reduction in road deaths did not meet the threshold for statistical significance, this initiative shows considerable promise as a
road safety intervention. Further investigation and the implementation of a well publicised reduced speed enforcement threshold over a longer period of time would more fully test the effects on the risk of crashes, injuries and deaths.
EVALUATION OF THE “SAFER SUMMER” ROAD SAFETY CAMPAIGN

1. Introduction

1.1 Background

Inappropriate driving speed and speeding are major issues affecting road safety, and safer speeds are approached as a high-priority area in the New Zealand Safer Journeys road safety strategy. New Zealand is committed to managing speed across the road network and effective enforcement of the speed limits is an important component in achieving this goal. As part of a wider set of sector initiatives, an enforcement campaign that focussed on the application of a reduced speed enforcement threshold was implemented across New Zealand over the months of December 2013 and January 2014. The campaign (“Safer Summer”), undertaken by New Zealand Police and road safety sector partners, involved a well-publicised reduced speed enforcement threshold combined with intensified speed enforcement. The aims of this intervention were to reduce speeding and decrease crash risk and crash severity. The present report contains a comprehensive evaluation of the road safety effects associated with the intervention.

1.2 Speed and road safety

The role of speed as an antecedent cause of traffic crashes, injuries and deaths has been well established in road safety research literature (United Nations, 2011; World Health Organization, 2013), and is likely the single most salient factor impacting road safety (European Transport Safety Council, 2011). Road deaths and serious injuries in particular have been inextricably linked to speed (Elvik, 2005; Global Road Safety Partnership, 2008), and while speed is also related to crash risk and occurrence (Aarts & van Schagen, 2006), the relationship between speed and crash severity is stronger than that of speed to the number of crashes (Elvik, 2012). Research has demonstrated that the risk of fatal crashes increases dramatically (according to an exponential or power function) with the magnitude of speed and prevalence of speeding (Aarts & van Schagen, 2006; Cameron & Elvik, 2010; Elvik, 2013; Kloeden, McLean, & Glonek, 2002; Kloeden, McLean, Moore, & Ponte, 1997; Kloeden, Ponte, & McLean, 2001; Nilsson, 2004).

Speed limits are set in order to balance the minimising of crash risk and road trauma while simultaneously maintaining traffic flow, mobility and travel times (Box & Bayliss, 2012; Elvik, 2010). The posted limits provide information to drivers about the speed deemed safe to travel at in average conditions, however, in spite of the known risks associated with exceeding the speed limit, this remains one of the most common
violations of the law in the western world (Box & Bayliss, 2012; Organisation for Economic Co-operation and Development & European Conference of Ministers of Transport, 2006).

1.3 Low level speeding

It is a common misconception that low-level speeding does not pose a road safety risk, and that Police enforcement should focus on high-end offenders (Job, Sakashita, Mooren, & Grzebieta, 2013). Research has revealed that the risks posed by speeding behaviour in terms of crash risk and the risk of serious injury or death resulting from crashes exists both at the higher end and lower end of the excess speed distribution (Doecke, Kloeden, & McLean, 2011). In fact, due to the fact that exceeding the speed limit by <10km/h occurs with far greater incidence (Greaves & Ellison, 2011), the collective risk attributed to low-level speeding has been found to be greater than higher-end violations, which in spite of carrying far more individual risk, are comparatively rare (Cameron, 2013; Doecke et al., 2011; Gavin et al., 2011).

1.4 The role of enforcement

Police enforcement of the speed limits is one of many countermeasures to speeding (SafetyNet, 2009), however, it remains a crucial component of raising and maintaining compliance with the speed limits (Global Road Safety Partnership, 2008; National Highway Traffic Safety Administration, 2008; United Nations, 2011). Research has shown speed enforcement to be one of the most effective and cost efficient methods of reducing crashes, serious injuries and deaths (Corbett, Delmonte, Quimby, & Grayson, 2008; Elvik, 2011, 2012). The impact of traffic law enforcement on influencing driver behaviour is commonly described as functioning through two processes: specific deterrence and general deterrence (Zaal, 1994). Where specific deterrence describes drivers’ actual experience with Police, in terms of apprehension and punishment for violations of road rules, general deterrence illustrates drivers’ perceived threat of detection, apprehension and punishment upon violating traffic laws (Wegman & Goldenbeld, 2006).

In regards to speed enforcement, general deterrence is in many cases the favoured mechanism through which to operate (SafetyNet, 2009). Since speeding is a very common type of offence, general deterrence has a bigger impact by being able to influence a much greater population of drivers with the same resources (Factor, 2014). This places the focus of effective speed enforcement on increasing the threat of detection, and not on maximising the number of apprehensions (Global Road Safety Partnership, 2008; Soole, Lennon, & Watson, 2008). Speed enforcement has also been shown to have a substantial positive impact on New Zealand road safety (Povey, Frith, & Keall, 2003).
1.5 Speed enforcement tolerance thresholds

Speed enforcement is often conducted with a tolerance margin in place (Zaidel, 2002). This is expressed as a percentage of the speed limit or a fixed number of kilometres above the limit within which drivers are not apprehended for excess speed (Fildes & Lee, 1993). The tolerance level applied to speed enforcement has previously been described as a de facto speed limit. This term is used to describe the level to which drivers believe they can drive above the limit before they will get apprehended and prosecuted, in spite of committing a legal violation (Cameron & Delaney, 2006). It follows that reducing the threshold of enforcement will also reduce the de facto speed limit that drivers may adhere to (i.e. the tendency of driving to the detection threshold, rather than to the posted speed limit). It can therefore be reasonably suggested that greater compliance with the speed limits can be obtained by operating with a lower enforcement threshold, than by operating with a higher one. Although empirical evidence on the topic is scant, two studies were identified that indicate that this is indeed the case (Andersson, 1989; Luoma, Rajamäki, & Malmivuo, 2012).

Both studies were set in Scandinavia and made use of control and experimental road sections, and both applied a reduced speed enforcement tolerance threshold accompanied by public awareness campaigns. Both studies also reported lower speeds for the experimental conditions. However, while Andersson (1989) was unable to separate the effects of the reduced threshold from the increased risk of detection, Luoma et al. (2012) were able to demonstrate independent effects on driving behaviour for the speed camera enforced experimental road. Luoma et al. (2012) specifically reported a decrease of 2.5km/h in mean speed, a decrease in the standard deviation of speed of 1.1km/h, and a decrease in the proportion of speeding vehicles of 11.8 percentage points.
2. The campaign

2.1 Description of the intervention and mechanisms of effects

The Safer Summer campaign involved the principles of good practice, including: high-profile publicity (Eeckhout, Persico, & Todd, 2010; Phillips, Ulleberg, & Vaa, 2011), increased enforcement intensity (Elvik, 2011; Stanojević, Jovanović, & Lajunen, 2013; Wilson, Willis, Hendrikz, & Bellamy, 2006; Yannis, Papadimitriou, & Antoniou, 2007), in addition to a lowered 4km/h speed enforcement threshold (Andersson, 1989; Luoma et al., 2012).

