INVESTIGATING COMMON PATTERNS IN NEW ZEALAND CYCLING FATALITIES

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ABSTRACT

Following five cycling deaths during November 2010, the Chief Coroner announced a national Inquiry to identify any common trends or information that could prevent a re-occurrence of such tragedies. To help inform this Inquiry, a larger investigation into New Zealand cycling fatalities back to 2006 was undertaken, to try to identify any consistent patterns in crash occurrences that were significantly over-represented.

From crash records and media reports, more than 90 cycling fatalities were identified between January 2006 and June 2013. A review of the relevant reports identified common attributes. Potential initiatives that could have prevented each fatality were also considered.

Some notable trends were found. Older cyclists (>50 years) are very over-represented, despite their relatively low cycling involvement, and are also more likely to be at fault. The number of fatalities involving heavy vehicles and/or state highways was also higher than expected. Poor observation by drivers was a very common factor. The study also identified inconsistencies in crash information recorded, including recording of non-motor vehicle crashes and clothing/helmets worn.

The study has provided valuable information to inform both the Inquiry and transport safety agencies in general about what is needed to reduce the cycling road toll. It identifies additional trends that are not evident from just examining cycle injury crashes.

1. INTRODUCTION

In recent decades, cycling has been a relatively marginal transport mode in New Zealand, particularly as transport planning has catered predominantly for the motor vehicle. That marginalisation is reflected in the relative road safety performances; whilst motor vehicle crashes have dropped dramatically in the past 25 years, cycle crash injuries and fatalities have remained relatively static for the past 10-15 years after dropping from the highs in the mid-1980s (MoT 2012). At the same time, the steadiness in absolute cycle crash numbers has been paralleled by a growth in concern about the perceived safety of cycling in New Zealand (e.g. Kingham *et al* 2011, MoT 2013a). However, walking and cycling were only deemed a "medium priority" in the current national road safety strategy (MoT 2010).

Over a five-day period in November 2010, five people in New Zealand were killed while cycling, including three in one crash (Fairfax NZ Ltd 2010). The Chief Coroner announced a national Inquiry to identify any common trends or information that could prevent a re-occurrence of such tragedies (Hawkes Bay Today 2010). Eight cycling fatalities were to be included in the Inquiry, although this was later expanded to thirteen cases from 2010-11. Coroner Gordon Matenga was appointed to lead the Inquiry and chose to visit five major centres around New Zealand to hear evidence in regards to these specific cases and cycling safety in general.

There was concern by the author that the Inquiry scope was of limited value in focusing on thirteen somewhat arbitrary fatalities, without reference to a much larger sample of crashes. From the first few hearings by the Coroner, it also appeared that the Inquiry could be distracted by potentially misleading "solutions", such as mandatory high-visibility clothing for cyclists (Forbes 2011). Therefore, to help inform the Inquiry, a larger investigation into NZ cycling fatalities dating back to 2006 was undertaken, to try to identify any consistent patterns in crash occurrences that were significantly over-represented. The findings were presented to the Inquiry during the final hearing (Koorey 2013); this paper summarises the evidence found (updated here to include more recent cases).

2. INVESTIGATION METHOD

The investigation looked into all identified fatalities involving cyclists on New Zealand roads or pathways, i.e. they do not include off-road fatalities such as mountain biking accidents. From crash records and media reports, **94** cycling fatalities in New Zealand were identified between January 2006 and June 2013. These include the 13 fatalities considered by the Coroner in the Inquiry.

NZTA's Crash Analysis System (CAS) data, Police crash investigation reports (including Serious Crash Unit reports where available), Coroner's findings, and other reports from the media were used to inform the analysis. While this provided a reasonably comprehensive dataset, there were some gaps in the information collected, as discussed later.

The relevant reports were reviewed and data collated in a single database. For each case, the available evidence was reviewed with a "fresh pair of eyes" to ascertain whether the original determination had overlooked any interpretations of the data, particularly in relation to contributory factors. This was felt quite important considering that one party (the cyclist) was obviously unable to provide their "side of the story". From this analysis, common attributes were identified, and potential initiatives that could have prevented each fatality were also considered (e.g. engineering, education, legislation, etc).

