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Analysis of treatments on the Duke's Highway in South Australia

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Analysis of treatments on the Duke's Highway in South Australia

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ABSTRACT

Since 2001 there have been a number of treatment programs applied to the Duke's Highway in South Australia with the aim of improving the safety of the road. Between 2001-2017 the shoulders of the road have been sealed, overtaking lanes have been installed and audio tactile line marking has been installed. Since 2009, rest areas have been installed, more overtaking lanes have been installed, clear zones have been made and roadside hazards have been removed or protected. Starting in 2011, a wide centre line is being painted along the length of the road. Since 2013, the road has been resurfaced, intersections have been treated and signage has been added. Average speed cameras were installed in 2013 and activated in 2014. Taken as a group, these treatments would be expected to reduce the number of injury crashes on the Duke's Highway beyond any pre-existing or general trend. Between 1983 and 2016 there were 742 injury crashes recorded on the Duke's Highway in 100 and 110 km/h speed zones. Over that time period the number of injury crashes per year has been generally declining. For the 1983-2000 period the number of injury crashes declined by about 1.7% per year. For the 2001-2016 period the number of injury crashes declined by about 6.8% per year. The trends for South Australian injury crashes on all 100 and 110 km/h roads were a 1.9% reduction for 1983-2000 and a 3.0% reduction for 2001-2016. The observed reduction on the Duke's Highway for 2001-2016 was greater than the previous trend on that road and the general South Australian trend during the same time period. This is highly suggestive of the Duke's Highway treatments having resulted in fewer injury crashes on that road than if no treatments had been applied.

KEYWORDS

Road safety, Road design, Hazards, Clear zone

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The views expressed in this report are those of the authors and do not necessarily represent those of the University of Adelaide or the funding organisations.

Summary

The Duke's Highway in South Australia runs between Taillem Bend and the Victorian Border. It is 191 km of undivided flat road with mostly one lane in each direction. It is part of the major traffic route between Adelaide and Melbourne.

The purpose of this report is to document the treatments made and the injury crashes occurring on the Duke's Highway over the past decades and to look for any evidence that the treatments are providing a road safety benefit.

Since 2001 there have been a number of treatment programs applied to the Duke's Highway in South Australia with the aim of improving the safety of the road. Between 2001-2017 the shoulders of the road have been sealed, overtaking lanes have been installed and audio tactile line marking has been installed. Since 2009, rest areas have been installed, more overtaking lanes have been installed, clear zones have been made and roadside hazards have been removed or protected. Starting in 2011, a wide centre line is being painted along the length of the road. Since 2013, the road has been resurfaced, intersections have been treated and signage has been added. Average speed cameras were installed in 2013 and activated in 2014. Taken as a group, these treatments would be expected to reduce the number of injury crashes on the Duke's Highway beyond any pre-existing or general trend.

Between 1983 and 2016 there were 742 injury crashes recorded on the Duke's Highway in 100 and 110 km/h speed zones. Over that time period the number of injury crashes per year has been generally declining. For the 1983-2000 period the number of injury crashes declined by about 1.7% per year. For the 2001-2016 period the number of injury crashes declined by about 6.8% per year.

The trends for South Australian injury crashes on all 100 and 110 km/h roads were a 1.9% reduction for 1983-2000 and a 3.0% reduction for 2001-2016.

The observed reduction on the Duke's Highway for 2001-2016 was greater than the previous trend on that road and the general South Australian trend during the same time period. This is highly suggestive of the Duke's Highway treatments having resulted in fewer injury crashes on that road than if no treatments had been applied.

Note that this report was substantially completed in August 2018 and does not consider developments after that date.

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1 Introduction

The Duke's Highway in South Australia runs between Taillem Bend and the Victorian border (Figure 1.1). It is 191 km of undivided flat road with mostly one lane in each direction. It is part of the major traffic route between Adelaide and Melbourne. A typical view of the road is shown in Figure 1.2.

Figure 1.1
The Duke's Highway running between Taillem Bend and the Victorian border
(Google Maps 12 Nov 2013)

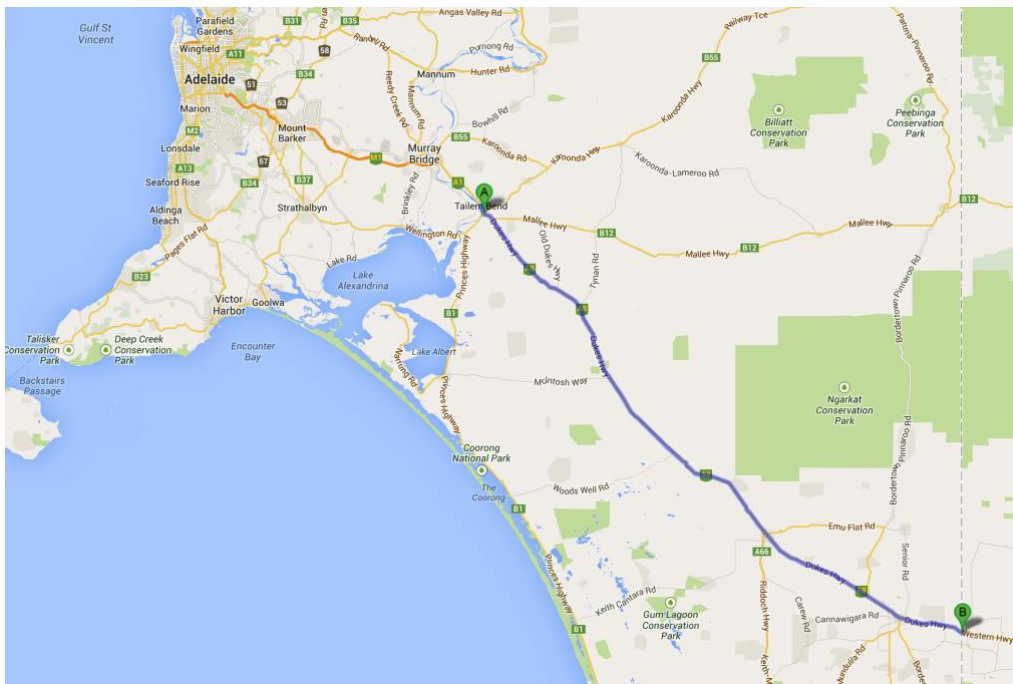


Figure 1.2
Typical Duke's Highway section
(Google Street View 7 Aug 2018)



The majority of the road has a speed limit of 110 km/h. The individual sections of road by speed limit are shown in Table 1.1. The 100 km/h section runs from Bordertown to the Victoria border. The continuation of the road into Victoria has a 100 km/h speed limit.

Table 1.1
Speed limits along the Duke's Highway (source: DPTI)

Section	Start	End	Length	Limit	110	100	80	60	Notes
1	0.00	31.40	31.40	110	31.40				
2	31.40	33.13	1.73	80			1.73		Coomandook
3	33.13	46.19	13.06	110	13.06				
4	46.19	46.71	0.52	80			0.52		Ki-Ki
5	46.71	60.87	14.16	110	14.16				
6	60.87	61.32	0.45	80			0.45		Coonalpyn
7	61.32	62.53	1.21	60				1.21	Coonalpyn
8	62.53	63.04	0.51	80			0.51		Coonalpyn
9	63.04	78.00	14.96	110	14.96				
10	78.00	78.55	0.55	80			0.55		Intersections
11	78.55	88.53	9.98	110	9.98				
12	88.53	89.03	0.50	80			0.50		Tintinara
13	89.03	90.42	1.39	60				1.39	Tintinara
14	90.42	90.97	0.55	80			0.55		Tintinara
15	90.97	125.43	34.46	110	34.46				
16	125.43	126.72	1.29	80			1.29		Keith
17	126.72	127.81	1.09	60				1.09	Keith
18	127.81	129.07	1.26	80			1.26		Keith
19	129.07	169.59	40.52	110	40.52				
20	169.59	170.42	0.83	80			0.83		Bordertown
21	170.42	171.86	1.44	80			1.44		Bordertown (median)
22	171.86	173.92	2.06	80			2.06		Bordertown
23	173.92	190.67	16.75	100		16.75			
Total length			190.67		158.54	16.75	11.69	3.69	

Annual average daily traffic two-way flows (measured in 2013) varied along its length from 5,000 just outside of Taillem Bend down to 2,600 near the Victorian border (see Appendix A). These relatively low traffic volumes have so far precluded turning it into a divided highway. However, there has been a considerable desire to improve the safety of the highway. This has led to numerous treatment programs particularly from 2001 onwards.

The purpose of this report is to document the treatments made and the injury crashes occurring on the Duke's Highway over the past decades and to look for any evidence that the treatments are providing a road safety benefit.

2 Treatments

A number of treatments have been applied to the Duke's Highway since 2001 (see Table 2.1 and Figure 2.1).