The underpinning principles of the initiative follow the mechanisms of specific and general deterrence; i.e. increasing drivers’ perceptions of the relative risk of apprehension for exceeding the speed limit—even for low-level violations. This, in theory, would affect road user behaviour and reduce speeding in terms of magnitude (in excess speed), and prevalence (the number of speeding vehicles). The reduction in speeds is in turn expected to lower the risk of serious injuries and fatalities resulting from vehicle crashes (DaCoTA, 2012), over the high-risk summer holiday period (Anowar, Yasmin, & Tay, 2013). Figure 1 shows the hypothesised outcomes associated with the introduction of the campaign.

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**Figure 1.** The theoretical model.

2.2 The speed enforcement threshold

The level of tolerance applied to speed enforcement varies strongly by country, with discretion often being given to the Police force (Zaidel, 2002). Researchers have argued that the tolerance threshold should be set at the minimum level practicable, taking into account the accuracy of the speed measurement devices, and small action slips on
behalf of drivers (Soole et al., 2008). As a point of reference, the speed measurement equipment operated by New Zealand Police already allow for ±2km/h of uncertainty, and are periodically calibrated to international standards to an accuracy that is closer to within 1km/h of actual speed.

The usual speed enforcement threshold applied by NZP is 10km/h over the limit for light motor vehicles, apart from school zones, which is 4km/h. Heavy motor vehicles (HMV) have been subject to a 5km/h enforcement threshold since 2004, when the HMV speed limit was raised from 80km/h to 90km/h on 100km/h posted speed limit roads. A reduced speed enforcement threshold of 4km/h has been applied by New Zealand Police during certain long weekend and holiday periods since 2010, the impacts of which have to date not been formally evaluated.

Other jurisdictions have already successfully lowered the speed enforcement threshold. For instance, the state of Victoria has operated with a zero tolerance threshold since 2002, allowing only 3km/h for maximum measurement error (Bobevski, Hosking, Oxley, & Cameron, 2007). It should be noted that New Zealand Police has long publicised the threshold applied to speed enforcement. Most jurisdictions, including all Australian states and territories, do not have a publicised or well-known speed enforcement threshold (Austroads, 2013).

Findings by Luoma et al. (2012) showed the proportion of speeding vehicles decreased by over 50% upon the introduction of a reduced speed enforcement threshold in Finland. It was intended to obtain similar results in New Zealand for the duration of the campaign period.

2.3 Enforcement operations

As part of the campaign, Police also increased speed enforcement operations with highly visible and less overt approaches. Officer patrols were intensified during this period, with more units being deployed to conduct stationary speed checks using laser speed detection devices, and directed mobile patrols fitted with radar equipment. Police also introduced a number of brightly painted red and orange highway patrol cars at the campaign’s launch to increase visibility and awareness (Appendix B, p. 40). Although it was difficult to determine precisely how many additional hours were spent on traffic enforcement, notice volumes were substantially higher compared to the previous year (a 41% increase).

Police also increased mobile camera deployments. Forty-three digital mobile speed cameras mounted inside vans are operated across the country. The cameras are operated in a semi-overt manner; they are mostly painted in plain colours and are not announced by means of signage, but are also not hidden from sight. In order to increase the camera deployments, additional traffic camera operators were contracted.
Approximately 12,500 mobile camera hours were completed during the campaign period, an increase of 15% over the same period in the previous year (~10,900 hours). Changes in notice volumes and ticketing rates are further explored under the Results section (p. 21).

2.4 Media coverage and public awareness

The purpose of the media and advertising aspects of the campaign was to ensure drivers were aware that there would be no tolerance for speeding over the two-month summer holiday period. The media and public relations components of the campaign were run in partnership with the Accident Compensation Corporation, the New Zealand Transport Agency (NZTA), the Ministry of Transport, and Z Energy. The primary audience were drivers aged 20–49 travelling from/to holiday destinations on 100km/h rural roads and motorways, who habitually drive between 0–10km/h over the speed limit. The media and public relations package included:

- a launch event to announce the campaign
- advertising at 88 Z Energy petrol stations
- placement of 55 road side billboards (Appendix A, p. 40)
- “Reach the beach” board games with a road safety message handed out by officers to families at the roadside (Appendix C, p. 41)
- radio advertisements
- videos released online and social media posts
- internet banner advertising targeting mobile and tablet users.

The media coverage and public awareness efforts reached a wide audience. The radio advertisements were heard at least once by over 60% of drivers in the target age group. Videos released in social media received over 1.1 million views, and posts made on Facebook received over 350,000 views. Online banner advertising delivered more than 2.6 million impressions. The campaign was widely featured in the media, and generated over 520 news articles.

Sentiment analysis showed that media coverage was substantially more polarising than that of typical Police news, which is usually 90% neutral. Twenty-five percent of messaging in news articles covering the campaign was positive, 33% was negative, and 42% was neutral. This mixed tone may have been beneficial as it is thought to be more likely to stimulate debate, which can generate more coverage of the campaign. The impact of earned media in terms of equivalent advertising was valued at over $1.5 million. The total marketing investment was $350,000. Safer Summer went on to win the 2014 Institute of Public Administration New Zealand’s Public Sector Excellence Award for Public Sector Communications.
3. Method

3.1 Evaluation design

A quasi-experimental evaluation design was used to analyse the influence of the intervention on speeding, crashes and injuries. Speed survey, crash, and injury data for the intervention period was compared to the same periods in the four preceding years. This would provide a control for any variation attributable to seasonality. A potential limitation of the quasi-experimental approach can include the lack of an established baseline. It is intended that by introducing more than a single control period, this will provide a measure of control for any year-on-year trends and variation. Subtracting the maximum variance between controls from the minimum reduction for the experimental period will provide a degree of control for such trends. Though this may be an over-conservative approach, there is also the possibility of an underlying non-linear trend in the crash and speed data that is difficult to quantify or control for with the data available. The intervention period spanned 1 December 2013 to 31 January 2014, and the December to January periods in the preceding 4 years will be regarded as controls.