It is appreciated that other non-fatal crashes (especially serious ones) could also be used to inform this analysis, and even "near misses" could provide useful clues to reduce the number of cycling deaths. For example, Wood (1999) investigated cycle safety in NZ by analysing patterns in cycle injury crashes from the mid-1990s and fatal crashes from the 1980s-90s. However the scale of that potential exercise was beyond the available resources (e.g. over the same period of time as the fatalities, there were over 1200 serious injury cycle crashes

and over 4800 minor injury crashes). It also became apparent that some factors prevalent in fatalities are not as evident when considering crashes with lesser injuries.

Although the Inquiry was triggered by the five fatalities in November 2010, it is important to acknowledge that (despite the ongoing media attention) cycling is **not inherently dangerous**, nor any more dangerous than previously. The five deaths in Nov 2010 simply brought the average number of motor-vehicle related cycle fatalities in the year up to the annual average for the previous decade (which has remained relatively static). During the period over which the 94 cycling deaths studied were recorded, New Zealanders collectively cycled for about 190 million hours (MoT 2013b), i.e. more than **2 million hours for every cycling death**. Over this same period, more than 6200 cycling injury crashes with motor vehicles were reported, which equates to about **one crash for every 30,000 hours of riding** (note that this does not include cycle crashes not involving a motor vehicle). These relatively small risks of death and injury are also swamped by the typical life-years gained by people who take up regular cycling as part of their health and well-being. A number of studies have found gains in the order of 20:1 over any safety losses (e.g. BMA 1992, de Hartog *et al* 2010).

3. SPECIFIC ISSUES NOTED

The following sections summarise the main findings of the investigation. From these findings, various recommendations were identified for the Coroner; these are listed in Section 7.1.

3.1. Reporting of non-motor vehicle cycle crashes

Figure 1 summarises the cycle (Bike) fatalities investigated from January 2006 to the present time (including three not fully examined yet). Most cases are conventional crashes involving a motor vehicle; however there are a smaller proportion of other cycle fatalities, including:

- Hitting an object on the road e.g. a pedestrian, dog, train, rock, or parked car
- Losing control and typically falling off the road/path and striking something
- Miscellaneous fatalities, often involving a medical condition like a heart attack

