Centre for Automotive Safety Research

NSW intelligent speed adaptation (ISA) trial: Modelling the effects of advisory ISA on the Australian driving population

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Summary

During 2009 and 2010 the New South Wales Centre for Road Safety conducted a trial of advisory ISA in the Illawarra region of New South Wales. Data from this trial was analysed to:

- estimate the reduction in serious and fatal crashes due to advisory ISA in Australia, and to do so at different levels of penetration.
- determine if the effect of advisory ISA is sensitive to the amount of time the driver is exposed to the advisory ISA device.
- predict the number of serious and fatal crashes that could be saved by advisory ISA in future years.

The reduction in crash risk was calculated by applying Kloeden's risk curves for travel speed to the distributions of speeds found in the trial. The risk curves were applied to the 'before ISA' speed profile and the 'during ISA' speed profile. The reduction in risk was then estimated in terms of the difference in the in total crash risk produced by these speed profiles. It was calculated that advisory ISA would reduce Australian serious crashes by 19.3% and fatal crashes by 18.9%.

To determine if the effect of advisory ISA is sensitive to the amount of time the driver is exposed to the advisory ISA device, the data from the period in which ISA was activated was grouped by week. Two measures of the effect of ISA were used; changes in mean speed and changes in percentage of distance travelled over the speed limit. The percentage of distance travelled over the speed limit was disaggregated into three groups; percentage of distance travelled speeding by 5 km/h or less, percentage of distance spent speeding by more than 5 km/h up to speeding by 10 km/h, and speeding by more than 10 km/h. The change in these measures over the 12-week 'during ISA' period was determined by calculating the slope of a fitted linear trend line for each vehicle. This process was conducted for the sample of drivers as a whole and also by disaggregating the drivers in several ways. No evidence was found that the effect of advisory ISA was sensitive to the length of time it had been installed in the driver's vehicle.

The crash savings attributable to all vehicles having advisory ISA in future years was determined by predicting the number of fatal and serious crashes in future years and applying the percentage reductions stated above. The number of serious and fatal crashes in future years was calculated by fitting an exponential trend line to previous years data and therefore determining a percentage change in these crashes per year. In 2015 this would represent 3,873 serious crashes and 219 fatal crashes, in 2020 4,190 serious crashes and 204 fatal crashes and by 2030 4,905 serious crashes and 176 fatal crashes.

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TITLE

NSW intelligent speed adaptation (ISA) trial: Modelling the effects of advisory ISA on the Australian driving population

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Contents

1 Introduction

Intelligent speed adaptation (ISA) is a generic term referring to many different types of devices that share the aim of helping the driver adhere to the posted speed limit. These devices use global positioning system (GPS) technology and on-board maps which are linked to a speed zone database to allow the ISA device to know where the vehicle is and what the speed limit is for the road it is travelling upon.

ISA devices can be divided into three categories: advisory, supportive and limiting. Advisory devices communicate to the driver that they are travelling above the speed limit by using audio and visual signals. The audio signal can be a simple tone or a statement delivered such as “you are driving above the speed limit”. The driver is not obliged to slow to the speed limit but some advisory devices encourage this by using more annoying audio signals the longer the speed limit is exceeded or the greater the amount the limit is exceeded by. Supportive devices prevent the vehicle breaking the speed limit by various methods such as ‘hardening’ the accelerator pedal, cutting fuel supply, electronically manipulating the throttle, applying the brakes or a combination of these methods, but allow this control to be overridden. A limiting device works in the same way as a supportive device except that the driver cannot override it.

The New South Wales Centre for Road Safety conducted a trial of advisory ISA during 2009 and 2010 in the Illawarra region of New South Wales. A total of 114 vehicles were fitted with an Advisory ISA device, although only 106 vehicles completed the before and ‘during ISA’ periods of the trial and only 101 vehicles completed the before, during and after ISA periods. Participants included a combination of ‘fleet drivers’ from nine non-government Illawarra businesses and general population ‘private drivers’. Most fleet vehicles were exclusively driven (defined as 80% of the time) by one driver, with a small proportion being driven by multiple drivers. All private vehicles were driven by only one driver throughout the trial.

The trial was conducted in three Illawarra Local Government Areas (LGA’s): Wollongong City, Shellharbour City, and Kiama Municipality. The total length of the road network in the trial area was approximately 2,500 km, containing 4,000 speed signs and 932 speed zones that were mapped for the trial.

The Advisory ISA devices selected for the trial were capable of two-way communication. This functionality allowed automatic speed zone changes to be sent to the device continuously. The ISA device was not calibrated to each vehicle's speedometer, but was calibrated to calculate the speed three per cent higher than determined by the GPS. This three per cent ‘over read’ was designed to match the vehicles speedometer. The device visually displayed the standard regulatory speed sign. When the driver exceeded the speed limit the background of the sign changed from white to red. When the speed limit was exceeded by 3 km/h the device would emit a single high-pitched tone. If the speed limit was exceeded by 5 km/h, or more, this audible warning would increase to a rapid three-tone warning. Drivers were also audibly warned of an approaching curve in the roadway by a voice stating, "curve warning ahead".

A speed data recorder was fitted to the vehicles at least a month before the ISA device was installed. This speed data recorder was used to measure speed behaviour of the vehicles, before, during and after the ISA device was operating in the vehicle. The 'before ISA' data was collected from the middle of August to the end of November 2009, the 'during ISA' data during December (2009), January and February, 2010, and the after ISA data was recorded during March and April, 2010. The speed of the vehicle was measured every 10 seconds, producing a total of 7.5 million speed measurements. Initial work on the data focussed on speeds 75% of the speed limit and greater, an approximation of free speed. Measurements below 75% of the speed limit had not been cleansed and validated and undertaking such a task was considered outside the scope of this project. 2.5 million speed measurements were recorded at speeds above 75% of the speed limit: 493,460 in the 'before ISA' period, 1,280,347 in the 'during ISA' period and 732,185 in the after ISA period. Only the data in the before and 'during ISA' periods was analysed in this report as any latent effect of advisory ISA was not relevant to the aims of this report. The total number of speed measurements used can be seen in Table 1.1 by speed zone. Note that 40, 90 and 110 km/h zones all had relatively few speed measurements. This is especially relevant for 40 km/h; because the speed measurements were time based the distance travelled in 40 km/h zones is much smaller than any other speed zone. For example, 30,000 measurements of 40 km/h taken at 10 second intervals represents 3,333 km of travel but only 15,000 measurements of 80 km/h would be needed to represent the same distance travelled.

Table 1.1
Number of speed measurements by period and speed zone

Speed Limit (km/h)	Before ISA	During ISA
40	15,076	30,663
50	114,089	310,384
60	87,109	233,047
70	41,873	122,821
80	104,259	267,183
90	17,765	47,366
100	92,796	225,676
110	20,493	43,207
Total	493,460	1,280,347

The analyses detailed in this report were conducted to achieve several aims. The first aim was to estimate the reduction in serious and fatal crashes due to advisory ISA in Australia, and to do so at different levels of penetration. The second aim was to determine if the effect of advisory ISA is sensitive to the amount of time the driver is exposed to the advisory ISA device. The final aim was to predict the number of serious and fatal crashes saved by advisory ISA in future years.

For further information on the ISA trial see the report by the New South Wales Centre for Road Safety (2010).