A further potential limitation of this study design is the fact that Police already applied a reduced speed enforcement threshold over the period spanning from the weekend before Christmas holidays until the weekend after New Year, commencing December 2010. Depending on the year, the reduced speed enforcement threshold applied over December–January during three out of four control periods covers approximately two weeks. If the lowering of the speed enforcement threshold independently causes drivers to slow down, and reduces crash risk, this aspect of the study is expected to reduce the magnitude of any observed differences for the intervention period compared to the previous three December–January periods to some extent.

3.2 Data sources

3.2.1 Speed data

Speed survey data was obtained from mobile speed cameras to measure any differences in speeds and speeding. The mobile cameras are deployed to a fixed number of allocated enforcement sites and capture the speed of every vehicle going past, which results in large volumes of speed survey data being recorded, with over 5 million vehicle speed readings per month across the country. This also means that the same roads are being monitored each year, allowing comparisons to be made over different time periods.

An aspect that is intrinsic to capturing speed survey data by means of speed cameras is identified in the so-called ‘kangaroo effect’. This describes a tendency for drivers to slow down in the vicinity of an overt camera and speed up after it is passed (Elvik, 1997). The plain, semi-overt mode of operation of mobile speed cameras is expected to have a
smaller impact on manipulation behaviour (drivers slowing down if/when the camera van is identified), as drivers will be less aware of the camera’s presence (Keenan, 2003). However, there is still expected to be a degree of manipulation behaviour present, meaning that the survey data captured by the cameras could be an underestimation of speeding and driving speeds. To ensure that any effects on driving speeds measured in the speed survey data is attributable to increased compliance across the road network, and not merely a product of increased manipulation behaviour, a second, independent source of speed survey data was also analysed.

The NZTA in association with Beca Group has gathered traffic data from the implementation of a Bliptrack journey monitoring system developed by Blip Systems that collects traffic flow information over time and distance using Bluetooth and WiFi sensors. This information can then be taken to calculate average speeds for individual vehicles over the distance monitored. Although this system has recently been introduced on a number of rural roads and state highways (SH) in New Zealand, there was only one implementation that was in place since at least one year prior to the intervention (i.e. from December 2012 onwards). This site was a 12.7km stretch of SH 1 in north Waikato between Mercer and Bombay. Speed was calculated by dividing the distance by the time travelled (rounded to the nearest second). The speed data collected from this site was used to compare and verify the results based on the mobile speed camera survey speed distributions.

The survey data from both data sources was taken from 100km/h speed limit zones, which is where most severe crashes occur. In order to reduce the influence of impeded traffic on observed vehicle speeds, only vehicles with ≥4 seconds headway in front of them were included in the analyses. The Ministry of Transport has applied the same rule to its speed survey analyses (Ministry of Transport, 2014).

### 3.2.2 Crash and injury data

Crash and injury data are recorded in the NZTA crash analysis system (CAS). CAS contains the data of all attended crashes in New Zealand. This database records crashes by injury severity (non injury crash, minor injury crash, serious injury crash, or fatal injury crash), and also contains the number of injuries resulting from traffic crashes (minor injuries, serious injuries, and fatal injuries). The data was formatted to consist of incident counts per day over each of the 62-day periods. This would allow for calculations to be performed on incident risk (e.g. fatal crash occurrence) for the treatment period compared with the control periods in the preceding four years.
3.3 Statistical analysis methods

3.3.1 Speeding

Although reporting mean speeds has been traditionally common in evaluating the impacts of speed-related interventions, there are a number of issues relating to the reliance on means comparisons. One of the issues associated with measures of mean speed was deemed particularly relevant to the present research. The mean speed is determined by the entire speed distribution of the sample, this means in practice that changes in the distribution at the low-to-medium end can mask reductions in high-end speeds and violation rates that actually pose the risk (Gavin et al., 2011). This means that a potentially lower risk scenario with more speeds at and below the speed limit can have the same or a similar mean to a scenario with a relatively high proportion of speeding vehicles (Doecke et al., 2011). Secondly, more uniform speeds with fewer extreme speeds are desirable and may additionally more accurately reflect the level of risk (Aarts & van Schagen, 2006; van Nes, Brandenburg, & Twisk, 2010). The main analyses will therefore consider the variation in vehicle speeds and analyse the rate of speeding vehicles.

In order to test if the prevalence of speeding reduced at the lower end (0-10km/h excess), and above 10km/h excess, the speed data was formatted as two binary variables (0 = not exceeding, 1 = exceeding). The analysis of speed data was conducted by fitting binary logistic (logit) regressions using generalised linear models (GLM). This method of analysis allows for the calculation of the significance and magnitude of the difference in speeding for the experimental period with the control periods. Keall, Povey and Frith (2001) have previously successfully used this procedure to analyse differences in vehicle speeds between control and experimental conditions. SPSS v21 (IBM Corp, 2012) was used to perform these tests using the GENLIN procedure.

3.3.2 Crashes and injuries

In order to test whether the intervention period had fewer crashes or fatalities by a statistically significant margin, GLMs were used to analyse the incident count data. D’Elia, Newstead and Cameron (2007) have previously successfully applied GLMs to crash count and crash severity data, and are the most commonly used methods for analysing crash frequency data over time periods or between experimental conditions (Lord & Mannering, 2010). Depending on the dispersion of data (conditional variance / conditional mean), either a Poisson regression (for dispersion ≈ 1) or negative binomial regression (dispersion > 1) is more appropriate (Lord & Mannering, 2010). The criterion variables fatal crashes and deaths met the dispersion assumptions of the Poisson distribution, while the remaining crash and injury variables were over-dispersed, and were therefore analysed by fitting negative binomial regressions.
The Poisson distribution does not assume a high zero count; a high proportion of zeros may be accounted for with a zero inflated Poisson model. Vuong’s test was used to determine if zero inflation or single-equation count models were more appropriate (Vuong, 1989). R v3.1.1 was used to conduct the Vuong tests (R Core Team, 2014). The Vuong tests returned non-significant at $\alpha < .05$ for fatal crashes and fatal injuries. It was therefore concluded that zero inflation was not required. SPSS v21 (IBM Corp, 2012) was used to perform the Poisson and negative binomial regressions, using the GENLIN procedure.
4. Results

4.1 Mean speeds and speed distributions

Table 1 contains descriptive data of the mobile speed camera survey data before and after being filtered for free-flow vehicles. As is visible from the sample data in Table 1, mean speeds do not appear to have decreased by a substantial amount. There was a 0.6 to a 2km/h difference in mean driving speed for the Safer Summer period compared with previous years. Similarly, the speed of the fastest 15% of vehicles (85th percentile speed) was only slightly lower by 1 to 2km/h compared with previous years. Examining vehicle speeds visually presents a more detailed representation of precisely where the changes for the Safer Summer period appear to have occurred.

