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# EVALUATION OF THE QUEENSLAND ROAD SAFETY INITIATIVES PACKAGE

By

Stuart Newstead

Irene Bobevski

Simon Hosking

Max Cameron

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**Author(s):**
Stuart Newstead, Irene Bobevski, Simon Hosking and Max Cameron



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**Abstract:**

This report presents an evaluation of the Queensland Road Safety Initiatives Package (RSIP) developed by Queensland Transport (QT) and the Queensland Police Service (QPS). The RSIP is a continuation of the Holiday Period Road Safety Enforcement and Education Campaign that was trialled between 13th December 2001 and 8th February 2002, and re-implemented from 13th December 2002 to 27th April 2003. The RSIP commenced on 28th April 2003 and continued into 2004. The RSIP aimed to target the road toll through increased hours of speed camera operation, increased hours of on-road Police enforcement to target the “Fatal Four” behaviours (drink driving, speeding, fatigue, and non-seat belt wearing), increased mass-media publicity to target the “Fatal Four” and increased hours of Police educative activities.

This study has evaluated the effectiveness of the Road Safety Initiatives Package implemented in Queensland over the period December 2002 to January 2004. The evaluation has examined the crash effects of the program and their associated economic worth for both the program as a whole as well as for specific program elements. It has also assessed changes in speeding behaviour and general attitudes through analysis of speed monitoring data and attitudinal surveys respectively.



**Key Words:**
Evaluation, Accident, Police, Enforcement, Publicity, Statistical Analysis,





Monash University Accident Research Centre,
Building 70, Clayton Campus, Victoria, 3800, Australia.
Telephone: +61 3 9905 4371, Fax: +61 3 9905 4363

# Preface

**Project Leader**

Dr Stuart Newstead

**Research Team**

Dr Simon Hosking

Dr Irene Bobevski

Dr Max Cameron

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# EXECUTIVE SUMMARY

To address the Queensland road toll, Queensland Transport (QT) and the Queensland Police Service (QPS) have developed the Road Safety Initiatives Package (RSIP). The RSIP is a continuation of the Holiday Period Road Safety Enforcement and Education Campaign that was trialled between 13$^{th}$ December 2001 and 8$^{th}$ February 2002, and re-implemented from 13$^{th}$ December 2002 to 27$^{th}$ April 2003. The RSIP commenced on 28$^{th}$ April 2003 and continued into 2004.

The RSIP involved the following measures to target the road toll:

1. Increase in the hours of operation of speed cameras, from five to eight hours per camera per day.
2. Increase in the hours of on-road Police enforcement to target the "Fatal Four" behaviours – drink driving, speeding, fatigue, and non-seat belt wearing.
3. Increase of mass-media publicity (planned TARPs) to target the "Fatal Four".
4. Increase in hours of Police educative activities: For example, educating motorists who have been pulled over about the Fatal Four and publicising analysis of crashes on the previous day.

The broad aim of this study was to evaluate the effectiveness of the Road Safety Initiatives Package implemented in Queensland. The evaluation has examined the crash effects of the program and their associated economic worth for both the program as a whole as well as for specific program elements. It has assessed changes in speeding behaviour and general attitudes through analysis of speed monitoring data and attitudinal surveys respectively.

***Effects on Crashes***

Crash effects of the RSIP were assessed using an explanatory Poisson regression model of monthly crash data series from January 1998 to January 2004. As the RSIP targeted crashes at all times of the day in all places, it was not possible to use an experimental or quasi-experimental study design. Hence an integrated regression time series model was used with the effect of factors other than the RSIP on crash outcomes represented, as far as possible, by using explicit measures of the other factors as explanatory variables in the regression model.

The crash data were divided into 32 strata. The 32 strata were defined by segregating each of the 8 Queensland police regions into speed zones less than 80km/h and greater than or equal to 80km/h and further dividing these into high and low alcohol hours of the day. High alcohol hours are the times when alcohol related crashes are most prevalent. The crash data was stratified in order to relate specific explanatory variables in the model to those crash strata to which they were targeted. A single integrated model was fitted to all 32 strata simultaneously. Separate models were fitted to each crash severity level considered.

Two formulations of the Poisson regression model were considered. The first, an intervention model, measured the overall effect of the RSIP on crashes. This model measured the RSIP effect after adjusting for the effects of changes in socio-economic factors and road safety programs other than the RSIP on crash outcomes as well as accounting for regular seasonality and long term trends in the crash data. The second model formulation was similar in format apart from replacing the RSIP intervention term with explicit measures of RSIP program components. This model aimed to measure the relative effects of the RSIP component activities on crash outcomes.

Socio-economic factors included in the model were population levels, unemployment rate and fuel sales by region in Queensland. Non-RSIP road safety programs considered were the introduction of the 50km/h local street speed limit in south-east and regional Queensland, increased penalties for use of hand-held mobile phones while driving, increased speeding penalties and the initial holiday period road safety education and enforcement campaign. Changes in crash reporting due to changes in the third party claims system were also represented. RSIP program variables considered were levels of road safety publicity awareness, the number of alcohol breath tests, the number of active speed camera sites available for use and hours of camera operation, hours of moving mode radar and laser speed enforcement operations and the number of mobile phone and non-camera speeding offences detected.

Parameter estimates from the regression models were used to estimate crash savings resulting from the RSIP both overall and for specific program components. These were further converted into estimates of economic worth to the community represented by measures of savings in crash costs and benefit to cost ratios.

Evaluation of the crash effects of the Queensland Road Safety Initiatives Package has shown clear reductions in crashes associated with implementation of the program. Overall the program was associated with a statistically significant estimated 13 to 14 percent reduction in fatal, hospitalisation and medically treated crashes after implementation and a 9 percent average reduction in crashes across all severity levels. This translated to an estimated saving of 627 fatal and hospitalisation crashes, 839 medically treated crashes and 2052 crashes across all severity levels in the 14 months post RSIP implementation period covered by the evaluation. Applying standardised crash cost values to the estimated crash savings yielded an estimated saving in crash cost to the community associated with program implementation of $380M. Of these savings, $361M were savings from reduced fatal and hospitalisation crashes. Comparing total program savings to expenditure incurred in implementing the program gave an estimated overall benefit to cost ratio for the program of 22.

The evaluation also identified a number of RSIP component activities that were significantly associated with crash outcomes. Monthly levels of television road safety advertising awareness, speed camera operation hours, alcohol breath tests conducted and seat belt and mobile phone offences detected were significantly related to monthly variation in observed crash numbers. Comparison of average measures of each program component before and after the RSIP program implementation resulted in estimates of relative program component effects on crashes.

A 100 percent increase in hours of speed camera enforcement under the RSIP was associated with a statistically significant reduction in fatal and hospitalisation crashes of 9 percent. This represents 410 crashes of these severity levels across the 14 month RSIP evaluation period with a value to the community of $236M. The estimated benefit to cost ratio for the speed camera program component of the RSIP was 21. A reduction in crashes of all severity levels of between 2 and 3 percent was associated with the 30 percent increase seat belt and mobile phone offences detected under the RSIP. This translated to savings of 146 fatal, hospitalisation and medically treated crashes and 275 crashes of all severity levels across the RSIP evaluation period, a saving of $23M to the community. A 20 percent increase in alcohol breath tests was associated with only modest crash reductions of about 1 percent with a value to the community of around $396,000. It was not possible to estimate specific program component benefit to cost ratios for the increased mobile phone and seat belt penalties or the increased alcohol breath tests.

Analysis found clear statistical association between increased levels of television road safety publicity and reduced observed crash frequency. However, levels of television road safety publicity achieved after RSIP implementation were only about one third that achieved before program implementation hence leading to an estimated increase in crashes associated with the program. The crash increase associated with the reduced level of advertising during the RSIP period was estimated to be 2 to 3 percent. This represented an increase 560 of crashes across all severity levels with a community value of $78M. The overall effectiveness of the RSIP could have been increased had the publicity levels remained at or increased from pre RSIP levels.

A significant proportion of the total crash savings attributable to the RSIP program was unexplained by the individual program components found to be significantly associated with crash outcomes. This suggests there were one or more RSIP components, other than those identified, that have led to substantial crash savings. The unidentified successful program components could include those for which explicit measure were available but were not significant in the analysis model as well as unmeasured program effort such as publicity generated through program launches or enforcement blitzes. Indicative benefit to cost ratio estimates for the unidentified program components suggest that, although unidentified in nature, they may have produced benefit to cost ratios as high as over 40.

***Effects on Travel Speeds***

Effects of the RSIP on travel speed were assessed through the analysis of speed survey data provided by Queensland Transport for 60km/h speed zones in regional Queensland, and from the Queensland Department of Main Roads for 100km/h speed zones in regional Queensland. Speed survey data was available once before the implementation of the RSIP and three and two times during the RSIP period on the 60km/h roads and 100km/h roads respectively. No centrally coordinated speed surveys were undertaken in South East Queensland during the evaluation period.

Analyses of speed surveys in 100km/h speed zones have shown that the implementation of the RSIP was associated with very small reductions in mean speeds and 85$^{th}$ percentile speeds. In contrast, relatively larger reductions in mean speeds and 85$^{th}$ percentile speeds were estimated in 60km/h zones, suggesting that the RSIP had a greater effect on drivers in this speed zone.

Implementation of the RSIP was also associated with large reductions in the proportion of vehicles exceeding the speed limit in 60km/h zones by 10km/h or more. This result is in concordance with the estimated significant decrease in serious casualty crashes in Queensland associated with RSIP implementation, and in particular with the estimated significant effect associated with the large increase in speed camera operation hours under the RSIP.

*Effects on Attitudes*

Effects of the RSIP on community attitudes was assessed through the analysis of data from four telephone surveys conducted by Market and Communications Research (MCR) and provided through Queensland Transport (QT). Change in attitudes and behaviours that may have occurred following the RSIP implementation were assessed through comparing the responses from the single available post-RSIP survey to responses of a survey that was conducted prior to (but close) to the beginning of the RSIP period.

Although the surveys were not totally compatible, there were 25 questions that were consistent between the two surveys and that were related to road behaviours targeted by the RSIP. The survey presented various questions and statements on which the respondents had to indicate the extent to which they disagreed or agreed, or select the option that was most applicable to them. Most of the questions that were consistent between the two surveys related to speeding attitudes and behaviours, and in particular to speed cameras. In addition, there were four questions related to the extent to which respondents might be deterred from speeding by various sanctions. There were also a small number of questions related to wearing seat belts and to fatigued driving. There were, however, no questions that could be compared pre and post RSIP on road safety advertising or on drink driving.

Five of the survey questions analysed had response patterns that changed significantly from before to after RSIP implementation. Compared to the pre RSIP survey, in the post RSIP survey:

- A higher proportion of respondents said they were confident they knew where to expect to see speed cameras
- More respondents agreed strongly that speeding is a major contributor to crashes
- A lower proportion of respondents said they would be deterred by double speeding fines during holidays or compulsory driver education for high demerit point accrual
- A lower proportion of respondents did not support at all the use of cameras or associated technology to detect dangerous road behaviours other than speeding
- A higher proportion of respondents supported the use of fixed speed cameras at overpasses where it was dangerous to place vehicle mounted units.

Overall, where significant changes occurred, they mainly indicated subtle shifts towards more favourable attitudes and less extreme disagreement with issues. The exception was the perceived deterrence effects of the various sanctions, where there was a small shift towards perceiving the sanctions as having a lesser deterrent effect over time. Possible explanations for this were offered but further studies were recommended to further understand these patterns.

Generally, the results of both surveys indicated favourable attitudes towards speed cameras, as well as a good awareness of road safety issues such as speeding, seat belts, and fatigued driving. Although the survey mainly focused on attitudes, rather than behaviours, the results are consistent with the estimated crash reductions associated with the increase in camera hours over the RSIP period. The reduction in crashes indicates changes in driving behaviours associated with the increased camera activity. Such behavioural changes are in line with the shift towards somewhat more favourable attitudes towards speed cameras and a somewhat higher awareness of speeding as a serious road safety issue.

It should be noted that low response rates were achieved for both surveys used in the reported analysis. This substantially limits the extent to which the survey findings can be reliably generalised to the population of Queensland, even though the survey data was weighted to the Queensland population. Therefore, the survey results should be interpreted cautiously and only as supplementary evidence to the RSIP outcome evaluation discussed in the first part of this report, rather than be used as a major indicator for road safety policy decision making.

# EVALUATION OF THE QUEENSLAND ROAD SAFETY INITIATIVES PACKAGE

## 1 BACKGROUND AND AIMS

### 1.1 THE QUEENSLAND ROAD SAFETY INITIATIVES PACKAGE

To address the Queensland road toll, Queensland Transport (QT) and the Queensland Police Service (QPS) have developed the Road Safety Initiatives Package (RSIP). The RSIP is a continuation of the Holiday Period Road Safety Enforcement and Education Campaign (HPRSEEC) that was trialled between 13th December 2001 and 8th February 2002, and re-implemented from 13th December 2002 to 27th April 2003. The RSIP commenced on 28th April 2003 and continued into 2004.

The RSIP involved the following measures to target the road toll:

1. Increase in the hours of operation of speed cameras, from five to eight hours per camera per day.
2. Increase in the hours of on-road Police enforcement to target the "Fatal Four" behaviours – drink driving, speeding, fatigue, and non-seat belt wearing:
   - 2.1. To target drink driving: increase in RBTs by buses and other stationary or mobile vehicles.
   - 2.2. To target speeding: increase in the hours of operation of moving mode radar (MMR) and LIDAR speed detectors.
   - 2.3. To target non-seat belt wearing and fatigue: increase in Police hours of "Stop and inspect" operations for seat belts, mobile phones and fatigue.
3. Increase of mass-media publicity (planned TARPs) to target the "Fatal Four":
   - 3.1. During 2002-03 an additional $658,000 was planned to spend on advertising.
   - 3.2. During 2003-04 an additional $1 million was planned and several TV advertisements were aired: *"Every K Over is a Killer"* (speeding theme), *"Blood on the Streets"* (speeding theme), and *"Seat belt"* (seat belt wearing theme).
4. Increase in hours of Police educative activities: For example, educating motorists who have been pulled over about the Fatal Four and publicising analysis of crashes on the previous day.

### 1.2 EVALUATION AIMS AND STUDY STRUCTURE

The broad aim of this study was to evaluate the effectiveness of the road safety initiatives package implemented in Queensland. This has been achieved by structuring the evaluation into two sections, each examining a different aspect of program effectiveness.

Section 1: Examines the effects of the RSIP on crash outcomes in Queensland. Program crash effects have been estimated through statistical modelling techniques both for the program as a whole as well as for specific program elements. Estimates of program crash effects have then been translated into economic savings and in turn into benefit to cost ratio estimates.

Section 2: Examines intermediate measures of RSIP effectiveness. Changes in speed behaviour associated with program introduction have been examined through the analysis of speed monitoring data. General behavioural changes associated with the RSIP in the driving population have also been examined through the analysis of behavioural surveys.

For the purposes of the study, the RSIP period has been defined to include both the re-implementation of the HPRSEEC as well as the formal RSIP period due to the compatibility of the programs in terms of structure. This has resulted in a total program evaluation period from 13$^{th}$ December 2002 to the end of January 2004, the latest month for which complete crash data was available for analysis in the project.

# 2 EVALUATION OF RSIP CRASH EFFECTS

## 2.1 CRASH EFFECTS EVALUATION DESIGN

The number of initiatives included in the RSIP (enforcement operations of various types, and mass media public education), and the reach of these program components over the crash population did not lend itself to a crash-based evaluation employing an experimental or quasi-experimental design framework. The coverage of crashes throughout Queensland by the components of the package across all times of day and all road users, did not result in any crash type which could be considered unaffected by the package and hence potentially useful for taking into account the influence of "other factors" as a "control" group in a quasi-experimental setting. Nor could crashes at any specific time of the year be considered to be unaffected, unlike the situation for the previously completed evaluation of the Holiday Period Road Safety Trial (14/12/2001 to 8/02/2002).

As the best alternative design, the evaluation of RSIP crash effects has sought to identify relationships between measures of the RSIP and the outcomes in terms of a time trend in observed monthly crashes through statistical regression modelling. The success of such an approach relies on the ability to effectively represent the majority of factors other than the RSIP that have influenced observed crash counts over an extended time period in order to be able to measure the pure effects of the RSIP. To do this, it is necessary to have accurate measures of the other influential factors and to model the crash data for a period sufficiently long to allow accurate associations between the available measures and the crash outcomes to be firmly established. This has required crash trends to be modelled over a time period including the RSIP implementation period but also for a significant time period before the introduction of the RSIP. The basic idea of the modelling approach is to accurately represent crash trends in the pre-RSIP period by the non-RSIP factors included in the regression model and then measure the perturbation from the pre-implementation crash trends once the RSIP program was in place. The perturbation is then inferred to represent the effect of the program on crashes.

A two stage approach to the regression modelling has been used in this evaluation. The first approach models the perturbation on the crash series attributed to a program effect as a single global effect. This model estimates the overall crash effects of the RSIP and is referred to as the "intervention model". The second stage measures the perturbation as a function of measures of key RSIP component activity measures. This model aims to measure the crash effects of each of the key RSIP activities and is referred to here as the "program component effects model".

The specific structure of the statistical regression models used in the evaluation will be discussed in detail later in the report but are classed as Poisson regression models, a class of Generalised Linear Models (GLMs) (McCullagh and Nelder 1989; Aitkin et al 1990). The use of GLMs in the context of this evaluation has been successfully demonstrated in other evaluations of crash outcomes in recent MUARC research examining the interaction between speed camera enforcement and mass media publicity (Cameron et al 2003a) and in a current study of the effects of increases in camera hours, "flashless" cameras and reduced speed enforcement tolerances in Victoria during 2001-2002. A paper summarising the method as applied in the first study has been peer-reviewed before publication (Cameron et al 2003b).

Key outputs from the statistical models have been used to estimate the absolute crash savings attributable to the implementation of the RSIP program both overall and for specific program components. The estimated crash savings have then been converted to crash cost savings by applying nationally accepted standardised crash cost estimates. These have then been further related to data on RSIP program implementation costs to derive estimates of the benefit to cost ratio of the program as a whole and for its components.

### 2.1.2 Evaluation Time Period

As noted, the definition of the RSIP period in the evaluation of the crash effects covers both the re-implementation of the HPRSEEC as well as the formal RSIP period, a time frame from 13th December 2002 to 26th January 2004. Because the crash data analysed was aggregated on a monthly level, exact dates of implementation could not be reflected in the time period defined for analysis. Hence, the time period for the RSIP defined for analysis was December 2002 to January 2004 inclusive. January 2004 was chosen as the final month in the evaluation time frame to account for the approximately three-month delay for Queensland crash data records to be complete. Final crash data for the project was supplied by Queensland Transport in May 2004.

The period from January 1998 to November 2002 is used as the pre RSIP intervention period from which general trends in the crash data were estimated. The length of this period was dictated largely by the available data on key factors influencing the observed crash trends.

### 2.1.3 Analysis Stratification

It is well established that some road safety programs are targeted specifically at crashes occurring in certain regions or at certain times of the day. Furthermore, because Queensland is such a geographically and socially diverse state, it is likely that the key factors considered in this study influence road trauma trends differently in different parts of the state. To accommodate these two things in the crash analysis, the monthly crash data series was stratified for modelling.

The first level of stratification was by the 8 Queensland Police Regions. Previous evaluations of both the Random Road Watch and Speed Camera programs in Queensland have shown clear differential crash effects of police enforcement programs between Police regions. There is also likely to be different latent trends in crash data series between police regions reflecting different trends in socio-economic factors such as population growth between regions.

Within each Police Region the monthly crash frequencies were then further stratified into two times of week (High versus Low Alcohol Hours) and two road environments (urban versus rural, defined by speed zone). This stratification was made in order to focus the factors included in the models on the crashes in those times and roads where the major effects of each enforcement initiative are likely to be apparent. For example, drink-driving targeted enforcement is likely to mainly affect crashes during High Alcohol Hours, whilst hand held enforcement tools such as laser speed detectors are likely to mainly affect crashes during daylight (Low Alcohol Hours) in urban areas.

The High Alcohol Hours of the week are defined as those times and days when alcohol involvement in crashes is much higher than at other times. In Victoria, Harrison (1990) found that during High Alcohol Hours, 38% of drivers killed or admitted to hospital had illegal blood alcohol concentrations (BAC), whereas only 4% of such drivers had illegal BACs at other times. Similar patterns of alcohol involvement by time of week have been found in New South Wales (Gantzer 1994) and in South Australia (Vulcan et al 1996), suggesting that the concept has universal application throughout Australia. The High Alcohol Hours defined by Harrison (1990) are:

- 4pm Sunday to 6am Monday
- 6pm to 6am on Monday to Thursday nights
- 4pm Friday to 8am Saturday
- 2pm Saturday to 10am Sunday

Low alcohol hours are the residual times of the week.

The definitions of Urban and Rural crashes were based on speed zone of the road where each crash occurred. Rural crashes were defined as crashes that occurred on roads that had a speed zone of equal-to or greater-than 80km/h (=> 80km/h) and Urban crashes were defined as crashes that occurred on roads in all other speed zones.

Stratification by police region, alcohol hours and urban or rural speed zone defined 32 crash strata (8x2x2). For each of the 32 strata, the monthly crash counts from January 1998 to January 2004 were assembled for analysis. The final stratified analysis design matrix is depicted in Figure 2.1.

**Figure 2.1:** *Crash analysis design matrix for evaluation of Road Safety Initiatives Package in Queensland*

| | | | | Jan-97 | Dec-01 Feb-02 | Mar-02 - Nov-02 | Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 | May-03 Jun-03 Jul-03 Aug-03 Sep-03 Oct-03 Nov-03 Dec-03 Jan-04 Feb-04 Mar-04 Apr-04 |
|---|---|---|---|---|---|---|---|---|
| **PERIOD** | | | | Base Period<br>1/97 - 11/01 | Holiday Period Road Safety Trial<br>14 Dec to 8 Feb | Base Programs<br>3/02 - 11/02 | Holiday Period Road Safety Enforcement and Education Campaign<br>13/12/2002 - 27/4/2003 | Road Safety Initiatives Package<br>28/4/02 - 4/04 |
| **QLD HOLIDAYS** | | | | | | | Christmas Holidays Dec-16 to Jan-28; Easter April 12 27 | June-28 to July-14; September-20 to October-5; Christmas Holidays Dec-19 to Jan-26; Easter April 9-19 |
| SPEED ZONE BY REGION BY WEEK | **Region 1** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 2** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 3** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 4** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 5** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 6** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 7** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | **Region 8** | **Urban** | **HAH** | | | | | |
| | | | **LAH** | | | | | |
| | | **Rural** | **HAH** | | | | | |
| | | | **LAH** | | | | | |

## 2.2 DATA FOR EVALUATION OF PROGRAM CRASH EFFECTS

### 2.2.1 Crash Data and Outcome Measures

Queensland Transport supplied crash data covering the period January 1997 to April 2004. It included all reported crashes in Queensland over that period with each unit record in the data representing a reported crash. Each record in the crash data contained the following critical information.

- Crash severity
- Crash date
- Crash time of day
- Police region of crash location
- Speed limit of crash location

These fields allowed crashes to be allocated to each of the 32 analysis strata defined above. Crash data from 1997 was not used as many of the input data measures for the statistical models described below were not available for this year. Crash data from February 2004 to April 2004 was also not used as it was incomplete due to delays in reported crash data being entered into the official database. For time series analysis of the type being carried out in this evaluation, it is critical that the crash data be complete so as not to bias the analysis.

Injury outcome in police reported crashes in Queensland is classified into one of five levels, being fatal, serious injury (requiring hospital admission), medically treated injury, other injury and non-injury. The severity of a crash is defined by the most serious injury level sustained by any person involved in the crash. Because of the relatively large number of strata into which the crash data has been divided for analysis, it was not possible to analyse each severity level of crashes individually.

This was particularly the case for fatal crashes. The analysis sub-divided the crash frequencies into eight Police Regions, two times of the week and two road environments monthly over 6 years and 1 month, a total of a total of 384 data analysis cells per year. This is greater than the total number of fatal crashes per annum in Queensland during 1997 to 2003, suggesting that on average less than one fatal crash will appear in each analysis category. This crash frequency was too small for the analysis to produce stable and satisfactory results. Furthermore, it was not possible to aggregate the analysis to quarterly or annual data counts as the basis for the analysis was to relate monthly variation in measures of road safety programs and other factors to monthly variations in observed crash counts. Aggregating the data to less than monthly intervals would attenuate the period to period variation in the data enough to significantly compromise the power and hence efficacy of the statistical analysis method. Hence it was not possible to analyse fatal crash frequencies alone. Instead, the data was collapsed into 3 crash severity levels for analysis covering the full spectrum of crash outcomes and defined as follows:

- fatal and serious injury crashes
- medically treated injury crashes
- other injury and non-injury crashes

The crash severity aggregations keep the most severe crashes together so that any effects of the anti-speeding and anti-drink-driving initiatives, which typically reduce the most severe crash types the most, can be detected in the analysis. The aggregations also ensured sufficiently numerous crashes in each analysis cell to make the analysis viable. Parallel analysis of all three crash type aggregations also provided the basis for the application of unit crash costs, related to crash severity, so that total crash cost savings could be estimated for the required cost-benefit analysis.

Selected monthly crash data series are depicted in Figures 2.2 and 2.3. Figure 2.2 shows monthly crash series for the three most severe crash severity levels individually and in total aggregated over the 32 analysis strata. Figure 2.3 shows monthly crash series by the urban versus rural and high versus low alcohol hour breakdowns aggregated across all police regions and crash severity levels.