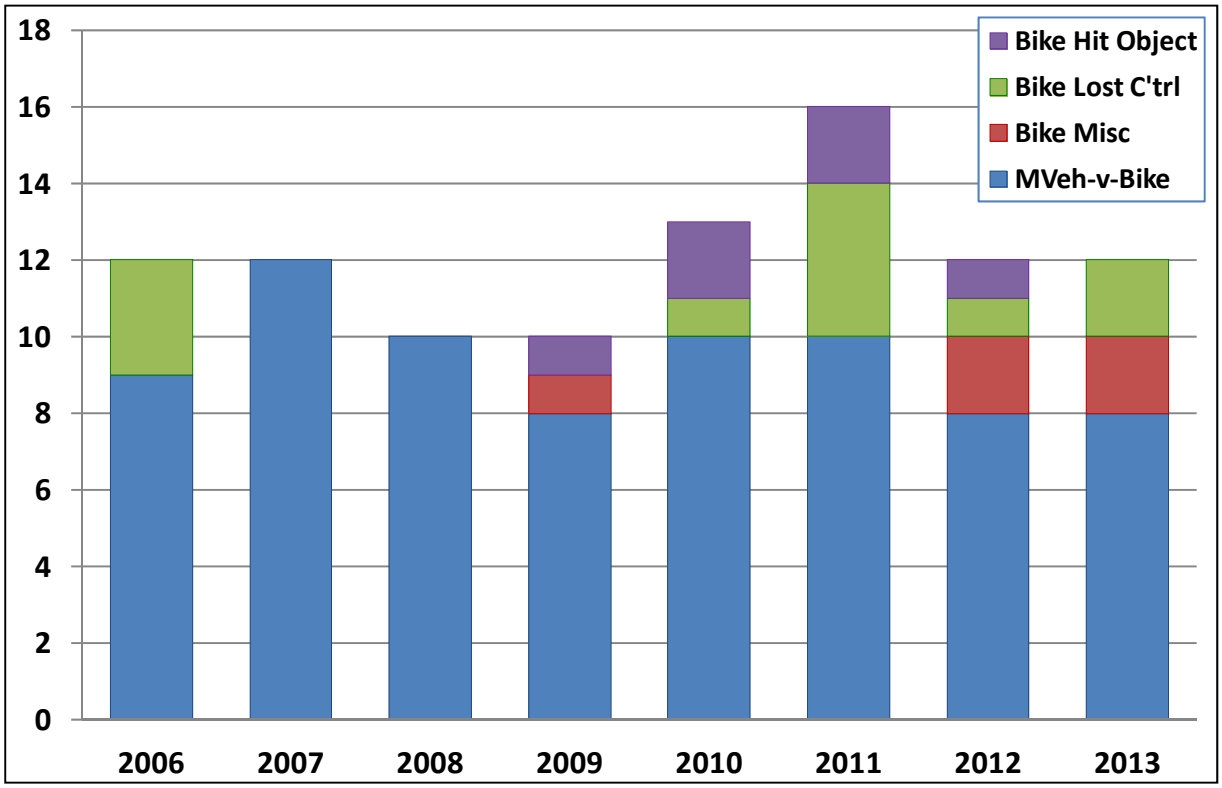

Figure 1: Cycle Fatalities per Year by Crash Type

The 94 fatalities identified through to June 2013 include 21 (22%) that did not involve a motor vehicle. The most common cycle-only crash involved a cyclist losing control along the road and hitting an object off the road. These crashes however were generally not able to be identified by means of the normal CAS database, as they were usually not recorded there. Historically, New Zealand policy was to not record non-motor vehicle crashes in CAS. It was usually only through media reports that these crashes could be identified, often with relatively limited information. There may in fact have been more such fatalities during the analysis period that were not identified.

More recently, *any* Police reports received have been entered into CAS, including non-motor vehicle ones. In practice, however, many cycle-only crashes are still not being reported by Police. By contrast, crashes involving only a single motor vehicle are recorded in CAS (in fact they make up about half of all rural crashes) and these are often very useful in identifying deficiencies in our roading network. It seems incongruous that similar data is not recorded within CAS for crashes on the road involving only a cyclist.

3.2. Victim Age

A striking feature about the fatal crashes is that the average age of the victims is 47 years; this compares with the average age of 33 years for all cycling travel in New Zealand (MoT 2013b). This includes 24 fatalities (26%) aged 65 years and over (maximum age 93), when they undertake less than 5% of all cycling travel hours (according to the NZ Travel Survey). In contrast, only 11 victims (12%) were aged under 15 (who undertake 24% of the cycling hours).

While some of this can be explained by the relative fragility of young and old people, it also highlights that older cyclists were more likely to make mistakes (possibly due to diminished senses or reactions) with fatal consequences. Many may have switched to cycling more when they were no longer able to drive a motor vehicle safely (or when they had more time for recreational riding); thus transferring the risk to their new transport mode.

Although cycle training for older or returning cyclists is a logical step (similar to the successful “Safe with Age” driver training programmes), it is also important to consider the environment in which they are attempting to travel in. Continuing mobility is very important as people get older and all efforts should be made to ensure that they are able to do so using the travel modes that are available to them, e.g. via lower speeds and separated facilities. It is significant that the best countries in the world for cycling have proportions of elderly people cycling that are far greater than our national average for young adults (Pucher & Buehler 2008).

3.3. Victim Gender

Only about one-quarter (23) of all fatalities were female. However this is in keeping with the relative amounts of cycling undertaken by males and females (from NZ Travel Survey). This is in contrast to countries where cycling has high usage and the gender balance is even, and highlights the work needed here for many women to see cycling as a convenient and safe option.

4. ROAD ENVIRONMENT

4.1. Speed Limits

Nearly half of the fatalities (44) occurred on high-speed (≥80 km/h) roads. However only one third of all cycling distance travelled (and a lesser proportion of time travelled) is on high-speed roads (MoT 2013b). Mainly due to the generally lower volumes, fewer than 10% of all cycle crashes occur in rural areas; in fact, on local rural roads the relative crash rate per hour for cycling is comparable to motor vehicles (Koorey & Wong 2013).

This highlights the significant effect of speed on the safety of active travel modes like cycling. Historically, little specific protection has been provided for cyclists on high-speed roads (e.g. sealed shoulders, separate paths, treated pinch-points). In many cases, it may also be appropriate to introduce a lower speed limit than the default 100 km/h limit.

In urban areas, a 50 km/h speed limit is clearly still not low enough to avoid serious injury and death, given that 50 people still lost their lives. Worldwide, lower (30-40 km/h) speed limits and traffic calmed areas are very prevalent in urban areas, and the safety benefits have been immense; yet in New Zealand they are still the exception rather than the norm. A lot of this has to do with the existing NZTA *Setting of Speed Limits* guidelines, which do not pro-actively encourage such speed limits where appropriate (although technically providing them), such as around schools, shopping areas, and residential zones (Koorey 2011).