Table 2.1
Treatments on the Duke's Highway (source: DPTI)

Treatment	Start	End	Notes
Shoulder sealing	2001/02	2003/04	1.5 m sealing all along road
Overtaking lanes	2002/03	2005/06	about 14 new and upgraded
Audio tactile line marking	2002/03	2006/07	about 62 km out of 190 km
Rest areas	2009/10	2010/11	about 17 both new and upgraded
Overtaking lanes	2009/10	2011/12	13 new and upgraded
Clear zones	2009/10	2012/13	5-6 m clear along length of road
Roadside hazard protection	2009/10	ongoing	Removal and barriers at targeted locations
Wide centreline	2011/12	2014/15	1.05 m clear wide between lines + ATLM
Resurfacing	2013/14	ongoing	Federal investment for resurfacing road
Intersection treatments	2013/14	2014/15	Nation building intersection works
Signage	2014/15	2015/16	Improved signage
Average speed cameras	2013/14	2014/15	Average speed cameras installed

Figure 2.1
Treatments on the Duke's Highway (source: DPTI)

Treatment	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Shoulder sealing	■	■	■													
Overtaking lanes		■	■	■	■	■										
Audio tactile line marking		■	■	■	■	■										
Rest areas									■	■						
Overtaking lanes									■	■	■					
Clear zones									■	■	■	■				
Roadside hazard protection									■	■	■	■	■	■	■	■
Wide centreline											■	■	■	■		
Resurfacing													■	■	■	■
Intersection treatments													■	■		
Signage													■	■	■	
Average speed cameras													■	■		

Most of these treatments can be assumed to provide a road safety benefit. However, there are conflicting views and uncertainty about the size of the effects and it is not apparent how they will apply individually and in combination specifically on the Duke's Highway.

Shoulder sealing is known to lower the incidence of run off road and loss of control crashes.

Overtaking lanes are popular for drivers but their net effect on crashes has not been established.

Audio tactile line markings have been shown to be beneficial both on edge and centre lines.

Rest areas have not been evaluated for their road safety benefits.

Clear zones are known to be effective but only at the locations where the treatments are provided. Unless they are applied on large sections of the roadway, they will only have a small effect on overall crash numbers.

Roadside hazard protection is effective but only at the locations where the treatments are provided. Unless they are applied on large sections of the roadway, they will only have a small effect on overall crash numbers.

Wide centrelines are an as yet unproven treatment although the audio tactile centre lines associated with them have been shown to be effective (see Figure 2.2 for what they look like).

Figure 2.2
Wide centrelines on the Duke's Highway



Resurfacing roads is generally beneficial for road safety but not necessarily when it leads to increased vehicle speeds.

Intersection treatments can be effective but only cover small sections of the whole road.

Signage can be effective in the area of the signs.

Average speed cameras were placed on the Duke's Highway between Coonalpyn and Ki Ki. The cameras were fully installed by August 2013, became operational in July 2014 and have been in operation since that time. They measure speeds at each end of the section covered and also calculate average speeds of vehicles over the road section. Speed fines are automatically issued to the owners of the vehicles identified as speeding. They would be expected to lower vehicle speeds for the section of road covered and possibly for some distance on either side. Even a small reduction in vehicle speeds would be expected to lead to reductions in injury crashes.

3 Injury crashes

Injury crashes along the Duke’s Highway were extracted from the Traffic Accident Reporting System (TARS). This is a database of crashes maintained by DPTI which is formed by processing police reports of crashes. Property damage only crashes were not extracted due to the changing criteria for recording them over the long time period examined.

Injury crashes were extracted for the years 1983-2016. Since the focus of this report is on the Highway rather than the towns, only injury crashes recorded as happening in 100 or 110 km/h speed zones were extracted. Table 3.1 shows the number of injury crashes by year and crash severity (the most severe injury in the crash).

Table 3.1
Number of injury crashes in 100/110 km/h speed zones on the Duke’s Highway
by year and crash severity

Year	Crash severity				Total injury crashes
	Treated by a doctor	Treated at hospital	Admitted to hospital	Fatally injured	
1983	2	5	20	3	30
1984	0	6	17	4	27
1985	3	1	12	4	20
1986	5	7	21	4	37
1987	5	10	15	4	34
1988	0	10	12	5	27
1989	1	12	18	2	33
1990	1	17	14	3	35
1991	2	6	13	3	24
1992	4	6	9	3	22
1993	1	8	2	4	15
1994	2	7	15	0	24
1995	0	10	5	4	19
1996	0	8	10	3	21
1997	1	14	14	3	32
1998	3	8	9	2	22
1999	1	6	8	5	20
2000	0	16	10	3	29
2001	2	8	15	3	28
2002	1	15	9	3	28
2003	1	9	13	4	27
2004	0	6	5	2	13
2005	0	4	7	7	18
2006	0	14	7	1	22
2007	1	4	8	1	14
2008	1	3	2	4	10
2009	0	8	6	2	16
2010	0	11	5	2	18
2011	0	9	6	4	19
2012	2	8	6	2	18
2013	1	8	5	2	16
2014	0	5	3	1	9
2015	0	3	4	2	9
2016	0	4	2	0	6
Total	40	276	327	99	742

Since major treatments were started in 2001 the periods 1983-2000 and 2001-2016 will be considered as distinct periods. Figure 3.1 shows the total number of injury crashes (including fatal crashes) on the Duke's Highway by year. A general decline in numbers is apparent with considerable variation year to year.

Figure 3.1
Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year

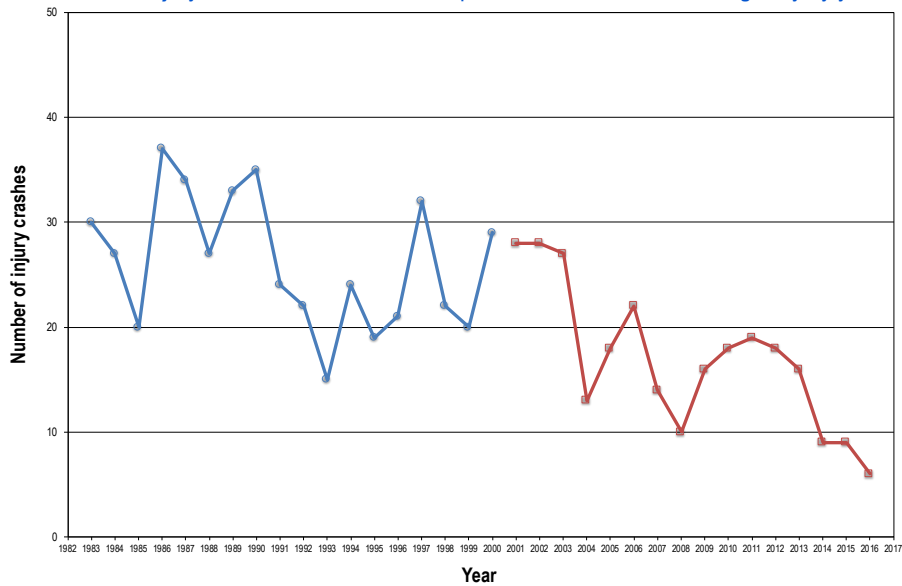


Figure 3.2 includes 95% confidence limit bars for the number of injury crashes each year. The low number of injury crashes means that the limits are very wide compared to the observed values. This precludes being able to find an effect associated with a treatment in a single year.

Figure 3.2
Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
(with 95% confidence limit bars shown for each year)

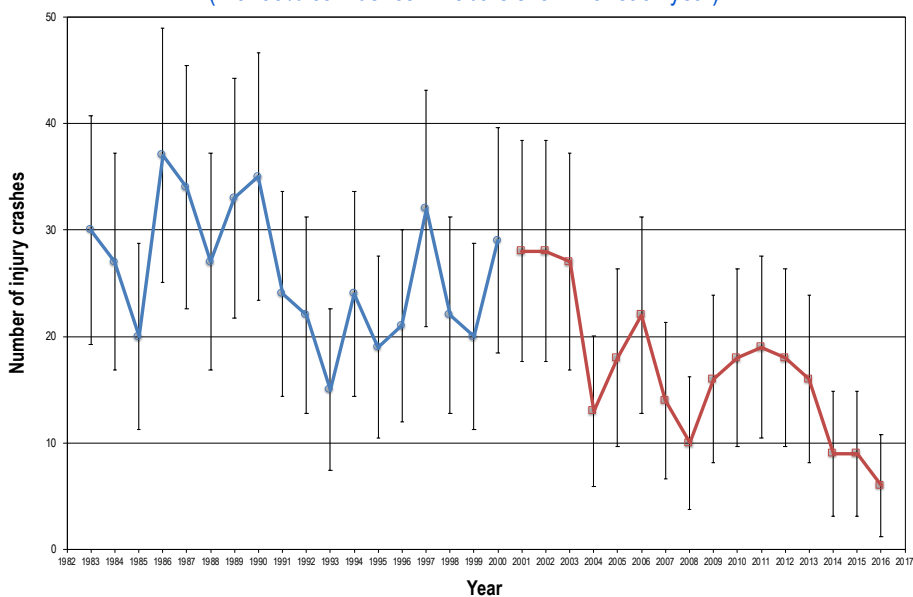
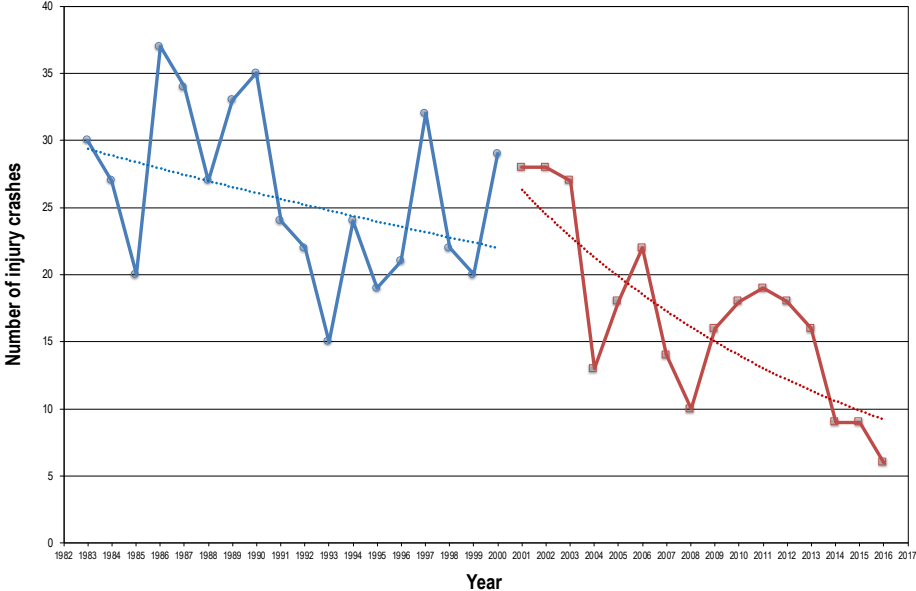


Figure 3.2 presents the same data but with separate exponential regression lines for the periods 1983-2000 and 2001-2016. These lines estimate the underlying trends in injury crash numbers before and after the treatments started being applied.