Table 1. December–January period descriptive statistics

<table>
<thead>
<tr>
<th>Period (Dec–Jan)</th>
<th>Original samples</th>
<th>Samples adjusted for free-flow traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>2009–2010</td>
<td>2,442,930</td>
<td>89.6(10.0)</td>
</tr>
<tr>
<td>2010–2011</td>
<td>3,022,918</td>
<td>90.3(9.5)</td>
</tr>
<tr>
<td>2011–2012</td>
<td>2,801,351</td>
<td>89.9(9.2)</td>
</tr>
<tr>
<td>2012–2013</td>
<td>2,514,265</td>
<td>89.0(9.5)</td>
</tr>
<tr>
<td>2013–2014</td>
<td>2,852,402</td>
<td>88.6(8.8)</td>
</tr>
</tbody>
</table>

Note. SD = Standard deviation

Figure 2 shows that Safer Summer, in comparison to the previous four years, follows the same shape of distribution, but with slightly higher kurtosis (as would be expected from the smaller standard deviation) and a much more sharply declining slope as vehicle speeds approached the 100km/h speed limit. While other periods remain closely grouped as the speed curves approach 100km/h, the solid line, representing the Safer Summer period breaks off around the 100km/h mark, shifting to the left. It appears that the change in driving speeds for the Safer Summer period has principally occurred at the top-end of the distribution (+1.3 SD from the mean).

Of interest in the descriptive data was the smaller standard deviation for the intervention period. The 2013-2014 period was associated with a (0.7km/h) decrease in the standard deviation of the speed distribution compared to the previous period. Vehicle speeds that are more homogenous are known to be safer, especially when combined with fewer speeding vehicles (van Nes et al., 2010). Analyses on the proportions of speeding drivers (speeding rates) presented under section 4.3 (p. 23) will provide more insight into the observed change at the tail-end of the speed distribution.
4.2 Speed notices

4.2.1 Notice volumes

The combination of a reduction in the speed enforcement threshold and increased enforcement intensity has meant that notice volumes increased by a significant margin. Officer issued notices increased substantially below the pre-intervention threshold, and by a smaller degree above 10km/h. A summary of officer issued speed offence and infringement notice volumes has been provided in Table 2.

Table 2. Comparison of officer issued notice volumes

<table>
<thead>
<tr>
<th>Period (Dec–Jan)</th>
<th>Notices &lt;11km/h excess</th>
<th>Notices ≥11km/h excess</th>
<th>Total notices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012–2013</td>
<td>3,244*</td>
<td>40,798</td>
<td>44,042</td>
</tr>
<tr>
<td>2013–2014</td>
<td>17,742</td>
<td>44,219</td>
<td>61,961</td>
</tr>
<tr>
<td>Change</td>
<td>+11,498</td>
<td>+3,421</td>
<td>+17,919</td>
</tr>
</tbody>
</table>

*The reduced threshold for this period only applied from 21 December 2012–6 January 2013, in addition to school zones.

Table 3 contains the descriptive offence and infringement data resulting from mobile speed camera operations. Unlike officer issued notices, camera notices did not increase above 10km/h excess, and actually decreased for higher-excess speeds. This may indicate that officer enforcement increased more substantially than mobile camera enforcement (refer also to Enforcement operations, p. 14), Ticketing rates (p. 20) will further examine this finding.
### Table 3. Comparison of mobile camera operations and notice volumes

<table>
<thead>
<tr>
<th>Period (Dec–Jan)</th>
<th>Deployment hours</th>
<th>Notices &lt;11km/h excess</th>
<th>Notices ≥11km/h excess</th>
<th>Total notices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012–2013</td>
<td>10,879</td>
<td>38,170*</td>
<td>52,607</td>
<td>90,777</td>
</tr>
<tr>
<td>2013–2014</td>
<td>12,463</td>
<td>198,226</td>
<td>48,393</td>
<td>246,619</td>
</tr>
<tr>
<td>Change</td>
<td>+1,584</td>
<td>+160,056</td>
<td>−4,214</td>
<td>+155,842</td>
</tr>
</tbody>
</table>

*Reduced threshold for this period only applied from 21 December 2012–6 January 2013, in addition to school zones.

#### 4.2.2 Ticketing rates

Based on previous research (Bobevski et al., 2007; Luoma et al., 2012), it was expected that the ticketing rate of speed infringement notices issued for exceeding the limit by 11km/h or more would decrease compared to previous years, while the additional notices issued within the 5km/h to 10km/h would lead to an overall increased notice volume. Since it was expected that officer issued speed notices would increase during this time period (considering there was an increased focus on speed enforcement), it was decided to use mobile speed camera notice volumes to compare ticketing rates. There are, however, further constraints when analysing this data.

Firstly, the number of mobile camera deployments and total deployment hours vary substantially per period. Considering the number of notices issued can be as much related to the number of speeding drivers, as to the number of observations that are made, the notices issued per hour of camera operation was analysed in order to get a comparable measure. Secondly, since cameras in the previous year were set to a higher tolerance threshold (10km/h) apart from the Christmas/New Year period (4km/h), it was expected that notice volumes would increase during Safer Summer because the threshold at which notices began to be issued was lower. It was therefore decided to report on notices issued at excess speeds of 11km/h+ of the posted 100km/h speed limit per hour of camera operation. Finally, the period December 2009 to January 2010 was excluded from the analysis as during this period there were a number of initial issues with the (then) newly introduced digital mobile cameras during the first few months of operation. The comparisons for notice volumes will therefore only include the previous three December–January periods.