2 Methods

2.1 Crash reductions due to ISA

The benefit of ISA flows from reductions in travelling speed, which in turn reduces the risk of being involved in a crash. In order to use the speed measurements from the New South Wales ISA trial to calculate a change in risk, the measurements were weighted by speed to produce distance-based measurements. Distance-based measurements are preferred over time-based measurements because the risk functions used in this study are interpretable as a risk per distance travelled rather than a risk per time spent travelling. This is the approach taken in several other ISA studies (Lai, Chorlton and Carsten, 2007; Madsen, 2002; Várhelyi and Mäkinen, 2001). Speeds were recorded in the New South Wales ISA trial to the nearest mile-per-hour (mph). The percentage of distance spent at each speed was calculated for the ‘before ISA’ period and the ‘during ISA’ period by speed zone.

It should be noted that speeds below 75% of the speed limit were not included in the data. The lack of data at lower speeds is of little consequence: the potential error in the estimate of benefit is in the order of only 2% because of the exponential nature of the speed - crash risk relationship.

The difference in crash risk between two speed distributions can be calculated by applying a crash risk function to each distribution. One of the widely recognised studies on the relationship between travel speed and crash risk was conducted in Australia by Kloeden, et al. (1997) and was further developed in Kloeden, Ponte and McLean (2001) and Kloeden, McLean and Glonek (2002). The relationships expounded in these analyses are widely accepted in the road safety community, and they have been applied to determining the benefits of ISA previously (Tate and Carsten, 2008; Doecke and Woolley, in press). Relevant in the present context is that they are based on Australian crashes. For this study, the risk curve was capped above 80 km/h in 40, 50, 60 and 70 km/h zones and at 30 km/h above the mean speed in 80, 100 and 110 km/h zones to minimise the impact of small, potentially variable, amounts of high level speeding. The validity of risk curves above these values is also uncertain, but the end result in this study will be a conservative estimate of benefit. The risk curves for travel speed as used in this analysis can be seen in Figures 2.1 and 2.2. The risk curve from these studies in low speed zones (40 to 70km/h) gives the risk at a given travelling speed relative to the risk if the travelling speed was 60 km/h; hence the relative risk at 60 km/h is one. In high-speed zones (80km/h and above) the risk is given relative to the mean speed of vehicles. Interpreting Figure 2.1 practically, if you are travelling in a low speed zone at 65 km/h you are about twice as likely to be involved in a casualty crash than if you were travelling at 60 km/h. If your speed increases to 80 km/h your risk of being involved in a casualty crash is now almost 18 times higher than if you were travelling at 60 km/h.

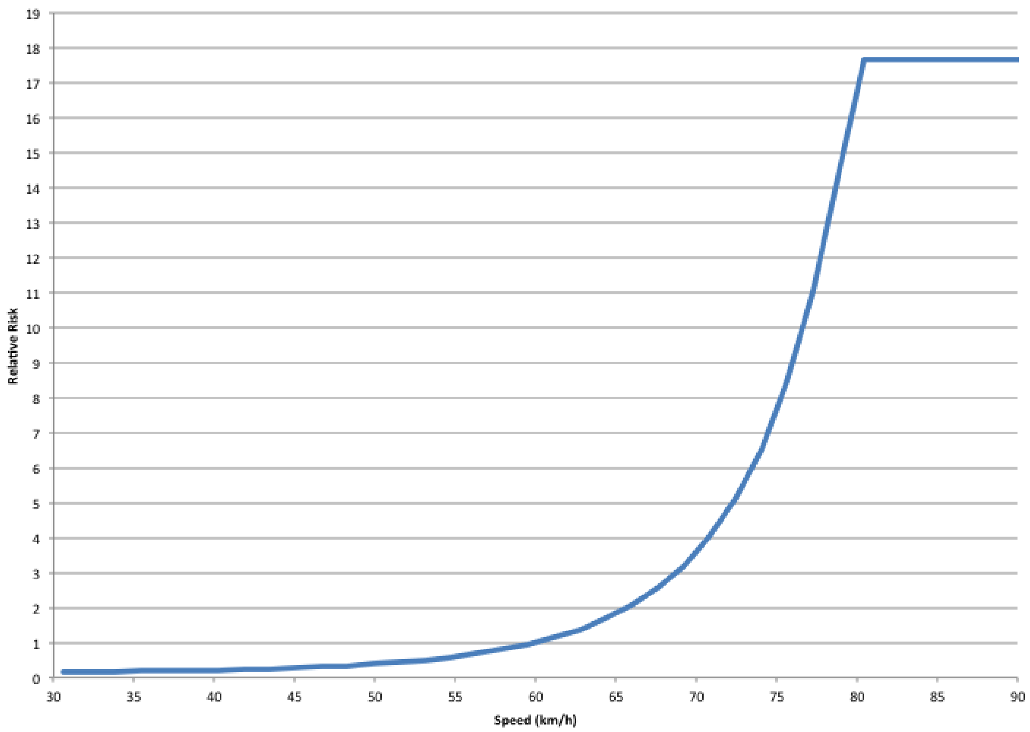

Figure 2.1
Risk curve for 40, 50, 60 and 70 km/h zones

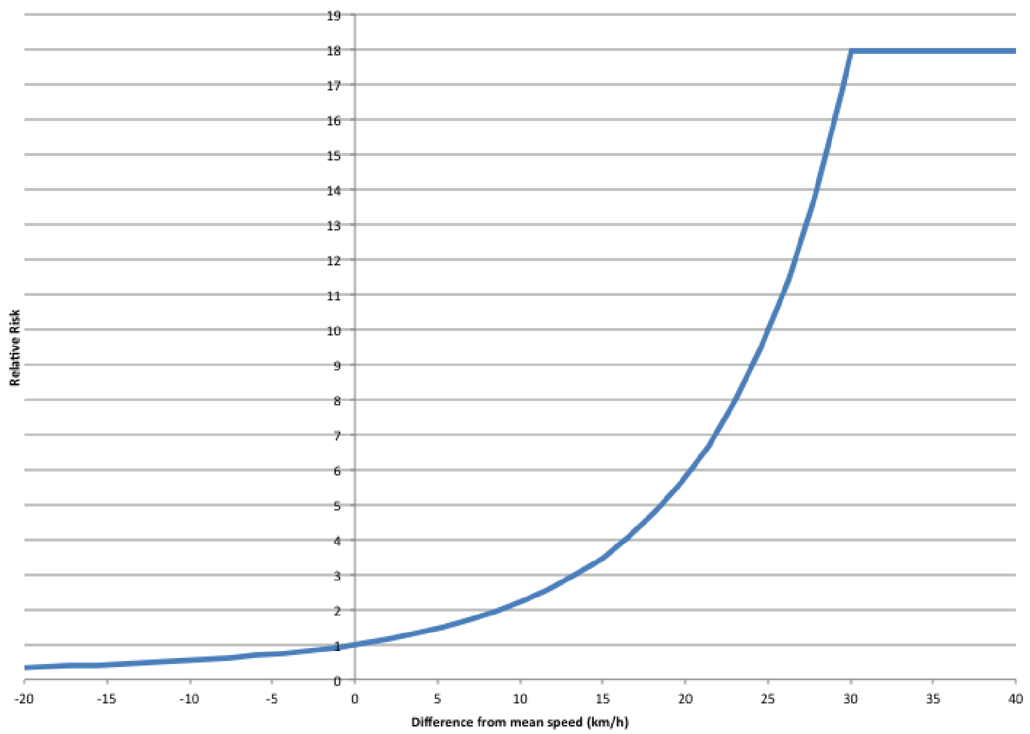

Figure 2.2
Risk curve for speed limits of 80km/h and above

The reduction in crash risk due to ISA was then calculated thus:

- The ISA and non-ISA speed distribution of the vehicles in the New South Wales trial was multiplied by the relevant risk curve. This was done for every speed zone speed distribution in the New South Wales trial. The result was a risk curve weighted by prevalence of each speed in the distribution.
- The total relative risk for each distribution was the weighted risk curve summed over all speeds in the distribution.
- The difference in the total relative risks for the ISA and non-ISA distributions was then used to estimate the reduction in relative risk brought about by the use of ISA.
- Multiplying the crash reduction in a given speed zone by the number of crashes of a particular severity in that speed zone produced the crash savings in that speed zone. By summing the crash savings and dividing by the total number of crashes (of a given severity) the overall percentage crash reduction produced by advisory ISA was estimated.