4.2. State Highways

Only one-sixth of cycling distance travelled occurs on State Highways (MoT 2013b). This is not surprising as many cyclists typically try to avoid high-volume arterial roads. Despite this, 30% (28) of fatalities occurred on State Highways, a reflection probably of the higher exposure to traffic and typically higher speeds (interestingly, the proportion of heavy vehicles involved in fatalities on State Highways is only slightly higher than the norm). Rural State Highways are also more heavily over-represented, with 64% of the State Highway fatalities occurring there (compared with 40% on local rural roads). This is of some concern, given the status of these roads. State Highways generally reflect a higher standard of safety for motorists; this may not be the case for cyclists.

While new State Highways often provide for cycling as part of their construction, there is a considerable network of existing highways with deficiencies that require retro-fitting.

4.3. Intersection crashes

Typically at least half of all cycle crashes nationally occur at intersections; two-thirds if one includes driveways too. However only 28% (26) of the fatal crashes were identified as occurring at intersections, with no particular type of intersection form standing out. This may reflect the higher speeds associated with non-intersection situations.

The role of intersections in urban areas is however quite evident; of the 33 motor vehicle vs bike crashes in urban areas, 58% (19) were at an intersection. This is often where people cycling encounter the greatest difficulties (and often where there are the least amount of facilities for cycling). Given that most cycling continues to occur in urban areas, it is therefore imperative to see increased investment in safe provision for cycling at intersections.

Most intersection crashes typically involved one party or the other failing to give way to or see the other party. Fault was fairly evenly distributed between motorist and cyclist. Again, education and training on both sides would help.

5. ROAD USER BEHAVIOUR

5.1. Road User Fault

Each case was re-reviewed to make a determination of road user fault. Ignoring the 21 cyclist-only fatalities, approximately half (34) of the remaining 73 fatalities were deemed the fault of the motorist, with another 12 at least involving partial fault. This continues to highlight what is evident in cycling crashes in general; that **motorists are far too often responsible for these crashes**. This points towards greater efforts in driver education and enforcement, and possibly legislation that places greater responsibility on drivers.

However, cyclist fault is more prevalent in the younger or older age groups; for both children under 15 and adults 65 and over. As shown in Figure 2, three-quarters of motorists involved were not at fault. This highlights:

(a) the need for suitable protection for young cyclists (e.g. lower speed limits, cycle training); and

(b) as mentioned previously, road safety education to make older road users aware of their limitations when cycling.