**Figure 2.2:** *Queensland Crash Data: Fatal, Hospitalisation, Medical Attention, and Total Serious Casualty Crashes; January 1998 to January 2004*

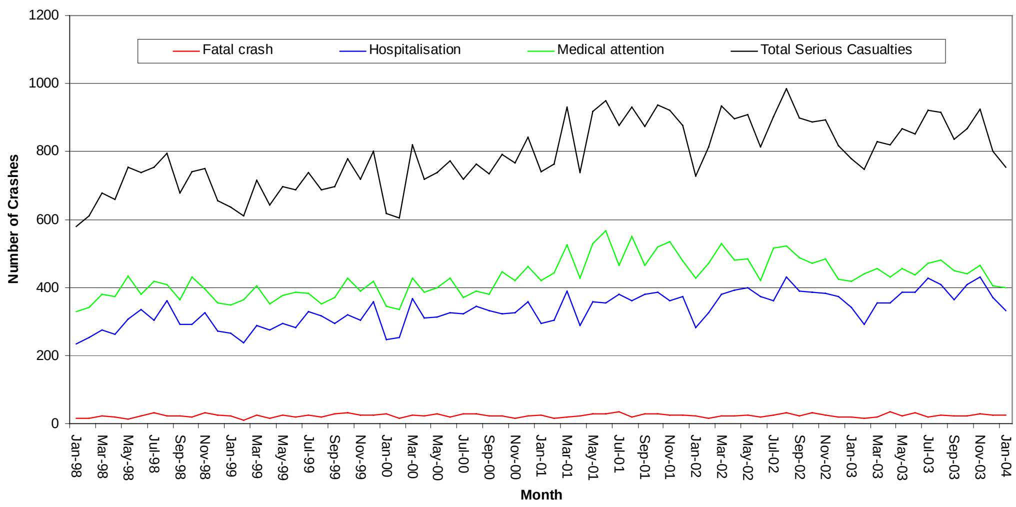
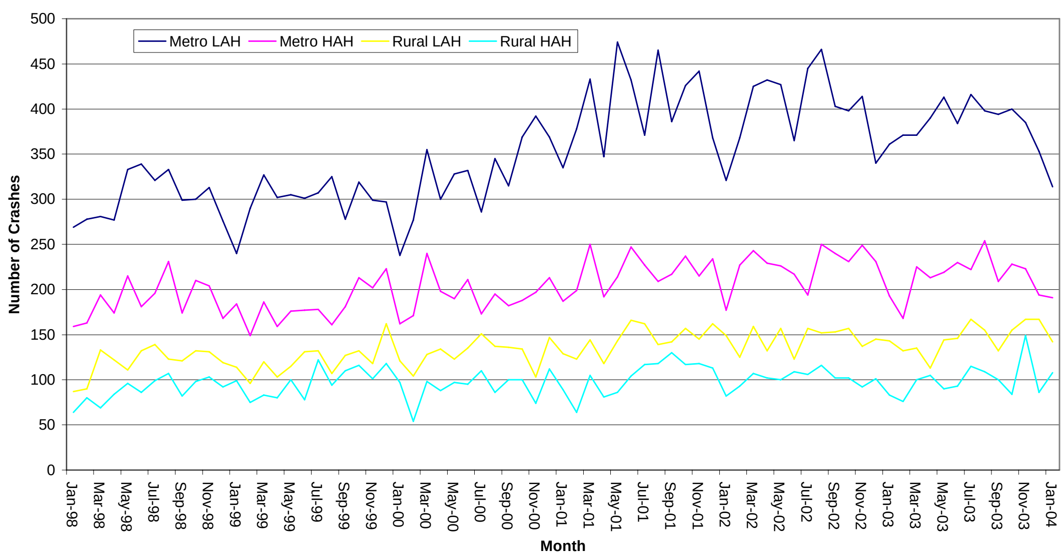



**Figure 2.3:** *Queensland Serious Casualty Crashes by month by Alcohol Hours by Road Environment; January 1998 to January 2004*



### 2.2.2 RSIP Measures

In order to relate RSIP activity to observed crash outcomes through the statistical modelling process, it was necessary to have measures of the RSIP activity. Measures of RSIP activity were collected under a number of broad program component areas with the data chosen for use largely dictated by what was reliably collected by the relevant authorities. The component areas and the specific component activities within each area are summarised as follows.

1 Speed Camera Activity:

- Hours of operation
- Sites used
- Compliance with randomised schedular

2 On-road (non speed camera) Police Enforcement:

- Moving Mode Radar (MMR) and Laser Speed Detection (LIDAR) operations
- Random Breath Testing (RBT) operations
- Seat belt offences detected
- Mobile phone offences detected

3 Mass Media Publicity:

- Monthly awareness levels of mass media television advertising with the following themes; speed, fatigue, seat belts, and drink driving

A brief summary description of each specific measure used in the analysis follows. A more comprehensive description as well as graphical time series representations of each is given in Appendix B. In the case of measures that were supplied broken down by Queensland population statistical divisions, rather than by police region, the algorithm for converting the statistical divisions to police regions is described in Appendix A.

<u>Speed Camera Activity:</u>

Six measures of speed camera activity that have been found to be key predictors of crash outcomes in the full formal evaluation of the Queensland speed camera program (Newstead & Cameron, 2003) were used in this evaluation:

1. Total number of speed camera operation hours per month by police region
2. Number of active sites available for use by police region
3. Hours of operation per active camera site available for use by police region (derived from the above measures)
4. Percentage of sites visited as expected according to randomised speed camera operations schedule by police region
5. Monthly rate of increase in active camera sites by police region
6. Monthly rate of increase in speed camera operation hours by police region

The first three measures above were considered to be RSIP activity measures as they were able to be influenced as part of RSIP funding. In contrast, the last three were not considered to be RSIP activity measures as they were not influenced by the RSIP funding and remained Police operational decisions. However, they were still included in the models due to their previously established links with crash outcomes.

<u>MMR and LIDAR On-Road Speed Enforcement:</u>

On road speed enforcement effort by moving mode radar (MMR) and laser speed detectors (LIDAR) were represented in the analysis model by the total monthly officer hours for MR and LIDAR. Only the total officer hours for the two devices (MMR and LIDAR) combined were available for the full evaluation period (January 1998 to January 2004). The combined measure was labelled as non-camera speed enforcement hours and was available by police region. The data collection for non-aggregated MMR and LIDAR hours did not begin until January 1999. In order to analyse the separate impact of MMR and LIDAR on crash frequencies, it would be necessary to exclude the period prior to January to December 1998 from the analysis.

<u>Random Breath Tests:</u>

The measure of random breath testing (RBT) activity used in the analysis was the number of monthly random breath tests conducted from booze buses and other stationary vehicles. The number of tests conducted was used rather than the number of offences detected as RBT is considered to be effective in reducing crashes primarily through creating the perception of a high probability of offence detection through testing of a large proportion of the driving population.

<u>Seat Belt Enforcement:</u>

The number of monthly detected seat belt offences was used as the measure of this initiative. Data was available monthly by police region apart from 3 months in 2000 where the data was unavailable.

<u>Mobile Phones Enforcement:</u>

The number of monthly detected mobile phone offences was used as the measure of this initiative. Again, data was available monthly by police region apart from 3 months in 2000 where the data was unavailable.

<u>Mass media publicity:</u>

Levels of monthly television road safety advertising were represented by the measure AdStock. AdStock is a measure of retained awareness following exposure to advertising and is a function of the measure Target Audience Ratings Points (TARPs). TARPs measure the base exposure of the advertising target audience to the advertising placement. Monthly AdStock was calculated for each of the four TV advertising themes targeting the "fatal 4" areas: speed, fatigue, drink driving, and seat belts. Total monthly AdStock, being the sum of AdStock across all themes, was also considered. Advertising was scheduled separately for South East Queensland and the rest of Queensland so AdStock has been calculated separately for each of these regions and related to the relevant police regions in the statistical models. Appendix B gives further description of the AdStock measure as well as plots of the monthly series.

### 2.2.3 Non-RSIP Road Safety Measures

A number of other road-safety related initiatives were introduced during the RSIP evaluation period, but which were not the central focus of this evaluation. In addition, there was also a change in crash reporting levels in Queensland in late 2000 associated with changes in the rules for making injury compensation claims following a motor vehicle crash. All of these factors were likely to have had an effect on observed monthly crash levels and consequently the presence of each needed to be reflected in the evaluation statistical models. The factors included were as follows.

- Introduction of the default 50km/h local street speed limit in south-east Queensland in June 1999 (enforcement amnesty period from March to May 1999)
- The Holiday Period Road Safety Trial from December 2001 to end of January 2002
- Introduction of the regional 50km/h local street speed limit from May 2003 (enforcement amnesty period from February to April 2003)
- the increase in speeding penalties from April 2003
- the increase in penalties for use of hand-held mobile phones while driving from December 2003
- the change in crash reporting levels from October 2000

Each of the above factors was represented in the statistical model as a step function. Each step function was defined as a binary variable with two levels: either "off" prior to the introduction of the initiatives, or "on" after the initiative was first introduced.

It is important to point out here that the effects of the introduction of the south-east Queensland and regional Queensland 50km/h local street speed limits were estimated across all roads and not only on the part of the road network to which they directly applied. This is likely to give smaller estimates of program crash effects in the statistical models used here than in an analysis specifically targeting the program effect on 50km/h roads. However, it should be noted that in the present evaluation, introduction of the 50km/h limit is only included to more accurately represent RSIP crash effects in the statistical models. It is otherwise not the main focus of the evaluation.

### 2.2.4 Socio-Economic Factors

Changes in socio-economic factors are known to have effects on observed road trauma. Like the non-RSIP related road safety initiatives, it was necessary to include measures of socio-economic effects in the statistical models to accurately describe trends in the crash data driven by factors other than the RSIP. Measures of several socioeconomic factors were included in the statistical models on a monthly and regional basis. These were: population size, unemployment rate, and fuel sales. Each of these measures is known to reflect differences in total exposure to crash risk, each in a subtly different way.

### 2.2.5 Effects Targeted to Particular Crash Strata

As noted in describing the stratification of the crash data for analysis, the motivation for the data stratification was to be able to relate certain measures used in the statistical models to those crash sub-populations to which they most directly relate. The measures considered only relating to certain crash strata and the strata to which they relate are as follows.

- Number of RBTs: High Alcohol Hour crashes
- Moving mode radar hours: Crashes on rural roads
- LIDAR speed detector hours: crashes on urban roads during Low Alcohol Hours
- Seat-belt and mobile phone penalties: Crashes on urban roads during Low Alcohol Hours
- Road safety publicity Adstock with drink-driving theme: High Alcohol Hour crashes
- South-east Queensland 50km/h local street speed limit: Police regions in south-east Queensland
- Regional Queensland 50km/h local street speed limit: Police regions outside of south-east Queensland

#### 2.2.6 Summary of Data Collection

All of the evaluation data sources described above were collected from one of three agencies. They were Queensland Transport (QT), the Queensland Police Service (Police) or the Queensland Office of Economic and Statistical Research (OESR). Table 2.1 gives a summary of the data sources collected including the time period of data supplied, a brief description of the data and the agency responsible for supply of the data.

**Table 2.1:** *Summary of evaluation data collected*

| Time of Collection | Description | Provider Agency |
|---|---|---|
| Jan 1998 - Jan 2004 | Hours of camera operations and number of active sites by region | Police/QT |
| Jan 1998 - Jan 2004 | Data on monthly compliance with randomised speed camera operations schedular by region | Police/QT |
| Jan 1998 - Jan 2004 | No. of RBTs conducted by region | Police |
| Jan 1998 - Jan 2004 (aggregated)<br><br>Jan 1999 – Jan 2004 (separate) | Hours of MMR and LIDAR on-road enforcement by region | Police |
| Jan 1998 - Jan 2004 | No. of mobile phone and seat belt offences detected per region | Police |
| 1998 - Jan 2004 | TARPS for TV advertising for each screened ad by region (weekly) | QT |

| | | |
|---|---|---|
| Jan 1998 - Jan 2004 | No. of crashes by severity and by type of crash (e.g. speed, alcohol, etc.) for each region | QT |
| Apr 2003 onwards | Information regarding increased speeding penalties | QT |
| Mar 2003 onwards | Information regarding increased mobile phone penalties | QT |
| Jan 1998 - Jan 2004 | Population growth (incl. interstate migration) by region | OESR |
| Jan 1998 - Jan 2004 | Unemployment rate by region | OESR |
| Jan 1998 - Jan 2004 | Fuel sales | OESR |

## 2.3 STATISTICAL ANALYSIS METHODS

### 2.3.1 Minimisation of Co-Linearity between Independent Variables

In order to build statistical regression models that are robust and easily interpreted the first step in the statistical modelling process was to test for co-linearity between the regression input (independent) variables. The presence of potential co-linearity between independent variables in the regression models has been investigated through analysing the correlations between the variables. Variables having a raw correlation co-efficient higher than 0.5 were considered to have a co-linearity high enough to be of concern to the analysis interpretation. In order to eliminate the co-linearity problem, one of each pair of highly correlated input variables was removed from the regression equation. The remaining variable could be considered to represent the effect of both itself as well as the removed highly correlated variable. This point has been kept in mind when interpreting the outcome of the relative effect of various RSIP program components from the statistical modelling outcome.

### 2.3.2 Regression Models of RSIP Program Crash Effects

***General Model Structure***

The analysis model used in this evaluation to relate measures of RSIP effort and other factors to observed monthly crash counts was a Poisson Regression model. The general form of the Poisson regression model is given by Equation 2.1.

$$\ln(y) = X\beta + \varepsilon \ldots\text{Equation 2.1}$$

In Equation 2.1, $y$ is the dependent variable, in this case the monthly crash counts, $X$ is the matrix of input or independent variables, $\beta$ is the vector of model parameters or regression coefficients and $\varepsilon$ is the random error of the dependent variable. In a Poisson regression model, the error terms are assumed to follow a Poisson distribution.

Use of the Poisson regression model for evaluating the RSIP crash effects was appropriate for a number of reasons. First, it is widely assumed that crash count data follow a Poisson distribution (Nicholson, A.J., 1985a, Nicholson, A.J., 1985b) which is reflected in the Poisson error structure of the Poisson regression model. The log-linear structure of the model ensures that fitted values from the model are non-negative, a property required of predicted crash counts. The log-linear structure of the model also reflects previous findings that the effects of many road safety countermeasures are multiplicative, with the absolute effect on crash outcomes resulting from changes in program effort dependent of the crash base before the change in program effort.

The Poisson regression model is also particularly useful for building predictive models of crash outcomes as required here, this is because the model structure lends itself to ready interpretation of the relationships between input and outcome variables and the statistical significance testing of these relationships. It is also relatively robust to some element of misspecification, in the form of less than perfect model fit, arising when not all the factors driving the observed crash outcomes are available and can be measured. This is because the Poisson distribution is a one parameter distribution, the mean being equal to the variance. As the variance is not estimated independently in the modelling process, the statistical significance estimates of the model parameters will not be compromised by less than perfect model fit. The only threat to the validity of relationships between input and outcome measures predicted by the model structure in the case of misspecification is when the factors not include in the model are not independent of the key model inputs that are being assessed. Whilst Poisson regression models are not useful for forecasting, providing crash forecasts was not the objective of the study.

Poisson regression models have been applied in many studies evaluating crash data (for example, Maher, M. and Summersgill, I., 1996). Furthermore, Poisson regression models have been effectively applied to evaluate both the Random Road Watch (Newstead, Cameron and Leggett, 2001) and Speed Camera (Newstead and Cameron, 2003) programs in Queensland, the evaluation methods of the former study being peer reviewed for publication.

A further advantage of the Poisson regression analysis model was the ability to conveniently measure the average RSIP crash effects over all 32 analysis strata. Even though the data was stratified into 32 individual time series of data, only a single regression model has been fitted to the entire data. As has been shown in the detailed description of the regression models given below, appropriate formulation of the analysis models allows the individual characteristics of each of the 32 time series of data to be captured in the single model whilst measuring the total average effects of either the RSIP program as a whole, or individual program component measures, across all 32 data series.

The overall purpose of the Poisson regression analysis models is to measure the level and statistical significance of association between RSIP program measures and observed crash outcomes. As such, the models are providing the tool for formal statistical hypothesis testing of the association between program input and outcome measures. The generic null hypothesis being tested is that there is no association between the RSIP measures and observed crash outcomes crashes. This is tested against the two-sided alternative hypotheses that the RSIP measures have a have a significant association with the number of observed monthly crashes. The two-sided hypotheses give a more conservative significance level on the estimates of crash effects because they do not make a presumption about the direction in which the crash frequencies will be associated with the program initiatives (i.e. whether the monthly numbers of crashes will be decreased or increased).

In the output from the statistical modelling included in the results section and in the following descriptions of the precise forms of the statistical models fitted, a shorthand notation for each variable included in the models has been used. A summary of the shorthand notations as well as an indication of the structure and treatment of the variable in the models is given in Table 2.2.

**Table 2.2:** *Summary of modelling variable shorthand names and structures*

| Variable Grouping | Variable Description | Shorthand Name | Structure in Modelling Process |
|---|---|---|---|
| Crash data | Monthly fatal and serious injury crash counts | FATHOSP | Count variable |
| | Monthly medically treated injury crash counts | MEDICAL | Count variable |
| | Monthly other and non injury crash counts | MINPROP | Count variable |
| Stratification Variables | Police Region | REGION | Categorical (8 level) |
| | Urban or Rural speed zone | METRUR | Categorical (1=Urban, 2=Rural) |
| | Alcohol Hours | ALCHOUR | Categorical (1=LAH, 2=HAH) |
| | Month of Crash | MONTH | Numeric (1-12) |
| | Year of Crash | YEAR | Numeric(1998-2004) |
| Socio-Economic Variables | Population | POP | Continuous Numeric |
| | Unemployment | UNEMPLOY | Continuous Numeric |
| | Fuel Sales | FUELSALES | Continuous Numeric |
| Other Road Safety Initiatives | S.E. QLD 50km/h local street speed limit | SEQLD50 | Categorical (1=Post, 2=Pre) |
| | Initial Holiday Period Road Safety Trial | HOLTRIAL | Categorical (1=During, 2=Not During) |
| | Change in Crash Reporting Levels | CRASHREP | Categorical (1=Post, 2=Pre) |
| | Regional QLD 50km/h local street speed limit | REGQLD50 | Categorical (1=Post, 2=Pre) |
| | Change in Speeding Penalties | SPDPEN | Categorical (1=Post, 2=Pre) |
| | Increase in Mobile Phone Use Penalties | MOBPEN | Categorical (1=Post, 2=Pre) |
| RSIP Measures | Drink-Driving AdStock | AD_DRINK | Continuous Numeric |
| | Speed AdStock | AD_SPEED | Continuous Numeric |
| | Belt Use AdStock | AD_BELT | Continuous Numeric |
| | Fatigue AdStock | AD_FATIGUE | Continuous Numeric |
| | Total AdStock | AD_ALL | Continuous Numeric |
| | Number of Random Breath Tests | BT | Continuous Numeric |
| | Hours of LIDAR Enforcement | LASHRS | Continuous Numeric |
| | Hours of Moving Mode Radar Enforcement | MOBHRS | Continuous Numeric |
| | Mobile Phone Offences | MOB | Continuous Numeric |
| | Seat Belt offences | BELT | Continuous Numeric |

| | | | |
|---|---|---|---|
| | Number of Hours of LIDAR and MR enforcement combined | NOCAMHRS | Continuous Numeric |
| | Hours of Speed Camera use | CAMHRS | Continuous Numeric |
| | Number of Active Speed Camera Sites | ACTSITE | Continuous Numeric |
| | Hours of Speed Camera Enforcement per Active Site | HRSACT | Continuous Numeric |
| Non-RSIP Controlled Speed Camera Variables | Compliance with Randomised Schedular | COMPLY | Continuous Numeric |
| | Monthly Difference in Active Site Numbers | ACTDIFF | Continuous Numeric |
| | Monthly Difference in Hours of Operation | HRSDIFF | Continuous Numeric |

***Assessment of Total Program Effects: The Intervention Model***

To measure the overall effect of the RSIP on crash outcomes throughout the program period, an intervention analysis was carried out. The intervention analysis makes no reference to the specific program components responsible for the crash effects.

The intervention model was specified to include all relevant factors aside from those associated with elements of the RSIP. By not using the RSIP program element measures, the model was designed to measure the total effect of the RSIP over its implementation period, without regard to the mechanisms producing the effect. To assist with understanding the form of the intervention model, the form used is given below in simplified notation similar to that used in programming the model in SAS. A brief note on the purpose of each model term is also included.

ln(crashes) = REGION*METRUR*ALCOHOL (different intercept for each crash strata)

+ POP*REGION (population effect within each region)

+ UNEMPLOY*REGION (unemployment effect within each region)

+ MONTH*REGION (seasonal term by region)

+YEAR*REGION (long term trend by region)

+ SEQLD50 + REGQLD50 + HOLTRIAL + SPDPEN + MOBPEN CRASHREP (non RSIP road safety variables)

+ RSIPINTERVENTION (RSIP intervention measure)

The RSIP intervention term (RSIPINTERVENTION) was defined as a categorical step function stepping at December 2002, the start of the RSIP trial. To measure the RSIP intervention effect by region the last term of the above model was interacted with the categorical REGION variable.

The long term trend and seasonal terms were included in the intervention model to better describe the data trends in the pre RSIP period. This was necessary because the majority of the RSIP program components were also operational in the period before the RSIP was introduced, albeit at a much lower level of effort or exposure. The trend and seasonal terms were included in the model to represent the potential variation in the monthly pre-program crash counts resulting from the operation of these measures at their pre RSIP levels.

A more formal definition of the intervention analysis model used is given by Equation 2.2.

$$\begin{aligned}\ln(crash_{asrm}) = {} & \alpha_{asr} + \beta_r^{Pop} Pop + \beta_r^{Unemploy} Unemploy + \beta_{mr}^{Month} Month_m + \beta_r^{year} Year \\ & + \beta^{SEQLD50} I_{SEQLD50} + \beta^{REGQLD50} I_{REGQLD50} + \beta^{HOLTRIAL} I_{HOLTRIAL} \\ & + \beta^{SPDPEN} I_{SPDPEN} + \beta^{MOBPEN} I_{MOBPEN} + \beta^{CRASHREP} I_{CRASHREP} \\ & + \beta^{RSIP} I_{RSIP}\end{aligned} \qquad \text{…Equation 2.2}$$

In Equation 2.2,

- $a$ is the index for alcohol hours
- $s$ is the index for urban or rural speed zone
- $r$ is the index for region
- $m$ is the index for month
- $\alpha, \beta$ are parameters of the model
- $I$ is an indicator function being 1 if the program/factor is active and 0 otherwise

The RSIP intervention term is the final term in Equation 2.2. It is defined as 1 for the RSIP period and 0 before the RSIP program was implemented and is included as a categorical variable in the analysis model. It is the key term for assessing the intervention effect of the RSIP on crash outcomes.

To assess the robustness of the estimate of the RSIP intervention parameter in Equation 2.2, a number of different forms of the model were fitted. These included allowing for separate seasonal and yearly trend terms for each of the 32 crash strata rather than just by region and similar modifications for effects of population, unemployment and other road safety programs. The modifications made essentially no difference to the estimated RSIP effect showing the result was robust to fine detail of model specification.

Separate analysis models were fitted to the monthly data series of each of the three crash severity levels considered in the evaluation. All models were fitted using the SAS statistical software.

***Assessment of Program Component Effects***

Assessment of the association between specific measure of RSIP program activities and observed monthly crash outcomes was made through a modification of the Poisson regression model described in Equation 2.2. Again, first in simple notation, the form of the program components effect model fitted to the crash data is as follows along with a brief description of the purpose of each model term.

ln(crashes) = REGION*METRUR*ALCOHOL (different intercept for each crash strata)

+ POP*REGION (population effect within each region)

+ UNEMPLOY*REGION (unemployment effect within each region)

+ SEQLD50 + REGQLD50 + HOLTRIAL + SPDPEN + MOBPEN CRASHREP (non RSIP road safety variables)

+ COMPLY + ACTDIFF + HRSDIFF (non RSIP controlled speed camera measures)

+AD_ALL + BT + CAMHRS + HRSACT + NOCAMHRS + BELT (RSIP program component measures)

A more formal definition of the program components effect analysis model used is given by Equation 2.2.

$$\begin{aligned}\ln(crash_{asrm}) = \alpha_{asr} + \beta_r^{Pop} Pop + \beta_r^{Unemploy} Unemploy + \\ +\beta^{SEQLD50} I_{SEQLD50} + \beta^{REGQLD50} I_{REGQLD50} + \beta^{HOLTRIAL} I_{HOLTRIAL} \\ +\beta^{SPDPEN} I_{SPDPEN} + \beta^{MOBPEN} I_{MOBPEN} + \beta^{CRASHREP} I_{CRASHREP} \\ +\beta^{COMPLY} COMPLY + \beta^{ACDIFF} ACDIFF + \beta^{HRSDIFF} HRSDIFF \\ +\beta^{AD\_ALL} AD\_ALL + \beta^{BT} BT + \beta^{CAMHRS} CAMHRS \\ +\beta^{HRSACT} HRSACT + \beta^{NOCAMHRS} NOCAMHRS + \beta^{BELT} BELT\end{aligned} \quad \ldots\text{Equation 2.3}$$

Interpretation of the components of Equation 2.3 is the same as for Equation 2.2. As before, separate models were fitted to the monthly crash counts for each crash severity level considered. Again, separate models were fitted to each crash severity level considered using the SAS software.

### 2.3.3 Estimation of Percentage and Absolute Crash Savings

Estimates of percentage crash change attributable to a factor included in the Poisson regression can be derived directly from the model parameter associated with that factor via Equation 2.4.

$$\%Change = (1 - \exp(\beta)) \times 100\% \ldots\text{Equation 2.4}$$

For a binary categorical variable, such as the RSIP intervention variable in the intervention model, Equation 2.4 gives the net percentage crash change due to the introduction of the program. For the parameter estimates associated with continuous measures, Equation 2.4 gives the estimated percentage crash change associated with a unit increase in the continuous measure.

To calculate the percentage crash change associated with a change in a continuous variable from level $a_0$ to level $a_1$, Equation 2.5 is applied.

$$\%Change = (1 - \exp(\beta(a_1 - a_0)) \times 100\% \ldots\text{Equation 2.5}$$

Equation 2.5 is particularly useful in assessing the effect of RSIP project components on crash outcomes during the RSIP period. For this assessment, $a_0$ is the average of the RSIP program component in the period before the RSIP was implemented (January 1998 to November 2002) whilst $a_1$ is the average of the RSIP program component after RSIP implementation.

In the above, positive percentage change estimates indicate crash reduction, whilst negative percentage change estimates indicate a crash increase. Statistical confidence limits can be placed on the estimated percentage changes by using the parameter standard error to estimate confidence limits on the parameter and then transforming the confidence limits into percentage changes using Equation 2.3.

Estimates of absolute monthly crash savings attributed to the RSIP or its components have been derived from the percentage crash savings through multiplying the estimated percentage crash savings by the average monthly crash count in the pre RSIP implementation period (January 1998 to November 2002). Annual crash savings or crash savings for the entire 14 months post RSIP implementation period were then derived by multiplying the average monthly savings by 12 or 14 respectively. Confidence limits have been estimated for the absolute crash savings by converting the confidence limits on the estimated percentage crash savings into absolute crash savings in the same way.

### 2.3.4 Estimation of Effects on Crash Severity

Assessment has also been made of the effects of the RSIP program on crash severity. Changes in crash severity have been measured through examining the proportion of crashes of a given severity level and above that are in the highest severity category or categories. Three principal measures of severity have been examined. They are:

- The proportion of fatal, serious and medically treated crashes that are fatal or serious
- The proportion of all reported crashes that are fatal or serious
- The proportion of all reported crashes that are fatal, serious or medically treated.

The same study design was used for assessing crash severity changes as that used for assessing changes in monthly crash counts, described above, apart from two key differences. First, instead of modelling monthly crash counts, the monthly proportions as defined above were modelled. Second, the form of the statistical models described in Equations 2.2 and 2.3 was altered to become a logistic regression model. The logistic model has the following general form.

$$\log \text{it}(\text{p}) = \log(\frac{\text{p}}{1-\text{p}}) = \text{X}\beta + \varepsilon \ldots \text{Equation 2.6}$$

In Equation 2.6, $p$ is the dependent variable, in this case the monthly crash proportion, $X$ is the matrix of input or independent variables, $\beta$ is the vector of model parameters or regression coefficients and $\varepsilon$ is the random error of the dependent variable. In a logistic regression model, the error terms are assumed to follow a binomial distribution.

As for the crash count analysis, the crash severity analysis has considered the overall effect of the RSIP on crash severity through an intervention model and the effect of specific program components through a program component effects models. The structure of the linear form of input measures for the logistic regression models is the same as used for the Poisson crash count models described in Equations 2.2 and 2.3.

### 2.3.5 Estimation of Crash Cost Savings and Benefit to Cost Ratio

Estimates of crash cost savings attributable to the RSIP have been obtained by multiplying the estimates absolute crash savings by standardised crash costs by crash severity estimated by the Australian Bureau of Transport Economics (BTE, 2000). Crash costs savings have been estimated both for the program as a whole using the results from the intervention analysis, as well as for individual program components showing a significant association with crash outcomes in the analysis of program component effects. Confidence limits on the estimated crash cost savings have also been derived through conversion to costs of the confidence limits on the absolute crash savings.