The crash savings were calculated individually for each state and territory and for Australia as a whole. This required crash data from each state and territory with speed zone and injury severity information. New South Wales is the only state or territory in Australia that does not differentiate between serious and minor injuries in their police reported crash data. To arrive at an estimate of serious and minor injuries for New South Wales the ratio of serious to minor injuries reported in the Bureau of Infrastructure, Transport, Regional Economics' (BITRE) report on road crashes costs in Australia (BITRE, 2009) was used. The Australian Capital Territory does not record the speed zones of crashes. To estimate the number of crashes saved with advisory ISA in the Australian Capital Territory the percentage reduction found in the other states and territories was applied to the total number of crashes, of a given severity, that occurred in the Australian Capital Territory.

BITRE calculated the cost of crashes in Australia in 2006 (BITRE, 2009). BITRE's estimated the average cost per crash by determining the overall costs of crashes and dividing by the number of crashes. It should be noted that BITRE's estimates of crash numbers far exceed those reported to police, and hence BITRE's crash costs should be multiplied by an under-reporting factor when applied to crash savings based on police reported crashes (as is the case in this report). For more discussion on this topic see Doecke, Woolley and Anderson (2010). The cost of a crash as reported by BITRE was converted to 2010 dollars using the consumer price index reported by the ABS (ABS, 2011). The overall cost per police reported crash calculated from BITREs report were determined to be $438,333 for a serious injury crash (hospitalised) and $2,988,011 for a fatal crash. The crash cost savings attributable to advisory ISA were calculated by multiplying these crash costs by the crash savings.

2.2 Sensitivity of advisory ISA effect to time

The effect of advisory ISA may be sensitive to the length of time drivers are exposed to the device. This effect may be positive: the longer the drivers are exposed to the advisory ISA device the more responsive to it they become and therefore they adhere to the speed limit more frequently; or negative: the longer the drivers are exposed to the advisory ISA device the more they learn to ignore the warnings it gives, or simply switch it off altogether. In this analysis the length of time the device was installed in the vehicle was used to approximate the drivers' exposure to the device. The sensitivity of the advisory ISA effect to time was tested over the 'during ISA' period.

To test the sensitivity of the effect of advisory ISA to time, the data from the period in which ISA was activated was grouped by week. Grouping by month was thought to provide too few data points to analyse and grouping by day was thought to produce too much variability in travel patterns. It was hoped that grouping by week would produce consistent travel patterns between the groups. The time of year that the trial was conducted (December to February) complicates this; it is a typical holiday period where a person's driving habits may differ from a regular weekly routine. Despite this, grouping by week was still considered to be the best option.

Two measures of the effect of ISA were used; changes in mean speed and changes in percentage of distance travelled over the speed limit. The percentage of distance travelled over the speed limit was disaggregated into three groups; percentage of distance travelled speeding by 5 km/h or less, percentage of distance spent speeding by more than 5 km/h up to speeding by 10 km/h, and speeding by more than 10 km/h.

The change in these measures over the 12-week period was determined by calculating the slope of a fitted linear trend line for each vehicle. The mean of these slopes was then calculated and the upper and lower 95th percentile confidence values determined. If the 95th percentile confidence interval included zero it was concluded that no sensitivity of effect of advisory ISA to time could be found over the 12-week period being considered.

This process was conducted for the sample of drivers as a whole and also by disaggregating the drivers in several ways. Drivers were disaggregated by; vehicle ownership, age group, gender, licence type, regularity with which the driver turned the ISA device off, comfort adapting to new technology, propensity to speed when unlikely to be caught, repetition of speeding, and intention to speed. When comparing groups of drivers a real difference in sensitivity of the effect of advisory ISA could only be concluded if the confidence intervals of the two groups being considered did not overlap.

2.3 Predicted crash reductions

To predict crash reduction in 2015, 2020 and 2030 some estimation of the change in crashes over time was required. For fatal crashes this was achieved by using the average annual per cent change found in the December 2010 Road Deaths Australia bulletin (BITRE, 2011). BITRE calculated the average annual per cent change by fitting an exponential trend line to the last six data points, which represent year 0 (2005) to year 5 (2010). A similar methodology was applied to serious crash data, with a couple of variations. An exponential trend line was fitted to serious crash data from 2004 to 2008, one less data point than was used for fatal crashes and a different time span.

The predicted crash reductions were then calculated by multiplying the predicted number of serious and fatal crashes in Australia in 2015, 2020 and 2030 by the percentage reduction in crashes produced by ISA, calculated by the method described in Section 2.1.

3 Results

3.1 Crash reductions due to ISA

3.1.1 40 km/h zones

The speed distributions in 40 km/h zones in the 'before ISA' period and 'during ISA' periods are shown in Figure 3.1.

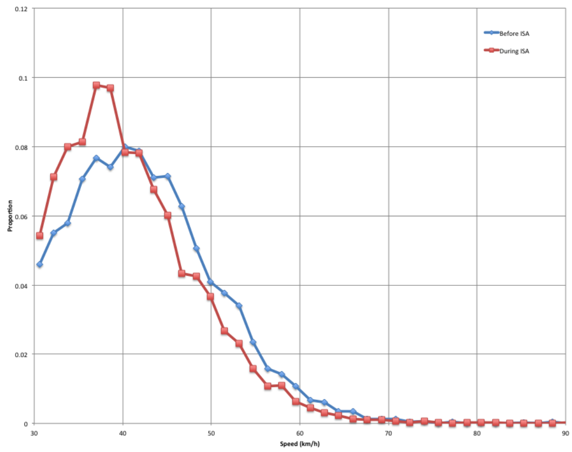

Figure 3.1
The distribution of speeds in 40 km/h zones,
'before ISA' and 'during ISA' periods

The risk curves weighted (multiplied) by the speed distributions for 40 km/h zones are shown in Figure 3.2. Note that a high degree of 'noise' is seen in the values graphed in Figure 3.2, especially at speeds above 65 km/h. This is a result of a low number of measurements being multiplied by a high level of risk, relative to the risk at the speed zone. This 'noise' above 65 km/h contributes 19% of the total 'before ISA' risk and 18% of the total 'during ISA' risk.

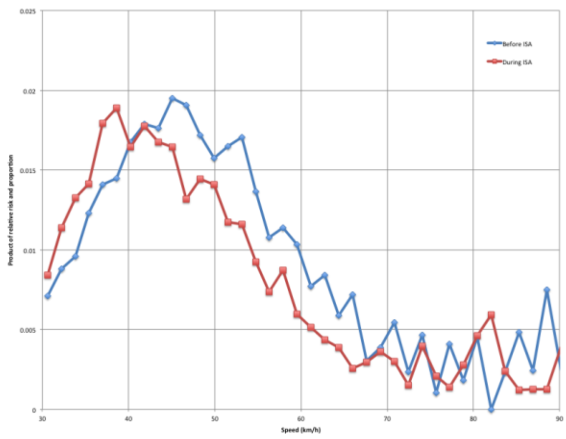

Figure 3.2
The sum of the risk curve and the speed distributions
for 40 km/h zones, ‘before ISA’ and ‘during ISA’ periods

The difference in casualty crash risk between the ‘before ISA’ and ‘during ISA’ periods was found to be 12.1%. As discussed above, the risk curve weighted (multiplied) by the speed distributions contained a high degree of noise at speeds above 65 km/h that contributed to around a fifth of the total risk. If only speeds below 65 km/h are considered the difference in casualty crash risk between the ‘before ISA’ is 10.8%.