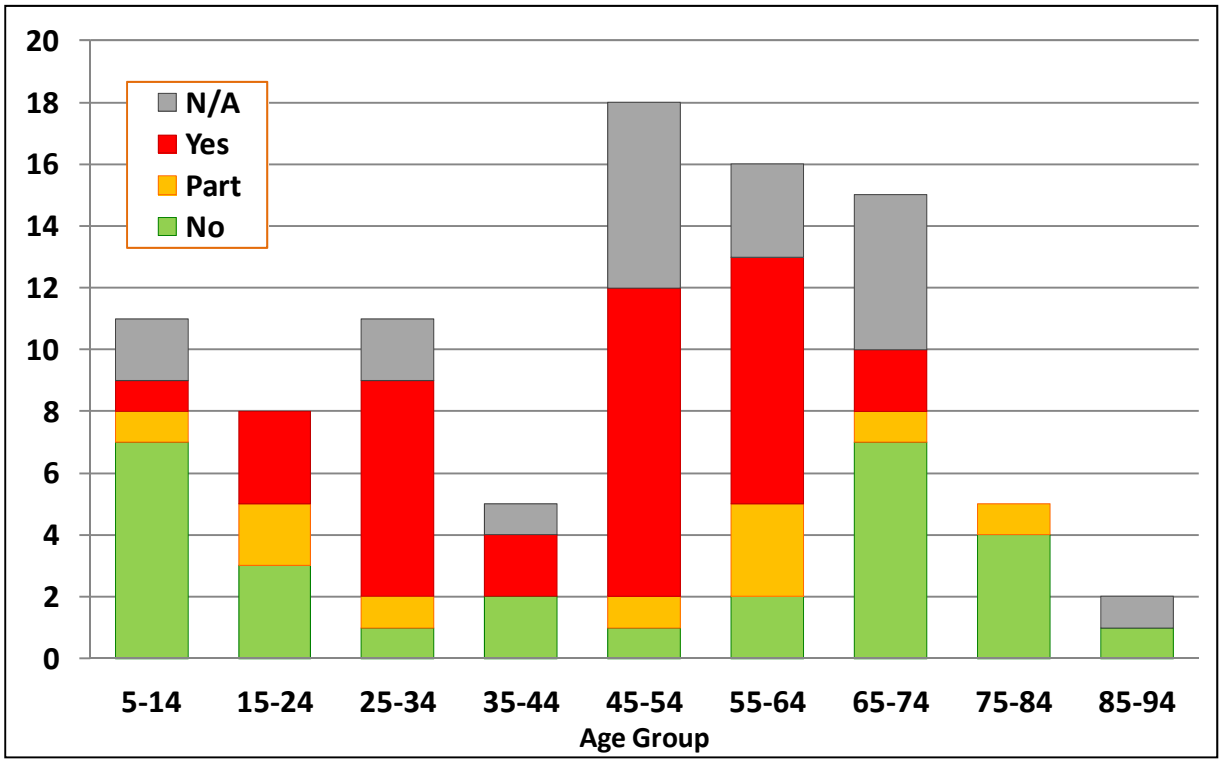

Figure 2: Cyclist Age vs "Driver at Fault?" ***(N/A denotes cycle-only crashes)***

Of the cyclist-only crashes, loss of control due to speed was a common factor; again more widespread cycle training of hazard awareness may be useful.

5.2. Helmet Wearing

Only ten victims were noted as not wearing a helmet, similar to current national helmet-wearing rates (92%). This highlights the fact that helmets are generally no protection to the serious forces involved in a major motor vehicle crash; they are only designed for falls. In fact, in only one case did the Police speculate that a helmet may have saved the victim's life if it had been present. There is a suspicion that some people (children in particular) have been "oversold" on the safety benefits of their helmet and have been less cautious in their riding style as a result.

One disappointing aspect with the dataset is the fact that helmet-wearing was not identified in every case; about 10% of records had no information on this. This should be a relatively easy thing to record in most circumstances.

5.3. Driver Observation

An analysis of driver behaviours and reports in the 73 multi-vehicle fatalities suggested that at least 30 motorists did not see the cyclist prior to impact, with another eight seeing them too late to avoid them – in other words, **more than half** of the motorists were not sufficiently aware of the presence of the cyclist. Particularly, in the case of many heavy vehicles, even after the collision they were not immediately aware that they had struck someone; three quarters of heavy vehicle drivers did not see the cyclist or not until it was too late.

Some of these situations may be attributable to dark clothing being worn by cyclists, and a reasonable number (6) attributed sun-strike for not seeing the cyclist. However quite a few simply seem to be the result of poor observation and checking; "inattentive" drivers were commonly noted. Rather than "not seeing" (as is often cited), more often than not this would appear to be more a case of **"not looking"**.

Fatigue was also mentioned in four crashes, although it is difficult to identify in crashes and likely to be higher. It was particularly prevalent with truck drivers and highlights the issue of the long driving hours commonly found in New Zealand for commercial drivers.

5.4. Cyclist Clothing and Visibility

Reporting of cyclist clothing colours was very sporadic, with many details not recorded. This seems like a simple piece of information to capture; yet fewer than half of the records had any information on this. Of those that did, 20/46 noted either "dark" or "non-reflective" cycle clothing, with a slightly greater number noting bright or reflective clothing. Interestingly, there was no notable difference to the split when cycling during day or night.

Clearly bright clothing did not guarantee a safer outcome; many motorists did not notice the cyclist prior to the crash even when they were wearing reflective or bright colours. In fact the proportion of drivers not noticing a cyclist prior to a crash was **not significantly different regardless of whether they were wearing high-visibility ("hi-vis") clothing or not** (Chi-square test, p=0.505). This mirrors research elsewhere, which has generally been inconclusive as to the effects of hi-vis clothing on rider conspicuity (e.g. Wood *et al* 2009, Washington *et al* 2011).