Program benefit to cost ratio estimates have been calculated by dividing the estimated cost savings by figures on RSIP program costs supplied by Queensland Transport. This has been done again for the program as a whole and for specific program components.

## 2.4 RESULTS: ANALYSIS OF RSIP CRASH EFFECTS

### 2.4.1 Elimination of Input Measure Co-Linearity

In order to build statistical regression models that were robust and could be easily interpreted, it was first necessary to test for co-linearity between the regression input (independent) variables. The presence of potential co-linearity between independent variables in the regression models has been investigated through analysing the Pearson correlations between the variables over the months for which data was available. Variable pairs having a raw correlation co-efficient higher than 0.5 were considered to have a co-linearity high enough to be of concern to the analysis interpretation. Variable pairs with high correlations were as follows with the level of correlation indicated.

- Fuel sales with unemployment rate (-0.500)
- Laser enforcement hours with seat belt offences (0.912)
- Laser enforcement hours with mobile phone offences (0.755)
- Mobile phone offences with seat belt offences (0.555)
- All adstock with belt adstock (0.704)
- All adstock with drink driving adstock (0.637)
- All adstock with fatigue adstock (0.737)
- All adstock with speeding adstock (0.807)
- Fatigue adstock with belt adstock (0.583)
- Speed camera hours with fuel sales (0.540)
- Active speed camera sites with speed camera hours (0.727)
- Active speed camera sites with fuel sales (0.539)
- Active speed camera sites with hours per active speed camera site (-0.585)

The full variable correlation matrix is given in Appendix C

To overcome the model co-linearity problems, a number of variables were excluded from the analysis. Because of the high correlation, the effect of the excluded variables is represented by the correlated variable included in the analysis. The following variables were excluded, whilst the variable representing the effect of each excluded variable is indicated in brackets.

- Fuel sales (in favour of unemployment rate)
- All individual adstock themes (in favour of total adstock)
- Active speed camera sites (in favour of speed camera hours)
- Mobile phone offences ( in favour of seat belt offences)

The number of laser (LIDAR) hours and Moving mode radar speed enforcement hours could not be used in the analysis from January 1998 as the data was only available separately from 1999. A separate analysis of data only from January 1999 was attempted. In this analysis, the laser hours represent both mobile phone and seat belt offences which were both excluded from the analysis.

### 2.4.2 Results of Crash Frequency Analysis

***Total Program Effects***

Estimates of the overall crash effects of the RSIP resulting from fitting the regression model described in Equation 2.2 are given in Table 2.3. The estimated crash reduction shown in Table 2.3 is derived from the model parameter estimates using Equation 2.4. Given along with the estimated crash reduction attributable to the program are 95% confidence limits on the estimate as well as the statistical significance of the estimate. Low statistical significance values indicate the crash effect is unlikely to have arisen through chance variation in the data. Selected output from the Poisson regression models fitted to each crash severity level, including the parameter estimates from which the crash reduction estimates in Table 2.3 are derived, are given in Appendix D.

**Table 2.3:** *Estimated Total Crash Reductions Attributable to the RSIP*

| Crash Severity | Estimated Crash Reduction | Upper 95% Confidence Limit | Lower 95% Confidence limit | Statistical Significance |
|---|---|---|---|---|
| Fatal + Hospital | 13.12% | 6.09% | 19.62% | 0.0004 |
| Medically Treated | 14.20% | 7.91% | 20.06% | <.0001 |
| Other Injury + Non-Injury | 4.34% | -0.36% | 8.83% | 0.0693 |
| All Crashes | 8.80% | 5.52% | 11.96% | <.0001 |

NB: Negative percentage crash reduction estimates indicate an estimated percentage crash increase.

Table 2.3 shows that the estimated overall reduction in fatal and hospitalisation crashes attributable to the introduction of the RSIP was 13.12%. The estimate was highly statistically significant. A similar estimate of program effectiveness was also obtained for medically treated crashes. In contrast, the estimate for the more minor crash severity levels, other injury and non-injury crashes, was a crash reduction of only 4.34% which was marginally statistically significant. This result indicates that the RSIP was much more effective in reducing higher severity crashes than lower severity crashes. The estimated reduction in all crashes due to the program was a highly statistical significant 8.8%.

The intervention analysis was also modified to test for differential RSIP intervention effects by police region. Whilst the point estimates of intervention effect by region suggested the RSIP program had achieved different effects across regions, the differences were not statistically significant and are not presented here.

***Effects of Specific Program Elements***

Having established the overall RSIP program crash effects through the intervention analysis, a second stage of modelling was undertaken to relate specific measure of the program components to the monthly crash outcomes. This analysis aimed to identify those program components principally responsible for the intervention effect measured in the previous analysis. Given the co-linearity problems between input variables had been largely solved by the process of pre conditioning described above, it was considered unnecessary to undertake a model building process. Instead, a single model was fitted including all the factors remaining after the process of removing co-linearity. This model is described by Equation 2.3. As there were no variable co-linearity problems, leaving non significant factors in the model had little bearing on the coefficient estimates or significant levels of the other factors in the model.

These are summarised below.

**Table 2.4:** *Parameter Estimates of RSIP Component Crash Effects*

| Crash Severity Level | RSIP Program elements | Regression Co-efficient | Standard Error | Statistical Significance |
|---|---|---|---|---|
| Fatal + Hospital | AD_ALL | -0.000012 | 0.000003 | 0.0003 |
| | BT | 0.000000 | 0.000002 | 0.7477 |
| | CAMHRS | -0.000204 | 0.000101 | 0.0429 |
| | HRSACT | 0.000156 | 0.005524 | 0.9774 |
| | NOCAMHRS | 0.000023 | 0.000021 | 0.2731 |
| | BELT | -0.000236 | 0.000141 | 0.0937 |
| Medical | AD_ALL | -0.000008 | 0.000003 | 0.0168 |
| | BT | -0.000003 | 0.000002 | 0.023 |
| | CAMHRS | -0.000074 | 0.000092 | 0.4212 |
| | HRSACT | 0.000103 | 0.004759 | 0.9827 |
| | NOCAMHRS | -0.000014 | 0.000019 | 0.4686 |
| | BELT | -0.000441 | 0.000112 | <.0001 |
| Other Injury and Non-Injury | AD_ALL | -0.000011 | 0.000002 | <.0001 |
| | BT | -0.000001 | 0.000001 | 0.1932 |
| | CAMHRS | -0.000018 | 0.000062 | 0.7714 |
| | HRSACT | -0.002599 | 0.003178 | 0.4135 |
| | NOCAMHRS | 0.000027 | 0.000012 | 0.0316 |
| | BELT | -0.000263 | 0.000079 | 0.0009 |
| All Crashes | AD_ALL | -0.000011 | 0.000002 | <.0001 |
| | BT | -0.000001 | 0.000001 | 0.0481 |
| | CAMHRS | -0.000071 | 0.000046 | 0.1218 |
| | HRSACT | -0.001553 | 0.00238 | 0.5142 |
| | NOCAMHRS | 0.000017 | 0.000009 | 0.0747 |
| | BELT | -0.000317 | 0.000059 | <.0001 |

A number of RSIP program elements were significantly associated with crash outcome in each of the models considered by crash severity level. It is evident from Table 2.4 that the RSIP program elements of total adstock (AD_ALL), speed camera hours (CAMHRS) and number of seat belt offences detected (BELT) were estimated to be statistically significantly associated with crash outcomes when considering the more severe crash levels (fatal and hospitalisation). The negative coefficient of the parameter estimate also shows that an increase in these measures was associated with a decrease in observed crash numbers. For the lower crash severity levels (medically treated and below), total adstock and number of seat belt offences were again significant along with the number of breath tests carried out (BT). It should be recalled that the high correlation between mobile phone and seat belt offences means that the BELT factor in the model is representing the effect of both these factors.

It should be noted that the analysis of RSIP program component crash effects reported here aimed to identify associations between monthly variation in the program component measures and monthly variation in the observed crash outcomes. A lack of measured association between a program component measure and crash outcome does not imply that the component is ineffective. It is still possible that program components not found to be significantly related to crash outcomes here had a significant and enduring effect on crash outcomes at the time of their initial introduction. It is also possible that the relationship between their variation and crash outcomes is more subtle than can be measured using the analysis design and techniques employed here.

Effects of the significant RSIP program components were translated into percentage crash effects following implementation of the RSIP using Equation 2.5. Application of Equation 2.5 for each significant program measure requires a measure of average program component effort both before and after the implementation of the RSIP. These have been obtained from the input data and are summarised in Table 2.5. It should be noted that the average monthly program component efforts reflect how the data were treated in the analysis. Adstock figures were disaggregated by south-east and the rest of Queensland so the averages represent the average monthly adstock across the two television regions. Data on speed camera hours, alcohol breath tests and belt offences were available by Police region so the averages represent the monthly average of each measure across all eight regions. Because of the high correlation between the seat belt and mobile phone measures, the pre and post RSIP seat belt offence measure is an average of both seat belt and mobile phone offence data.

**Table 2.5:** *Parameter Estimates of RSIP Component Crash Effects*

| Crash Severity Level | Significant RSIP Component | Average Pre RSIP Level | Average Post RSIP Level | Estimated Crash Reduction | Lower 95% CL | Upper 95% CL |
|---|---|---|---|---|---|---|
| Fatal + Hospital | AD_ALL | 3126 | 939 | -2.66% | -1.35% | -3.99% |
| | CAMHRS | 417 | 856 | 8.58% | 0.27% | 16.20% |
| | BELT | 306 | 390 | 1.95% | -0.34% | 4.19% |
| Medical | AD_ALL | 3126 | 939 | -1.76% | -0.46% | -3.08% |
| | BT | 20333 | 24390 | 1.21% | -0.37% | 2.77% |
| | BELT | 306 | 390 | 3.62% | 1.83% | 5.37% |
| Other Injury and Non-Injury | AD_ALL | 3126 | 939 | -2.43% | -1.56% | -3.32% |
| | BELT | 306 | 390 | 2.17% | 0.90% | 3.43% |
| All Crashes | AD_ALL | 3126 | 939 | -2.43% | -1.56% | -3.32% |
| | BT | 20333 | 24390 | 0.40% | -0.39% | 1.19% |
| | BELT | 306 | 390 | 2.62% | 1.67% | 3.55% |

NB: Negative percentage crash reduction estimates indicate an estimated percentage crash increase.

Table 2.5 also shows the estimated percentage crash reductions derived from the regression parameter and change in average monthly program component effort level. The 95% confidence limits on the estimated percentage crash reductions are also shown being derived directly from the 95% confidence limits on the parameter estimate. Negative estimated percentage crash reductions indicate an estimated crash increase.

One notable feature of Table 2.5 is that average adstock levels were actually higher in the pre RSIP period than after the program was implemented, by a factor of almost 3 times. This is despite increased road safety television advertising levels being one of the key RSIP features. The net effect of this drop in advertising levels was a 2-3 percent increase in crashes associated with this program component during the RSIP period.

Of the other RSIP component measures that were significantly associated with crash outcomes, the increase in speed camera hours was estimated to be associated with the largest crash savings. Table 2.5 shows that an estimated doubling of the speed camera hours was associated with a reduction in fatal and hospitalisation crashes of around 9 percent. This represents over half the total effect of the RSIP on these crash severity levels estimated in the intervention analysis. Increased detection of mobile phone and seat belt offences under the RSIP was estimated to have been associated with a 2-3 percent crash reduction. Increases in random breath testing were estimated to have reduced crashes by only around 1 percent during the RSIP period.

Tallying the estimated crash reductions associated with each significant RSIP component leads to a total crash reduction associated with these components which is far less than the overall program crash effects measured in the intervention analysis. This implies that there were other components of the RSIP not identified amongst those above that were also effective in reducing crashes. These could include components for which explicit measures were available and included in the model but which did not show significant association with monthly crash counts. If this was the case, the contributing program components must have produced crash effects in a way that was inconsistent with the relationship assumed by the analysis model structure. Further specific evaluation of each program component beyond the scope of this evaluation would be needed to identify such effects.

It is also possible that there have been other effects from the RSIP for which no explicit measure was available but which have produced crash savings. One such example is general community awareness of the RSIP generated through media interest in the general implementation of the program. Queensland Police Service has indicated this is highly likely, as their officers aimed to get significant media coverage of events such as enforcement blitzes. Unlike scheduled road safety advertising, there is no direct measure of audience exposure to the media coverage generated. Consequently, the evaluation process cannot assess the effect of this unscheduled publicity.

*Relative Crash Effects of MMR and LIDAR Enforcement Hours*

A further analysis was carried out to attempt to identify the relative effect on crashes of LIDAR and Moving Mode Radar speed enforcement. In the previously described models, only the total hours spent on these two activities (NOCAMHRS) was used in the statistical models as hours spent on each activity separately were not available until 1 year after the start of the analysis period (i.e. from January 1999). The additional analysis focused only on data from January 1999 and substituted the total hours spent on both activities combined for the hours spent on each activity individually (LASHRS and MOBHRS) into the model. Otherwise, the structure of the regression models was the same as used previously.

Regression parameter estimates for the two factors from the models fitted to each of the three crash severity levels are summarised in Table 2.6.

**Table 2.6:** *Parameter Estimates of Laser and Moving Mode Radar Enforcement Hours Crash Effects*

| Crash Severity Level | RSIP Program elements | Regression Co-efficient | Standard Error | Statistical Significance |
|---|---|---|---|---|
| Fatal + Hospital | LASHRS | 0.000019 | 0.000061 | 0.7477 |
| | MOBHRS | 0.000036 | 0.000036 | 0.3158 |
| Medical | LASHRS | -0.000073 | 0.000047 | 0.1202 |
| | MOBHRS | 0.000058 | 0.000041 | 0.1561 |
| Other Injury and Non-Injury | LASHRS | 0.000019 | 0.000034 | 0.5860 |
| | MOBHRS | -0.000039 | 0.000026 | 0.1370 |

None of the regression parameters summarised in Table 2.6 reached statistical significance meaning that the statistical modelling process was unable to identify an association between either of the two enforcement activity measures and the observed crash outcomes. Consequently, the analysis was unable to identify the relative effectiveness of each speed enforcement activity.

As for the other program components considered previously, the lack of association between these two speed enforcement measures and crash outcomes does not imply that the activities were not effective in reducing crashes. Research in Victoria suggests that these methods of on-road enforcement can be very effective in appropriate circumstances (see Sections 5.5.4-5). As before, it is still possible that these RSIP components had a significant and enduring effect on crash outcomes at the time of their initial introduction or that the relationship between their variation and crash outcomes is more subtle than can be measured using the analysis design and techniques employed here.

It is particularly relevant here to note the strong correlation between laser enforcement hours and mobile phone and seat belt offences. The high correlation suggests that many of the seat belt and mobile phone penalties may be detected by police whilst undertaking laser operations. Whilst the laser hours themselves were not related to crash outcomes on a monthly basis, the belt and mobile phone offences were. The chain of association between laser operations, seat belt and mobile phone offences and crash outcomes suggests that laser enforcement is important as a mechanism for reducing crashes, at least through the detection of the mobile phone and seat belt offences (and possibly through the detection and deterrence of speeding offences as well).

Similar referred association between moving mode radar operations and crash outcomes cannot be made as there are no linking correlated factors. However, it is possible that moving mode radar operations have contributed to some of the total program crash reduction unexplained by the identified significant program component measure. It is, however, not possible to establish if this is the case under the evaluation framework used here.

### 2.4.3 Results of Crash Severity Analysis

***Total Program Effects***

Effects on relative crash severity of the introduction of the RSIP have been assessed using the logistic regression analysis detailed in the analysis methods section. Results of the analysis are presented in Table 2.7 for the three measures of crash severity that have been considered. Each crash severity measure is the proportion of high severity crashes in the total or a subset of the crash population. The analysis outcome measure presented is the relative odds ratio. It essentially gives an estimate of the severity proportion in the post RSIP period relative to the pre RSIP period. For example, the proportion of all crashes that were medically treated or higher severity in the post RSIP period was estimated to be only 90 percent of the same proportion in the pre RSIP period (the last line of Table 2.7). Table 2.7 also gives 95 percent confidence limits on the estimated relative odds ratio as well as the statistical significance level of the estimate.

**Table 2.7:** *Estimated Relative Crash Severity Post versus Pre RSIP*

| Crash Severity | Relative Odds Ratio | Upper 95% Confidence Limit | Lower 95% Confidence limit | Statistical Significance |
|---|---|---|---|---|
| Fatal + Hospital / Fatal + Hospital + Medical | 1.01 | 1.13 | 0.91 | 0.8179 |
| Fatal + Hospital / All Crashes | 0.94 | 1.02 | 0.86 | 0.1533 |
| Fatal + Hospital + Medical / All Crashes | 0.90 | 0.97 | 0.84 | 0.0033 |

Results of the severity analysis for the RSIP as a whole presented in Table 2.7 show that implementation of the program had similar effects on medical treatment crashes as on fatal and hospitalisation crashes. There is some suggestion in the results that the proportion of all crashes that were fatal and hospitalisation reduced following program introduction however the result did not achieve statistical significance. A statistically significant drop in the proportion of all crashes that were medically treated or more severe was estimated following program introduction.

Results of the severity analysis confirm that the RSIP has been more effective in reducing high severity crashes than relatively minor crashes, confirming the observations about relative program effects by crash severity made from Table 2.3.

***Effects of Specific Program Elements***

Logistic regression analysis was also undertaken to see if any of the RSIP component measures were significantly associated with changes in crash severity. The analysis parallelled analysis to that assessing the effects of RSIP components on crash counts with the same factors considered in the logistic regression model. The same crash severity measures were considered as for the overall program severity effects analysis presented above.

None of the program components considered showed an association with any of the three crash severity measures considered.

### 2.4.4 Absolute Crash Savings

***Total Program***

Estimates of the overall percentage crash reduction attributable to the RSIP have been converted to absolute crash savings by multiplying the percentage crash effect estimate by the average monthly crash frequency in the pre-RSIP implementation evaluation period (January 1998 to November 2002). The resulting average monthly absolute crash savings by severity level are summarised in Table 2.8 along with the average pre implementation period monthly crash counts on which they are based. Also presented are 95 percent confidence limits on the estimated absolute crash savings derived directly from the 95 percent confidence limits on the percentage crash savings.

**Table 2.8:** *Estimated Absolute Monthly Crash Savings Attributable to the RSIP*

| Crash Severity | Average Monthly Crashes Pre RSIP | Estimated Monthly Crash Savings | Upper 95% Confidence Limit | Lower 95% Confidence limit |
|---|---|---|---|---|
| Fatal + Hospital | 342 | 45 | 21 | 67 |
| Medically Treated | 422 | 60 | 33 | 85 |
| Other Injury + Non-Injury | 963 | 42 | -3 | 85 |
| Total | 1727 | 147 | 51 | 237 |

NB: Negative crash reduction estimates indicate an estimated percentage crash increase.

Table 2.8 shows the RSIP was estimated to have saved 147 reported crashes per month, including 45 fatal and hospitalisation crashes and 60 medically treated crashes. Estimates of average monthly crash savings for the RSIP as a whole have been converted into estimated absolute crash savings across the whole 14 month period following RSIP implementation. These estimates, along with corresponding 95 percentage confidence limits are shown in Table 2.9.

**Table 2.9:** *Estimated Total Absolute Crash Savings across the Entire RSIP Period*

| Crash Severity | Estimated Total Crash Savings | Upper 95% Confidence Limit | Lower 95% Confidence limit |
|---|---|---|---|
| Fatal + Hospital | 627 | 291 | 938 |
| Medically Treated | 839 | 468 | 1185 |
| Other Injury + Non-Injury | 586 | -49 | 1191 |
| Total | 2052 | 710 | 3314 |

NB: Negative crash reduction estimates indicate an estimated percentage crash increase.

Over the whole 14 month RSIP evaluation period, the program was estimated to have saved 2052 reported crashes including 627 fatal and hospitalisation crashes and 839 medically treated crashes.

***Specific Program Elements***

Estimates of total crash savings over the entire 14 month RSIP evaluation period have been obtained for the program component measures that were statistically significantly related to crash outcomes in the Poisson regression analysis. Estimates have been derived in the same way as for the total program effects above and are summarised in Table 2.10 along with the corresponding 95 percent confidence limits. Results are grouped by RSIP component with total crash savings shown for those programs that produced significant effects across more than one crash strata.

**Table 2.10:** *Estimated Absolute Crash Savings of the RSIP Components across the Entire RSIP Period*

| Significant RSIP Component | Crash Severity Level | Estimated Crash Savings | Lower 95% CL | Upper 95% CL |
|---|---|---|---|---|
| AD_ALL | Fatal + Hospital | -127 | -64 | -191 |
| | Medical | -104 | -27 | -182 |
| | Other Injury + Non-Injury | -328 | -210 | -447 |
| | All Crashes | -560 | -302 | -820 |
| CAMHRS | Fatal + Hospital | 410 | 13 | 775 |
| BT | Medical | 24 | -8 | 56 |
| BELT | Fatal + Hospital | 34 | -6 | 74 |
| | Medical | 112 | 57 | 166 |
| | Other Injury + Non-Injury | 129 | 53 | 203 |
| | All Crashes | 275 | 104 | 443 |

NB: Negative crash reduction estimates indicate an estimated percentage crash increase.

Of the significant program components, the increase in speed camera hours during the RSIP produced the biggest savings in high severity crashes, reducing the number of fatal and serious injury crashes by an estimated 410 across the RSIP evaluation period. Estimated savings in medically treated crashes from increased breath testing were modest. Increased detection of seat belt and mobile phone offences resulting from the RSIP was estimated to have reduced all reported crashes by 275 over the evaluation period although only 34 of these crashes saved were fatal or hospitalisation crashes. Lower levels of road safety television advertising were estimated to have led to 560 more crashes during the RSIP period, with 127 of these being fatal or hospitalisation crashes.

### 2.4.5 Program Crash Cost Savings and Benefit to Cost Ratio

The BTE have estimated standardised crash costs in 1996 Australian dollars by the five crash severity levels represented in the Queensland crash data (BTE, 2000). Derivation of the BTE crash costs is based on the human capital approach and takes into account incident costs in property damage and injury treatment as well as loss in human productivity though injury or death.

To enable direct comparison with expenditure on the RSIP, which was made mostly in 2003, the BTE crash costs have been converted to 2003 Australian dollars by inflating the figures using Consumer Price Index changes from 1996 to 2003. The resulting cost estimates by crash severity level are given in Table 2.11.

Analysis of the RSIP crash effects has focused on crash outcomes aggregated into three levels: fatal and hospital, medically treated, and minor injury and non injury. Average crash costs at each of the three aggregated levels have been obtained by calculating a weighted average of the costs for the component severity levels. The weightings used are the relative proportion of crashes at each severity in the pre RSIP period crash data. The weighting proportions are shown in Table 2.11 along with the weighted average crash costs for the aggregated severity levels analysed.

**Table 2.11:** *Crash Costs and Their Conversion to Aggregate Severity Levels*

| Crash Severity Level | BTE Crash Cost Estimate (2003 A$) | Proportion of Crashes at Severity | Weighted Average Crash Cost of Aggregate Categories |
|---|---|---|---|
| Fatal | $1,949,650 | 1.33% | $576,292 |
| Hospitalisation | $481,210 | 19.21% | |
| Medically Treated | $16,248 | 24.63% | $16,248 |
| Other Injury | $16,248 | 14.43% | $9,323 |
| Non-Injury | $6,850 | 40.40% | |

***Total Program***

Estimates of total crash savings associated with the RSIP over the entire 14 month evaluation implementation period shown in Table 2.9 were converted to crash cost savings. This was achieved by multiplying the estimated crash savings by the BTE crash costs in Table 2.11 by crash severity. The resulting crash cost savings estimates are summarised in Table 2.12 along with the corresponding 95 percent confidence limits.

**Table 2.12:** *Estimated Total Crash Cost Savings Attributable to the RSIP*

| Crash Severity | Estimated Crash Cost Saving | Lower 95% Confidence Limit | Upper 95% Confidence limit |
|---|---|---|---|
| Fatal + Hospital | $361,529,520 | $167,743,396 | $540,808,493 |
| Medically Treated | $13,634,867 | $7,596,508 | $19,260,740 |
| Other Injury + Non-Injury | $5,461,266 | -$456,048 | $11,101,146 |
| All Crashes | $380,625,653 | $174,883,856 | $571,170,379 |

NB: Negative crash cost savings estimates indicate an estimated percentage crash increase.

Total crash costs savings resulting from the RSIP over the 14 months of the evaluation period it was operational were estimated to be around $380M. Relating this figure to total expenditure on the RSIP over the same period leads to an estimated program benefit to cost ratio of 22 with 95 percent confidence limits from 10 to 33. That is, for every dollar spent on the RSIP, resulting savings to the community through reduced road trauma were estimated to be 22 dollars. It should be noted that when calculating the benefit to cost ratio, only the costs of implementing the RSIP have been considered, not the potential costs of not directing the funds to other initiatives.

***Specific Program Elements***

Using the same approach as for the total program effects, estimated crash savings associated with the RSIP components were converted into crash cost savings. The resulting crash cost savings estimates are summarised in Table 2.13.

**Table 2.13:** *Estimated Total Crash Cost Savings Attributable to Specific RSIP Components*

| Significant RSIP Component | Crash Severity Level | Estimated Crash Cost Saving | Lower 95% CL | Upper 95% CL |
|---|---|---|---|---|
| AD_ALL | Fatal + Hospital | -$73,280,627 | -$37,132,847 | -$109,896,163 |
| | Medical | -$1,693,926 | -$446,009 | -$2,957,992 |
| | Other Injury + Non-Injury | -$3,061,316 | -$1,961,920 | -$4,170,176 |
| | All Crashes | -$78,035,869 | -$39,540,776 | -$117,024,331 |
| CAMHRS | Fatal + Hospital | $236,403,487 | $7,308,200 | $446,406,675 |
| BT | Medical | $395,842 | -$122,360 | $905,866 |
| BELT | Fatal + Hospital | $19,856,397 | -$3,435,185 | $42,615,984 |
| | Medical | $1,814,929 | $919,862 | $2,693,719 |
| | Other Injury + Non-Injury | $1,200,433 | $496,881 | $1,894,935 |
| | All Crashes | $22,871,760 | -$2,018,441 | $47,204,639 |
| Total Non Speed Camera Enforcement | All Crashes | $23,267,602 | -$2,140,801 | $48,110,505 |

NB: Negative crash cost savings estimates indicate an estimated percentage crash increase.

Reflecting the relative savings in absolute crash numbers, the increase in speed camera hours under the RSIP led to the largest reduction in crash costs associated with a program component. In fact, the crash savings from the speed camera component represented around 62 percent of the cost savings estimated from the RSIP in its entirety. Relating the estimated crash costs savings from the increased speed camera hours to the cost of the increase enforcement effort gave a program component benefit to cost ratio estimate of 21 for the speed camera component. The 95 percent confidence limits on this estimate were from 1 to 41. Interpretation of the benefit to cost ratio for the program components is the same as for the total program.

The estimated benefit to cost ratio of the additional speed camera enforcement is somewhat smaller than the benefit to cost ratio of 47 estimated in the full evaluation of the program (Newstead and Cameron, 2003). This reflects that the additional speed camera hours scheduled under the RSIP reduced crashes from a lower base, the lower base being a result of the large crash reductions resulting from the initial introduction of the speed camera program. For this reason, it is expected that the further the camera hours are increased, the closer the program gets to a point of diminishing returns. However given that the doubling of speed camera hours under the RSIP still produced a benefit to cost ratio of 21, it appears that further increases in speed camera hours of operation could still be justified before the point of diminishing returns is reached.