3.1.2 50 km/h zones

The speed distributions in 50 km/h zones in the ‘before ISA’ and ‘during ISA’ periods are shown in Figure 3.3. The sum of the risk curve and the speed distributions for 50 km/h zones are shown in Figure 3.4. The difference in casualty crash risk between the ‘before ISA’ and ‘during ISA’ periods was found to be 16.6%.

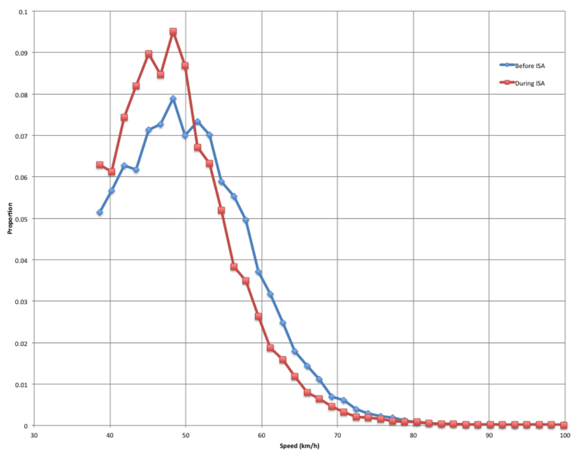

Figure 3.3
The distribution of speeds in 50 km/h zones,
‘before ISA’ and ‘during ISA’ periods

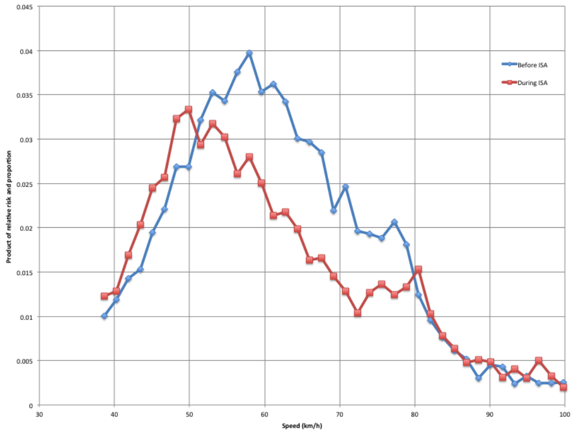

Figure 3.4
The sum of the risk curve and the speed distributions
for 50 km/h zones, 'before ISA' and 'during ISA' periods

3.1.3 60 km/h zones

The speed distributions in 60 km/h zones in the 'before ISA' and 'during ISA' periods are displayed in Figure 3.5. Figure 3.6 shows the sum of the risk curve and the speed distributions for 60 km/h zones.

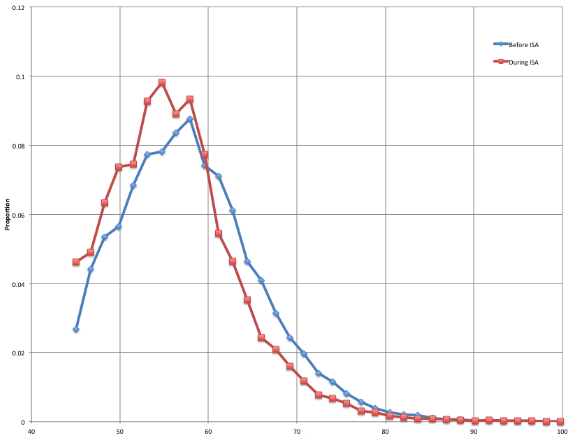

Figure 3.5
The distribution of speeds in 60 km/h zones,
'before ISA' and 'during ISA' periods

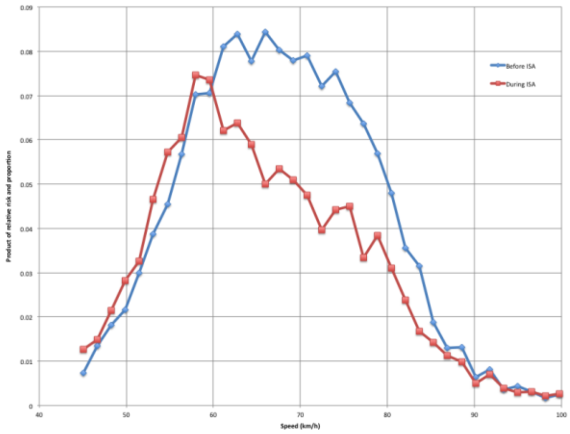

Figure 3.6
The sum of the risk curve and the speed distributions
for 60 km/h zones, 'before ISA' and 'during ISA' periods

The difference in casualty crash risk between the 'before ISA' and 'during ISA' periods was found to be 21.9%.

3.1.4 70 km/h zones

The speed distributions in 70 km/h zones in the ‘before ISA’ and ‘during ISA’ periods are displayed in Figure 3.7. Figure 3.8 shows the sum of the risk curve and the speed distributions for 70 km/h zones.

The difference in casualty crash risk between the ‘before ISA’ and ‘during ISA’ periods was found to be 25.4%.

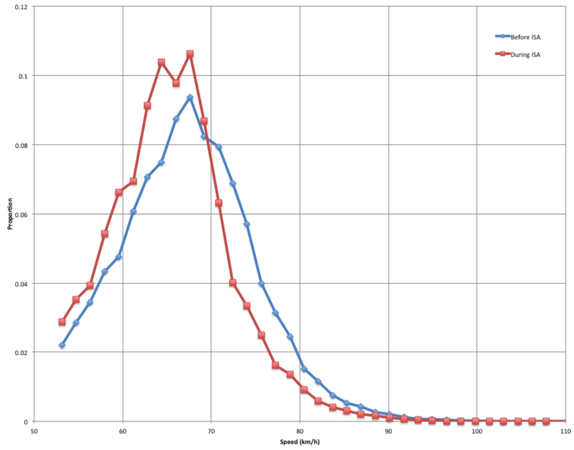

Figure 3.7
The distribution of speeds in 70 km/h zones,
‘before ISA’ and ‘during ISA’ periods

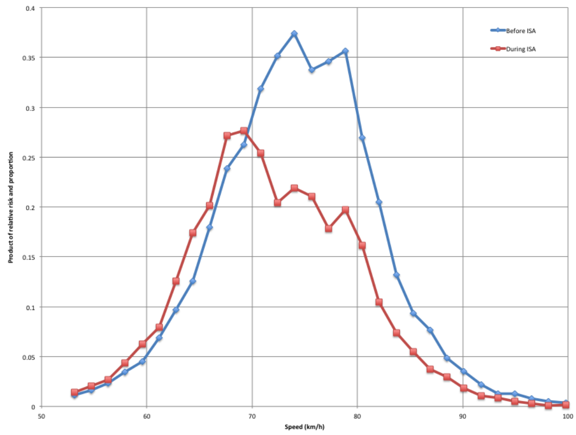

Figure 3.8
The sum of the risk curve and the speed distributions
for 70 km/h zones, ‘before ISA’ and ‘during ISA’ periods