Figure 3.3
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 (with fitted exponential lines)



For comparison, the number of injury crashes in South Australia recorded as being in 100 and 110 km/h speed limit zones are shown in Figure 3.4. Separate exponential regression lines for the periods 1983-2000 and 2001-2016 are shown.

Figure 3.4
 Number of injury crashes in 100/110 km/h speed zones in South Australia by year
 (with fitted exponential lines)

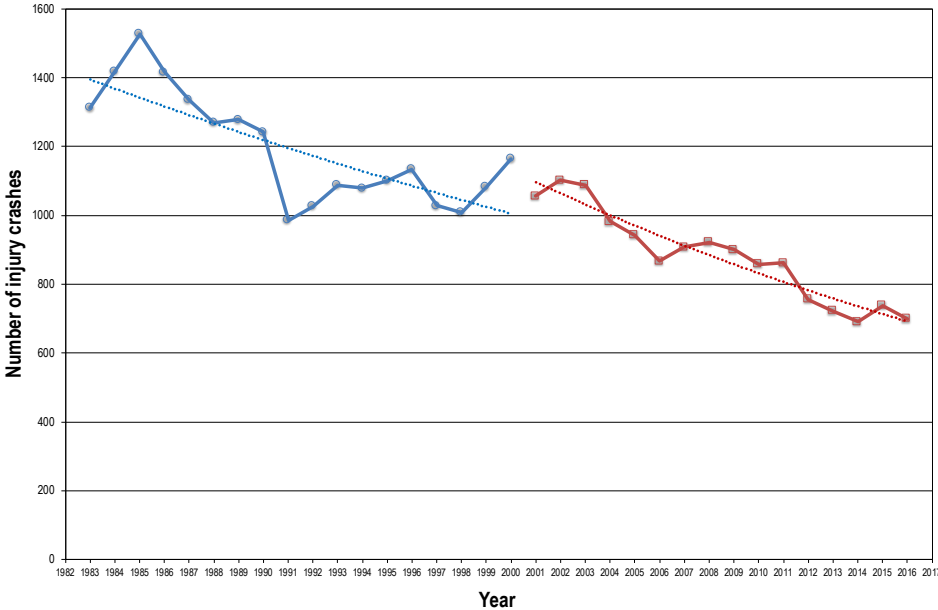
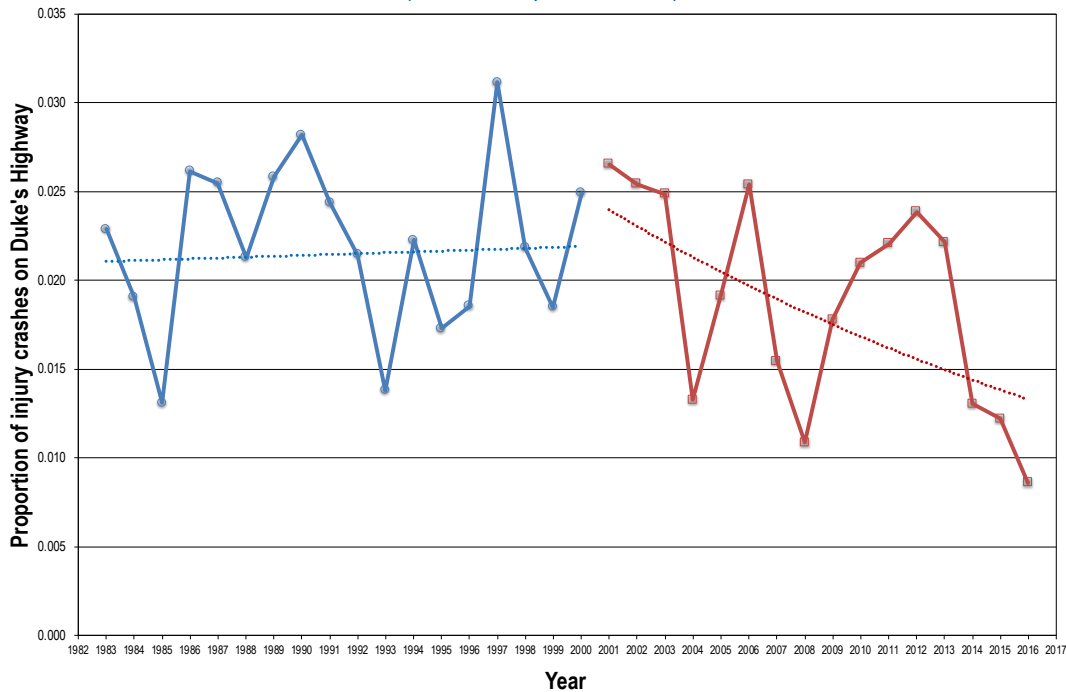


Figure 3.5 gives the proportion of all South Australian 100 and 110 km/h injury crashes that occurred on the Duke’s Highway with exponential regression lines for the periods 1983-2000 and 2001-2016.

Figure 3.5
Proportion of South Australian injury crashes in 100/110 km/h speed zones that occurred on the Duke’s Highway by year (with fitted exponential lines)



The use of exponential regressions on the injury crash data for the Duke’s Highway and all of South Australia allows the various trends to be directly compared. Table 3.2 presents the outputs of the analyses fitting exponential curves to the data. A positive slope factor indicates increasing crashes over time while a negative slope indicates decreasing crashes over time. The standard error measures the uncertainty of the slope factor and the lower and upper limits give the 95% confidence limits of the slope. The statistical significance is the probability of observing a slope factor this large or larger when there is no actual effect.

Table 3.2
Modelling injury crash rates for the given time periods
for the Duke’s Highway and all of South Australia (100/110 km/h road sections)

Area and period	Slope factor	Standard error	Lower limit	Upper limit	Statistical significance
Duke’s Highway					
1983-2000	-0.017	0.011	-0.038	0.004	0.139
2001-2016	-0.070	0.017	-0.102	-0.038	0.001
All of SA					
1983-2000	-0.019	0.004	-0.027	-0.012	0.000
2001-2016	-0.031	0.003	-0.036	-0.026	0.000
Ratio of Dukes to All of SA					
1983-2000	0.002	0.011	-0.019	0.023	0.833
2001-2016	-0.039	0.017	-0.072	-0.006	0.034

The factors in Table 3.2 were used to produce the annual percentage changes in the number of injury crashes for the various roads over the various periods along with upper and lower limits. The statistical significance level used was 0.05. The results are shown in Table 3.3.

Table 3.3
Percentage changes in injury crash rates per year for the given time periods
for the Duke's Highway and all of South Australia (100/110 km/h road sections)

Area and period	% Change per year	Lower limit	Upper limit	Statistical significance
Duke's Highway				
1983-2000	-1.7	-3.8	0.4	No
2001-2016	-6.8	-9.7	-3.7	Yes
All of SA				
1983-2000	-1.9	-2.7	-1.2	Yes
2001-2016	-3.0	-3.5	-2.5	Yes
Ratio of Dukes to All of SA				
1983-2000	0.2	-1.9	2.4	No
2001-2016	-3.8	-7.0	-0.6	Yes

During the 1983-2000 period the number of injury crashes on the Duke's Highway is estimated to have fallen by 1.7% each year. This was very similar to that for all South Australian 100 and 110 km/h roads over the same time period (1.9% reduction per year). However, in the 2001-2016 period, the number of injury crashes on the Duke's Highway is estimated to have fallen by 6.8% each year. This was higher than the reduction of 3.0% per year for all of South Australia for the same time period. The ratio of Duke's Highway injury crashes to all SA injury crashes confirms that the Duke's Highway was similar to the rest of South Australia before 2001 and better between 2001 and 2016. The statistical significance of the reduction on the Duke's Highway from 2001 onwards both in absolute terms and relative to the rest of South Australia gives a strong indication that crashes were going down on the Duke's Highway and at a greater rate than would be expected.

The effect of individual treatments could not be ascertained from the overall injury crash data due to the overlapping periods of the treatments, the short duration of recent treatments and the large volatility of injury crash numbers year to year.

The injury crashes were examined by severity and crash type to look for evidence of the effects of individual treatments (see Appendix B for injury crash disaggregations). However, the smaller numbers of individual injury crashes for each type leads to greater volatility in the numbers and no clear evidence could be found. The one interesting observation was a distinct reduction in the number of rollover injury crashes between 1983 and 2016 (Figure B.5) although the low numbers and variability meant that no specific conclusions could be drawn.