It was not considered sensible to estimate a benefit to cost ratio for the television advertising component considering that the relative reduction in advertising during the RSIP period led to an estimated crash cost increase to the community of around $78M.

Assessment of the benefit to cost ratio of the increase breath testing and mobile phone and seat belt enforcement achieved under the RSIP is difficult because the program cost information supplied by Queensland Transport did not break down non speed camera enforcement expenditure by enforcement type. Comparing the crash cost savings from only the increased breath testing and mobile phone and seat belt offence detection with the total cost of non speed camera enforcement activities yields a benefit to cost ratio of 6 with 95 percent confidence limits from -1 to 13. This is a little misleading, however, as comparing total program cost savings in Table 2.12 to the savings attributable to television advertising (negative savings) and the speed camera program shows a residual of some $222M. This figure is only partly explained by the two significant non speed camera enforcement program components identified, suggesting that there are a number of unidentified program components producing significant crash cost savings under the RSIP

Comparing the non speed camera and advertising residual crash cost savings to the cost of non speed camera enforcement and public education undertaken as part of the RSIP gives and estimated benefit to cost ratio of 43 with 95 percent confidence limits from 40 to 47. This suggests that the effects of the unidentified successful program components of the RSIP have been highly cost beneficial. As discussed above, unidentified successful program components could include those for which explicit measures were available but were not significant in the analysis model as well as unmeasured program effort such as publicity generated through program launches or enforcement blitzes. Unfortunately, the current evaluation cannot identify these components nor can it measure their relative contributions. The benefit to cost ratio estimates for the residual program component effects should be treated with some caution given that the specific mechanisms of producing the effects and hence their net costs to the community are unknown.

## 2.5 CONCLUSIONS FROM THE RSIP CRASH EFFECTS EVALUATION

Evaluation of the crash effects of the Queensland Road Safety Initiatives Package has shown clear reductions in crashes associated with implementation of the program. Overall the program was associated with a statistically significant estimated 13 to 14 percent reduction in fatal, hospitalisation and medically treated crashes after implementation and a

9 percent average reduction in crashes across all severity levels. This translated to an estimated saving of 627 fatal and hospitalisation crashes, 839 medically treated crashes and 2052 crashes across all severity levels in the 14 months post RSIP implementation period covered by the evaluation. Applying standardised crash cost values to the estimated crash savings yielded an estimated saving in crash cost to the community associated with program implementation of $380M. Of these savings, $361M were savings from reduced fatal and hospitalisation crashes. Comparing total program savings to expenditure incurred in implementing the program gave an estimated overall benefit to cost ratio for the program of 22.

The evaluation also identified a number of RSIP component activities that were significantly associated with crash outcomes. Monthly levels of television road safety advertising awareness, speed camera operation hours, alcohol breath tests conducted and seat belt and mobile phone offences detected were significantly related to monthly variation in observed crash numbers. Comparison of average measures of each program component before and after the RSIP program implementation resulted in estimates of relative program component effects on crashes.

A 100 percent increase in hours of speed camera enforcement under the RSIP was associated with a statistically significant reduction in fatal and hospitalisation crashes of 9 percent. This represents a saving of 410 crashes of these severity levels across the 14 month RSIP evaluation period with a value to the community of $236M. The estimated benefit to cost ratio for the speed camera program component of the RSIP was 21. A reduction in crashes of all severity levels of between 2 and 3 percent was associated with the 30 percent increase in seat belt and mobile phone offences detected under the RSIP. This translated to savings of 146 fatal, hospitalisation and medically treated crashes and 275 crashes of all severity levels across the RSIP evaluation period, a saving of $23M to the community. A 20 percent increase in alcohol breath tests was associated with only modest crash reductions of about 1 percent with a value to the community of around $396,000. It was not possible to estimate specific program component benefit to cost ratios for the increased mobile phone and seat belt penalties or the increased alcohol breath tests.

Levels of television road safety publicity achieved after RSIP implementation were only about one third that achieved before program implementation, leading to an estimated increase in crashes. The crash increase associated with the reduced level of advertising during the RSIP period was estimated to be 2 to 3 percent. This represented an increase of 560 crashes across all severity levels with a community value of $78M. The overall effectiveness of the RSIP could have been increased had the publicity levels remained at or increased from pre RSIP levels.

A significant proportion of the total crash savings attributable to the RSIP program was unexplained by the individual program components found to be significantly associated with crash outcomes. This suggests there were one or more RSIP components, other than those identified, that have led to substantial crash savings. The unidentified successful program component could include those for which explicit measures were available but were not significant in the analysis model as well as unmeasured program effort such as publicity generated through program launches or enforcement blitzes. Indicative benefit to cost ratio estimates for the unidentified program components suggest that, although unidentified in nature, they may have produced benefit to cost ratios as high as over 40.

## 2.6 CRASH EFFECTS EVALUATION ASSUMPTIONS AND QUALIFICATIONS

Results of the analysis of the crash effects of the RSIP presented here are subject to a number of assumptions and qualifications. These are as follows.

- It is assumed that all the data supplied for the evaluation is correct and measures both evaluation inputs and outcomes as described.

- It is assumed that the form of the statistical analysis model used, including the functional relationship between dependant and independent variables and the distribution of random error, is appropriate.

- It is assumed that estimates of total program effects and program component effects are not biased through measures missing from the statistical models that are associated with program intervention or component measures.

- Derivation of the crash effects and the related crash cost savings of the program were made using the assumed functional forms of the analysis regression equations used and are hence dependent on those functional forms. The real “dose-response” relationship between the independent and dependent measures may be different to that assumed.

- Because of an inability to analyse fatal crash outcomes on their own, it is assumed that the effect of the RSIP on fatal crashes is the same as on hospital admission crashes.

- Crash cost estimates used for the economic evaluation are based on a standardised mix of crash types (however the estimates were related to the injury severity of the crashes, a key factor affecting the unit costs of crashes as well as crash type). It is possible that changes in the distribution of crash types resulting from the RSIP implementation has produced some bias in the cost savings estimates. It was beyond the scope of the evaluation to analyse program effects by crash type.

# 3 EFFECTS OF THE RSIP ON RECORDED SPEEDS

In order to evaluate the effect of the RSIP on speed trends in Queensland, speed survey data was obtained from QT for 60km/h speed zones in regional Queensland, and from the Queensland Department of Main Roads for 100km/h speed zones in regional Queensland. For the 60km/h roads, speed survey data was collected at four separate times of the year, once before the implementation of the RSIP (November, 2002) and three times during the RSIP period (March 2003, August 2003, and February 2004). Speed survey data for the 100km/h zones was collected at identical times to the 60km/h zones, with the exception that speed surveys were not conducted during February 2004. Speed survey data for South East Queensland was not available for this evaluation.

## 3.1 SPEED SURVEY DATA FOR 60 KM/H ZONES

QT speed surveys for 60km/h roads were conducted in five QPS regions in regional Queensland during daylight hours and on weekdays only, excluding public holidays and holiday periods. In this section, changes in speeds are reported only for comparisons between speed survey data collected before the RSIP implementation (November 2002), and at the end of the RSIP program (February 2004). A complete set of speed comparisons between November 2002 and March 2003, November 2002 and August 2003, and November 2002 and February 2004 are reported in Appendix E (see tables E1 to E6). Estimates were obtained for speed parameters of this data, including mean speed, 85$^{th}$ percentile speed, and the proportions of vehicles exceeding 60km/h, 70km/h, 80km/h, and 90km/h. Figure 3.1 shows mean speeds and 85$^{th}$ percentile speeds collapsed across all QPS regions for 60km/h roads. There were small reductions of mean speeds and 85$^{th}$ percentile speeds of 3.4% and 3.7% respectively.

**Figure 3.1:** *Mean speeds and 85$^{th}$ percentile speeds vehicles surveyed in 60km/h speed zones for all of regional Queensland as a function of month of speed survey.*

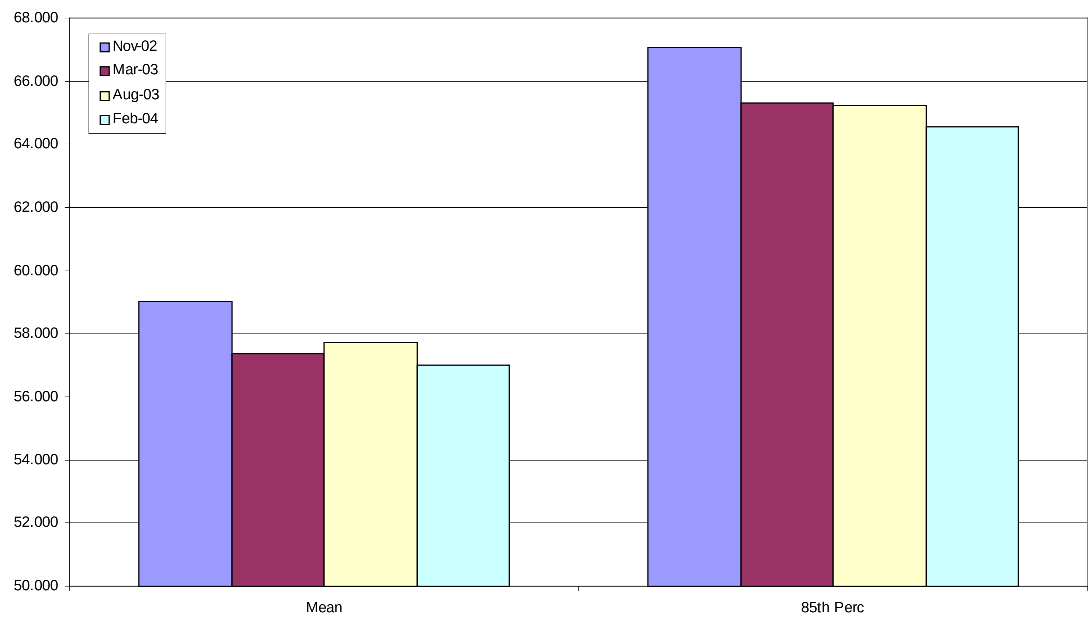
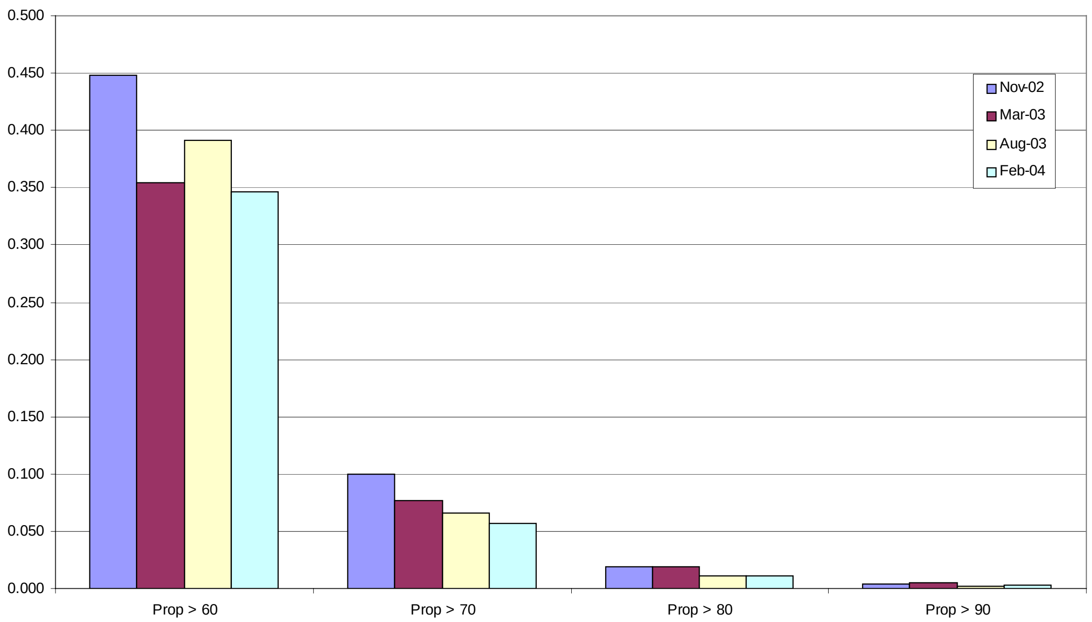


Figure 3.2 shows the proportion of vehicles surveyed exceeding 60km/h, 70km/h, 80km/h, and 90km/h. Substantial reductions in speeds were found over the period of the RSIP. A comparison of pre and post RSIP speeds showed a 22.7% reduction in traffic exceeding 60km/h, a 43.1% reduction in traffic exceeding 70km/h, a 40.0% reduction in traffic exceeding 80km/h, and a 15% reduction in traffic exceeding 90km/h. Since the force of vehicle crashes increases exponentially with the speed of a vehicle, there is an increased likelihood of fatalities and severe injuries for crashes at high speeds. Hence, any reductions in the relatively small proportion of vehicles exceeding 70km/h, 80km/h, and 90km/h are considered important. The effectiveness of the RSIP in substantially reducing vehicles exceeding 10km/h above the speed limit in 60km/h zones corresponds to the increased speed camera hours in these zones and the subsequent significant reductions in serious casualty crashes (fatal, hospital, and medical attention crashes).

**Figure 3.2:** *Proportion of surveyed vehicles in 60km/h speed zones exceeding 60km/h, 70km/h, 80km/h and 90km/h for all of regional Queensland as a function of month of speed survey.*

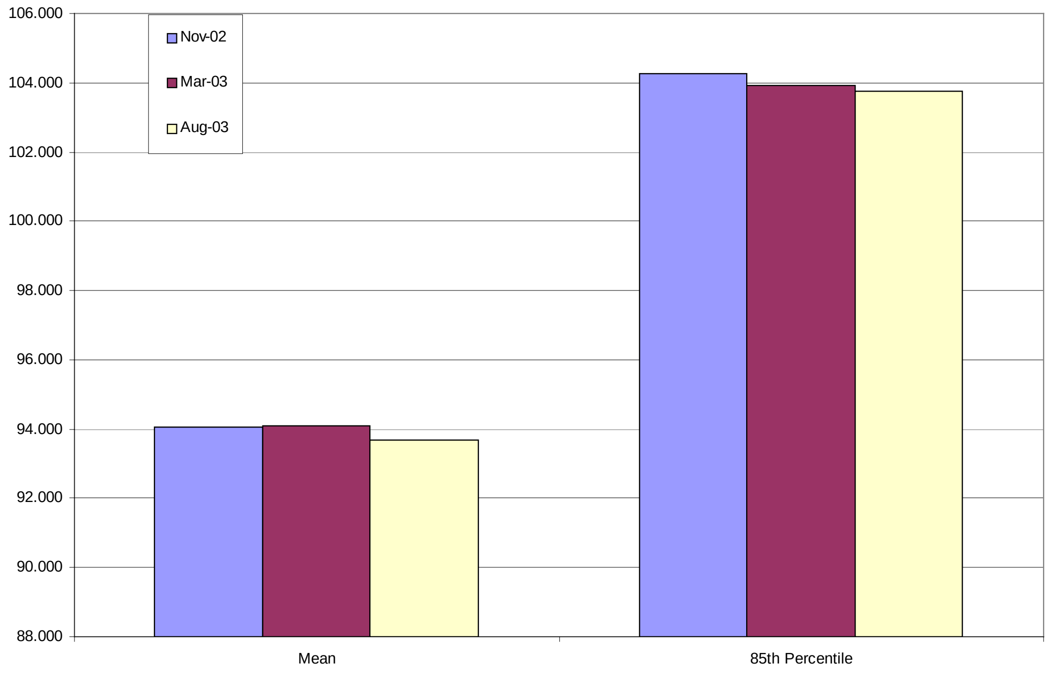



Speed survey analyses by QPS region (see Appendix E tables E2 to E6) showed that the Northern, Southern, and North Coast regions had much larger reductions in vehicles exceeding 10km/h above the 60km/h speed limit than in the Central and Far Northern regions. For the proportion of vehicles exceeding 70km/h, 80km/h and 90km/h in QPS regions, the North Coast region had reductions of 40.7%, 52%, and 67% respectively, the Northern region had decreases of 69.2%, 76.4%, and 75.7% respectively, and the Southern Region had decreases of 57.2%, 70.9%, and 40.6% respectively. The Central Region reported similarly sized reductions in the proportion of vehicles exceeding 70km/h and 80km/h (40.1% & 36.2% respectively), but a relatively smaller reduction in the proportion of vehicles exceeding 90km/h (6.1%). In the Far Northern region, there were large increases in the proportion of vehicles exceeding 70km/h, 80km/h, and 90km/h of 23.7%, 22% and 13.4% respectively. A possible explanation for the observed differences in vehicle speeds between QPS regions is that the regions with the largest decreases in vehicle speeds are closest to the South Eastern region where the implementation of RSIP program variables, such as police enforcement and advertising, was most intensive.

## 3.2 SPEED SURVEYS FOR 100 KM/H ZONES

Speed survey data for 100km/h speed zones from Queensland Department of Main Roads was supplied for four QPS regions for mean speeds and 85th percentile speeds only. Changes in speeds are reported for comparisons between speed survey data collected during November 2002 and August 2003. A complete set of speed comparisons between November 2002 and March 2003, and November 2002 and August 2003 are reported in Appendix E (see tables E7 to E8). Figure 3.3 shows the mean speeds and 85th percentile speeds collapsed across QPS regions. Small reductions were found for mean speeds and 85th percentile speeds of 0.4% and 0.5% respectively. Further analysis of both of these speed parameters for each of the four QPS regions found small reductions in mean speeds in the Central and Far Northern regions of 2.7% each, and very small increases in mean speeds in the Northern and Southern regions of 0.4% and 0.3% respectively. Similarly small changes in 85th percentile speeds were found for each of the four QPS regions with 0.6% and 3.3% reductions for the Central and Far Northern regions respectively, and 2.0% and 0.2% increases for the Northern and Southern regions respectively.

**Figure 3.3:** *Mean Speeds and 85th Percentile speeds for 100km/h roads for all of regional Queensland as a function of time of speed survey.*



### 3.3 CAVEATS

The results of the speed survey analysis and the effect of the RSIP on vehicle speeds should be interpreted with caution for three main reasons. Firstly, the scope of this report did not include a statistical analysis of vehicle speeds, and hence, any small changes in speeds may not be significant, due to variability in the sampled vehicle speeds. Secondly, the relatively small number of carriageways surveyed overall and for each QPS region do not provide a representative sample of the population of carriageways in regional Queensland, and hence may only indicate localised variations in speed for each QPS region and not for all of Queensland. The number of streets surveyed and vehicle counts for both 60km/h and 100km/h speed zones for each QPS region are reported in Appendix E (see tables E9 & E10). Finally, since 50km/h local street speed limits in regional Queensland were implemented during the RSIP period, including an amnesty from February to April 2003, and enforced from 1st May 2003, it is possible that there were some carry over effects of changes in speeds from 50km/h speed zones to 60km/h speed zones. Therefore, it is difficult to delineate any reported changes in speed as a function of the RSIP or the implementation of 50km/h local street speed limits.

### 3.4 CONCLUSION: ANALYSIS OF SPEED SURVEYS

In conclusion, analyses of speed surveys in 60km/h and 100km/h speed zones have shown that the implementation of the RSIP was associated with small (and possibly non-significant) reductions in mean speeds and 85th percentile speeds. However, relatively larger reductions in mean speeds and 85th percentile speeds were reported in 60km/h zones, indicating that the RSIP had a greater effect on drivers in these speed zones. One explanation for this effect is that a greater amount of QPS speed enforcement may be applied in 60km/h speed zones that are primarily located in Queensland towns and cities, relative to 100km/h zones that are predominant throughout regional areas of Queensland, yet more difficult to enforce due to the extensive size of regional Queensland. Moreover, the implementation of the RSIP was associated with large reductions in the proportion of vehicles exceeding the speed limit in 60km/h zones by 10km or more, and coincides with the significant decrease in serious casualty crashes in Queensland as a function of the RSIP, and the significant effect of the increased speed camera hours that are predominantly operated in 60km/h zones. This finding is considered a very positive effect of the RSIP since reductions in extreme speeds should lead to a reduction in the seriousness of crashes in 60km/h zones and a reduction in conflicts between road users and speeding motorists.

# 4 ANALYSIS OF BEHAVIOURAL SURVEYS

This chapter summarises and discusses the analysis of two surveys conducted in Queensland pre and post the implementation of the RSIP in order to assess whether attitudes towards various road safety initiatives have changed following the introduction of the RSIP.

## 4.1 SURVEYS DESCRIPTION

Data from four telephone surveys conducted by Market and Communications Research (MCR) were provided through Queensland Transport (QT). MCR has been commissioned by QT to conduct ongoing surveys on road safety attitudes and behaviours. These surveys have been carried out yearly starting from March 1998 to July 2003. Thus, only one survey (in July 2003) has been conducted after the implementation of the RSIP. In order to investigate the change in attitudes and behaviours that may have occurred after the RSIP implementation it is necessary to compare the post-RSIP survey responses to responses of a survey that was conducted prior to (but close) to the beginning of the RSIP period. Many of the questions in the July 2003 survey were consistent only with the questions in the August 2002 (pre-RSIP) survey, thus making such comparison possible between these two time points.

## 4.2 SURVEY METHODOLOGY

For both the August 2002 and the July 2003 surveys, data was collected by MCR through telephone interviews with a Computer Aided Telephone Interviewing (CATI) system. Each survey collected data from a total of 400 respondents. As described by MCR, the surveyed households were drawn from the most current Queensland White Pages directory. Survey quotas were applied for respondents' location, age, sex, and presence of school aged children in the household. The response rate for the 2002 survey was 15%. For the 2003 survey, an advance letter from QT was posted to 1000 targeted households, followed by multiple call-backs, to maximise the response rate. The response rate based on the pre-notified sample was 29% (174 participants). The remaining 226 participants were obtained by means of random digit dialling, achieving a 7% response rate.

The two samples (August 2002 and July 2003) were very similar in their demographics. At both time points, there were 50% of males and 50% of females. Also, 20% of the respondents were from the Northern QT region, 20% from the Central QT region, 20% from the Southern QT region, and 40% from the South East QT region. Thirty percent of the 2002 sample and 34% of the 2003 sample were under 30 years of age. The two samples were also very similar in the educational levels of respondents, with 23% in August 2002 and 22% in July 2003 having completed university degrees.

As summarised above, despite the demographic compatibility of the two samples, low response rates were achieved for both surveys, thus substantially limiting the extent to which the survey findings can be reliably generalised to the population of Queensland. Even after the survey data is weighted to the Queensland population, the ability to generalise results will remain limited. Therefore, the survey results should be interpreted cautiously and only as supplementary evidence to the RSIP outcome evaluation discussed in the first part of this report, rather than be used as a major indicator for road safety policy decision making.

## 4.3 SURVEY QUESTIONNAIRE

Respondents were presented with various questions and statements on which they had to indicate the extent to which they disagreed or agreed, or select the option that was most applicable to them. There were 24 questions that were consistent between the two surveys and that were related to road behaviours targeted by the RSIP. These questions are listed below:

1. Speed cameras were introduced to help reduce the road toll. (agree strongly; agree slightly; disagree slightly; disagree strongly)

2. Speed cameras were introduced to raise revenue for the government. (agree strongly; agree slightly; disagree slightly; disagree strongly)

3. I am confident I know where I can expect to see speed cameras. (agree strongly; agree slightly; disagree slightly; disagree strongly)

4. I think speeding is a major contributor to crashes. (agree strongly; agree slightly; disagree slightly; disagree strongly)

5. I only avoid speeding where I've seen or heard speed cameras operate. (agree strongly; agree slightly; disagree slightly; disagree strongly)

6. Speed cameras fixed to overpasses are acceptable in locations where mobile police or camera vans are dangerous for police or motorists. (agree strongly; agree slightly; disagree slightly; disagree strongly)

7. Do you feel speeding is as dangerous as drink driving? (yes; no)

8. Have you seen a speed camera operating in the last six months? (yes; no)

9. Have you personally been caught by a speed camera in the last six months? (yes; no)

10. Do you know anyone who has been caught by a speed camera in the last six months? (yes; no)

11. Have you heard traffic reports suggesting where speed cameras are operating? (yes; no)

12. Do you deliberately seek out this information on radio stations? (yes; no)

13. Do you deliberately seek out this information on the Internet? (yes; no)

14. How much would double demerit points during holiday periods deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

15. How much would double demerit points at all times deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

16. How much would double speeding fines during holiday periods deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

17. How much would double speeding fines at all times deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

18. How much would impounding of vehicles for extreme or dangerous driving deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

19. How much would compulsory driver education classes if you had less than two points remaining on your licence deter you from speeding? (strongly deter you; somewhat deter you; not deter you at all)

20. Do you travel as a passenger in a car without wearing a seat belt? (never; rarely; sometimes; always)

21. Do you drive without wearing a seat belt? (never; rarely; sometimes; always)

22. Do you drive while allowing child passengers to not wear their seat belt or child restraint? (never; rarely; sometimes; always)

23. Do you drive when really tired? (never; rarely; sometimes; always)

24. Driving in a fatigued state is a serious road safety issue. (agree strongly; agree slightly; disagree slightly; disagree strongly)

25. How strongly do you support the use of cameras or other technologies to detect dangerous road user behaviours other than speeding (like not wearing seat belts or driving when using a hand held mobile phone)? (strongly support; somewhat support; support a little; not support at all)

As can be seen from the above list, most of the questions that were consistent between the August 2002 and the July 2003 surveys related to speeding attitudes and behaviours, and in particular to speed cameras. In addition, there were four questions related to the extent to which respondents might be deterred from speeding by various sanctions. There were also a small number of questions related to wearing seat belts and to fatigued driving. Speed, seat belts, and fatigue were all major targets of the RSIP campaign. There were, however, no questions that could be compared pre and post RSIP on road safety advertising or on drink driving.

## 4.4 SURVEY ANALYSIS

Descriptive statistics of survey data have already been provided by MCR. The present analysis is different in its focus, as it only examines changes of attitudes and behaviours that might have occurred following the implementation of the RSIP. Although it is not possible to make a direct association of such changes with the RSIP program, this analysis can still provide an indication of how the road behaviours and attitudes targeted by the RSIP may have changed during the relevant period. However, the limitations of the surveys must be borne in mind when interpreting the results.

In order to analyse the data, for each of the above questions chi-square ($\chi^2$) tests were carried out on the frequencies of each response category. Results were tested for significance at the 5% level (i.e. no more than 5% probability that the observed difference between the pre- and post-RSIP survey responses could have been due to chance). There were a small number of respondents that answered "don't know" or "unsure" on some questions. All "don't know" and "unsure" responses were excluded from the analysis because of the very small number of people in these categories (in some cases less than five).

Prior to the analysis, the data from each survey was standardised to the population of Queensland by sex, age, and location, using the survey weights supplied by MCR based on the most recent data from the Australian Bureau of Statistics (ABS).