3.1.5 80 km/h zones

The speed distributions in 80 km/h zones in the ‘before ISA’ and ‘during ISA’ periods are displayed in Figure 3.9

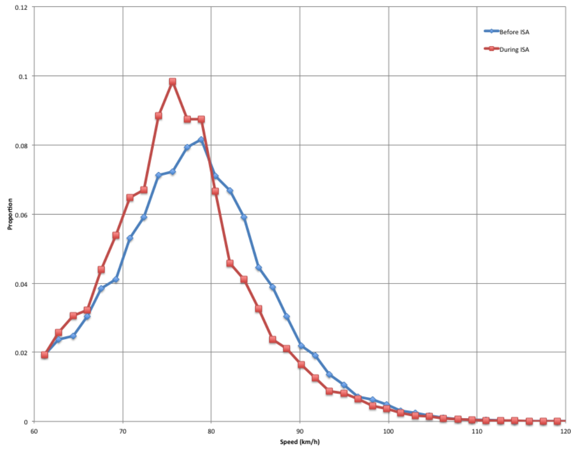

Figure 3.9
The distribution of speeds in 80 km/h zones,
‘before ISA’ and ‘during ISA’ periods

Figure 3.10 displays the sum of the risk curve and the speed distributions for 80 km/h zones. The difference in casualty crash risk between the ‘before ISA’ and ‘during ISA’ periods was found to be 11.7%.

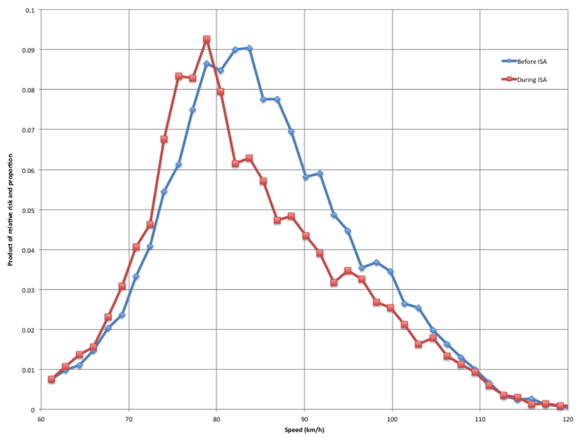

Figure 3.10
The sum of the risk curve and the speed distributions
for 80 km/h zones, ‘before ISA’ and ‘during ISA’ periods

3.1.6 90 km/h zones

The speed distributions in 90 km/h zones in the 'before ISA' and 'during ISA' periods are displayed in Figure 3.11.

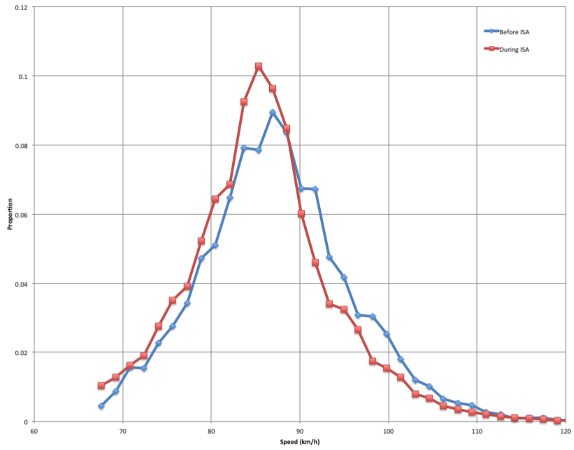

Figure 3.11
The distribution of speeds in 90 km/h zones,
'before ISA' and 'during ISA' periods

Figure 3.12 shows the sum of the risk curve and the speed distributions for 90 km/h zones.

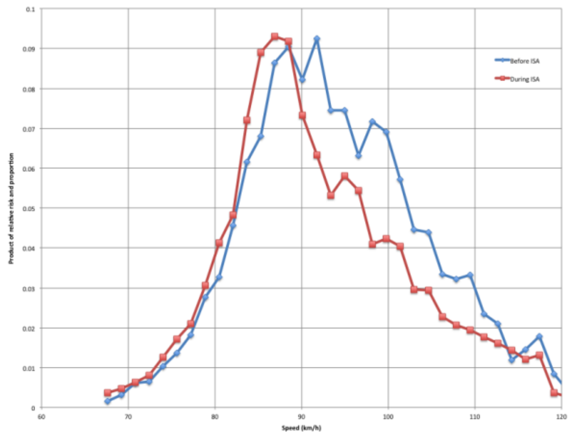

Figure 3.12
The sum of the risk curve and the speed distributions
for 90 km/h zones, 'before ISA' and 'during ISA' periods

The difference in casualty crash risk between the 'before ISA' and 'during ISA' periods was found to be 13.6%.

3.1.7 100 km/h zones

The speed distributions in 100 km/h zones in the ‘before ISA’ and ‘during ISA’ periods are displayed in Figure 3.7. Figure 3.8 shows the sum of the risk curve and the speed distributions for 100 km/h zones.

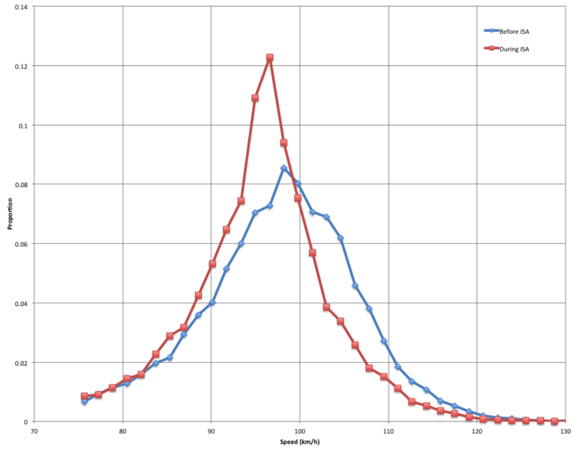

Figure 3.13
The distribution of speeds in 100 km/h zones, ‘before ISA’ and ‘during ISA’ periods

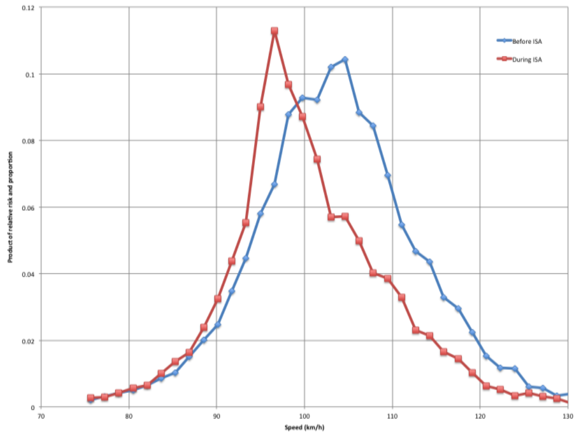

Figure 3.14
The sum of the risk curve and the speed distributions for 100 km/h zones, ‘before ISA’ and ‘during ISA’ periods

The difference in casualty crash risk between the ‘before ISA’ and ‘during ISA’ periods was found to be 18.8%.

3.1.8 110 km/h zones

The speed distributions in 110 km/h zones in the 'before ISA' and 'during ISA' periods are displayed in Figure 3.11. Figure 3.12 shows the sum of the risk curve and the speed distributions for 110 km/h zones.

The difference in casualty crash risk between the 'before ISA' and 'during ISA' periods was found to be 23.6%.