It is accepted that wearing hi-vis clothing when cycling may be useful in some circumstances, particularly in low-visibility or busy road environments, and should be encouraged when appropriate. However, in addition to the afore-mentioned lack of scientific evidence, mandatory requirements for high-visibility clothing (as proposed earlier by the Coroner) would pose major problems, due to practical difficulties in complying with and enforcing such a law and the effect it would have on encouraging anyone to cycle for everyday trips or on a casual one-off basis. There is also a real fear that, with a mandatory requirement, the *absence* of hi-vis gear would be seen as a major contributor to a crash, irrespective of the circumstances of the case, which has implications for Police charges or insurance.

It is important to also recognise the differences between "fluorescent" clothing (which shows up well under UV light like sunlight) and "reflective" clothing (which shows up well under reflected lights such as headlights and street-lights). Thus, some hi-vis garments appropriate for daytime riding may not be appropriate for night-time riding (and vice versa). Other clothing, such as white tops, may be equally "hi-vis" without strictly being fluorescent or reflective.

Only two cyclists were noted as not having adequate headlights in dark conditions, which suggests that this is not a widely prevalent problem. However, given the widespread availability these days of relatively inexpensive but powerful bike-lights (e.g. LED systems), people should be encouraged to invest in sufficiently strong lighting systems for cycling at night (although not so bright as to dazzle other road users). Greater use of visibility aids on wheels (e.g. reflectorised rims and wheels, spoke reflectors) may also improve the visibility of people cycling at night from side-on.

5.5. Heavy Vehicles

Nationally, trucks and buses are only involved in about 6% of all cycle crashes. However 21 out of the 73 multi-vehicle fatalities (29%) involved a heavy vehicle. Although the crash movements vary, a reasonably common incident involves a cyclist being caught on the left-hand side of a truck (possibly turning left) and being swept underneath the truck wheels. This highlights the benefits of truck front and side under-run protection (as used in other countries), something that groups such as CAN (the Cycling Advocates Network of NZ) has been calling to make mandatory here for over a decade (Porteous 2011).

Both drivers and cyclists also need to be aware of the blind-spot limitations when cyclists are near heavy vehicles. Experience of each other's position is a useful way to obtain the necessary empathy and understanding, and this is currently being achieved through "Road User Workshops" between cyclists and bus/truck drivers run by CAN (Koorey & Niquidet-Western 2012). Additional side mirrors focused on blind spots may also be very useful, as is now required in Europe.

6. CRASH ANALYSIS

6.1. Common Crash Patterns

Some of the most common cycle crash patterns identified were:

- Motorist passing cyclist (overtaking or possibly turning left) did not provide sufficient clearance and struck cyclist (27)
- Cyclist lost control, went off road or hit an object (17)
- Cyclist turning or moving over to the right failed to give way to a passing motor vehicle (12)
- Cyclist turning/crossing failed to give way to through motorist with right of way (11)
- Motorist turning/crossing failed to give way to through cyclist with right of way (8)

It is clear that there are issues requiring attention both for people driving and cycling.

6.2. Miscellaneous Factors

Factors recorded that did not seem unusually high for the numbers of crashes (particularly in relation to all injury cycling crashes) included: Wet weather (6), Darkness/twilight (16), Driver or cyclist alcohol or drugs (7). Therefore, no special focus on aspects relating to these factors is recommended on top of normal road safety promotion.

6.3. Preventative Factors

In reviewing the 94 cases examined above, an attempt has been made to identify what may have helped to prevent each tragedy from occurring, e.g. by removing a contributing element from the scene, or by changing an undesirable behaviour. These are the most common factors identified (note that one fatality may have multiple factors identified):

- Improved education/training/promotion/enforcement/legislation of better **motorist behaviours** around people cycling, e.g. giving more space, waiting until safe to pass, slowing down, looking for cyclists, road user workshops (41)
- Improved education/training/promotion/enforcement/legislation of better **cyclist behaviours** when riding, e.g. adult/child cycle training, placement at intersections and along roads, checking properly for gaps (38)
- Improved **cycling facilities**, e.g. cycle lanes, separated cycleways, wider shoulders, intersection or crossing facilities (25)
- **Heavy vehicle safety** equipment, e.g. truck under-run protection, blind spot mirrors (12)
- **Lower speed** limits or lower speed environments *(this is a minimum number; it should be noted that the survivability of virtually all cycling fatalities would be greatly improved if lower impact speeds were present)* (10)

Concerted efforts to focus on these identified factors would have the greatest chance of improving our current cycling fatality record. They are also likely to greatly improve general cycling safety for New Zealanders.