Table 4 contains a comparison of notices issued per camera hour. The percentage decrease presented in the right-hand column represents the proportion change for the experimental period (e) in the bottom row compared to the control period appearing in the left-hand column of each preceding row (c).
Table 4. Comparison of mobile camera issued notices in 100km/h zones

<table>
<thead>
<tr>
<th>Period</th>
<th>Camera hours</th>
<th>Camera notices ≥11km/h excess</th>
<th>Notices issued per camera hour</th>
<th>Percentage change (e vs. c_x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010–2011</td>
<td>6,119</td>
<td>14,001</td>
<td>2.3</td>
<td>−60</td>
</tr>
<tr>
<td>2011–2012</td>
<td>5,772</td>
<td>10,943</td>
<td>1.9</td>
<td>−52</td>
</tr>
<tr>
<td>2012–2013</td>
<td>5,218</td>
<td>9,232</td>
<td>1.8</td>
<td>−48</td>
</tr>
<tr>
<td>2013–2014</td>
<td>5,953</td>
<td>5,470</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

Per hour of operating, the notice volume of mobile speed cameras decreased by 48 percentage points during the intervention period compared to the nearest control period. The shift in notice volumes by excess speed for the December 2013–January 2014 period has been shown in Figure 3, which visualises the decrease in speed notices issued above the pre-intervention (10km/h) threshold, and an increase in 10km/h-and-under notices.

Figure 3. Mobile camera issued speed notice distributions (100km/h zones).

4.3 Speeding

4.3.1 Comparison with previous years

The percentage of speeding vehicles for the intervention period was compared to the percentage of vehicles speeding in control periods. Speeding vehicles were separated into excess speed categories of 1–10km/h over the limit, and speeds of 11km/h+ over the 100km/h limit. Table 5 shows these comparisons; the percentage unit change denotes a comparison for each control period with the experimental period (i.e. the value for the experimental period is subtracted from the value for each control period).
The proportion of speeding vehicles decreased by three percentage points for speeds in the 1–10km/h excess speed range, and by 0.3 percentage points for speeds exceeding 10km/h excess.

Table 5. Proportion of speeding vehicles in 100km/h limit zones

<table>
<thead>
<tr>
<th>Period (Dec–Jan)</th>
<th>1–10km/h excess speed</th>
<th>&gt;10km/h excess speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speeding (%)</td>
<td>Percent unit change (e^{-c_x})</td>
</tr>
<tr>
<td>2009–2010</td>
<td>10.7</td>
<td>-5.3</td>
</tr>
<tr>
<td>2010–2011</td>
<td>11.0</td>
<td>-5.6</td>
</tr>
<tr>
<td>2011–2012</td>
<td>9.5</td>
<td>-4.1</td>
</tr>
<tr>
<td>2012–2013</td>
<td>8.4</td>
<td>-3.0</td>
</tr>
<tr>
<td>2013–2014</td>
<td>5.4</td>
<td></td>
</tr>
</tbody>
</table>

4.3.2 Main effect estimation

Binary logistic regressions were performed to test if significantly fewer drivers were speeding during the intervention period compared to the control periods. The results of the procedures described under Statistical analysis methods (p. 18) have been presented in Table 6. The model as a whole is first compared to the intercept (null model) in the omnibus test, if the probability value is smaller than the critical .05 level, the model is called significant. Table 6 shows the model coefficients, which indicate that vehicles speeding at 1–10km/h over the limit significantly decreased during the intervention period. The model for speeding at 11km/h+ over the limit also showed significant decreases in speeding during the intervention period.


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Coefficient estimate (\beta)</th>
<th>Odds ratio (Exp. (\beta))</th>
<th>95% confidence interval</th>
<th>Wald (\chi^2)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–10km/h excess speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.74</td>
<td>2.10*</td>
<td>2.07, 2.12</td>
<td>28,720.52</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Dec 2010–Jan 2011</td>
<td>.77</td>
<td>2.15*</td>
<td>2.13, 2.18</td>
<td>21,313.60</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.61</td>
<td>1.83*</td>
<td>1.82, 1.85</td>
<td>13,971.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.47</td>
<td>1.60*</td>
<td>1.58, 1.62</td>
<td>7,653.82</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

| >10km/h excess speed       |                               |                            |                         |                |      |
| Dec 2009–Jan 2010          | .96                           | 2.61*                      | 2.52, 2.70              | 3,136.75       | <.001|
| Dec 2010–Jan 2011          | .89                           | 2.44*                      | 2.35, 2.53              | 2,675.22       | <.001|
| Dec 2011–Jan 2012          | .67                           | 1.95*                      | 1.88, 2.03              | 2,344.92       | <.001|
| Dec 2012–Jan 2013          | .59                           | 1.80*                      | 1.73, 1.87              | 1,207.16       | <.001|

Note. *Significant at 99.9% probability level.
The odds ratios given in Table 7 can be seen as the prevalence of speeding in each of the control periods compared with the intervention period (which is set at 1). Odds ratios below 1 indicate lower risk, while odds ratios exceeding 1 denote increased risk. For example, the odds ratio for speeding in excess of 10km/h in December 2012–January 2013 is 1.8 times (80%) higher than the experimental period. The confidence interval shows the reliability range of the odds ratio parameter estimate; that is the 95% probability that the parameter falls within this range.

To ease interpretation of these results, the odds ratios presented in Table 7 are reversed and represented as a percentage reduction in speeding vehicles for the treatment period compared to the control periods. The percentage decrease represents the proportional change for the experimental period (e) in the bottom row compared to each of the control periods (c_x). The results show that prevalence of speeding decreased both at the lower level (within the pre-intervention tolerance level), and at the higher level (above 10km/h).

Table 7. Change in speeding for intervention period vs. controls

<table>
<thead>
<tr>
<th>Time period (Dec–Jan)</th>
<th>1–10km/h excess speed</th>
<th>&gt;10km/h excess speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speeding (%)</td>
<td>Percentage decrease (e vs. c_x)</td>
</tr>
<tr>
<td>2009–2010</td>
<td>10.7</td>
<td>49.5*</td>
</tr>
<tr>
<td>2010–2011</td>
<td>11.0</td>
<td>50.9*</td>
</tr>
<tr>
<td>2011–2012</td>
<td>9.5</td>
<td>43.2*</td>
</tr>
<tr>
<td>2012–2013</td>
<td>8.4</td>
<td>35.7*</td>
</tr>
<tr>
<td>2013–2014</td>
<td>5.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Note. *Significant at 99.9% probability level.

Speeding in the 1–10km/h excess range decreased by a statistically significant 35.7% compared to the closest control period. When accounting for the maximum year-on-year variance between control periods of 13.6%, this leaves a 22.1% conservative estimated net reduction outside of any expected variation. Speeding in excess of 10km/h decreased by a statistically significant 45.2% compared to the closest control. When accounting for the maximum year-on-year variance between control periods of 20.2%, this leaves a 25% conservative estimated net reduction outside of the maximum variation observed prior to the intervention.