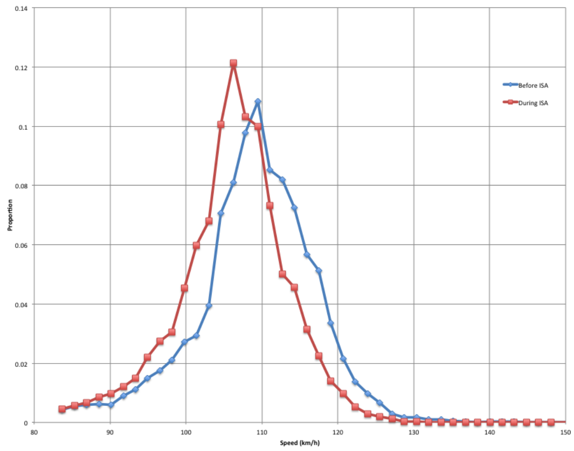

Figure 3.15
The distribution of speeds in 110 km/h zones, 'before ISA' and 'during ISA' periods

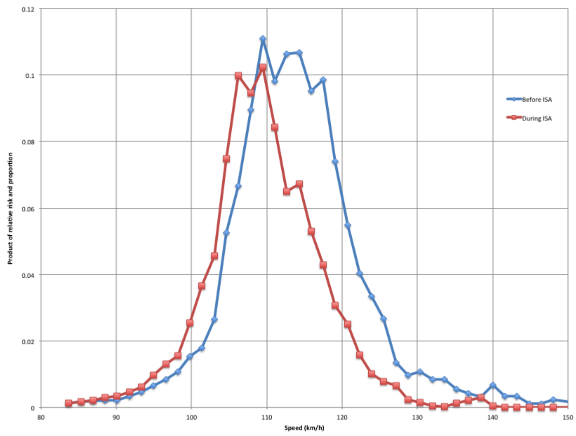

Figure 3.16
The sum of the risk curve and the speed distributions for 110 km/h zones, 'before ISA' and 'during ISA' periods

3.1.9 Overall crash reductions due to ISA

The percentage reductions in casualty crashes by speed zone produced by advisory ISA are shown in Table 3.1.

Table 3.1
Percentage reduction in casualty crash risk produced by advisory ISA, by speed zone

Speed Limit	Crash risk reduction
40	12.1%
50	16.6%
60	21.9%
70	25.4%
80	11.7%
90	13.7%
100	18.8%
110	23.6%

The percentage reductions shown in Table 3.1 were multiplied by the average number of serious (hospitalised) and fatal crashes per year from 2004 to 2008 to calculate the total crash reductions that may be achieved if every vehicle in the Australian states was equipped with advisory ISA. The serious casualty crash reductions, and overall percentage reductions are shown by state in Table 3.2. The percentage reductions only include crashes in the speed zones listed. In all states and territories except the Northern Territory this excludes very few crashes. The Northern Territory had a unique open speed limit on certain roads before 2007 when the speed limits on these roads were changed to either 110 or 130 km/h. About 10% of serious crashes and 9 to 15% of fatal crashes in the Northern Territory occurred on 130 km/h roads in 2007 and 2008. Undoubtedly advisory ISA applied to 130 km/h roads would produce a safety benefit but this cannot be determined from the NSW ISA trial data. Note also that Australian Capital Territory does not record the speed zones of crashes therefore only total crash reductions could be calculated. As a result the total crashes saved in the bottom right corner of Table 3.2 is the sum of the total row, not the total column. The percentage reduction in serious crashes is consistently around 19% in every state. Overall, it is estimated that 3,310 serious crashes could be saved if all vehicles in the states were fitted with advisory ISA.

Table 3.2
Serious casualty crash reductions per year produced by advisory ISA in Australian states

Speed Limit	State								Total
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
40	-	3.6	1.2	9.0	1.0	0.3	11.7	1.6	28.3
50	-	121.3	4.5	108.9	39.3	6.6	163.5	100.2	544.3
60	-	179.9	21.9	514.1	72.9	10.7	431.6	131.4	1362.4
70	-	53.6	6.9	82.2	5.3	2.2	130.1	86.9	367.2
80	-	21.0	7.8	59.5	12.2	3.7	85.8	23.4	213.3
90	-	5.1	0.7	5.4	1.0	0.0	6.1	9.4	27.6
100	-	45.3	7.2	186.2	30.4	20.3	219.8	33.2	542.4
110	-	14.8	5.6	22.1	37.2	3.4	14.2	57.2	154.4
Total	70.0	444.5	55.7	987.4	199.2	47.2	1062.8	443.2	3310.0

Percentage Reduction	19.3%	19.2%	18.7%	19.6%	19.3%	18.6%	19.1%	19.7%	19.3%

The fatal crash reductions and overall percentage reductions are shown in Table 3.3. The percentage reduction in fatal crashes is consistently around 19% in every state, as was the case for serious casualty crashes. Overall, it is estimated that 265 fatal crashes could be saved per year if advisory ISA were to be installed in all vehicles.

Table 3.3
Fatal crash reductions per year produced by advisory ISA in Australian states

Speed Limit	State								Total
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
40	-	0.4	0.1	0.4	0.0	0.0	0.3	0.1	1.3
50	-	11.4	0.3	3.9	1.5	0.5	3.8	5.4	26.8
60	-	16.9	1.5	18.0	5.8	1.1	12.6	5.2	61.2
70	-	7.4	0.6	3.5	0.7	0.4	5.5	4.4	22.5
80	-	7.1	0.8	5.1	1.6	0.6	5.0	2.2	22.4
90	-	2.1	0.0	0.4	0.4	0.1	0.8	1.5	5.1
100	-	26.4	1.3	23.4	6.1	3.8	25.6	3.8	90.5
110	-	7.0	1.8	2.3	5.2	1.8	2.3	12.1	32.5
Total	2.9	78.8	6.5	56.8	21.4	8.4	55.9	34.6	265.3
Percentage Reduction	18.9%	18.5%	19.1%	18.8%	19.5%	19.1%	18.7%	19.8%	18.9%

The crash reductions and monetary savings by penetration of advisory ISA into the vehicle fleet are shown for all of Australia in Table 3.4 and only for New South Wales in Table 3.5. These results assume a linear relationship between level of ISA penetration and crash reduction. In reality vehicles equipped with ISA may slow some vehicles not equipped with ISA, producing a non-linear relationship. Research seeking to answer this question was undertaken concurrently with this report (Searson, Woolley and Crotty, in press) but was outside the scope of this report. Even at modest penetration levels advisory ISA produces substantial crash and monetary savings.