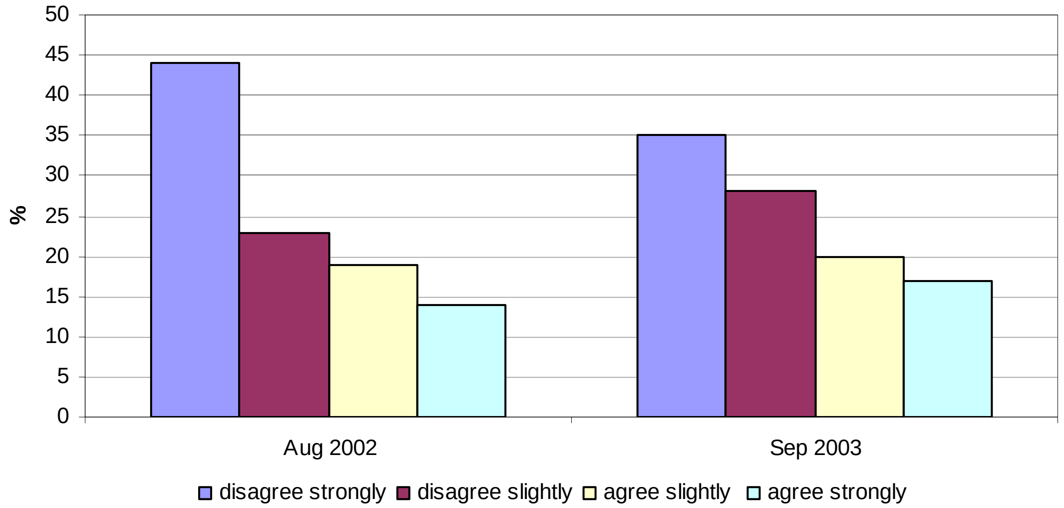
The results of the analysis are presented and discussed in the following section.

## 4.5 RESULTS AND DISCUSSION

Overall, changes in responses to five of the survey questions from August 2002 (the pre-RSIP period) to July 2003 (the post-RSIP period) were statistically significant. The results from these questions are presented first, and then the overall patterns of responses on the remaining questions are discussed. In each of the following figures and the material presented in Appendix F, $\chi^2_{(a,\ b)}$ refers to a chi-squared statistic on *a* degrees of freedom and calculated from *b* survey responses.

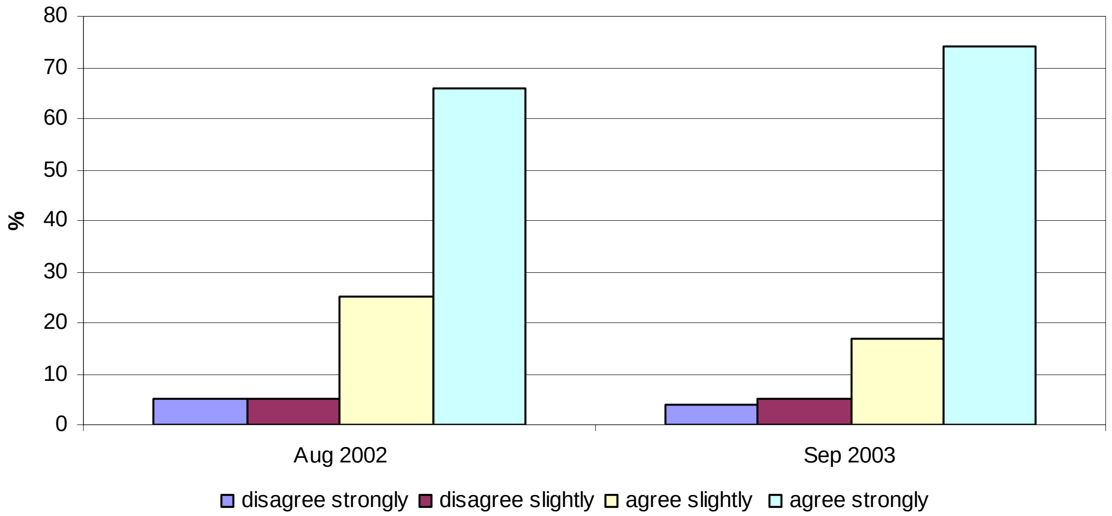
In July 2003 a higher proportion of respondents stated that they were confident that they knew where to expect to see cameras, compared to August 2002. The largest change was a 9% reduction in the proportion of respondents who strongly disagreed with the statement (from 44% to 35%), with slightly higher proportions either disagreeing only slightly or agreeing strongly. As the camera activity was increased during the RSIP period, camera spotting may have become a more frequent occurrence, therefore increasing people's confidence that they know where to expect the cameras. Still, at both time points only a minority of respondents (23%-27%) believed that they were confident at all of where they could spot cameras, perhaps indicating a fair unpredictability in the speed camera operations. These results are presented in Figure 4.1.

**Figure 4.1:** *Response frequencies: "I am confident I know where I can expect to see speed cameras" ($\chi^2_{(3,775)}$=7.86, p=.049).*




In the post-RSIP period significantly more respondents agreed strongly (74%) that speeding is a major contributor to crashes, compared to the pre-RSIP period (66%). However, this change in opinion was mainly due to a shift from agreeing only slightly to agreeing strongly, rather than a reduction in the number of people disagreeing with the statement. Thus, it appears that over time there has been a subtle strengthening of people's belief that speeding is a major contributor to crashes, rather than a drastic change in opinion. Moreover, at both time periods the majority agreed strongly with the above statement, indicating that generally respondents considered speeding to be a serious road safety issue, both pre- and post-RSIP. These results are presented in Figure 4.2 below.

**Figure 4.2:** *Response frequencies: "I think speeding is a major contributor to crashes" ($\chi^2_{(3,791)}$=8.10, p=.044).*




Significant changes in responses were also found for two of the questions related to the deterrence effect of speeding related sanctions: double speeding fines during holiday periods and compulsory driver education classes. The figures with the response frequencies for these questions are presented below in Figures 4.3 and 4.4.

**Figure 4.3:** *Response frequencies: "How much would double speeding fines during holiday periods deter you from speeding?" ($\chi^2_{(3,726)}$=10.78, p=.005).*

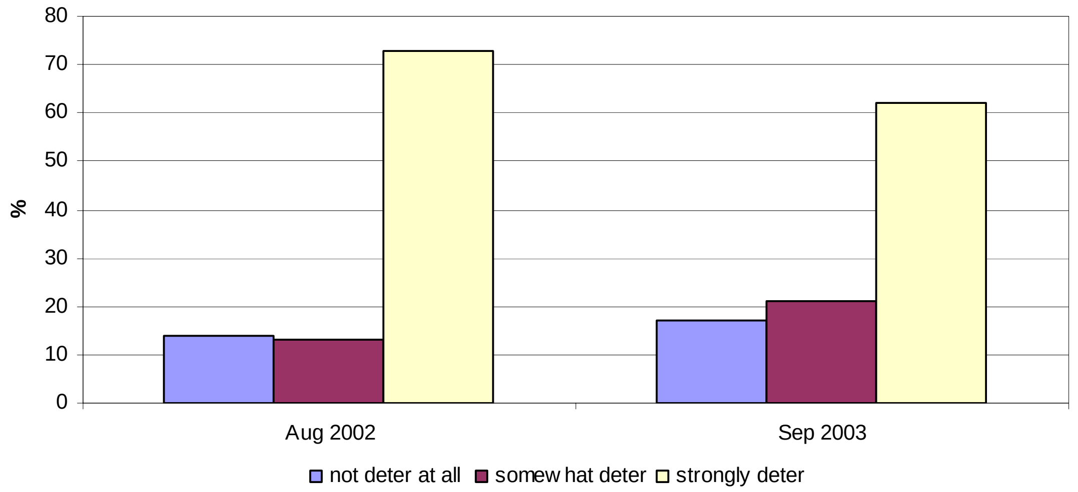
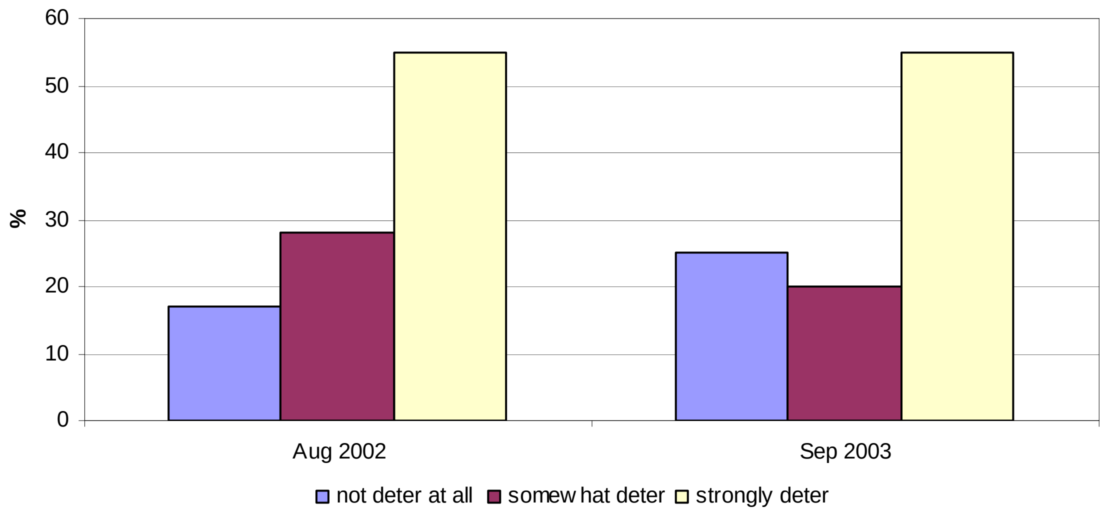



**Figure 4.4:** *Response frequencies: "How much would compulsory driver education classes if you had less than two demerit points available on your licence deter you from speeding?" ($\chi^2_{(3,719)}$=10.59, p=.005).*



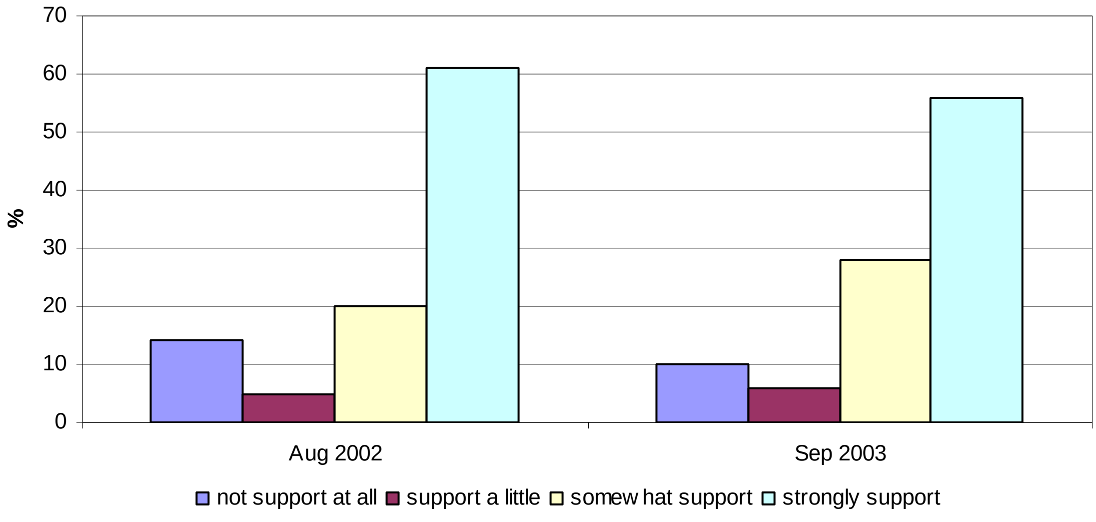

As shown in the above figures, a higher proportion of people stated that they would not be deterred or would be less deterred by these sanctions post-RSIP, compared to pre-RSIP. For the double speeding fines, there was an 11% decrease in the proportion of people stating that they would be strongly deterred (from 73% to 62%), with the major shift being towards being only somewhat deterred (an increase from 13% to 21%).

For the compulsory education classes statement, the change in opinion mainly resulted from an 8% increase in the proportion of respondents indicating that they would not be deterred at all by the sanction (17% to 25%), and an 8% decrease in the proportion of respondents who would be somewhat deterred (from 28% to 20%).

Thus, the perceived deterrence effect of both the double speeding fines during holiday periods and of compulsory driver education classes appear to have somewhat decreased from the pre-RSIP to the post-RSIP period. The reason for this is not apparent from the survey data. There are a number of possible explanations, for example because many respondents may have been rarely caught speeding they estimate the risks of detection to be low; alternatively, perhaps many of the respondents do not speed (or the number of those speeding has decreased) so they do not consider the penalties to be relevant to them. Despite this weakening of the perceived deterrence effect, it is important to point out that at both time points more than half of the respondents still indicated that they would be strongly deterred by the sanctions. The remaining deterrence related questions (about double demerit points in holiday periods and at all times, and vehicle impounding for dangerous driving) exhibited similar trends to the ones described above, although they did not reach statistical significance.

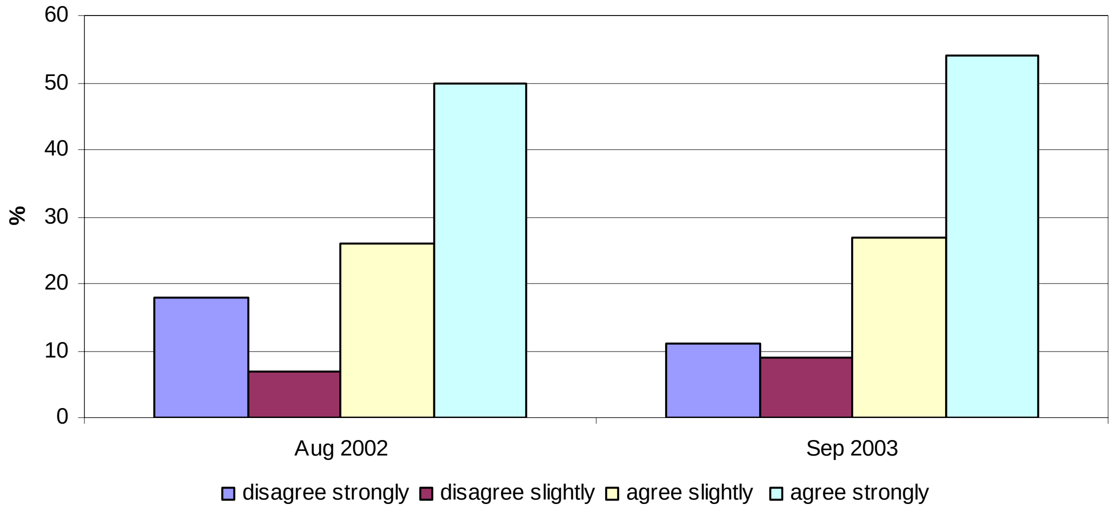
There was also a statistically significant change in responses to the question "How strongly do you support the use of cameras or other technologies to detect dangerous road user behaviours other than speeding?". Post-RSIP a smaller proportion of people did not support this statement at all (change from 14% to 10%) and a higher proportion supported it somewhat (change from 20% to 28%), compared to pre-RSIP. Once more, there appears to be some shift from the position of extreme disagreement to a more moderate position in support of camera use for non-speeding behaviours. However, over half of respondents strongly supported camera use both pre- and post-RSIP. These results are presented in Figure 4.5 below.

**Figure 4.5:** *Response frequencies: "How strongly do you support the use of cameras or other technologies to detect dangerous road user behaviours other than speeding (like not wearing seat belts or driving when using a hand held mobile phone?" ($\chi^2_{(3,791)}$=8.75, p=.033).*




There was one survey question on which the change in responses closely approached significance (p=.059): "Speed cameras fixed to overpasses are acceptable in locations where mobile police or camera vans are dangerous for police or motorists". The number of people strongly disagreeing that speed cameras fixed to overpasses are acceptable decreased by 7% (from 18% in Aug 2002 to 11% in Jul 2003), and the numbers of responses in all the other categories ("disagree slightly" to "agree strongly") increased slightly. About half the respondents strongly agreed that speed cameras fixed to over-passes are acceptable both pre- and post-RSIP, as shown in Figure 4.6 below.

**Figure 4.6:** *Response frequencies: "Speed cameras fixed to overpasses are acceptable in locations where mobile police or camera vans are dangerous for police or motorists?"* ($\chi^2_{(3,764)}=7.44, p=.059$).




On all the other 18 questions no statistically significant differences in responses were found from the pre-RSIP to the post-RSIP period. The results for these questions are presented in Figures F7 to F27 in Appendix F. An examination of the pattern of responses of these questions revealed that at both survey time points a sizable minority of respondents (about 36%) agreed strongly that speed cameras were introduced to help raise revenue for the government, and most (about 69%) agreed at least slightly with this statement. Nevertheless, nearly half the respondents (about 47%) strongly agreed that speed cameras were introduced to help reduce the road toll and the majority (76%) agreed at least slightly with the last statement. These results suggest that while the above two statements are opposing and that they are not necessarily mutually exclusive. Although a substantial proportion of respondents view speed cameras as a revenue generating activity, most also believe in the positive road safety purpose of speed cameras. A similar belief in dual objectives of speed cameras has been found in Victoria (Cameron et al 2003c).

However, the high proportion of people who view cameras as a revenue generating opportunity should not be ignored, as it may still be undermining some otherwise positive perceptions towards road safety initiatives. It must also be noted, that respondents were only asked what the purpose of the introduction of speed cameras had been, rather than to what extent they believed that speed cameras had, in fact, been successful in achieving this purpose of reducing the road toll. The latter question could be used in future surveys to provide a better understanding of respondents' attitudes towards the road safety value of speed cameras.

In relation to exposure to speed cameras within the past six months, most respondents (over 80%) reported that they had seen speed cameras, about half reported that they personally knew someone who had been caught by camera, and a much smaller proportion (about 10%) reported having been personally caught by a speed camera. No significant changes were found in the frequencies of these responses. Since there was a substantial increase in camera activity between August 2002 and July 2003, it might be expected that there would have been an increase in reported exposure as well. Nevertheless, the majority of respondents reported that they had sighted cameras. Furthermore, respondents were only asked whether they had sighted a camera at all, rather than the frequency with which they had sighted cameras in the last six months. Therefore, it cannot be inferred from this question whether the frequency of sightings for each person had indeed changed. In fact, the finding discussed earlier, that there was a slight increase in the number of respondents being confident that they know where they can spot cameras, indicated an increase in camera sightings over time.

There were also no significant changes in people reporting being caught or knowing of others that had been caught, despite the increased camera activity during the RSIP period. However, data provided by the Queensland Police Service indicates an increase in the number of speeding infringement notices issued from camera detections between August 2002 and July 2003. A possible explanation for this discrepancy may be the limited representativeness of the sample, as people who exhibit more deviant social behaviours, such as dangerous driving, are usually less likely to respond to telephone surveys.

At both time points of the surveys about half of the respondents stated that they have heard speed camera reports in the media, but most said they do not deliberately seek out such reports. In relation to fatigued driving, about 20% in 2002 and in 2003 stated that they drive when really tired sometimes or always, although the majority (about 88%) agreed that driving in a fatigued state is a serious road safety issue. Nearly all respondents (about 95%) stated that they never or rarely drive without a seat belt, indicating a very high seat belt compliance rate.

As discussed previously, there were mobile phone related questions only in the July 2003 (post-RSIP) survey. Therefore, it is not possible to assess whether any changes in behaviours or attitudes related to the use of mobile phones while driving have occurred after the implementation of the RSIP. A brief summary is provided here of the MCR's mobile phone findings in 2003. The responses indicate that although most people believe it is dangerous to use a hand held mobile phone (60% viewed it as extremely risky, and 30% as somewhat risky), a minority (14%) reported that they use hand held mobiles while driving sometimes or always. This indicates that although most people are aware of the risks it is still a road safety issue.

## 4.6 CONCLUSIONS: ANALYSIS OF BEHAVIOURAL SURVEYS

Overall, where statistically significant changes occurred, they mainly indicated subtle shifts towards more favourable attitudes and less extreme disagreement with issues. The exception was the perceived deterrence effects of the various sanctions, where there was a small shift towards perceiving the sanctions as having a lesser deterrent effect over time. Possible explanations for this were offered earlier, but further studies would be needed to further understand these patterns.

Generally, the results of both surveys indicate that most respondents hold favourable attitudes towards speed cameras, and are well aware of road safety issues such as speeding, seat belts, and fatigued driving.

Although the survey mainly focused on attitudes, rather than behaviours, the results are consistent with the RSIP outcome evaluation described in this report. In particular, the survey results are consistent with the finding of the RSIP evaluation that the increase in camera hours over the RSIP period was associated with a decrease of severe crashes. The reduction in crashes indicates changes in driving behaviours associated with the increased camera activity. Such behavioural changes are in line with the shift towards somewhat more favourable attitudes towards speed cameras and a somewhat higher awareness of speeding as a serious road safety issue.

As discussed earlier, all survey results must be interpreted cautiously, and only as supplementary results to the RSIP outcome evaluation, in view of the limitations of the survey samples. The lack of representativeness of the survey samples is a major limitation in the extent to which the survey results can be generalised to the population of Queensland. Furthermore, people with more deviant social behaviours, such as dangerous driving, as well as people with more hostile attitudes towards certain road safety initiatives would have been less likely to volunteer for the telephone surveys. Therefore, the results are perhaps more representative of people with less extreme driving behaviours and attitudes, rather than the full range of Queensland drivers.

Another limitation of the surveys is that they focused mostly on attitudes, rather than on behaviours. Attitudes are not equivalent to behaviours, although they are generally moderately correlated. This limits any inferences that can be made from the surveys about actual changes in the road behaviours targeted by the RSIP. Nevertheless, the survey data can be viewed as supplementary evidence to the outcome evaluation, as discussed above. In future, similar surveys would benefit from an inclusion of more behaviour related questions and more representative samples.

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# APPENDIX A

# ALGORITHM FOR CONVERSION OF DATA TO REGIONAL MEASURES

Where data was obtained based on Queensland Statistical Region (QSR), it was necessary to convert this data to Queensland Police Service (QPS) region in order for it to be entered into the data matrix. Since the 13 QSRs do not fit within the same boundaries as the eight QPS regions, the conversion of data based on QSR to QPS region is a problematic issue. In order to resolve this issue, QSR data was first categorised as either South East Queensland (SEQ) or Regional Queensland (RQ). SEQ and RQ were defined as consisting of the QSRs outlined in Table A1.

**Table A1:** *South East Queensland and Regional Queensland categories based on Queensland Statistical divisions.*

| South East Queensland | Regional Queensland |
|---|---|
| Brisbane City Inner Ring Statistical Region | Wide Bay-Burnett Statistical Region |
| Brisbane City Outer Ring Statistical Region | Mackay-Fitzroy-Central West Statistical Region |
| North and West BSD Balance Statistical Region | Darling Downs-South West Statistical Region |
| Gold Coast City Part A Statistical Region Sector | Northern-North West Statistical Region |
| South and East BSD Balance excluding Gold Coast City Part A | Far North Statistical Region |
| North and West Moreton Statistical Region | |
| Gold Coast City Part B Statistical Region Sector | |
| South and East Moreton Balance excluding Gold Coast City Part B | |

Once QSR data were categorised as SEQ and RQ, it was then converted into QPS regions. This was accomplished by defining QPS regions as either SEQ or RQ based on the proportion of the population in each QPS region that was in each QSR (see Table A2). That is, each QPS region was defined as comprising a QSR if the majority of its population was in that QSR. QPS regions were then categorised as SEQ or RQ as outlined in Table A3.

**Table A2:** *Percentage of Queensland Police Service Regions in Queensland Statistical Divisions.*

| POLICE REGION | STATISTICAL DIVISION | % of Police Region in SD |
|---|---|---|
| Central Region | Central West | 3.3 |
| Central Region | Fitzroy | 56.1 |
| Central Region | Mackay | 39.1 |
| Central Region | Wide Bay-Burnett | 1.5 |
| Far Northern Region | Far North | 100.0 |
| Metropolitan North Region | Brisbane | 100.0 |
| Metropolitan South Region | Brisbane | 100.0 |
| North Coast Region | Brisbane | 24.5 |
| North Coast Region | Moreton | 40.3 |
| North Coast Region | Wide Bay-Burnett | 35.2 |
| Northern Region | Central West | 0.4 |
| Northern Region | Mackay | 5.1 |
| Northern Region | North West | 13.8 |
| Northern Region | Northern | 80.8 |
| South Eastern Region | Brisbane | 36.5 |
| South Eastern Region | Moreton | 63.5 |
| Southern Region | Brisbane | 28.8 |
| Southern Region | Central West | 0.1 |
| Southern Region | Darling Downs | 49.8 |
| Southern Region | Moreton | 15.1 |
| Southern Region | South West | 6.2 |

Note: SEQ is the aggregate of the Brisbane and Moreton Statistical Divisions

**Table A3:** *South East Queensland and Regional Queensland categories based on Queensland Police Service (QPS) Regions.*

| **South East Queensland** | **Regional Queensland** |
|---|---|
| Metropolitan North QPS Region | Far Northern QPS Region |
| Metropolitan South QPS Region | Northern QPS Region |
| North Coast QPS Region | Central QPS Region |
| South Eastern QPS Region | Southern QPS Region |

# APPENDIX B

# DERIVATION AND PLOTS OF KEY EVALUATION MEASURES

This Appendix describes the definition and derivation of the key RSIP crash effects evaluation measures as well as well as displaying each measure graphically.

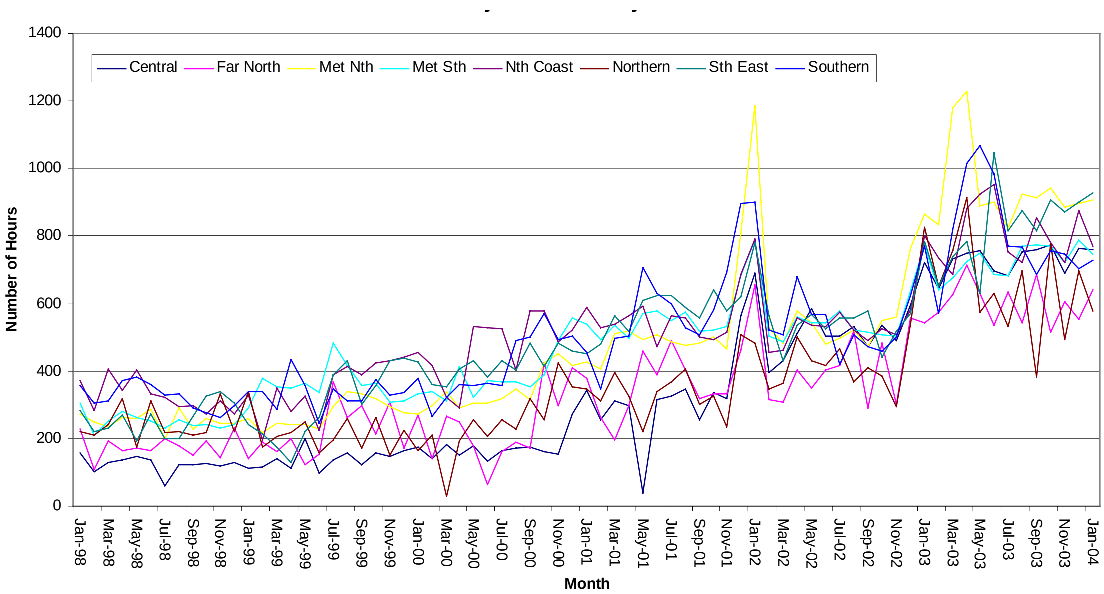
## ROAD SAFETY PROGRAM MEASURES

### SPEED CAMERA PROGRAM MEASURES

*Number of Camera Hours*

The monthly numbers of camera hours over the period of the analysis are presented below for each Region. As can be seen from Figure B1, for each region the monthly camera hours started increasing towards the end of 2000, with the highest levels being reached in 2003 during the RSIP period.