4.3.3 Comparison of mobile speed camera and Bliptrack speed survey data

Data gathered by the Bliptrack journey monitoring system was used to validate the speed camera survey data. The excess speed readings produced by the Bliptrack system are lower than might be expected on a 100km/h road for all of the measurement
periods (see Figure 4). The data recorded involves the average speed over the entire stretch of road, and is not a cross section of speed readings at any particular point in time (as is the case with the speed camera data). However, the purpose of this analysis is to examine what effect the intervention of a reduced speed enforcement threshold had on speed and driver behaviour, rather than produce estimates of road speeds.

![Figure 4. Percentage of speeding vehicles observed in two independent speed surveys.](image)

The percentage of speeding vehicles for speed camera captured survey data and *Bliptrack* data varies by approximately ±1% per month during the one-year period leading up to the intervention period. The proportion of speeding vehicles in both datasets appears fairly stable until November 2013, and drops considerably in the subsequent December 2013 and January 2014 months. This decrease was not observed for the same months in the previous year, and also does not persist in February, when the enforcement threshold reverted to 10km/h. The decrease in speeding observed in the speed camera survey data was also present in the data captured by the *Bliptrack* system. This indicates that the effects on speeding estimated in the analysis (Table 7) are not a result of a ‘kangaroo effect’. This is evidence that intervention was associated with overall increased compliance, rather than being limited to speed manipulation behaviour at camera sites.

### 4.4 Crashes and injuries

#### 4.4.1 Comparison with previous years

The top rows of Table 8 present the total crash counts for each time period, along with the number difference in the intervention period. At least 201 fewer minor injury crashes, 21 serious injury crashes, and 11 fatal crashes occurred during the intervention period compared to the closest control period. The numbers of injuries resulting from
crashes are broken down by severity and are presented in the bottom rows of Table 8. The change columns denote a comparison for each control period with the experimental period (i.e. the value for the experimental period is subtracted from each control period). Note that vehicle occupancy for crash involved vehicles also influences the number of resulting injuries or deaths. This may account for the discrepancy of the reduction in serious injury crashes and a simultaneous increase in serious injuries compared to the December 2011–January 2012 period.

**Table 8. Crash and injury counts by period**

<table>
<thead>
<tr>
<th>Time period (Dec–Jan)</th>
<th>Minor</th>
<th></th>
<th>Serious</th>
<th></th>
<th>Fatal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td></td>
<td>Change (e–c&lt;sub&gt;Stan&lt;/sub&gt;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009–2010</td>
<td>1,441</td>
<td></td>
<td>–386</td>
<td></td>
<td>312</td>
<td>–30</td>
</tr>
<tr>
<td>2011–2012</td>
<td>1,360</td>
<td></td>
<td>–305</td>
<td></td>
<td>303</td>
<td>–21</td>
</tr>
<tr>
<td>2012–2013</td>
<td>1,256</td>
<td></td>
<td>–201</td>
<td></td>
<td>308</td>
<td>–26</td>
</tr>
<tr>
<td>2013–2014</td>
<td>1,055</td>
<td></td>
<td>–201</td>
<td></td>
<td>282</td>
<td></td>
</tr>
<tr>
<td>Injuries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009–2010</td>
<td>2,026</td>
<td></td>
<td>–590</td>
<td></td>
<td>387</td>
<td>–24</td>
</tr>
<tr>
<td>2010–2011</td>
<td>1,899</td>
<td></td>
<td>–463</td>
<td></td>
<td>413</td>
<td>–50</td>
</tr>
<tr>
<td>2011–2012</td>
<td>1,858</td>
<td></td>
<td>–422</td>
<td></td>
<td>362</td>
<td>+1</td>
</tr>
<tr>
<td>2012–2013</td>
<td>1,680</td>
<td></td>
<td>–244</td>
<td></td>
<td>374</td>
<td>–11</td>
</tr>
<tr>
<td>2013–2014</td>
<td>1,436</td>
<td></td>
<td></td>
<td></td>
<td>363</td>
<td></td>
</tr>
</tbody>
</table>

### 4.4.2 Main effect estimation

Depending on dispersion of the data, Poisson or negative binomial regressions were performed to test if the risk of crashes and injuries significantly decreased during the intervention period compared to the control periods (refer to p. 18). The results of the procedures, described under *Statistical analysis methods* (p. 18), have been presented in Table 9. The Exponential beta parameter (Exp. β) is a measure of the relative risk of the incident occurring in each of the control periods compared to the experimental period. A value of 1 would denote equal risk, values smaller than 1 equal lower risk, and values greater than 1 indicate higher risk.

A significant reduction in the risk of fatal crashes and deaths was obtained for the intervention compared to the December 2009–January 2010 control period; however, the lack of statistical precision in the estimates for crash effects has resulted in non-significant results for the models tested as a whole. The best estimates for odds ratios show higher risk for fatal, serious and minor injury crashes; however, the degree of error or uncertainty in the model has meant that these estimates did not return as
statistically significant. Similar to the results of the crash analyses, the models for injuries returned as being non-significant. The model for fatal injuries was close to reaching the 95% probability threshold at $p = .06$.

Table 9. Model estimation and odds ratios vs. December 2013–January 2014 for crashes and injuries