7. CONCLUSIONS AND RECOMMENDATIONS

Some notable trends were found in this investigation. Older cyclists (>50 years) are very over-represented in the crashes, despite their relatively low cycling involvement, and also more likely to be at fault. Fatalities involving heavy vehicles and/or state highways were also higher than expected. Poor observation by drivers was very common, and did not seem to be influenced by the brightness of what riders were wearing. The study also identified inconsistencies in crash information recorded, including limited recording of non-motor vehicle crashes and details of clothing/helmets worn.

The study has provided valuable information to inform both the Inquiry and transport safety agencies in general about what is needed to reduce the cycling road toll. It also identifies additional trends that are not evident from just examining cycle injury crashes.

7.1. Recommendations

The following recommendations for the Coroner were identified as a result of this investigation:

- Require NZTA/Police to report and record all on-road cycle crashes in CAS, regardless of the involvement of a motor vehicle.
- Improve Police reporting of helmet wearing and cyclist clothing in crash reports.
- Require cycle training to national standards (i.e. NZTA Grade 2) for all school children by Year 6.
- Encourage the provision of suitable cycle training and support for older cyclists.
- Support the development of national campaigns that encourage drivers to behave appropriately in mixed traffic (including enforcement and legislative changes where necessary).
- Ensure that driver education and cycle training clearly highlights the obligation of all road users to properly check for and give way to other parties where appropriate, and to “drive/ride to the conditions” when road visibility is not optimal.
- Consider highlighting aspects of these road user situations in driver and cyclist training and education.
- Require all drivers charged with serious cycle crash offences to undertake a suitable road-sharing course, e.g. Cycling Advocates Network’s “Road User Workshops”.
- Investigate the introduction of European-style “stricter liability” laws, whereby a motorist (through their insurance company) has the burden of proof in a crash with a more vulnerable road user that they were not at fault.
- Highlight to cyclists the dangers of “sneaking up” on the inside of heavy vehicles.
- Investigate mandatory use of “blind spot mirrors” and side under-run protection on heavy vehicles.
- Investigate reductions in, or better enforcement of, the maximum allowable driving hours between breaks for commercial drivers.
- Encourage greater take-up by cyclists and heavy vehicle operators of CAN’s “Road User Workshops”.
- Invest in cycle facilities that appeal to a wider range of prospective riders.
- Provide increased investment for treatment of cycling at intersections, particularly busy ones.
- Encourage greater investment in rural safety treatments such as sealed shoulders, separated pathways, and removal of pinch-points.

- Introduce greater review of existing State Highways (e.g. using NZTA Non-Motorised User Audits) and implement programmes for improvements for cycling e.g. shoulders or separate paths, and treated pinch-points
- Encourage the adoption of lower traffic speeds and lower speed limits in community and residential areas to support local cycling.
- Implement lower speed (30-40 km/h) zones around all schools and shopping centres in NZ.
- Investigate options for lower rural speed limits, especially on minor roads that are popular for cycle touring and training rides.
- Review the existing Setting of Speed Limits guidelines in New Zealand, to proactively encourage introducing lower urban speed limits where warranted (e.g. by current/potential cycling numbers).
- Improve road user education to clarify the value and limitations of wearing a helmet when cycling.
- Encourage people cycling to wear suitably visible clothing in appropriate low-visibility or busy road environments, and to invest in strong (but not dazzling) bike-light systems for night-time riding.
- Encourage cycle retailers and road safety providers to provide a greater range of options for making bicycles visible at night, e.g. reflectorised rims and spoke reflectors.

Subsequent to this investigation, Coroner Matenga has now released his findings from the Inquiry (Matenga 2013). Acknowledging the complexity of the investigation, the Coroner has avoided making specific recommendations and instead suggested that:

"The NZTA convene an expert panel drawn from stakeholders with an interest and expertise in cycling and road safety, to consider the evidence gathered by this Review and such other evidence as it considers necessary, with a view to compiling a list of recommendations to central and local government which will improve cycling safety in New Zealand and prevent further cycling crashes and fatalities."

NZTA has recently commissioned such a panel, which is beginning to investigate these issues; the author is amongst the panel members. It is hoped that the above information derived for the Coroner can help to inform this expert panel and that, from it, concrete actions can ultimately improve the state of cycling safety in New Zealand.

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9. ACKNOWLEGEMENTS

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This paper is dedicated to the nearly 100 people who have lost their lives while cycling in New Zealand since 2006. It is the author's hope that the lessons from their tragedies will save many more people from dying while cycling in the future.