**Figure B1:** *Number of Camera Hours per Month by QPS Region; January 1998 to January 2004*

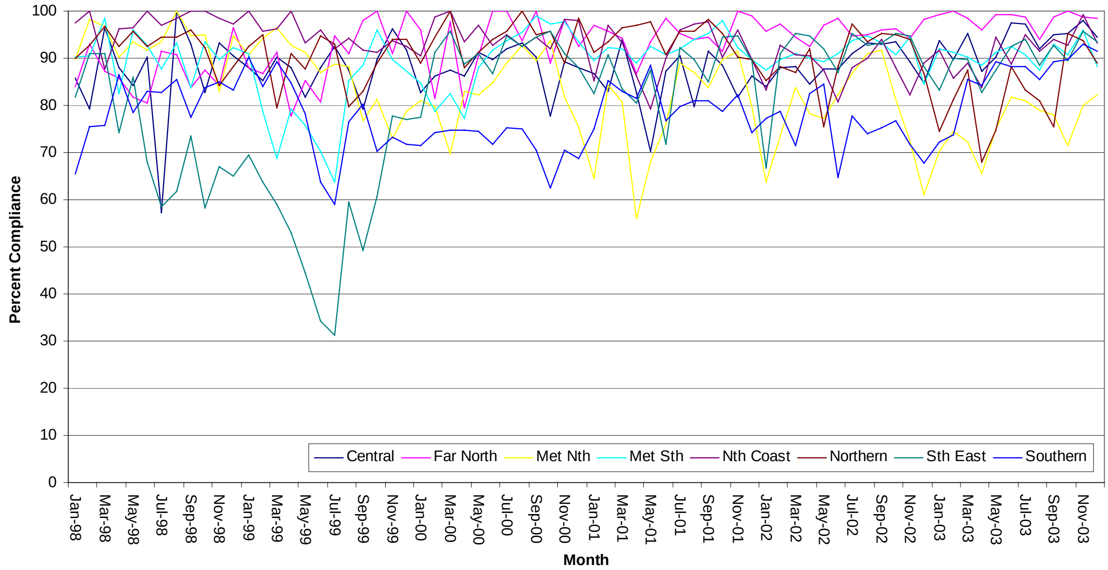



*Compliance with Schedular*

Percentage compliance with Schedular was calculated by dividing the number of sites visited in compliance with the scheduler by the number of deployments.

Figure B2 indicates that compliance with the schedular tended was overall fairly high over time, varying from about 80% to 100%. Overall, there does not appear to be a trend over time, and there does not appear to be a substantial change in compliance level during the RSIP period relative to previous periods.

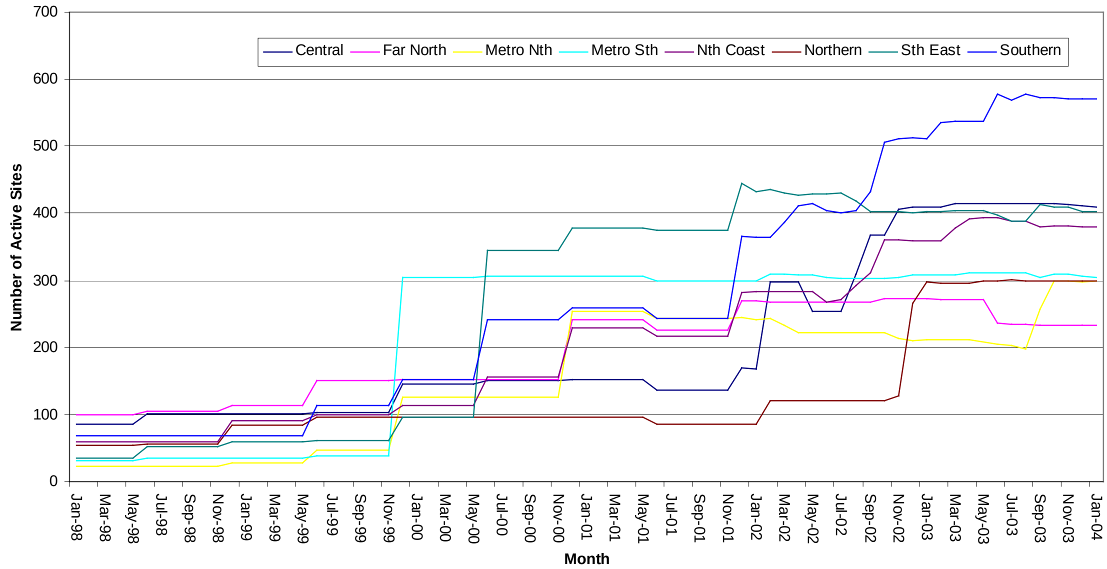
**Figure B2:** *Percentage Compliance with Scheduler per Month by QPS region; January 1998 to December 2003*




## *Number of Active Camera Sites*

The monthly numbers of active camera sites are presented in Figure B3, which shows that the number of sites tended to increase over time in a stepwise manner, with fairly sharp increases in most regions towards the end of 2000.

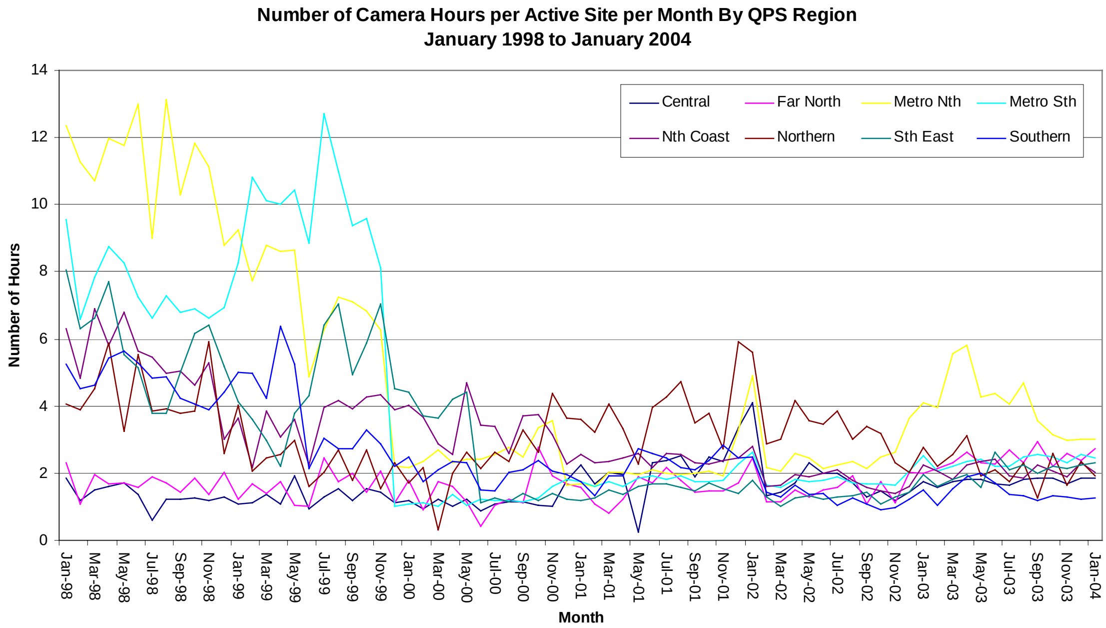
**Figure B3:** *Number of Camera Sites available per month by QPS Region; January 1998 to January 2004*



*Number of Camera Hours per Active Camera Site*

The numbers of monthly camera hours per camera site were calculated for each region as a measure of program density, and are presented in Figure B4 below. This figure indicates that during the RSIP period there seems to be a slight increase in hours per site compared to the previous year. However, when the trend over the whole time period is considered, as the size of the camera program increased over time (i.e. camera hours and number of sites increased), the program density (hours per site) either decreased or remained the same overall. There was even a substantial drop in hours per site in October 1999 from the previous periods. This is because the number of available sites increased in steps, starting from around October 1999, whereas the number of camera hours increased more gradually and less dramatically over time.

**Figure B4:** *Number of Camera Hours per Available Camera Site per month by QPS Region; January 1998 to Janury 2004*

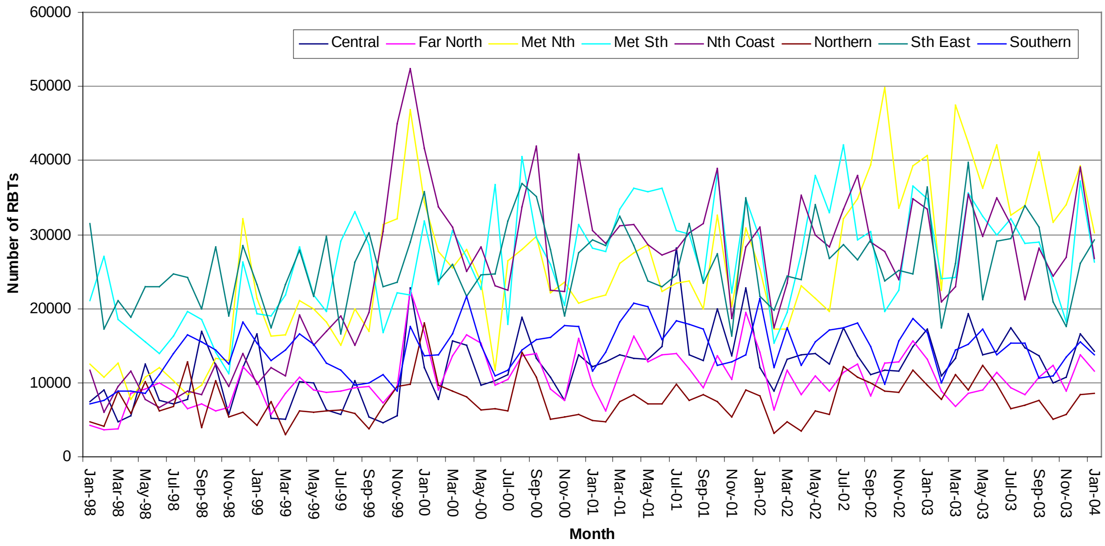



## OTHER POLICE ENFORCEMENT

*Random Breath Tests*

The number of random breath tests per month conducted for each region is presented in Figure B5. There appears to be a slight trend of increase of the number of breath tests conducted over time, in particular for the Metro South, Metro North, and the North Coast regions.

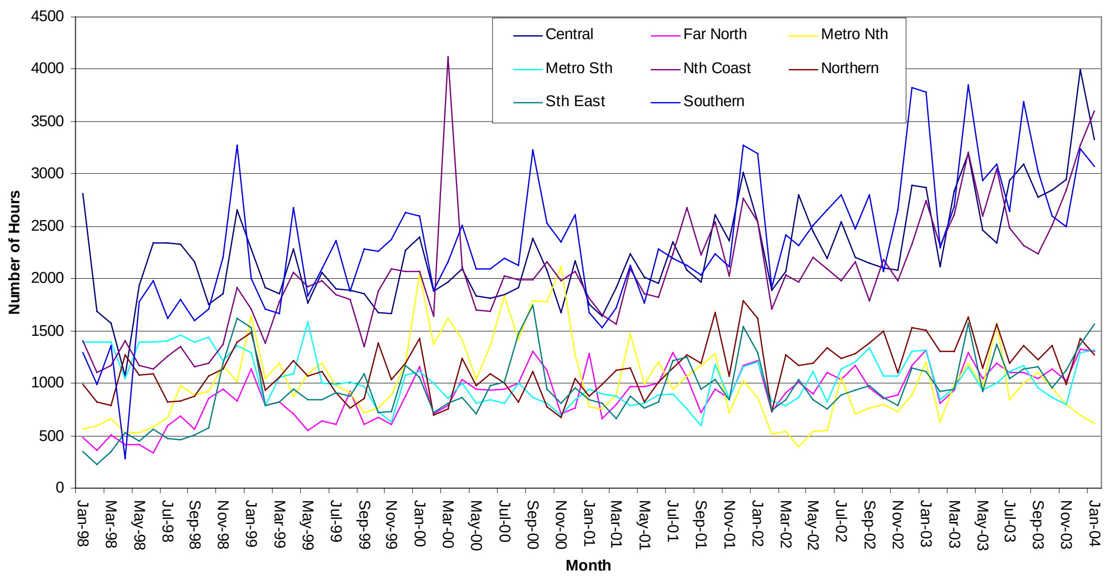
**Figure B5:** *Number of Random Breath Tests per month by QPS Region; January 1998 to January 2004*




*MR and LIDAR Officer Hours*

Mobile radars (MR) are attached to police vehicles to allow monitoring of vehicle speeds while the vehicles are mobile. LIDARs are hand held devices that are used by operators to target specific vehicles. QPS only recorded total MR+LIDAR up to January 1999, after which mobile radar and laser camera hours were recorded separately. The total number of MR+LIDAR hours per month for each QPS region is shown in Figure B6.

**Figure B6**: *Number of Mobile Radar and LIDAR officer hours per Month by QPS Region; January 1998 to January 2004*

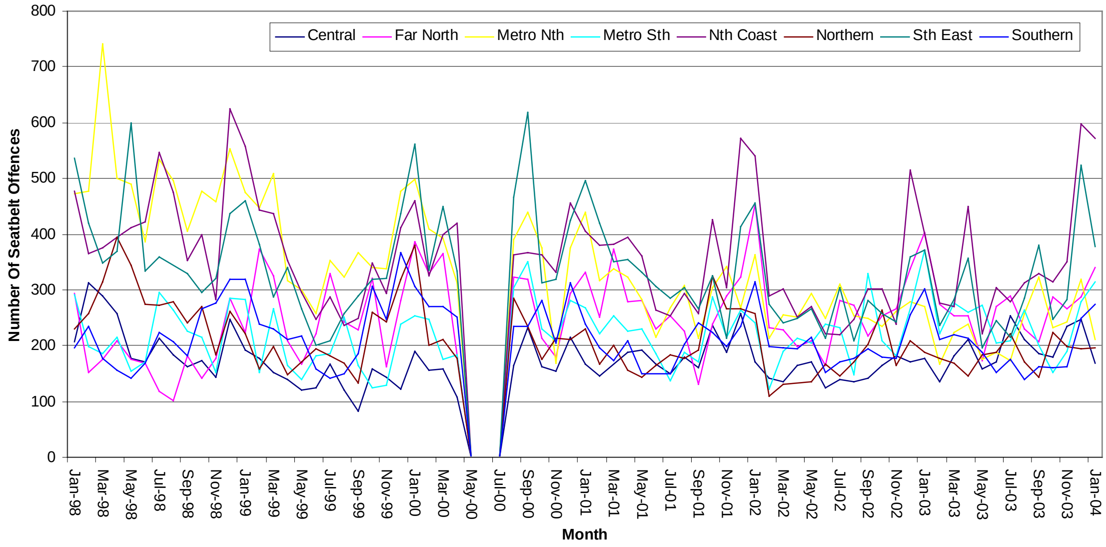



As can be seen from the above figure, there was substantial variation in the number of MR and LIDAR officer hours between the regions. Overall, the hours tended to increase over time during 2002 and 2003, but this trend was much more apparent for some of the regions.

*Detected Seat Belt Offences*

QPS did not collect seat belt offence data from May 2000 to July 2000 and this data has been treated as missing in the present analysis. The changes in detected seat belt offences over time are presented in Figure B7 below. As indicated in this Figure, there were more offences detected in the earlier period, up to about June 1999, and similarly thee was a drop in the number of offences after about January 2002, with several peaks during the RSIP period.

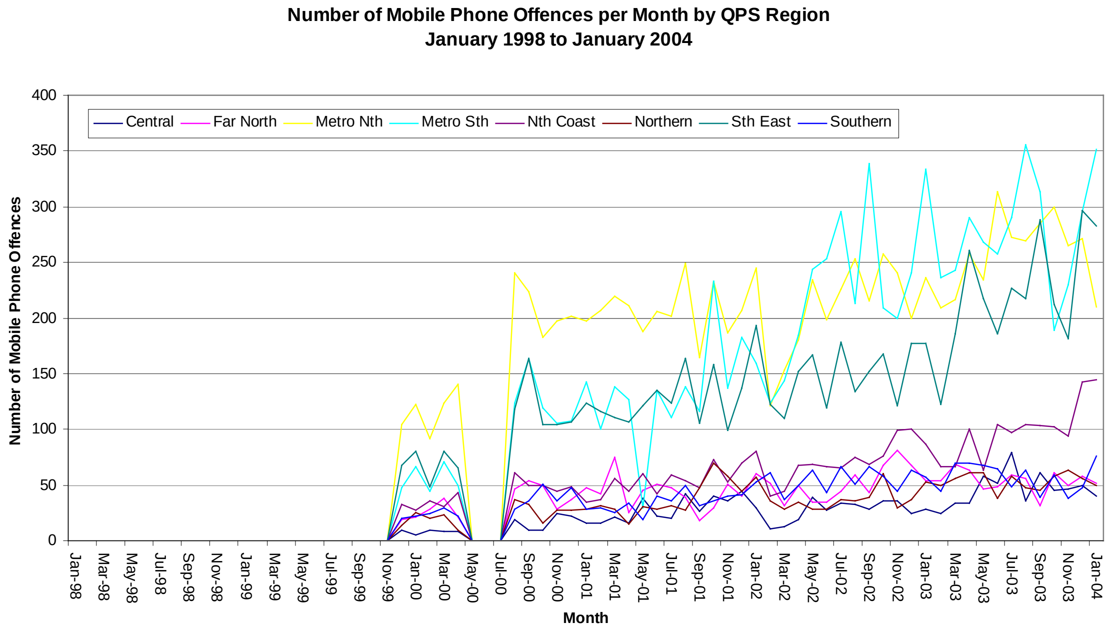
**Figure B7:** Number of Seat belt Offences per month by QPS Region; January 1998 to January 2004




*Mobile Phone Offences*

Legislation concerning the use of mobile phones while driving was introduced in November 1999 and QPS began collecting data for mobile phone offences in December 1999. QPS did not collect mobile phone offence data from May 2000 to July 2000 and this data was treated as missing in the present analysis. The mobile phone offences data is presented in Figure B8, which indicates an increasing trend in offences over time, especially after April 2000.

**Figure B8:** *Number of Mobile Phone Offences per month by QPS Region; January 1998 to January 2004*




## MASS MEDIA PUBLICITY

Data for planned Target Audience Rating Points (TARPs) for mass media publicity targeting the fatal four were obtained from Queensland Transport (QT) for the Brisbane (SEQ) and Regional Queensland markets During the period January 1998 to January 2004, four advertising themes collectively referred to as the “Fatal Four” were used: Drink Driving, Speed, Seat belts, and Fatigue.

Weekly TARPs for both SEQ and Regional Queensland were converted into a measure of audience awareness using an exponential decay function known as Adstock (Broadbent, 1979, 1984) with a half-life of five weeks (see Figures B9 & B10). Previous research has shown that Adstock is related to casualty crash variations in Victoria (Cameron et al., 2003a, b), and Adstock for South East Queensland and Regional Queensland were used in the present analysis.

**Figure B9:** *ADSTOCK per month by Theme in Regional Queensland (5–week half-life); January 1998 to January 2004*

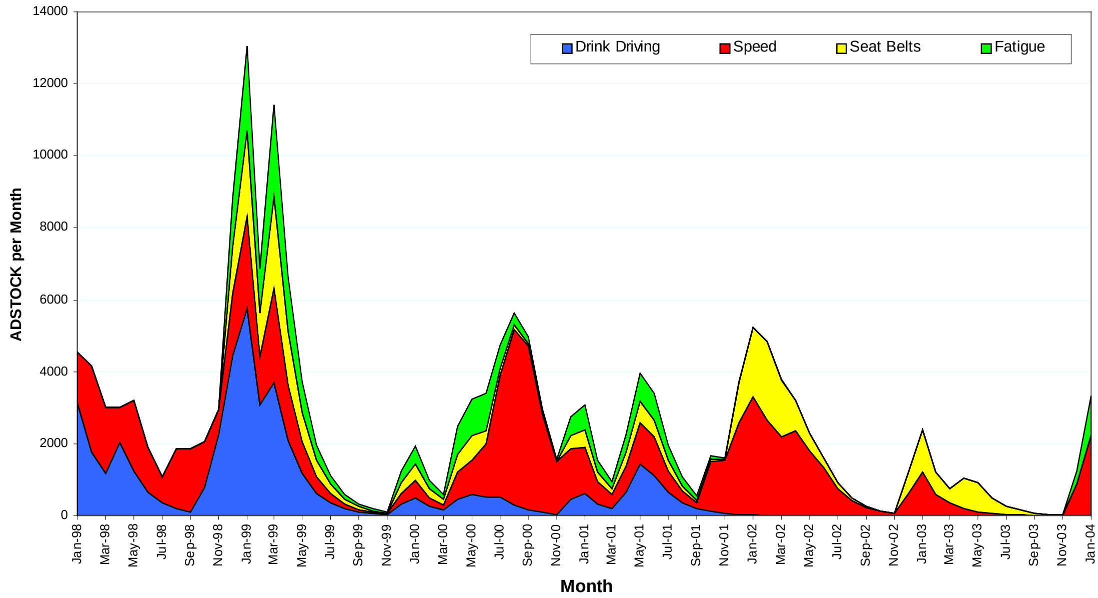
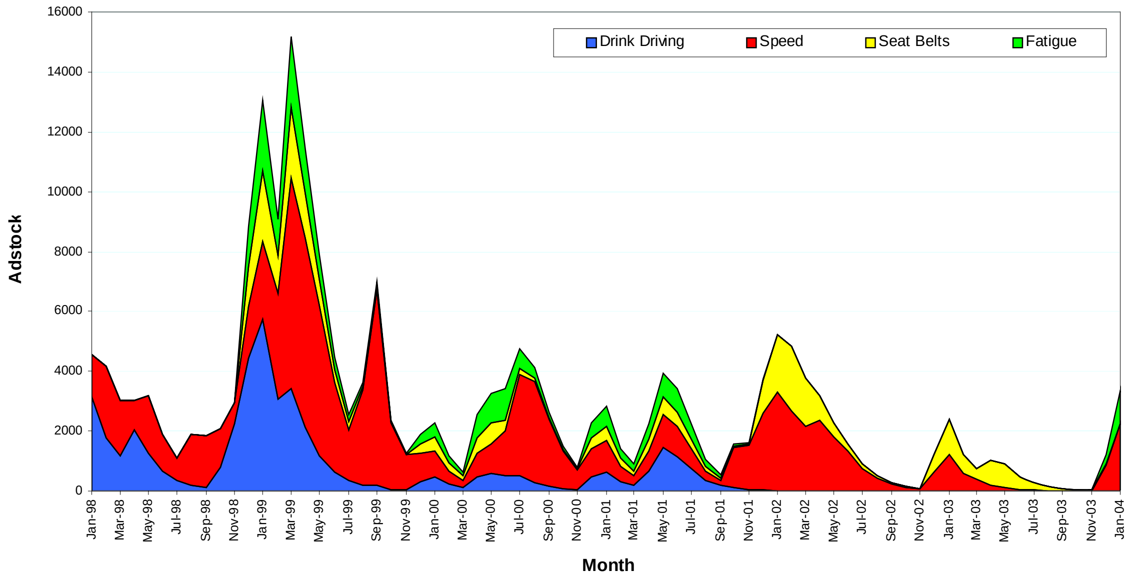



**Figure B10:** *ADSTOCK per month by Theme in South East Queensland (5-week half-life); January 1998 to January 2004*



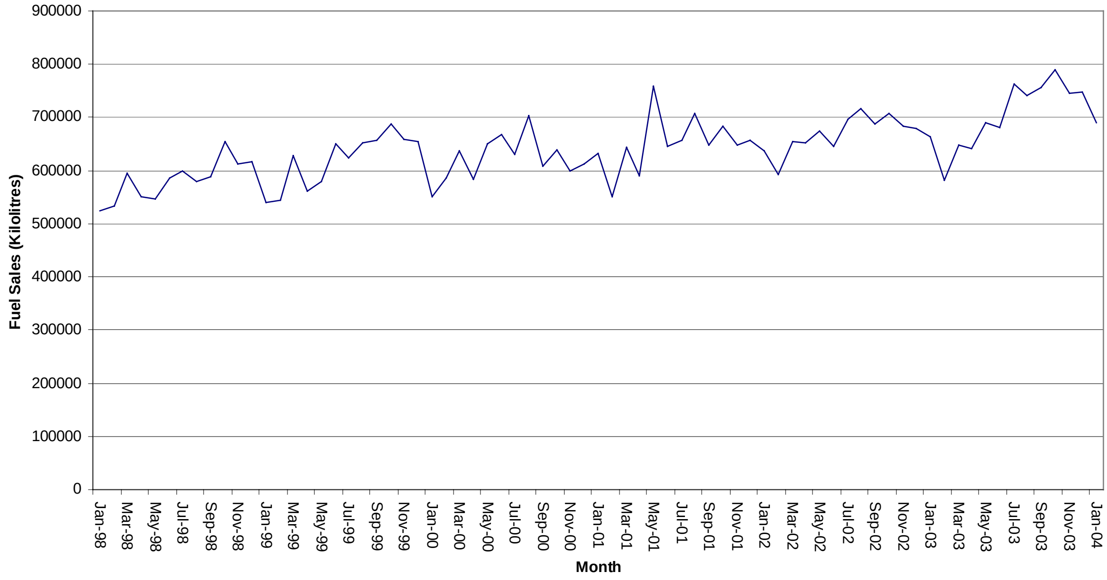

## SOCIO-ECONOMIC FACTORS

The crash effects analysis included measures of factors representing a general growth in the propensity for road crashes such as population, road use, and economic activity. These variables were (i) population growth, (ii) travel measured by fuel sales, and (iii) economic growth measured by unemployment rate. Greater population size, increased travel (as represented by fuel sales), and lower unemployment rates have been found to relate to increased crash frequency and vice versa. These three variables are described below.

*Fuel Sales Data*

Fuel sales data was obtained from the Department of Industry, Science and Resources. This data consisted of sales of petroleum products for automotive use for the whole of Queensland, and included LPG, automotive gasoline, and automotive diesel oil. Fuel sales data were selected on a monthly basis for the corresponding time series of the RSIP evaluation. Since the data was only available for the whole of Queensland, fuel sales data were not analyses separately for police regions or statistical divisions. Figure B11 below indicates that there was a slight increasing trend over time for fuel sales, with reasonable monthly variation.

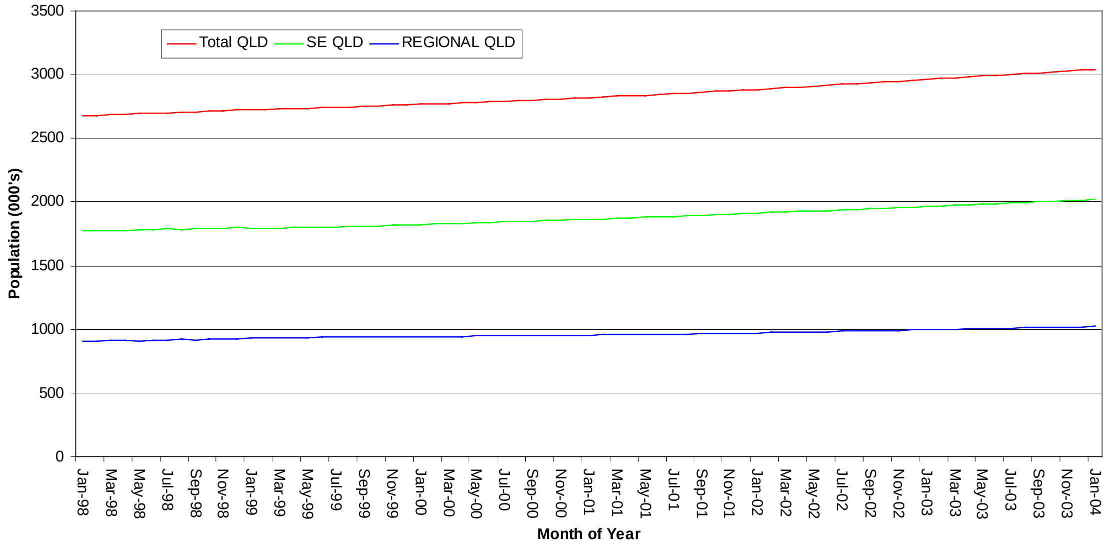
**Figure B11:** *Queensland Fuel Sales by month; January 1998 to January 2004*




*Population Data*

Population data was obtained from Space-Time Research (via OEST) on a monthly basis for each Queensland statistical division. This data was entered into the data matrix for each Queensland Police region using the SD-QPS conversion process described previously. The population data is presented in Figure B12 below, which indicates a slight upward trend in each region over the years.