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Coefficient estimate ($\beta$)</th>
<th>Odds ratio (Exp. $\beta$)</th>
<th>95% confidence interval</th>
<th>Wald $\chi^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crashes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal crashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.50</td>
<td>1.64*</td>
<td>1.10, 2.44</td>
<td>5.95</td>
<td>.015</td>
</tr>
<tr>
<td>Dec 2010–Jan 2011</td>
<td>.36</td>
<td>1.44</td>
<td>.95, 2.16</td>
<td>3.00</td>
<td>.083</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.36</td>
<td>1.44</td>
<td>.95, 2.16</td>
<td>3.00</td>
<td>.083</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.25</td>
<td>1.28</td>
<td>.84, 1.95</td>
<td>1.35</td>
<td>.245</td>
</tr>
<tr>
<td>Serious injury crashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.10</td>
<td>1.10</td>
<td>.75, 1.62</td>
<td>.24</td>
<td>.621</td>
</tr>
<tr>
<td>Dec 2010–Jan 2011</td>
<td>.15</td>
<td>1.17</td>
<td>.79, 1.72</td>
<td>.61</td>
<td>.436</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.07</td>
<td>1.07</td>
<td>.73, 1.58</td>
<td>.12</td>
<td>.730</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.09</td>
<td>1.09</td>
<td>.67, 1.60</td>
<td>.18</td>
<td>.668</td>
</tr>
<tr>
<td>Minor injury crashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.31</td>
<td>1.37</td>
<td>.95, 1.96</td>
<td>2.87</td>
<td>.090</td>
</tr>
<tr>
<td>Dec 2010–Jan 2011</td>
<td>.26</td>
<td>1.30</td>
<td>.91, 1.87</td>
<td>2.06</td>
<td>.152</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.25</td>
<td>1.29</td>
<td>.90, 1.85</td>
<td>1.90</td>
<td>.168</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.17</td>
<td>1.19</td>
<td>.83, 1.71</td>
<td>.89</td>
<td>.344</td>
</tr>
<tr>
<td><strong>Injuries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal injuries (deaths)</td>
<td></td>
<td></td>
<td></td>
<td>8.91</td>
<td>.064</td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.54</td>
<td>1.71**</td>
<td>1.17, 2.51</td>
<td>7.71</td>
<td>.006</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.48</td>
<td>1.62*</td>
<td>1.10, 2.38</td>
<td>6.03</td>
<td>.014</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.31</td>
<td>1.36</td>
<td>.91, 2.02</td>
<td>2.36</td>
<td>.133</td>
</tr>
<tr>
<td>Serious injuries</td>
<td></td>
<td></td>
<td></td>
<td>.60</td>
<td>.963</td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.06</td>
<td>1.06</td>
<td>.72, 1.55</td>
<td>.08</td>
<td>.773</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>-.01</td>
<td>.99</td>
<td>.67, 1.45</td>
<td>.00</td>
<td>.955</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.02</td>
<td>1.02</td>
<td>.70, 1.50</td>
<td>.12</td>
<td>.911</td>
</tr>
<tr>
<td>Minor injuries</td>
<td></td>
<td></td>
<td></td>
<td>4.30</td>
<td>.367</td>
</tr>
<tr>
<td>Dec 2009–Jan 2010</td>
<td>.34</td>
<td>1.41</td>
<td>.99, 2.02</td>
<td>3.54</td>
<td>.060</td>
</tr>
<tr>
<td>Dec 2010–Jan 2011</td>
<td>.28</td>
<td>1.32</td>
<td>.92, 1.89</td>
<td>2.33</td>
<td>.127</td>
</tr>
<tr>
<td>Dec 2011–Jan 2012</td>
<td>.26</td>
<td>1.29</td>
<td>.90, 1.85</td>
<td>2.00</td>
<td>.159</td>
</tr>
<tr>
<td>Dec 2012–Jan 2013</td>
<td>.16</td>
<td>1.17</td>
<td>.82, 1.68</td>
<td>.73</td>
<td>.392</td>
</tr>
</tbody>
</table>

*Significant at 95% probability level; **Significant at 99% probability level.

To ease interpretation, the odds ratios presented in Table 10 are reversed and represented as an estimated percentage reduction in crashes and injuries. The percentage decrease represents the proportional change for the experimental period ($e$).
in the bottom row compared to each of the control periods \((c_k)\). The results, shown in Table 10, demonstrate that the risk of crashes and injuries decreased for minor injury, serious injury and fatal crash types, and for minor injuries and deaths for the intervention period compared to the nearest control period.

Table 10. Crash and injury counts by period

<table>
<thead>
<tr>
<th>Time period (Dec–Jan)</th>
<th>Minor</th>
<th>Percentage Decrease ((e \text{ vs. } c_k))</th>
<th>Serious</th>
<th>Percentage Decrease ((e \text{ vs. } c_k))</th>
<th>Fatal</th>
<th>Percentage Decrease ((e \text{ vs. } c_k))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N)</td>
<td></td>
<td>(N)</td>
<td></td>
<td>(N)</td>
<td></td>
</tr>
<tr>
<td><strong>Crashes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009–2010</td>
<td>1,441</td>
<td>26.8</td>
<td>312</td>
<td>9.6</td>
<td>64</td>
<td>39.1*</td>
</tr>
<tr>
<td>2010–2011</td>
<td>1,374</td>
<td>23.2</td>
<td>330</td>
<td>14.6</td>
<td>56</td>
<td>30.4</td>
</tr>
<tr>
<td>2011–2012</td>
<td>1,360</td>
<td>22.4</td>
<td>303</td>
<td>6.9</td>
<td>56</td>
<td>30.4</td>
</tr>
<tr>
<td>2012–2013</td>
<td>1,256</td>
<td>16.0</td>
<td>308</td>
<td>8.4</td>
<td>50</td>
<td>22.0</td>
</tr>
<tr>
<td>2013–2014</td>
<td>1,055</td>
<td></td>
<td>282</td>
<td></td>
<td>39</td>
<td></td>
</tr>
<tr>
<td><strong>Injuries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009–2010</td>
<td>2,026</td>
<td>29.1</td>
<td>387</td>
<td>6.2</td>
<td>72</td>
<td>41.7**</td>
</tr>
<tr>
<td>2010–2011</td>
<td>1,899</td>
<td>24.4</td>
<td>413</td>
<td>12.1</td>
<td>60</td>
<td>30.0</td>
</tr>
<tr>
<td>2011–2012</td>
<td>1,858</td>
<td>22.7</td>
<td>362</td>
<td>–.3</td>
<td>68</td>
<td>38.2*</td>
</tr>
<tr>
<td>2012–2013</td>
<td>1,680</td>
<td>14.5</td>
<td>374</td>
<td>2.9</td>
<td>57</td>
<td>26.3</td>
</tr>
<tr>
<td>2013–2014</td>
<td>1,436</td>
<td></td>
<td>363</td>
<td></td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Negative values denote an increase; *Significant at 95% probability level; **Significant at 99% probability level.

Although some of the decreases observed for the intervention period compared to the control periods appear to be considerable (particularly for fatal crashes and deaths), these decreases were not statistically significant. The confidence limits for all crash and injury types are wide and overlap for at least one of the control periods. This indicates a high degree of uncertainty in that is likely attributable to the small sample size.