The location of injury crashes in 100-110 km/h zones on the Duke's Highway are shown for 1993-2000, 2001-2008 and for 2009-2016 in Appendix B (B.18-B.20). No obvious changes were apparent apart from the general reduction in crash numbers over time.

4 Discussion

Since 2001 there have been a number of treatment programs applied to the Duke's Highway in South Australia with the aim of improving the safety of the road. Between 2001-2017 the shoulders of the road have been sealed, overtaking lanes have been installed and audio tactile line marking has been installed. Since 2009, rest areas have been installed, more overtaking lanes have been installed, clear zones have been made and roadside hazards have been removed or protected. Starting in 2011, a wide centre line is being painted along the length of the road. Since 2013, the road has been resurfaced, intersections have been treated and signage has been added. Average speed cameras were installed in 2013 and activated in 2014. Taken as a group, these treatments would be expected to reduce the number of injury crashes on the Duke's Highway beyond any pre-existing or general trend.

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The trends for South Australian injury crashes on all 100 and 110 km/h roads were a 1.9% reduction for 1983-2000 and a 3.0% reduction for 2001-2016.

The observed reduction on the Duke's Highway for 2001-2016 was greater than the previous trend on that road and the general South Australian trend during the same time period. This is highly suggestive of the Duke's Highway treatments having resulted in fewer injury crashes on that road than if no treatments had been applied.

Acknowledgements

This research was funded via a deed with the South Australian Government. Treatment data was supplied by the Department for Infrastructure and Transport.

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Appendix A – Duke’s Highway traffic flows



Appendix B – Duke’s Highway injury crash disaggregations

Figure B.1
Number of injury crashes in 100/110 km/h speed zones on the Duke’s Highway by year
where the most serious injury required **treatment by a doctor**

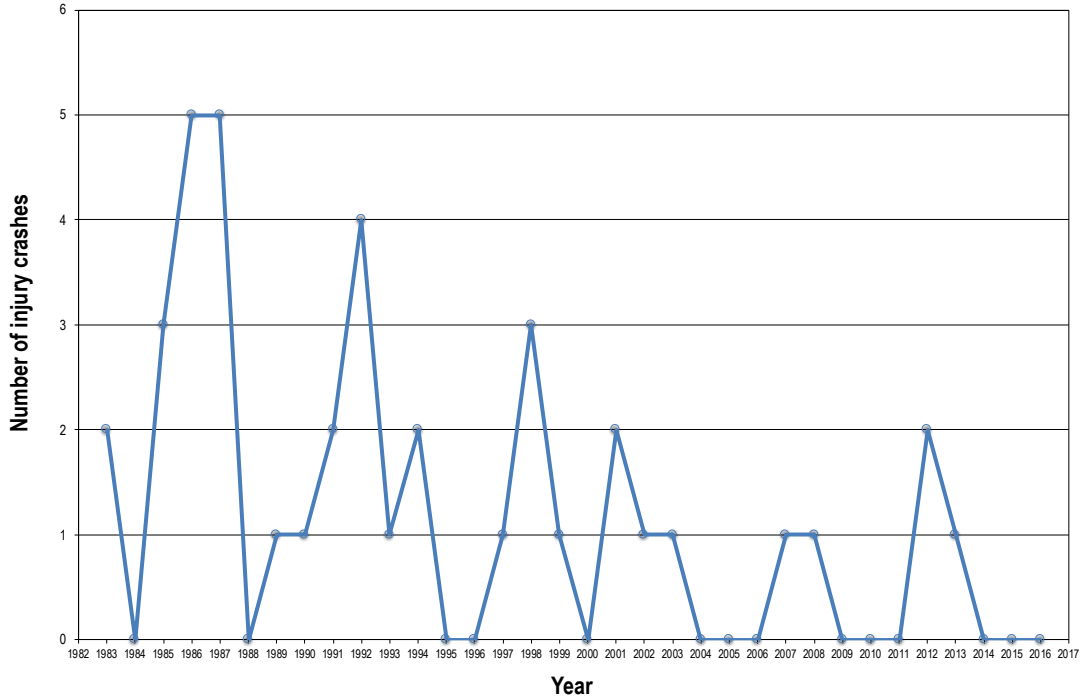


Figure B.2
Number of injury crashes in 100/110 km/h speed zones on the Duke’s Highway by year
where the most serious injury required **treatment at a hospital**

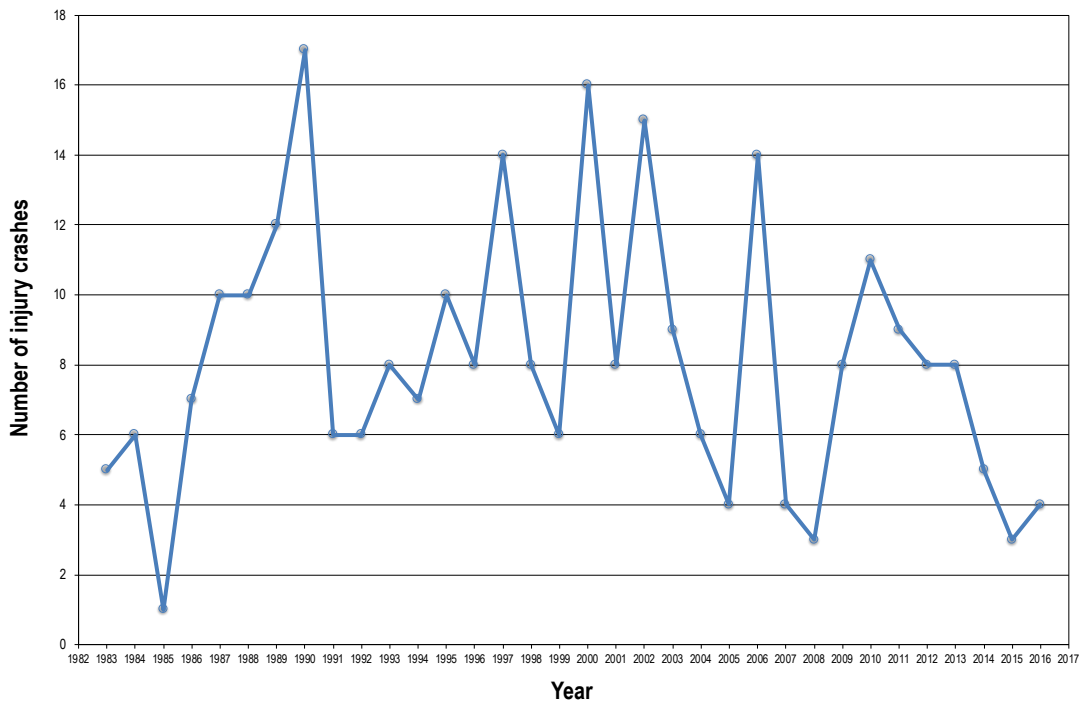
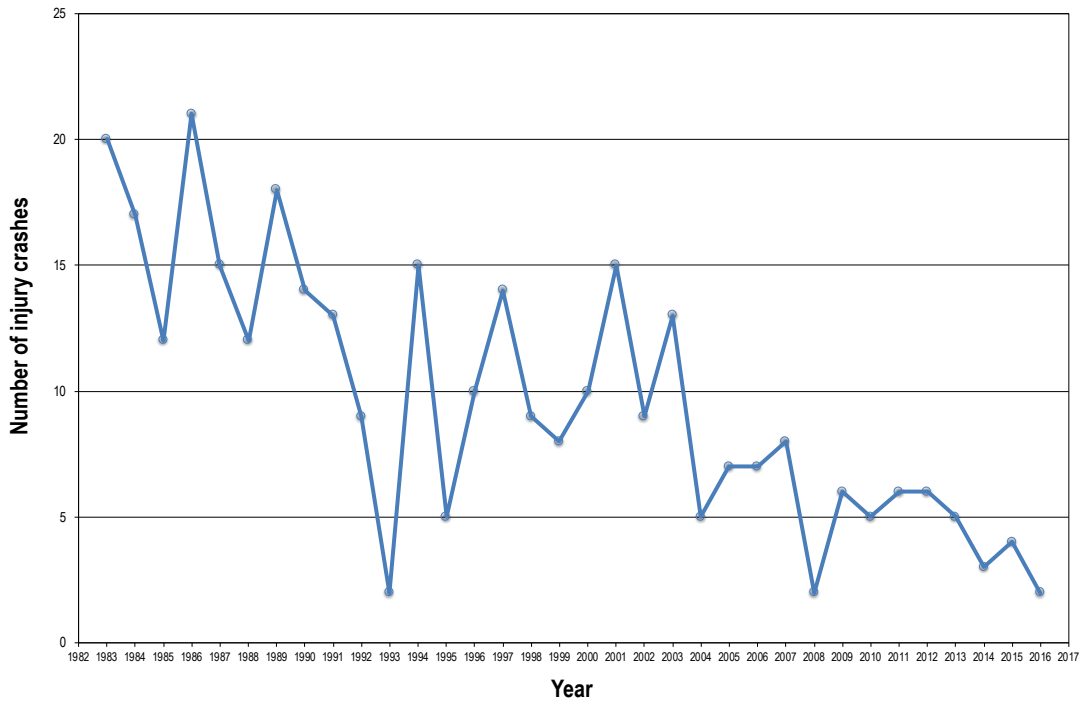


Figure B.3
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the most serious injury required **admission to hospital**



Note: in recent years police have been following up admissions to hospital to a greater degree leading to a apparent decrease in admissions greater than any actual decrease

Figure B.4
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the most serious injury was a **fatality**