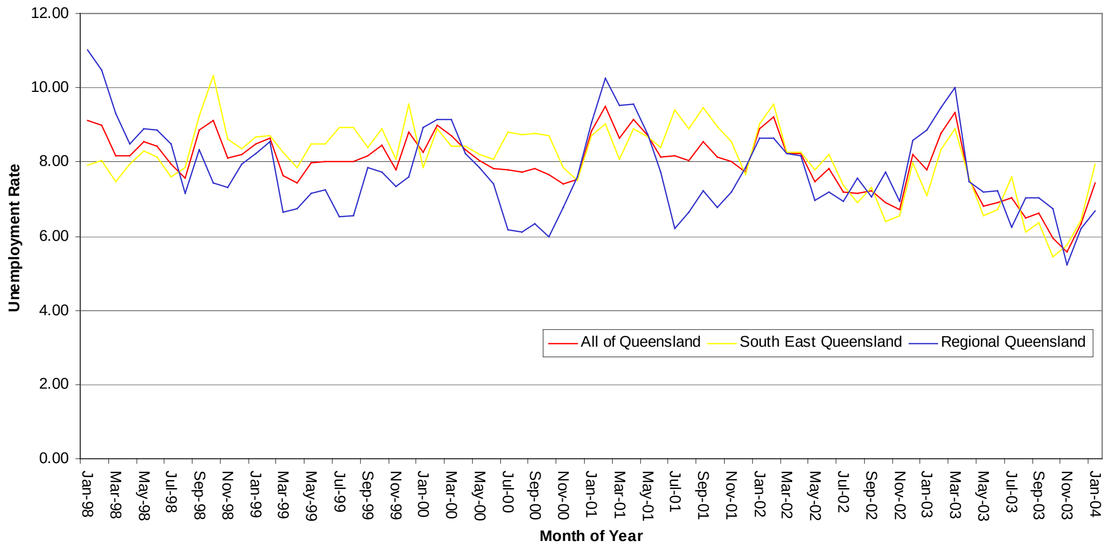
**Figure B12:** Queensland Population per month for South East Queensland and Regional Queensland; January 1998 to January 2004




## *Unemployment Data*

Unemployment data was obtained from Space-Time Research (via OESR) on a monthly basis for each Queensland statistical division. This data was entered into the data matrix for each Queensland Police region using the SD-QPS conversion process described in Appendix A. The unemployment rate over time is graphed in Figure B13. There appear to be only slight changes over the years, with monthly variations inmost regions.

**Figure B13:** *Queensland Unemployment rate per month by Broad Queensland Region; January 1998 to January 2004*



# APPENDIX C

# CORRELATIONS OF REGRESSION INPUT VARIABLES

| | rate of active SC site creation | active speed camera sites | all adstock | belt use adstock | drink driving adstock | fatigue adstock | speed adstock | breath tests | speed camera hours | complianc e with schedular |
|---|---|---|---|---|---|---|---|---|---|---|
| rate of active SC site creation | 1.000 | | | | | | | | | |
| active speed camera sites | 0.113 | 1.000 | | | | | | | | |
| all adstock | -0.004 | -0.335 | 1.000 | | | | | | | |
| belt use adstock | 0.051 | 0.002 | 0.704 | 1.000 | | | | | | |
| drink driving adstock | -0.030 | -0.298 | 0.637 | 0.302 | 1.000 | | | | | |
| fatigue adstock | 0.012 | -0.244 | 0.737 | 0.583 | 0.464 | 1.000 | | | | |
| speed adstock | -0.016 | -0.323 | 0.807 | 0.411 | 0.202 | 0.389 | 1.000 | | | |
| breath tests | 0.016 | 0.124 | 0.063 | -0.003 | 0.199 | -0.016 | -0.006 | 1.000 | | |
| speed camera hours | 0.016 | 0.727 | -0.281 | 0.040 | -0.269 | -0.269 | -0.250 | 0.197 | 1.000 | |
| compliance with schedular | -0.058 | 0.068 | -0.112 | -0.111 | -0.027 | -0.047 | -0.119 | -0.062 | -0.039 | 1.000 |
| QLD fuel sales | 0.039 | 0.539 | -0.378 | -0.217 | -0.314 | -0.237 | -0.296 | 0.096 | 0.540 | 0.100 |
| hours per active speed camera sites | -0.099 | -0.585 | 0.249 | -0.003 | 0.208 | 0.056 | 0.299 | 0.003 | -0.144 | -0.085 |
| rate of SC hours increase | 0.007 | 0.028 | 0.001 | -0.016 | -0.015 | -0.003 | 0.020 | 0.048 | 0.262 | -0.050 |
| laser hours | 0.011 | 0.040 | -0.044 | -0.014 | -0.161 | -0.016 | 0.017 | -0.416 | 0.087 | -0.016 |
| moving mode radar hours | 0.021 | 0.125 | -0.035 | 0.005 | -0.011 | -0.020 | -0.051 | -0.060 | 0.055 | -0.018 |
| Unemployment Rate | 0.026 | -0.225 | 0.178 | 0.134 | 0.130 | 0.045 | 0.162 | 0.008 | -0.233 | -0.100 |
| Population number | 0.000 | 0.130 | 0.030 | -0.001 | -0.039 | -0.030 | 0.091 | 0.326 | 0.345 | -0.040 |
| laser + MMR hours | 0.066 | 0.338 | -0.048 | 0.060 | -0.057 | 0.005 | -0.079 | 0.002 | 0.266 | -0.049 |
| mobile phone offences | -0.006 | 0.214 | -0.117 | -0.019 | -0.123 | -0.077 | -0.096 | -0.263 | 0.261 | -0.003 |
| seat belt offences | 0.006 | -0.023 | -0.042 | 0.010 | -0.196 | 0.026 | 0.034 | -0.420 | 0.002 | 0.019 |

| | QLD fuel sales | hours per active speed camera sites | rate of SC hours increase | laser hours | moving mode radar hours | Unemploy ment Rate | Population number | laser + MMR hours | mobile phone offences | seat belt offences |
|---|---|---|---|---|---|---|---|---|---|---|
| rate of active SC site creation | | | | | | | | | | |
| active speed camera sites | | | | | | | | | | |
| all adstock | | | | | | | | | | |
| belt use adstock | | | | | | | | | | |
| drink driving adstock | | | | | | | | | | |
| fatigue adstock | | | | | | | | | | |
| speed adstock | | | | | | | | | | |
| breath tests | | | | | | | | | | |
| speed camera hours | | | | | | | | | | |
| compliance with schedular | | | | | | | | | | |
| QLD fuel sales | 1.000 | | | | | | | | | |
| hours per active speed camera sites | -0.311 | 1.000 | | | | | | | | |
| rate of SC hours increase | 0.074 | 0.100 | 1.000 | | | | | | | |
| laser hours | 0.019 | 0.033 | 0.031 | 1.000 | | | | | | |
| moving mode radar hours | 0.042 | -0.102 | 0.028 | -0.348 | 1.000 | | | | | |
| Unemployment Rate | -0.500 | 0.158 | -0.030 | 0.022 | -0.087 | 1.000 | | | | |
| Population number | 0.082 | 0.266 | 0.007 | 0.163 | -0.258 | 0.114 | 1.000 | | | |
| laser + MMR hours | 0.183 | -0.230 | 0.097 | 0.028 | 0.491 | -0.159 | -0.246 | 1.000 | | |
| mobile phone offences | 0.177 | -0.111 | 0.025 | 0.755 | -0.248 | -0.077 | 0.229 | -0.061 | 1.000 | |
| seat belt offences | -0.034 | 0.059 | 0.019 | 0.912 | -0.360 | 0.031 | 0.095 | -0.017 | 0.555 | 1.000 |

# APPENDIX D

# KEY STATISTICAL MODEL OUTPUT:

# TOTAL PROGRAM EFFECTS

This appendix presents selected output from the intervention analysis models fitted to the monthly crash data series using the SAS statistical package. The output gives the parameter estimates, standard error, Wald 95% confidence limits and parameter goodness of fit chi-squared and statistical significance statistics for the key road safety and RSIP parameters in the Poisson regression model. Estimates of the intercept, seasonal, general trend and socio-economic variable coefficients are not shown as these are of generally little interest in assessing the RSIP program effects. Model output is given for the analysis models of fatal and hospital crashes, medically treated crashes, other injury and on-injury crashes and all crashes separately

## FATAL + HOSPITALISATION CRASHES

| Parameter | | DF | Estimate | Standard Error | Wald 95% Confidence Limits | | Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|---|---|
| SEQLD50 | 1.00 | 1 | 0.0267 | 0.0331 | -0.0381 | 0.0915 | 0.65 | 0.4192 |
| SEQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| REGQLD50 | 1.00 | 1 | -0.0238 | 0.0609 | -0.1431 | 0.0956 | 0.15 | 0.6963 |
| REGQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| SPDPEN | 1.00 | 1 | 0.0831 | 0.0643 | -0.0429 | 0.2091 | 1.67 | 0.1962 |
| SPDPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| CRSHREP | 1.00 | 1 | 0.0213 | 0.0313 | -0.0400 | 0.0826 | 0.46 | 0.4957 |
| CRSHREP | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| HOLTRIAL | 1.00 | 1 | -0.0682 | 0.0444 | -0.1553 | 0.0189 | 2.36 | 0.1249 |
| HOLTRIAL | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| MOBPEN | 1.00 | 1 | -0.1000 | 0.0493 | -0.1965 | -0.0034 | 4.12 | 0.0424 |
| MOBPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| RSIP | 0.00 | 1 | -0.1406 | 0.0397 | -0.2184 | -0.0627 | 12.51 | 0.0004 |
| RSIP | 1.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |

## MEDICALLY TREATED CRASHES

| Parameter | DF | Estimate | Standard Error | Wald 95% Confidence Limits | | Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|---|
| SEQLD50 | 1.00 | 1 0.0195 | 0.0308 | -0.0409 | 0.0799 | 0.40 | 0.5272 |
| SEQLD50 | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| REGQLD50 | 1.00 | 1 0.0010 | 0.0574 | -0.1115 | 0.1136 | 0.00 | 0.9859 |
| REGQLD50 | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| SPDPEN | 1.00 | 1 0.0039 | 0.0599 | -0.1212 | 0.1135 | 0.00 | 0.9484 |
| SPDPEN | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| CRSHREP | 1.00 | 1 0.1823 | 0.0280 | 0.1275 | 0.2371 | 42.46 | <.0001 |
| CRSHREP | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| HOLTRIAL | 1.00 | 1 0.0143 | 0.0395 | -0.0918 | 0.0632 | 0.13 | 0.7171 |
| HOLTRIAL | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| MOBPEN | 1.00 | 1 0.0999 | 0.0471 | -0.1922 | -0.0075 | 4.50 | 0.0340 |
| MOBPEN | 2.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| RSIP | 0.00 | 1 0.1532 | 0.0361 | -0.2239 | -0.0825 | 18.03 | <.0001 |
| RSIP | 1.00 | 0 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |

## OTHER AND NON_INJURY CRASHES

| Parameter | DF | Estimate | Standard Error | Wald 95% Confidence Limits | Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SEQLD50 | 1.00 | 1 | 0.0036 | 0.0198 | -0.0351 | 0.0423 | 0.03 | 0.8543 |
| SEQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| REGQLD50 | 1.00 | 1 | 0.0541 | 0.0387 | -0.0218 | 0.1300 | 1.95 | 0.1627 |
| REGQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| SPDPEN | 1.00 | 1 | -0.0471 | 0.0405 | -0.1264 | 0.0323 | 1.35 | 0.2448 |
| SPDPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| CRSHREP | 1.00 | 1 | 0.0091 | 0.0189 | -0.0280 | 0.0462 | 0.23 | 0.6309 |
| CRSHREP | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| HOLTRIAL | 1.00 | 1 | -0.1253 | 0.0284 | -0.1810 | -0.0697 | 19.47 | <.0001 |
| HOLTRIAL | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| MOBPEN | 1.00 | 1 | 0.0355 | 0.0300 | -0.0233 | 0.0943 | 1.40 | 0.2362 |
| MOBPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| RSIP | 0.00 | 1 | -0.0444 | 0.0245 | -0.0923 | 0.0035 | 3.30 | 0.0693 |
| RSIP | 1.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |

## ALL CRASHES

| | | | | Standard | Wald 95% Confidence | | Chi- | |
|---|---|---|---|---|---|---|---|---|
| Parameter | | DF | Estimate | Error | Limits | | Square | Pr > ChiSq |
| SEQLD50 | 1.00 | 1 | 0.0123 | 0.0148 | -0.0168 | 0.0414 | 0.68 | 0.4089 |
| SEQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| REGQLD50 | 1.00 | 1 | 0.0239 | 0.0284 | -0.0317 | 0.0796 | 0.71 | 0.3992 |
| REGQLD50 | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| SPDPEN | 1.00 | 1 | -0.0088 | 0.0297 | -0.0670 | 0.0495 | 0.09 | 0.7679 |
| SPDPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| CRSHREP | 1.00 | 1 | 0.0557 | 0.0140 | 0.0283 | 0.0832 | 15.81 | <.0001 |
| CRSHREP | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| HOLTRIAL | 1.00 | 1 | -0.0831 | 0.0205 | -0.1232 | -0.0431 | 16.53 | <.0001 |
| HOLTRIAL | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| MOBPEN | 1.00 | 1 | -0.0246 | 0.0225 | -0.0687 | 0.0195 | 1.20 | 0.2740 |
| MOBPEN | 2.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |
| RSIP | 0.00 | 1 | -0.0921 | 0.0180 | -0.1275 | -0.0568 | 26.12 | <.0001 |
| RSIP | 1.00 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | . | . |

# APPENDIX E

# RESULTS OF SPEED SURVEY ANALYSIS

**Table E1:** *Speed parameter estimates for 60km/h speed zones for QLD, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 59.03144 | 67.06368 | 0.447948 | 0.100084 | 0.018947 | 0.003703 |
| **Mar-03** | 57.36425 | 65.29958 | 0.354233 | 0.076905 | 0.019165 | 0.005308 |
| **Aug-03** | 57.72352 | 65.23125 | 0.391356 | 0.06605 | 0.010496 | 0.002287 |
| **Feb-04** | 57.01612 | 64.55194 | 0.346194 | 0.056958 | 0.011378 | 0.003141 |
| **Nov-02 Vs Mar-03** | -2.82% | -2.63% | -20.92% | -23.16% | 1.15% | 43.35% |
| **Nov-02 Vs Aug-03** | -2.22% | -2.73% | -12.63% | -34.01% | -44.60% | -38.24% |
| **Nov-02 Vs Feb-04** | -3.41% | -3.75% | -22.72% | -43.09% | -39.95% | -15.16% |

**Table E2:** *Speed parameter estimates for 60km/h speed zones for QPS Central region, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 60.56763 | 69.56069 | 0.514811 | 0.156675 | 0.033004 | 0.006 |
| **Mar-03** | 59.07582 | 68.26167 | 0.440099 | 0.131316 | 0.035011 | 0.009 |
| **Aug-03** | 58.51499 | 66.9 | 0.42982 | 0.104004 | 0.01869 | 0.004 |
| **Feb-04** | 58.27293 | 66.51056 | 0.411392 | 0.093901 | 0.021075 | 0.006 |
| **Nov-02 Vs Mar-03** | -2.46% | -1.87% | -14.51% | -16.19% | 6.08% | 48.03% |
| **Nov-02 Vs Aug-03** | -3.39% | -3.82% | -16.51% | -33.62% | -43.37% | -33.87% |
| **Nov-02 Vs Feb-04** | -.79% | -4.38% | -20.09% | -40.07% | -36.15% | -6.06% |

**Table E3:** *Speed parameter estimates for 60km/h speed zones for QPS Far Northern region, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 57.70753 | 62.8 | 0.306871 | 0.018677 | 0.001361 | 0.000213 |
| **Mar-03** | 56.68788 | 61.6 | 0.236589 | 0.012797 | 0.000689 | 0 |
| **Aug-03** | 59.25214 | 64.3 | 0.440466 | 0.026758 | 0.002035 | 0.000303 |
| **Feb-04** | 57.33126 | 63.5 | 0.324357 | 0.023098 | 0.001661 | 0.000241 |
| **Nov-02 Vs Mar-03** | -1.77% | -1.91% | -22.90% | -31.48% | -49.36% | -100.00% |
| **Nov-02 Vs Aug-03** | 2.68% | 2.39% | 43.53% | 43.27% | 49.48% | 42.48% |
| **Nov-02 Vs Feb-04** | -0.65% | 1.11% | 5.70% | 23.67% | 22.03% | 13.37% |

**Table E4:** *Speed parameter estimates for 60km/h speed zones for QPS North Coast region, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 57.45972 | 64.3 | 0.384088 | 0.034567 | 0.003446 | 0.000887 |
| **Mar-03** | 55.93393 | 62.425 | 0.275802 | 0.017387 | 0.001714 | 0.000246 |
| **Aug-03** | 56.41526 | 63.025 | 0.307263 | 0.020516 | 0.001602 | 0.000221 |
| **Feb-04** | 55.8796 | 62.7425 | 0.276565 | 0.020491 | 0.001654 | 0.000293 |
| **Nov-02 Vs Mar-03** | -2.66% | -2.92% | -28.19% | -49.70% | -50.26% | -72.28% |
| **Nov-02 Vs Aug-03** | -1.82% | -1.98% | -20.00% | -40.65% | -53.53% | -75.13% |
| **Nov-02 Vs Feb-04** | -2.75% | -2.42% | -27.99% | -40.72% | -52.01% | -66.92% |

**Table E5:** *Speed parameter estimates for 60km/h speed zones for QPS Northern region, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 57.92753 | 66.6 | 0.465889 | 0.075377 | 0.009283 | 0.002057 |
| **Mar-03** | 55.4028 | 63.4875 | 0.321411 | 0.038368 | 0.007332 | 0.003393 |
| **Aug-03** | 57.00806 | 64.7875 | 0.420535 | 0.04413 | 0.003673 | 0.000678 |
| **Feb-04** | 55.48597 | 63.0875 | 0.315931 | 0.023206 | 0.002192 | 0.0005 |
| **Nov-02 Vs Mar-03** | -4.36% | -4.67% | -31.01% | -49.10% | -21.02% | 64.94% |
| **Nov-02 Vs Aug-03** | -1.59% | -2.72% | -9.74% | -41.45% | -60.43% | -67.05% |
| **Nov-02 Vs Feb-04** | -4.21% | -5.27% | -32.19% | -69.21% | -76.39% | -75.70% |

**Table E6:** *Speed parameter estimates for 60km/h speed zones for QPS Southern region, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th | Prop>60 | Prop>70 | Prop>80 | Prop>90 |
|---|---|---|---|---|---|---|
| **Nov-02** | 56.48945 | 62.8 | 0.279686 | 0.022395 | 0.002514 | 0.00041 |
| **Mar-03** | 54.55473 | 60.6 | 0.179189 | 0.010655 | 0.001129 | 0.000281 |
| **Aug-03** | 55.49349 | 61.45 | 0.221292 | 0.012526 | 0.001226 | 0.000264 |
| **Feb-04** | 54.49339 | 60.4 | 0.176628 | 0.009591 | 0.000733 | 0.000244 |
| **Nov-02 Vs Mar-03** | -3.42% | -3.50% | -35.93% | -52.42% | -55.10% | -31.58% |
| **Nov-02 Vs Aug-03** | -1.76% | -2.15% | -20.88% | -44.07% | -51.22% | -35.65% |
| **Nov-02 Vs Feb-04** | -3.53% | -3.82% | -36.85% | -57.17% | -70.85% | -40.56% |

**Table E7:** *Speed parameter estimates for 100km/h speed zones for QLD, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| Period | Mean | 85th |
|---|---|---|
| **Nov-02** | 94.043 | 104.274 |
| **Mar-03** | 94.104 | 103.922 |
| **Aug-03** | 93.696 | 103.743 |
| **Nov-02 Vs Mar-03** | 0.065% | -0.338% |
| **Nov-02 Vs Aug-03** | -0.370% | -0.509% |

**Table E8**: *Speed parameter estimates for 100km/h speed zones for QPS regions, and percent changes in speeds (a negative value indicates a reduction for the parameter being measured).*

| | QPS Region | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Central | | Far Northern | | Northern | | Southern | |
| **Period** | **Mean** | **85th** | **Mean** | **85th** | **Mean** | **85th** | **Mean** | **85th** |
| **Nov-02** | 94.794 | 105.275 | 87.750 | 97.500 | 96.300 | 104.300 | 92.733 | 103.433 |
| **Mar-03** | 95.350 | 105.363 | 86.700 | 96.200 | 96.450 | 104.400 | 90.833 | 101.067 |
| **Aug-03** | 94.494 | 104.681 | 85.400 | 94.300 | 96.650 | 106.400 | 93.000 | 103.267 |
| **Nov-02 Vs Mar-03** | -1.197% | 0.083% | -1.197% | -1.333% | 0.156% | 0.096% | -2.049% | -2.288% |
| **Nov-02 Vs Aug-03** | -2.678% | -0.564% | -2.678% | -3.282% | 0.363% | 2.013% | 0.288% | -0.161% |

**Table E9**: *Number of streets and number of cars surveyed by QPS region and month for 60km/h speed surveys*

| QPS REGION | Number of Streets Surveyed | Number of Cars Surveyed | | | |
|---|---|---|---|---|---|
| | | Nov-02 | Mar-03 | Aug-03 | Feb-04 |
| North Coast | 4 | 75011 | 74627 | 76148 | 80180 |
| Southern | 2 | 37652 | 38838 | 37583 | 39277 |
| Central | 11 | 146943 | 177130 | 156347 | 190319 |
| Far Northern | 1 | 23505 | 23209 | 23096 | 37320 |
| Northern | 8 | 179558 | 170328 | 192033 | 207158 |
| Total Regional QLD | 26 | 462669 | 484132 | 485207 | 554254 |

**Table E10**: *Number of streets and number of cars surveyed by QPS region and month for 100km/h speed surveys*

| QPS REGION | Number of Streets Surveyed | Number of Cars Surveyed | | |
|---|---|---|---|---|
| | | Nov-02 | Mar-03 | Aug-03 |
| Southern | 3 | 72504 | 53798 | 108476 |
| Central | 16 | 267856 | 177303 | 217288 |
| Far Northern | 2 | 123539 | 40338 | 107791 |
| Northern | 2 | 6526 | 4124 | 4127 |
| Total Regional QLD | 23 | 470425 | 275563 | 437682 |

# APPENDIX F

# RESULTS OF BEHAVIOURAL SURVEY ANALYSIS

**Figure F1:** *Response frequencies: "Speed cameras were introduced to help reduce the road toll" ($\chi^2_{(3,787)}$=5.70, p=.127).*

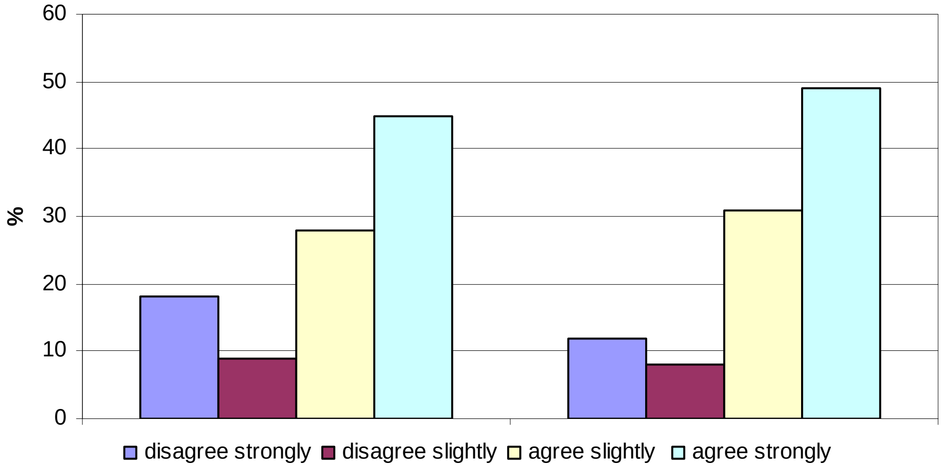



**Figure F2:** *Response frequencies: "Speed cameras were introduced to help raise revenue for the government" ($\chi^2_{(3,760)}$=6.49, p=.090).*

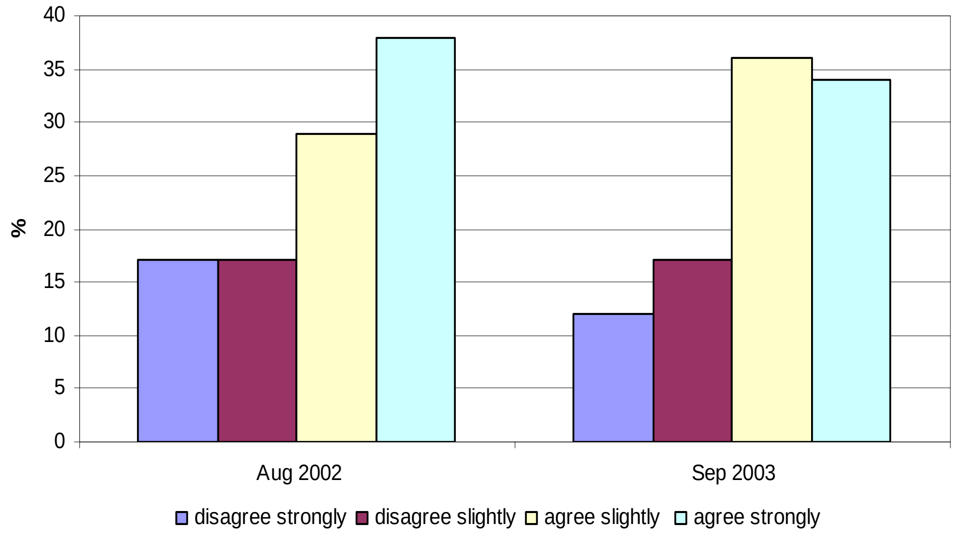


**Figure F3:** *Response frequencies: "I only avoid speeding where I've seen or heard speed cameras operate" ($\chi^2_{(3,785)}$=3.79, p=.285).*