Table 3.4
Serious and fatal crash reductions per year produced by advisory ISA in Australia, by penetration level

Penetration of ISA	Serious Injury Crashes			Fatal Crashes			Total Savings ($M)
	Number	Percentage	Savings ($M)	Number	Percentage	Savings	
20%	662.0	3.9%	290.2	53.1	3.8%	158.5	448.7
40%	1324.0	7.7%	580.4	106.1	7.6%	317.1	897.4
60%	1986.0	11.6%	870.5	159.2	11.3%	475.6	1346.1
80%	2648.0	15.5%	1160.7	212.2	15.1%	634.1	1794.8
100%	3310.0	19.3%	1450.9	265.3	18.9%	792.6	2243.5

Table 3.5
Serious and fatal crash reductions per year produced by advisory ISA in New South Wales, by penetration level

Penetration of ISA	Serious Injury Crashes			Fatal Crashes			Total Savings ($M)
	Number	Percentage	Savings ($M)	Number	Percentage	Savings ($M)	
20%	88.9	3.8%	39.0	15.8	3.7%	47.1	86.1
40%	177.8	7.7%	77.9	31.5	7.4%	94.2	172.1
60%	266.7	11.5%	116.9	47.3	11.1%	141.2	258.2
80%	355.6	15.4%	155.9	63.0	14.8%	188.3	344.2

100%	444.5	19.2%	194.9	78.8	18.5%	235.4	430.3

3.2 Sensitivity of advisory ISA effect to time

The sensitivity of the advisory ISA effect to time in use was tested over the 12 complete weeks of the 'during ISA' period. This was tested for the sample of drivers as a whole and also by disaggregating the drivers in several ways. Table 3.6 shows the sensitivity of the effect of ISA on percentage of distance travelled over the speed limit by up to 5km/h to time. The change is expressed as a per year change for ease of viewing and application. For example, a value of one in Table 3.6 represents a reduction of one percentage point per year in the percentage of distance travelled over the speed limit by up to 5 km/h. Note that the number of drivers within a category, such as licence type, may not equal the total amount of drivers (102), as some driver variables were unknown. No sensitivity of the effect of ISA on percentage of distance travelled over the speed limit by up to 5 km/h to time was found when considering all the drivers, or any category shown in Table 3.6.

Table 3.6
Sensitivity of the effect of advisory ISA on percentage of distance travelled over the speed limit by up to 5 km/h to time

		Change in percentage of distance spent over the speed limit by up to 5 km/h per year			Number of drivers
		Mean	Upper 95th	Lower 95th	
Overall		-1.42	3.95	-6.80	102
Owner of vehicle	Fleet	1.96	8.59	-4.67	40
	Private	-3.60	4.34	-11.54	62
Age Group	25 or under	-9.08	3.91	-22.06	30
	26-29	22.02	51.82	-7.78	3
	30-39	-2.30	19.79	-24.38	8
	40-49	2.42	11.30	-6.46	28
	50-59	3.22	13.24	-6.79	24
	60+	-7.28	12.24	-26.79	9
Gender	Male	1.36	9.17	-6.44	44
	Female	-3.53	4.12	-11.18	58
Licence type	P1	-4.74	3.30	-12.77	7
	P2	-4.78	10.01	-19.56	12
	Full	-0.47	6.00	-6.94	82
Turn off ISA regularly	Yes	-1.75	6.77	-10.26	10
	No	-1.62	4.48	-7.72	90
Extremely comfortable adapting to new technology	Yes	-1.75	6.77	-10.26	45
	No	-1.62	4.48	-7.72	48
Speed when unlikely to be caught	Yes	1.11	9.37	-7.14	42
	No	-3.62	4.10	-11.34	58
Repeat Speeder	Yes	1.11	9.37	-7.14	19
	No	-3.62	4.10	-11.34	83
Deliberate speeder	Yes	1.10	16.10	-13.90	11
	No	-1.73	4.17	-7.62	91

The sensitivity of the effect of ISA on percentage of distance travelled between 5 and 10 km/h over the speed limit to time is shown in Table 3.7. Once again no sensitivity to time was found.

Table 3.7
Sensitivity of the effect of advisory ISA on percentage of distance travelled 5 - 10 km/h over the speed limit to time

		Change in percentage of distance spent 5 -10 km/h over the speed limit per year			Number of drivers
		Mean	Upper 95th	Lower 95th	
Overall		-2.08	1.88	-6.04	102
Owner	Fleet	0.19	6.10	-5.72	40
	Private	-3.54	1.93	-9.01	62
Age Group	25 or under	-3.85	6.58	-14.27	30
	26-29	-11.53	52.21	-75.27	3
	30-39	-5.02	7.33	-17.37	8
	40-49	1.79	9.32	-5.75	28
	50-59	-1.18	5.02	-7.37	24
	60+	-4.85	0.59	-10.30	9
Gender	Male	0.92	5.89	-4.06	44
	Female	-4.35	1.65	-10.35	58
Licence type	P1	2.24	17.43	-12.95	7
	P2	-7.49	9.75	-24.73	12
	Full	-1.84	2.49	-6.17	82
Turn off ISA regularly	Yes	2.18	18.23	-13.86	10
	No	-2.76	1.46	-6.99	90
Extremely comfortable adapting to new technology	Yes	2.18	18.23	-13.86	45
	No	-2.76	1.46	-6.99	48
Speed when unlikely to be caught	Yes	-0.26	7.06	-7.58	42
	No	-3.72	1.03	-8.47	58
Repeat Speeder	Yes	-0.26	7.06	-7.58	19
	No	-3.72	1.03	-8.47	83
Deliberate speeder	Yes	8.05	24.52	-8.42	11
	No	-3.30	0.78	-7.39	91

The sensitivity of the effect of ISA on percentage of distance travelled more than 10 km/h over the speed limit to time is shown in Table 3.8. While no sensitivity to time was found, it can be seen that for drivers who are not deliberate speeders a reduction of zero per cent per year is only just within the confidence intervals. Note also that the mean change per year within this category was negative.

Table 3.8
Sensitivity of the effect of advisory ISA on percentage of distance travelled more than 10 km/h over the speed limit to time

		Change in percentage of distance spent more than 10 km/h over the speed limit per year			Number of drivers
		Mean	Upper 95th	Lower 95th	
Overall		-2.55	1.81	-6.92	102
Owner	Fleet	-2.80	4.18	-9.78	40
	Private	-2.39	3.45	-8.24	62
Age Group	25 or under	-4.61	8.04	-17.26	30
	26-29	-21.69	81.53	-124.91	3
	30-39	-7.00	7.47	-21.47	8
	40-49	1.10	7.61	-5.41	28
	50-59	-0.19	3.96	-4.35	24
	60+	-3.02	2.01	-8.06	9
Gender	Male	1.06	4.47	-2.35	44
	Female	-5.29	2.05	-12.64	58
Licence type	P1	8.17	28.18	-11.85	7
	P2	-12.59	12.99	-38.17	12
	Full	-2.23	1.85	-6.30	82
Turn off ISA regularly	Yes	-0.68	21.75	-23.11	10
	No	-3.03	1.41	-7.47	90
Extremely comfortable adapting to new technology	Yes	-0.68	21.75	-23.11	45
	No	-3.03	1.41	-7.47	48
Speed when unlikely to be caught	Yes	-2.90	6.43	-12.22	42
	No	-2.72	1.19	-6.64	58
Repeat Speeder	Yes	-2.90	6.43	-12.22	19
	No	-2.72	1.19	-6.64	83
Deliberate speeder	Yes	12.94	29.47	-3.59	11
	No	-4.42	0.07	-8.92	91

The sensitivity of the effect ISA had on mean speed to time was also tested. To combine data from all speed zones the mean difference from the speed limit was used. The results are shown in Table 3.9. Once again, no sensitivity to time can be concluded from these results.