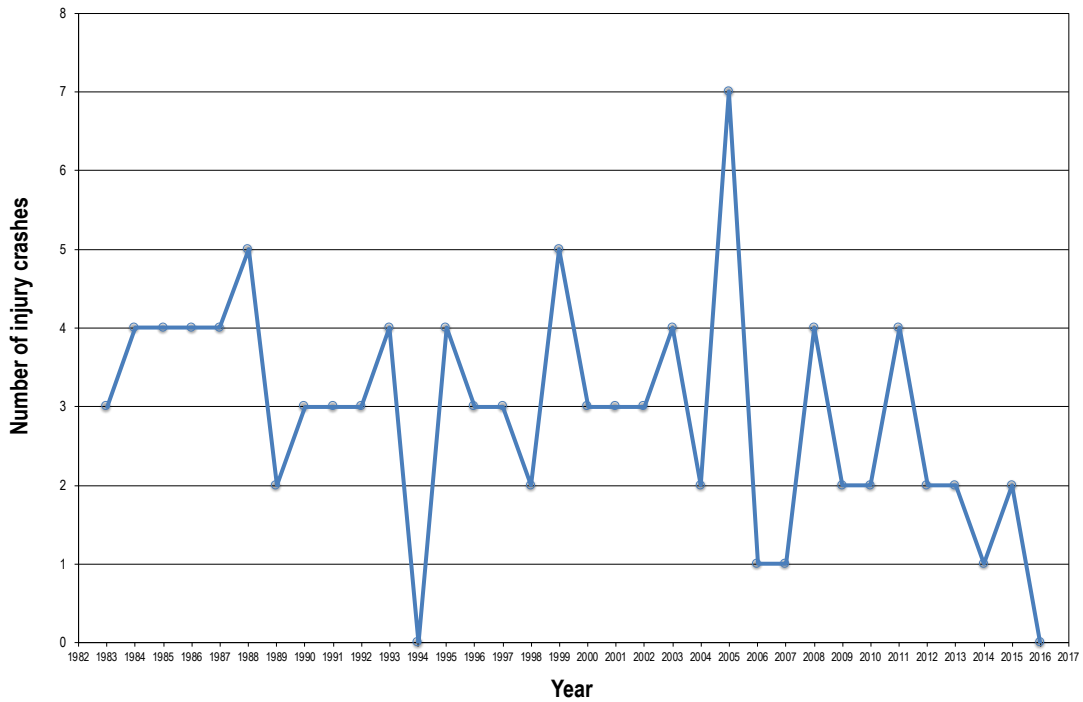


Figure B.5
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **roll over**

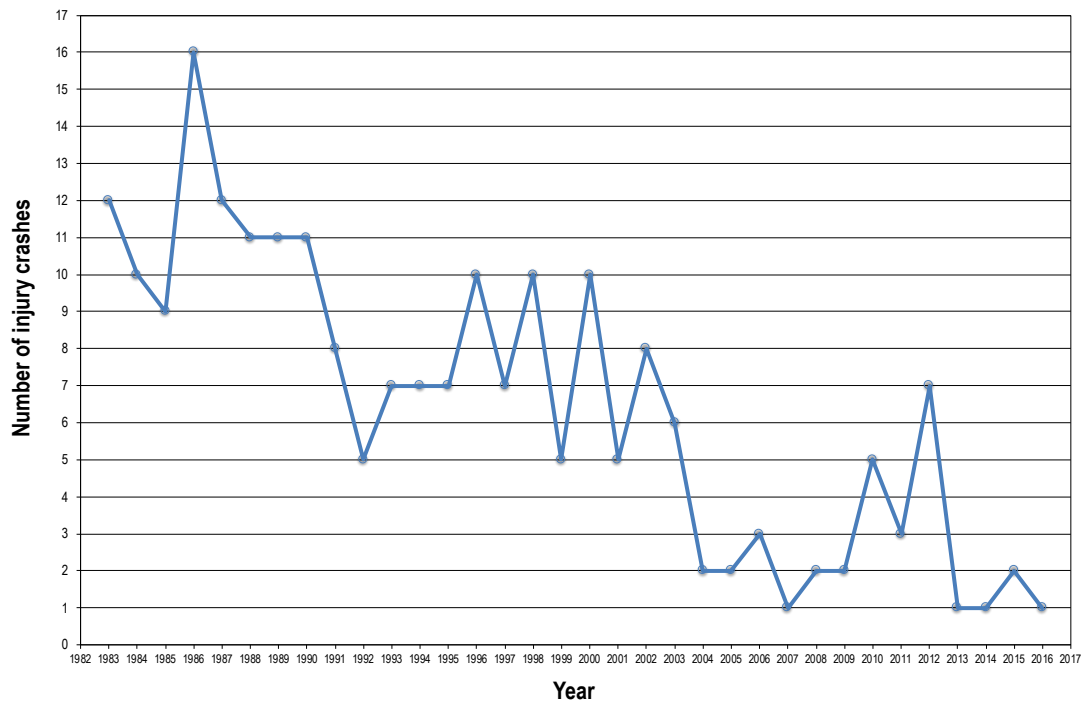


Figure B.6
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **hit fixed object**

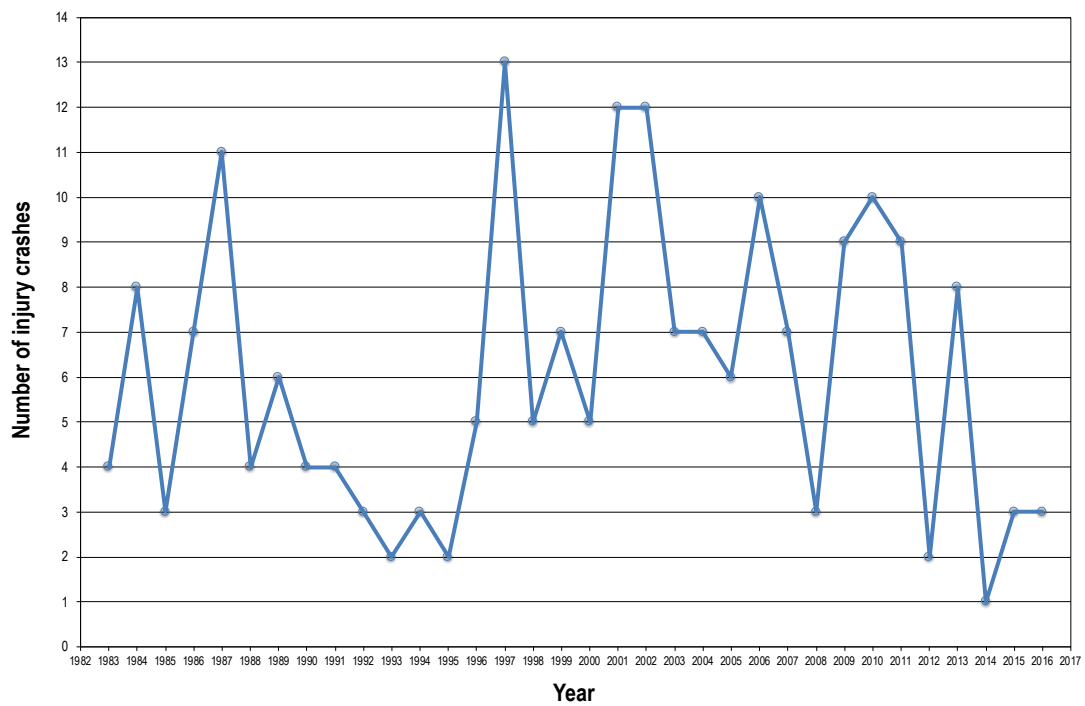


Figure B.7
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **head on**

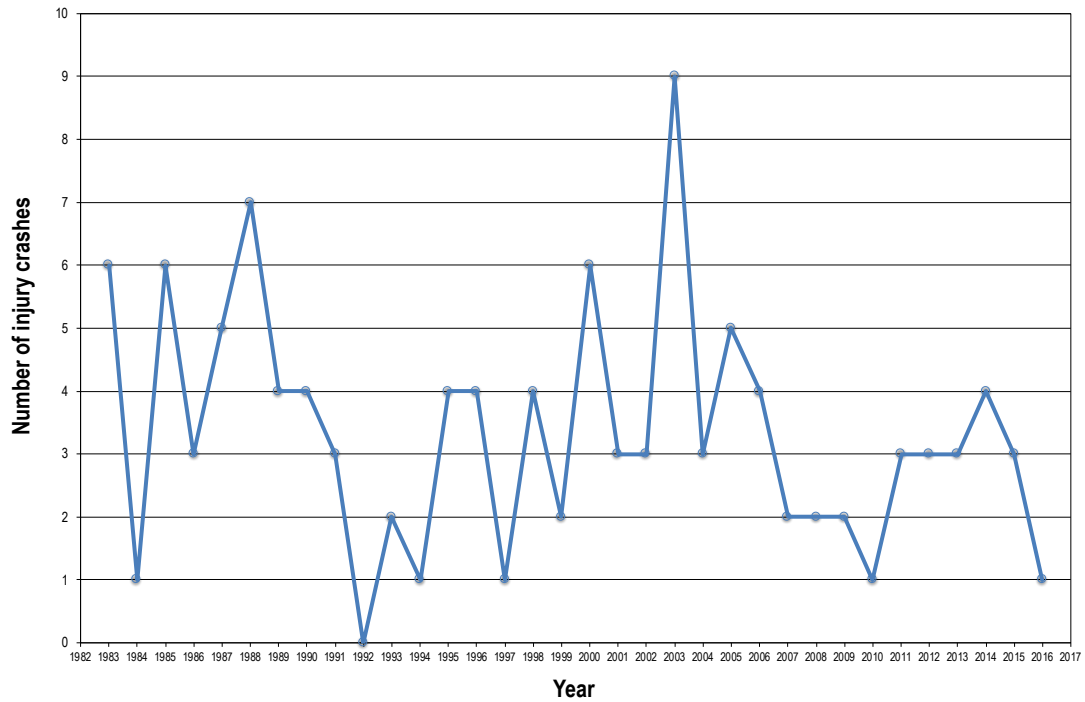


Figure B.8
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **left road out of control**