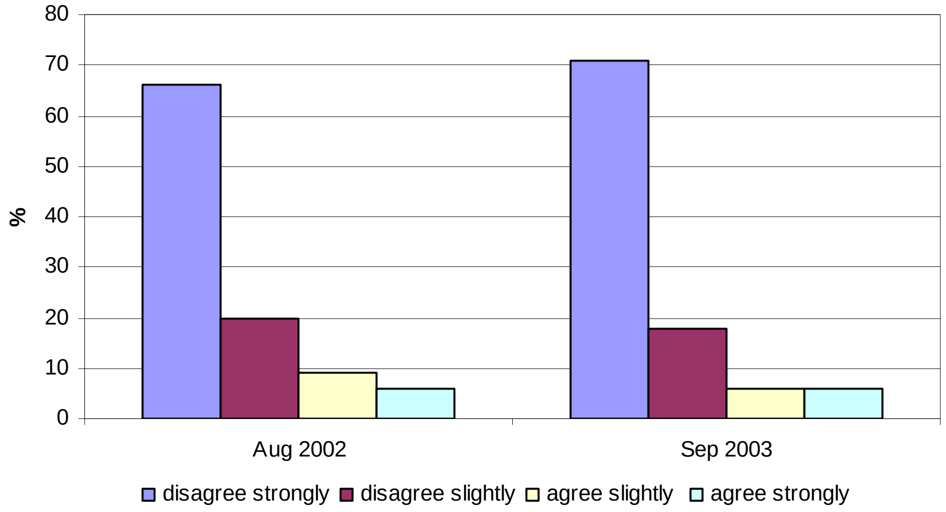



**Figure F4:** *Response frequencies: "Do you feel speeding is as dangerous as drink driving?" ($\chi^2_{(1,764)}$=2.20, p=.138).*

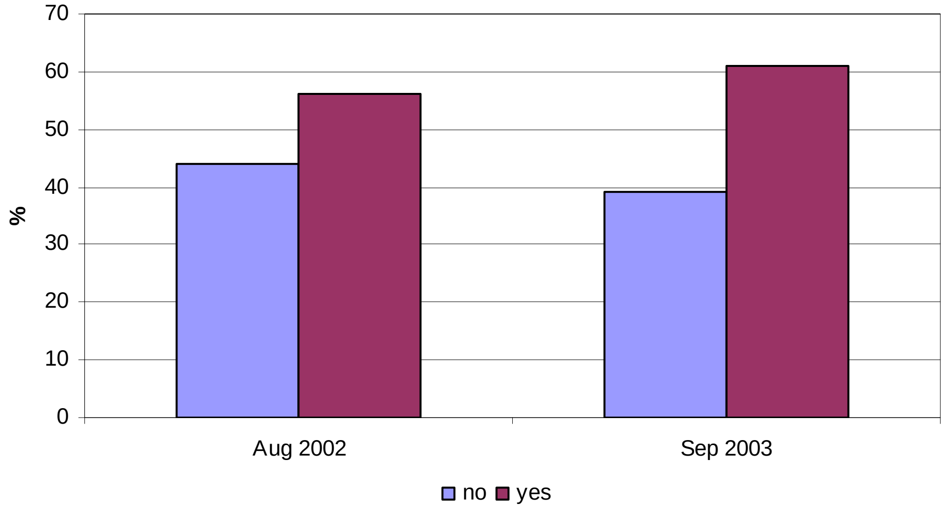


**Figure F5:** *Response frequencies: "Have you seen a speed camera operating in the last six months?" ($\chi^2_{(1,800)}$=1.82, p=.177).*

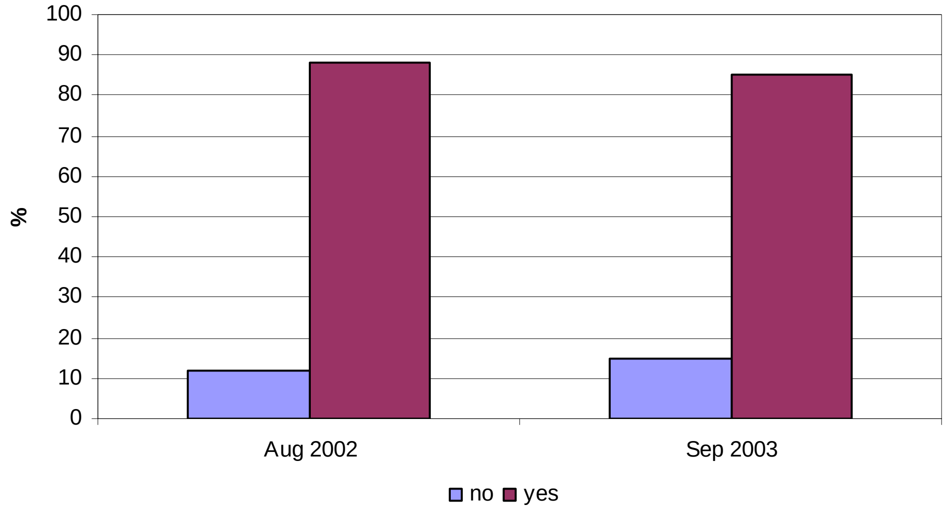



**Figure F6:** *Response frequencies: "Have you personally been caught by a speed camera in the last six months?" ($\chi^2_{(1,800)}$=0.21, p=.648).*

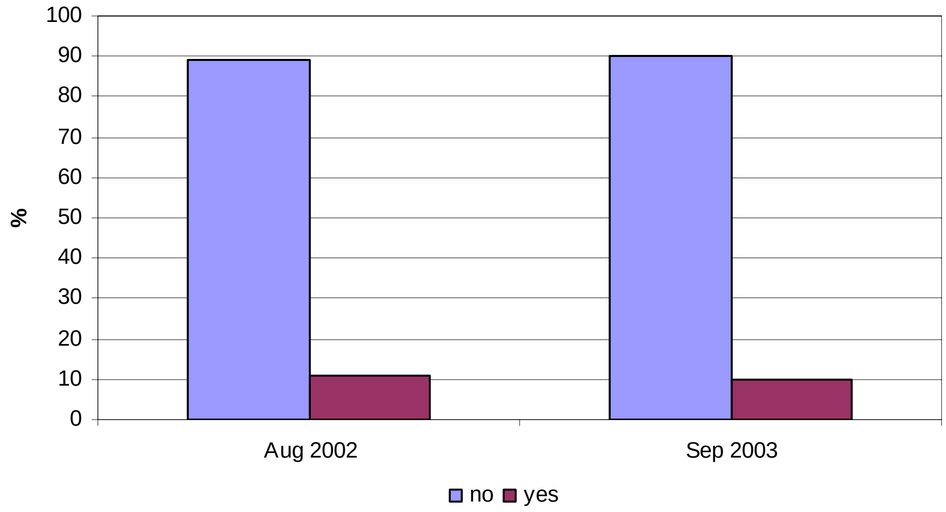


**Figure F7:** *Response frequencies: "Do you know anyone who has been caught by a speed camera in the last six months?" ($\chi^2_{(1,800)}$=0.72, p=.395).*

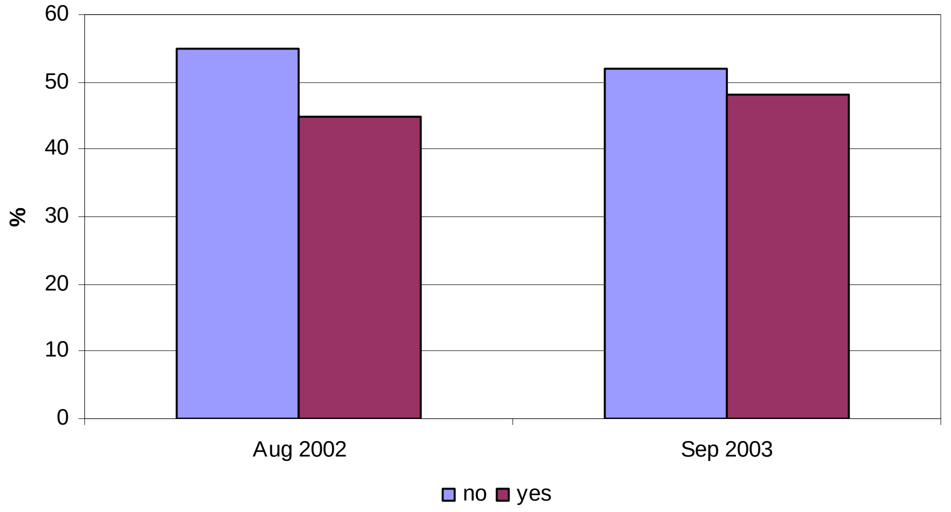



**Figure F8:** *Response frequencies: "Have you heard traffic reports suggesting where speed cameras are operating?" ($\chi^2_{(1,797)}$=0.00, p=.970).*

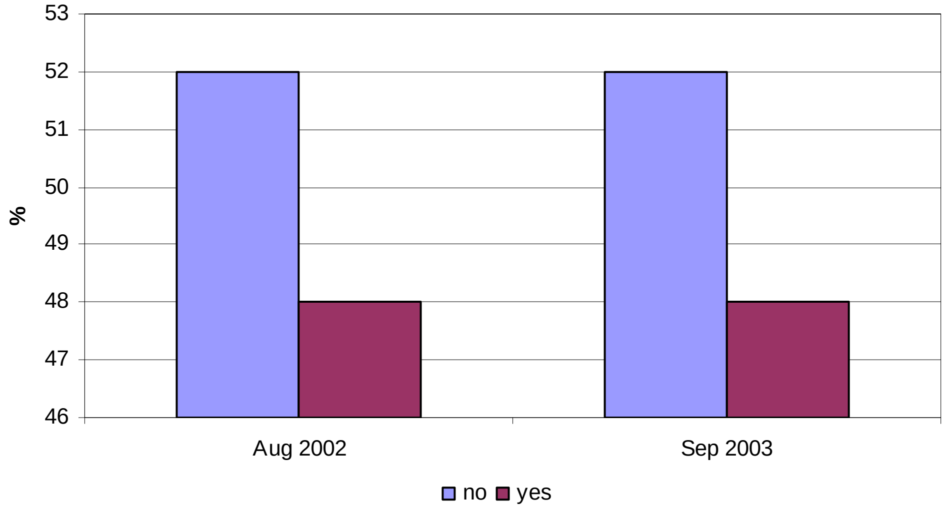


**Figure F9:** *Response frequencies: "Do you deliberately seek out this information on radio stations?" ($\chi^2_{(1,379)}$=1.29, p=.256).*

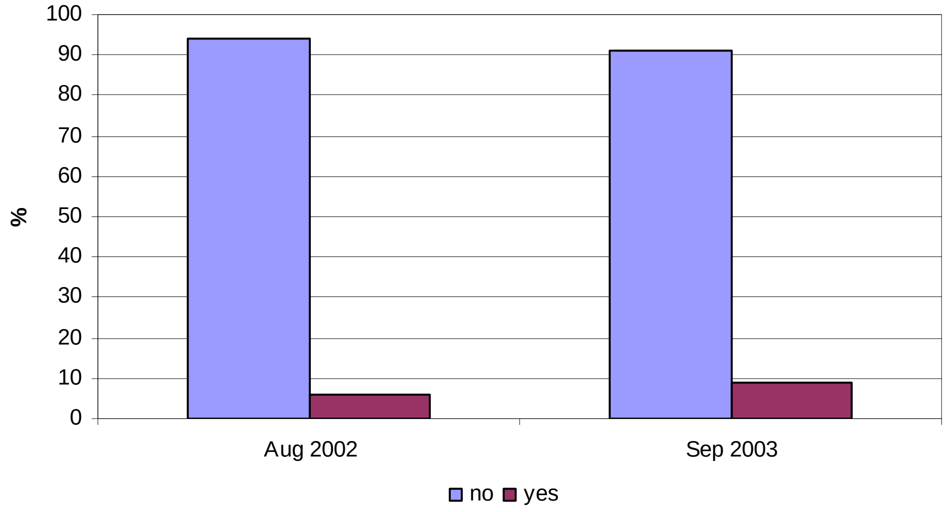



**Figure F10:** *Response frequencies: "Do you deliberately seek out this information on the Internet?" ($\chi^2_{(1,800)}$=0.00, p=1.000).*

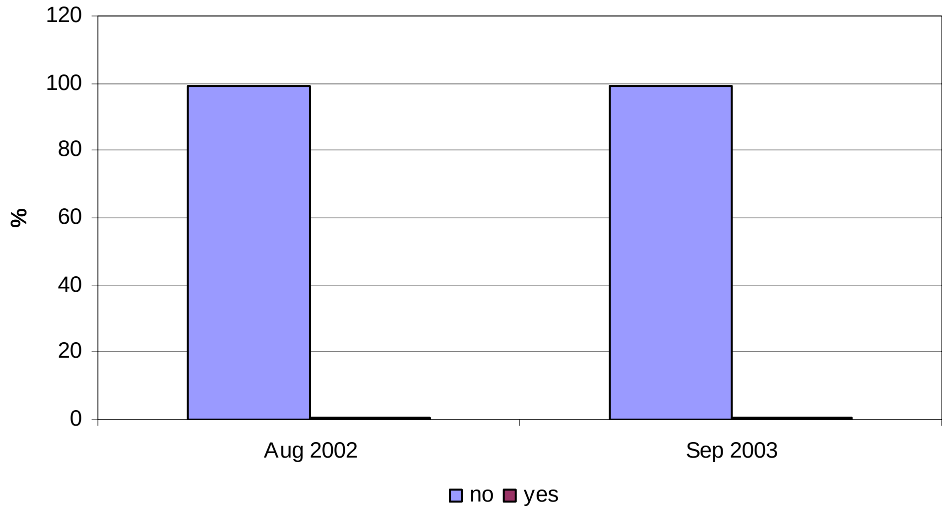


**Figure F11:** *Response frequencies: "How much would double demerit points during holiday periods deter you from speeding?" ($\chi^2_{(2,725)}$=0.51, p=.774).*

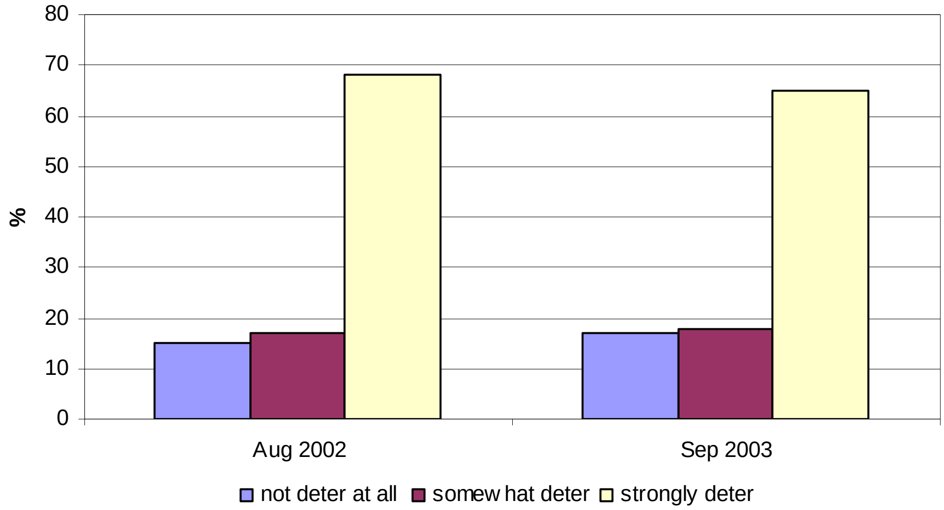



**Figure F12:** *Response frequencies: "How much would double demerit points at all times deter you from speeding? ($\chi^2_{(2,719)}$=3.28, p=.194)".*

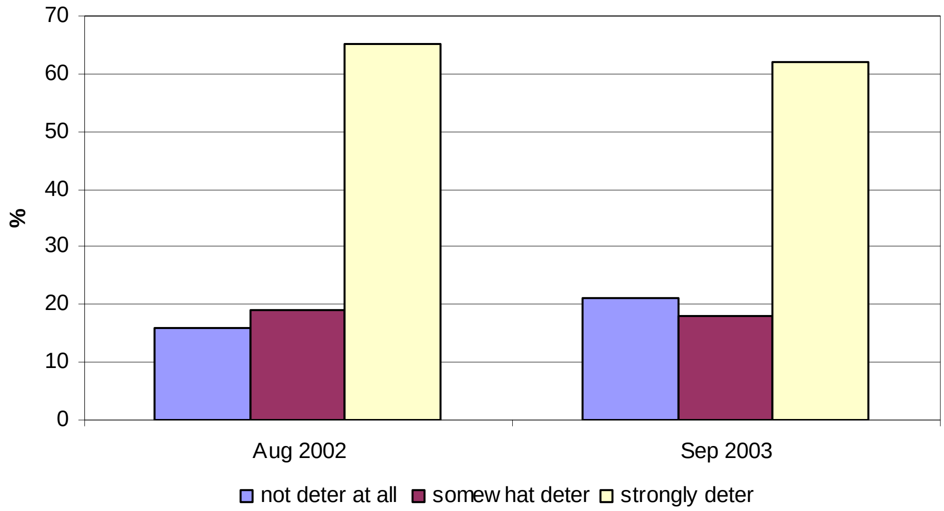


**Figure F13:** *Response frequencies: "How much would double speeding fines at all times deter you from speeding?" ($\chi^2_{(2,724)}$=4.22, p=.121).*

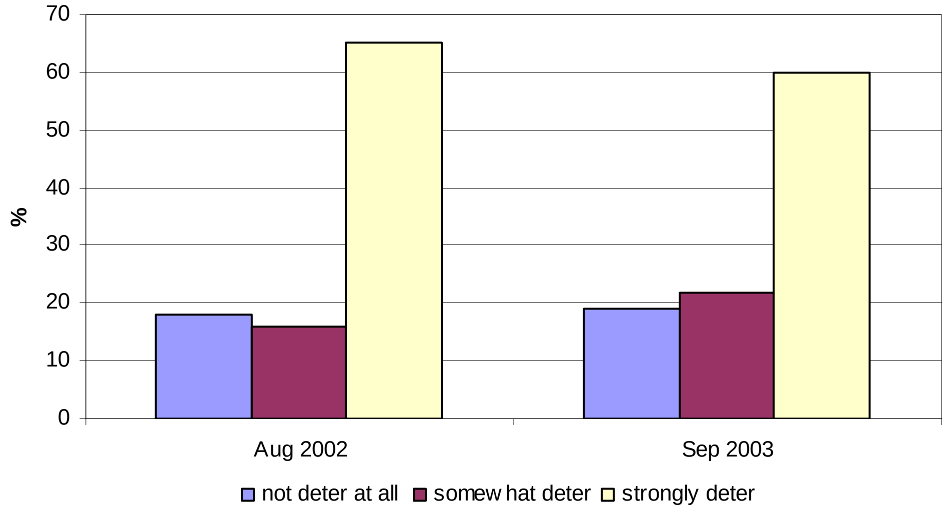



**Figure F14:** *Response frequencies: "How much would impounding of vehicles for extreme or dangerous driving deter you from speeding?" ($\chi^2_{(2,721)}$=0.93, p=.629).*

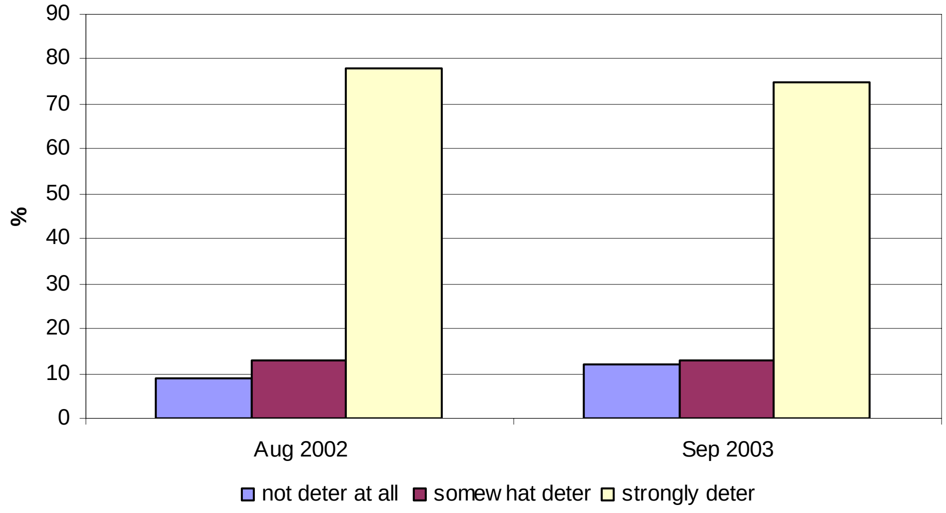


**Figure F15:** *Response frequencies: "Do you travel as a passenger in a car without wearing a seat belt?"*($\chi^2_{(3,799)}$=1.17, p=.761).

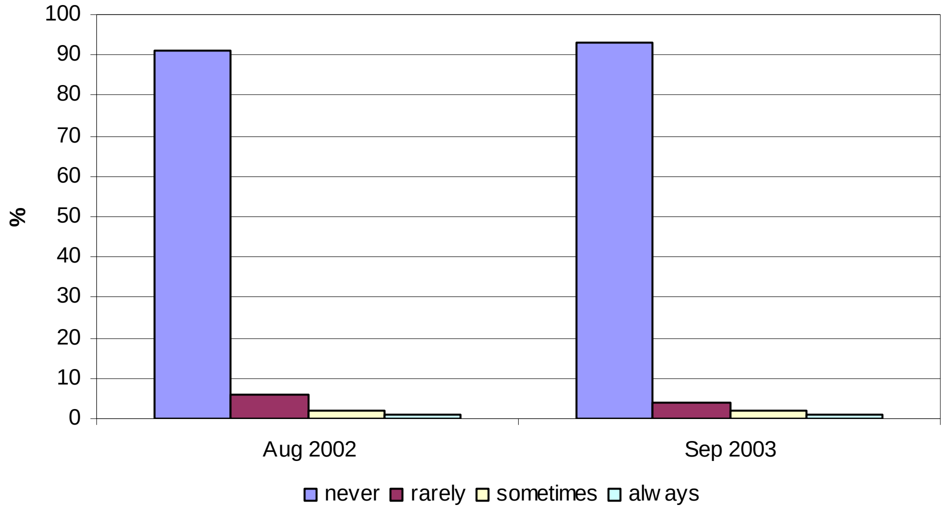



**Figure F16:** *Response frequencies: "Do you drive without wearing a seat belt?"* ($\chi^2_{(3,800)}$=3.60, p=.308).

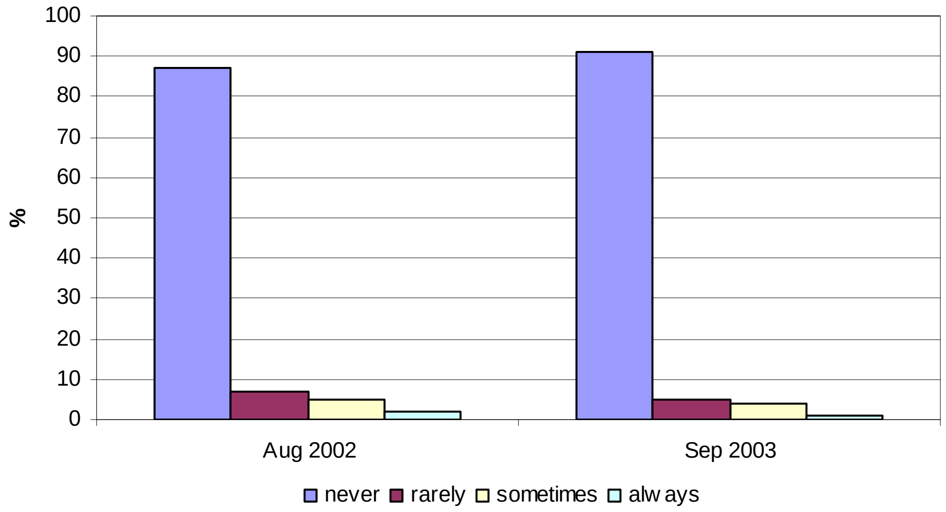


**Figure F-17:** *Response frequencies: "Do you drive while allowing child passengers to not wear their seat belt or child restraint?" ($\chi^2_{(3,799)}$=2.16, p=.539).*

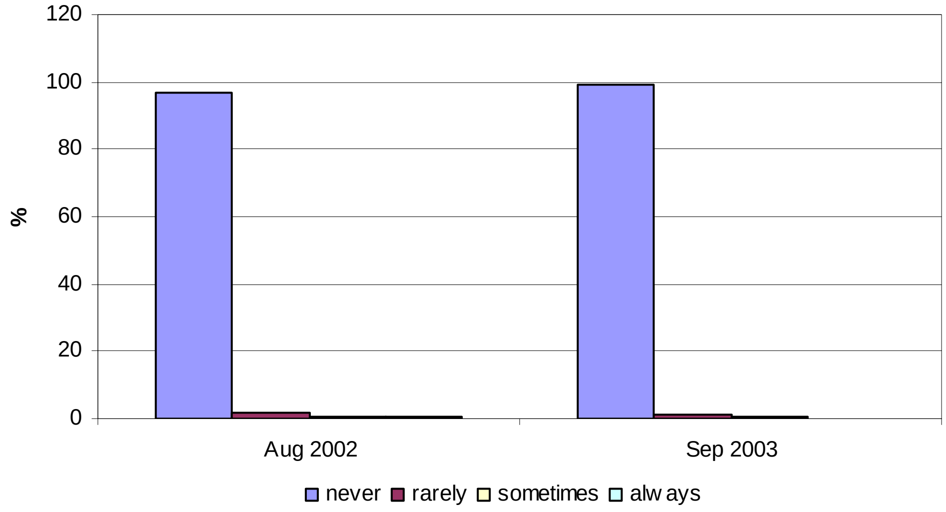



**Figure F18:** *Response frequencies: "Do you drive when really tired?" ($\chi^2_{(3,798)}$=5.83, p=.120).*

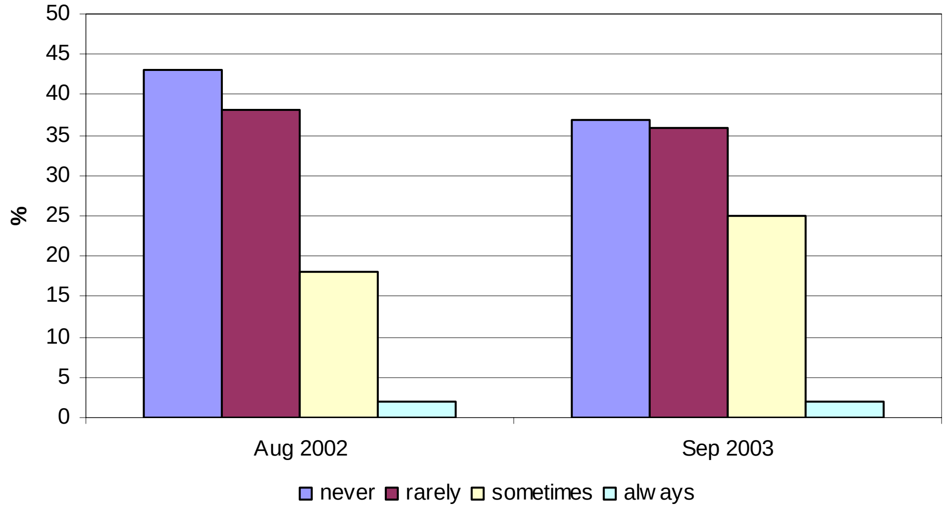


**Figure F19:** *Response frequencies: "Driving in a fatigued state is a serious road safety issue" ($\chi^2_{(3,796)}$=3.70, p=.296).*