Table 3.9
Sensitivity of the effect of advisory ISA on mean difference from the speed limit to time

		Change in mean difference from the speed limit per year			Number of drivers
		Mean	Upper 95th	Lower 95th	
Overall		-1.26	0.86	-3.38	102
Owner	Fleet	-1.06	2.02	-4.14	40
	Private	-1.38	1.59	-4.36	62
Age Group	25 or under	-2.97	2.87	-8.81	30
	26-29	-3.09	35.94	-42.13	3
	30-39	-2.01	3.95	-7.97	8
	40-49	-0.13	3.57	-3.83	28
	50-59	0.44	3.37	-2.50	24
	60+	-2.29	2.26	-6.84	9
Gender	Male	0.31	2.54	-1.91	44
	Female	-2.45	0.95	-5.85	58
Licence type	P1	3.56	8.99	-1.88	7
	P2	-5.07	4.79	-14.92	12
	Full	-1.17	1.12	-3.46	82
Turn off ISA regularly	Yes	0.54	7.60	-6.52	10
	No	-1.60	0.70	-3.90	90
Extremely comfortable adapting to new technology	Yes	0.54	7.60	-6.52	45
	No	-1.60	0.70	-3.90	48
Speed when unlikely to be caught	Yes	-0.89	2.76	-4.55	42
	No	-1.74	1.00	-4.48	58
Repeat Speeder	Yes	-0.89	2.76	-4.55	19
	No	-1.74	1.00	-4.48	83
Deliberate speeder	Yes	3.91	11.57	-3.75	11
	No	-1.88	0.35	-4.12	91

3.3 Projected crash reductions

To project crash reduction in 2015, 2020 and 2030 some estimation of the change in crashes over time is required. The current trend in fatal crashes was determined to be a 3.3% reduction per year. For serious crashes the current trend was determined to be a 1.6% increase per year. As no evidence was found that the effect of advisory ISA was sensitive to the length of time it had been installed in the driver's vehicle no modifier of the percentage reduction of crashes was needed. The number of crashes saved if all vehicles were equipped with advisory ISA in future years are shown in Table 3.10.

Table 3.10
Serious and fatal crash savings produced if all vehicles were equipped with advisory ISA in future years

Year	Serious crash savings	Fatal crash savings
2015	3872.8	219.3
2020	4190.0	203.8
2030	4904.5	175.9

4 Discussion

The reduction in risk found by speed zone (Table 3.1) increased from 40 km/h zones to 70 km/h zones, reduced from 70 km/h to 80 km/h and then increased again to 110 km/h. As different risk curves were used for 40 to 70 km/ zones and 80 to 110 km/h zones this represents an increase in risk reduction with increasing speed limit for a given risk curve used.

The analysis in this report assumes that the effect of advisory ISA on the drivers of the vehicles in the New South Wales ISA trial in Illawarra, New South Wales, is representative of the effect that advisory ISA would have on the drivers of vehicles across Australia. It should be noted that this represents an improvement over previous work that, by necessity, relied on the results of international trials.

The overall crash reduction for serious and fatal crashes produced by advisory ISA were found to be 19.3% and 18.9% respectively. This is higher than previous estimations based on an international trial that found reductions of 8.3% for serious crashes and 11% for fatal crashes (Doecke, Woolley and Anderson, 2010). Doecke, Woolley and Anderson (2010) found that these lower crash reductions would produce benefit-cost ratios (BCRs) of around two if the device used in the New South Wales ISA trial was installed on all vehicles. Given the crash reductions found in this report are around twice as high the BCR may actually be much higher.

It was noted that 40 km/h zones had a high degree of 'noise' in the risk curve weighted by the speed distribution. Such noise reduces the confidence in the percentage risk reduction (12.1%) determined for 40 km/h zones. The estimated crash savings produced by advisory in 40 km/h zones represent less than one per cent of the overall crash savings; therefore any uncertainty in percentage risk reduction in 40 km/h zones has a negligible effect on the overall reductions found.

No evidence was found that the effect of advisory ISA was sensitive to time. This may be largely due to a considerable amount of variance between drivers, even when grouped by common attributes. A greater number of drivers may have reduced the size of the confidence intervals and assisted in identifying significant trends.

The time of year the 'during ISA' period was conducted (December to February) may have hindered identifying a sensitivity to time in the effect of advisory ISA. School holidays occurring during about half of this period may have altered typical travel and travel speed patterns. Even drivers who do not have school children may be more likely to take holidays around this time of year, and therefore alter their travel and travel speed patterns.

It was found that advisory ISA would produce significant crash savings well into the future. This assumed that crashes will continue to change at the rate they have over the past 4 or 5 years. The accuracy of these numbers is therefore dependant upon the suitability of trends seen over these past years to predict the number of serious and fatal crashes in 5, 10 and 20 years time.

For advisory ISA to be successfully implemented on all vehicles speed limit maps are required. Currently speed limit maps used by ISA devices cover major cities, some rural centres, and major interconnecting highways. The coverage of the commercial speed limit maps is ever increasing. The exact coverage may vary from device to device, depending on the map provider the device uses. Most states are progressing towards producing completed speed limit maps, with Victoria and WA being completed already. Achieving the benefits of advisory ISA identified in this report is dependant upon the completion of national speed limit maps.

5 Conclusions

The analysis conducted for this report estimated that advisory ISA has the potential to reduce serious crashes by 19.3% and fatal crashes by 18.9% in Australia.

No evidence was found that the effect of advisory ISA is sensitive to the length of time it is installed in the driver's vehicle.

In 2015 the estimated crash reductions produced by advisory ISA would represent 3,873 serious crashes and 219 fatal crashes, in 2020 4,190 serious crashes and 204 fatal crashes and by 2030 4,905 serious crashes and 176 fatal crashes in Australia.

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References

ABS (2011). Consumer Price Index, Australia, Dec 2010. 6401.0. Canberra: Australian Bureau of Statistics.

BITRE (2009). Cost of road crashes in Australia 2006. BITRE118, Canberra: Bureau of Infrastructure, Transport and Regional Economics.

BITRE (2011). Road deaths Australia: December 2010. Canberra: Bureau of Infrastructure, Transport and Regional Economics.

Searson DJ, Woolley JE, Crotty S (in press). An exploratory study to determine if a critical mass exists for intelligent speed adaptation. Adelaide: Centre for Automotive Safety Research.

Doecke S, Woolley J and Anderson RWG (2010) 'Cost benefit analysis of intelligent speed adaptation' in Proceedings of the 2010 Australasian Road Safety Research, Policing and Education Conference, Canberra, Australia, 31 August – 3 September 2010.

Doecke S and Woolley JE (in press). Cost benefit analysis of intelligent speed assist. Adelaide: Centre for Automotive Safety Research.

Kloeden CN, McLean AJ, Moore VM, Ponte G (1997) Travelling speed and the risk of crash involvement, CR172, Canberra: Federal Office of Road Safety, Transport and Communications.

Kloeden CN, Ponte G, McLean AJ (2001) Travelling speed and the risk of crash involvement on rural roads, CR 204, Adelaide: Road Accident Research Unit for Canberra: Australian Transport Safety Bureau.

Kloeden CN, McLean AJ, Glonek G (2002) Reanalysis of travelling speed and the risk of crash involvement in Adelaide South Australia, CR 207, Adelaide: Road Accident Research Unit for Canberra: Australian Transport Safety Bureau.

Lai F, Chorlton K, Carsten O (2007) ISA – UK: Overall field trial results. Leeds: Institute for Transport Studies, University of Leeds and MIRA Ltd.

Madsen JR (2002) 'Intelligent speed adaptation: an analysis of behavioural changes' e-Safety Congress and Exhibition, Lyon, France, Intelligent Transport Systems and Services, Brussels, Belgium.

New South Wales Centre for Road Safety (2010). Results of the NSW intelligent speed adaptation trial: effects of road safety attitudes, behaviours and speeding. RTA/Pub. 10.327. Wollongong: New South Wales Centre for Road Safety.

Tate F, Carsten O (2008). ISA – UK: implementation scenarios. Leeds: Institute for Transport Studies, University of Leeds and MIRA Ltd.

Várhelyi A, Mäkinen T (2001), 'The effects of in-car speed limiters: field studies', Transportation Research Part C, 9, pp. 191-211.