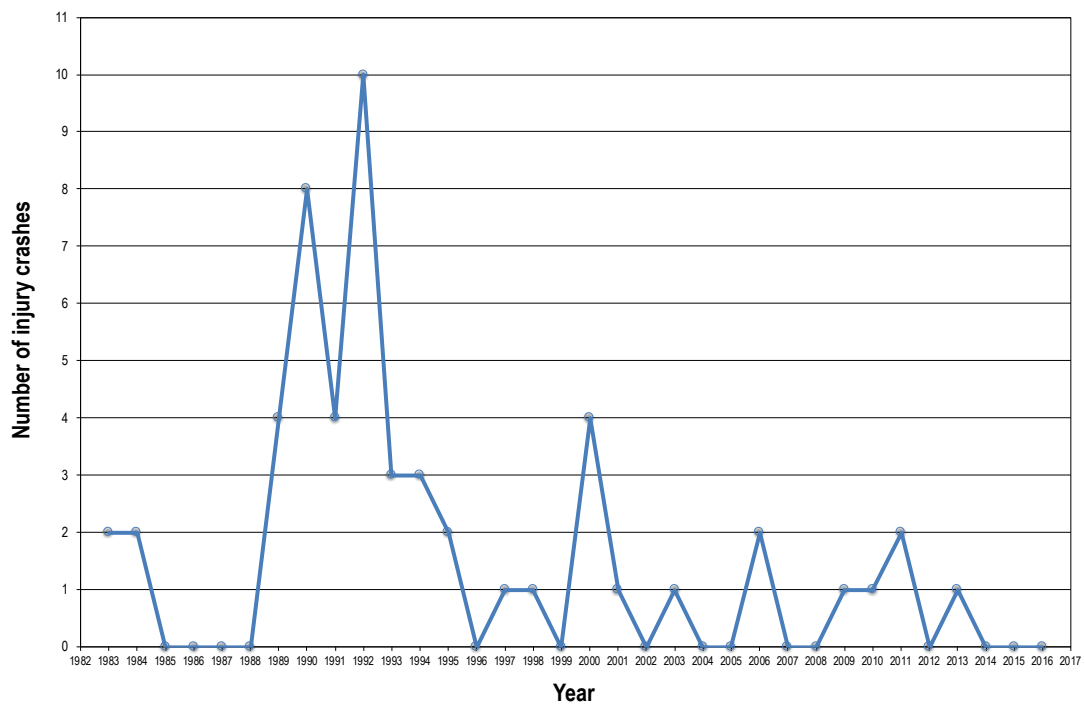


Figure B.9
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **rear end**

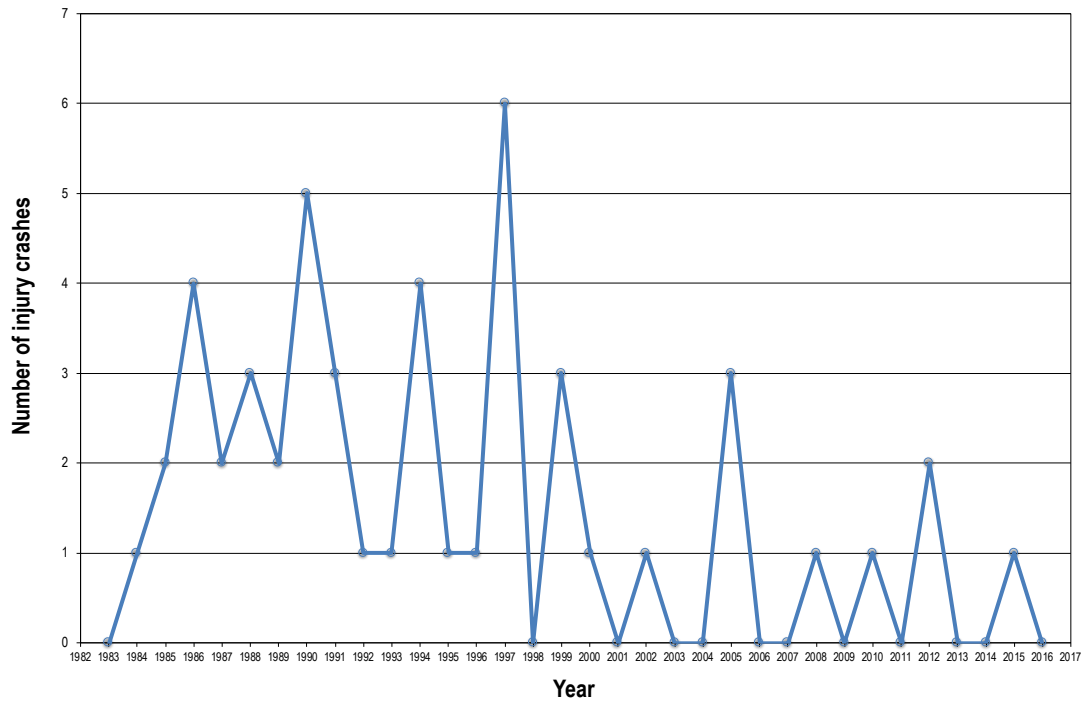


Figure B.10
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **side swipe**

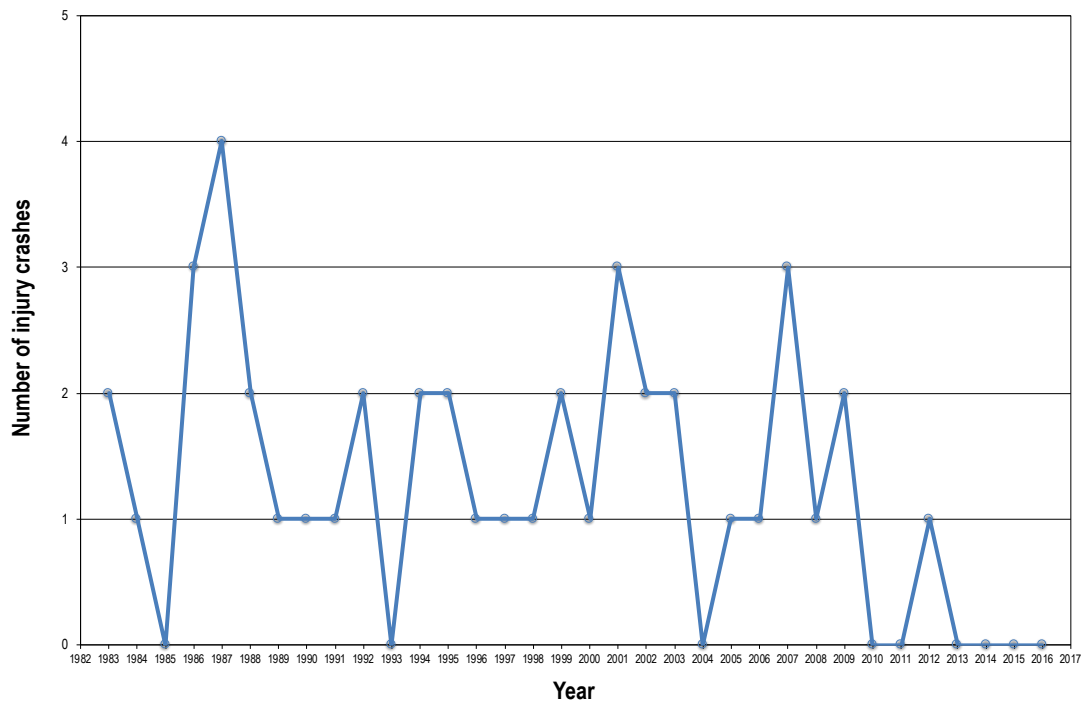


Figure B.11
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **right angle**

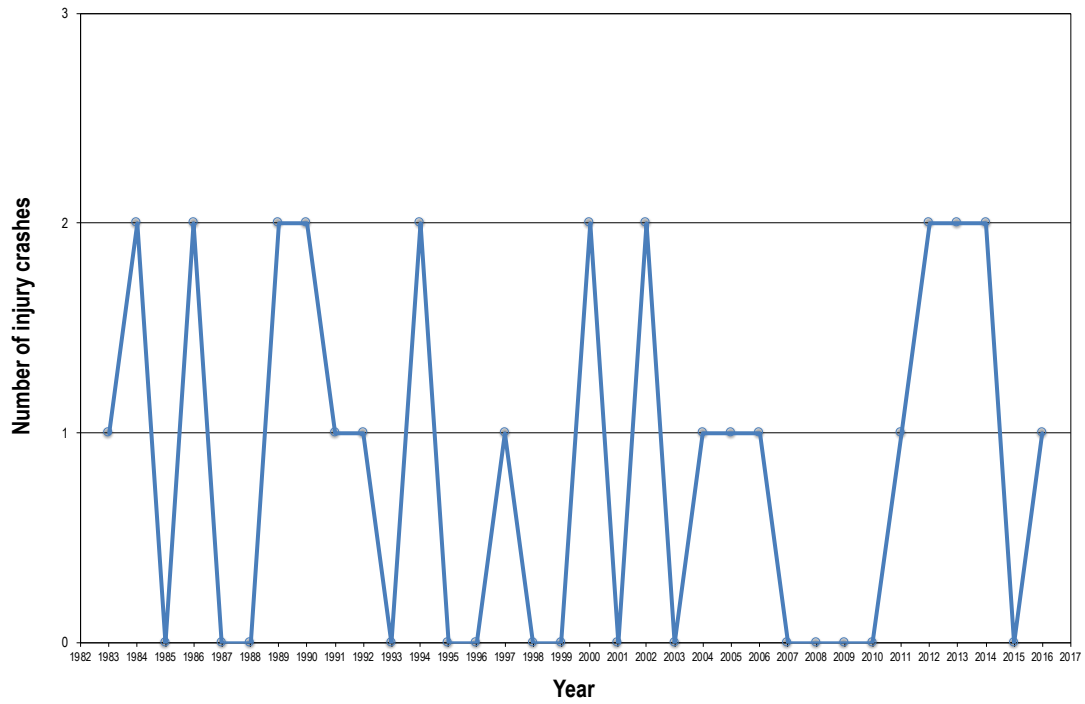


Figure B.12
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **other**