4.5 Public opinion surveys

Three surveys run by organisations external to Police that captured public perceptions and opinions on the campaign were identified. A survey by the Automobile Association showed that 57% of those surveyed \((N \approx 10,000)\) supported the lower speed enforcement threshold applied during the campaign, while 37% were opposed (“Speed tolerance makes a difference,” 2014). A second survey by the New Zealand Herald showed that 66% of those surveyed \((N \approx 8,900)\) supported the lower enforcement threshold, and agreed that the initiative was about increasing road safety, while 29% of
those surveyed opposed the initiative (Davidson, 2014). Finally, a survey conducted by Horizon Research showed that 43% of those surveyed ($N = 3,104$) supported a reduced enforcement threshold during holiday periods only, while 30% were opposed (Preston, 2014). A similar distribution of opinions was obtained for a hypothetical permanent reduction in the threshold, with 43% supporting the proposition, and 37% against (Preston, 2014). Overall, based on these surveys, the public was more supportive of the initiative than opposed.
5. Discussion

5.1 The campaign

The aims of the Safer Summer campaign were to reduce the prevalence of low-level speed violations and higher-end speeding in order to reduce the risk of crashes and injuries. The Safer Summer campaign consisted of three distinct components: a reduction in the speed enforcement threshold, increased speed enforcement intensity, and a publicity campaign. Considering that more than one variable was changed during the treatment period, this creates a difficulty in attributing the effects to antecedents, as these could have resulted from any one aspect or a combination. A reduced speed enforcement threshold has previously been shown to have independent effects on driving speeds (Andersson, 1989; Luoma et al., 2012). Speed enforcement intensity has also been shown to independently affect driving speeds and crashes (Elvik, 2011; Povey et al., 2003), especially when combined with publicity (Tay, 2005), although publicity by itself did not have significant effects on speeding (Tay, 2005).

Considering these previous findings, publicity is considered to have been a key component of achieving increased compliance with the speed limits during the treatment period by creating awareness of the reduced speed enforcement threshold. The increase in enforcement intensity is seen as having enhanced this effect. Overall, the combination of the three components of the enforcement campaign appears to have successfully instilled a message of zero tolerance for speeding.

5.2 Changes in speeds and speeding

The reduced enforcement threshold over the two-month period resulted in an increase in the total number of notices issued during the Safer Summer period in comparison to the previous four years. However, this increase in mobile camera issued notices was restricted to the 5–10km/h excess speed range. Per hour of camera operation almost 50% fewer notices were issued at speeds exceeding 10km/h. This indicates that greater compliance was obtained during the intervention period with fewer notices being issued at speeds exceeding the pre-intervention speed enforcement threshold. The intensification of officer speed enforcement has led to increases in notice volumes both between 5–10km/h and above 10km/h excess speed. Notice volumes are expected to normalise if the lowered threshold were implemented over a greater period of time and the increase in speed notices in the lower 5–10km/h speed range will decrease as drivers adjust to the new enforcement threshold (Cameron, 2008).

The descriptive data did not indicate a substantial mean speed decrease, but did suggest that the homogeneity of speeds increased. The standard deviation decreased from 9.5 to 8.8, indicating that speed variability decreased substantially during the intervention period. Previous research has shown that the “homogeneity of driving speeds is an
important variable in determining road safety; more homogenous driving speeds increase road safety” (van Nes et al., 2010, p. 944). The speed distribution indicated that the greatest change in vehicle speeds occurred at and above the speed limit (Figure 2, p. 21). Speed data was further analysed by comparing the proportions of speeding vehicles. This would provide an estimate of the decrease in the prevalence of speeding.

The results of these analyses showed that substantial and statistically significant decreases in speeding rates were present during the intervention period. Speeding within the usual 0–10km/h speed enforcement tolerance decreased by 36%, which was a 22% net reduction when controlling for the maximum variance between control periods. Speeding above 10km/h excess speed decreased by 45%, which was a 25% net reduction when controlling for the maximum variance between control periods. These findings were also in accordance with previous research findings (Luoma et al., 2012). A comparison with a supplementary source of speed survey data confirmed the decreases in speeding were likely present across the road network, and not limited to camera sites.

5.3 Effect of speed of crashes and injuries

On the basis of previous research findings, the decreases in speeding associated with the campaign were expected to have a significant and substantial impact on reducing the risk of serious crashes, injuries and deaths (Cameron, 2013; Doecke et al., 2011; Elvik, 2012; Gavin et al., 2010). Although the number of crashes decreased during the treatment period, and the best estimates show decreases in crash risk, there was insufficient evidence in the data to confirm the significance of the reductions in fatal crashes (22%), serious injury crashes (8%), and minor injury crashes (16%).

Decreases in speeds and speeding have been shown to strongly relate to crash severity, and to a lesser extent, crash occurrence in a number of studies (Cameron, 2013; Doecke et al., 2011; Gavin et al., 2010). While this relationship could not be statistically reproduced in the present research, these findings provide indirect evidence of reductions in the risk of crashes and injuries. If speeding can be kept down over prolonged periods of time (which was associated with the intervention), the risk of fatal and serious injury crashes is expected to reduce by a significant margin. It is therefore likely that if the duration of the campaign were increased, the lower crash and casualty counts that were present during the campaign period would reach a critical point where statistically significant decreases are realised.
6. Conclusions

The combined efforts of a reduced speed enforcement threshold, enforcement intensity, and public awareness effectively and significantly reduced extreme driving speeds and speeding over the high-risk holiday period. On the basis of previous research findings, these effects can be expected to have led to substantial reductions in the risk and severity of crashes. Serious injury and fatal crashes did decrease during the intervention period, and the lowest number of road deaths was recorded for this period since the 1950s. While the analysis of crash and injury data presented difficulty in accurately estimating the reductions associated with the intervention, there is every indication that the application of well-publicised reduced speed enforcement threshold shows considerable promise as a road safety intervention.

This was the safest summer on New Zealand roads in recent history. However, it is unclear from the analyses precisely how much of the reductions in crashes, injuries and deaths can be attributed to the intervention. It can also not be determined how many additional crashes and casualties would have occurred in its absence. It can, however, be concluded that the well-publicised, prolonged reduction in the speed enforcement threshold, combined with a strong enforcement effort, demonstrated high efficacy in changing road user behaviour. This was evident from the immediate decrease in speeding upon the commencement of the campaign, and instant increase in speeding after the intervention ended (refer to Figure 4, p. 26).

Luoma et al. (2012) have previously published similar findings to the present study; that a publicised lower speed enforcement threshold causes drivers to slow down, increases speed homogeneity and decreases speeding. However, Luoma et al. (2012) did not examine the impact on crash risk and occurrence. While the present study did include a statistical analysis of crash rates, the inability to detect significant effects for crashes and injuries is likely a result of insufficient data (Lord & Mannering, 2010). A trial of a reduced speed enforcement threshold over a longer period (4 to 6 months or longer) would assist in being able to more accurately estimate the associated reductions in crash risk and injury severity.
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Appendix A

Figure 5. Example roadside billboard.

Appendix B

Figure 6. Red and orange marked Police highway patrol vehicles at the Safer Summer campaign launch event.
Appendix C

Figure 7. Reach the beach board game.