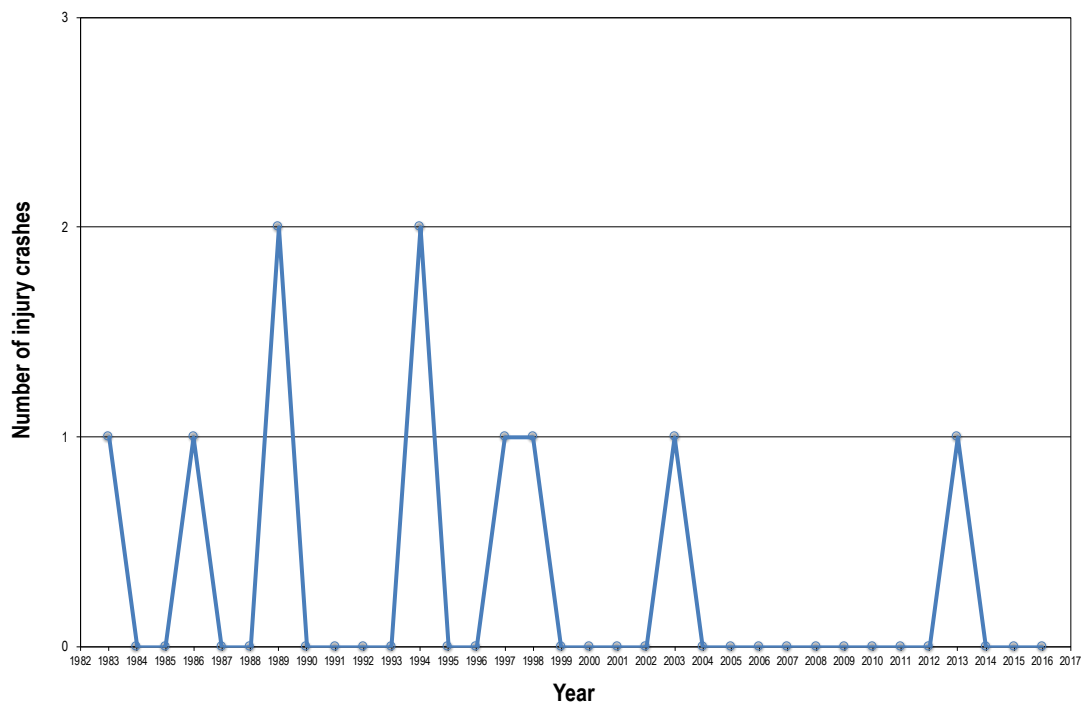


Figure B.13
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **right turn**

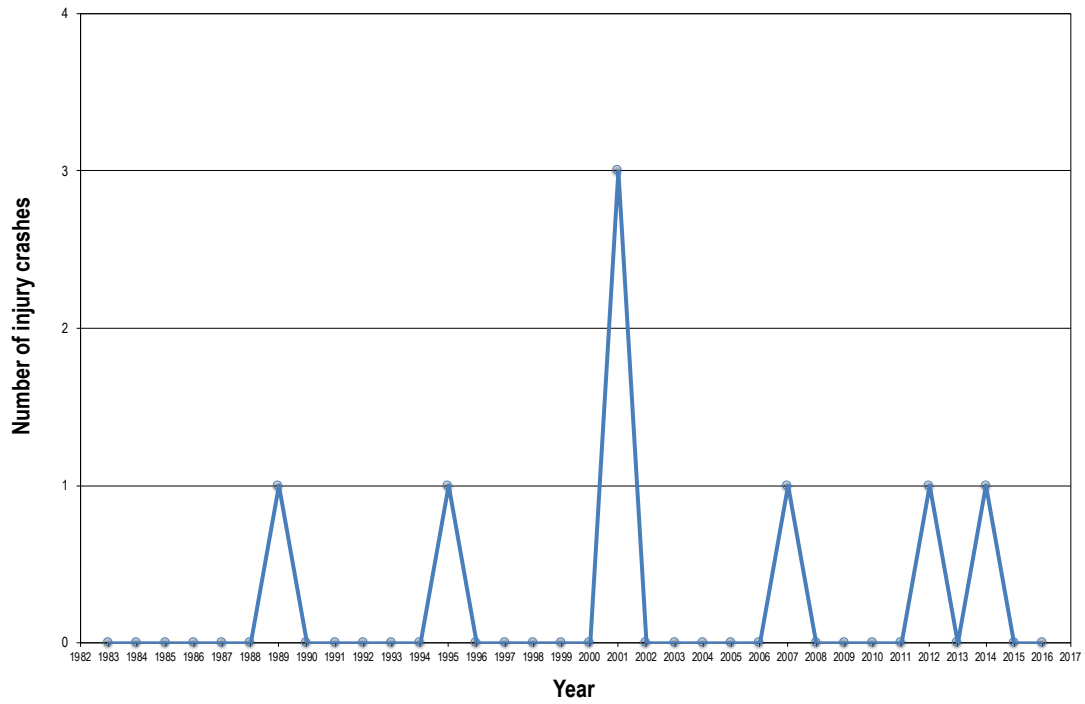


Figure B.14
 Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
 where the crash type was **hit pedestrian**

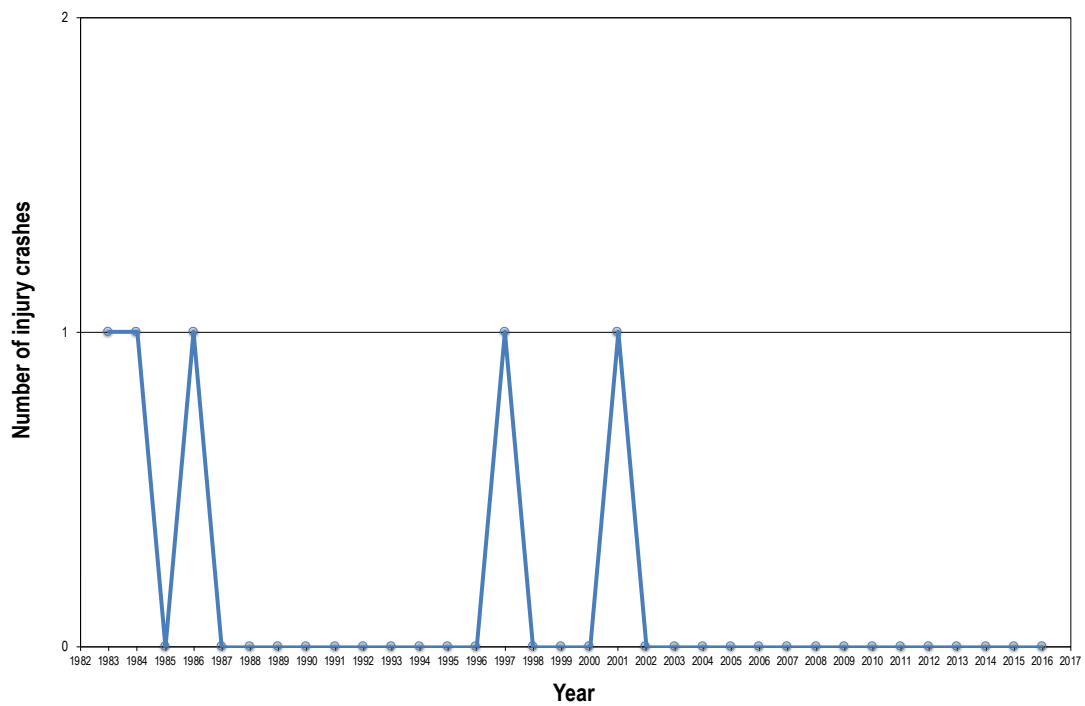


Figure B.15
Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
where the crash type was **hit parked vehicle**

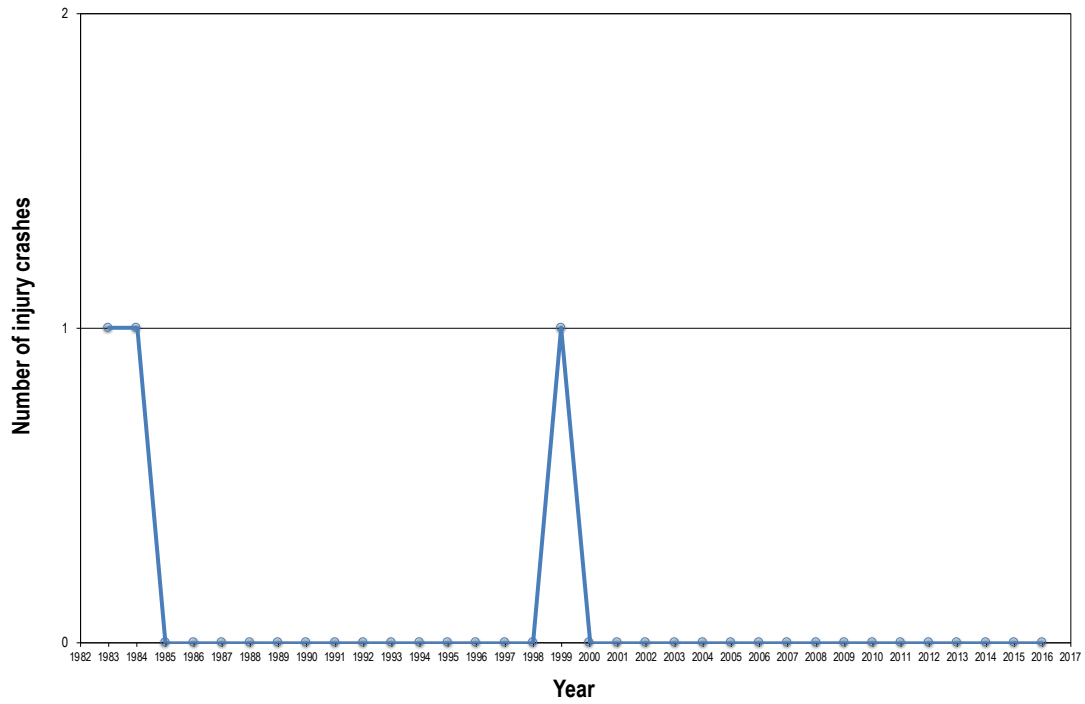


Figure B.16
Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
where the crash type was **hit animal**

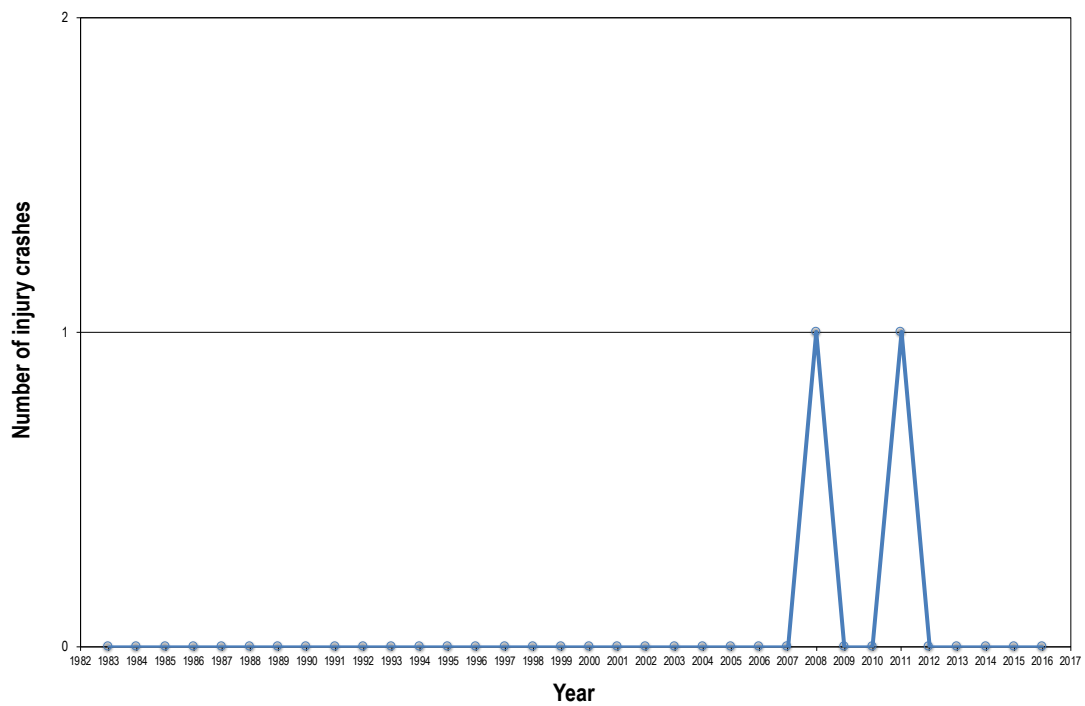


Figure B.17
Number of injury crashes in 100/110 km/h speed zones on the Duke's Highway by year
where the crash type was **hit object on road**

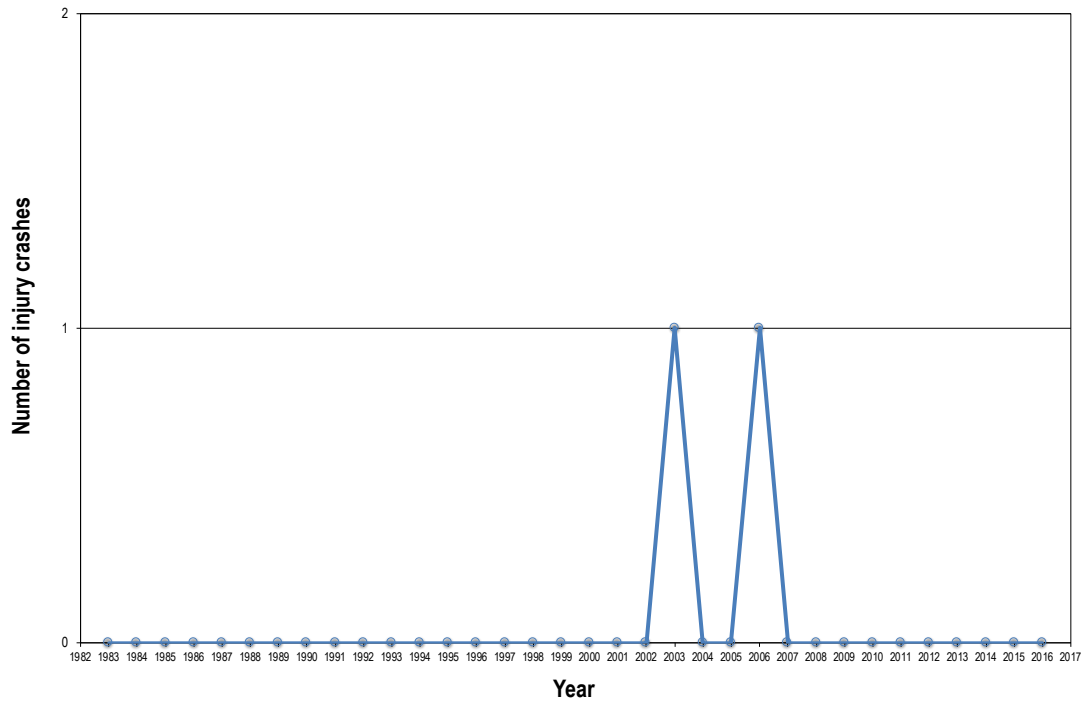


Figure B.18
Injury crash locations on Duke's Highway 1993-2000 (Google Maps 2 Aug 2018) - 182 crashes

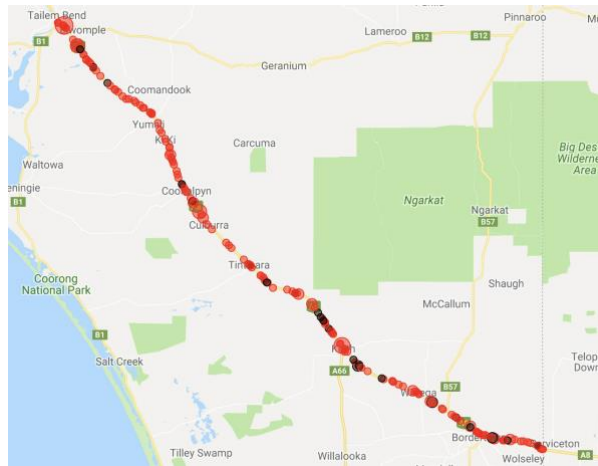


Figure B.19
Injury crash locations on Duke's Highway 2001-2008 (Google Maps 2 Aug 2018) - 160 crashes

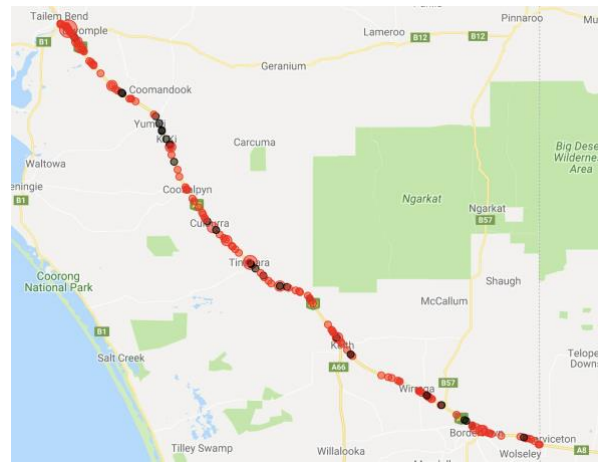


Figure B.20
Injury crash locations on Duke's Highway 2009-2016 (Google Maps 2 Aug 2018) - 111 crashes

